

STANDARD

DNVGL-ST-0378

Edition May 2016

Standard for offshore and platform lifting appliances



FOREWORD

DNV GL standards contain requirements, principles and acceptance criteria for objects, personnel, organisations and/or operations.

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Any comments may be sent by e-mail to rules@dnvgl.com

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CHANGES - CURRENT

This is a new document.

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SECTION 1 GENERAL INFORMATION

1.1 Introduction

1.1.1 Objective

1.1.1.1 This standard provides requirements for certification and verification of cranes intended for load handling outside vessel while at sea (offshore cranes), and load handling onboard offshore units/installations (platform cranes).

Guidance note:

Cranes for load handling within and outside ships while in harbour and in sheltered waters and within ships at sea, please refer to ST 0377 *Shipboard lifting appliances*.

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1.1.2 Scope

1.1.2.1 This standard covers the design, materials, fabrication, installation, testing and commissioning of offshore cranes and platform cranes.

The categorization of lifting appliances is based on installation and intended function for the lifting appliance:

a) Offshore cranes:

- lifting appliances on board vessels intended for load handling outside vessels while at open sea

b) Platform cranes:

- lifting appliances onboard offshore units/installations intended for load handling within and outside the unit/installation while in harbour and within the unit/installation while at sea.

Guidance note:

Cranes intended for operating from an offshore unit/installation in jacked up condition to other fixed installation will be categorized as platform crane.

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1.1.2.2 Each lifting appliance has its separate intended functions. Examples of intended functions are, but not limited to:

- cargo handling within deck area on board offshore units/installations
- loading and discharging of offshore supply vessels
- launch and recovery of diving systems
- launch and recovery of ROV
- loading and discharging from sea or sea bed
- pipe/cable laying
- personnel handling

1.1.2.3 Requirements presented herein are minimum requirements to be satisfied, although subject to acceptance by the Society, other minimum requirements may be agreed e.g. based on new technology available at the time of application for certification.

1.1.2.4 The requirements of this standard may be supplemented with additional requirements where installation of specific design or assessment shows that standards that provides equivalent or higher level of integrity and safety are more appropriate.

1.1.2.5 The standard consists of a three level hierarchy of documents.

- [Sec.1](#) and [Sec.2](#) provides principles and procedures of the Society's classification, certification, verification and consultancy services.
- [Sec.3](#) through [Sec.14](#) provides technical provisions and acceptance criteria as well as the technical basis for the services stated in the first two sections.
- Appendices, provides proven technology and sound engineering practice as well as guidance for the higher level documents mentioned in this document.

1.1.2.6 This standard distinguishes between:

- information and description of services
- requirements.

Consequently, these two subjects are separated, and the standard is divided into three parts:

- [Sec.1](#) - [Sec.2](#): General information, application, definitions and references. Description of applicable services and relations to rules and regulation from institutions other than the Society
- [Sec.3](#) - [Sec.14](#): Requirements and technical provisions
- Appendices.

1.1.3 Application

1.1.3.1 This standard shall be applied for certification of offshore cranes and platform cranes for vessels with class notation **Crane vessel**, **Crane**, or **Crane (N)**. This standard may also be applied as voluntary basis for verification and certification of lifting appliances that are not classed with the Society.

This standard shall be applied for certification of cranes onboard ships and offshore units carrying out offshore crane operations, also with respect to additional functionality related to internal handling and harbor operations - in accordance with [Sec.7](#).

For cranes solely carrying out shipboard crane operations onboard ships, certification shall be in accordance with DNV GL [ST-0377](#).

Pipe- and cable laying equipment are also included in the Lifting Appliance concept. The notation **Cable laying vessel** and **Pipe laying vessel** may be granted to a vessel specially intended for cable/pipe laying operations and for that purpose fitted with laying systems certified by the Society as specified in [RU SHIP Pt.5 Ch.10 Sec.1](#).

Guidance note:

The standard may also be applied to mobile cranes, i.e. crane that are transported by vehicle or other means from one location to another, and cranes that can move long distances by road by means of their own machinery and wheel arrangement. In the latter case the moving machinery and its arrangement as well as the overturning stability of the mobile crane are not covered by the certification.

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1.1.3.2 The requirements presented herein should be applied consequently from concept design through the final construction, including major modifications.

1.1.3.3 Specifications of the services provided by this standard are given in [\[1.2\]](#) and [\[1.4\]](#).

1.1.3.4 The standard does not apply to cable cranes, personnel lifts (elevators), jacks, overhead drilling equipment, fork lifts, portable hoisting gear etc.

1.1.3.5 Personnel lifting with cranes otherwise designed for lifting of loads/cargo may be covered upon agreement.

Lifting appliances rated to a safe working load of less than 10 kN will be especially considered.

1.1.3.6 Without prejudice to [1.1.2.4], deviations from the requirements given in this standard may only be substituted where shown to provide an equivalent or higher level of integrity or safer than under this standard.

1.1.3.7 At the Society's discretion equivalent solutions and exemptions from the requirements given in this standard may be accepted.

1.1.3.8 In case of conflict between requirements given in this standard and a reference document, the requirements given in this standard shall prevail.

1.1.3.9 Where reference is made to codes other than the Society's documents, the valid revision shall be taken as the revision which was current at the date of issue of this standard, unless otherwise noted.

1.1.4 Relation to the Society's other documents

1.1.4.1 For lifting appliances covered by the class notation, **Crane vessel**, see RU SHIP Pt.5 Ch.10 Sec.2 *Crane vessel*.

1.1.4.2 For lifting appliances covered by the class notation, **Crane**, see RU SHIP Pt.6 Ch.5 Sec.3 *Permanently installed cranes – Crane*.

1.1.4.3 Lifting appliances covered by the class notation, **Crane (N)**, see DNVGL SI 0166 *Verification for compliance with norwegian shelf regulations*.

1.1.4.4 For lifting appliances covered by class notation **Cable laying vessel**, see RU SHIP Pt.5 Ch.10 Sec.3 *Cable laying vessel*.

1.1.4.5 For lifting appliances covered by class notation **Pipe laying vessel**, see RU SHIP Pt.5 Ch.10 Sec.4 *Pipe laying vessel*.

1.1.4.6 For lifting appliances covered by service notation **Crane unit**, see RU OU 0101 Ch.2 Sec.5, RU OU 0101 Ch.2 Sec.7 and RU OU 0101 Ch.2 Sec.9 *Offshore drilling and support units*.

1.1.5 Definitions, abbreviations, symbols and references

1.1.5.1 Accessories

Load-bearing, not rigidly attached, interchangeable parts which may be integral components of lifting appliances and loose gear as well as employed individually, such as: hooks, blocks, shackles, swivels, rings, chains, claws, clamps, pliers, load fastening ropes (slings/strops), lifting straps, etc.

1.1.5.2 Active cable tensioning system (ACT)

System keeping the tension of the hoisting wire to a given set point value.

Guidance note:

A supply of external energy is required.

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1.1.5.3 Active heave compensation system (AHC)

System that maintains the position of the load to a given set point value.

Guidance note:

A supply of external energy is required.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.1.5.4 Actual hook load

The static weight of the load attached to the hook; includes the useful load lifted plus any loose gear and rigging used, such as slings, lifting beams, etc.

1.1.5.5 Additional class notations

Code used by the classification societies to confirm that a vessel possesses certain systems, equipment or features covered by the classification. (Examples are **HELDK**, **Crane**, **E0** and **F-AMC**).

Guidance note:

E0 means that the vessel complies with requirements for having unattended machinery space and **F-AMC** means that the vessel complies with requirements for additional fire protection, in this case both for accommodation, machinery space and cargo space.

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1.1.5.6 Ship type notations

Code used by the classification societies to define a type of vessel related to its most typical service. (**Tanker for oil**, **Passenger ship** and **Crane vessel** are typical examples).

1.1.5.7 Automatic overload protection system (AOPS)

A system that automatically safeguards and protects the crane against overload and "over-moment" during operation by allowing the hook to be pulled away from the crane in order to avoid significant damage.

1.1.5.8 Certificate of conformity

A document attesting that a product or service is in conformity with specific standards or technical specifications. (*ISO "Certification - Principles and practice."*, 1980). Issued by manufacturer or vendor.

1.1.5.9 Competent person/body

Person or body possessing knowledge and experience required for performing thorough examination and test of lifting appliances and loose gear, and who is acceptable to the competent authority.

1.1.5.10 Crane stiffness

Coefficient defined as the weight attached to the hook necessary to obtain a unit deflection at the hook level.

1.1.5.11 Customer

Agreement (contract) holder with the Society. Signifies the party who has requested the Society's service.

1.1.5.12 Dead loads

Dead loads are the weights of all the fixed and mobile components of lifting appliances and loose gear permanently present during operation.

For the purpose of marking, the dead loads of loose gear are designated as weight by the ILO. The unit is specified in tons (t) or kilograms (kg).

1.1.5.13 Designer

Signifies a party who creates documentation submitted to the Society for approval or information.

1.1.5.14 Design approval

Verifying that a design, represented by a drawing or set of drawings, is found to comply with all requirement given in a specified DNV GL standard or DNV GL regulation.

Guidance note:

In the Society's business procedures design approvals are valid for one order only. One order, however, may include a specified number of units for specified locations/vessels.

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1.1.5.15 Design approval letter

Written confirmation of a design approval.

1.1.5.16 Design assessment for type approval

Examination and acceptance of a design for type approval. The type approval will be assigned first after a prototype test also has been successfully carried out.

1.1.5.17 Design dynamic factor

The dynamic factor applied to the working load for a specific SWL

Guidance note:

For an offshore crane the design dynamic factor is normally referred to the still water condition for determining the SWL at still water. The design dynamic factor may, however, be defined also to refer to a specified significant wave height.

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1.1.5.18 Design verification report (DVR)

Formalized report confirming the result of a completed design verification assignment.

1.1.5.19 Dynamic factor

A variable factor representing the dynamic effects that the working load is exposed to. Also named *dynamic coefficient*.

1.1.5.20 Dynamic load

The working load when subjected to (multiplied with) a *dynamic factor*.

1.1.5.21 Dynamic load chart

Diagram or table showing rated capacity depending on sea state and on radius or boom angle.

1.1.5.22 Engineered lift

Safe lift planned by qualified engineers with basis in thorough information with respect to crane capacity, crane functions and performance, rigging, crane support as well as weather window and sea conditions.

1.1.5.23 Heavy lift crane

Crane with SWL above 2500 kN.

1.1.5.24 ILO

International Labour Organization.

1.1.5.25 Inertia forces

The forces induced by change of velocity.

1.1.5.26 Inspection certificate 3.1

A document issued by the manufacturer which contains the results of all the required tests. It shall certify that the tests have been carried out by the manufacturer on samples taken from the delivered products direct. Ref. EN 10204 and ISO 10474.

1.1.5.27 Inspection certificate 3.2

A document prepared by both the manufacturer's authorized inspection representative, independent of the manufacturing department, and either the purchaser's authorized representative or the inspector designated by the official regulations, and in which they declare that the products supplied are in compliance with the requirements of the order and in which test results are supplied. Ref. EN 10204 and ISO 10474.

1.1.5.28 Lifting appliance

Machine or appliance used for the purpose of lifting goods and materials, or in special modes, personnel.

1.1.5.29 Lifting equipment

General expression including lifting appliances, lifting gear, loose gear and other lifting attachments; used separately or in combination.

1.1.5.30 Lifting gear

Ref. also *Accessories* ([1.1.5.1]) and *Loose gear* ([1.1.5.33]).

Load carrying accessories used in combination with a lifting appliance, however, that are not necessarily a part of the permanent arrangement of the lifting appliance, such as:

- attachment rings, shackles, swivels, balls, pins
- sheaves, hook-blocks, hooks, load cells
- loose gear.

Guidance note:

Lifting gear, considered as separate components, shall be designed and tested in accordance with the provisions for loose gear.

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1.1.5.31 Load chart

Diagram or table showing rated capacity depending on radius or boom angle.

1.1.5.32 Loose gear

Means by which loads can be attached to lifting appliances but which do not form part either of the lifting appliance or of the load. They include devices and steel structures such as, but not limited to: grabs, spreaders, lifting magnets, traverses, etc, as well as *Accessories* (see [1.1.5.1]) which are integral components of the loose gear.

1.1.5.33 Machinery components

Rotating components transferring torque for driving/braking purpose. Examples are gearboxes, wheels and shafts.

1.1.5.34 Man riding winch

Device specially designed for hoisting/lowering of a person. Not covered by this standard.

1.1.5.35 Manual overload protection system (MOPS)

System, activated by the crane operator, protecting the crane against overload and “over-moment” by reducing the load-carrying capacity and allowing the hook to be pulled away from the crane.

1.1.5.36 Mean time to failure (MTTF)

The mean value of service time until failure occurs.

1.1.5.37 Mechanism

Devices needed to cause or to stop a relative motion between two rigid parts of a crane, between the crane and its foundation, or between the crane and the lifted load. Thus motors brakes, transmission systems and similar components are defined as mechanisms.

1.1.5.38 Mobile deck crane

A mobile deck crane is a cable-controlled crane on crawlers or rubber-tired carriers or a hydraulic-powered crane with a boom mounted on truck-type carriers or as self-propelled types.

1.1.5.39 MRU

Motion Response Unit.

1.1.5.40 Nominal load

Nominal load is the designation for the maximum permissible useful load of lifting appliances and loose gear. Lifting appliances and loose gear can have different nominal loads depending on varying equipment condition or operational conditions, cable tackle systems or load radii.

1.1.5.41 Overload

Load which exceeds the safe working load (SWL).

1.1.5.42 Over-moment

Load moment which exceeds the maximum load moment (safe working load (SWL) multiplied by radius).

1.1.5.43 Passive cable tensioning system (PCT)

System keeping the tension of the hoisting wire between predefined limits, using stored energy.

1.1.5.44 Passive heave compensation system (PHC)

System that maintains the position of the load between predefined limits, using stored energy.

1.1.5.45 Probability of failure on demand (PFD)

Probability of failure on demand.

1.1.5.46 Product certificate (general)

A compliance document validated and signed by the issuing organization:

- identifying the product that the certificate applies to
- conforming compliance with the referred requirements.

It is required that:

- the tests and inspections have been performed on the certified product itself, or, on samples taken from the certified product itself
- the tests were witnessed by a qualified representative of the organization issuing the certificate, or, his authorized representative.

1.1.5.47 Product certificate (the Society's)

The Society's product certificate is a compliance document validated and signed by the issuing organization and the Society's representative:

- identifying the product that the certificate applies to
- confirming compliance with referred requirements

It is required that:

- the tests and inspection s have been performed on the certified product itself, or, on samples taken from the certified product itself
- that the tests were witnessed by a qualified representative of the organization issuing the certificate and the Society's representative, or, in accordance with special agreements.

1.1.5.48 Purchaser

Company or person who orders the lifting equipment from a manufacturer. This standard does not necessarily require that the purchaser will need to have any direct relationship to or communication with the Society.

1.1.5.49 Rated capacity

Actual hook load that the crane is designed to lift for a given operating condition (e.g. boom configuration, reeving arrangement, off lead/side lead, heel/trim, radius, wave height, etc.)

1.1.5.50 REP

Rope Exit Point. Location on the lifting appliance where the rope is suspended - typically found at the outer sheave in the crane boom tip.

1.1.5.51 Risk

Combination of the probability of occurrence (frequency) of harm and the severity (consequence) of the harm.

1.1.5.52 Risk control measure (RCM)

A means of controlling a single element of risk; typically, risk control is achieved by reducing either the consequence or the frequencies.

1.1.5.53 ROV

Remote operated vehicle (ROV).

1.1.5.54 Running rigging

Wire ropes passing over rope sheaves of guide rollers, or wound on winches, irrespective of whether or not the ropes are moved under load.

1.1.5.55 Reference SWL

A theoretically increased SWL used for determining of overload for load tests and rating of loose gear. Used when the *design dynamic factor* (see above) exceeds 1.33. (See [5.2.3.1]).

1.1.5.56 Safe working load (SWL)

Safe working load is the international designation for the nominal load by ILO. The abbreviation SWL is used for marking the lifting appliance, loose gear and accessories.

1.1.5.57 Significant wave height H_{sign}

Average height of the highest one third of the individual wave heights in a short-term constant seastate, typically 3 hours.

1.1.5.58 The Society

The *Society* signifies DNV GL.

1.1.5.59 Standing rigging

Ropes that are not turned round or wound on to winches (e.g. guided wires, pendants, stays).

1.1.5.60 Subsea cranes

Cranes intended for handling of unmanned submersibles, for lowering to and retrieval from below sea level.

1.1.5.61 Test report

A document signed by the manufacturer stating:

- conformity with requirements given by a relevant standard
- that tests are carried out on samples from the current production.

1.1.5.62 Type approval

Approval of conformity with specified requirements on the basis of systematic examination of one or more specimens of a product representative of the production.

1.1.5.63 Type approval certificate (DNV GL)

A document issued by the Society confirming compliance with specified requirements is named DNV GL Type Approval Certificate (TA).

1.1.5.64 Useful load

Useful load is the load which may be directly lifted by the supporting component (e.g. cargo hook or grab) of the lifting appliance, by the lift car of a lift, by the platform of a lifting platform or by loose gear.

The useful load consists of the load to be transported and, where applicable, also of the dead load of the loose gear.

1.1.5.65 Verification

A service that signifies a confirmation through the provision of objective evidence (analysis, observation, measurement, test, records or other evidence) that specified requirements have been met.

1.1.5.66 Vessel

A common term for ships, craft, offshore units and offshore installations.

1.1.5.67 Working load (suspended load)

Also designated "hoist load".

The static weight of the useful load lifted, plus the weight of the lifting gear. The working load is subjected to *inertia forces*.

1.1.5.68 Works product certificate

Reference is made to [RU SHIP Pt.1 Ch.3 Sec.5 \[2.5\]](#). A document signed by the manufacturer stating:

- conformity with rule requirements
- that tests are carried out on the certified product itself
- that tests are made on samples taken from the certified product itself
- that tests are witnessed and signed by a qualified department of the manufacturers.

1.1.6 Crane design types

1.1.6.1 *Winch luffing crane*: a crane where the boom is controlled by wire ropes through a winch.

1.1.6.2 *Cylinder luffing crane*: a crane where the boom is controlled by hydraulic cylinder(s).

1.1.6.3 *Knuckle boom crane*: a crane where the boom is hinged and the boom and knuckle angles are controlled by a set of hydraulic cylinders.

1.1.6.4 *Derrick crane*: a simple crane consisting of a vertical mast and a hinged jib. The derrick crane is provided with devices for raising and lowering a load, luffing the jib and slewing the jib about the mast.

1.1.6.5 *Overhead travelling crane*: a crane which lifts the object by a trolley which normally moves horizontally along the crane beam. The crane beam ends have wheels running on rails at high level.

1.1.6.6 *Gantry crane*: a crane which lifts the object by a trolley which normally moves horizontally along the crane beam. The crane beam is supported by vertical legs having wheels running on rails at ground level.

1.1.6.7 *A-frame crane*: a hinged frame intended for lifting. Hydraulic cylinders control the movement of the A-frame while a winch is fitted for hoisting and lowering the load.

1.1.7 Design temperature

1.1.7.1 *Design temperature* is a reference temperature used as a criterion for the selection of steel grades.

1.1.7.2 The design temperature T_D for lifting appliances is defined as the *lowest acceptable service temperature* for the crane.

1.1.7.3 For lifting appliances installed on vessels or mobile offshore units classed with the Society, the design temperatures of the appliances shall be compatible with the design temperature specified for the vessel/unit.

1.1.7.4 If not otherwise specified design temperature according to [Table 1-1](#) shall be applied.

Table 1-1 Design temperature for lifting appliances.

Type of Lifting Appliance	Design temperature
Offshore Cranes and Platform Cranes	-20°C
Engine rooms and other similar spaces with controlled temp.	+10°C

Guidance note:

The design temperature for a vessel/unit shall be the lowest mean daily average temperature (LMDAT) recorded for the area where the unit is anticipated to operate. The design temperature for the lifting appliance is the lowest operational temperature for the lifting appliance. Unless otherwise agreed with the yard or the end user, their numeric value shall be the same.

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1.2 Services

1.2.1 Introduction

1.2.1.1 This sub-section describes possible combinations of the different services offered. Furthermore, various alternatives are described for the Society's confirmation of the various services. See also [Table 1-2](#).

1.2.1.2 [Figure 1-1](#) describes the services offered and the associated documents issued by the Society to proof compliance.

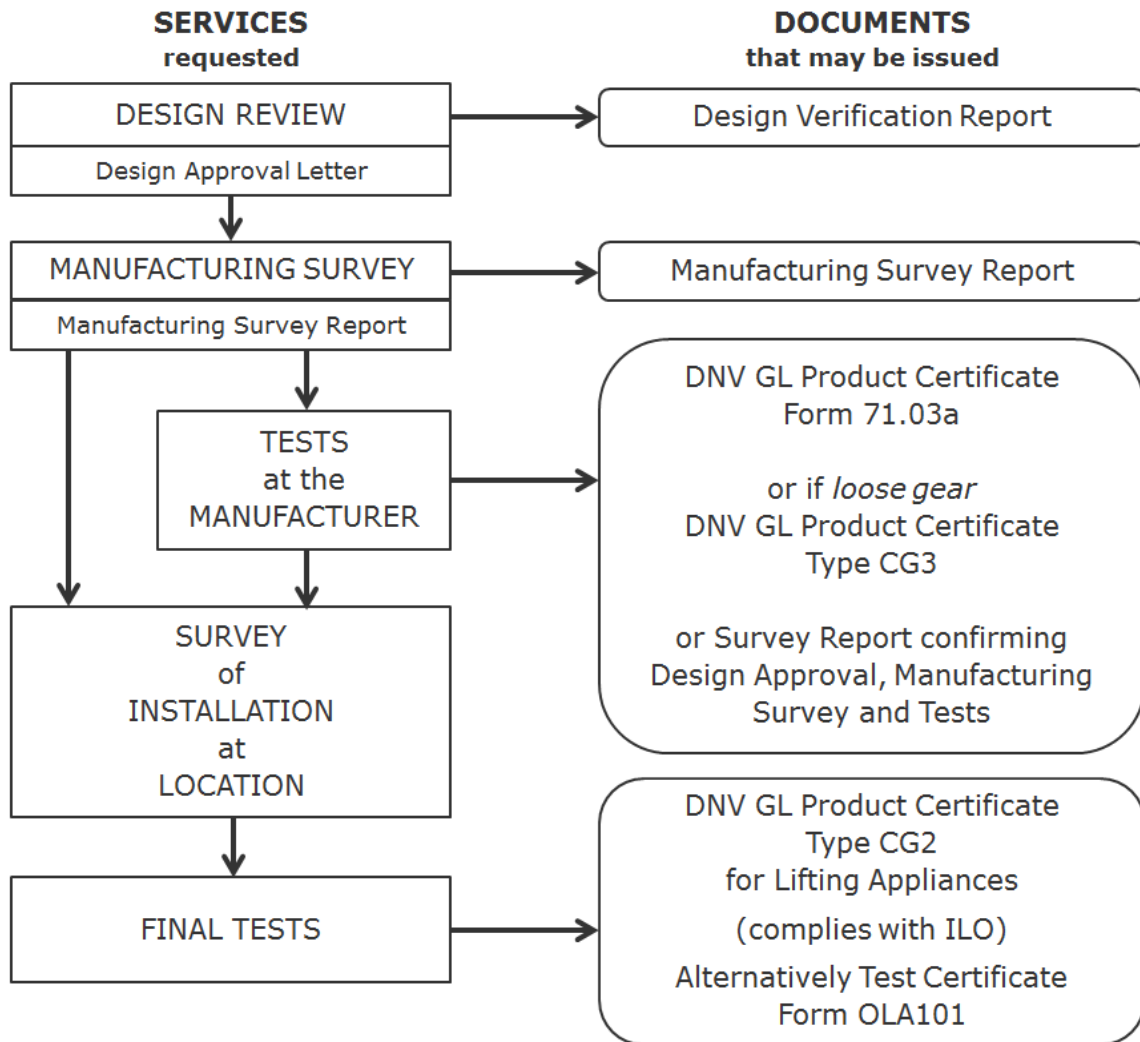


Figure 1-1 Alternatives for documentation that may be issued to Customers depending on type and combination of services requested.

1.2.2 Regulatory basis

1.2.2.1 This standard is based on the Society's understanding and interpretation of the ILO Convention No.152 of 1979.

1.2.3 Acceptance by national authorities

1.2.3.1 Regulatory bodies, such as port authorities, flag administrations, shelf authorities and municipal or governmental health and safety authorities require that lifting appliances and loose gear shall be certified. Normally, the Society's certification in accordance with this standard will satisfy the authorities' requirements.

1.2.3.2 In cases where requirements laid down by the pertinent body exceeds the Society's requirements described in [Sec.3](#) through [Sec.14](#). The Society may, as a voluntary service, include the additional requirements in the examination and confirm whether or not they are found to be fulfilled

1.2.3.3 The conditions for review in accordance with other bodies' requirements are as set out in [\[1.4.5\]](#).

1.3 Certification procedure

1.3.1 General

1.3.1.1 The following parts, components and systems are covered by this standard:

- all load-carrying structural members and components of the lifting appliance
- cargo hooks, chains, rings, blocks, sheaves, shackles, lifting beams, swivels and ropes
- cylinders, accumulators, pressure vessels
- structural integrity of grabs, hydraulic dampers or other load transferring components
- structural integrity of active heave compensation systems (AHC) and active cable tensioning systems (ACT)
- rope drums
- slewing bearing including fasteners
- power systems (for hoisting, derricking, slewing and travelling)
- brakes and braking systems
- safety equipment
- protection against fire
- seating and fasteners for prime movers, winches and for bearings of power transmitting components
- control and monitoring systems
- electrical installation.

1.3.1.2 The following activities are covered by this standard:

- design review
- survey during fabrication and installation
- witness testing and marking.

1.3.2 Design review

1.3.2.1 Load-carrying and other important components of a lifting appliance are subject to design review with respect to strength and suitability for its purpose. A *design approval* is granted when the design review has been concluded without detection of non-compliances.

The design review may be substituted, partly or completely, by enhanced manufacturing survey and/or testing. In cases where the substitutions are applied for by the customer, agreements shall be made between the customer and the Society regarding possible reductions of documentation to be submitted for approval/information.

Upon special agreement, the design review may be substituted by a strength evaluation based upon testing until failure.

Strength review of components related to power supply and safety equipment is normally not carried out by the Society.

Guidance note:

The Society's splitting of the certification process in the sequences design approval, manufacturing survey (including installation survey) and testing, shall be considered as a part of the Society's internal scheme to organize its work.

The Society's reports covering the separate phases is considered internal documents, and information enabling the progress of the certification project.

The Society's formal documentation of the certification to the customer will be the product certificate Form 71.03a issued after completion of manufacturing process and full testing at the manufacturer and CG2 issued after installation and full testing onboard in accordance with ILO152 requirements. For lifting appliances not subject to ILO 152, test certificate in accordance with Form OLA101 may be issued after installation and full testing onboard.

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1.3.2.2 Each lifting appliance is normally given a separate design approval.

1.3.2.3 The design approval may be obtained either on a case-by-case basis or as a type approval.

The type approval means that the design as approved can be applied for identical units to be fabricated, i.e. requested documents need not be submitted for each unit.

The type approval will be based on certain conditions and its period of validity will be limited.

Reference is made to the Society's document DNVGL [CP 0338](#) *DNV GL type approval scheme*.

1.3.3 Survey during fabrication and installation

1.3.3.1 Normally, a survey during manufacture of each separate lifting appliance shall be carried out by the Society's surveyor in order to ascertain compliance with the approved drawings, other requirements given in this standard as well as general good workmanship.

1.3.3.2 As an alternative to survey during manufacture of each separate lifting appliance, modified survey procedures and survey arrangements may be accepted provided the manufacturer operates a quality-assurance system approved and certified by the Society. Acceptance shall be clearly formalized.

1.3.3.3 After a lifting appliance has been installed on its permanent foundation, and before testing can take place, it shall be subjected to a survey by the Society.

1.3.4 Testing and marking

1.3.4.1 Components and each completed lifting appliance shall be subjected to functional testing and load-testing as specified in [Sec.14](#).

1.3.5 Extension of scope of work

1.3.5.1 Upon request from the customer, the scope of work may be extended beyond the subjects and aspects covered in this standard.

1.3.5.2 Extensions shall be agreed in writing. The Society may, if found necessary, require that the customer presents reference documents for the extended scope of work, such as authority regulations, norms and standards.

1.3.5.3 In case of disputes regarding interpretations of requirements on which extended work is based, the customer shall contact the publisher/owner of the requirements and obtain their written interpretation.

If the publisher/owner is not willing to interpret the disputed requirement, or an interpretation for other reasons cannot be acquired, the respective extension of the scope of work shall be omitted.

1.3.6 Safe means of access and personnel safety devices

1.3.6.1 Personnel safety protection devices such as guard rails, shielding, safety of ladders, etc. are not covered by this standard and the scope of work. If the customer requests that such aspects shall be covered, the provisions set out in [1.3.5] shall be followed.

1.3.7 Reduced scope of work

1.3.7.1 Upon request from and agreement with the customer, parts of the scope of work, components, systems or specific aspects or requirements may be excluded from the scope of work specified in the standard. This will be annotated in the documentary evidence of the completed assignment (certificate).

1.3.7.2 The Society will not agree to limit the scope of work or parts of the suggested services if they are of the opinion that this may lead to hazards or unacceptable lowering of the safety standard.

1.4 Type of services

1.4.1 Basic certification

1.4.1.1 The basic requirements presented in Sec.3 through Sec.14 are considered to cover the requirements given in the ILO Convention No.152 of 1979 specified in [1.2.2.1]. Lifting appliance and loose gear found to comply with these basic requirements are qualified for the Society's product certification, whereupon the product certificate Form 71.03a may be issued based on FAT (Factory Acceptance Test) and survey. Following successful testing and survey after installation onboard, a DNV GL CG2 certificate will be issued for cranes covered by the ILO regime (cargo cranes). For cranes not covered by the ILO regime, a test certificate Form OLA101 will be issued by the Society following successful onboard testing. The cargo gear register (CG1 if published by the Society) may be endorsed accordingly, either as ILO crane or as "other lifting appliances".

1.4.1.2 The basic requirement covers the two categories of lifting appliances a) and b) defined in [1.1.2] as well as loose gear components allocated the same lifting appliances, as well as personnel lifting as denoted in [1.1.2.2].

1.4.1.3 Some details of the basic requirements given in Sec.3 through Sec.14 are different for the different category of lifting appliance a) and b). Furthermore, some specific requirements are stated for cranes also used for personnel lifting.

1.4.2 Cranes included in class scope

1.4.2.1 On a *voluntary* basis, cranes installed on board vessels and offshore units classed with the Society may be included in the scope of work covered by classification. In such cases the vessel/offshore unit will be assigned the additional class notation **Crane** or **Crane (N)**.

In order to obtain this notation at least the main crane onboard shall have been certified in accordance with the basic requirements given in Sec.3 through Sec.14 as well as having been assigned the product certificate CG2 or test certificate Form OLA101.

1.4.2.2 Vessels whose main purpose is to support a crane, may be assigned the ship type notation **Crane vessel** if the crane has been certified in accordance with the basic requirements given in Sec.3 through Sec.14 and as well as having been assigned the product certificate CG2 or test certificate Form OLA101.

Guidance note:

A crane certified by the Society and installed on a unit that fulfill the requirements given in [1.1.4] may be given the class notation:

1A Crane vessel

Crane vessels classed with the Society and where the crane (major crane) is not certified by the Society may be given the main class notation **1A**.

For further information with respect to the difference between class notations, see [RU SHIP Pt.1 Ch.2](#).

In addition to the requirements given in [Sec.3](#) through [Sec.14](#) for cranes that are certified by the Society, vessels or offshore units having cranes installed, shall fulfill a number of essential class requirements. These requirements apply whether or not the cranes are certified by the Society. The requirements cover topics such as deck support, foundations (pedestals), boom rests (cradles), electrical and hydraulic power supply, earthing as well as trim, stability and ballasting conditioned by the cranes or their lifting operations.

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1.4.2.3 Some of the requirements given in this standard have been extended with additional detailed requirements for cranes to be covered by classification.

1.4.3 Assignments completed before installation

1.4.3.1 Assignments completed at the manufacturers' premises can be agreed. Such services are normally to be completed with monitoring of tests at the manufacturer, (FAT-tests). Applicable reports or certificates may be issued. See also [\[1.4.3.2\]](#).

1.4.3.2 The reason for, or purpose of, such assignments may e.g. be:

- completed certification of loose gear or components. The Society will normally issue the product certificate CG3 after completion of the tests
- provisional certification after FAT-test. For instance, if final destination is not decided, or if the manufacturer is producing for stock. Or the customer has requested FAT-tests and a documentary confirmation of the Society's service rendered until a certain point. A manufacturing survey report, certificate of conformity may be assigned.

See also [Figure 1-1](#).

1.4.4 Verifications

Guidance note:

Verification constitutes a systematic and independent examination of the product itself or its design and/or manufacturing to determine whether it is in compliance with some or all of the specifications. Verification activities are expected to identify errors or failures in the work and to contribute to reducing the risks to the operation of the product and to the health and safety of personnel associated with it or in its vicinity or other unwanted situations.

Verification shall be complementary to routine design, construction and operations activities and not a substitute for the work, and the assurance of that work, carried out by the customer and its contractors, it is inevitable that verification will duplicate some work that has been carried out previously by other parties involved.

The Society's verification may be based on risk evaluation. This is founded on the premise that the risk of failure can be assessed in relation to a level that is acceptable and that the verification process can be used to manage that risk. The verification process is therefore a tool to maintain the risk below the acceptance limit. Verification based on risk aims to be developed and implemented in such a way as to minimise additional work, and cost, but to maximise its effectiveness. The Society's verification level will be chosen based on experience combined with engineering judgement and the findings from the examination of documents and production activities.

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1.4.4.1 The Society may upon request carry out specified examination or combination of separate services referring to the requirements given in [Sec.3](#) through [Sec.14](#) or the related standards and services described in [\[1.2\]](#) and [\[1.3\]](#) and in this item.

1.4.4.2 The depth, thoroughness and completeness of the examinations shall be agreed upon for each specific verification assignment, and shall be unambiguously described in the contract and in the documentation of the verification service.

Guidance note:

The Society is flexible in agreeing on type of documentation of verification services performed. Normally, the Society's proposal will be to issue a verification report. For instance, for a completed design examination the Society will suggest issuance of a *Design verification report*.

The Society endeavours to find the best solution for issuance of required verification documentation.

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1.4.4.3 Whereas the scope, standards and acceptance criteria for a certification or classification assignment is laid down by the Society, the scope, standards and acceptance criteria forming the basis for a verification assignment may, if requested, be adapted to the needs and desires of the customer. However, the Society will decline to carry out a commission that may be used, intentionally or unintentionally, to mislead a third party with regard to the safety of the object.

1.4.4.4 A verification report may be edited in accordance with the customer's needs and requests. The Society is, however, not prepared to omit non-conformities or other negative observations or results detected during the examinations.

1.4.5 Review in accordance with other standards

1.4.5.1 Upon request, additional requirements, other than the Society's own as laid down in [Sec.3](#) through [Sec.14](#), may be included in the examination work.

Examples on additional standards that have been found applicable are:

- EN13852 *Offshore Cranes*
- EU *Machinery Directive*
- EU *Machinery Directive App.4*
- PSA
- API 2C.

Applicable combinations of certification/verification assignments and review of additional requirements are illustrated in [Table 1-2](#).

1.4.5.2 It is emphasized that the comparisons are based upon the Society's understanding and interpretation of the additional requirements.

In cases where the Society's interpretation is questioned or it gives rise to conflicts between involved parties or for other reasons are considered inappropriate, the Society may refuse to carry out the work based on the Society's own interpretation of the additional requirements. In such cases, the customer shall obtain written interpretation from the legislators/standard publishers.

