

# Offshore Pedestal-mounted Cranes

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## Introduction

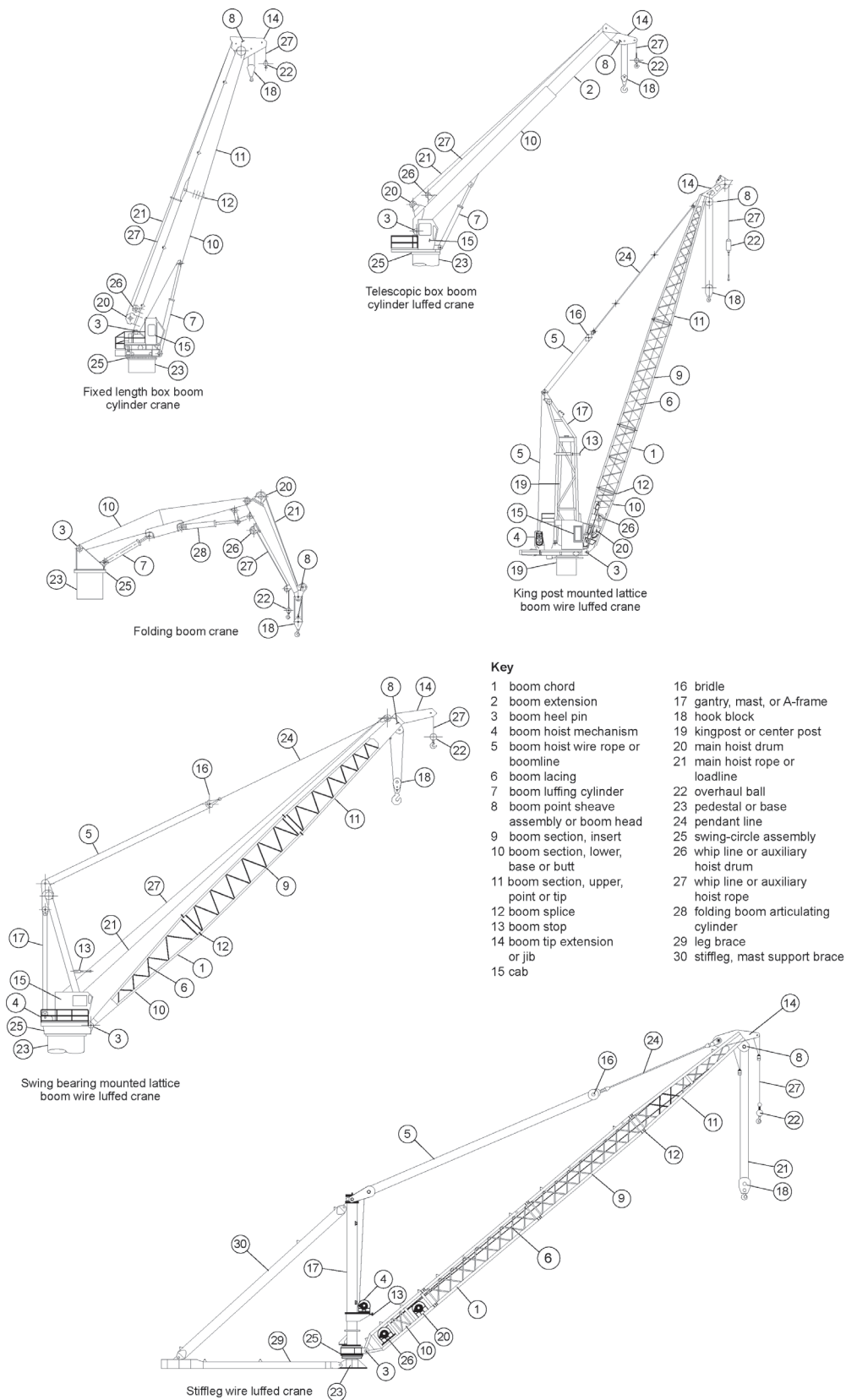
The API crane standards provide the design basis and construction, operations and maintenance, and training guidelines and requirements for pedestal-mounted cranes intended for use in offshore oil and gas applications on fixed and floating structures or vessels. They are intended to be used together, as appropriate, in order to better serve the product manufacturers and users—these include:

- Specification 2C, *Offshore Pedestal-Mounted Cranes*
- Recommended Practice 2D, *Operation and Maintenance of Offshore Cranes*
- Recommended Practice 2D-2, *Training for Offshore Pedestal-Mounted Crane Riggers, Operators, and Inspectors*

The requirements, procedures and guidance provided are based on internationally recognized industry standards and global best practices, as well as the collective knowledge and experiences of those that participated in developing these standards. As such, the material in these standards represent the contribution from industry representatives of crane users, crane manufacturers, wire rope manufacturers, and ancillary crane device or component manufacturers. Conformance to the intent of the practices herein is intended to result in cranes that operate safely and efficiently between inspection periods and in accordance with a company's safety and environmental management system (see API 75).

It should be understood that the crane operating, and maintenance practices cover a wide range of crane types and configurations. Not all practices are applicable to all cranes. When applying this standard, care should be taken to review each item as stated and use those items specifically applicable to the crane's type, usage, and duty-cycle. It may be necessary to modify a procedure due to a particular crane requirement. This modification would be wholly acceptable as long as the original intent of the practice or procedure is met.

See Figure 1 below for general illustrations of the various types of cranes.



NOTE Stiffleg designs differ depending on application. All components shown are not required for all designs.

**Figure 1—General Crane Illustrations**

# Offshore Pedestal-mounted Cranes

## 1 Scope

This standard provides requirements for design, construction, and testing of new offshore pedestal-mounted cranes. For the purposes of this standard, offshore cranes are defined as pedestal-mounted elevating and rotating lift devices for transfer of materials and personnel to or from marine vessels, barges, and structures or for transfer of materials to or from the sea or the seabed.

Typical applications can include:

- a) offshore oil exploration and production applications; these cranes are typically mounted on a fixed (bottom-supported) structure, floating structure, or vessel used in drilling and production operations;
- b) shipboard applications; these cranes are mounted on surface-type vessels and are used to move cargo, containers, and other materials while the crane is within a harbor or sheltered area; and
- c) crane vessel applications; these cranes are typically mounted on ship-shaped vessels, semi-submersibles, barge, or self-elevating type marine vessels specialized in lifting heavy and/or unique loads for construction, pipe lay, renewable energy, salvage, and subsea applications in both harbor and offshore waters.

Figure 1 illustrates some (but not all) of the types of cranes covered under this standard (see Introduction). While there are many configurations of pedestal-mounted cranes covered in the scope of this standard, it is not intended to be used for the design, fabrication, and testing of davits or emergency escape devices. This standard does not cover the use of cranes for life-saving applications or for the launch and recovery of manned underwater units such as diving bells or submersibles.

## 2 Normative References

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Recommended Practice 2A-WSD, *Planning, Designing, and Constructing Fixed Offshore Platforms—Working Stress Design*

API Recommended Practice 2D, *Operation and Maintenance of Offshore Cranes*

API Specification 2H, *Carbon Manganese Steel Plate for Offshore Structures*

API Recommended Practice 2X, *Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians*

API Specification 9A, *Wire Rope*

API Recommended Practice 500, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*

API Recommended Practice 505, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2*

API Specification Q1, *Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

ABMA Standard 9 <sup>1</sup>, *Load Ratings and Fatigue Life for Ball Bearings*

ABMA Standard 11, *Load Ratings and Fatigue Life for Roller Bearings*

AISC 335-89 <sup>2</sup>, *Specification for Structural Steel Buildings—Allowable Stress Design and Plastic Design*

NOTE Also available as the specification section in AISC 325-05, *Manual of Steel Construction—Allowable Stress Design*, Ninth Edition.