1.4.5.3 Commissions such as described in [\[1.2.3.2\]](#) and [\[1.4.5.1\]](#) will normally be limited to the topics and aspects covered in the DNV GL requirements given in [Sec.3](#) through [Sec.14](#). Upon request, however, the commissions may be extended to cover also additional topics.

Such extensions and amendments of scope of work shall be reflected in written agreements.

1.4.5.4 If it has been agreed to include additional requirements in the certification work and the additional requirement is not complied with, this shall be reported to the customer in writing.

1.4.5.5 Covering of additional requirements may be limited to; design examination, manufacturing survey, installation survey and testing, or to any combinations of these phases.

1.4.5.6 The measures applied to demonstrate compliance with the additional requirements dealt with in [1.2.3.2] and [1.4.5.1] shall be documented by the customer.

1.4.6 Customers who may request certification and verification

1.4.6.1 Certification may be requested by:

- manufacturer of a complete lifting appliance
- manufacturer of components or loose gear
- owner/user of a lifting appliance
- owner of a ship, mobile offshore unit or offshore installation, etc.
- shipyard or offshore installation fabrication site, etc.

1.4.6.2 Verification services may be requested by persons/bodies/institutions/companies possessing legitimate access to the documentation forming the basis for the requested verification.

1.4.6.3 Request for certification and verification shall be made in writing as specified in [9.1].

1.4.7 Written confirmation

1.4.7.1 Before a certification or verification assignment is commenced, at least following shall be confirmed in writing:

- category of lifting appliance to be certified, see [1.2]
- for offshore crane or platform crane it shall also be specified whether the crane is to lift loads from decks of other vessels or only from the sea/seabed.
- whether the assignment shall be extended to cover requirements for lifting of personnel.
- whether the assignment shall be extended to cover also requirements for qualifying the lifting appliance for additional class notations **Crane vessel**, **Crane** or **Crane (N)**.
- whether the assignment shall be extended to cover any of the additional requirements listed in [1.2.3] or [1.4.4.1].

1.4.8 Certificate annotations

1.4.8.1 Unless otherwise requested by the customer, compliance with the requirements pertaining to the additional requirements review as described in [1.2.3.2] or [1.4.5.1] shall be confirmed in writing in the relevant documents.

Applicable combinations of the Society's certification and verification and additional standards assumed especially relevant.

Table 1-2 Modular service scheme

	<i>Loose gear</i>	<i>Platform cranes</i>	<i>Offshore cranes</i>
Basic certification (ILO)	X	X	X
Certification extended to cover class (Crane , Crane vessel or Crane (N))		X not Crane (N)	X
EN 13852 (verification)			X

	<i>Loose gear</i>	<i>Platform cranes</i>	<i>Offshore cranes</i>
EU Mach. Dir. (verification)	X	X	X
EU Mach. Dir. ANNEX 4 (verification)		X	X
PSA Guidelines (verification)	X	X	X
MODU code	X	X	X
API 2C (verification)			X

SECTION 2 DOCUMENTATION AND CERTIFICATION

2.1 Documentation to be submitted

2.1.1 General

2.1.1.1 The documentation necessary for verification assignments will depend on the scope of work agreed. The documentation and information requirements stated below are necessary for design approval and ensuing certification.

2.1.2 Documentation requirements

2.1.2.1 Documentation shall be submitted as required by [Table 2-1](#), as applicable for the lifting appliance.

Table 2-1 Documentation requirements

<i>Object</i>	<i>Document type</i>	<i>Additional description</i>	<i>Offshore cranes Info</i>	<i>Platform cranes Info</i>
General	C010 - Design criteria	Load charts and/or load tables (derating tables will be approved if Crane notations) Dynamic factors Environment conditions Category of crane, see definitions [1.1.2] Particulars of brake spring performance	FI	FI
	C020 - Assembly or arrangement drawing		FI	FI
	C030 - Detailed drawing	Crane structure and components for slewing, luffing and hoisting, slewing gears, slewing rings, etc. Gears and brakes for platform cranes are normally not subject to approval. Drawings of gears transmitting braking forces should contain relevant parameters including torque capacity. Foundations/pedestals welded to the hull - with exception of the upper pedestal flange - are categorized as part of the vessel's hull and are thereby not handled within the crane approval	AP	AP
	C040 - Design analysis		FI	FI
	C050 - Non-destructive testing (NDT) plan	This might be structural weld drawings detailing weld category (special, primary or secondary), including notes detailing the required NDT extent, or, such drawings in combination with fabrication specification stating the same.	AP	FI
	Z060 - Functional description	Including a filled in verification template, see App.G , for offshore cranes	FI	FI

<i>Object</i>	<i>Document type</i>	<i>Additional description</i>	<i>Offshore cranes Info</i>	<i>Platform cranes Info</i>
	Z252 - Test procedure at manufacturer		AP	FI
	Z253 - Test procedure for quay and sea trial		AP	FI
	Z161 - Operation manual		FI	FI
Power supply	Z030 - System arrangement plan	Type and maker of prime mover or specification of other main and emergency power supply Including mechanical components.	FI	FI
Electric power system	E170 - Electrical schematic drawing	Including cable list.	AP	FI
	Z090 - Equipment list		FI	FI
Hydraulic power system	S011 - System diagram (P&ID)		AP	FI
	S042 - Hydraulic control diagram		AP	FI
	Z060 - Functional description		FI	FI
	Z090 - Equipment list		FI	FI
Control and monitoring	I200 - Control and monitoring system documentation	Functional description of safety system and the safety equipment to be included	AP	FI
Fire safety	G060 - Structural fire protection drawing		AP	FI
AP = For approval; FI = For information				

For general requirements for documentation, including definition of the info codes, see [RU SHIP Pt.1 Ch.3 Sec.2](#).

For a full definition of the documentation types, see [RU SHIP Pt.1 Ch.3 Sec.3](#).

2.1.3 Design analysis

2.1.3.1 For structural parts and components specified in [\[2.1.2\]](#), the drawings shall be supplemented with calculations demonstrating that the structural strength complies with the requirements.

2.1.3.2 A complete listing of structural components and parts subjected to strength calculations shall be submitted. The list shall include information of:

- types of failures considered (excessive yielding, buckling, fatigue fracture)
- elastic or plastic analysis performed
- permissible stress or limit state method used.

See also [\[4.3\]](#).

2.1.3.3 For offshore cranes to be covered by class, the calculations of the dynamic factors shall cover:

- a) The still-water dynamic factor or specification of a possible increased figure chosen as dynamic factor for design purposes. See definition in [\[1.1.5\]](#).

- b) Calculations of the dynamic factors for all combinations of boom angles and H_{sign} .
- c) The crane-supporting vessel's heave- and roll velocities used in the calculations referred to in b) above, as well as a description of the geometrical location of the crane on board the vessel.
- d) As an alternative to the figures required in c) above, the vertical velocity components at the boom tip caused by the crane-supporting vessel's heave and roll.
- e) For lifts of submerged loads, the maximum acceptable dynamic factors contribution caused by hydrodynamic effects shall be specified. This includes also hydrodynamic effects occurring when the load is lifted through the sea surface.

2.1.3.4 The design calculations for hydraulic cylinders shall be carried out as specified in [5.5.1.19].

2.2 Certification

2.2.1 Certificate requirements

2.2.1.1 Certificates shall be issued as required by Table 2-2 for platform cranes and as required by Table 2-3 for offshore cranes

For certificate definitions, ref. [1.1.5] *Definitions, abbreviations, symbols and references*.

Table 2-2 Certificate requirements for platform cranes

<i>Object</i>	<i>Certificate type</i>	<i>Issued by</i>	<i>Additional description</i>
Slewing rings	PC	The Society	
Hydraulic cylinders	PC	The Society	Ref. App.[D.2]. Applicable also for accumulators, ref. RU SHIP Pt.4 Ch.7 Sec.1
Sheaves	PC	The Society	Works product certificate will be satisfactory for unwelded metallic sheaves. Composite sheaves to be delivered with the Society's PC
Hoisting blocks	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Hooks	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Chains	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Swivels	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Shackles	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.

<i>Object</i>	<i>Certificate type</i>	<i>Issued by</i>	<i>Additional description</i>
Wire ropes	PC	The Society	Certificate of test and thorough examination of Wire Rope (CG4). Alternatively ILO form No. 4.
Fibre ropes	PC	The Society	The Society's product certificate in accordance with DNVGL OS E303. Alternatively manufacturers product certificate.
Winches	PC	The Society	
Slewing gear	PC	Manufacturer	Works product certificate. Also other transmission gears for non-critical applications.
Transmission gears and brakes	PC	Manufacturer	Works product certificate. Applicable when transmitting braking forces for hoisting and luffing. For personnel handling, the Society's PC required.
Hydraulic components	TR	Manufacturer	Except mountings
*Unless otherwise specified the certification standard is this standard. PC = Product Certificate, MC = Material Certificate, TR = Test Report			

Table 2-3 Certificate requirements for offshore cranes

<i>Object</i>	<i>Certificate type</i>	<i>Issued by</i>	<i>Additional description</i>
Slewing rings	PC	The Society	
Hydraulic cylinders	PC	The Society	Ref. App.[D.2]. Applicable also for accumulators, ref. RU SHIP Pt.4 Ch.7 Sec.1
Winches	PC	The Society	
Sheaves	PC	The Society	Works product certificate will be satisfactory for unwelded metallic sheaves. Composite sheaves to be delivered with the Society's PC.
Hoisting blocks	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Hooks	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.

<i>Object</i>	<i>Certificate type</i>	<i>Issued by</i>	<i>Additional description</i>
Chains	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Swivels	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Shackles	PC	The Society	Certificate of test and thorough examination of loose gear (CG3). Alternatively ILO form No. 3.
Wire ropes	PC	The Society	Certificate of test and thorough examination of loose gear (CG4). Alternatively ILO form No. 4.
Fibre ropes	PC	The Society	The Society's product certificate in accordance with DNVGL OS E303
Transmission gears and brakes	PC	Manufacturer	Works product certificate. Applicable when transmitting braking forces for hoisting and luffing. For personnel handling, the Society's PC required.
Slewing gear	PC	Manufacturer	Works product certificate. Also other transmission gears for non-critical applications.
Hydraulic components	TR	Manufacturer	Except mountings
*Unless otherwise specified the certification standard is this standard. PC = Product Certificate, MC = Material Certificate, TR = Test Report			

Table 2-4 Additional certificate requirements for the class notation Crane and Crane(N)

<i>Object</i>	<i>Certificate type</i>	<i>Issued by</i>	<i>Certification standard*</i>	<i>Additional description</i>
Control & monitoring system	PC	The Society		
EL.motors with rating 100 kW and above	PC	The Society		
Motor starters and frequency converters with rating 100 kW and above	PC, TA	The Society		The Society's product certificates or the Society's type approval certificate
Slip rings, 100 kW and above	PC	The Society		

<i>Object</i>	<i>Certificate type</i>	<i>Issued by</i>	<i>Certification standard*</i>	<i>Additional description</i>
*Unless otherwise specified the certification standard is this standard. PC = Product Certificate, TA = Type Approval Certificate, MC = Material Certificate, TR = Test Report				

For general certification requirements, see [RU SHIP Pt.1 Ch.3 Sec.4](#).

For a definition of the certification types, see [RU SHIP Pt.1 Ch.1. Sec.4](#) and [RU SHIP Pt.1 Ch.3 Sec.5](#).

SECTION 3 MATERIALS AND FABRICATION

3.1 General

3.1.1 Scope

3.1.1.1 This section gives requirements for materials for structural members and equipment for lifting appliances with design temperature T_D down to -30°C .

Materials for lifting appliances with design temperature below -30°C will be especially considered. Design temperature is defined in [1.1.7].

3.1.1.2 Materials with properties deviating from the requirements in this section may be accepted upon special consideration by the Society. See also [RU SHIP Pt.2 Ch.1 Sec.1 \(3.4\)](#).

3.1.1.3 For materials where no specific requirements are given, generally recognised standards and engineering principles may be applied.

3.1.1.4 A traceability system that ensures correct installation and documentation of the material grades or strength classes shall be established by the customer throughout the prefabrication and installation process. Proper care shall be exercised during handling and storage to preserve identification of such material.

3.1.2 Structural category

3.1.2.1 The following categorisation will be used for structural members:

- *Special*: highly stressed areas where no redundancy for total collapse exists.
- *Primary*: structures carrying main load as well as components with highly stressed areas.
- *Secondary*: structures other than primary and special members.

Slewing bearings with flanges will normally be categorised as special, other structure transmitting principle loads are normally categorised as primary.

The categories shall be agreed with the Society in each case.

See also detailed categorisation for bolt connections in [3.4.4.1].

Guidance note:

Highly stressed areas are considered to be areas utilised more than 85% of the allowable yield capacity.

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3.1.3 Steel manufacturing process

3.1.3.1 Steel shall be made by the basic oxygen process, electric furnace process, or by other process especially approved by the Society.

3.1.4 Material manufacture survey, certification and testing procedures

3.1.4.1 Certificates covering specification of the chemical composition and mechanical properties shall be presented for all materials for all load-carrying structures and mechanical components. The test values shall show conformity with the approved specification. Test specimens shall be taken from the products delivered. Requirements as per [RU SHIP Pt.2 Ch.1 General requirements for materials](#) to be fulfilled.

Approved steel manufacturer will not be required.

Material certificates type 3.1 will suffice for special and primary structures, except for slewing rings for offshore cranes in which case certificate type 3.2 is required.

Guidance note:

The document designation inspection certificate type 3.1, 3.2 and 2.2 are in accordance with ISO 10474 .

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3.1.4.2 The materials shall be adequately marked for identification. The marking shall at least comprise name or trade mark of the manufacturer, material grade, heat number, and when referred to 3.2 certificates, the stamp of the purchaser's authorized representative.

3.1.4.3 Marking and identification of smaller items, e.g. bolts and nuts, shall be especially agreed upon between manufacturer and the Society, but shall at least comply with fastener product standard.

3.1.4.4 Materials without proper identification will be rejected unless renewed testing verifies compliance with approved specifications. The number and type of tests will be decided in each case.

3.1.5 Retesting

3.1.5.1 Materials that prove unsatisfactory during delivery testing may be retested. If the standard, with which the materials shall comply, gives no directive for retesting, the retesting shall be carried out as given in [RU SHIP Pt.2 Ch.1](#). Provided the new test results are found to satisfy the prescribed specification, the material may be accepted.

3.2 Rolled structural steel for welding

3.2.1 General

3.2.1.1 In addition to the requirements for structural steels set out in the following, further requirements may be stipulated in special cases depending on the material application. Thus, testing for fracture mechanics analysis and through thickness ductility properties may be required. Fracture mechanics testing in accordance with an approved procedure will be required for materials and welded joints when the crane manufacturer cannot document satisfactory experience from previous similar material application.

3.2.1.2 Rolled structural steel for welded constructions may be carbon steel or carbon-manganese steel. The steels are divided into three groups dependent on the specified yield strength as follows:

- normal strength steels, with specified minimum yield stress 235 N/mm^2
- high strength steels, with specified minimum yield stress of 265 N/mm^2 and up to and including 420 N/mm^2
- extra high strength steels with specified minimum yield stress of 420 N/mm^2 and up to and including 750 N/mm^2 .

3.2.1.3 Application of steel with specified minimum yield strength above 750 N/mm^2 shall be especially agreed.

3.2.1.4 Steels having through thickness ductility ("Z-steel") may be required for primary members which will be significantly strained in the thickness direction.

3.2.1.5 The requirements for chemical composition, mechanical properties etc., are given in [RU SHIP Pt.2 Ch.2 Sec.2 3](#) for normal strength steels, [RU SHIP Pt.2 Ch.2 Sec.2 4](#) for high-strength steels, and [RU SHIP Pt.2 Ch.2 Sec.2 5](#) for extra high strength steels.

3.2.1.6 As an alternative to [3.2.1.5], materials that comply with national or proprietary specifications may be accepted provided such specifications give reasonable equivalence to the requirements given in this section or are approved for a specific application. See also [RU SHIP Pt.2 Ch.1 Sec.1 \(3.4\)](#).

3.2.2 Impact test temperatures

3.2.2.1 Required impact test temperatures are dependent on design temperature T_D and the material thickness. Impact test temperatures are given in [Table 3-1](#) for structural steel for special, primary and secondary applications. For definition of design temperature see [1.1.7].

For structural members subjected to compressive and/or low tensile stresses, modified requirements may be considered, i.e. greater material thicknesses for the test temperatures specified.

3.2.2.2 Impact test temperature for flanges for slewing bearings shall be as for "special and primary members" given in [Table 3-1](#) based on actual thickness.

3.2.2.3 When welding a thinner plate to a thicker plate, e.g. connecting a flange to the supporting structure for the flange, inserted reinforcement rings etc., the following apply provided the thicker plate does not contain butt welds:

The impact test temperature shall be the lower of the temperatures according to [Table 3-1](#), based on $t = t_1$ or $t = 0.25 \cdot t_2$ where:

t_1 = thickness of the thinner supporting plate

t_2 = thickness of the flange.

However, the impact test temperature for the flange (thicker plate) shall not be higher than the required test temperature, based on t_2 according to [Table 3-1](#), plus 30° C.

Table 3-1 Impact test temperatures for welded structural steel

Material thickness t in mm	Impact test temperature in °C ¹⁾			
	Structural steel for special and primary members ²⁾		Structural steel for secondary members ²⁾	
	Offshore lifting appliances	Platform lifting appliances	Offshore lifting appliances	Platform lifting appliances
$6 \leq t \leq 12$ ³⁾	$T_D + 10$	$T_D + 20$	Test not required	Test not required
$12 < t \leq 25$	T_D	$T_D + 10$	Test not required	Test not required
$25 < t \leq 50$	$T_D - 20$	$T_D - 10$	T_D	$T_D + 10$
$t > 50$	$T_D - 40$	$T_D - 30$	$T_D - 10$	T_D
1) For steel with yield stress below 500 MPa, the test temperature need not be taken lower than -40°C. For steel with yield stress above 500 MPa, the test temperature shall not be taken higher than 0°C and not lower than -60°C. 2) See [3.1.2.1] for definitions. 3) For plate thickness less than 6 mm, Charpy V testing will not be required.				

3.2.3 Testing

3.2.3.1 Test samples

Unless otherwise required the test samples shall be taken for positions as specified in [RU SHIP Pt.2 Ch.2](#) or other recognised standards. The sample of material from which test specimens are cut shall be treated

together with and in the same way as the material presented. The samples shall be suitably marked for identification.

3.2.3.2 Test specimens

Test specimens shall be as specified in the approved standards. The following additional requirements shall apply:

- for impact testing of thin materials where the thickness makes it impossible to use an impact test specimen of 10 × 10 mm the largest practicable of the following specimens shall be used:
10 × 7.5 mm or 10 × 5 mm.

By this procedure the required impact values are reduced to 5/6 and 2/3, respectively, of the value of the standard 10 × 10 mm test specimen.

3.3 Rolled steel not for welding

3.3.1 General

3.3.1.1 Rolled steel for special and primary components other than those mentioned in [3.3.2] and [3.3.3] (e.g. mechanisms) shall be specified with reference to a recognised standard, see [3.2.1.5] and [3.2.1.6]. The material shall be delivered in the following conditions:

- carbon and carbon/manganese steel in normalized condition.
- alloy steel in quenched and tempered condition.
- as rolled (AR) condition, when subjected to special consideration.

For all materials, impact toughness shall be documented by Charpy V-notch impact tests. Test temperatures shall be as required by Table 3-2 but, in the case of low calculated stresses, e.g. not exceeding 50 N/mm², a test temperature of 20°C will be accepted. Required minimum impact energy shall be as required for welded parts, ref. [3.2.1.5].

3.3.2 Bolts and nuts

Materials for bolts and nuts considered as important for the structural and operational safety of the assembly in question, shall comply with the requirements given in [3.4.4] for bolts and nuts. This includes requirements for chemical composition and mechanical properties.

3.3.3 Rolled rings

3.3.3.1 Rolled rings for important components such as slewing rings, toothed wheel rims etc. shall comply with the requirements for steel forgings, see [3.4.5].

3.4 Steel forgings

3.4.1 General

3.4.1.1 Forgings shall generally be manufactured in accordance with the requirements given in RU SHIP Pt.2 Ch.2 Sec.6 *Steel Forgings*.

3.4.1.2 As an alternative to [3.4.1.1], materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements given in [3.4.1.1] or are especially approved. As a minimum the following particulars shall be specified: manufacturing process,

chemical composition, heat treatment, mechanical properties and non-destructive testing. See also [RU SHIP Pt. 2 Ch.1 Sec.1 \(3.4\)](#). For machinery components, see [RU SHIP Pt.4 Ch.2 Sec.3](#).

3.4.2 Forgings for general application

3.4.2.1 Forgings shall be specified with reference to [RU SHIP Pt.2 Ch.2 Sec.5 Steel Forgings](#) or other national or proprietary specification, see [\[3.4.1.2\]](#). As a minimum the standard shall require impact testing according to [Table 3-5](#). Other mechanical properties shall minimum be according [RU SHIP Pt.2 Ch.2 Sec.6 Table 6](#) for unwelded forgings and according to [RU SHIP Pt.2 Ch.2 Sec.6 Table 4](#) for welded forgings. For thicknesses over 100 mm, smaller deviations from the specified mechanical properties may be accepted based on specific approval by the Society. For forged shackles, cargo hooks, swivels, sockets, chains, bolts/nuts and slewing bearings, the special requirements given in [\[3.4.3\]](#) to [\[3.4.5\]](#) apply.

3.4.3 Forged shackles, cargo hooks, swivels, sockets and chains

3.4.3.1 Carbon and carbon-manganese steel forgings shall be made from killed and fine-grain treated non-ageing steel. It may be required that the non-ageing properties are verified by tests. The chemical composition and mechanical properties of the material, with the exception of the impact test temperature, shall be as given in [\[3.4.2.1\]](#). It may be required that the non-ageing properties are verified by tests, see [RU SHIP Pt.2 Ch.1 Sec.3 \[3.8\]](#).

Chemical composition and mechanical properties for alloy steels shall be specified with reference to recognised standard and are subject to individual consideration and approval by the Society. The chemical composition shall be suitable for the thickness in question. Alloy steels shall be delivered in quenched and tempered condition.

Requirements for impact test temperatures are specified in [Table 3-2](#).

Table 3-2 Impact test temperature for shackles, cargo hooks, chains, sockets and swivels

Material thickness t (mm)	Impact test temperature
$t \leq 10$	Impact test not required
$10 < t \leq 50$	$T_D + 20 \text{ }^\circ\text{C}$
$50 < t \leq 100$	$T_D + 10 \text{ }^\circ\text{C}$
$t > 100$	T_D

T_D = design temperature

3.4.4 Bolts and nuts

3.4.4.1 Bolt connections are normally considered to be in the following groups:

Special

— where it is part of a slewing ring connection.

Primary

— where the bolts or nuts are transferring principle loads

Secondary

- where the bolts or nuts are transferring load, not belonging in the category special or primary. Examples are bolt connections in driver's cabin, platforms, stairs and ladders.

3.4.4.2 Bolts and nuts for use in connections categorised as special or primary shall conform with and be tested in accordance with a recognised standard, e.g. pertinent parts of ISO 898 or other recognised standard. Charpy testing will generally not be required for nuts.

Additional requirements for testing and inspection of slewing ring bolts are given in [Table 3-3](#).

Bolt connections considered as secondary shall be made from suitable materials.

3.4.4.3 Nuts may be accepted to be in one strength class lower than the bolts of bolt/nut assemblies.

3.4.4.4 Bolts and nuts shall be delivered with the following certificates as per ISO 10474, verifying compliance with the material requirements and other test requirements:

- Inspection certificate type 3.2 for slewing ring bolts and nuts for offshore cranes
- works certificate type 3.1 for slewing ring bolts and nuts for platform cranes
- 2.1 test report for bolts and nuts in *primary* and *secondary* connections.

3.4.4.5 Slewing ring bolts for offshore cranes shall have rolled threads, and the rolling shall be performed after final quenching and tempering of the bolts. 12.9 bolts are not accepted as slewing ring bolts for offshore cranes.

3.4.4.6 Fasteners (bolts, nuts and washers) in marine environment shall normally be hot-dipped galvanized or sherardized with coating thickness min. 50 micrometer. If special thread profiles or narrow tolerances prohibit such coating thickness, bolts/-nuts may be supplied electro-plated or black provided properly coated/painted after installation. Pickling and electro-plating operations shall be followed by immediate hydrogen-relief (degassing) treatment to eliminate embrittling effects.

3.4.4.7 Galvanizing of bolts and nuts are acceptable provided additional loss of bolt load (pretension) of at least 4% is compensated for.

Unless specific measures are taken against absorption of hydrogen, galvanizing is not accepted for 12.9 bolts.

3.4.5 Forged rings for slewing bearings

3.4.5.1 Specifications of slewing rings essential for the structural and operational safety of the crane are subject to individual approval by the Society. All relevant details shall be specified such as chemical composition, mechanical properties, heat treatment, depth and hardness of surface hardened layer and surface finish of fillets. Position of test specimens shall be indicated. Method and extent of non-destructive testing shall be specified and the testing procedures shall be stated. Detailed information about method of manufacture shall be submitted.

3.4.5.2 For each new material of which the manufacturer has no previous experience and for any change in heat treatment of a material previously used, a principal material examination shall be carried out. This means that the Society may impose additional requirements not specified in this standard. The results shall be submitted to the Society for consideration. The programme for such examination shall be agreed with the Society.

3.4.5.3 All test results shall comply with the approved specifications.

3.4.5.4 Steel for slewing rings shall satisfy the requirements given in [Table 3-4](#).

Table 3-3 Testing and inspection of slewing ring bolts

Strength class, ISO 898, or equivalent	Diameter d in mm	Ultimate strength N/mm ²	Yield strength. Minimum. N/mm ²	Elongation A5	Required Charpy V energy ¹⁾ at test temp. T _D	Fracture mechanics testing (CTOD)	Surface inspection ⁴⁾
8.8	d < 25	800 - 1000	640	14	—	—	Visual
	d ≥ 25				Offshore cranes: 42 J Platform cranes: 25 J	—	Visual and magnetic particle (MPI)
10.9	d < 25	1000 - 1200	940	12	—	—	Visual
	d ≥ 25				Offshore cranes: 42 J Platform cranes: 25 J	—	Visual and magnetic particle (MPI)
12.9 (not allowed for off-shore cranes)	d < 25	1200 - 1400	1080	12 (10) ²⁾	Platform cranes: 25 J	To be documented ³⁾	Visual and magnetic particle (MPI)
	d ≥ 25				Platform cranes: 25 J	To be tested ³⁾	

- 1) Average value of three specimens. One single value may be max 30% lower.
2) May be accepted on case-by-case basis.
3) Alternatively, a Charpy-V notch energy of minimum 55 J at T_D may be accepted.
4) For all the bolts (100 %), magnetic particle testing shall be carried out at least 48 hours after completion of quenching and tempering for bolts with yield strength above 355 N/mm². Inspection shall be in accordance with ASTM E 709.
Depth of longitudinal discontinuities shall not exceed 0.03 of the nominal diameter. Transverse cracks will not be acceptable irrespective of crack depth and location. Other surface irregularities will be considered in each case.

Table 3-4 Slewing materials

Heat treatment		Offshore cranes	Platform cranes
		According to approved Spec.	
Charpy V-notch test temperature		T _D	
	Average	42	25
Charpy V notch value, J	Single min. value	27	20
Elongation A5		14%	14%
Fatigue properties		Documentation may be required by type tests on specimen of ring section	
Fracture toughness		Documentation may be required by type tests on specimen of ring section in question	

Table 3-5 Impact testing for steel forgings

<i>Design temperature T_D</i>	<i>Test temperature</i>	<i>Minimum Charpy Value</i>
$T_D \geq -20^\circ\text{C}$	0°C	27 J
$-20^\circ\text{C} > T_D > -30^\circ\text{C}$	-20°C or (0°C)	27 J (48 J)

3.5 Steel castings

3.5.1 General

3.5.1.1 Steel castings shall generally be manufactured in accordance with [RU SHIP Pt.2 Ch.2 Sec.8 Steel Castings](#).

3.5.1.2 As an alternative to [\[3.5.1.1\]](#), materials which comply with national or proprietary specifications may be accepted provided such specifications give reasonable equivalence to the requirements given in [\[3.5.1.1\]](#) or are approved for each specific application. As a minimum the following particulars shall be specified: manufacturing process, chemical composition, heat treatment, mechanical properties and non-destructive testing. See also [RU SHIP Pt.2 Ch.1 Sec.1 \(3.4\)](#). For machinery components, see [RU SHIP Pt.4 Ch.2 Sec.1 \[2\]](#).

3.5.2 Castings for general application

3.5.2.1 Steel castings shall generally be manufactured in accordance with [RU SHIP Pt.2 Ch.2 Sec.8 Steel Castings](#) or other national or proprietary specification. As a minimum the standard shall require impact testing and mechanical properties according to [Table 3-5](#). Other mechanical properties shall minimum be according [RU SHIP Pt.2 Ch.2 Sec.8 Table 5](#) for welded castings and according to [RU SHIP Pt.2 Ch.2 Sec.8 Table 7](#) for unwelded castings.

3.6 Iron castings

3.6.1 General

3.6.1.1 Iron castings shall generally be manufactured in accordance with the [RU SHIP Pt.2 Ch.2 Sec.9 Iron Castings](#).

3.6.1.2 As an alternative to [\[3.6.1.1\]](#), materials that comply with national or proprietary specifications may be accepted provided such specifications give reasonable equivalence to the requirements given in [\[3.6.1.1\]](#) or are approved for each specific application. See also [RU SHIP Pt.2 Ch.1 Sec.1 \[3.4\]](#).

3.7 Steel tubes, pipes and fittings

3.7.1 General

3.7.1.1 Reference is made to [RU SHIP Pt.2 Ch.2 Sec.5 Steel pipes and fittings](#), or other recognised standard/code. Recognition of other standards shall be evaluated by the Society.

3.8 Aluminium alloy structures

3.8.1 General

3.8.1.1 Reference is made to [RU SHIP Pt.2 Ch.2 Sec.10 Aluminium alloys](#)

3.9 Composite materials

3.9.1 General

3.9.1.1

Requirements to be specially developed for the intended use applying the technology qualification process required by DNV [RP A203 Technology qualification](#).

3.10 Steel wire ropes

3.10.1 General

3.10.1.1 Steel wire ropes and wire locks for cranes shall generally be manufactured and tested in compliance with the requirements stipulated in the following, as well as EN 12385-1 *Steel wire ropes - Safety*, EN 13414-1 *Steel wire rope slings - Safety* and EN 13411 *Terminations for steel wire ropes*.

For sockets and socketing specially, the socket shall be designed and the socketing procedure performed according to an internationally recognized standard (e.g. ISO 3189 *Sockets for wire ropes for general purposes* parts 1,2 and 3; EN 13411-4 *Terminations for steel wire ropes - Metal and resin socketing*; ISO 17558 *Steel wire ropes - Socketing procedures*).

3.10.1.2

For wire ropes delivered with socket, the socket shall have been load tested together with the wire rope (load test criteria as for the wire rope).

For wires with sockets fitted after the steel wire rope has been reeved, the load testing will only be during the load testing of the crane (load test criteria as for the crane); socket design and socketing procedure to be in accordance with an internationally recognized standard or approved by a competent person.

For sockets delivered as separate parts/individual components by the manufacturer, product certificates shall be provided. The product certificate shall contain the following information:

- manufacturer's name, type designation, serial number, type of marking
- method of manufacture (forged, cast, machined)
- applied standard
- wire dimension(s)
- proof test force applied (for the prototype when serial production)
- a statement that the sockets are of the same design, material and method of manufacture which has passed the prototype tests
- the specific methods of socketing for which the socket is suitable and a statement that these methods of socketing have passed the prototype tests
- any design limitations.

For sockets to be used in lifting appliances to be certified by DNV GL, product certificates issued by manufacturers will be accepted. If, however, DNV GL is requested to certify sockets, they must be based

on DNV GL approved drawings and the following requirements, in addition to those specified in section [3.10.1.1]:

- The socket, pin and associated components shall be designed for a load not less than the MBL of the wire
- Load and fatigue testing (for prototype and serial production) according to ISO 3189/1, or, otherwise agreed with DNV GL. The reference force shall be based on the 90% of the MBL of the rope/socket.

Guidance note:

The reference test force should be based on the rope with the highest tensile grade expected to be used together with the socket

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- NDT requirements as per DNV GL [OS E304 Ch.2 Sec.5 \[2.2\]](#) *Offshore Mooring Steel Wire Ropes* or DNV GL approved manufacturer's specification.

3.10.2 Materials

3.10.2.1 Wire for steel wire ropes shall be made by LD process, or by other processes especially approved by the Society or an other classification society.

Normally, the minimum tensile grade of the wires shall be 1-570 N/mm², 1-770 N/mm², 1-960 N/mm² or 2-160 N/mm²

3.10.3 Construction

3.10.3.1 The strands shall be made in equal lay construction (stranded in one operation).

3.10.3.2 All wire ropes shall be lubricated and impregnated in the manufacturing process with a suitable compound to thoroughly protect ropes both internally and externally to minimize corrosion until the rope is taken into use.

3.10.3.3 The rope lubricant selected shall have no detrimental effect on the steel wires or any fibres (in the core) and shall reduce the friction in the rope.

3.10.3.4 Certain wire-lay types shall be avoided (for example 4 × 29). Selection of wire type shall be based on manufacturer's recommendations (or catalogue specifications).

3.10.4 Testing

3.10.4.1 Steel wire ropes shall be tested by pulling a portion of the individual wires to destruction. Alternatively, the whole rope shall be pulled to destruction (no requirement for tensile testing on the individual wires).

The breaking load shall be according to ISO 2408, EN 12385-1 or other internationally recognized standard.

The testing of wire with/without end terminations shall be carried out according to EN 12385-1 and EN 13411.

3.10.4.2 If facilities are not available for pulling the whole rope to destruction, the breaking load may be determined by testing separately 5% of all wires from each strand. The breaking strength of the rope is then considered to be:

$$P = f \cdot t \cdot k \text{ [kN]}$$

f = average breaking strength of one wire in kN

t = total number of wires

k = lay factor as given in [Table 3-6](#) or according to special agreement.

Table 3-6 Lay factor k

<i>Rope construction</i>	<i>Rope with FC</i>	<i>Rope with IWRC</i>
6 × 19 group	0.860	0.801
6 × 36 group	0.835	0.775
Non-rotating ropes		
17/18 × 7	0.780	0.758
35/36 × 7	0.750	0.743

FC = fibre core

IWRC = independent wire rope core.

3.10.4.3 Individual wire tests shall be performed for every wire dimension represented in the strands. The number of tests for each wire dimension shall be the same as the number of strands in the rope. The tests may be performed before or after rope manufacture. In the case of compacted ropes, wire tests shall be carried out before rope manufacture.

3.10.4.4 The following individual wire tests shall be performed:

- tensile test
- torsion test
- weight and uniformity of zinc coating.

These tests shall be made in accordance with ISO 6892, ISO 7800 and ISO 7801. If tested before rope manufacture, the tests shall comply with ISO 2232 else the tests shall comply with ISO 2408 App.E or ISO 10425 App.I.

3.10.4.5 For issuance of DNV GL Form 4, the wire testing shall be witnessed by DNV GL, unless the manufacturer is approved by the Society. If approved manufacturer, the surveyor shall, as a minimum, review and accept the test results.

3.11 Crane manufacturing and construction

3.11.1 General

3.11.1.1 The manufacturer shall organize a system for quality control involving competent personnel with defined responsibilities that shall cover all aspects of quality control. For qualification of welders, reference is made to [RU SHIP Pt.2 Ch.4 Sec.3](#) The materials shall be identifiable during all stages of manufacturing and construction.