AISC 360, *Specification for Structural Steel Buildings*

ALI A14.3 <sup>3</sup>, *American National Standards for Ladders—Fixed—Safety Requirements*

ASME Boiler and Pressure Vessel Code (BPVC) <sup>4</sup>, Section VIII: Rules for Construction of Pressure Vessels

ASNT SNT-TC-1A <sup>5</sup>, *Personnel Qualification and Certification in Nondestructive Testing*

ASSE A1264.1 <sup>6</sup>, *Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems*

ASTM A295 <sup>7</sup>, *Standard Specification for High-Carbon Anti-Friction Bearing Steel*

ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A485, *Standard Specification for High Hardenability Antifriction Bearing Steel*

ASTM A578/A578M, *Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*

ASTM A770/A770M, *Standard Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications*

ASTM E23, *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

ASTM E45, *Standard Test Methods for Determining the Inclusion Content of Steel*

ASTM E165, *Standard Practice for Liquid Penetrant Examination for General Industry*

ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4<sup>1</sup>/<sub>2</sub> in. (50.8 to 114 mm)) Steel Castings*

ASTM E280, *Standard Reference Radiographs for Heavy-Walled (4<sup>1</sup>/<sub>2</sub> to 12 in. (114 to 305 mm)) Steel Castings*

ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

<sup>1</sup> American Bearing Manufacturers Association, 1001 N. Fairfax Street, Suite 500, Alexandria, VA 22314, [www.americanbearings.org](http://www.americanbearings.org).

<sup>2</sup> American Institute of Steel Construction, 130 East Randolph, Suite 2000, Chicago, IL 60601, [www.aisc.org](http://www.aisc.org).

<sup>3</sup> American Ladder Institute, 330 N. Wabash, Suite 2000, Chicago, IL 60611, [www.americanladderinstitute.org](http://www.americanladderinstitute.org).

<sup>4</sup> ASME International, 2 Park Avenue, New York, NY 10016, [www.asme.org](http://www.asme.org).

<sup>5</sup> American Society for Nondestructive Testing, PO Box 28518, 1711 Arlington Lane, Columbus, OH 43228, [www.asnt.org](http://www.asnt.org).

<sup>6</sup> American Society of Safety Engineers, 520 N. Northwest Highway, Park Ridge, IL 60068, [www.asse.org](http://www.asse.org).

<sup>7</sup> ASTM International, PO Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428, [www.astm.org](http://www.astm.org).

AWS D1.1/D1.1M <sup>8</sup>, *Structural Welding Code—Steel*

DIN 50602 <sup>9</sup>, *Metallographic examination; microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions*

ISO 148-1 <sup>10</sup>, *Metallic materials—Charpy pendulum impact test—Part 1: Test method*

ISO 281, *Roller bearings—Dynamic load ratings and rating life*

ISO 683-17, *Heat-treated steels, alloy steels and free-cutting steels—Part 17: Ball and roller bearing steels*

### 3 Terms, Definitions, Acronyms, Abbreviations, Units, and Symbols

#### 3.1 Terms and Definitions

For the purposes of this document, the following definitions apply.

##### 3.1.1

**A-frame  
gantry  
mast**

A structural frame extending above the upper structure to which the boom support ropes are reeved.

NOTE See Figure 1, Item 17.

##### 3.1.2

**articulating boom  
folding boom  
knuckle boom**

A type of crane boom where the boom tip can change its angle relative to the base section of the boom.

NOTE See Figure 1 example.

##### 3.1.3

**auxiliary hoist  
whip line**

A secondary rope system, usually of lighter load capacity than provided by the main rope system. Also known as **auxiliary**.

NOTE See Figure 1, Item 26 and Item 27.

##### 3.1.4

**auxiliary tip**

An extension attached to the boom point to provide added boom length for the auxiliary hoist.

NOTE See Figure 1, Item 14.

##### 3.1.5

**axis of rotation  
centerline of rotation**

The vertical axis around which the crane upper structure rotates.

<sup>8</sup> American Welding Society, 8669 NW 36 Street, # 130, Miami, FL 33166, [www.aws.org](http://www.aws.org).

<sup>9</sup> DIN Deutsches Institut für Normung e. V., Saatwinkler Damm 42/43, 13627 Berlin, Germany, [www.din.de](http://www.din.de).

<sup>10</sup> International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, [www.iso.org](http://www.iso.org).

**3.1.6****base (mounting)****pedestal (base)**

The supporting substructure on which the revolving upper structure is mounted.

NOTE See Figure 1, Item 23.

**3.1.7****bearing raceway**

The surface of the bearing rings that contact the rolling element (balls or rollers) of the swing-bearing assembly.

**3.1.8****bearing ring**

The rotating and stationary rings that house the rolling elements (balls or rollers) of the swing-bearing assembly.