3.11.1.2 Manufacturing and construction shall be in accordance with the approved drawings and specifications. The specification shall refer to a recognised code, standards or rules relevant for the structure in question. Supplementary requirements amending the reference documents may be stipulated.

3.11.1.3 Dimensional tolerances specified in the design analysis of the crane structures shall be complied with during manufacturing and construction.

3.11.1.4 All defects and deficiencies shall be corrected before the structural parts and equipment are painted, coated or made inaccessible.

3.11.1.5 Alternative methods making joints may be considered by the Society and will be subject to consideration in each case.

3.11.2 Welding procedure specifications

3.11.2.1 Reference is made to [RU SHIP Pt.2 Ch.4 Fabrication and testing](#).

3.11.2.2 As alternatives to the requirements given in [\[3.10.2.1\]](#), the following standards will also be accepted:

- AWS D.1.1, or
- EN ISO 15614 -1 for steel
- EN ISO 15614 -2 for aluminium.

3.11.3 Welding consumables

3.11.3.1 Welding consumables type approved by the Society or accepted based on welding procedure tests shall be used.

Guidance note:

Welding consumables type approved by the Society are recommended. The type approved welding consumables are listed on the intranet. On internet: <https://approvalfinder.dnvgl.com/>.

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3.11.3.2 Welding consumables shall be selected such as to produce a weld with mechanical properties at least equal to that specified for the structural steel type in question. The weld metal shall be compatible with the base material regarding heat treatment and corrosion. Only welding consumables specified in the qualified welding procedure shall be used, or same grading of different brand.

3.11.3.3 Manual welding of high-strength and extra high-strength steels shall be performed with low hydrogen welding processes.

3.11.3.4 Welding consumables shall be supplied in sealed moisture-proof containers or packages. Routines for storage, handling and rebaking of consumables as advised by the manufacturer shall be established and followed.

Consumables that have been contaminated by moisture, rust, oil, grease, dirt etc. shall be discarded.

3.11.4 Forming of materials

3.11.4.1 Forming of plates, structural shapes, tubes etc. shall be carried out according to a specification outlining the successive and controlled steps. Forming of steels above 650°C shall be subject to agreement.

3.11.4.2 The degree of cold deformation of special and primary structural elements shall be less than 5%, unless otherwise agreed and qualified. The customer shall prepare a procedure for cold forming before the production starts, and the procedure shall be agreed.

If the deformation exceeds 5% and up to a maximum deformation of 12%, subject to agreement, the cold forming shall be qualified. The qualification procedure shall at least include destructive testing of representative cold formed material.

In addition to representative cold forming, in this context "representative material" means at least same material grade, with similar chemical composition and mechanical properties, and from one steel manufacturer.

For destructive testing, the following shall be tested as a minimum: impact toughness tests of representative strained material and strained aged material. Test temperature shall be the same as required for the base material.

Cold deformation exceeding 12% followed by heat treatment may, subject to agreement, be considered for acceptance case-by-case based on qualification. The customer shall prepare a procedure for qualification and the procedure shall be agreed before the production starts. The qualification procedure shall at least include non-destructive, destructive and weldability testing of representative cold formed material. For destructive testing, at least full scope of testing as for qualification of the base material is required.

All cold formed and heat treated areas shall be tested 100% by MT (or PT for stainless steels) after final forming, heat treatment and welding.

3.11.4.3 Forming of steels at high temperatures shall be effectuated with due regard to adverse effects of the material's properties. Forming of steels above 650°C shall be subject to agreement with the Society.

3.11.5 Welding preparation

3.11.5.1 Mill scale, rust etc. shall be removed prior to welding, and the grooves shall be dry and clean. The fit-up shall be checked before welding. Deviation of cut edges shall generally be within the standard specified by IACS REC No.47 *Shipbuilding and Repair Quality Standard* Part 4. Where materials of different thickness are butt welded, material tapering shall be in accordance with recognised codes or standards.

3.11.6 Welding performance

Unless welding performance according to alternative standards as referred in [3] is applied, the following applies. The qualification shall in addition to primary and special steel structures include structural category secondary steel welded towards primary or special steel.

3.11.6.1 All welding operations, including tack and seal welding, shall be carried out in accordance with an approved welding procedure specification WPS. The WPS shall be supported by a welding procedure qualification test, WPQT, reference is made to [RU SHIP Pt.2 Ch.4 Sec.5](#).

3.11.6.2 Preheating may be required for materials of certain thicknesses and chemical compositions. For welding of extra high-strength steel the preheating and interpass temperature shall be as advised by the steel manufacturer.

3.11.6.3 The weld reinforcement shall have a regular finish and shall merge smoothly into the base material without significant undercutting. The height of weld reinforcement shall not exceed 3 mm for material thickness $t \leq 12.5$ mm and max. 4 mm for greater thickness.

3.11.6.4 Welds which are essentially perpendicular to the direction of applied fluctuating stresses in members important to the structural integrity, shall normally be full penetration type and, if possible, welded from both sides. Dressing of welds by grinding may be required. Joint members subjected to high stress in the thickness direction shall be of Z-quality, alternatively ultrasonically tested for lamellar tearing after welding.

3.11.6.5 The use of permanent steel backing strips may be accepted when properly accounted for in the design analysis. Ceramic and other neutral backing strips may be used. A test weld for the intended application shall be produced and subjected to mechanical testing agreed upon in each case.

3.11.6.6 Temporary cut-outs shall be made of sufficient size allowing sound replacement. Corners of cut-outs shall be given appropriate radius minimizing the local stress concentration.

3.11.6.7 When difference in plate thickness of butt welds exceeding 4 mm, the thicker plate shall be tapered not steeper than 1 : 3 generally. Butt joints, which are prone to fatigue loading, shall be tapered not steeper than 1 : 4.

3.11.7 Repair of welds

3.11.7.1 For every type of repair, a repair welding procedure specification shall be prepared. In addition to the details mentioned in [3.10.2] the method for removal of defects, preparation of weld area and subsequent non-destructive testing as well as minimum and maximum repair length/depth shall be specified.

3.11.7.2 Repairs by welding of special and primary structural members and connections of primary to secondary members, shall be carried out in accordance with approved WPS. Documentation shall be presented prior to commencement of repair welding.

3.11.7.3 Weld defects may be rectified by grinding, machining or welding. Welds of insufficient strength, ductility or notch toughness shall be completely removed prior to repair. The mechanical properties of repair welds shall satisfy the minimum specified properties of the steel in question. Repair with arc-air gouging shall be followed by subsequent grinding.

Repair welding in the same area may be carried out twice. Further repairs are subject to the Society's consent.

3.11.7.4 Repair welding shall be carried out with extra low hydrogen welding consumables applying an appropriate pre-heating and working/interpass temperature. Generally the preheating and working temperature when making shallow and local repairs shall be raised 50°C above level used for production welding, but shall not be less than 100°C. The working temperature shall be maintained until the repair has been completed ensure sound repair welds. The single repair length shall not be shorter than approx. 100 mm.

3.11.7.5 When repair welding is carried out on heat-treated steel, reheat treatment may be required. When post heat-treated parts need repair by welding, the post heat treatment (PWHT) shall normally be repeated.

3.11.7.6 Minor discontinuities may be removed by grinding or machining, making a smooth transition into the surrounding material. The thickness shall not be reduced to less than 93% of the nominal thickness, but in no case by more than 3 mm. The extent of such repair shall be agreed upon.

3.11.8 Heat-treatment after forming and welding

3.11.8.1 If heat treatment after forming or welding is specified in procedures or on drawings, a detailed heat treatment procedure shall be submitted to the Society for approval.

3.11.8.2 Thermal stress relieving of cold-worked material, if found necessary, shall be carried out in accordance with the conditions stated below for post-weld heat treatment.

3.11.8.3 Post-weld heat-treatment of C-steels and C-Mn-steels shall be performed with a soaking temperature in the range 550°C to 620°C, for a time of 2 minutes per mm thickness. Soaking temperature for low-alloyed steel shall be decided in each case.

3.11.8.4 Post-weld heat-treatment shall, wherever possible, be carried out in an enclosing furnace. Where it is not practical to heat-treat the whole structure in a closed furnace, local heat-treatment may be adopted subject to the Society's consent.

3.11.8.5 The heat-treatment cycle shall be recorded using thermocouples equally spaced externally, and whenever possible internally, throughout the heated region. Heat-treatment records shall be submitted to the Society for consideration.

3.11.9 Production weld tests

3.11.9.1 *Welding production test (WPT)* may be required to be carried out during the production welding under identical condition as that of the production welding in order to verify the properties of the welds. Number and type of tests will be specified in each case.

3.11.9.2 When a WPT fails to meet the requirements, retesting may be carried out in accordance with the following.

If the impact test (3 specimens) fails to meet the requirements, 3 additional impact test specimens may be prepared and tested provided that only one of the below mentioned cases occurred in the first test:

- the average value was below the requirement, one value was below the average requirement but not below the minimum requirement for a single value
- the average value met the requirement. Two values were below the average requirement but not below the requirement for a single value
- the average met the requirement. Two values were above or equal to the average requirement and one value was below the requirement for a single value.

The initial 3 impact values and the additional 3 values shall form a new average of six values. If this new average complies with the requirement and no more than two individual results of all six specimens are lower than the required average and no more than one result is lower than the required value for a single specimen, the test may be accepted.

3.11.9.3 Upon special request and at the discretion of the Society, welding production tests may replace welding procedure qualification tests.

3.11.10 Inspection and testing of welds

3.11.10.1 Completed welds shall be subjected to visual inspection and non-destructive testing as manufacturing and construction proceeds. For material grade NV 420 and higher, NDT shall not be carried out before 48 hours after completion. When post weld heat treatment is performed, the final non-destructive testing shall normally to be carried out when the heat-treatment has been carried out/completed.

3.11.10.2 All welds shall be visually inspected over their full length.

3.11.10.3 Methods for non-destructive testing (NDT) shall be chosen with due regard to the conditions influencing the sensitivity of the methods. Unless otherwise agreed, structural welds shall be subjected to non-destructive testing to the extent stipulated in [Table 3-7](#). The specified percentages refer to the total length of weld for each structural assembly in question. The categories of the structural members shall be agreed with the Society in each case, ref. [\[3.1.2.1\]](#).

3.11.10.4 The non-destructive testing shall include intersection of butt-welds, cruciform joints and other areas where the stress level is high, as well as start and stop-points of automatically welded seams.

3.11.10.5 If non-destructive testing reveals defects which indicate unacceptable weld quality, the Society's surveyor may require increased extent of testing until the specified overall quality level has been re-established. If serious defects (i.e. cracks and other planar defects, excessive slag lines and cluster porosities) occur repeatedly, all welds made with the same welding procedure during the period in question shall be tested over their full length.

3.11.10.6 The Society's surveyor shall be the final judge when assessing the weld quality.

3.11.10.7 All non-destructive testing shall be properly documented and identified in such a way that the tested areas may be easily retraced at a later stage.

3.11.11 NDT-procedures and NDT-operators

3.11.11.1 NDT shall be performed in accordance with agreed written procedures that, as a minimum are in accordance with the Society's document DNVGL CG 0051 *Metallic materials - non-destructive testing* and give detailed information on the following aspects:

- materials, dimensions and temperature of tested material
- periodically verification of equipment requirements
- joint configuration and dimensions
- technique (sketches/ figures to be referenced in the NDT report)
- equipment and consumables
- sensitivity, and light conditions for MT and PT
- calibration techniques and calibration references
- testing parameters and variables
- assessment of imperfections and the surfaces from which the examination has been performed
- reporting and documentation of results. The reporting system shall ensure that there is no doubt what is examined, where it is examined and give a clear and exact description of reportable defect location.
- reference to applicable welding procedure(s)
- personnel qualification
- acceptance criteria.

3.11.11.2 All testing shall be carried out by qualified and certified personnel accepted by the attending surveyor. The NDT operators and the supervisors shall be certified according to a 3rd party certification scheme accepted by the Society based on EN ISO 9712 or ASNT Central Certification Program (ACCP). SNT-TC-1A may be accepted if the NDT company's written practice is reviewed and accepted by the Society. The supplier's written practice shall as a minimum, except for the impartiality requirements of a certification body and/or authorised body, comply with EN ISO 9712. The certificate shall clearly state the qualifications as to which testing method and within which category the operator is certified. NDT operators shall be certified at minimum Level 2 in the testing method and industrial sector concerned. Supervisors shall, unless otherwise agreed, be certified Level 3 in the testing method and industrial sector concerned.

3.11.11.3 The NDT-operators shall issue reports describing the weld quality. The reports shall clearly distinguish between accepted and rejected welds, and the number of repairs carried out to meet the specified acceptance standard shall be stated. The inspection reports shall specify the NDT-methods and procedures used including all NDT-parameters necessary for a proper assessment.

3.11.12 Weld acceptance criteria

3.11.12.1 All welds shall show evidence of good workmanship. For visual inspection and NDT the acceptance level shall normally comply with ISO 5817 quality level C, intermediate ("primary" and "secondary"). For critical areas more stringent requirements, such as ISO 5817 level B, stringent ("special"), may be applied. Welds in aluminium shall comply with ISO 10042 level B (applies for category special) or level C (applies for category primary/ secondary).

Level B and level C of ISO 5817 / ISO 10042 are equal to, respectively, acceptance level 2 and level 3 of EN-ISO 11666 *Non-destructive testing of welds. Ultrasonic Ultrasonic testing, acceptance levels*.

Ref. correlation given in EN-ISO 11666, EN 126062 and EN 17635.

Regarding ultrasonic examination EN-ISO 11666 level 2 or level 3 applies. with the following amendment: All imperfections from which the reflected echo amplitude exceeds the evaluation level shall be characterised, and all that are characterised as planar (e.g. cracks, lack of fusion, incomplete penetration) shall be rejected.

Table 3-7 Minimum NDT of structural welds

Category of member	Type of connection	Test method			
		Visual inspection	Magnetic particle ³⁾	Radio-graphy ¹⁾	Ultrasonic
Special	Butt weld	100%	100%	100%	
	Cross- and T-joints, full penetration welds	100%	100%	-	100%
	Cross- and T-joints, partly penetration and fillet welds	100%	100%	-	-
Primary	Butt weld	100%	20%	20%	
	Cross- and T-joints, full penetration welds	100%	20%	-	20%
	Cross- and T-joints, partly penetration and fillet welds	100%	20%	-	-
Secondary	Butt weld	100%	spot ²⁾	spot ²⁾	
	Cross- and T-joints, full penetration welds	100%	spot ²⁾	-	spot ²⁾
	Cross- and T-joints, partly penetration and fillet welds	100%	spot ²⁾	-	-

1) May be partly or wholly replaced by ultrasonic testing upon agreement.
 2) Approximately 2-5%.
 3) Liquid-penetrant testing to be adopted for non-ferromagnetic materials.
 4) Ultrasonic testing shall not be used for thickness less than 10 mm.

3.11.13 NDT acceptance criteria for components machined after forged/cast

3.11.13.1 Unless otherwise specified in this standard or approved manufacturer's specification, acceptance criteria from the following documents can be used for NDT of machined components:

For forged components:

- IACS Recommendation no.68, Inspection zone 1

For cast components:

- IACS Recommendation no.69, Quality level 1

NDT testing shall be focused on critical areas. Extent shall be specified by the manufacturer and shall be according to recognised standards.

Guidance note:

The objective and scope of quality control for materials, material testing and documentation thereof is to verify that the relevant properties as specified by the designer and accepted by the Society are obtained.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.11.14 Material protection against corrosion

3.11.14.1 Manufacturer is to provide protection of steel surfaces exposed to marine atmospheric conditions either by means of coating or by oiling, greasing, grouting etc. following commonly accepted industry practice and/or according specific proprietary procedures and instructions.



3.11.14.2 Bolts, nuts and associated elements shall be protected by hot-dip galvanizing according to relevant standards, i.e. BS 729 or ASTM A 153-82. Alternatively they may be fully encapsulated and the open space be filled with inhibited oil, grease etc.

Other protection methods may be accepted upon special consideration by the Society.

SECTION 4 STRUCTURAL DESIGN AND STRENGTH

4.1 Design loads

4.1.1 General

4.1.1.1 The loads to be considered in the analysis of structures are divided into:

- a) principal loads (see [4.1.2])
- b) vertical loads due to operational motions (see [4.1.3])
- c) horizontal loads due to operational motions (see [4.1.4])
- d) loads due to motion of the vessel on which the crane is mounted (see [4.1.5])
- e) loads due to climatic effects (see [4.1.6])
- f) miscellaneous loads (see [4.1.7]).

4.1.1.2 The loads to be considered in the analysis of mechanisms are divided into:

- a) loads which are directly dependent upon the action of motors or brakes
- b) loads which are not directly dependent upon motor or brake action, and which in fact are responses to the loads a) through f) in [4.1.1.1].

Furthermore, the loads may be considered belonging into two other groups; those initially specified by the Customer, and those determined by the designer.

The determination of the loads specified by the designer shall be documented with enclosed calculations, references to standards, or other justification.

The loads mentioned in [4.1.1.1] and [4.1.1.2] shall be determined and applied in accordance with [4.1.2] through [4.1.8]. Clearly, for many cranes and components some of the defined loads will never be present. Note that in the following there is not always a clear distinction between loads and responses to loads. A "load" acting on a component may well be an internal "response" in the crane as a whole. Accordingly, terms like "load due to weight" may be used instead of "weight".

4.1.2 Principal loads

4.1.2.1 The principal loads are:

- the loads due to dead weight of the components (S_G)
- the loads due to working load (S_L)
- the loads due to prestressing.

Working load (suspended load) is the static weight of the useful load lifted, plus the weight of the accessories (sheave blocks, hooks, lifting beams, grab, etc.).

Safe working load is the static weight of the load lifted (working load exclusive the weight of accessories plus any lifting beam).

Loads due to prestressing are loads imposed on structural items due to prestressing of bolts, wire ropes, etc.

4.1.2.2 Except for prestressing, all the principal loads are due to weight which always acts vertically (in the normal sense). This means that if the crane is mounted on an object which can obtain inclination (heel and/or trim) in any direction, the principal loads may have "horizontal" components when referred to a practical coordinate system of the crane. These components shall be taken into account, and shall be considered as principal loads, also if the angles are due to motions such as rolling and pitching of a vessel. Note that the simultaneous inertia forces are not considered as principal loads, see [4.1.1.1], item d) and [4.1.5].

4.1.2.3 For cranes mounted on floating vessels the horizontal components of S_G and S_L shall be taken into account as explained in [4.1.2.2]. The angles to be considered are the maximum angles expected during lifting operation with no wind and waves acting. Minimum values to be used, when decisive, are given in Table 4-1. These values are considered as minimum but may be especially considered provided statistically evidence or separate means/-operational conditions proving that list and trim could be assessed smaller.

Table 4-1 Minimum heel and trim angles, still water

Type of vessel	Heel	Trim
Ships and vessels having ship-shape hull properties	Min. 5°	Min 2°
Barges of length less than 4 times breadth, and catamarans	Min. 3°	Min. 2°
Semi-submersibles	Min. 3°	Min. 3°
Submersibles and jack-ups	Min. 1°	Min. 1°

4.1.3 Vertical loads due to operational motions

4.1.3.1 Vertical refers to the coordinate system of the crane. For a crane onboard a floating unit it is assumed that vertical state is so defined that it corresponds to physical vertical state in the ideal position with zero "heel" and "trim" of the "unit" on which the crane is mounted.

The vertical loads due to operational motions shall be taken into account by multiplying the working load by a "dynamic factor", ψ .

The dynamic factor covers inertia forces and shock.

4.1.3.2 The dynamic factor can be assessed by

$$\psi = 1 + V_R \sqrt{\frac{C}{W \cdot g}}$$

C = geometric stiffness coefficient referred to hook position (also called "spring constant" defined as force at hook to produce unit deflection at hook (kN/m))

g = standard acceleration of gravity
= 9.81 m/s²

W = working load (see [4.1.2.1]) (kN)

V_R = relative velocity (m/s) between load and hook at the time of pick-up, ref. also [8.2.2.1].

For the purpose of assessing the C-value, the modulus of elasticity of steel wire ropes shall be as specified by the wire manufacturer for an un-used wire rope. The crane stiffness (C-value) shall be calculated taking into account all elements from the hook to the pedestal support structure.

4.1.3.3 For grab duty the dynamic factor shall be increased by 20% for use of self-closing grabs (closed by lifting wire pull) and with 30% for use of grabs with motor closing.

4.1.3.4 For cranes located on the barges or the bulk carriers from where the load is lifted (picked up), the cranes may be considered as shipboard crane, see DNVGL ST 0377, *Standard for shipboard lifting appliances*.

4.1.4 Horizontal loads due to operational motions

4.1.4.1 Horizontal refers to the coordinate system of the crane. It is assumed that horizontal is so defined that it corresponds to physical horizontal in the ideal position with zero “heel” and “trim” on which the crane is mounted.

The horizontal loads (S_H) due to operational motions are:

- inertia forces due to acceleration or deceleration of horizontal motions (see [4.1.4.2])
- centrifugal forces (see [7.2.3] and [8.2.3])
- forces transverse to rail resulting from reeling and skew motion (see [4.1.4.3])
- buffer loads (S_T) (see [4.1.4.4]).

It should be noted that these horizontal forces act in addition to possible simultaneously acting horizontal components of the principal loads, see [4.1.2.2].

4.1.4.2 The inertia forces stated in [4.1.4.1] shall be determined on the basis of the maximum possible acceleration with the given machinery, and on the basis of the maximum possible deceleration with the given brakes. Typically, forces of this type occur by starting and stopping of travelling-, traversing- and slewing motions. The inertia due to angular acceleration (deceleration) of rotating machinery components shall be taken into account when this effect is significant.

For travelling cranes (and trolleys) it will normally be sufficient to consider horizontal forces corresponding to 15% of maximum vertical load on each wheel with brakes, or on each driven wheel.

4.1.4.3 Horizontal forces transverse to rail due to travelling motion occur in two ways, of which the more unfavourable one shall be considered:

- Horizontal inertia forces - to be taken as 10% of the weight of the travelling unit - balanced by lateral wheel reactions (Reeling).
- A lateral force acting on one of the “forward” wheels (or bogies) - to be taken as λ times the wheel load - balanced by other physically possible horizontal wheel reactions (skew motion). λ shall be taken according to Figure 4-1.

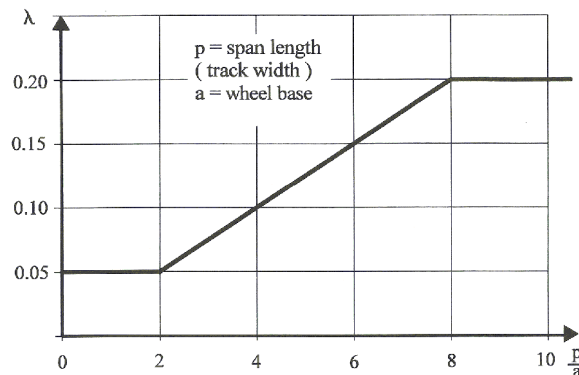


Figure 4-1 Lateral wheel force

4.1.4.4 The following requirements for determination of buffer effects are based on the assumption that the buffers are capable of absorbing the kinetic energy of the crane (or trolley) at a travelling (or traversing) speed of 0.7 times rated speed. If the suspended load can swing, the kinetic energy of it need not be taken into account.

Buffer effects need not be taken into account for speeds below 0.7 m/sec.

For speeds in excess of 0.7 m/s the resulting loads set up in the structure shall be calculated on the basis of the deceleration, which in turn shall be based upon the buff characteristics.

If automatic decelerating devices are used, the speed of the crane after deceleration upon approach to the end of the track may be used, instead of the rated speed, in the determination of buffer effects. Thus, if the speed is reduced, by the decelerating device, to a value of 0.7 m/sec or less, buffer effects need not be considered

4.1.5 Loads due to motion of vessel on which the crane is mounted

4.1.5.1 Inertia forces due to ship motion shall be calculated in accordance with [RU SHIP Pt.3 Ch.4 Sec.3 B Ship Motions and Accelerations](#). The forces shall be combined to 10^{-8} probability level to correspond with safety factors as specified for Load Case III. See also [App.C](#).

Guidance note:

Horizontal inertia forces due to motion of the mobile offshore unit (semi-submersibles, self-elevating units in transit, etc.) should be calculated, but need normally not be taken larger than $0.5g$ [m/s^2]

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.1.6 Loads due to climatic effects

4.1.6.1 The possible loads due to climatic effects are

- loads due to wind
- loads due to snow and ice
- loads due to temperature variations.

4.1.6.2 Loads due to wind shall be calculated in accordance with [App.A](#) or a recognised code or standard.

4.1.6.3 Snow and ice loads may be neglected in the design calculations except for cranes working under exceptional conditions, or for cranes of special designs being particularly sensitive to such effects.

4.1.6.4 Loads due to temperature variations shall be considered only in special cases, such as when members are not free to expand. In such cases the maximum temperature fluctuation for outdoor cranes shall normally not be taken less than 65°C . For indoor cranes possible special sources of heat shall be considered. (Note that the maximum and minimum temperatures shall always be taken into account when selecting the materials).

4.1.7 Miscellaneous loads

4.1.7.1 Access gangways, driver's cabins and platforms shall be designed to carry the following concentrated loads in arbitrary (most unfavourable) position:

- 3000 N for maintenance gangways and platforms where materials may be placed
- 300 N as the horizontal lateral force which may act outwards or inwards on handrails and toe-boards.

4.1.7.2 The loads given in [\[4.1.7.1\]](#) need not be taken into account in the strength evaluation of the main structural system of the crane, except as far as necessary for the connection between this system and the structures mentioned in [\[4.1.7.1\]](#). The dead weight of the latter structures however, shall be included in the principal loads, see [\[4.1.2.1\]](#).

4.1.8 Loads for strength analysis of mechanisms

4.1.8.1 A mechanism will always have to transmit forces when it is in motion, i.e. it shall be considered for the most unfavourable motor or brake action ([4.1.1.2], a). The loads of this type are those associated with:

- vertical displacement of centres of gravity of load and parts moved by the mechanism
- friction between moving parts
- acceleration (or braking) of the motion
- effect of wind acting on the parts moved by the mechanism.

4.1.8.2 A mechanism may have to transmit forces even when it is stationary. In such a case the function of the mechanism is similar to that of a structural component. Consequently, the loads to be considered are the same as those to be considered in the analyses of structures.

4.2 Cases of loading

4.2.1 General

4.2.1.1 For the purpose of making the nominal safety dependent upon the probability of occurrence of the loading, three general cases of loading are defined, for which the required safety margins are different:

- Case I: Crane working without wind. (See [4.2.2]).
- Case II: Crane working with wind. (See [4.2.3]).
- Case III: Crane subjected to exceptional loadings. (See [4.2.4]).

4.2.1.2 For the various types of cranes the detailed loading to be considered for each case may be different. For instance, Case III may include different conditions for stationary cranes, mobile cranes and ship-mounted cranes.

4.2.2 Case I: Crane working without wind

4.2.2.1 Case I is the main case of loading and includes the loads that necessarily will occur under normal operation:

- The principal loads (S_G and S_L) according to [4.1.2].
- The vertical loads due to operational motions according to [4.1.3].
- The horizontal loads due to operational motions (S_H), according to [4.1.4]. The two most unfavourable effects are used, excluding buffer loads.

By use of symbols Case I may be defined as follows:

$$S_G + \psi \cdot S_L + S_H$$

4.2.2.2 For cranes mounted on floating vessels horizontal components of S_G and S_L shall be taken into account as explained in [4.1.2.2] and [4.1.2.3].

4.2.2.3 With regard to S_H the following should be noted: Maximum two of the effects mentioned in [4.1.4.1] (excluding buffer loads) need be considered simultaneously. Further, in cases where travel motion takes place only for positioning the crane and is not used for moving loads, the effect of this motion shall not be combined with the effect of other motions.

4.2.3 Case II: Crane working with wind

4.2.3.1 Principally, Case II includes the same loads as Case I, with the addition of loads (S_W) due to “working” wind:

$$S_G + \psi \cdot S_L + S_H + S_W$$

S_W shall be determined in accordance with [4.1.6]. The meaning of the other symbols is as given in [4.2.2.1], with the exceptions given in [4.2.3.2].

4.2.3.2 The actual difference between Case I and Case II will depend on type and use of the crane. For indoor cranes there will be no difference, meaning the Case II need not be considered. For outdoor, stationary, land cranes the difference is normally S_W only. For cranes mounted on floating vessels the “horizontal” components of S_G and S_L shall be based on increased angles compared with Case I. Minimum angles shall be 1.5 times the values given in [4.1.2.3].

4.2.3.3 “Working” wind acting on the suspended load shall be taken into account if the effect is significant. The wind force shall be determined by taking into account the largest area which can face the wind, taking $C = 1.2$ for containers and similar shapes, and $C = 1$ for more arbitrary shapes.

4.2.4 Case III: Crane subjected to exceptional loadings

4.2.4.1 Any loading condition where one or more exceptional loads are included belongs to Case III. The following loads are defined as exceptional loads:

- buffer loads, according to [4.1.4.4] (Symbol S_T)
- inertia forces due to motion of the vessel on which the crane is mounted, according to [4.1.5] (Symbol S_M). For the vessel’s transit condition special attention shall be given to how the crane is secured. See App.C which presents an example on how this may be dealt with
- loads due to “out of service” wind according to [4.1.6] (Symbol S_W).

Other forces which necessarily must act together with the above exceptional loads are included in Case III.

4.2.4.2 Defined by symbols, the following load combinations shall be considered in Case III:

IIIa: $S_G + S_L + S_T$

IIIb: $S_G + S_M + S_{Wmax}$

For land cranes S_M will be zero. For indoor cranes combination IIIb is not considered. For cranes mounted on floating vessels the horizontal components of S_G and S_L shall be considered for estimated maximum rolling and pitching angles, including possible initial heel and trim.

4.3 Strength calculations

4.3.1 General

4.3.1.1 It shall be shown that structures and components have the required safety against the following types of failure:

- excessive yielding (see [4.3.2])
- buckling (see [4.3.3])
- fatigue fracture (see [4.3.4]).

4.3.1.2 The safety shall be evaluated for the three cases of loading defined in [4.2]. For each of these cases and for each member or cross section to be checked, the most unfavourable position and direction of the forces shall be considered.

4.3.1.3 The strength calculations shall be based on accepted principles of structural strength and strength of materials. When applicable, plastic analysis may be used. If elastic methods are not suitable to verify safety, for instance due to pre-stressing, plastic analysis may be required.

4.3.1.4 The verification of safety may be based on the permissible stresses method or the limit state method. With the factors given in this standard there will be only a formal difference between the two methods. The relation is

Safety Factor = Load Factor times Material Factor.

$$S_F = \gamma_f \cdot \gamma_m$$

For structures with nonlinear behaviour, however, significant differences may occur. In such cases the limit state method shall be used, or the safety factor shall refer to load and not to stresses.

4.3.2 Checking with respect to excessive yielding

4.3.2.1 For members made of structural steel the requirements for the various cases of loading are given. With reference to method of analysis and method of verification of safety given in Table 4-2, σ_y is the guaranteed minimum yield strength (or 0.2% proof stress). If σ_y is higher than 0.8 times the ultimate strength σ_u use in this connection $0.8 \cdot \sigma_u$ instead of σ_y .

4.3.2.2 When using elastic analysis, the permissible stresses (or the required safety factors) given in Table 4-2 refer in cases of combined stresses to the equivalent stress according to von Mises. Local peak stresses in areas with pronounced geometrical changes may be accepted by case by case evaluation.

4.3.2.3 For components made of other materials than structural steel, and for other special components, refer to [4.4], *Design and strength of particular components*.

4.3.2.4 Joints shall not be weaker than the minimum required strength of the members to be connected. For riveted joints, bolted joints, friction-grip joints, and welded joints refer to F.E.M./I or other recognised codes.

4.3.3 Checking with respect to buckling

4.3.3.1 The guiding principle is that the safety against buckling shall be the same as the required safety against the yield limit load being exceeded. This principle indicates that the factors given in the second line of Table 4-2 should represent the normal requirement. However, other values may be required or allowed, for instance due to uncertainty in the determination of the critical stresses (or load) or due to the post-buckling behaviour. Required factors are given for various types of buckling in Table 4-3.

4.3.3.2 The safety factors given in Table 4-3 are based on the assumption that the critical stresses (or loads) are determined by recognised methods, taking possible effects of geometrical imperfections and initial stresses into account. Elastic buckling in Table 4-2 means that elastic buckling stress does not exceed the yield strength.

4.3.3.3 Calculation methods and corresponding required safety factors as specified by other crane standards/codes or other specialized literature may also be used.

Table 4-2 Criteria for the checking with respect to excessive yielding

Method of verification		Load Case I	Load Case II	Load Case III
Safety Factor	Elastic analysis	1.50	1.33	1.10
	Plastic (ult. str.) analysis	1.69	1.51	1.25
Permissible stresses	Elastic analysis	$\sigma_y/1.50$	$\sigma_y/1.33$	$\sigma_y/1.10$
Limit state method	Load factor		1.30	1.16
	Material factor	Elastic analysis	1.15	1.15
		Plastic analysis	1.30	1.30

Table 4-3 Safety factors for the checking with respect to buckling

Type of buckling	S_F or $\gamma_f \cdot \gamma_m$		
	Load Case I	Load Case II	Load Case III
Elastic buckling	1.86	1.66	1.38
Elastic-plastic buckling	1.69	1.51	1.25

4.3.4 Checking with respect to fatigue

4.3.4.1 For fatigue calculations normally the latest edition of F.E.M. standard (Federation Europeenne de la Manutention), EN13001-3-1, DNVGL RP 0005 or equivalent national or international standards for cranes may be referred to.

Guidance note:

If F.E.M. 1.001 3rd edition Rev.1998.10.01. is used, and if not otherwise documented by statistical evidence and/or limitation with respect to operational performance Table 4-4 applies as guidance. (terminology as in F.E.M. 1.001 3rd edition Rev.1998.10.01.)

Table 4-4 Group classification of lifting appliances, general

Definition of crane	Particulars concerning nature of use ¹⁾	Appliance group ²⁾
Cranes for exceptionally low service time, e.g. BOP cranes		A2
Workshop and similar industrial cranes with hook		A4
Overhead travelling cranes for maintenance purpose		A3
Pipe rack cranes	hook	A3
Pipe rack cranes	magnet	A6-A8
Store room cranes		A4
Jib or gantry cranes for container service		A5
Dock side and ship-yard jib cranes	hook	A5
Dock side and ship-yard jib cranes	grab or magnet	A6-A8
Shipboard cranes for cargo-, provision- or hose handling	hook	A4

<i>Definition of crane</i>	<i>Particulars concerning nature of use ¹⁾</i>	<i>Appliance group ²⁾</i>
Platform cranes	hook	A4
Offshore cranes, whip hoist		A5
Offshore cranes, main hoist		A3
For cranes with safe working load more than 250 tonnes, the group-classification can normally be set at the lower alternative or one group lower, but at least group A2.		
1) Only a few typical cases of use are shown, by way of guidance, in this column.		
2) See F.E.M. 1.001 3 rd edition Rev.1998.10.01. Item 2.1.2.4.		

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4.2 The method of fatigue calculation, for example by using group classification in accordance with F.E.M. 1.001 3rd edition Rev.1998.10.01. on one side and calculation procedure and the specific requirements on the other, shall be consistent.

The crane group chosen for the calculation shall also be specified in the crane manual.

4.3.4.3 The fatigue strength, expressed as the critical amplitude of a fluctuating or alternating stress, shall be determined on the basis of the following information:

- component group according to [Table 4-4](#)
- the material used and the notch effect at the point being considered
- the fluctuation factor = $\sigma_{\min}/\sigma_{\max}$
- whether the maximum stress is tension or compression.

With the above data given, the critical amplitude is defined as that which corresponds to 90% probability of survival. Regarding detailed procedure for the determination of the critical stress amplitude, see F.E.M./I or other specialized literature.