**3.1.9****boom**

A member hinged to the revolving upper structure and used for supporting the hoist tackle.

**3.1.10****boom angle**

The angle above or below horizontal of the longitudinal axis of the base boom section.

**3.1.11****boom angle indicator**

An accessory that measures the angle of the boom above horizontal.

**3.1.12****boom chord**

A main corner member of a lattice type boom.

NOTE See Figure 1, Item 1.

**3.1.13****boom extension**

Intermediate section of a telescoping boom.

NOTE See Figure 1, Item 2.

**3.1.14****boom heel pin****heel pin**

The boom pivot point on the upper structure.

NOTE See Figure 1, Item 3.

**3.1.15****boom hoist****boom hoist mechanism**

The mechanism responsible for raising and lowering the boom.

NOTE See Figure 1, Item 4 and 7.

**3.1.16****boom hoist wire rope**

Wire rope that operates on a drum controlling the angle positioning of the boom.

NOTE See Figure 1, Item 5.

**3.1.17****boom insert**

Intermediate section of a lattice type boom.

NOTE See Figure 1, Item 9.

**3.1.18****boom lacing  
lacing**

Structural truss members at angles to and supporting the boom chords of a lattice-type boom.

NOTE See Figure 1, Item 6.

**3.1.19****boom length**

The straight-line distance from the centerline of the boom heel pin to the centerline of the boom-point load hoist sheave pin, measured along the longitudinal axis of the boom.

**3.1.20****boom line**

Boom hoist rope that reels on drums or passes over sheaves.

NOTE See definition of boom hoist wire rope.

**3.1.21****boom luffing cylinder**

Means for supporting the boom and controlling the boom angle.

NOTE See Figure 1, Item 7.

**3.1.22****boom-point sheave assembly**

An assembly of sheaves and a pin built as an integral part of the boom point.

NOTE See Figure 1, Item 8.

**3.1.23****boom splices**

Splicing connections for sections of a basic crane boom and additional sections; usually of the splice plate type, pin type, or butt type.

NOTE See Figure 1, Item 12.

**3.1.24****boom stop**

A device used to prevent the boom from falling backward in the case of high winds or a sudden release of load.

NOTE See Figure 1, Item 13.

**3.1.25****boom-tip extension****jib**

An extension attached to the boom point to provide added boom length for lifting specified loads.

NOTE See Figure 1, Item 14.

**3.1.26****bottom-supported structure**

A fixed, stationary structure without significant movement in response to waves and currents in normal operating conditions.

EXAMPLE Fixed offshore platforms (e.g. gravity base or jacket and pile supported), jackup rigs (once in position and bottom supported), and submersible bottom-supported rigs.

**3.1.27****brake**

A device used for retarding or stopping motion or holding.

**3.1.28****bridle**

A frame equipped with sheaves and connected to the boom by stationary ropes that are usually called pendants.

NOTE See Figure 1, Item 16.

**3.1.29****cab**

An enclosure for the operator and the machine operation controls.

NOTE See Figure 1, Item 15.

**3.1.30****clutch**

A means for engagement or disengagement of power.

**3.1.31****critical component**

Any component of the crane assembly devoid of redundancy and auxiliary restraining devices whose failure shall result in an uncontrolled descent of the load or uncontrolled rotation of the upper structure.

NOTE See examples in Annex C of this standard.

**3.1.32****davit**

A fixed radius structure with a relatively small capacity used for lifting.

**3.1.33****deck appurtenance response spectrum**

The way in which objects on the deck of a platform or vessel respond to seismic activity.

**3.1.34****designated representative**

A person selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

**3.1.35****design requirements**

The requirements set forth by the manufacturer's engineering authority for materials, manufacturing, fabrication, and inspection procedures to be employed in the production of the crane.

**3.1.36****design service temperature**

The lowest average temperature for the coldest 24 hours in 1 year.

**3.1.37****drillship**

A floating vessel fitted with a drilling apparatus used mainly for oil exploration.

**3.1.38****dynamic friction brake**

A means of slowing and stopping a rotating object by a mechanical means accomplished by modulating friction.

**3.1.39****dynamic loading**

Loads introduced into the machine or its components due to accelerating or decelerating loads.

**3.1.40****emergency escape device**

A means of evacuation in extreme circumstances where normal evacuation means are not possible.

**3.1.41****factored load****FL**

Equal to the safe working load hook (SWLH) multiplied by the vertical dynamic coefficient ( $C_v$ ).

NOTE 1 This load is the load acting on the boom tip for calculation purposes.

NOTE 2 Other loads considered include offload, sideload, environmental loads, loads due to crane base motion, and other loads as defined herein.

**3.1.42****fitness-for-purpose**

The manufacture or fabrication of an assembly or component to the quality level required (but not necessarily the highest level attainable) to assure material properties, environmental interactions, and any imperfections present in the assembly or connection are compatible with the intended purpose.

**3.1.43****fleet angle**

The angle at which the wire rope enters a drum or a sheave.

**3.1.44****floating platform and vessel**

A moving structure that the crane is mounted on.

EXAMPLE Tension leg platforms (TLPs), spars, semi-submersibles, drillships, and floating production storage offloadings (FPSOs).

**3.1.45****floating production storage offloading****FPSO**

A floating vessel used for processing and storing oil and gas that is produced by a separate platform or subsea template.

**3.1.46****foundation bolts**

Bolts used to connect a swing bearing to the upper structure and pedestal.

**3.1.47****fracture control plan**

The consideration of material properties, environmental exposure conditions, potential material and fabrication imperfections, and methods of inspection for the purpose of eliminating conditions that may result in failure under the design requirements for the projected life of the crane.

**3.1.48****gross overload protection system****GOPS**

A system or device used to protect the crane operator's cabin in the event of an unbounded overload applied to the crane hook.

**3.1.49****hoisting**

The process of lifting, either raising or lowering.

**3.1.50****hoist mechanism**

A hoist drum and rope reeving system used for lifting and lowering loads.

**3.1.51****hoist rope**

Wire rope involved in the process of lifting.

**3.1.52****hoist tackle**

Assembly of ropes and sheaves arranged for pulling.

**3.1.53****hook block**

Block with a hook attached used in lifting service.

NOTE 1 A hook block can have a single sheave for double or triple line or multiple sheaves for four or more parts of line.

NOTE 2 See Figure 1, Item 18.

**3.1.54****hook rollers**

A means to connect the upper structure to the foundation or pedestal by using rollers to prevent the revolving upper structure from toppling.

**3.1.55****horizontal acceleration**

Acceleration acting horizontally on the crane components or load due to vessel motions.

**3.1.56****in service**

A crane is in service when the operator is in control of the crane.

**3.1.57****kingpost**

A fixed tubular member that acts as an axis of rotation for the revolving upper structure and as the connective member to the platform.

NOTE See Figure 1, Item 19.

**3.1.58****lattice boom**

Boom of open construction with lacing between main corner members (chords) in the form of a truss.

**3.1.59****legacy rating**

A simplified method of calculating safe working load (SWL) based on a constant fixed dynamic coefficient.

NOTE 1 This method was first used in the third edition of this standard and has been superseded by the “general” and “vessel-specific” methods.

NOTE 2 See 5.4.4 for the specific circumstances when use of the Legacy Method is allowed.

**3.1.60****lifting geometry**

The arrangement of the load to the crane and all supporting elements.

**3.1.61****list**

The static angle of a vessel about its longitudinal axis.

**3.1.62****live-load-side**

The side of a wedge socket where the wire rope that is to support a load enters the socket.

**3.1.63****load**

An applied force.

**3.1.64****load block**

The assembly of hook or shackle, swivel, sheaves, pins, and frame suspended by the hoisting ropes.

**3.1.65****load chart**

A document at the operator's station that contains SWLs at multiple radii along with other crane specific information.

**3.1.66****load indicator system****LIS**

A device that tells the operator the load on the hook.

**3.1.67****load line****hoist line**

The main hoist rope, usually multiple part reeving.

NOTE 1 See Figure 1, Item 21.

NOTE 2 The secondary hoist rope is referred to as a whip line or auxiliary line (see Figure 1, Item 27).

**3.1.68****load-moment indicator system****LMIS**

A device that tells the operator the load on the hook, the distance from the axis of rotation to the center of the load, and the SWL at that distance.