4.3.4.4 Fatigue considerations shall be made for Case I for all types of cranes. In addition, for ship mounted cranes where the transit condition may be of considerable duration, it may be required to consider fatigue effect on certain components in Case III. The effect of wind need not be taken into account.

4.4 Design and strength of particular components

4.4.1 General

4.4.1.1 This standard does not attempt to make a clear distinction between structural and mechanical components. A mechanism, as defined in [\[1.1.5.38\]](#) may well contain components which could be defined as structural components. Such components shall be evaluated according to [\[4.3\]](#). The only difference from an ordinary structural component is that Cases I and II shall include forces acting on the component when the mechanism to which it belongs is in motion, see [\[4.1.8.1\]](#). The term “particular components” may mean structural as well as mechanical components.

4.4.1.2 Components that transmit forces, whether “structural” or “mechanical”, and that are not directly or completely covered by this standard shall be designed and calculated in accordance with applicable recognised codes or standards. To the extent applicable, FEM/I is advised.

4.4.2 Buckling stability of jibs

4.4.2.1 The buckling problems of a jib may be solved by determining slenderness ratios and by considering the permissible stress as a function of these ratios. Hence the determination of effective lengths with respect to the possible buckling modes may become a key problem.

4.4.2.2 The effective length of the jib depends on its support and of whether the jib is of latticed design or battened design.

4.4.2.3 The effective length of the jib – considering support effect at jib head – may e.g. be estimated in accordance with British Standard BS 2573:Part I:1983.

For a rope supported jib the effective length may, with reference to [Figure 4-2](#), be taken as

$$l_{eff} = L \left(2 - \frac{B}{A} \right) \text{ for lateral buckling}$$

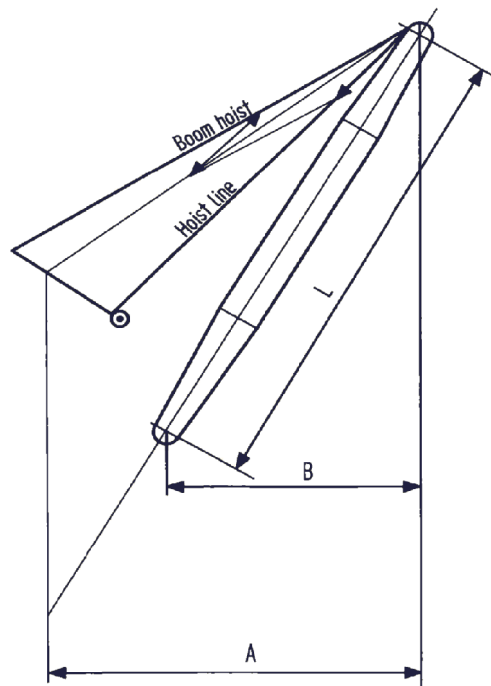


Figure 4-2 Effective length of jib

4.4.2.4 For jibs having solid webs in the considered plane of buckling, the above values of l_{eff} may be used without correction. Jibs that are latticed or battened in the considered plane of buckling l_{eff} (or the slenderness ratio) according to [\[4.4.2.3\]](#) shall be increased due to shear deformation of the jib. Recognised, simplified methods for this correction may be accepted.

The following correction factor may be used for latticed jibs:

$$\sqrt{1 + \frac{300}{(l_{eff}/i)^2}} \text{ for } \frac{l_{eff}}{i} > 40$$

$$1.1 \text{ for } \frac{l_{eff}}{i} \leq 40$$

i = radius of gyration, see [4.4.2.5].

4.4.2.5 The overall slenderness ratio l_{eff}/i of the jib in each plane may be obtained by dividing the effective length of the jib by the smallest radius of gyration of the complete cross section of the jib. Correction shall be made for tapering off cross section towards jib ends.

4.4.2.6 Stresses arising from axial compression and bending shall comply with the requirements for recognised combination formulae.

4.4.3 Slewing bearing for jib cranes

4.4.3.1 For slewing bearings of the ball and roller type the following aspects shall be examined:

- 1) plastic deformation of rolling elements and raceways (raceway capacities)
- 2) bolt capacity
- 3) ultimate carrying capacity of the slewing ring as a whole, based on the capacities of the bolts and cross sections – with due regard to the rigidity of the structures supporting the (fixed and revolving) rings
- 4) fatigue of critical sections of the outer and inner rings, i.e. the “nose” for multi-row bearings.

The slewing bearings are specialized components, and the design criteria for a given type shall as far as practicable be based on tests carried out for the particular type. Item 2), 3) and 4), however, will normally be required to be checked by calculations as indicated/specified in the following.

For design loads note special requirements given in [8.2.2.4] (offshore cranes)

4.4.3.2 The vertical component of rolling element forces on the raceway (roller element track) is assumed to vary linearly across the diameter of the raceway, i.e. a sinuous distribution with reference to the raceway circumference.

The maximum vertical force per unit length (bolt segment) is then

$$q_A = \frac{4 M_k}{\pi D^2} \pm \frac{F_a}{\pi D}$$

respectively at the front (+) and rear (-) bolt segment of the crane (front is regarded the side on which the boom is fitted).

M_k = overturning design moment on the slewing bearing. Dynamic factor is included

F_a = axial design force on the slewing bearing. Dynamic factor is included

D = raceway (track) diameter.

4.4.3.3 Slewing ring fasteners (bolts) shall have a yield capacity per bolt (i.e. stress area of bolt, A_s , times the material yield stress, f_y) not less than

- pr = degree of permanent pre-stressing related to yield (100% = 1.0)
 F_A = maximum vertical raceway load per bolt sector at the rear of the ring
 χ = F_R/F_A
 F_R = maximum horizontal (radial) load per bolt sector.

$$(F_B)_{0.2} \geq \frac{0.75}{pr} \cdot F_A \left(\frac{a + \chi b + c}{c} \right)$$

a , b and c as per Figure 4-3.

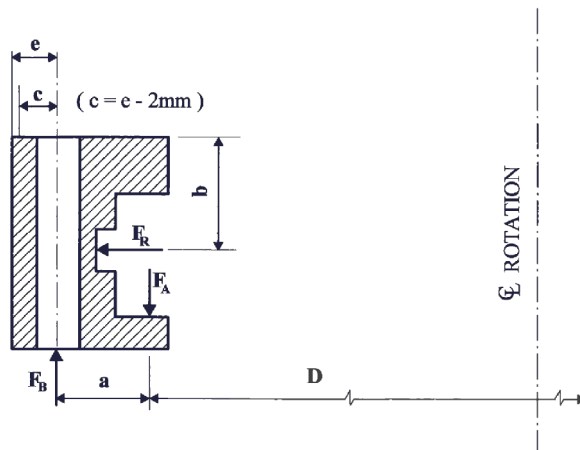


Figure 4-3 Slewing ring measures

4.4.3.4 The effective bolt length shall be at least 4.5 times the bolt diameter. Alternatively, fatigue analysis according to recognized standard to be provided and accepted.

Guidance note:

The effective bolt length can be reached by use of extension sleeves. Effective bolt length is the part of the bolt that may be free to be elongated at tension. In other words, it does not include the part of the bolt being constrained by the treads.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.4.3.5 Slewing ring fasteners shall be pre-stressed according to a written procedure. The degree of permanent prestressing shall be as high as possible without producing permanent elongation in bolt during prestressing. The degree of permanent prestressing shall at least be 65% but normally not more than 80% of bolt material yield strength. If documented by testing, procedures claiming a degree of permanent prestressing up to 90% of bolt material yield strength may be credited.

4.4.3.6 The holding-down bolts shall - as far as practical - be equally spaced over the 360° circumference.

Guidance note:

With equally spaced bolts, F_A and F_R in [4.4.3.3] becomes

$$F_A = \left(\frac{4M_k}{D} - F_a \right) \frac{1}{m}$$

Normally, the following formula applies to the rear "element" of all the bearing.

$$F_R = \frac{1}{m} \left[4F_r + \left(\frac{4M_k}{D} + F_a \right) \tan \beta \right]$$

where:

- β = 0° for "multi-row" roller bearings and multi-row ball bearings with balls fully supported in vertical direction
- β = 30° for single-row ball bearings and multi-row ball bearings with balls partly supported in vertical direction
- β = 45° for cross roll bearings
- m = is number of bolts
- F_r = radial force on the slewing bearing.

(Note that F_r is here assumed to act horizontally in the direction of the jib).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.4.3.7 Yield limit load (capacity) of the slewing bearing shall be evaluated considering equilibrium between rolling element forces and the following "reactions" acting on an "element" of the ring:

- Bolt forces acting on the considered "element" possible shear included.
- Possible interface pressure between the considered "element" and the structure supporting the ring.
- Forces acting in the cross section of the ring (i.e. the "end surfaces" of the considered "element").

4.4.3.8 The ratio between the ultimate carrying capacity (ring and bolt simultaneously) and calculated load on the slewing bearing shall not be less than 1.5 for load case I (LCI) and 1.33 for LCII. The calculations shall be carried out for one bolt segment (the rear bolt segment) of the inner ring, the outer ring and the retaining ring (if provided) separately.

For finite element calculations, reference is made to DNV GL document P261.1C-J-70107, Rev. 01 "FE Modeling and Analysis Accepted Procedure for Crane Slewing Bearings".

4.4.3.9 Penetration of aggressive materials into the raceways shall be prevented. For bearings that are often exposed to splash and surge water, the use of an adequate seal is recommended.

4.4.3.10 The vertical support in the bearings companion structure should preferably be in the vicinity of the track diameter in the heaviest loaded areas (main tension/compression zones). If this is not the case, the Society will normally require use of bracket plates. The Society may, upon evaluation of each actual bearing and companion structure design, ask for detailed calculations of any deflection of the support surfaces under maximum operating load together with documentation of the permissible limits as specified by the bearing manufacturer.

See also comments on desired avoidance of brackets in [4.4.4.2].

Guidance note:

Slewing bearings of the ball or roller type are required to be opened up periodically for inspection.

However, for cranes on which a retention device (with minimum capacity equivalent to the slewing bearing) is arranged, or the slewing bearing has been specially adapted and approved for non-destructive crack detection, or a procedure for regular clearance measurements, grease sampling and fatigue evaluations are adopted in agreement with the crane and slewing bearing manufacturer, the requirement for opening up may be waived.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.4.4 Flanges

4.4.4.1 For rounded shaped crane columns, the thickness of connecting flanges shall be checked locally according to

$$t_{\min} = \sqrt{\frac{6 \cdot S_F \cdot \left(\frac{2M_k}{r_x} - F_a \right) \cdot \left(|r_b - r_x| - \frac{1}{2} d_h \right)}{m \cdot \left(s - \frac{1}{2} d_h \right) f_y}}$$

where

S_F = required safety factor, given in [Table 4-2](#)

r_b = bolt circle radius for the flange in question

r_x = pedestal radius or kingpost radius measured to middle of plate

d_h = bolt hole diameter

s = centre /centre spacing for boltholes

f_y = yield strength flange material.

4.4.4.2 Normally there shall be a full penetration weld between the pedestal/kingpost shell and the flanges.

4.4.4.3 Flatness of the connecting flange mating surface to the slewing bearing shall comply with the slewing bearing manufacturer's specification.

No surface levelling compound shall be used in order to obtain required flatness.

4.4.5 Pedestal and pedestal adapter for jib cranes

4.4.5.1 Pedestals and pedestal adapters shall be designed for the same crane group as that of the crane.

4.4.5.2 Fatigue evaluation of pedestal/pedestal adapter shall be carried out in accordance with FEM or other acceptable crane standard.

SECTION 5 MACHINERY AND EQUIPMENT

5.1 Basic requirement

5.1.1 Design conditions (environmental, operational) for machinery and systems

5.1.1.1 Machinery and systems for lifting appliances shall be designed to operate under the following environmental conditions if not otherwise specified in the detail requirements for the component or system:

- ambient air temperature between the design temperature and 35°C
- ambient air temperature inside machinery housing or other compartments containing equipment between 5°C and 55°C
- relative humidity of air up to 96%.

5.1.1.2 Where the certification standard stipulates requirements for capacity or effect of machinery, these shall normally be determined on the basis of the following:

- ambient air temperature: 40°C
- relative humidity of air: 50%.

These values will be reconsidered if the crane shall work in tropical or sub-tropical areas.

Guidance note:

Consideration should be taken to the heat generated by machinery or other equipment and also to the heat caused by sun radiation on surrounding bulkheads.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.1.1.3 The effect of ice on an appliance installed in cold weather areas shall be considered for the parked/stowed position.

5.1.2 Materials

5.1.2.1 The applied material standards shall be in compliance with [Sec.3](#) or other relevant recognised code or standard.

5.1.2.2 Materials with high heat resistance shall be applied where a fire may cause unacceptable consequences of damage, such as collapse, outflow of flammable fluids etc.

Non-metallic materials shall be flame-retardant in accordance with recognised standard.

5.1.3 Arrangement and general design of components and equipment

5.1.3.1 All components in a system shall be adequately matched with regard to strength, capacity and functional performance.

5.1.3.2 Relative movements due to load variations, thermal expansion, misalignment, vibration and interaction from foundations shall be allowed to avoid detrimental effects.

5.1.3.3 Bolts and nuts exposed to dynamic forces and vibrations shall be properly secured or pre-stressed.

5.1.3.4 All operational equipment shall be arranged for easy access. Components and equipment normally subject to inspection and maintenance shall be installed so as to provide easy access.

5.1.3.5 Arrangement for adequate lubrication of bearings and gears shall be provided.

5.1.3.6 All means of access shall be of a permanent nature and shall be considered in each case with due respect to type of crane and its intended service.

5.1.3.7 Protection against rain, sea-spray, snow, ice and sand shall be provided (essential for brakes, clutches etc.). Provisions shall be made to prevent accumulation of water in any construction. Rapid drainage shall be ensured.

5.1.3.8 Crane seatings and their supporting structures shall be of rigid design. As far as relevant tolerances of travelling cranes and gantry cranes and their tracks shall at least comply with FEM/I regulations. Tolerances of mating surfaces of seatings shall meet the standard required by the manufacturer of the slewing ring and general engineering standards.

5.1.3.9 Cranes shall be arranged with emergency escape in addition to the main access. Portable escape equipment may be accepted.

5.1.4 Ventilation

5.1.4.1 Forced ventilation (heating/cooling) shall be provided - when necessary - to ensure inside temperatures within the range required by [5.1.1.1].

5.1.4.2 Higher temperatures inside cubicles, desks etc. will be accepted provided installed equipment is regarded as suitable for such higher temperature.

5.1.4.3 Verification of temperature and final acceptance shall be based on loads and operational sequence relevant to the lifting appliance.

5.1.5 Strength

5.1.5.1 The strength of components and equipment shall generally be in compliance with [4.3] and [4.4] of Sec.4. Specific requirements for some important components are given in the following. Recognised codes and standards may be applied as a supplement to this Standard for Certification.

5.1.5.2 If acceptable accuracy cannot be obtained by strength calculations, special tests may be required for determination of the strength of a design.

5.2 Components

5.2.1 Winches

5.2.1.1 For design of the support of the winch to its foundation, relevant forces from crane operations are understood to having been evaluated at their maximum.

5.2.1.2 Winches shall be fitted with an operational brake, which normally absorbs energy through the winch power system. The operational brake is used to brake normal operating movements. Capacity and strength for the operational brake shall be documented through testing. In addition there shall be a mechanical brake, which satisfy requirements given in [5.2.3].

5.2.1.3 The direction of motion of the operating devices shall be such that the load is raised by clockwise movement of a hand-wheel or crank handle, or alternatively movement of a hand-lever towards the operator.

5.2.1.4 The operating device shall be arranged to return automatically to the braking position when the operator releases the control. However, for cranes operating in constant tension or active heave compensation modus – the brake shall remain off when the operator releases the control.

5.2.2 Drums

5.2.2.1 Drum diameters shall be determined with due respect to:

- type of reeving
- state of loading
- daily operating time

and shall be suitable for the selected steel wire rope, as directed by the rope manufacturer.

The ratio D_p/d shall normally not be less than 18 where

- D_p = pitch diameter of drum
 d = nominal diameter of steel wire rope.

For fibre rope drums, the required diameters of rope drums shall be agreed with the Society in each case.

5.2.2.2 As far as practicable and suitable for the arrangement, drums shall be designed with a length sufficient to reel up the rope in not more than 3 layers.

More than 3 layers (reel up) may be accepted if the wire rope has an independent wire rope core (IWRC) and one of the following conditions is complied with:

- spooling device is provided
- drum is grooved
- fleet angle is restricted to 2°
- split drum is arranged
- separate traction drum is fitted.

However, when the number of layers exceeds 7, special consideration and approval will be required.

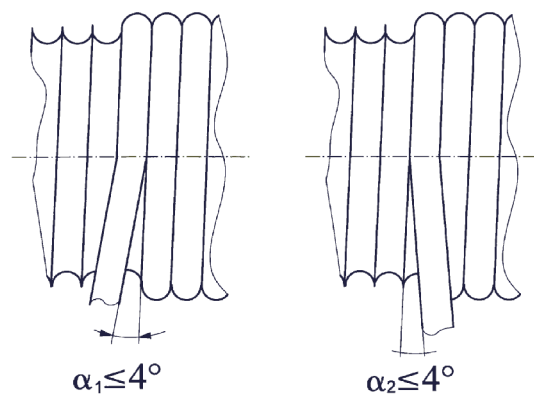


Figure 5-1 Wire rope fleet angles

5.2.2.3 For all operating conditions, the distance between the centre of the top layer of the wire rope on the drum and the outer edge of the drum flanges shall be at least 2.5 times the diameter of the wire rope, except in the cases where wire rope guards are fitted to prevent over spilling of the wire.

Guidance note:

It is advised that the drums have grooves to accept the rope. Where a grooved rope drum is used the drum diameter shall be measured to the bottom of the rope groove. To avoid climbing of the rope on the grooves the angles α_1 and α_2 shall not exceed 4° , see [Figure 5-1](#). The groove shall be smooth. Advised radius of groove is $0.53 d$ (d = nominal rope diameter) and should be between $0.52d < r < 0.57d$.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.2.4 Drums shall either be fabricated from steel plates or be castings.

Ferritic nodular cast iron with minimum elongation (A_5) 10% may be accepted. By special consideration a lower elongation may be acceptable. Impact testing of ferritic nodular cast iron will for this application be waived.

5.2.2.5 Drums shall be checked with respect to their overall equilibrium situation and beam action, with the maximum rope tension acting in the most unfavourable position. The effect of support forces, overall bending, shear and torsion shall be considered. The rope tension shall in this case include any amplifying coefficient and the dynamic factor ψ . If more unfavourable however, the situation with forces directly dependent upon motor or brake action shall be considered.

5.2.2.6 The drum barrel shall be designed to withstand the surface pressure acting on it due to maximum number of windings. The rope is assumed to be spooled under maximum uniform rope tension. Maximum uniform rope tension means the tension due to safe working load without taken into account the amplification factors and dynamic factor. If the rope tension varies systematically, such as when an object is lifted from bottom and out of water, this variation shall be taken into account.

5.2.2.7 Unless comprehensive tests justify a lower value, the hoop stress in the barrel shall not be taken less than

$$\sigma_h = C \cdot \frac{S}{p \cdot t_{av}}$$

- σ_h = hoop stress in drum barrel
- S = maximum rope tension under spooling
- p = pitch of rope grooving (the distance between ropes, centre to centre, within one layer)
- t_{av} = average wall thickness of drum barrel
- C = 1 for one layer
- = 1.75 for two layers
- = Special consideration, for more than two layers (thorough documentation or special testing may be required).

Guidance note:

The value of the C-factor depends on variables such as drum design, rope characteristics, type of operations, load characteristics and spooling. For 5 layers and above, a C-factor of 3 will normally be accepted for subsea retrieval operations with the full load from the first layer, applying "stiff" wire ropes. However, in some cases, and special for winches with constant layer pull, the C-factor may be even higher. Between two and 5 layers, linear interpolation may be applied.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

The calculated hoop stress σ_h shall not exceed 85% of the material yield stress.

5.2.2.8 The drum flanges shall be designed for an outward pressure corresponding to the necessary lateral support of the windings near the drum ends. Unless a lower pressure is justified by tests (special tests may be required), the pressure is assumed to be linearly increasing from zero at the top layer to a maximum value of

$$p_f = \frac{2 \cdot t_{av}}{3 \cdot D} \cdot \sigma_h$$

near the barrel surface. (The pressure acting on the barrel surface is assumed to be three times this value. D is the outer diameter of the barrel.)

The calculated flange stress shall not exceed 85% of the material yield stress.

It is assumed proper spooling and low flange deflections, avoiding cutting/burying of the wire rope into the underlying layers. Further, wire rope crushing is not covered.

5.2.3 Brakes

5.2.3.1 Unless a crane operates in constant tension or active heave mode, automatic braking systems shall be arranged and shall be activated when the operating device is brought to zero or braking position.

5.2.3.2 Brake mechanisms shall be so designed that the brakes are activated upon failure of the power drive or the control system. Means shall, however, be provided for overriding such systems at any time.

5.2.3.3 Braking systems shall be such as not to introduce shock loads.

5.2.3.4 Brakes shall preferably act directly on the drum. Where a brake is arranged in front of a transmission, the components in the transmission subjected to loads due to braking shall be designed to comply with the requirements for strength of the brake itself.

5.2.3.5 Brakes for hoisting and luffing shall normally exert a torque not less than 80% in excess of the maximum torque on the brake caused by the loads being regarded as static loads (i.e. the braking capacity). However, for subsea handling winches and other special applications this requirement will be subjected to special consideration, with due evaluation of both minimum and maximum braking capacity. The forces introduced on the accompanying structure by the maximum braking capacity (when the brakes slip) shall not lead to any structural damage. The lowest expected coefficient of friction for the brake lining with due consideration to service conditions (humidity, grease, etc.) shall be applied in the design calculation of braking torque capacity, but this coefficient of friction shall not be taken higher than 0.3.

5.2.3.6 Automatic braking is assumed to be obtained by a spring force (or equivalent) and that the brake is released by hydraulic, pneumatic or electric means. The spring force shall be such that the braking torque capacity required by [5.2.3.5] will be obtained.

5.2.3.7 Components of brakes shall be designed to fulfil strength requirements as given in Sec.4, i.e. the design loads for actual load cases. The inertia due to angular acceleration of rotating components shall be taken into account when this effect is significant.

5.2.3.8 Brakes shall be designed with due regard to inspection, adjustments and maintenance. Brake surface (e.g. on drum) should not be recessed.

5.2.4 Gear transmissions

5.2.4.1 Gears transmitting braking forces for mechanical brakes shall be considered with respect to excessive yielding according to actual loads, see [5.2.3.7], and with respect to fatigue based on a recognised code and according to a relevant load spectrum (i.e. load-time characteristics).

5.2.4.2 When the Society's document DNVGL CG 0036 *Calculation of gear rating for marine transmissions* are used for dimensioning of the gears, safety factors as specified in the Table 5-1 should be used.

Table 5-1 Safety factors for gear

Type of stress	Safety factor
Tooth root stresses	1.4
Contact stresses	1.0
Scuffing	1.0

5.2.5 Steel wire rope with fittings and anchorages

5.2.5.1 For wire and rope materials and construction of steel wire ropes, see Sec.3.

For testing of steel wire ropes, see Sec.14.

5.2.5.2 Length of wire rope for a lifting appliance shall be such that there is not less than 3 turns of wire rope on the drum with the hook at the lowest position and the boom in the most adverse position. Normally the ropes for hoisting and derricking shall be in one length.

5.2.5.3 Steel wire rope safety factor for running application shall be the greater of:

- not less than the greater of 3 and

$$S_F = \frac{10^4}{0.885 \cdot SWL + 1910}$$

but need not exceed 5.

- $S_F = 2.3 \psi$

ψ = dynamic factor for the crane

SWL = Safe Working Load (kN).

For cranes with wire rope suspended jibs, the required safety factor shall be calculated with basis in the static and dynamic load the boom will be subjected to, leading to a separate boom ψ to be applied in the calculations.

5.2.5.4 For safety factor of wire ropes used for lifting people or manned objects see [11.5.2.1].

5.2.5.5 The minimum breaking load B of steel wire ropes shall not be less than

$$B = S_F \cdot S$$

where S is the maximum load in the rope resulting from the effect of the working load (suspended load) and loads due to any applicable dead weights. The number of parts and friction in sheaves shall be considered.

5.2.5.6 Where not otherwise demonstrated by testing, a combined allowance for friction and bending of the wire ropes, taken as

- 1.5% for each sheave with ball or roller bearings
- 5% for each sheave with plain bearings

shall be applied for calculation purpose of S in [5.2.5.5]. However, reduction due to wrap angle may be applied.

5.2.5.7 In wire ropes for running application the number of wires shall not be less than 114 (6 strands with 19 wires each).

In the case of one part hoist line (whip hoist) non-rotation wire shall be used or ball bearing swivel shall be provided for preventing accumulation of twist.

Guidance note:

A swivel should always be fitted between the hoist rope and the hook or other lifting attachment, and, except in the case of a ship's derrick, the swivel should be fitted with ball- or roller bearings that can be lubricated regularly

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.2.5.8 For rope anchorage properly designed rope sockets like spelter sockets, ferrule secured-eyes (with thimble only) or self-locking wedge sockets shall preferably be used.

Socketing of wire ropes shall be carried out in accordance with a recognised standard and the socket manufacturer's instruction.

5.2.5.9 Where wire rope clamps are used, the free length of rope end shall be prevented from fraying. Only properly designed wire rope clamps with two gripping areas shall be used (the U-bolt type is not acceptable). The number of clamps depends on the diameter of the wire rope and shall comply with maker's specification. The number of clamps shall in no case be less than 3.

5.2.5.10 A thimble or loop splice shall have at least five tucks, three tucks with the whole strand of the rope, and two tucks with one-half of the wires cut out of each strand. The tucks shall be under and over against the lay of the rope. Splices shall be tightly drawn and neatly made. These requirements will not prevent the use of another form of splice that can be shown to be as efficient.

5.2.5.11 Where other connections are fitted, the method of splicing shall be according to recognised codes and standards.

5.2.5.12 Where wire ropes are wound around design elements with a small diameter (e.g. shackles bolts, crane hooks, load connecting elements, etc.), the permissible breaking load shall be reduced.

5.2.5.13 The efficiency of the applicable wire rope termination shall comply with an EN-or ISO standard or be documented by the test certificate/report covering the actual wire rope being used. If the efficiency of the end termination is below 80%, the loss shall be compensated for up to minimum 80% efficiency.

5.2.5.14 The rope anchorage of the boom rope to the drum shall not be taken less than the maximum design rope pull. Anchorage including friction of the remaining turns on the drum when the boom is in the lowest allowed position shall withstand the breaking load of the boom wire rope. The friction force shall be based on a coefficient of friction of 0.1.

5.2.5.15 All wire rope anchorages shall be accessible for inspection. Exception may be granted, assuming redundant end stop at 3 safety turns of wire on the drum.

5.2.6 Fibre ropes

5.2.6.1 General requirements

5.2.6.1.1 Fibre ropes for running rigging or standing rigging as well as "loose gear" shall comply with DNV GL offshore standard DNVGL OS E303 *Offshore fibre ropes*. The rope design is subject to approval. The approach as specified in DNV GL offshore standard DNVGL ST E407 *Underwater deployment and recovery systems* shall be applied.

5.2.6.1.2 Synthetic fibre ropes shall be stabilized with respect to light and heat.

5.2.6.1.3 Free rope ends shall be yarn-wound to prevent disintegration of the rope structure. Synthetic fibre ropes may be partially melted.

5.2.6.2 Definitions

5.2.6.2.1 The terms "running rigging" and "standing rigging" are defined in [1.1.5].

5.2.6.3 Dimensioning

5.2.6.3.1 For fibre ropes intended for running rigging the approach as specified in DNV GL offshore standard DNVGL ST E407 shall be applied.

In the case of fibre ropes intended for loose gear not in accordance with DNV GL offshore standard DNVGL OS E303 but in accordance with recognized standard, the breaking load B shall not be less than the product of the static rope tension S and one of the safety factors S_F given in Table 5-2:

$$B = S_F \cdot S$$

where S is the maximum load in the rope resulting from the effect of the working load and loads due to any applicable dead weights. The number of parts and friction in sheaves shall be considered. Further, reduction in breaking load due to small diameter attachments - such as shackle bolts, crane hooks, etc. - shall be considered.

Table 5-2 Safety factors for fibre ropes for loose gear

Nominal diameter of rope [mm]	Safety factor S_F
10 – 13	12
14 – 17	10
18 – 23	8
24 – 39	7
40 and over	6

5.2.7 Sheaves

5.2.7.1 Sheaves for steel wire ropes

Sheaves shall comply with a recognised code or standard. Normally, the sheave diameter for steel wire ropes shall at least correspond to a ratio $D_p/d = 18$, where D_p is the pitch diameter of the sheave and d is the wire rope diameter. Further, the sheave groove shall comply with the corresponding guidance for grooves in drums as specified in [5.2.2.3].

For non-rotating sheaves and similar arrangements where the wire is not moving the ratio D_p/d shall be at least 10.

5.2.7.2 Sheaves for fibre ropes

For fibre rope applications as running rigging and standing rigging, the requirements for the rope sheave diameter and to the groove shall be established in accordance with DNV GL offshore standard DNVGL ST E407. For non-rotating sheaves in loose gear and similar arrangements where the rope is not moving and where the fibre rope is in accordance with recognized standard, but not DNV GL offshore standard DNVGL OS E303, the ratio D_p/D_s shall be adequate and at least as shown in Table 5-3. For non-standardized fibre ropes, the rope sheave diameter shall be agreed with the Society.

Table 5-3 Minimum diameter of non-rotating rope-sheaves for fibre ropes in accordance with recognized standard, but not DNV GL offshore standard DNVGL OS E303, and intended for loose gear

<i>Rope material</i>	<i>Rope-sheave diameter, minimum</i>
manila, hemp	5.5ds
polyamide	4ds
polypropylene	6ds
polyester	6ds
carbon-fibre	14ds

where ds is the fibre rope diameter.

5.2.7.3 Sheaves shall either be castings, forgings, welded or be gas cut and machined from steel plate. However, sheaves made from nylon castings or other composite material may be accepted after special considerations, provided thorough documentation of the applied design criteria as well as material properties (confirmed by independent testing).

5.2.7.4 Castings and plates for sheaves shall comply with Sec.3. However, for non-welded sheaves the required impact testing of the material will be waived.

5.2.7.5 All sheaves and blocks shall be so arranged that the wire rope cannot run off the sheave.

5.2.8 Anti-breakdown device for slewing mechanism

5.2.8.1 Slewing mechanism shall be so designed that it will not be damaged by heavy braking or reversal of the motion.

Guidance note:

This may be achieved either by designing the drive mechanism to resist the torque imposed by the above conditions or by the insertion of a torque limiting device (e.g. a slipping clutch) which will protect the mechanism from excessive shock loading. The torque limiting device should also allow the brake to slip if the horizontal load on the boom exceeds the load for which the boom has been designed.

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5.2.9 Lifting gear, including loose gear and grabs

5.2.9.1 For definition of lifting gear, including loose gear, see [1.1.5].

5.2.9.2 Material requirements shall be as specified in the applied codes or standards. If the codes or standards used do not cover applicable material requirements, or a design is not covered by code or standard, the material requirements given in [Sec.3](#) shall be complied with. Where certification by other competent persons (for example the manufacturer) is accepted, the material certificates shall be filed by the competent person and shall be presented upon the Society's request.

In general, cargo hooks, shackles, swivels and rings shall be forged. Exceptions to this require the consent of the Society.

5.2.9.3 Design and strength of lifting gear shall comply with recognised codes or standards. For pad eyes and skids, ref. is made to Appendix E.

5.2.9.4 Where applicable codes or standards are not followed, the safety factor for chain as given in [\[5.2.10.1\]](#) will normally be acceptable.

5.2.9.5 Based on control of magnitude of load, or, overload protection in the crane, lifting and spreader beams/frames will normally be accepted calculated as outlined in [Sec.4](#) with stress level as required for Load Case II and with dynamic factor not less than the overload test factor as given in [Sec.13](#). In addition, Load Case I based on applied ψ shall be fulfilled.

5.2.9.6 Design load for lifting gear as well as grabs shall be the greater of:

- $0.75 \times \psi \times \text{SWL}$, and
- SWL

ψ is the dynamic factor for which the crane is designed.

5.2.9.7 The main and auxiliary hook (whip hoist) for offshore cranes shall at least meet the requirements given in DIN 15400 machinery group 1 AM and 2M respectively. However, in cases where the design hook load corresponds to that caused by the dynamic response for significant wave heights exceeding 3 metres, machinery group 1 AM may also be accepted for the auxiliary hook.

5.2.9.8 Hooks shall be fitted with a safety latch or be so designed that the ring or sling cannot fall out. Irrespective of design, hooks for offshore cranes shall be fitted with a safety latch.

5.2.9.9 Hook blocks shall have protective plates and shall be easy to handle from any side.

5.2.9.10 In cases where, upon special agreement see [Sec.1 \[1.3.7\]](#), the damping effect of a hydraulic damper shall be included in the approval, the damping effect shall be documented by both calculations submitted and practical tests. The test program shall be submitted by the customer, accepted by the Society's approval unit, and monitored by the certifying surveyor to the extent agreed before the tests are initiated.

5.2.9.11 Lifting gear and grabs shall be marked with the safe working load. The crane manual shall contain information of necessary specifications for ordering replacements.

5.2.10 Chains

5.2.10.1 The safety factor for chains, measured against the minimum specified breaking strength, shall not be less than 4 with respect to the design load as specified in [\[5.2.9.4\]](#)

5.2.10.2 The material of the chains and/or the grade shall be documented with a certificate, for example an inspection certificate of type 3.1, referring to a recognised standard.

5.2.10.3 Before being taken into use for the first time the chains shall be load tested as for loose gear, and the tests shall be documented by CG3, alternatively ILO Form 3, certificate.

5.2.11 Skids

5.2.11.1 Skids designed for lifting of varying loads as well as skids designed for a specific load and/or a specific transport assignment may be certified in accordance with the requirements given in [5.2.9], however with observation of the conditions outlined in App.E [E.1.3].

5.3 Power systems

5.3.1 Prime movers

5.3.1.1 Prime movers shall be designed to accept normal load conditions such as running at load levels characteristic for the expected use of the crane, and to accept frequent and large load variations. Max dynamic load shall not lead to stalling.

5.3.1.2 The crane prime mover shall be such that the full power demands of any loading and speed combinations associated with the various motions are compatible with the operations that the crane is designed for.

5.3.1.3 For operation within hazardous (gas-dangerous) areas, prime movers and their installation shall meet additional pertinent requirements.

5.3.1.4 Adequate insulation and shielding shall be provided for the protection of personnel during performance of their normal duties and to prevent ignition of flammable fluids.

5.3.1.5 The internal combustion engines shall normally not be located in hazardous areas. The exhaust gas outlet of the engines shall have an effective spark arrestor. The outlet shall be led to the atmosphere at a safe distance from any hazardous area.

5.3.2 Power independency

5.3.2.1 Hoisting and derricking functions shall be independent of travelling and slewing functions.

5.3.2.2 The crane and its load shall be able to remain in unchanged position in the event of power failure, see also [5.2.3.2].

5.4 Electrical installations, equipment and systems

5.4.1 General

5.4.1.1 Electrical installation shall comply with relevant and recognised codes or standards pertinent to the location of the crane.

5.4.1.2 Electrical installations of the Society certified lifting appliances certified by the Society and installed onboard vessels classed with the Society shall comply with *DNV GL rules for classification of ships RU SHIP Pt.4 Ch.8 Electrical installations*. However, the documentation requirements shall still be taken from [2.1.2.1] in this crane standard. Further, the certification requirements shall still be taken from [2.2.1.1] in this crane standard.

5.4.1.3 For cranes covered by class notations **Crane**, **Crane vessel**, or **Crane (N)**; the electrical equipment and systems supporting the crane main functions shall comply with *RU SHIP Pt.4 Ch.8 Electrical installations*

and will generically be defined as “essential”. Specifically equipment and systems having impact on the Risk Contributors listed in [8.4.2.2] shall fulfil requirements with respect to essential installations.

5.5 Hydraulic, pneumatic, instrumentation, automation and wireless remote control systems

5.5.1 Hydraulic systems

5.5.1.1 Hydraulic systems and their lay-out shall satisfy recognised codes or standards and engineering principles and shall as far as relevant or applicable comply with pertinent rules of the Society.

5.5.1.2 When designing hydraulic circuits, all aspects of possible methods of failure (including control supply failure) shall be considered. In each case, components shall be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel shall be the prime consideration, and damage to equipment minimized. (Fail-safe concept)

5.5.1.3 All parts of the system shall be designed or otherwise protected against pressures exceeding the maximum working pressure of a system or any part of the system or the rated pressure of any specific component.

5.5.1.4 Systems shall be designed, constructed and adjusted to minimize surge pressures and intensification pressures. Surge pressure and intensified pressure shall cause no hazards.

5.5.1.5 Loss of pressure or critical drops in pressure as well as missing hydraulic refilling shall not cause a hazard.

5.5.1.6 Leakage (internal or external) shall not to cause a hazard.

5.5.1.7 Whatever type of control or power supply used (e.g., electrical, hydraulic, etc.), the following actions or occurrences (unexpected or by intention) shall create no hazard:

- switching the supply on or off
- supply reduction
- supply cut-off or re-establishment.

5.5.1.8 Hydraulic systems and other machinery in connection with the hydraulic system shall be designed to protect personnel from surface temperatures that exceed touchable limits by either insulating or guarding.

5.5.1.9 To facilitate maintenance, means shall be provided or components so fitted that their removal from the system for maintenance:

- shall minimize the loss of fluid
- shall not require draining of the reservoir
- shall not necessitate extensive disassembly of adjacent parts
- drip trays shall be provided.

5.5.1.10 The fluid reservoir shall be designed with respect to:

- dissipation of heat from the oil
- separation of air
- settling of contamination in the oil
- maintenance work.

Indicators showing the fluid level shall be permanently marked with system “high” and “low” levels.

Air breathers on vented reservoirs should be provided which filter air entering the reservoir to a cleanliness level compatible with the system requirements, taking into consideration the environmental conditions in which the system shall be installed.

5.5.1.11 Effective means for filtration and cooling of the fluid shall be incorporated in the system.

A means of obtaining a representative fluid sample shall be provided to allow for checking fluid cleanliness condition.

Valves for fluid sampling shall be provided with sealing and with warning signs marked "System under pressure"

5.5.1.12 Flexible hoses and couplings shall be type approved and delivered with pressure test report.

5.5.1.13 Flexible hoses shall only be used

- between moving elements
- to facilitate the interchange of alternative equipment
- to reduce mechanical vibration and/or noise.

5.5.1.14 Flexible hoses shall be located or protected to minimize abrasive rubbing of the hose cover.

5.5.1.15 Accumulators shall be separately approved.

5.5.1.16 Load carrying hydraulic cylinders (luffing cylinders and boom telescoping cylinders) shall be separately approved in accordance with the Society's document DNVGL [CG 0194 Hydraulic cylinders](#). Materials for hydraulic cylinders shall specially fulfil the requirements given in DNVGL [CG 0194 Hydraulic cylinders](#).

5.5.1.17 Requirements regarding cylinder wall thickness are described in the standard mentioned in [\[5.5.1.16\]](#).

5.5.1.18 Welds for hydraulic cylinders shall be in accordance with DNVGL [CG 0194](#). Welds shall normally be full penetration welds. Other than full penetration welds may be accepted on a case-to-case basis provided that acceptable stresses (both with respect to fatigue and static) can be documented. This will primarily be applicable for cylinders used for pushing only (e.g. jib cylinders).

5.5.1.19 The design calculations for hydraulic cylinders shall be based on the maximum obtainable pressure (safety valve setting). Alternatively, if the maximum dynamic force applied on the crane is known, this may be used as basis for the design calculations. In both cases different outreach positions shall be evaluated.

Buckling shall be calculated in accordance with DNVGL [CG 0194](#). However, if more accurate calculation methods are applied, on case by case considerations, a safety factor with respect to buckling down to 2.3 (LCI) and 2.04 (LCII) may be accepted for slenderness ratios above 110. For slenderness ratios below 90, buckling is not considered and a safety factor of 1.8 with respect to yield will be required. For slenderness ratios between 90 and 110, linear interpolation between the two acceptance criteria will be applied.

5.5.2 Testing of hydraulic systems

5.5.2.1 Except for mountings, each component shall be pressure tested to 1.3 times the design pressure, though not more than 70 bars above the design pressure.

5.5.2.2 Hydraulic testing of the assembly shall be performed in the presence of a surveyor, unless otherwise agreed. The pressure from the overload testing is deemed sufficient and shall be maintained for a time sufficient for check of leakage. The assembly shall exhibit no sign of defects or leakage.

5.5.3 Pneumatic systems

5.5.3.1 Air intakes for compressors shall be so located as to minimize the intake of oil- or water-contaminated air.

5.5.3.2 When designing pneumatic circuits, all aspects of possible methods of failure (including control supply failure) shall be considered. In each case, components shall be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel shall be the prime consideration, and damage to equipment minimized. (*Fail-safe concept.*)

5.5.3.3 Loss of pressure or critical drops in pressure shall cause no hazard.

5.5.3.4 Leakage (internal or external) shall create no hazard.

5.5.3.5 Whatever type of control or power supply used, the following actions or occurrences (unexpected or by intention) shall not create a hazard:

- switching the supply on or off
- supply reduction
- supply cut-off or re-establishment.

5.5.3.6 Air supply to instrumentation equipment shall be free from oil, moisture and other contaminants. The dew point shall be below 5°C for air in pipes located in crane engine room. In pipes outside the engine room the air shall have a dew point below $(T_D - 5)^\circ\text{C}$.

5.5.3.7 Components requiring extremely clean air shall not be used.

5.5.3.8 Main pipes shall be inclined relative to the horizontal, and drainages shall be arranged.

5.5.3.9 Piping and pressure vessels shall comply with relevant recognised codes and shall generally comply with the Society's rules.

5.5.4 Control and monitoring systems

5.5.4.1 For cranes covered by class notations **Crane**, **Crane vessel** or **Crane (N)**; components and installations shall comply with [RU SHIP Pt.4 Ch.9](#) *Control and monitoring systems*.

Control and monitoring systems supporting the crane main functions are generically defined as “essential” according to [RU SHIP Pt.4 Ch.9](#).

Specifically equipment and systems having impact on the Risk Contributors listed in [\[8.4.2.2\]](#) shall fulfil requirements with respect to essential installations.

5.5.4.2 Wireless remote control systems

1) The principles for wireless remote control should be:

Safe state for the crane and for the wireless remote control operation should be defined. In general, all over systems have a defined fail-safe mode. This means that all outputs returns to normal mode (normally open/normally closed depending of type of output) in case of an emergency stop situation, communication error, loss of power-supply or other defined failure modes. Wiring diagram and test-reports for all inputs/outputs are delivered with each system.

Normally we will assume that safe state is immediate stop of all crane movements. The crane brake capacities should be sufficient to hold the crane and the cargo at any position within a given response time.

(Some cranes are equipped with heave compensation, automatic overload protection, emergency operation, etc. In such cases safe state may not be complete stop). The reaction of the complete system

(crane) related to a stop-situation will depend of the functionality of the connection of the remote control system, and is the responsibility of the crane-builder.

Furthermore:

- the system should prevent operation if the operator leaves the normal operating area for the crane. Prevention of this shall be implemented by the crane-builder
 - the data sent to/from the remote control unit should be subjected to error detection and/or error correction
 - transmitting of radio data should also be made possible by “handshaking”.
- 2) The wireless communication with the crane should not be disturbed by any other external communication signals, and it should be designed in accordance with accepted standards for emission. Radio solutions shall be tested in accordance to ETSI EN 301 489 *Electromagnetic compatibility and radio spectrum matters (ERM)*; *ElectroMagnetic Compatibility (EMC) standard for radio equipment and services*.
- 3) If it cannot be proven that the frequencies allocated for the wireless communication for a specific crane are unique in all areas where the crane will be operated, and that such communication will never be interrupted by external communication signals, some kind of unique cryptation or ID of the wireless communication or similar is strongly recommended.
- 4) The main concern is that such arrangements should prevent other signals from controlling the crane movements.
- 5) Loss of communication with the unique remote control should cause the crane to go into a safe state as outlined in item 1 above.
- 6) Additionally an emergency stop independent of the wireless remote control should be installed. Responsibility of the crane-builder
- 7) Furthermore:
- by starting of the remote control unit a self-check shall be conducted in order to prevent movements if the control has been left in such mode
 - the lifting unit should also be provided with a hardwired emergency stop easily accessible. Responsibility of the crane-builder
 - the remote control unit should be provided with a keyswitch for closing when not in use. This issue is depending of customer requirement (order). In those cases where a keyswitch is not ordered, The customer is responsible for solution
 - when used for lifting of persons, the remote control unit should also be provided with a “dead man button”. This issue is depending of customer requirement (order). In those cases where a keyswitch is not ordered, The customer is responsible for solution.
- 8) The planned operation should be subjected to an analysis where special hazards and risks should be identified. For high-risk operations caused by mal-operation or equipment failure, the risk and the safety measures should be documented in a detailed analysis. Responsibility of the crane-builder.

SECTION 6 SAFETY AND SAFETY EQUIPMENT

6.1 Safety

6.1.1 Operator's cabin

6.1.1.1 On deck cranes an operator's cabin will normally be required. This may also apply to other types of cranes. National authorities may require a cabin on cranes for the protection of the operator against noise and weather.

6.1.1.2 If required or fitted, the cabin shall satisfy the following overall requirements:

- be of adequate size and give adequate protection against weather and other environmental exposure
- give the operator an adequate view of the area of operation including hook and hook position
- have windows capable of being readily and safely cleaned inside and outside and to have defrosting and defogging means. Outdoor cranes shall have windscreen wipers fitted to all windows necessary for the crane operator's free view when operating the crane
- be adequately tempered (heated, cooled) and ventilated according to local conditions
- be of fireproof construction, have doors that can be readily opened from both inside and outside
- in the case of a derrick crane access/exit shall not be obstructed by any boom elevation
- noise and vibration shall remain within acceptable limits
- have a comfortable and purpose-designed seat from which all operations can easily be controlled. Foot rests shall be arranged where necessary
- have the crane controls marked and lit to show their respective function.

Guidance note:

It is recommended that the design complies with international recognized standard/code (i.e. EN-13557).

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6.1.1.3 Where the operator's cabin is attached to and travels with the crane, the cabin suspension gear shall be so designed that the cabin cannot fall if the cabin or the crane is accidentally displaced from its rails.

6.1.1.4 Cranes shall be arranged with emergency escape in addition to the main access. Portable escape equipment may be accepted.

6.1.2 Platforms, access gangways and operator's cabins

6.1.2.1 For documentation of satisfactory structural strength, see [4.1.7].

Guidance note:

It is recommended that the design complies with international recognized standard/code (i.e. EN-13586).

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6.1.3 Parking and precautions against wind loads

6.1.3.1 Lifting appliances shall be provided with means to secure the appliance in the "out of service condition" in a safe manner. The effect of wind and wind gusts and any roll, list and trim shall be considered.

6.1.4 Protection and precautions against fire

6.1.4.1 Necessary protection and precautions against fires and explosions shall be considered in each case.



The number, capacity and location of fire extinguishers shall be adequate for the type of crane and its intended service. However, at least one fire extinguisher shall be provided in the operator's cabin and accessible crane housings.

6.1.4.2 Air pipes from fuel tanks shall be led to open air.

6.1.4.3 Drip trays shall be arranged at fuel filling pipe.

6.1.4.4 It shall be possible to stop/close the following components from a central place outside the crane engine room:

- valves on tanks for flammable fluids
- pumps for flammable fluids
- flaps (shutters) in air ducts to engine room
- fans for ventilation
- engines.

6.1.4.5 Reference is made to [RU SHIP Pt.4 Ch.3 Sec.1](#) for fire protection of diesel engines and other combustion engines.

SECTION 7 PLATFORM CRANES

7.1 Material and fabrication

7.1.1 General

7.1.1.1 Material and fabrication requirements are given in [Sec.3](#).

7.2 Structural strength

7.2.1 General

7.2.1.1 General description of structural strength is given in [Sec.4](#). This section specifies supplementary information for structural strength valid for platform cranes.

7.2.2 Loads due to operational motions

7.2.2.1 The dynamic factor shall not be taken less than:

$$\psi = 1.15 \text{ for } 10 \text{ kN} < W \leq 2\,500 \text{ kN}$$

7.2.2.2 For cranes used for internal load handling in open sea, due considerations shall be taken to ensure that the resultant impact on the crane due to wave introduced motions is within the crane's design limitations.

7.2.3 Horizontal loads due to operational motions

7.2.3.1 For revolving cranes a lateral force of

$$(W/100) \cdot [2.5 + 0.1 \cdot r \cdot n]$$

may be assumed at the jib head where:

r = load radius (m)

(distance from revolving axis to load W)

n = revolution per minute (RPM)

7.2.3.2 Radial force on revolving cranes may be determined on the basis of maximum angular velocity and radius to the considered mass. Radial force equal to $(W/1\,000) n^2 \cdot r$ may be assumed at the jib head.

7.3 Machinery and equipment

7.3.1 General

7.3.1.1 General requirements are given in [Sec.5](#). This section specifies supplementary requirements valid for platform cranes.

7.3.2 Steel wire rope anchorage

7.3.2.1 The strength of the anchorage of the hoist rope to the drum shall have strength not less than the smallest of 80% of the breaking load of the hoist wire rope or 2.5 times the maximum design tensile force in the rope. The force may include the friction of the turns remaining on the drum, based on coefficient of friction of 0.1.

7.4 Safety and safety equipment

7.4.1 General

7.4.1.1 Basic requirements are given in [Sec.6](#).

7.4.1.2 For "Protection and precautions against fire", the following applies:

For cranes installed onboard offshore units/installations with hydrocarbon contact (production- and drilling units), DNV GL offshore standard DNVGL [OS A101 Safety Principles and Arrangements](#), Sec.4 *Emergency shutdown (ESD)*, [2.1.4] applies. The crane manufacturer shall ensure proper fire safety accordingly.

7.4.2 Specific requirements

7.4.2.1 General

As an alternative to document safety as outlined in for offshore cranes, platform cranes will be accepted based on fulfilment of the prescriptive requirements as set out below.

Monitoring of safety equipment shall be as required in [Table 7-1](#).

7.4.2.2 List of required functionality

Lifting appliances/cranes shall generally to be provided with:

- safety brakes on all movements (see [\[5.2.3\]](#))
- overload protection (see [\[7.4.2.3\]](#))
- load indicator or load moment indicator (see [\[7.4.2.4\]](#))
- limit switches (see [\[7.4.2.5\]](#))
- safety valves on all main circuits of the hydraulic system (see [\[5.5.1\]](#))
- emergency stop system (see [\[7.4.2.6\]](#))
- boom stopper on derrick cranes (see [\[7.4.2.6\]](#))
- end stoppers for travelling cranes (see [\[7.4.2.7\]](#))
- audible warning alarm (see [\[7.4.2.8\]](#))
- slack wire rope detection (see [\[7.4.2.9\]](#))
- means for emergency lowering of load (see [\[7.4.2.10\]](#)).

7.4.2.3 Overload protection

All cranes/lifting appliances shall be provided with automatic overload protection, arresting the hoisting movement if overload is detected.

The overload protection shall be activated if the response of the load being raised or lowered exceeds a predetermined amount which shall not be greater than the effect of a static load equal to the safe working load times the dynamic factor for which the lifting appliance has been designed.

When activated, the overload protection shall not prevent the load or crane to be moved to a better position (e.g. lower the load or hoist the boom) when the load is airborne.

Guidance note:

Lifting an overload from deck position ("lift-off") by means of hoisting the boom will not be allowed.

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7.4.2.4 Load/load moment indicator

A rated capacity indicator giving continuous information shall be provided when the working load is 50 kN or greater except for cranes where the allowed maximum rated load is constant (i.e. independent of load radius).

Further, cranes with a variable rated capacity dependent on the radius shall be provided with a radius indicator clearly visible from the control station. Indication in the control station screen will be sufficient.

7.4.2.5 Limit switches

As specified for limit switches in [8.4.2.5]. For cranes with SWL not exceeding 20 tonnes without cabin, the requirement for indication will be omitted.

7.4.2.6 Emergency stop system

As specified for emergency stop in [8.4.2.7].

7.4.2.7 End stops

End stoppers shall be fitted to prevent over-running where movements are restricted. Shut-down of the power shall be arranged before the end stoppers are activated. The end stoppers or the moving parts shall be fitted with buffers made of timber, rubber, etc. If the nominal speed exceeds 1 m/s, the buffers shall be of spring type or similar energy absorbing type. If practicable, the buffers shall be fitted on the main sill and not on the bogies.

7.4.2.8 Audible warning alarm

Gantry cranes and similar cranes shall be provided with a horn or other audible warning device operated by the crane operator to warn or attract the attention of any personnel within the operational area.

In case of travelling cranes moving at ground level, a continuous audible warning shall automatically be given when the crane is to move/is moving along the track/rails. The warning signal shall be distinctly different from other audio signals on the installation.

7.4.2.9 Slack wire rope detection

As specified for slack wire rope detection in [8.4.2.10]. However, auto stop for arresting the slack wire rope is not required.

7.4.2.10 Emergency lowering

Means shall be provided for safe lowering of hanging load to a safe position in the event of power failure. In addition emergency slewing will be required where slewing is necessary to obtain a safe position.

Guidance note:

If the emergency lowering is achieved by external means, this means shall be readily available or easily retrievable in any area where the crane is intended to be operated.

If it is satisfactorily documented in a risk evaluation that the risk is acceptable without any means for emergency operating, the requirements in this paragraph will not apply.

Table 7-1 Monitoring of safety equipment, required monitoring (stated by an x)

Event	Platform cranes		
	Indication	Alarm	Auto stop
Load high or Over-turning moment high (see [7.4.2.3])			x

	<i>Platform cranes</i>		
<i>Event</i>	<i>Indication</i>	<i>Alarm</i>	<i>Auto stop</i>
Hook position, upper and lower (see [7.4.2.5])	x		x x
Boom/jib position, upper and lower			
Travelling motion, end stops Warning		x	x
Slack wire rope (see [7.4.2.9])	x		
Remote control:		x	
Power failure to safety system	x		
Emergency stop (see [7.4.2.6])	x	x	

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SECTION 8 OFFSHORE CRANES

8.1 Material and fabrication

8.1.1 General

8.1.1.1 Material and fabrication requirements are given in [Sec.3](#). This section specifies supplementary information.

8.1.2 Bolts for main slewing ring

8.1.2.1 Bolt material having minimum specified yield strength for 10.9 ISO strength higher than 1050 N/mm² will normally not be accepted.

8.2 Structural strength

8.2.1 General

8.2.1.1 General description of structural strength is given in [Sec.4](#). This section specifies supplementary information .

8.2.2 Loads due to operational motions

8.2.2.1 The dynamic factor ψ for design purposes shall not be taken less than:

$$\begin{aligned}\psi &= 1.3 \text{ for } 10 \text{ kN} < W \leq 2\,500 \text{ kN} \\ \psi &= 1.5 - W/12500 \text{ for } 2500 \text{ kN} < W < 5\,000 \text{ kN} \\ \psi &= 1.1 \text{ for } W > 5\,000 \text{ kN},\end{aligned}$$

where W is the maximum working load for the load curve in question.

When the dynamic factor ψ is calculated by the formula given in [\[4.1.3.2\]](#), the following shall be taken into account when assessing the relative velocity between load and hook at the time of lift-off, V_R :

$$V_R = 0.5 \cdot V_L + \sqrt{V_{in}^2 + V_t^2}$$

Where the value $0.5 \cdot V_L$ above is less than V_H , as given in [\[8.2.2.2\]](#), then V_H shall be used instead of $0.5 \cdot V_L$.

- V_L = maximum steady hoisting speed (m/s) for the rated capacity to be lifted.
- V_{in} = downward velocity (m/s) of the load at the time of lift off (due to movement of the deck of a supply vessel from which the load is lifted).
- V_t = velocity (m/s) from motion of the crane jib tip if the crane is located on a mobile offshore unit or other floating unit.

V_{in} shall be determined as a function of sea state and motion parameters (roll, pitch and heave response) of the vessel/offshore unit or hydrodynamic response of an underwater object to be handled.

8.2.2.2 The hoisting and lowering speed shall normally not be less than

$$V_H = 0.1 \cdot (H_{sign} + 1)$$

for cranes used for cargo operations towards supply boats.

where:

H_{sign} = significant wave height (m).

The V_L used for calculation of dynamic factors for derating shall be the actual maximum available hook speed attainable, and shall normally be equal to or larger than V_H . For significant wave heights where the hoisting speed V_L is less than V_H , the derating chart will be shaded and giving information that it is dependent upon the crane driver's skill to avoid re-entry of the next wave.

8.2.2.3 For cranes located on semi submersibles units and bottom supported platforms the following values for V_L may be used for the calculation of the dynamic factor when lifting off loads from a supply vessel.

$$V_L = \text{Available hoisting speed or } 0.6 H_{sign}$$

whichever is the smaller.

For V_{in} the following values can be applied for cranes located on crane vessels, semi submersibles units and bottom supported platforms when lifting off from a supply vessel:

$$V_{in} = 0.6 H_{sign} \text{ (m/s) for } 0 < H_{sign} \leq 3 \text{ (m)}$$

or

$$V_{in} = [1.8 + 0.3 (H_{sign} - 3)] \text{ (m/s) for } H_{sign} > 3 \text{ (m)}$$

8.2.2.4 Where the operator cabin is attached above the slewing bearing, the design loads for the crane foundation including pedestal and slewing bearing with fasteners, shall, for structural strength calculations (fatigue excepted), be taken as the design loads as applied for the crane members multiplied with an additional offshore safety factor SF1. For mast cranes, this requirement is valid for the mast up to and including the lower bearing support.

- for cranes with lifting capacity up to 2500 kN, minimum required SF1= 1.3
- for cranes with lifting capacity of 2500 kN and more, minimum required SF1= 1.1.

8.2.2.5 For cranes located on barge or bulk carrier, the dynamic factor ψ may be calculated as in [4.1.3.2]. The hoisting speed V_L may be taken as given in [8.2.2.3].

The relative velocity V_R may be calculated in accordance with the formula in [8.2.2.1], where:

V_{in} = downward velocity (m/s) of the barge or bulk carrier from which the load is unloaded at the moment of pickup. (It is foreseen that the crane is located on the other vessel involved.)

V_t = velocity (m/s) of the jib tip of the crane located on the barge or bulk carrier to which the load is brought at the moment of pickup from the other vessel.

V_{in} shall be documented by calculations, or ¹ may be taken as $1/10 \cdot k \cdot H_{sign}$

¹ The two formulas above are valid only for vessels with DWT between 10 000 and 100 000 tonnes.

V_t shall be documented by calculations, or ¹ may be taken as

$$1/6 \cdot k \cdot H_{\text{sign}}$$

$$k = 5.5 - \frac{DWT}{20000}$$

DWT = the deadweight tonnage in metric tonnes of the barges or bulk carriers used in the operation.

8.2.3 Horizontal loads due to operational motions

8.2.3.1 The following horizontal force at jib head shall be assumed.

Lateral force (side lead):

$$(W/100) \cdot [2.5 + 0.1 \cdot r \cdot n + H_{\text{sign}}]$$

Radial force (off lead):

$$(W/1\,000) n^2 \cdot r \text{ (when the load is airborne)}$$

or

$$\psi \cdot W \cdot \frac{2.5 + 1.5 H_{\text{sign}}}{H_w + L_{\text{vert}}} \quad (\text{at lift-off})$$

whichever is the greater.

- L_{vert} = vertical distance from jib heel bearing to outer jib sheave
- H_w = distance from jib heel bearing to supply boat deck
- θ = jib angle to the horizontal.

8.2.4 Load chart or table

8.2.4.1 A load chart or table shall be available at operating stand, and where applicable the load chart or table shall give the safe working load for boom angles or load radii for the various wave heights. For cranes subjected to **CRANE** notations, the load charts shall be approved.

Guidance note:

Load charts for various wave heights should normally be based on the specified lifting capacity and design dynamic factor at $H_{\text{sign}} = 0$ m. However, in cases where the maximum lifting capacity for the crane at $H_{\text{sign}} = 0$ m is larger than specified by the $H_{\text{sign}} = 0$ m load curve (for the crane in general, or, for specific boom angles/radius), the load charts can be calculated with basis in maximum lifting capacity. In such cases, the maximum lifting capacity should be specified and documented. Due consideration to loose gear capacity should be taken.

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8.3 Machinery and equipment

8.3.1 General

8.3.1.1 General requirements are given in [Sec.5](#). This section specifies supplementary requirements valid for offshore cranes.

8.3.2 Brakes for hoisting and luffing

8.3.2.1 The mechanical brake shall not be arranged in front of same gear transmission as the operational brake. Alternative a 30% increase of gear and brake design loads may be applied, ref. [\[8.4.2.13\]](#).

8.3.3 Steel wire rope anchorage

8.3.3.1 The load carrying capacity of the fixed hoist rope anchorage to the drum shall approximately equal the dynamic wire rope line pull. Further, including the frictional force being applied through the turns of rope always to remain on the drum, the total capacity of anchorage shall be equal to the breaking load of the rope. In order to achieve this frictional force it may be necessary to increase the minimum remaining turns on the drum to more than 3.

For cranes with radius dependent load chart, the fixed anchorage shall be designed for the lowest line pull as caused by the load chart (number of wire rope parts to be taken into consideration). The end stop for the remaining turns shall in such cases be redundant

8.3.4 Control and monitoring systems

8.3.4.1 Components and installations shall comply with [RU SHIP Pt.4 Ch.9 Control and monitoring systems](#). Control and monitoring systems supporting the crane main functions will generically be defined as “essential” according to [RU SHIP Pt.4 Ch.9](#).

Specifically equipment and systems having impact on the risk contributors listed in [\[8.4.2.2\]](#) shall fulfil requirements with respect to essential installations.

8.3.4.2 For offshore cranes covered by class notations **Crane**, **Crane vessel** or **Crane (N)**, testing at manufacturer's works and issuance of product certificate will, as addressed in [RU SHIP Pt.4 Ch.9 Control and monitoring systems](#), be required.

8.3.4.3 For offshore cranes onboard mobile offshore units (semi submersibles, jack-ups, etc.), additional requirements as specified by the governing DNV GL offshore standards shall be applied as far as relevant.

8.3.5 Power systems

8.3.5.1 Hoisting, slewing and luffing shall have such response to the controls that minimum required speed from stand still shall be obtained within 2 seconds from activation of the control lever. The control levers shall have predictable smooth motions proportional to their position.

8.3.5.2 Cranes intended for supply boat/barge operations shall have enough power to satisfy the following speed requirements:

- minimum hoisting speed, see [\[8.2.2.2\]](#)
- minimum steady slewing speed at $\frac{3}{4}$ of maximum radius, empty hook: 2 m/s

- minimum steady radial speed at $\frac{3}{4}$ of maximum radius, empty hook: 0.16 m/s for $H_{\text{sign}} = 2\text{m}$, 0.28 m/s for $H_s = 4\text{ m}$ and 0.4 m/s for $H_s = 6\text{m}$.

8.3.6 Electrical equipment and systems

8.3.6.1 The electrical equipment and systems supporting the crane main functions shall comply with [RU SHIP Pt.4 Ch.8](#) *Electrical installations* and will generically be defined as “essential”. Specifically equipment and systems having impact on the risk contributors listed in [\[8.4.2.2\]](#) shall fulfil requirements with respect to essential installations.

8.3.6.2 Electrical motors for hoisting and luffing shall be fitted with alarms for high temperature and shut-down for high-high temperatures.

8.3.6.3 For cranes onboard mobile offshore units (semi submersibles, jack-ups, etc.), additional requirements as specified by the governing DNV GL offshore standards shall be applied as far as relevant.

Guidance note:

The following codes and standards are recognised:

- Norwegian Standard NS 5513 - *Cranes and Lifting Appliances*.
- [RU SHIP Pt.4 Ch.8](#), *Electrical Installations*.
- British Standard BS 5345 - *Selection, Installation Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres*.
- NEK 420.

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Other codes and standards may after special consideration be recognised by the Society.

8.4 Safety and safety equipment

8.4.1 General

8.4.1.1 Basic requirements are given in [Sec.6](#). This section specifies supplementary requirements .

8.4.2 Specific requirements

8.4.2.1 General

All lifting appliances categorised as *Offshore cranes* shall be provided with safety functions, reducing the risk connected to crane operations. The subsequent safety function requirements are founded on a risk based approach. It is up to the customer to select the technological platform for the safety functions. In principle, all alternatives providing equivalent safe operation will be accepted.

In the following, the safety function requirements are organised as follows:

- listing of generic (i.e. standard) risk contributors, ref. [\[8.4.2.2\]](#)
- description of the generic risk contributors and corresponding required generic safety functions, ref. [\[8.4.2.4\]](#) to [\[8.4.2.19\]](#)
- monitoring of the safety functions, ref. [Table 8-1](#)
- ranking of the safety functions, ref. [\[8.4.2.20\]](#)
- verification, ref. [\[8.4.2.21\]](#)
- handling of deviations and extended risk, ref. [\[8.4.2.22\]](#)

The corresponding documentation- and verification requirements are specified in the *Verification guideline for safety functions, offshore cranes*, ref. [App.G](#).

8.4.2.2 Generic risk contributors.

The following hazards are identified as *generic risk contributors* for offshore cranes:

- over-loading (see [8.4.2.4])
- crane movements outside operational limitations (over travel) (see [8.4.2.5])
- dangerous lifting gear/cargo movements (see [8.4.2.6])
- dangerous crane movements (see [8.4.2.7])
- lack of visibility (see [8.4.2.8])
- lack of communication (see [8.4.2.9])
- slack wire rope at drum (see [8.4.2.10])
- failure in control systems (see [8.4.2.11])
- failure in safety components/systems (see [8.4.2.12])
- lack of braking capacity (see [8.4.2.13])
- lack of load holding capacity (see [8.4.2.14])
- blackout/shutdown of power (see [8.4.2.15])
- unintended activation of safety functions (see [8.4.2.16])
- spurious trip of safety functions (see [8.4.2.17])
- hazards due to activation of safety functions (see [8.4.2.18])
- fire/fire ignition [8.4.2.19])

The maximum consequence assumed for each of the above listed generic risk contributors is *one fatality*, with the exception of *Fire/fire ignition* ([8.4.2.19]). For lifting appliances where the *specific risk* exceeds one fatality (not including *Fire/fire ignition*), or where the specific risk contributors deviates from the above, ref. [8.4.2.22] *Handling of deviations/extended risk*.

8.4.2.3 Description of risk contributors and corresponding required generic safety functions

The following description of the generic risk contributors and corresponding required *generic safety functions* applies.

For lifting appliances with *specific safety functions* that deviates from the following *generic safety functions*, ref. [8.4.2.22] "Handling of deviations/extended risk".

Guidance note:

The below *bold/italic* number references in parentheses refer to applied numbering in the "Text reference" row of the tables in App.G [G.2.3].

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8.4.2.4 Over-loading

Generic risk contributors:

Over-loading due to crane hook entangled to the supply boat or other moving objects, due to load sucked to the seabed, due to heave compensation not working properly, or other overload situations, may lead to crane structure collapse.

Generic risk control measures:

Cranes shall therefore be provided with overload protection. The safety functions for overload protection shall be implemented by means of the following automatic protection systems: A boom overload protection system ([4.2.4].a), and an automatic overload protection system (AOPS) [4.2.4].c). In addition, a manual overload protection system (MOPS) ([4.2.4].b) shall be provided. The boom overload protection shall be implemented by means of an *Overload limiting device* [4.2.4].a) and - additional for supply boat and barge handling cranes operating in nautical zones with short wave characteristics - an AOPS (*Automatic overload protection system*) [4.2.4].c).

- a) For cranes intended for supply boat/barge operations and for subsea handling cranes, an "Overload limiting device", stopping the boom from being luffed further out ([4.2.4].a) will be required. The "Overload limiting device" shall automatically be activated when the crane is subject to an over-load

response close to the crane's design load (given by the safe working load times the dynamic factor). When activated, any movement reducing the overturning moment shall stay intact.

- b) MOPS ([4.2.4].b) will generally be required for all offshore cranes, including subsea operating cranes. The MOPS shall operate under all conditions, including failure in the main power supply and shall override all other functions when activated. The system shall be arranged for manual activation for all reeving configurations. The activation switch or handle (one only) shall be located for rapid access at the control station, permanently marked with yellow colour, and protected against inadvertent use. The MOPS shall be hardwired (MOPS at wireless control station will not be accepted).

At any time, the system shall be able to be reset by the crane operator, without causing significant damage to the crane. The system, when activated, shall maintain a retaining force in the hoisting system of approx. 10% to 25% of the maximum rated capacity for internal lift. The capacity of the system shall be sufficient for activating/reset for at least 3 times in succession, and for continuous activation for at least 5 minutes.

A detailed assessment of the control system, including hydraulic, electric/electronic or pneumatic engine drive components or other relevant components for the design, should be performed at component level, documenting the behaviour of the system in terms of a single failure of individual components and cable damages. The purpose of this assessment is to prove reliability of MOPS and other safety functions in the event of single failures. It is recommended that FMECA in accordance with IEC 60812 or equivalent standard presenting same level of safety is performed.

- c) The requirement for provision of AOPS ([4.2.4].c) for supply boat and barge handling operations will be based on due consideration to which nautical zone, with corresponding wave parameters, the crane will operate. Provision of AOPS will be required for operations in nautical zones with a short wave characteristic, for instance the North Sea, whereas operations in nautical zones with a long wave characteristic will not require AOPS. Operational limitations for use in nautical zones with long wave characteristics only shall be stated in the crane certificate as well as in the crane's operational manual.

Guidance note:

"Short wave characteristics" is a term used for nautical zones with mainly wind induced waves, while "long wave characteristics" is used for nautical zones with swell dominated waves. Categorization will be based on customer specified nautical zones.

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- d) AOPS will generally not be required for subsea handling cranes. The AOPS, when installed, shall be operational for all reeving configurations. The trigger load shall not be less than rated capacity for internal lift, giving an appropriate response time to avoid significant damage to the crane.

Automatic overload protection for lateral boom loads exceeding the design limits for the slew system shall also be provided (not required for heavy lift cranes). The lateral overload protection shall be independent of the AOPS.

The AOPS - with the exception of the lateral overload system - shall include sector limitation and height limitation, preventing system activation when the load is positioned above the platform. The requirement for automatic application of the brakes when the motion control lever is returned to neutral position may be omitted when the hook is within the AOPS sector. Manual overriding of the AOPS shall not be possible unless for the purpose of lifting of personnel. The AOPS shall be designed with respect to response time and retaining force in the hoisting rope, protecting the crane from any structural damage.

When the system is activated, the crane shall maintain a retaining force at the hook sufficient to suspend a load corresponding to the rated capacity for internal lift. If the hook load increases beyond this value, the minimum payout hook speed due to the increased actual hook load shall not be less than the velocity given in the expression $(V_{in}^2 + V_t^2)^{0.5}$, see [8.2.2.1] (the velocities as indicated in EN 13852-1 App.B may be used as a simplified method). When the overload/-moment situation no longer exists, the system shall automatically deactivate. However, due to possible oscillation, delayed deactivation of the AOPS shall be considered.

- e) When subjected to an overload response equal to the activation load for the shut-down device or the trigger load for the AOPS, an alarm warning all the personnel within the working area, including all personnel onboard the attending supply vessel, shall automatically be activated.
- f) When the AOPS or the MOPS is activated, the end stop at the winch drum (limiting the residual windings to minimum 3) shall be overridden, allowing the wire rope to be spooled completely off the drum.

- g) Both the AOPS and MOPS shall have control indicators in the cabin, i.e. a continuous visual signal to indicate whether the system is operational or not. A different continuous visual and acoustic signal shall be given when the system is activated. In addition, an external acoustic alarm giving a sound level of approx. 110 dB (A) measured at 1 m from the alarm when the MOPS is activated, shall be provided.
- h) A load indicator, a rated capacity indicator and a crane inclinometer (if the crane is installed on a floating unit) to display the pedestal inclination in the longitudinal and traverse direction of the crane, giving continuous information to the operator, shall be provided. The rated capacity indicator shall include a display of the selected crane configuration and the significant wave height. Further, cranes with a variable rated capacity dependent on the radius shall be provided with a radius indicator clearly visible from the control station. An audible and visual warning/alarm, giving a continuous warning to the crane operator when the load response exceeds 90% of the crane's rated capacity/overturning moment for the offshore rated load curve for $H_s = 0$ m, shall be fitted. The audible warning/alarm at 90 % may, though, be temporarily disconnected for subsea operations continuously subjected to loads at 90 % and more.

8.4.2.5 Crane movements outside operational limitations

Generic risk contributors:

Crane movements outside operational limits may lead to stress beyond the crane's structural strength and to operational hazards.

Generic risk control measures:

All crane movements are therefore to be kept within safe operational limitations, either by means of limit switches/alarms or physical layout ([4.2.5].a). The hoisting and luffing winches shall be equipped with upper and lower limiters, stopping the winch movements within safe margins to avoid collision with other parts of the crane and keeping safe number of retaining wire rope turns on the drum - usually minimum 3. Special consideration shall be paid to the crane boom's upper limit protection ([4.2.5].b) for wire rope suspended booms, where redundancy by means of 2 independent limit switches is required.

Limit switches shall be positively activated and be of failsafe type, i.e. the crane shall go to a defined safe condition in case of failure (power failure, cable defect, etc.). Activation of limit switches shall lead to indication in the crane cabin. After activation of a limiting device, movement in the reverse direction - to a more safe position - shall not be prevented. Where more than one movement cause over-travel, all limit switches limiting such over-travel shall be activated simultaneously (e.g. hoist block over-travel at boom top may be caused either by hoisting or luffing). A manually operated "over-ride" system, provided positive and maintained action combined with indication and alarm, may be fitted.

8.4.2.6 Dangerous lifting gear/cargo movements

Generic risk contributors:

Unintended lifting gear/cargo movements may lead to hazardous situations for personnel involved in crane operations.

Generic risk control measures:

- a) Means for keeping constant tension in the hoisting wire rope ("constant tension") when carrying out supply boat operations, compensating for the relative movement between the lifting gear/cargo and the supply boat, may be provided (optional) ([4.2.6].a). The constant tension system shall, when installed, be designed with due consideration to the retaining force (usually in the area of 2 – 3 tonnes), response time and unintentional activation. It shall not be possible to activate the system outside a defined zone close to the supply boat - neither horizontal nor vertical, and shall not be possible to activate when the crane is loaded. The winch shall automatically return with soft characteristic to normal hoisting, braking or holding condition when the constant tension is disengaged. An indication, informing when the constant tension system is active, shall be present in the cabin.
- b) Special consideration shall also be paid to dangerous lifting gear movements when lifting or lowering the boom/lifting gear to or from the boom rest/cradle. Only slow motions of the boom shall be possible.
- c) An audible warning (horn or similar device) ([4.2.6].c) to warn or attract the attention of any person within the operational area of the crane, operated by the crane operator, shall be provided.

8.4.2.7 Dangerous crane movements

Generic risk contributors:

Dangerous crane movements or unintentional crane movements due to malfunction in the crane's control system may lead to operational risks.

Generic risk control measure:

A manually operated emergency stop function, leading to shut-down and stop of the crane movements, shall therefore be fitted. Simultaneously, the brakes shall be engaged in a progressive and safe manner. The emergency stop shall retain its function regardless of any malfunction in the crane's control system. Emergency stop actuators shall be located at convenient locations at control station for immediate use by personnel in the event of a hazardous situation occurring.

The emergency stop shall function as, or stopping by:

- immediate removal of power to the machine actuators, or
- mechanical disconnection (declutching) between the hazardous elements and their machine actuators.

The emergency stop shall be so designed that deciding to actuate the emergency stop actuator shall not require the operator to consider the resultant effects (stopping zone, deceleration rate, etc.). The emergency stop command shall over-ride all other commands except the MOPS (ref. [8.4.2.20]). The emergency stop function shall not impair the effectiveness of the safety devices or devices with safety related functions. Resetting the control device shall only be possible as the result of a manual action on the control device itself. Resetting the control device shall not cause a restart command.

The emergency stop actuators shall be designed for easy actuation. Types of actuators that may be used include:

- mushroom type push button.
- wires, ropes, bars.
- handles.
- in specific applications, foot pedals without protective cover.

Measures against inadvertent operation shall not impair the accessibility of the emergency stop actuator. The emergency stop actuator shall be coloured red. The background shall be coloured yellow, as far as practicable. If the emergency stop actuator is not located directly on the machine, labels shall be provided addressing the actuator to the machine. A warning/alarm and an indication in the crane cabin shall inform the crane operator that the emergency stop has been activated.

8.4.2.8 Lack of visibility

Generic risk contributors:

Lack of visibility due to poor sight or due to crane operations in the crane driver's blind zone may lead to operational hazards.

Generic risk control measure:

Consequently, a boom tip camera is normally required for all offshore cranes intended for supply boat or barge handling. The camera and camera installation shall be designed with due consideration to environmental factors (wind, salt, moisture, vibrations, etc.) and operational suitability.

8.4.2.9 Lack of communication

Generic risk contributor:

Lack of communication between the crane operator and the other participants in the crane operation may lead to operational hazards.

Generic risk control measure:

Two-way communication equipment, enabling the crane operator to communicate with the participants in the crane operation in a safe way, shall be provided. The crane operator shall be able to operate the communication system without moving his hands from the main control levers.

8.4.2.10 Slack wire rope at drum

Generic risk contributor:

Slack wire rope at the drum may lead to improper spooling and entangled wire rope.

Generic risk control measure:

The drums - both for the hoisting winch and the luffing winch - shall therefore be equipped with a slack wire rope detection device which will be activated automatically if the wire rope becomes slack during lowering. The device shall stop the winch lowering motion until the wire rope is re-tightened, before automatically returning to normal operation. When activated, a visual and acoustic signal/indication shall be given in the crane cabin. Where the crane driver has a full view of the drums from his normal position, the slack wire rope detection device may be omitted.

8.4.2.11 Failure in control systems

Generic risk contributor:

Failure in the crane's control system may result in unintentional crane response and movements.

Generic risk control measures:

Control system design and components shall therefore be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety shall be the prime consideration (fail-safe concept). All aspects of possible methods of failure - including power supply failure - shall be considered. If any failure occurs, the control system shall always return to the safest condition with respect to stabilising the crane and the load. Special consideration shall be paid to the below points if subjected to failure in the control system:

- unintended start of machinery shall not be possible
- safety devices or devices with safety related functions shall be impaired to a minimum degree.

An alarm and an indicator revealing any detectable failure in the control system affecting the operation shall be present in the crane cabin.

8.4.2.12 Failure in safety components/system

Generic risk contributors:

Failure in safety components and the safety system may result in hazardous situations due to override of safety limits.

Generic risk control measures:

The safety components/system shall therefore be so designed that all aspects of failure - including power supply failure - shall lead to indication and alarm in the crane cabin (monitoring), or - alternatively - safeguarded by redundancy design.

8.4.2.13 Lack of braking capacity

Generic risk contributor:

Insufficient braking capacity may lead to falling load and uncontrolled crane movements (falling boom, etc.).

Generic risk control measures:

All driving mechanisms and winches intended for hoisting and luffing shall be fitted with fail-safe brakes, i.e. failure of the brake's control system shall normally lead to automatic application of the brake, ref. [5.2.1.4] and [5.2.3.1].

If a single geared transmission is placed between the operational brake (ref. [5.2.1.2]) and the drum for the load hoisting and boom hoisting winches, redundancy in case of breakage in the brake and gear transmission shall be provided by fitting an additional brake with an independent load path to the drum.

In case of multiple gear transmissions, redundancy shall be provided by increasing the number of gear and brake sets at least 30% above required, however, more than 3 additional sets will not be required.

As an alternative to redundancy, a 30% increase of the brake and gear design loads may be applied (not with respect to fatigue loads).

8.4.2.14 Lack of load holding capacity

Generic risk contributors:

Lack of load holding capacity due to missing hydraulic refilling or loss/drop of hydraulic pressure, may lead to falling load or boom.

Generic risk control measures:

The crane's hydraulic system shall therefore be designed such a way that missing hydraulic refilling shall not occur. Further, the hydraulic system shall be fitted with safety or load holding valves on all main circuits protecting against unintended movements in case of hose rupture.

8.4.2.15 Blackout/shutdown of power

Generic risk contributor:

Blackout/shutdown may lead to crane stop with the crane and the load in unfavourable and unsafe position.

Generic risk control measures:

- a) Power failure/blackout or unintended shut-down shall lead to automatic application of the brakes ([4.2.15].a) and an alarm at the operator's stand.
- b) Facilities for emergency operation ([4.2.15].b), bringing the load to safe condition, shall be provided by means of connection to an independent emergency power supply, rated to handle full SWL under all conditions. Slewing speed shall be minimum 15 % of max speed for normal operation. The emergency power supply may be a redundant main power supply or an emergency power supply from the installation, or a "stand-alone" emergency power supply in the crane rated for minimum 30 min capacity. The activation switches or handles for emergency operation shall be of "hold to run" type and clearly and permanently marked for their purpose.
- c) A mobilization time of maximum 120 seconds is recommended.
- d) For cranes installed onboard vessels with **DYNPOS (AUTRO)** class notation, the slip ring units for transfer of redundant power supplies are to be divided and separated by a flame-retardant partition such that a short-circuit in a compartment for one supply will not damage the other.

8.4.2.16 Unintended activation of safety functions

Generic risk contributors:

Unintended activation of safety functions may lead to crane response giving unintentional hazards/risks.

Generic risk control measures:

Handling devices for safety functions shall be protected against inadvertent use and positioned away from ordinary operating handles. Interlock devices, preventing inadvertent activation in dangerous zones (water zone only, etc.) shall be fitted when possible.

8.4.2.17 Spurious trip of safety functions

Generic risk contributors:

Initiation of a safety functions in no-hazardous situations and where there is no true demand for safety activation due to safety- or control system failure, may cause other types of hazards/risks.

Generic risk control measures:

Consideration to spurious trip shall be taken in the design of the safety- and control systems. A risk assessment may be required for identification and possible elimination/reduction of spurious trip and corresponding hazards/risks.

8.4.2.18 Hazards due to activation of safety functions

Generic risk contributors:

Activation of safety functions may lead to secondary effects that may be harmful to the crane and/or the load.

Generic risk control measures:

Design of safety systems and components shall be done with consideration to dangerous secondary effects, even if the crane/load movements are stopped from full speed and/or full load. Sector limitations for some safety functions shall be considered.

8.4.2.19 Fire/fire ignition

Generic risk contributors:

Fire/fire ignition may arise from the crane itself or from the ship/installation, and thereby lead to disaster.

Generic risk control measures:

Generally, necessary protection and precautions against fires and explosions shall be separately considered in each case, with consideration to the hazardous area classification in which the crane or parts of the crane will operate and to the requirements for the crane's emergency preparedness. The application of fire extinguishers and/or automatic fire fighting system shall be considered in each case.

Guidance note:

For cranes installed onboard offshore units/installations with hydrocarbon contact (production- and drilling units), DNV GL offshore standard DNVGL OS A101 *Safety Principles and Arrangements*, Sec.4 *Emergency shutdown (ESD)*, [2.1.4] applies. The crane manufacturer shall ensure proper fire safety accordingly.

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Table 8-1 Monitoring of safety functions

Event	Ref.	Indication	Alarm	Auto stop
Load high	[8.4.2.4]	×	×	
Overturning moment high	[8.4.2.4]	×	×	×
Hook position (upper, lower)	[8.4.2.5]	×		×
Boom/jib position (upper, lower)	[8.4.2.5]	×		×
Constant tension	[8.4.2.6]	×		
Emergency stop	[8.4.2.7]	×	×	×
Slack wire rope detection	[8.4.2.10]	×		×
Failure in control system	[8.4.2.11]	×	×	
Failure in safety system	[8.4.2.12]	×	×	
Blackout/shut-down	[8.4.2.15]		×	×
Fire/gas	[8.4.2.19]		×	×
High temperature, el. motors	[8.3.6.2]		×	
High-high temperature, el.motors	[8.3.6.2]			×

8.4.2.20 Ranking of the safety functions

The manual overload protection (MOPS) and the emergency stop function shall be the preferred safety functions and have equal priority, before other safety devices/limiters.

8.4.2.21 Verification

The verification will be carried out according to the *Verification guideline for safety functions*, as given in App.G. This document enables verification by means of verification templates, leading to effective and time-saving verification.



8.4.2.22 Handling of deviations and extended risks

In cases where the risk deviates from the generic by means of:

- assumed maximum consequence for one hazard/risk contributor that will exceeds one fatality (with the exception of “fire/fire ignition”), or where the specific risk contributors deviates from the specification in [\[8.4.2.2\]](#)

identification of the specific risk and risk contributors is the customer’s responsibility and shall be shown in the verification templates and submitted documentation.

Further, when the specific safety functions deviates from the generic as specified in [\[8.4.2.4\]](#)–[\[8.4.2.19\]](#) this shall appear from the verification templates, and Customer’s proposal to functional and technical requirements for the safety functions shall be submitted for review and agreement.

8.4.2.23 Handling of deviations is also described in [App.G Verification guideline for safety functions](#), [App.G \[2.2\]](#).

SECTION 9 CRANES INTENDED FOR SUBSEA OPERATIONS

9.1 General

9.1.1 Basic requirements

9.1.1.1 Generally the requirements given in [Sec.8](#) for offshore cranes are valid for subsea cranes. This section specifies additional requirements and it points out requirements which normally deviate from [Sec.8](#).

Guidance note:

It is generally referred to DNV GL recommended practices DNVGL [RP H201](#) *Lifting appliances used in subsea operations* as additional guidance.

Further reference is made to DNVGL ST [E407](#) *Underwater deployment and recovery systems*.

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9.1.1.2 This section is valid for handling of unmanned submersibles or for lowering to and retrieval from below sea level.

9.1.1.3 Subsea handling operation are normally to be handled as an engineered lifts. However, for smaller cranes, the approach as specified in [\[9.2.2.1\]](#) below may be applied in lieu of engineered lifts.

9.2 Structural strength

9.2.1 Principal loads

9.2.1.1 Working load (measured at the crane's rope exit point ("REP")) shall be taken as maximum static load in the lifting rope.

9.2.2 Loads due to operational motions

9.2.2.1 As a simplified approach for operations up to a significant wave height of 2 m, a dynamic factor of not less than 1.7 shall be applied. The requirement for *Load charts or table* [\[9.2.4.1\]](#) will then be omitted.

9.2.3 Horizontal loads due to operational motions

9.2.3.1 The only horizontal loads (S_H) due to operational motions for subsea operations are regarded caused by relative horizontal movement between load and vessel in the sea. These forces are assumed to be 9% of working load acting both as off lead and as side lead.

9.2.4 Load charts or table

9.2.4.1 Load charts or tables, reflecting the crane's derated allowable working load for various wave heights shall be presented at the operator's stand. The load charts shall normally be calculated with basis in the vessel's accelerations and roll/pitch angles, ref. DNV GL recommended practices DNVGL [RP H201](#) *Lifting appliances intended for subsea operations*. It is assumed that the imposed loading on the crane when carrying out subsea lifts will not exceed the crane's derated working load for the specified maximum wave height.

9.3 Machinery and equipment

9.3.1 Drums

9.3.1.1 Documentation of drum and flange strength as given in [5.2.2.8] will normally be accepted also when the number of layers exceed 7.

9.3.1.2 The factor C given in equation in [5.2.2.7] is normally not to be taken higher than 3.

9.3.2 Steel wire rope

9.3.2.1 Where the static submersed load measured at the crane tip (F_{sub}) exceeds SWL, SWL shall be substituted by F_{sub} in equation for SF given in [5.2.5.3]. Galvanized steel wire ropes are recommended. Reference is also made to DNVGL ST E407 *Underwater deployment and recovery systems*.

9.3.3 Fibre rope

9.3.3.1 For fibre rope applications, reference is made to DNVGL ST E407 *Underwater deployment and recovery systems*.

9.3.4 Sheaves

9.3.4.1 The sheave diameter for steel wire ropes intended to work in heave compensation mode shall at least correspond to a ratio $D_p/d = 20$.

9.4 Systems

9.4.1 Power systems

9.4.1.1 Requirements to hoisting, slewing and luffing speeds given in [8.3.5.2] are not applicable.

9.4.2 AHC/PHC systems

9.4.2.1 AHC/PHC systems shall be designed with due consideration to DNVGL RP H201 *Lifting appliances intended for subsea operations*.

9.4.2.2 Overheating effects on ropes during AHC operations shall be considered. Operational limitations from this effect shall be identified.

9.4.3 Safe state

9.4.3.1 "Safe state" in connection with stop execution and landing on seabed will be specially considered with due attention to effects such as rope elongation, AHC dependance and characteristics, etc.



9.5 Testing

9.5.1 Load testing

9.5.1.1 The winch strength shall normally be tested through a retrieval of max working load from full retrieval depth. If not tested to full depth, the actual test depth may be specified in the crane certificate as an operational limitation. Prototype testing, winch to winch testing, or other methods ensuring sufficient design may suffice.

9.5.2 AHC/PHC testing

9.5.2.1 Normally, AHC/PHC testing is carried out by means of simulation. Additional sea testing may be agreed.

SECTION 10 HEAVY LIFT CRANES

10.1 General

10.1.1 Definition

10.1.1.1 All cranes except subsea cranes with lifting capacity of 2500 kN and more are considered as heavy lift crane. Heavy lift cranes are categorised as platform cranes or offshore cranes.

10.1.2 Basic requirements

10.1.2.1 Generally the requirements given in [Sec.7](#) for platform cranes and in [Sec.8](#) for offshore cranes are valid for heavy lift cranes. This section specifies additional requirements for heavy lift cranes and it points out requirements which normally deviate from [Sec.7](#) and [Sec.8](#).

10.1.2.2 All operations are taken to be engineered lifts.

10.2 Structural Strength

10.2.1 Loads due to operational motions

10.2.1.1 When categorized as offshore crane, the dynamic factor ψ for design purposes shall not be taken less than:

$$\psi = 1.3 \text{ for } W = 2\,500 \text{ kN}$$

$$\psi = 1.5 - W/12500 \text{ for } 2500 \text{ kN} < W < 5\,000 \text{ kN}$$

$$\psi = 1.1 \text{ for } W \geq 5\,000 \text{ kN,}$$

where W is the maximum working load for the load curve in question.

When categorized as platform crane, the dynamic factor ψ for design purposes shall not be taken less than 1.1.

10.2.2 Strength

10.2.2.1 Offlead/sidelead to be special considered.

10.2.3 Horizontal loads due to operational motions

10.2.3.1 Forces due to rotation of the crane will be special considered.

10.2.4 Load chart or table

10.2.4.1 Load charts tables shall give the safe working load for boom angles or load radii for various dynamic amplifications.



10.3 Safety and safety equipment

10.3.1 Overload

10.3.1.1 Overload protection as described in [\[7.4.2.3\]](#) will be satisfactory.

10.4 Machinery and equipment

10.4.1 Power systems

10.4.1.1 Requirements to hoisting, slewing and luffing speeds given in [\[8.3.5\]](#) are not applicable.

SECTION 11 LIFTING OF PERSONNEL

11.1 General

11.1.1 Basic requirements

11.1.1.1 Lifting of personnel may be done by all crane types. General requirements for the crane type are given in previous sections. This section specifies additional requirements for cranes used for lifting of personnel.

11.1.1.2 Attention is drawn to the fact that many national shelf authorities, as well as maritime authorities, have their own requirements pertaining to lifting of persons.

11.1.1.3 The requirements specified below are aiming at lifting persons with ordinary crane arrangements and are not intended for *man riding winches* (lifting/lowering of one person) and other specialised equipment.

11.1.1.4 Lifting of personnel by means of wireless control will not be accepted.

11.2 Documentation

11.2.1 Documentation requirements

Status for documentation will be as for offshore cranes.

11.3 Certification

11.3.1 Certification requirements

11.3.1.1 Offlead/sidelead to be special considered.

11.3.1.2 The Society's product certificates will be required for the following items:

- winches for hoisting and luffing
- transmission gears and brakes (applicable when transmitting braking forces for hoisting and luffing).

11.4 Loads

11.4.1 Rated capacity

11.4.1.1 The rated capacity shall not exceed 50% of the rated capacity for lifting of loads at the actual radius and wave height. This information shall be given in the instructions, load chart and by the safe load indicator whenever the mode for lifting of persons is selected.

11.5 Machinery and equipment

11.5.1 Brakes

11.5.1.1 Hoisting and luffing winches shall be equipped with two mechanically and functionally independent brakes, primary brake and back-up brake, acting simultaneously.

11.5.1.2 Means shall be provided for separate testing of each brake.

11.5.1.3 Mechanical brakes shall fulfil the requirements for brakes as given in [5.2.3] based on SWL for the actual load cases. For the back-up brake, SWL will be replaced by rated capacity for personnel handling provided the brake is used in personnel handling mode only.

11.5.1.4 Hydraulic restriction may be considered as one of the required two brakes, provided the rated capacity does not exceed 50% of the rated capacity for lifting of loads, see [11.4.1.1].

11.5.1.5 Where hydraulic restriction is used as a brake, the following applies:

- mechanically and functionally fully independent of the mechanical brake (separate load path to the winch drum).
- The hydraulic motor shall have a closing valve directly at the high-pressure (load) connection (no pipe or hose connection in between)
- the closing valve shall close as a result of pressure loss at the low-pressure connection (inlet connection during lowering). This function shall be accomplished by direct bore or piping between the closing valve and the low-pressure connection
- the hydraulic motor shall always be ensured sufficient working fluid, also in the event of power failure, i.e. gravity feeding.

11.5.1.6 Where cylinders are used for luffing, folding or telescopic, they shall be provided with a hydraulic shut-off valve directly connected to the cylinder. Alternatively each motion shall have two independent cylinders where each cylinder is capable of holding the rated capacity for lifting of persons.

11.5.2 Steel wire ropes

11.5.2.1 Steel wire ropes for hoisting shall have a minimum safety factor of 8 and chains shall have a minimum safety factor of 6, related to the rated capacity for the lifting of persons.

11.5.3 Shock absorbers

11.5.3.1 Where a shock absorber is installed it shall be fail-safe and automatic in operation.

11.5.4 Baskets

11.5.4.1 Lifting of personnel shall only be performed using equipment specially designed for the purpose. Baskets shall be designed in accordance with EN 14502-1 or other recognized standard/code for baskets of equivalent safety level.

11.6 Safety

11.6.1 Mode selection for lifting of persons

11.6.1.1 The control station shall be equipped with a manual key selection switch for the purpose of lifting persons. The switch shall be lockable in both positions with a removable key and have an adjacent warning light which continuously shall indicate when it is activated. The light shall not illuminate unless selection for personnel lifting is made. When the mode for personnel lift is selected, the following functions shall be maintained:

- all brakes shall automatically be activated when the controls are in neutral position and in cases where the emergency stop has been activated
- where fitted, automatic overload protection system (AOPS) shall be overridden; i.e. it shall not be possible that this system is activated
- where fitted, motion compensators; i.e. cable tensioning systems and heave compensator systems shall be overridden.
- where fitted, emergency release systems shall be overridden; i.e. it shall not be activated regardless of the position of the emergency release switch or handle
- where fitted, the slinging shall be of double/redundant type, or, means for bypassing the slinging shall be fitted, in case of short-circuiting or fire
- manual overload protection system (MOPS) shall be overridden; i.e. shall not be possible to activate.

11.6.1.2 Emergency lowering

For personnel handling cranes which may be subjected to enforced shutdown (ESD) due to fire, gas, etc., a hand pump or similar is to be provided to lower the personnel in case of ESD.

11.6.2 Operational limitation

11.6.2.1 Operational procedures including any conditions, precautions and limitations for the lifting of personnel shall be stated in the instructions for use. The following shall particularly be taken into account:

Except for emergency operations, the operational limitations for lifting of personnel shall be as follows, unless otherwise stated in the instructions for use.

- mean wind velocity: 10 m/s
- significant wave height: 2 m
- visibility: daylight or equivalent.

SECTION 12 LAUNCH AND RECOVERY SYSTEMS FOR DIVING

12.1 General

12.1.1 Basic requirements

12.1.1.1 Generally the requirements given in [Sec.8](#) (offshore cranes) and [Sec.11](#) (personnel lifting) are valid for launch and recovery systems for diving. This section specifies additional requirements for launch and recovery systems for diving and it points out requirements which normally deviate from [Sec.8](#) and [Sec.11](#).

12.1.2 Design principles

12.1.2.1 The normal handling system shall be designed for a safe, smooth and easily controllable transportation of the bell.

The lowering of bells is, under normal conditions, to be controlled by the drive system for the winches, and not by mechanical brakes.

Bell and guide-wire winches used for dry transfer into a habitat shall include a heave compensation and constant tension system.

Guidance note:

Care should be taken when designing handling systems with heave compensation and constant tension systems incorporated, as the added systems often contribute to the increase in the stiffness of the overall system.

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12.1.2.2 Manoeuvring systems shall be arranged for automatic stop when the operating handle is not operated (dead man's handle).

12.1.2.3 Hoisting systems shall be fitted with a mechanical brake, which shall be engaged automatically when the hoisting motor stops. In the event of failure of the automatic brake a secondary means shall be provided to prevent the load from falling.

12.1.2.4 The handling system shall be designed so that the systems are locked in place if the energy supply fails or is switched off.

12.1.2.5 The hoisting system shall be equipped with a device which stops the bell at its lowermost and uppermost positions. Travelling cranes and trolleys shall be equipped with mechanical stops at their end positions. The system shall be equipped with limit switches preventing the handling of the bell, wet bell or basket outside of the handling area.

12.1.2.6 Precautions shall be taken to avoid exceeding the design load in any part of the handling system including hoisting ropes and umbilical due to:

- large capacity of the power unit
- motions of the supporting vessel when the bell or weights are caught or held by suction to the sea floor
- failure on umbilical winch during launching of bell.

12.1.2.7 Structural members of the handling system might be subjected to forces imposed by separate units of a power system. (e.g. A-frame tilted by hydraulic actuator on each leg.) The structural members are therefore either to be strong enough to sustain the resulting forces when one of the power units fails, or the power units shall be synchronised and an automatic alarm and stop system shall be activated when the synchronising is out of set limits.

12.1.3 Power

12.1.3.1 The bell hoisting power system shall be designed and tested to lift a load of 1.25 times the working weight.

12.1.3.2 The power of horizontal transportation systems shall be designed and tested for safe handling at list and trim as specified in [Table 12-1](#).

12.1.3.3 The strength of the mechanical brake for the bell hoisting system shall be based on holding of the design load. After the static test, however, the brake may be adjusted to the working weight of the bell plus 40%.

12.2 Structural strength

12.2.1 Design loads

12.2.1.1 The design load shall be taken as the largest most probable, resultant load over 24 hours in the operational design sea-state due to the following:

- working weight of bell and structural members of the handling system,
- dynamical amplification due to list, trim and motion of the vessel,
- operation and response of the handling system,
- hydrodynamic forces,
- jerks in the hoisting ropes and impact on the system.

12.2.1.2 In locked positions on a vessel, the handling system shall have a structural strength at least sufficient for the environmental conditions described in [Sec.4](#). In addition to the motions and accelerations in the operational design sea-state, the minimum inclinations given in [Table 12-1](#) shall be taken into account:

Table 12-1 Permanent inclinations

<i>Vessel type</i>	<i>Permanent list</i>	<i>Permanent trim</i>
Ship	5°	2°
Semi-submersible	3°	3°

12.2.1.3 Dynamic loads due to start, stop, or a slack wire rope followed by a jerk, and hydrodynamic loads shall be determined.

12.2.2 Strength calculations

12.2.2.1 The safety to be checked for Case I of loading defined in [\[4.3\]](#) using design load as specified in [\[12.2.1\]](#).

12.3 Machinery and equipment

12.3.1 Steel wire rope

12.3.1.1 Steel wire rope safety factor shall be according to [\[11.5.2\]](#).
Ropes shall be of a type that minimises rotation.



12.3.2 Cross hauling

12.3.2.1 In the case of cross hauling, such equipment shall fulfil the same requirements for strength as the rest of the handling system.

12.3.3 Testing after completed installation

12.3.3.1 Handling systems shall be subjected to tests for structural strength and for function and power.

- a static load test to a load equal to the design load shall be carried out
- functional and power testing of normal and emergency systems shall be carried out with a functional test load of 1.25 times the working weight in the most unfavourable position. It shall be demonstrated that the systems are capable of carrying out all motions in a safe and smooth manner
- monitoring of functional parameters during the test, e.g. pressure peaks in hydraulic systems may be required
- a recovery test of the bell shall be carried out simulating emergency operations conditions.

SECTION 13 LAUNCH AND RECOVERY ARRANGEMENT FOR ROV

13.1 General

13.1.1 Basic requirements

13.1.1.1 Generally the requirements given in [Sec.8](#) for offshore cranes are valid for launch and recovery arrangement for ROV. This section specifies additional requirements for launch and recovery arrangement for ROV and it points out requirements which normally deviate from [Sec.8](#).

13.2 Documentation

13.2.1 Documentation requirements

13.2.1.1 Status for documentation will be as specified for “platform cranes” in [Table 2-2](#).

13.3 Machinery and equipment

13.3.1 Brakes

Guidance note:

Requirements for brakes as specified in [\[8.3.2.1\]](#) are not applicable.

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13.4 Safety and safety equipment

13.4.1 General

13.4.1.1 Requirements given in [\[8.4.2\]](#) (offshore cranes) are not applicable. Specific requirements as defined for platform cranes in [\[7.4.2\]](#) are valid.

SECTION 14 TESTING AND TEST CERTIFICATES MARKING

14.1 Functional testing of completed lifting appliances

14.1.1 General

14.1.1.1 Each completed crane shall be thoroughly tested to confirm that all the safety, power and control functions are correctly implemented onboard.

If complete functional testing has been documented to have been carried out at the test bed at manufacturers' location, limited functional testing may be carried out after final installation.

In such case, the proposed test plan shall specify the extent of the limited functional testing to be done after final installation.

14.1.1.2 The functional testing shall be carried out in accordance with a detailed programme, which shall be submitted well in advance of the actual testing. The programme shall specify in detail how the respective functions shall be tested and how observations during the test can be ensured. The tests specified below shall be included in the test programme.

14.1.1.3 A copy of the approved test programme shall be kept in the crane manual. It shall be completed with final results and endorsed by the "competent person".

14.1.1.4 The significant characteristics of power and braking systems as well as the safety equipment shall be considered. Braking systems and safety equipment shall be checked by function testing. Pressure testing of hydraulic components is normally not required to be witnessed by the surveyor. The tightness of the systems shall be checked after the installation of the components and during functional testing.

14.1.2 Prime movers and fluid power systems

14.1.2.1 Relevant parameters such as power, ambient temperature and pressure, exhaust gas temperature etc. shall be measured and recorded.

14.1.2.2 Automatic control, remote control and alarm systems connected with power systems shall be tested.

14.1.2.3 After the test, the lubricating and/or hydraulic oil filters shall be checked for solid particles. Other components of machinery may be required opened up by the surveyor.

14.1.3 Governing and monitoring systems

14.1.3.1 It shall be verified that control systems function satisfactorily during normal load changes.

14.1.3.2 Failure conditions or boundary conditions shall be simulated as realistically as possible, preferably letting the monitored parameters pass the alarm safety limits.

14.1.4 Electrical installations

14.1.4.1 Insulation-resistance test shall be carried out for all outgoing circuits between all insulated poles and earth and, where practicable, between poles. Under normal conditions a minimum value of 1 mega ohm shall be obtained. This also applies to instrumentation and communication circuits with voltages above 30 V A.C. or 50 V D.C.

The insulation resistance of a motor shall not be less than:

$$\frac{3 \cdot \text{rated voltage}}{\text{rated kVA} + 1000} \text{ megaohms}$$

tested on a clean and dry motor when hot.

14.1.4.2 When found necessary by the surveyor, switchgear shall be tested on load to verify its suitability and that operating of over-current release and other protective measures are satisfactory. Short circuit tests in order to verify the selectivity may also be required.

14.1.5 Brakes

14.1.5.1 Brakes shall be tested with safe working load applied on crane by braking each motion to full stop by releasing the joystick/handle.. In addition, each brake for the hoisting and derricking motions shall be tested for three such stops in quick succession during lowering motion.

14.1.5.2 If the winch design incorporates an exposed brake, the testing shall be carried out with the brake wetted.

14.1.5.3 The emergency stop system shall be tested. The test may be carried out at reduced speed and with reduced load.

14.1.6 Safety equipment

14.1.6.1 Safety functions as presented in [Table 7-1](#) in [Sec.7](#) and [Table 8-1](#) in [Sec.8](#) as well as the specific safety function requirements as given in the respective discipline sections shall be tested.

14.2 Load testing

14.2.1 General

14.2.1.1 Lifting appliance shall be load tested as part of FAT and after it has been installed at its operational location:

- before being taken into use the first time
- after any substantial alteration or renewal, or after repair of any stress bearing part
- at least once in every five years (preferably at regular five-yearly intervals after the date on which the appliance was first taken into use).

Above requirements are in compliance with international and national regulations.

14.2.1.2 Every item of loose gear shall be load tested:

- before being taken into use first time
- after substantial alteration or renewal
- after repair of any stress bearing part.

14.2.2 Test weights

14.2.2.1 Movable, certified weights shall be used by initial load-testing and by all load-testing where SWL exceeds 15 tonnes.

14.2.2.2 A mechanical or hydraulic precision dynamometer may be used:

- in cases of periodical retesting and after repair/renewal of mechanical parts of lifting appliances with
- $SWL \leq 15$ tonnes.
- in cases where a test that follows repair/renewal of a structural part is carried out.

The accuracy of the dynamometer shall be within ± 2 per cent and the indicated load of such dynamometers under test load shall remain constant for approximately 5 minutes.

14.2.2.3 Test equipment used for the testing of loose gear, either assembled units or components of loose gear, shall have been checked for accuracy (calibrated) at least once during the 12 months preceding the test.

14.2.3 Test loads

14.2.3.1 The test load applied to a lifting appliance shall exceed the safe working load (SWL) of the appliance as follows:

Table 14-1 Test load for cranes and derrick rigs

Safe working load	Test load
Up to 20 tonnes	25% in excess of the SWL
Exceeding 20, but not exceeding 50 tonnes	5 tonnes in excess of the SWL
Above 50 tonnes	10% in excess of the SWL
Note: Where the dynamic factor ψ exceeds 1.33, the reference SWL in the table shall be taken as $0.75 \times \psi \times SWL$	

14.2.3.2 For hydraulic cranes where, due to limitation of hydraulic oil pressure by the safety valve, it is not possible to lift a test load in accordance with Table 14-1, it will suffice to lift the greatest possible load. Generally this should not be less than 10 per cent in excess of the SWL. It is then, however, assumed that the structure is load tested with a load reflecting the overload based on the reference SWL by means of other methods.

14.2.3.3 The test load applied to a cargo or pulley block and to loose gear shall exceed the safe working load (SWL) of the block and gear as follows:

Table 14-2 Test load for loose gear and other accessories

Item	Test load, in tonnes ⁴⁾
Chains, hooks, shackles, swivels, etc.:	
$SWL \leq 25$ t	$2 \cdot SWL$
$SWL > 25$ t	$(1.22 \cdot SWL) + 20$
Multi-sheave blocks: ²⁾	

<i>Item</i>	<i>Test load, in tonnes ⁴⁾</i>
SWL ≤ 25 t	2 · SWL
25 t < SWL ≤ 160 t	(0.933 · SWL) + 27
SWL > 160 t	1.1 · SWL
<i>Single-sheave blocks: ^{1) 3)}</i>	4 · SWL
<i>Lifting beams, etc.: ⁵⁾</i>	
SWL ≤ 10 t	2 · SWL
10 t < SWL ≤ 160 t	(1.04 · SWL) + 9.6
SWL > 160 t	1.1 · SWL
Notes: 1) For single sheave blocks with or without becketts the SWL shall be taken as one half of the resultant load on the head fitting. See also App.B . 2) The SWL of a multiple sheave block shall be taken as the resultant load on the head fitting. 3) For single sheave blocks with a permissible load at the head fitting exceeding 25 tonnes, the test load may be reduced as permitted for the chains, hooks, shackles, swivels, etc. in the table. In this case the SWL notation shall be the resultant load on the head fitting. 4) Where the dynamic factor ψ exceeds 1.33: See Note to Table 14-1 . 5) The fittings to a lifting beam or frame such as hooks, rings and chain shall be tested independently before they are fitted to the beam.	

14.2.3.4 Built-in sheaves and other items permanently attached to the lifting appliance are not considered loose gear. The test of the lifting appliance “as rigged” will be accepted as the load test of these items.

14.2.3.5 Where hand-operated blocks are used with pitched chains and permanently attached rings, hooks, shackles or swivels, the hand-operated blocks, the pitched chains and the permanently attached rings, hooks, shackles and swivels shall be tested with a test load 50% in excess of the safe working load.

14.2.4 Examination after testing

14.2.4.1 After testing, the lifting appliance including gear accessories shall be examined thoroughly to observe whether any part has been damaged or permanently deformed by the test. Dismantling and/or non-destructive testing may be required if deemed necessary by the surveyor.

The above also applies to blocks and loose gear.

14.2.4.2 Any overload protection system and automatic safe load indicators that may have been disconnected during load testing shall be reconnected. Accordingly safety valves and/or electrical circuit-breakers shall be adjusted. Set points shall be verified and sealed by the surveyor.

14.2.5 Certificates

14.2.5.1 When a lifting appliance or component to a lifting appliance after testing and examination have been found satisfactory the following certificates/reports shall be issued (as far as applicable and relevant):

Form 71.03a	certificate of test and thorough examination of lifting appliances (FAT-testing)
Form No. CG2 :	certificate of test and thorough examination of lifting appliances (on board testing, ILO152)
Form OLA101	test report of test and thorough examination of lifting appliances (onboard testing, non-ILO152)
Form No. CG3 :	certificate of test and thorough examination of loose gear
Form No. CG4 :	certificate of test and thorough examination of wire rope

14.2.5.2 As final documentation for a lifting appliance installed and to be taken into use for the first time, Form No. CG1 *Register of lifting appliances and i loose gear* shall be presented. See also [App.F](#).

Guidance note:

The Forms Nos. 71.03a, CG2, OLA101, CG3 and CG4 should be attached to Form No. CG 1 in completed order.

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14.2.6 Procedure for load testing of a lifting appliance

14.2.6.1 Before load testing, the surveyor shall ensure that:

- support of the lifting appliance is acceptable
- for a ship or other vessel, necessary pre-cautions with respect to stability, ballasting or similar conditions have been taken
- for a mobile crane, the crane has a sufficient margin of stability against overturning
- required test certificates for blocks and loose gear are available and acceptable
- for a new installation, design approval and survey during fabrication of the lifting appliance are documented.

14.2.6.2 A written test programme acceptable to the surveyor should be available.

14.2.6.3 The test weights shall be lifted by the lifting machinery used for the regular handling of loads. Testing a lifting appliance driven by electrical motor(s) the regular electrical supply shall be used. For ships, electrical shore connection is acceptable when the power is distributed through the ship's main switchboard and distribution panels.

14.2.6.4 For cranes, the test load shall be hoisted, slewed and luffed at slow speed. Gantry and travelling cranes together with their trolleys, where appropriate, shall be traversed and travelled over the full length of their track.

14.2.6.5 For variable load-radius cranes, the tests are generally to be carried out at three points on the load curve, with the appropriate test load at maximum, minimum and at an intermediate radius.

14.2.6.6 Additional winch testing for subsea cranes, see [\[9.4\]](#).

14.3 Periodical surveys

ILO Convention No.152 require that cargo related lifting appliances shall be subjected to a thorough examination by a Competent Person at least every 12 months ("Annual Survey"), and in addition be

subjected to an overload test of the appliance as a whole in connection with a thorough examination every 5th year. Some national authorities have extended this requirement to cover all lifting appliances onboard. Note that some countries still base their legislation on ILO Convention No.32 and require special survey every 4th year.

Special requirements applicable for specific flags to be considered as additional to what is described in this chapter 14.3.

14.3.1 Procedure

- Verify that initial certification, or 5-yearly thorough examination for installations older than 5 years, has been carried out by a Competent Person (by DNVGL if Crane, Crane(N) or Crane Vessel) and is valid up to date. This means that ILO Form No.1 (CG1) shall be available and endorsed as required and that certificates, ILO Form No.2 (CG2 or OLA101 for non-ILO cranes), ILO Form No.3 (CG3) and ILO Form No.4 (CG4) are included in the pocket of Form No.1.

- Survey the lifting appliance having in mind the relevant items listed below, and with due attention to the overload test required every 5th year.

- Upon successful completion, credit the survey in NPS FiS template and issue Form No. CG 11 when required (initial and 5-yearly thorough examinations). Endorse CG1 in the appropriate sections for ILO and non-ILO items, and - for 5-yearly thorough examination - re-issue certificate (CG2 or OLA101).

Parts which are found to be worn or corroded to a significant degree shall be required to be replaced or repaired as found appropriate.

Alterations typically involving structural modifications and/or modifications to systems and safety functions/equipment shall be approved by RAC. Surveyors may accept minor alterations.

14.3.2 Annual Survey

14.3.2.1 Time window

The annual survey is in ILO Convention No.152 stipulated to be conducted at least once every 12 months prior or on the anniversary date without time window.

For Crane, Crane(N) and Crane Vessels, the Annual Survey of the lifting appliances not concurrently subject to ILO can be performed concurrently with the vessel's Annual General Survey and a time window of +/- 3 months.

14.3.2.2 Items to be considered for Annual Survey

- Structural condition (cracks, distortions, corrosion). NDT shall be applied when deemed necessary.
- Support structure.
- Excessive clearance in sheave bearings and eye-bolt connections.
- Wire rope, including end attachments, with respect to wear, broken wires and corrosion.
- Hooks, including rings and chains.
- Shackles.
- Operational condition of slewing system (slewing bearing and hook rollers). Check lubrication, ensure tightness of bolts and check that there is no detrimental noise, wear or movement.
- Functional operation and testing of brakes.
- Safety devices (compliance and relevant regulations).
- Emergency stop function.
- Leakages in hydraulic system and correct safety valve adjustment.
- Proper arrangement and condition of electrical systems.
- Marking (crane and loose gear marking as per certificates).
- Component and loose/lifting gear certificates available and in order.

- Load charts (if relevant).
- Provisions for securing the crane during open sea conditions.
- Fire extinguishers (if relevant).

14.3.3 Quinquennial (5 yearly) Survey

14.3.3.1 Time window

See [14.3.2.1].

14.3.3.2 Additionally for 5-yearly survey

In addition to the examinations listed for Annual Survey, the following additional surveys and load test shall be carried out (the surveyor may apply other scope if found acceptable):

- Load testing as required for initial certification.
- Loose gear is generally not required to be overload tested at 5-yearly survey.
- Boom heel bearings, hydraulic cylinder hinge shafts, fixed sheaves, blocks, axle pins and housings to be confirmed documented as dismantled (opened up), examined and found in order once during the last two years, or, to be opened up now.
- Slewing bearings to be opened up and internal fillets, raceway and bolts to be subjected to MPI. Exemption to opening up will be granted provided: a) an approved securing device (retainer) is fitted, or, b) the slewing bearing has been specially adapted and approved by DNVGL for non-destructive crack detection, or, c) a company is available possessing method, skill and specially trained operators within non-destructive crack detection of bearings in question. The company, operators and qualification tests to be approved by DNVGL in each case. Alternatively, a procedure including regular clearance measurements established when the crane was new, grease sampling and fatigue evaluations are adopted in agreement with the crane and slewing bearing manufacturer.

For single ball slewing bearings, opening up may be waived unless required upon detection of unacceptable clearances, excessive noise, etc.

Holding-down bolts: a) For platform cranes, minimum 50 % of the holding down bolts shall be documented as being dismantled, examined and found in order once during the last 3 years, or, 20 % opened now. b) For offshore cranes, 20 % of the bolts shall be removed and examined. The initial 20 % shall be taken in the most loaded sector of the crane. If any significant defects are found during this examination another 20 % are to be drawn. If any of these second set is found to be defective, than all the bolts shall be drawn. If the first 20 % are found to be acceptable and the examination is stopped, a maintenance schedule shall be established for examining the remaining 80 % during the 5 years period.

When refitting, all bolts shall be pre-stressed as stated in the crane manual as found on approved drawings.

14.4 Testing of steel wire ropes

14.4.1 Cross reference

14.4.1.1 Steel wire ropes shall be tested as required by [3.9.4]. Quality control of every rope and end termination to be done in accordance with recognized standard.

14.4.2 Certificates

14.4.2.1 After testing of steel wire ropes certificates of type CG4 shall be issued.

14.4.2.2 A manufacturer or supplier who has obtained a certificate for a coil of wire rope, shall, when he resells the coil or part of it, issue a certificate to the buyer. The certificate shall be a copy of the original certificate additionally dated and signed by the supplier.

14.5 Marking and signboards

14.5.1 General

14.5.1.1 Cranes and all items of fixed and loose gear and accessories shall be marked with their safe working load (SWL) in a legible and durable way. To prevent effacement of the inscriptions, they shall normally be incised, punched or marked as specified below.

14.5.1.2 All blocks and all items of loose gear and accessories shall be marked with an identification mark to enable them to be readily related to their appropriate test certificates, with the stamp of institution, society, body or manufacturer who carried out the load test.

14.5.1.3 Cranes on board vessels shall be marked with a reference number to enable them to be related to their location onboard.

14.5.2 Cranes

14.5.2.1 The markings of SWL and allowed radii be painted in a conspicuous place on the crane. The identification numbers and stamp of the surveyor shall be punched or incised.

14.5.2.2 Cranes with constant SWL for all radii shall be marked with possible crane reference number, SWL and minimum and maximum radii for this load. Example: No.5 SWL 5 t 4 - 14 m.

14.5.2.3 Cranes with SWL depending on one variable only shall be marked with possible crane reference number and with SWL for two or more instances of the variable, including the ones giving extreme values of SWL. If possible, the variable shall be expressed as radius. Example: No.5 SWL 15 t 5 m, SWL 3 t 12 m.

14.5.2.4 Cranes with SWL depending on two or more variables (e.g. knuckle boom crane) shall be marked with possible crane reference number and the maximum SWL within the range together with a reference to load chart.

14.5.2.5 Reference numbers and SWL shall be marked in letters and figures of at least 80 mm height and the radii in letters and figures of at least 60 mm height.

14.5.2.6 Cranes with dual function, e.g. hook duty and grab duty, shall be marked for both alternatives. Clear instructions/signboard shall be available for the crane driver.

Guidance note:

Self weight of loose gear/grab shall be deducted from cranes' SWL before deciding suitability of lifting gear/grab.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

14.5.3 Launch and recovery systems for diving

14.5.3.1 The handling system shall, in an easily visible place, be fitted with a nameplate giving the following particulars:

- identification number
- static test load
- functional test load
- working weight
- surveyor's mark and identification



The above loads shall be specified for each transportation system involved.

14.5.4 Blocks

14.5.4.1 The SWL of blocks together with the identification numbers and the surveyor's/manufacture's stamp shall be marked on one of the plates of the blocks.

For definition of SWL of blocks, see Notes to [Table 14-2](#).

14.5.5 Slings and lifting tackles

14.5.5.1 Slings and lifting tackles are considered as "loose gear" and shall comply with [\[5.2.8\]](#).

14.5.5.2 Slings and lifting tackles shall be marked with SWL, identification number and the certifying authorities' stamp on a legibly and durably fitted ring or plate.

14.5.5.3 Where wire rope slings are fitted with pressure locks the markings shall be located on the locks.

14.5.5.4 For wire rope slings the SWL by 0° shall be marked for single slings.

The safe working load marked on a multi-legged sling shall be:

- in the case of a two-legged sling, the safe working load of the sling when the included angle between the legs is 90°
- in the case of a three-legged sling, the safe working load of the sling when the included angle between any two adjacent legs is 90°
- in the case of a four-legged sling the safe working load of the sling when the included angle between any two diagonally opposite legs is 90° and the total load is carried by 3 of the four legs.

14.5.5.5 Instead of marking of slings as stated in [\[14.4.5.3\]](#) above, displayed information on use of the slings may be accepted. The display shall be easily seen and the slings shall be easily identified in accordance with the display.

14.5.5.6 Lifting gear and grabs shall be marked with SWL, own weight, identification number and the certifying authority's stamp.

APPENDIX A WIND LOADS ON CRANES

A.1 Wind load calculation

A.1.1 General

A.1.1.1 A simplified method of wind load calculation is presented below. The method will be acceptable for all normal crane designs and applications where the wind loads are of significant less importance than the other design loads.

A.1.1.2 In the design of cranes the distribution of wind pressure and suction around the structure need not be considered in detail, and wind loads may normally be determined in terms of resulting forces on each of the larger parts of the crane, or on each «assembly» of smaller members, such as a truss. A basic assumption is that wind pressure and suction will act normal to surfaces. As a consequence the resulting wind force on a prismatic member will act normal to the axis of the member, irrespective of wind direction. This applies to long prismatic members and, if the ends are not exposed to wind, also to short prismatic members.

A.1.2 Wind force on flat surfaces

A.1.2.1 The wind force normal to a flat surface of area A is taken as:

$$P = A \cdot q \cdot C \cdot \sin\alpha$$

where:

- P = wind force in N.
- A = exposed area in m²
- q = air velocity pressure = $\rho v^2/2$. See [A.1.5].
- C = average «pressure coefficient» for the exposed surface.
- α = angle between the wind direction and the exposed surface
- ρ = mass density of the air (1.225 kg/m³)
- v = wind velocity in m/sec.

A.1.3 Wind force on bodies of flat surfaces

A.1.3.1 For a body bounded by flat surfaces, such as a machinery house or the like, the resulting wind force may be determined as the vector sum of one force acting on each surface, each force being determined according to [A.1.2.1]. In general, A, C and α will be different for the different surfaces, and on the leeward surfaces there will be suction. In most practical cases, however, it is more convenient to use values of C which represent the sum of pressure and suction on two opposite sides. Such values of C are given in Table A-1.

A.1.4 Wind force on structural members

A.1.4.1 For flat-sided structural members, such as rolled sections, the equation in [A.1.2.1] may be used for both of the possible components normal to the member axis:

$$P_1 = A_1 \cdot q \cdot C_1 \cdot \sin \alpha_1$$

$$P_2 = A_2 \cdot q \cdot C_2 \cdot \sin \alpha_2$$

Referring to [Figure A-1](#), P_1 is the total force acting normal to the flanges (resulting from pressure and suction on both flanges) and P_2 is the total force acting normal to the web.

Further $A_1 = l \cdot h_1$ and $A_2 = l \cdot h_2$.

α_1 = angle between velocity vector and flange plane and

α_2 = angle between velocity vector and web plane.

Applicable values of C are given in [Table A-1](#). Note that C is used as a common symbol for «pressure coefficient» (pressure or suction) and «force coefficient» (sum of pressure and suction).

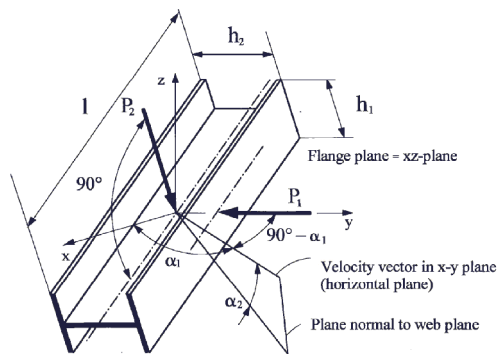


Figure A-1 Wind force on H-shaped members

Table A-1 Coefficient C

Type of member	Coefficient C		
	Pressure	Suction	Total
Flat-sided section			2.0
<i>Tubular member:</i>			
diameter < 0.3 m			1.2
diameter ≥ 0.3 m			0.7
Trusses of flat-sided sections			1.8
Trusses of tubular members			1.1
For leeward truss in case of two trusses behind each other			2/3 of above values
Machinery houses, cabins, counterweights and the like	Max:1.0 Average:0.7	Max:1.0 Average:0.7	1.2
<i>Working load:</i>			
Containers and similar shapes	(0.7)	(0.5)	1.2
Other shapes			1.0

A.1.4.2 For members of circular (or nearly circular) cross section the equation in [A.1.2.1] may be used for the resulting force, taking $A = ld$, C as force coefficient, and α as angle between wind direction (velocity vector) and member axis, see Figure A-2.

P acts in the plane defined by the member axis and the velocity vector, in the direction normal to the member axis. For values of C , see Table A-1.

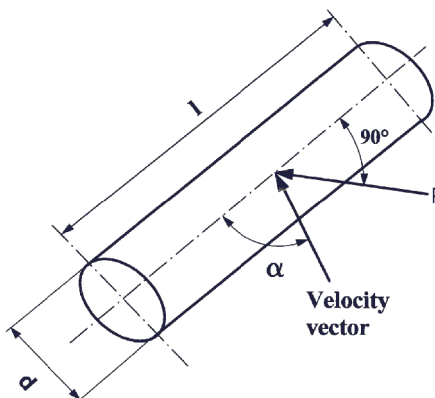


Figure A-2 Wind force on tubular members

A.1.5 Air velocity pressure

A.1.5.1 The velocity pressure q to be used as design parameter shall be based on expected conditions for each particular crane or part of crane. The variation with height above ground (or sea level) may be taken as:

$$q = q_{10}(0.9 + 0.01 \cdot H)$$

where

q_{10} is the velocity pressure 10 metres above ground (or sea level) and H is the considered height in metres. General minimum values of q_{10} are given in Table A-2. The corresponding «free-stream» wind velocity v_{10} (m/sec) is also given.

Table A-2 Design velocity pressure in N/m^2

Location	Crane condition	v_{10}	q_{10}
Inland and sheltered conditions	“Working”	≈ 20	250
Ship in harbour	“Out of service”	≈ 36	800
Offshore and open areas	“Working”	≈ 24	360
Ship at sea	“Out of service”	≈ 44	1200

APPENDIX B MARKING OF SINGLE-SHEAVE BLOCKS

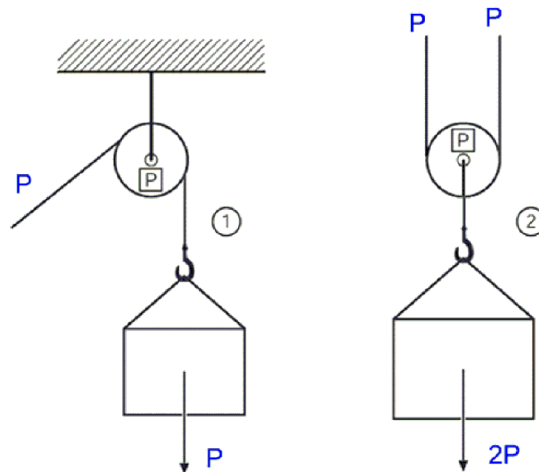
B.1 General

B.1.1 Method of marking the safe working load

B.1.1.1 This appendix explains the method of marking the safe working load (SWL) of single-sheave blocks with or without a becket. Experience shows that this subject is frequently discussed and often misunderstood.

B.1.1.2 The text is an excerpt from ILO's Code of Practice *Safety and health in ports*, 2005, Item 4.4.5 "Blocks", published by the *International Labour Office*, Geneva, Switzerland.

- the safe working load of a single-sheave block is the maximum load that can be safely lifted by that block when it is suspended by its head fitting and the load is secured to a wire rope passing round its sheave (Figure B-1 ①)
- when a single-sheave block is rigged with the load to be lifted secured to its head fitting and the block is suspended by a wire rope passing around its sheave, it should be permissible to lift a load twice the safe working load marked on the block (Figure B-1 ②)
- the safe working load of a multi-sheave block is the maximum force that may be applied to its head fitting
- the design of blocks to be used with wire ropes should be based on a wire rope having a tensile strength of 180 to 220 kg/mm² (1 770 to 2 160 N/mm²).



① Load attached to rope passing around the pulley

② Load attached directly to the block

P Safe working load of the block

Figure B-1 Safe working load of a single-sheave block

APPENDIX C SHIP MOUNTED CRANES WITHOUT JIB SUPPORT IN TRANSIT CONDITION

C.1 Example on checking for compliance with the structural strength

C.1.1 General

The requirements for ship mounted cranes with respect to transport condition are dealt with on a general bases in [Sec.4](#). For jib cranes where the jib rests in a cradle in transport condition, the transport condition is generally not critical with respect to excessive yielding. The contribution to fatigue damage from this condition is, for a normal crane design, insignificant compared to the crane operating condition. The use of jib cradle is the most frequently used way of securing the crane in transport condition.

However, for a jib crane without a jib cradle, the situation is quite another. This document describes how the Society, in general, ensures that the requirement in this standard is fulfilled when a jib crane in transport condition is secured in the following way:

- slewing column rotation is prohibited by applying locking bolts in the slewing ring
- the jib is secured by tension in the crane's hoisting wire and tension in the crane's luffing cylinders.

Design checks that apply to jib cranes generally are not included here, only the special checks that follow from the special securing of the crane in transport condition are covered.

C.1.2 Case of loading to be considered

The case of loading that shall be considered when accounting for ship movement, is described in [\[4.2.4\]](#):

$$S_G + S_M + S_{Wmax}$$

where:

- S_G = loads due to dead weight of the components
- S_M = inertia forces due to motion of the vessel on which the crane is mounted
- S_{Wmax} = loads due to out-of-service wind.

The procedure followed when calculating the loading is independent of how the crane is secured in transport condition. However, some explanations to how S_M and S_{Wmax} are calculated are presented in the items below.

The above load case, denoted IIIb in our Standard, is actually not one single load case. The reason is that the inertia forces caused by the ship motion, in accordance with *DNV GL rules for classification of ships*, are dealt with as four different load combinations:

- vertical force alone
- vertical and transverse force
- vertical and longitudinal force
- vertical, transverse and longitudinal force.

For these four load combinations it may be easy to foresee what direction of the accelerations will give the highest loading, and thereby decide what the four load combinations shall look like when checking for static strength. When checking for fatigue, however, it is the stress ranges that are of interest. The crane must therefore be analysed for both directions of the accelerations, giving 8 different load combinations.

In addition to the above, the crane is preferably analysed for both initial heel/trim and no heel/trim. The total number of load combinations will therefore be 16.

C.1.3 Calculation of vessel motion

The vessel motion is calculated in accordance with *DNV GL rules for classification of ships* [RU SHIP Pt.3 Ch.4 Sec.3](#). The ship accelerations thus calculated are extreme values (i.e., probability level = 10^{-8}). The crane's location on board the ship is accounted for. To be sure to avoid shock loads in the crane, it is important to check that the upward vertical acceleration never exceeds $1.0 \cdot g$. (If the upward vertical acceleration exceeds $1.0 \cdot g$, special considerations must be made regarding requirements to tension in the jib luffing cylinders and redundancy of the same.)

Typical values for the calculated accelerations may, for a ca. 180 m ship with 60 000 tonnes displacement and the crane near the bow, be:

Combined¹⁾ vertical acceleration: $a_V = 1.0 \cdot g$

Combined¹⁾ transverse acceleration: $a_T = 0.7 \cdot g$

Combined¹⁾ longitudinal acceleration: $a_L = 0.3 \cdot g$

¹⁾ Combined means that the acceleration is a result of all the ship motion (surge, sway/yaw, heave, roll and pitch). Gravity is, however, not included.

C.1.4 Calculation of loading due to vessel motion

The forces acting on the crane due to vessel motion are calculated in accordance with *DNV Rules for Classification of Ships* Pt.3 Ch.1 Sec.4 C501. This means that the forces are based on the extreme response as calculated above, but are modified to a probability level of approximately 10^{-4} . The four load case combinations calculated are:

— vertical force alone:

$$P_V = (g_0 \pm 0.5 \cdot a_V) \cdot M$$

— vertical and transverse force:

$$P_V = g_0 \cdot M$$

$$P_T = \pm (0.67 \cdot a_T) \cdot M$$

— vertical and longitudinal force:

$$P_V = (g_0 \pm 0.5 \cdot a_V) \cdot M$$

$$P_L = \pm (0.67 \cdot a_L) \cdot M$$

— vertical, transverse and longitudinal force:

$$P_V = (g_0 \pm 0.5 \cdot a_V) \cdot M$$

$$P_T = \pm (0.27 \cdot a_T) \cdot M$$

$$P_L = \pm (0.67 \cdot a_L) \cdot M$$

where M = total mass of unit.

Applying load combinations on a 10^{-8} level corresponds to [\[4.2.4\]](#) Load Case III.

Applying load combinations on a 10^{-4} level corresponds to [\[4.2.3\]](#) Load case II.

C.1.5 Calculation of wind load

The procedure for calculation of wind load is the same as for the working condition, except that the wind pressure 10 metres above the sea level, q_{10} , is increased from 250 N/m^2 for working conditions in sheltered locations, to $1\,200 \text{ N/m}^2$ for ship at open sea. The critical wind direction will in most cases be normal to the plane spanned by the crane slewing column and the jib.

C.1.6 Checking with respect to excessive yielding

By calculating the acting forces in the crane for the above load combinations, remembering the special conditions with tension in both luffing cylinders and in the hoisting wire, stress calculations and check with respect to excessive yielding may be performed. The requirement to safety factor is given in Table 4-2.

For cranes with a long jib that are designed for small SWL, a transport condition with the jib not supported may tend to be the critical condition. However, the shorter the jib and the higher the SWL for which the crane is designed, the less critical the transport condition becomes compared to the working condition of the crane. An example; for a typical design of a crane with 26 meter jib and a SWL of 36 tonnes, the lowest safety factors calculated by applying elastic analysis were approximately 3.0 for both the critical spot in the jib and in the housing (our requirement is $S_F \geq 1.10$).

C.1.7 Checking with respect to buckling

Based on consideration of the static system of the crane in transport condition, the acting forces and the calculated stresses in the transport condition as compared to the stresses in the working condition, it may be concluded that the transport condition will normally not be critical with respect to buckling. Consequently, it is normally not necessary to perform buckling check.

C.1.8 Checking with respect to fatigue

The fatigue check is based on the stress ranges found by applying the $\pm$ altering of the accelerations as shown in [C.1.4]. Conservatively, for each hot spot, the maximum stress ranges from the four load combinations may be selected: $\Delta\sigma_0$. The $\Delta\sigma_0$ value is the stress range (for a particular hot spot) that has a probability of 10^{-4} of being exceeded (ref. [C.1.4]). $\Delta\sigma_0$ therefore represents the maximum stress range within $n_0 = 10^4$ cycles.

In the following we will calculate the fatigue damage for a ship service life of 20 years. We will need to know the number of cycles within 20 years. By assuming a mean wave period of 6 seconds (the mean wave period will vary depending on sheltered condition, open sea, on which ocean the ship operates, etc., 6 seconds is assumed to be a sufficient good estimate for the actual purpose) the number of cycles in 20 years may be calculated:

$$n_{20} = \frac{20 \text{ years} \cdot 365 \frac{\text{days}}{\text{year}} \cdot 24 \frac{\text{hours}}{\text{day}} \cdot 3600 \frac{\text{seconds}}{\text{hours}}}{6 \frac{\text{seconds}}{\text{cycle}}} = 10^{8.0}$$

After deciding which SN curve applies to a particular hot spot, an estimate for the fatigue damage in a 20 year period for the given hot spot may be calculated by applying a closed form fatigue formula:

$$D_{ir20} = \frac{n_0}{a} \cdot \frac{(SCF \cdot \Delta\sigma_0)^m}{(\ln n_0)^m} \cdot \Gamma(1+m) \cdot \frac{n_{20}}{n_0}$$

For Weibull shape parameter $h = 1.0$ and with a one slope S-N curve, where:

- D_{tr20} = Accumulated fatigue damage over a 20 year period for the actual hot spot, as caused by ship movement only
- n_0 = Number of cycles corresponding to the calculated $\Delta\sigma_0$
- $\bar{a}$ = Parameter in S-N curve.

SCF = Stress concentration factor (in addition to that included in the S-N curve)

$\Delta\sigma_0$ = Stress range found as explained above

m = Parameter in S-N-curve

Γ = gamma function

m = 3.0 $\Gamma = 6.00$

m = 3.5 $\Gamma = 11.63$

m = 4.0 $\Gamma = 24.00$

n_{20} = Number of cycles in a twenty year period.

For the crane's working condition, the fatigue check is normally done by comparing the actual stress level with allowed stress levels in accordance with the FEM standard. This check does not account for the special fatigue damage as caused by supporting the jib in transport condition without a cradle. It is therefore of interest to calculate how the fatigue check for the working condition may be performed in such a way that the special damage from the transport condition is accounted for. This is done by calculating the factor that the stress level in the working condition must be reduced by, to still keep the fatigue damage below the acceptable level

$$k = [1 - D_{tr20}]^{\frac{1}{m}}$$

where:

k = Factor to multiply the allowed fatigue stress for working condition with to account for both working condition and transport condition

D_{tr20} = Fatigue damage from transport condition (without accounting for required safety factor) calculated as shown above

m = Parameter in S-N curve.

The procedure for checking fatigue is then:

- 1) select a hot spot
- 2) select applicable S-N curve.
- 3) calculate possible SCF (only the stress concentration that comes in addition to the stress concentration built into the SN curve)
- 4) calculate the stress range for the transport condition: $\Delta\sigma_0$
- 5) calculate the fatigue damage for transport condition (without accounting for the required safety factor on stress level of 1.33)
- 6) calculate the allowed fatigue stress in working condition factor k
- 7) check fatigue for working condition. Multiply the allowed stress as found in accordance with the FEM standard by factor k
- 8) repeat step 1 to 7 for all actual hot spots.

Example of calculated k values for a typical design of a crane with 26 meter jib and a SWL of 36 tonnes: The factor k is calculated for the most highly stressed area of the housing and jib respectively. Assuming $SCF = 1.0$ (i.e., no SCF except for that included in the SN curve) and SN curve F, the following values were found:

Jib: $k = 0.96$

Housing, tension side: $k = 0.93$

Housing, compression side: $k = 0.89$

C.1.9 Considerations not included in the Society's approach

The above approach to special transport condition support for the jib covers the safety of the crane in transport condition and contributes to the overall fatigue damage of the crane. Some typical items that are not covered are:

- Increased abrasion on part of the crane system. The hydraulic luffing cylinders are a typical example of parts that may be exposed to increased abrasion. As part of a normal ship crane, the hydraulic cylinders are exposed to $2 \cdot 10^5$ load cycles in the crane's working condition. As the hydraulic cylinders are part of the system supporting the jib in transport condition, they are exposed to additionally 10^8 load cycles due to ship movement. Even if the loading in transport condition is smaller than those in working condition, the transport condition may, due to the large amount of cycles (500 times more cycles than that for working condition) be of significance when considering the expected life duration of the cylinders.
- The design check of a crane does not cover investigations whether the crane interferes with other equipment onboard the ship. For example, if the jib points along the ship's longitudinal axis, the transverse displacement of the jib tip in a storm may be significant. The ship buyer/owner should, when ordering cranes, ensure (or ask the crane manufacturer to assure him) that the cranes do not interfere with each other or other equipment, not only for working condition, but also for transport condition.

Calculation of natural-frequencies and Eigenmodes is normally not covered. The natural period of the jib is quite different when the jib rests in a cradle compared to when it is supported by hoisting wire and luffing cylinders. If, for instance, the ship movement has the same period as a natural period for the jib, quite a dynamic amplification of the displacements in the jib may occur. Additional securing systems for the jib may be required if the in-service experience of the crane shows that large vibrations may occur under transport condition.

Guidance note:

Most S-N curves for air environment are presented as two-slope S-N curves. The presented closed form fatigue equation will, for the present purpose, give a reasonable estimate while used together with the part of the S-N curve that is to the left of 10^7 cycles. Alternatively, the damage may be calculated by a more direct integration of fatigue damage using the actual S-N curves.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

APPENDIX D EXAMPLES ON BASIS FOR ACCEPTANCE OF WORKS PRODUCT CERTIFICATES

D.1 Transmission gears for platform cranes

D.1.1 Designed in accordance with this certification standard or other recognised standard

D.1.1.1 The following shall be confirmed:

General

- name of manufacturer
- type designation
- serial number
- marking
- type of marking (e.g. chiselled, painted or on attached plate) and place on the component on which the mark is attached.

Testing

- date and place of functional testing
- special observations made or remarks to be made to the functional testing.

General design

- applied standard.

D.1.1.2 The following drawings and documents shall be attached:

- sectional drawings
- calculations documenting necessary and available torque capacity.

D.1.1.3 Signatures and qualifications:

- date and place of issuance of documentation
- name in printed letters and signature of person responsible for the certification (preferably a person related to quality assurance work and who is in a unit unrelated to production).

D.2 Hydraulic cylinders exempted from the Society's certification

D.2.1 Conditions for use

D.2.1.1 May be used provided the following condition is met for cylinders not taking part in the main load path, i.e. not luffing and telescoping cylinders.

D.2.1.2 The following shall be confirmed:

General

- name of manufacturer
- type designation
- serial number
- marking

- type of marking (e.g. chiselled, painted or on attached plate) and place on the component on which the mark is attached.

Agreement for exception

- date of application for exception
- the following submitted as attachments to the application:
 - one copy of documentation on the cylinder, including all main dimensions and material specifications (yes or no)
 - suggested extent of NDT and pressure testing procedure (yes or no)
- date when the extent of NDT and pressure testing was agreed
- DNV GL office that agreed on extent of NDT and pressure testing
- date when the exception was granted
- DNV GL office that granted the exception

Testing

- date and place of pressure testing
- special observations made or remarks to be made to the pressure testing
- date of acceptance of NDT

General design

- design standard applied
- structural standard applied in combination with the design standard (in cases where the design standard does not state acceptable structural design utilization)
- material used in all primary load-carrying parts
- dynamic design load
- design pressure
- design temperature
- the cylinder is accepted for pushing only (yes or no)
- the cylinder is certified for use in lifting appliances only (yes or no)

D.2.1.3 Signatures and qualification:

- date and place of issuance of documentation
- name in printed letters and signature of person responsible for the certification (preferably a person related to quality assurance work and who is in a unit unrelated to production)

APPENDIX E EXAMINATION OF PAD EYES AND SKIDS

E.1 Purpose

E.1.1 Questions related to specific lifting appliances and fundamentals

E.1.1.1 This appendix aims to present clarifications to some frequently addressed questions related to a few specific lifting appliances and fundamentals.

E.1.2 Pad eyes (lifting lugs)

E.1.2.1 For pad eyes (lifting lugs) and their supporting structures, the Society is prepared to carry out verification, based on the procedures below:

- design approval of the bracket and its fixation to its support
- manufacturing survey including examination of material certificates and NDT
- monitoring of load testing (if agreed)
- check of marking.

E.1.2.2 The design of pad eyes is to be based on the Society's standards such as DNVGL ST 0377 Sec.7 *Standard for shipboard lifting appliances*, DNV OS H205 App.B *Lifting operations*, or other applicable recognized standard for pad eyes.

Design drawings shall be submitted for examination. Unless the details comply completely with a standard referred to, structural strength calculations shall be submitted for the Society's design examination.

E.1.2.3 Although not subject to certification, the Society will base possible necessary design examination on the structural requirements of these standards.

E.1.2.4 The verification will be documented with reports. Certificates will normally not be issued.

E.1.2.5 The Norwegian Maritime Directorate has introduced requirements for certificates (NIS/NOR Circular no.1/2006) for pad eyes used as foundations for non-permanent lifting equipment, the Society has decided to offer issuance of certificates (Form OLA101) upon specific request related to this circular, i.e. onboard Norwegian flag vessels only.

Guidance note:

Often a number of such pad eyes exist on an installation. When standardized pad eyes are used, testing of different sizes may be accepted to follow the guide as outlined at the end of this Appendix, provided in agreement with flag state requirements.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

E.1.3 Skids

E.1.3.1 Both skids designed for transport of different varying loads as well as skids designed for a specific load may be certified by the Society. For special offshore services one should consider whether certification as *offshore portable unit* might be an alternative to certification as loose gear. Reference is made to the Society's document DNVGL ST 0367 *Portable offshore units*.

E.1.3.2 If *certification* as loose gear is requested, the skid will, in principle, be certified in accordance with the ILO Convention. By the Society, this implies that this Certification Standard will form the basis for certification. The certification work will be documented by the Society's certificate CG3.

E.1.3.3 The certification work will include the same four steps as listed in [E.1.2.1]. The load test will be mandatory in the case of certification.

E.1.3.4 Any limiting design conditions for the operation of the skid shall be defined and annotated on the CG3 and will normally also be required to be included in the marking. This may, in addition to the SWL, include such details as limitations for the centre of gravity of the load and angles of the lifting slings that may be attached.

E.1.3.5 The Society receives requests to certify separately only the pad eyes on the top corner of the skids where the lifting slings are connected.

This is not considered feasible. Certification of skids shall include the complete structure.

It is possible, however, to request a separate verification limited only to the pad eyes, in line with the principles for *verification* as stated in [E.1.2].

E.1.3.6 The Society is frequently requested to certify skids designed for one specific load, sometimes for one specific transport operation only – and sometimes for a skid on which the load (piece of equipment, motor, etc.) shall be permanently installed. Such commissions are accepted according to the procedures set out above. In most such cases, however, verification of the design will suffice.

E.1.3.7 For *offshore lifting operations* it is advisable (care shall be taken) to ascertain that the load stipulations include necessary reserves for dynamic amplifications that follow from lifting in waves. The same applies in cases of general certification for issuing of CG3, as well as for verification.

Reference is made to [5.2.9.4].

For verification assignment of a one-off operation it might be possible to specify the exact necessary dynamic amplification factor. Where, for example, the deck crane to be used is known it will be possible to retrieve the dynamic amplification from the crane's dynamic derating table. Such tables are required for all deck cranes for offshore operations certified by classification societies. Derating tables are also required by most shelf legislators and maritime authorities.

E.1.4 Testing of pad eyes (lifting lugs) applied as foundations for non-permanent lifting equipment

E.1.4.1

1) Pad eyes with SWL equal or less than 1 tonne:

- a) visual inspection by a surveyor (support and welding).
- b) surveyor's on-the-spot evaluation of pad eyes scantling if not a standard type.
- c) marking of individual pad eyes by SWL or group marking (i.e. common signboard in each room/space with several identical pad eyes. In case of pad eyes with different SWL in the same room/space individual marking or for instance a colour distinguishing system for the pad eyes shall be applied).
- d) description of location, SWL and loading directing shall be included in the operations manual.

2) Pad eyes with SWL above 1 tonne and less or equal to 3 tonnes as for item 1 a), c) and d):

Drawing approval locally, and

- load test + spot NDT, alternatively
- spot load test + 100% NDT

If spot load-test is chosen, it will be decided after visual inspection which pad eyes shall be load tested.

3) Pad eyes with SWL above 3 tonnes as for item 1 a) and d):

- drawing approval by the Society
- load test

- NDT extent to be included in the NDT programme
- individual marking

Guidance note:

Load factor for pad eyes (lifting lugs):

Pad eyes (lifting lugs) are to be designed with a load factor relative to the SWL in question:

<i>Safe working load</i>	<i>Load factor</i>
Up to 5 tonnes	2.0
5 – 20 tonnes	1.75
Above 20 tonnes	1.5

Load testing of pad eyes (lifting lugs):

Where load testing of pad eyes (lifting lugs) are required the testing shall be carried out according to the following:

<i>Safe Working Load</i>	<i>Test Load</i>
Up to 20 tonnes	$1.25 \times \text{SWL}$
20 – 50 tonnes	5 tonnes + SWL
Above 50 tonnes	$1.10 \times \text{SWL}$

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

APPENDIX F REGISTER AND CERTIFICATE FORMS

F.1 List forms

The following forms are relevant:

Form No.	Title
CG1	Register of lifting appliances and cargo handling gear
CG2	Certificate of test and thorough examination of Lifting appliances (ILO)
CG3	Certificate of test and thorough examination of loose gear
CG4	Certificate of test and thorough examination of wire rope
71.03a	Certificate of test and thorough examination of Lifting appliances (FAT)
OLA101	Test certificate for test and thorough examination of Lifting appliances (non-ILO)

F.2 Sample Copies

DNV GL	
REGISTER OF LIFTING APPLIANCES AND CARGO HANDLING GEAR	
Register No:	
Construction to which this register relates	
Name of Vessel, Platform etc:	
DNV GL Id No:	
Call sign:	
Owners:	
Port of Registry:	
Issued at (place) on (yyyy-mm-dd)	
	for DNV GL
	(name)
	Surveyor
Note: This Register is the standard international form as recommended by the International Labour Office in accordance with ILO Convention No. 152.	

Figure F-1 CG 1: Register of lifting appliances and cargo handling gear

DNV GL			
CERTIFICATE OF TEST AND THOROUGH EXAMINATION OF LIFTING APPLIANCES (CG2)			Certificate No: _____ Date of issue: (yyyy-mm-dd) _____
Location			
Name of Vessel, Platform etc:	_____		
DNV GL Id No:	_____		
Call sign:	_____		
Owners:	_____		
Port of Registry:	_____		
(1) Situation and description of lifting appliances (with distinguishing numbers or marks, if any) which have been tested and thoroughly examined	(2) Angle to the horizontal or radius at which test load is applied	(3) Test load tonnes	(4) Safe working load (SWL) at angle or radius shown in column 2 (tonnes)
_____	_____	_____	_____
_____	_____	_____	_____
If e, add rows to the table above, place cursor in the table and select eForms > Document Tools > Add row(s)			
Reason for issuing the certificate: ☐ Initial certification ☐ Recertification ☐ Repair ☐ Other, (give reason): _____			
DNV GL station employing the competent person: _____			
I certify that on the date to which I have appended my signature, the gear shown in column (1) was tested and thoroughly examined and no defects or permanent deformation were found; and that the safe working load is as shown.			
Issued at (place) on (yyyy-mm-dd) _____			
		for DNV GL (name) Surveyor	
Note: This Certificate is based on the standard international form as recommended by the International Labour Office in accordance with ILO Convention No. 152.			
☐ Tick off here if an appendix is issued			
Form code: CG2 Revision: 2014-11 www.dnvgl.com Page 1 of 1 © DNV GL 2014. DNV GL and the Horizon Graphic are trademarks of DNV GL AS.			

Figure F-2 CG2: Certificate of test and thorough examination of lifting appliances

		Certificate No: Date of issue: (yyyy-mm-dd)								
Instructions										
1.	Every lifting appliance shall be tested with a test load which shall exceed the safe working load (SWL) as follows: <table style="margin-left: 40px; border: none;"> <tr> <td style="padding-right: 20px;">SWL</td> <td>Test Load</td> </tr> <tr> <td>Up to 20 tonnes</td> <td>25 per cent in excess</td> </tr> <tr> <td>20 to 50 tonnes</td> <td>5 tonnes in excess</td> </tr> <tr> <td>over 50 tonnes</td> <td>10 per cent in excess</td> </tr> </table>		SWL	Test Load	Up to 20 tonnes	25 per cent in excess	20 to 50 tonnes	5 tonnes in excess	over 50 tonnes	10 per cent in excess
SWL	Test Load									
Up to 20 tonnes	25 per cent in excess									
20 to 50 tonnes	5 tonnes in excess									
over 50 tonnes	10 per cent in excess									
2.	In the case of derrick systems the test load shall be lifted with the ship's normal tackle with the derrick at the minimum angle to the horizontal for which the derrick system was designed (generally 15 degrees), or at such greater angle as may be agreed. The angle at which the test was made should be stated in the certificate of test. After the test load has been lifted it should be swung as far as possible in both directions. 2.1. The SWL shown is applicable to swinging derrick systems only. When derricks are used in union purchase the SWL(U) is to be as shown on Form No. CG.2U. 2.2. In the case of heavy derricks, care should be taken that the appropriate stays are correctly rigged.									
3.	In the case of cranes, the test load is to be hoisted, slewed and luffed at slow speed. Gantry and travelling cranes together with their trolleys, where appropriate, are to be traversed and travelled over the full length of their track. 3.1. In the case of variable load-radius cranes, the tests are generally to be carried out with the appropriate test load at maximum, minimum and at an intermediate radius. 3.2. In the case of hydraulic cranes where limitations of pressure make it impossible to lift a test load 25 per cent in excess of the safe working load, it will be sufficient to lift the greatest possible load, but in general this should not be less than 10 per cent in excess of the safe working load.									
4.	As a general rule, tests should be carried out using test loads, and no exceptions should be allowed in the case of initial tests. In the case of repairs, replacement or when the periodic examination calls for re-test, consideration may be given to the use of spring or hydraulic balances provided the SWL of the lifting appliance does not exceed 15 tonnes. Where a spring or hydraulic balance is used, it shall be calibrated and accurate to within 2 per cent and the indicator should remain constant for five minutes. 4.1. If test weights are not used this is to be indicated in column (3).									
5.	The expression 'tonne' shall mean a tonne of 1000 kg.									
6.	The terms 'competent person', 'thorough examination' and 'lifting appliance' are defined in Form No.CG.1.									
Note: For recommendations on test procedures, reference may be made to the ILO document 'Safety and Health in Dock Work'.										
Form code: CG2 Revision: 2014-11 www.dnvgl.com Page 2 of 2										

Figure F-3 CG2: Certificate of test and thorough examination of lifting appliances (page 2)

DNV GL					
CERTIFICATE OF TEST AND THOROUGH EXAMINATION OF LOOSE GEAR (CG3)					Certificate No: _____ Date of issue: (yyyy-mm-dd) _____
Location					
Name of Vessel, Platform etc:		" _____ "			
DNV GL Id No:		_____			
Call sign:		_____			
Owners:		_____			
Port of Registry:		_____			
(1) Distinguish number or remark	(2) Description of gear (the dimension of the gear, the type of the material of which it is made, and where applicable, the heat treatment received in manufacture should be stated)	(3) Number tested	(4) Date of test	(5) Test load applied (tonnes)	(6) Safe working load (SWL) (tonnes)
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
To add rows to the table above, place cursor in the table and select eForms > Document Tools > Add row(s)					
Makers or Suppliers name:		_____			
Makers or Suppliers address:		_____			
Reason for issuing the certificate: ☐ Initial certification ☐ Recertification ☐ Repair ☐ Other, (give reason): _____					
DNV GL station employing the competent person: _____					
I certify that the above items of loose gear were tested and thoroughly examined and no defects affecting their SWL were found.					
Issued at (place) on (yyyy-mm-dd) _____					
			for DNV GL		

			(name)		
			Surveyor		
Note: This Certificate is the standard international form as recommended by the International Labour Office in accordance with ILO Convention No. 152.					
Form code: CG3 Revision: 2014-11 www.dnvgl.com Page 1 of 1 © DNV GL 2014. DNV GL and the Horizon Graphic are trademarks of DNV GL AS.					

Figure F-4 CG3: Certificate of test and thorough examination of loose gear

	Certificate No: Date of issue: (yyyy-mm-dd)
Instructions	
1. Every item of loose gear is to be tested and thoroughly examined before being put into use for the first time and after any substantial alteration or repair to any part liable to affect its safety. The test loads to be applied shall be in accordance with the following table:	
Item	Test load (tonnes)
Single sheave blocks (see Note 1)	$4 \times \text{SWL}$
Multi sheave blocks (see Note 2):	
SWL $\leq$ 25 tonnes	$2 \times \text{SWL}$
25 tonnes < SWL $\leq$ 160 tonnes	$(0.933 \times \text{SWL}) + 27$
SWL > 160 tonnes	$1.1 \times \text{SWL}$
Chains, hooks, rings, shackles, swivels etc.:	
SWL $\leq$ 25 tonnes	$2 \times \text{SWL}$
SWL > 25 tonnes	$(1.22 \times \text{SWL}) + 20$
Lifting beams, spreaders, frames, and similar devices:	
SWL $\leq$ 10 tonnes	$2 \times \text{SWL}$
10 tonnes < SWL $\leq$ 160 tonnes	$(1.04 \times \text{SWL}) + 9.6$
SWL > 160 tonnes	$1.1 \times \text{SWL}$
1. The SWL for a single sheave block, including single sheave blocks with becketts, is to be taken as one half of the resultant load on the head fitting.	
2. The SWL of a multi sheave block is to be taken as the resultant load on the head fitting.	
2. This form may also be used for the certification of interchangeable components of lifting appliances.	
3. The expression 'tonne' shall mean a tonne of 1000 kg.	
4. The terms 'competent person', 'thorough examination' and 'lifting appliance' are defined in Form No.CG.1.	
Note: For recommendations on test procedures, reference may be made to the ILO document 'Safety and Health in Dock Work'.	
Form code: CG3 Revision: 2014-11 www.dnvgl.com Page 2 of 2	

Figure F-5 CG3: Certificate of test and thorough examination of loose gear (page 2)

DNV GL			
CERTIFICATE OF TEST AND THOROUGH EXAMINATION OF WIRE ROPE (CG4)		Certificate No: Date of issue: (yyyy-mm-dd)	
Location			
Name of Vessel, Platform etc:			
DNV GL Id No:			
Call sign:			
Owners:			
Port of Registry:			
Nominal diameter of rope (mm):		Number of strands:	
Core:		Lay:	
		Number of wires per strand:	
		Quality of wire (N/mm ²):	
Date of test of sample: (yyyy-mm-dd)			
Load at which sample broke (tonnes):		Safe working load of rope (tonnes):	
Intended use:			
Remarks:			
Makers or Suppliers name:			
Makers or Suppliers address:			
DNV GL station employing the competent person:			
I certify that the above particulars are correct, and that the rope was tested and examined and no defects affecting its SWL were found.			
Issued at (place) on (yyyy-mm-dd)			
		for DNV GL	
		(name)	
		Surveyor	
Note: This Certificate is the standard international form as recommended by the International Labour Office in accordance with ILO Convention No. 152.			
Form code: CG4 Revision: 2014-11 www.dnvgl.com Page 1 of 1 © DNV GL 2014. DNV GL and the Horizon Graphic are trademarks of DNV GL AS.			

Figure F-6 CG4: Certificate of test and thorough examination of wire rope

	Certificate No: Date of issue: (yyyy-mm-dd)
Instructions	
1. Wire rope shall be tested by sample, a piece being tested to destruction. 2. The test procedure should be in accordance with an international or recognized national standard. 3. The SWL of the rope is to be determined by dividing the load at which the sample broke, by a coefficient of utilisation, determined as follows:	
Item	Coefficient
Wire rope forming part of a sling:	
SWL of the sling	
SWL ≤ 10 tonnes	5
10 tonnes < SWL ≤ 160 tonnes	10 ⁴
	(8.85 × SWL) + 1910
SWL > 160 tonnes	3
Wire rope as integral part of a lifting appliance:	
SWL of the lifting appliance	
SWL ≤ 160 tonnes	10 ⁴
	(8.85 × SWL) + 1910
SWL > 160 tonnes	3
These coefficients should be adopted unless other requirements are specified by a national authority.	
4. The expression 'tonne' shall mean a tonne of 1000 kg. 5. The terms 'competent person', 'thorough examination' and 'lifting appliance' are defined in Form No.CG.1.	
Note: For recommendations on test procedures, reference may be made to the ILO document 'Safety and Health in Dock Work'.	
Form code: CG4	Revision: 2014-11 www.dnvgl.com Page 2 of 2

Figure F-7 CG4: Certificate of test and thorough examination of wire rope (page 2)

APPENDIX G VERIFICATION GUIDELINE FOR SAFETY FUNCTIONS

G.1 Application, scope and objective

G.1.1 Application

This guideline provides a recommended and simplified method for *1. part verification* (see definition in [G.1.2]) of safety functions and equipment for lifting appliances subject to design verification in accordance with the requirements as presented in this standard, see [8.4.2].

If so preferred, customer may use other verification methods.

Successful verification will serve as a condition for issuance of the Society's CG2 *Certificate of Test and Thorough Examination of Lifting Appliances*.

The guideline is intended, primarily, for designers, manufacturers, yards, operators, and owners applying for the Society's certification of lifting appliances in accordance with the above requirements.

G.1.2 Verification

1. Part verification is the supplier's responsibility.

The definition of verification: *Confirmation by examination and provision of objective evidence that the requirements have been fulfilled (ISO 8402, IEC 61508-4, 3.8.1.).*

G.1.3 Scope

This guideline provides an introduction to the recommended verification method and corresponding documentation requirements.

The basis for this guideline is the requirements for safety functions as specified in this Certification Standard ([8.4.2]), based on the IMO-FSA method for development of risk-based rules.

The intention of this guideline is to provide an introduction and specification of:

- the safety function verification method
- the verification sheet templates
- the basic documentation requirements.

G.1.4 Objective

The objective of this guideline is to provide a practical and adequate method for verification of safety functions and equipment as well as to provide the corresponding documentation requirements for lifting appliances in accordance with the Society's requirements.

G.2 Verification procedure

G.2.1 General

[8.4.2.4] – [8.4.2.19] requires a set of generic risk reduction measures (safety functions) as follows:

- overload limiting device ([8.4.2.4].a)
- Manual Overload Protection System MOPS ([8.4.2.4].b)
- Automatic Overload Protection System AOPS ([8.4.2.4].c)
- operational limit protection, general ([8.4.2.5].a)
- operational limit protection, boom up ([8.4.2.5].b)

- constant tension system (optional) ([8.4.2.6].a)
- reduced boom lifting/slewing speed ([8.4.2.6].b)
- audible alarm ([8.4.2.6].c)
- emergency stop function ([8.4.2.7])
- boom tip camera ([8.4.2.8])
- communication equipment ([8.4.2.9])
- slack wire rope detection ([8.4.2.10])
- failure in control systems, protection and precautions ([8.4.2.11])
- failure in the safety systems, precautions ([8.4.2.12])
- maintenance of braking capacity ([8.4.2.13])
- maintenance of holding capacity ([8.4.2.14])
- blackout/shutdown, precautions ([8.4.2.15].a)
- blackout/shutdown, emergency operation ([8.4.2.15].b)
- unintended activation of safety functions, protection ([8.4.2.16])
- spurious trip of safety functions, precautions ([8.4.2.17])
- hazards due to activation of safety functions, precautions ([8.4.2.18])
- gas alarm ([8.4.2.19].a)
- gas alarm, shut-down ([8.4.2.19].b).

Above safety functions are required for reducing the assumed generic risk.

In this guideline, most of the above safety functions are represented by a *verification form* stating a subset of the main functional and technical requirements.

The verification process obliges the customer to fill in (or tick off, whatever is appropriate) the verification papers and send them in completed order to the Society together with corresponding documents verifying that the requirements have been complied with. Requirements for documentation are specified in [Sec.2](#).

However, some of the more detailed functional and technical requirements for the safety functions, as specified in [\[8.4.2.4\]](#) - [\[8.4.2.19\]](#), are not included in the verification forms. It is assumed that fulfilment of these requirements is properly documented.

As a part of the verification of compliance with the Standard, it shall be confirmed that the maximum consequence of the stated hazard/risk contributor is *one fatality* (ref. [\[8.4.2.2\]](#)), with the exception of the hazard "Fire, fire ignition" ([\[8.4.2.19\]](#)).

In case the maximum consequence exceeds one fatality, this shall appear from the filled-in verification papers. The basis for the generic requirements for the safety functions is thereby not fulfilled, and the requirements for the safety functions will be subjected to deviation handling.

Further, also for other cases of deviation from the generic risk/risk contributors as specified by [\[8.4.2.2\]](#), and/or from the generic safety functions as specified in [\[8.4.2.4\]](#) - [\[8.4.2.19\]](#), this shall appear from the verification papers and lead to deviation handling of the requirements for the safety functions.

In such cases, the customer shall document in detail the actual safety functions with respect to functional and technical specifications. The actual solution will be subjected to a risk based assessment where the specific requirements for the safety functions will be developed and agreed with the customer.

Generally, there are no requirements for establishing detailed information for verifying target reliability by means of PFD or MTTF values.

A complete verification of target reliability may be applied, if preferred by the Customer, and may be based on methods described in different standards. Examples on applicable standards are IEC 61508 (SIL), IEC 62061 (SIL), ISO 13849 (PL).

G.2.2 Explanation of the verification templates elements

<i>Text in verification sheet</i>	<i>Explanation of element</i>
Hazard and risk	The generic hazard and initial risk briefly explained in a text.
Type of safety function	Textual name of safety function.
Safe state	Specification of the assumed safe state.
Energy principle (NE,NDE, CE)	Energy principle for normal operation (not activated). NE means "Normally Energised", NDE means "Normally De-Energised" and CE means "Continuous Energised".
On demand/continuous	On demand means that the safety function shall be activated when a given demand or state occurs. In this case the safety function shall establish the safe state as described above. Continuous means that the function is assumed to be working during normal operation of the facility.
Automatic/manual activation	Automatic activation means that the safety function shall be triggered by the safety system without manual operator intervention. Manual activation means that operator shall trigger the activation by means of button or joystick
Response time	Maximum time from system has been triggered to safe state is achieved.
Test procedure	Name and reference to periodic test procedure. Test procedure shall at least include how the test should be carried out and the success criterion for the test.
Test interval	Length of test interval between tests.
Detector 1	Reference to the detector or activation unit for triggering the safety function.
Detector 2	Reference to the redundant or secondary means for triggering the safety function.
Actuator 1	Reference to actuating device (valve, brake, etc.) for establishing the safe state. The safe state of the actuator shall be given.
Actuator 2	Reference to redundant or secondary means for establishing the safe state. The safe state of the actuator shall be given.
Monitoring of safety function	Specifies how the safety function, when active, is monitored - by means of indication and/or alarm. Ref. also Table 8-1 .
Independency to other functions	Reference to other specific functions that shall not be impaired by the safety function.

G.2.3 Verification sheet templates

G.2.3.1 Boom overload protection system ([8.4.2.4].a)

<i>Hazard and risk</i>	<i>Overloading</i>			
<i>Type of safety function</i>	<i>Overload limiting device</i>			
<i>Safe state</i>	<i>Boom luffing out movement stop</i>			
<i>Main items</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE, NDE, CE)</i>	CE (monitoring)			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Designer's specification			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Load cell or similar			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Boom luffing out stop			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Indication and alarm			
<i>Independency to other functions</i>	Shall not prevent lowering the load and boom luffing in safe direction			

G.2.3.2 Manual overload protection MOPS ([8.4.2.4].b)

<i>Hazard and risk</i>	<i>Overloading</i>			
<i>Type of safety function</i>	<i>Manual overload protection MOPS</i>			
<i>Safe state</i>	<i>Load paid out / released or clutched out. Holding force of 10–25% of internal lift</i>			
<i>Main items</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE (monitoring)			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Manual			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Designer's specification			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Operator switch/handle			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Designer's specification			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Indication and alarm			
<i>Independency to other functions</i>	NA			

G.2.3.3 Automatic overload protection system AOPS ([8.4.2.4].c)

<i>Hazard and risk</i>	<i>Overloading</i>			
<i>Type of safety function</i>	<i>Automatic overload protection system AOPS</i>			
<i>Safe state</i>	<i>Load paid out/released or clutched out, holding force of internal lift capacity. Boom luffing out movement stopped</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE, NDE, CE)</i>	CE (monitoring)			

<i>Hazard and risk</i>	<i>Overloading</i>			
<i>Type of safety function</i>	<i>Automatic overload protection system AOPS</i>			
<i>Safe state</i>	<i>Load paid out/released or clutched out, holding force of internal lift capacity. Boom luffing out movement stopped</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Designer's specification			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Load cell or similar			
<i>Detector 2</i>	Not applicable (NA)			
<i>Actuator 1</i>	Designer's specification			
<i>Actuator 2</i>	Boom luffing out stop			
<i>Monitoring of safety function</i>	Indication and alarm			
<i>Interdependency to other functions</i>	Shall not prevent boom luffing in safe direction			

G.2.3.4 Operational limit protection, general ([8.4.2.5].a)

<i>Hazard and risk</i>	<i>Crane movements outside operational limits</i>			
<i>Name of safety function</i>	<i>Operational limit protection, general</i>			
<i>Safe state</i>	<i>Stop of movements outside given limitations</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			

<i>Hazard and risk</i>	<i>Crane movements outside operational limits</i>			
<i>Name of safety function</i>	<i>Operational limit protection, general</i>			
<i>Safe state</i>	<i>Stop of movements outside given limitations</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Manual test procedure			
<i>Test interval</i>	12 months/Daily			
<i>Detector 1</i>	Limit switch, physical barrier			
<i>Detector 2 (required)</i>	NA			
<i>Actuator 1</i>	Stop movement			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Indication			
<i>Independency to other functions</i>	Shall not prevent movement in safe direction			

G.2.3.5 Operational limit protection, boom up ([8.4.2.5].b)

<i>Hazard and risk</i>	<i>Boom up movement outside limits (wire luffing cranes)</i>			
<i>Name of safety function</i>	<i>Operational limit protection, boom up</i>			
<i>Safe state</i>	<i>Stop of boom movement</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			

<i>Hazard and risk</i>	<i>Boom up movement outside limits (wire luffing cranes)</i>			
<i>Name of safety function</i>	<i>Operational limit protection, boom up</i>			
<i>Safe state</i>	<i>Stop of boom movement</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	6 months/Daily			
<i>Detector 1</i>	Limit switch			
<i>Detector 2 (required)</i>	Boom high high detection, fail safe detect			
<i>Actuator 1</i>	Boom up winch stop			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Indication			
<i>Independency to other functions</i>	Shall not prevent movement in safe direction			

G.2.3.6 Constant tension system ([8.4.2.6].a)

<i>Hazard and risk</i>	<i>Dangerous lifting gear/cargo movements</i>			
<i>Name of safety function</i>	<i>Constant tension system (optional)</i>			
<i>Safe state</i>	<i>Constant tension provided before lift off. Wire rope tension set to 1-3 tonnes</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NDE			
<i>On demand/continuous</i>	On demand			

<i>Hazard and risk</i>	<i>Dangerous lifting gear/cargo movements</i>			
<i>Name of safety function</i>	<i>Constant tension system (optional)</i>			
<i>Safe state</i>	<i>Constant tension provided before lift off. Wire rope tension set to 1-3 tonnes</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Automatic/manual activation</i>	Manual			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months/Daily			
<i>Detector 1</i>	Crane operator activation/button			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Designer's specification			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Indication			
<i>Independency to other functions</i>	NA			

G.2.3.7 Audible alarm ([8.4.2.6].c)

<i>Hazard and risk</i>	<i>Dangerous lifting gear/cargo movements</i>			
<i>Name of safety function</i>	<i>Audible alarm</i>			
<i>Safe state</i>	<i>Alarm signal given</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NDE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Manual			
<i>Response time</i>	Immediately			

<i>Hazard and risk</i>	<i>Dangerous lifting gear/cargo movements</i>			
<i>Name of safety function</i>	<i>Audible alarm</i>			
<i>Safe state</i>	<i>Alarm signal given</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months/Daily			
<i>Detector 1</i>	Crane operator activation/button			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Audible alarm/horn			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Alarm			
<i>Independency to other functions</i>	NA			

G.2.3.8 Emergency stop function ([8.4.2.7])

<i>Hazard and risk</i>	<i>Dangerous crane movements</i>			
<i>Name of safety function</i>	<i>Emergency stop function</i>			
<i>Safe state</i>	<i>Crane movements stopped</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Manual			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Crane operator button			
<i>Detector 2</i>	Working personnel activation (button)			

<i>Hazard and risk</i>	<i>Dangerous crane movements</i>			
<i>Name of safety function</i>	<i>Emergency stop function</i>			
<i>Safe state</i>	<i>Crane movements stopped</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Actuator 1</i>	Removal of power or mechanical disconnection (declutching)			
<i>Actuator 2</i>	Application of brakes			
<i>Monitoring of safety function</i>	Indication and alarm			
<i>Independency to other functions</i>	NA			

G.2.3.9 Slack wire rope detection ([8.4.2.10])

<i>Hazard and risk</i>	<i>Slack wire rope at drum</i>			
<i>Name of safety function</i>	<i>Slack wire rope detection</i>			
<i>Safe state</i>	<i>Stop winch motion and re-tighten of slack wire rope before automatically returning to normal operation.</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Wire rope tension measuring device			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Stop winch movement			

<i>Hazard and risk</i>	<i>Slack wire rope at drum</i>			
<i>Name of safety function</i>	<i>Slack wire rope detection</i>			
<i>Safe state</i>	<i>Stop winch motion and re-tighten of slack wire rope before automatically returning to normal operation.</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Actuator 2</i>	Start winch movement			
<i>Monitoring of safety function</i>	Indication			
<i>Independency to other functions</i>	NA			

G.2.3.10 Failure in control systems, protection and precautions ([8.4.2.11])

<i>Hazard and risk</i>	<i>Failure in control system</i>			
<i>Name of safety function</i>	<i>Failure in control systems, protection and precautions</i>			
<i>Safe state</i>	<i>Auto stop and automatic application of brakes and alarm signal to operator.</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE (monitoring)			
<i>On demand/continuous</i>	Continuous monitoring, alarm on demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Designer's specification			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Failure in control system monitoring			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Auto stop and automatic application of brakes.			

<i>Hazard and risk</i>	<i>Failure in control system</i>			
<i>Name of safety function</i>	<i>Failure in control systems, protection and precautions</i>			
<i>Safe state</i>	<i>Auto stop and automatic application of brakes and alarm signal to operator.</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Actuator 2</i>	Alarm signal to operator.			
<i>Monitoring of safety function, when active</i>	Indication and alarm			
<i>Interdependency to other functions</i>	Shall not override MOPS			

G.2.3.11 Monitoring of safety systems ([8.4.2.12])

<i>Hazard and risk</i>	<i>Failure in safety systems</i>			
<i>Name of safety function</i>	<i>Monitoring of safety systems</i>			
<i>Safe state</i>	<i>Indication and alarm signal to crane operator</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE (monitoring)			
<i>On demand/continuous</i>	Continuous monitoring, alarm on demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Failure in safety systems detector			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Indicator and alarm signal to crane operator			
<i>Actuator 2</i>	NA			

<i>Hazard and risk</i>	<i>Failure in safety systems</i>			
<i>Name of safety function</i>	<i>Monitoring of safety systems</i>			
<i>Safe state</i>	<i>Indication and alarm signal to crane operator</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Monitoring of safety function</i>	Indication and alarm			
<i>Independency to other functions</i>	Shall not affect/override other crane functions			

G.2.3.12 Maintenance of holding capacity, hydraulic cranes ([8.4.2.14])

<i>Hazard and risk</i>	<i>Lack of holding capacity</i>			
<i>Name of safety function</i>	<i>Maintenance of holding capacity</i>			
<i>Safe state</i>	<i>Holding capacity retained</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE			
<i>On demand/continuous</i>	Continuous			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months/Daily			
<i>Detector 1</i>	Customer's specification			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Hydraulic system designed to avoid insufficient hydraulic refilling			
<i>Actuator 2</i>	Safety/holding valves on all main circuits			
<i>Monitoring of safety function</i>	NA			
<i>Independency to other functions</i>	NA			

G.2.3.13 Blackout/shutdown, precautions ([8.4.2.15].a)

<i>Hazard and risk</i>	<i>Blackout / shutdown</i>			
<i>Name of safety function</i>	<i>Blackout/shutdown, precautions</i>			
<i>Safe state</i>	<i>Stop all movements</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Loss of power supply			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Brakes applied			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Alarm			
<i>Interdependency to other functions</i>	Shall not override MOPS			

G.2.3.14 Blackout / shutdown, emergency operation ([8.4.2.15].b)

<i>Hazard and risk</i>	<i>Blackout / shutdown</i>			
<i>Name of safety function</i>	<i>Blackout / shutdown, emergency operation</i>			
<i>Safe state</i>	<i>Hoisting/slewing/ luffing out/load lowering to safe position</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	NDE			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Manual			

<i>Hazard and risk</i>	<i>Blackout / shutdown</i>			
<i>Name of safety function</i>	<i>Blackout / shutdown, emergency operation</i>			
<i>Safe state</i>	<i>Hoisting/slewing/luffing out/load lowering to safe position</i>			
<i>Main item</i>	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Response time</i>	120 sec (re-commended)			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	12 months			
<i>Detector 1</i>	Loss of power supply			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Operator controlled power unit			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Alarm			
<i>Independency to other functions</i>	NA			

G.2.3.15 Gas alarm ([8.4.2.19].a)

<i>Hazard and risk</i>	<i>Fire/fire ignition</i>			
<i>Name of safety function</i>	<i>Gas alarm</i>			
<i>Safe state</i>	<i>Alarm signal to operator upon gas in area</i>			
	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE (monitoring)			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			

<i>Hazard and risk</i>	<i>Fire/fire ignition</i>			
<i>Name of safety function</i>	<i>Gas alarm</i>			
<i>Safe state</i>	<i>Alarm signal to operator upon gas in area</i>			
	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Test interval</i>	6 months			
<i>Detector 1</i>	Gas/explosive atmosphere detector			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Acoustic fire/gas alarm to operator			
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	Alarm			
<i>Interdependency to other functions</i>	NA			

G.2.3.16 Shutdown ([8.4.2.19].b)

<i>Hazard and risk</i>	<i>Fire/fire ignition</i>			
<i>Name of safety function</i>	<i>Shutdown</i>			
<i>Safe state</i>	<i>Shut down of crane</i>			
	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick-off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Energy principle (NE,NDE, CE)</i>	CE (monitoring)			
<i>On demand/continuous</i>	On demand			
<i>Automatic/manual activation</i>	Automatic			
<i>Response time</i>	Immediately			
<i>Test procedure</i>	Test to be carried out manually			
<i>Test interval</i>	6 months			
<i>Detector 1</i>	Fire/explosive atmosphere detector			
<i>Detector 2</i>	NA			
<i>Actuator 1</i>	Shut down of crane			

<i>Hazard and risk</i>	<i>Fire/fire ignition</i>			
<i>Name of safety function</i>	<i>Shutdown</i>			
<i>Safe state</i>	<i>Shut down of crane</i>			
	<i>Requirement/ Specification</i>	<i>Customer's verification of compliance with the requirements ("tick- off"), or reference to other solution</i>	<i>Customer's document reference to objective evidence verifying compliance</i>	<i>The Society's check</i>
<i>Actuator 2</i>	NA			
<i>Monitoring of safety function</i>	NA			
<i>Independency to other functions</i>	NA			

CHANGES – HISTORIC

There are currently no historical changes for this document.

DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

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