**3.1.69****load ratings**

Crane ratings established by the manufacturer in accordance with Section 8.

**3.1.70****lock valve**

A valve that holds pressure and requires positive pressure from the power source to release.

NOTE 1 A lock valve actuates automatically to bring the mechanism to a stop in the event of a control or motive power loss.

NOTE 2 Includes valves (i.e. counter-balance valves, over-center valves, pilot-to-open check valves, load-lock valves, and load-hold valves).

**3.1.71****luffing**

The operation of changing boom angle in a vertical plane (in effect changing the working radius).

**3.1.72****luffing cylinder**

A hydraulic actuator used to change the boom angle.

NOTE See Figure 1, Item 7.

**3.1.73****magnetic particle**

A nondestructive test method that detects defects in ferrous metals using magnetic fields or electrical currents.

**3.1.74****motion compensation system**

A system used to control hoist rope tension or relative hook position to counteract vessel motion.

**3.1.75****mounting flatness**

The extent to which a mating surface is free of distortion.

**3.1.76****mounting stiffness**

The extent to which a mating surface shall resist deflection.

**3.1.77****nominal breaking load**

The minimum static load required to fail a component.

**3.1.78****not stowed**

The crane is out of service, but the crane relies solely on its own structure for support from environmental conditions.

**3.1.79****offboard lift**

The operation of raising a load (cargo or personnel) off of or landing a load onto a deck where relative vertical motion exists between the deck and the crane.

NOTE See B.5.4.1.

**3.1.80****offlead angle**

The angle to vertical in the same plane as the boom caused by a load not directly underneath the load sheave.

NOTE See Figure 2.

**3.1.81****offload**

A radial load applied in the plane of the boom at the boom tip.

**3.1.82****offload force**

A load applied to the boom tip perpendicular to the vertical load and in the same plane as the boom.

NOTE See Figure 2 and Figure 3.

**3.1.83****offloading loads**

Loads lifted while unloading a vessel.

**3.1.84****onboard lift**

The operation of raising a load (cargo or personnel) off of or landing a load onto a deck where no relative vertical motion exists between the deck and the crane.

NOTE See B.5.4.1.

**3.1.85****operator's station**

The designated location for the operator to operate the machine.

**3.1.86****out of service**

A situation when the operator is not controlling the crane and no load is suspended from the hook.

**3.1.87****overhaul**

Ability of a weight on the end of the hoist line to unwind rope from the drum when the brake is released.

**3.1.88****overhaul ball**

The weight on a single part line used to pull the wire rope off of the drum.

NOTE See Figure 1, Item 22.

**3.1.89****overturning moment**

The product of force and distance:

- a) in plane—overturning moment in the same plane as the boom, and
- b) side plane—overturning moment in the plane perpendicular to the boom.

**3.1.90****pitch diameter**

Root diameter of a drum, lagging, or sheave, plus the diameter of the rope.

NOTE See 7.2.4.2, 7.3.2.5, Figure 6, and Figure 7.

**3.1.91****prototype**

An initial manufactured component or unit of a specific design.

**3.1.92****qualified**

A person who, by possession of a recognized degree, certificate of professional standing, or by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

**3.1.93****rack and pinion mechanism**

A set of gears that translate rotational motion and torque into linear motion and force.

**3.1.94****rated capacity**

The rated load or SWL at specified radii as established by the manufacturer, which are the maximum loads at those radii covered by the manufacturer's warranty for the conditions specified.

**3.1.95****reeving**

A rope system where the rope travels around drums and sheaves.

**3.1.96****revolving upper structure**

The rotating upper frame structure where the operating machinery is mounted.

**3.1.97****roller path****swing-circle**

The surfaces contacting the rollers that support the revolving upper structure. It may accommodate cone rollers, cylindrical rollers, or live rollers.

**3.1.98****rolling element**

The balls or rollers contained between the rings of the swing bearing.

**3.1.99****rope**

Wire rope, unless otherwise specified.

**3.1.100****running block**

A frame that is not rigidly connected to the structure containing sheaves.

EXAMPLE Bridle and load blocks.

**3.1.101****safe working load (SWL)****rated capacity**

The maximum rated load within crane-rated capacity for the given operating conditions.

**3.1.102****safe working load hook****SWLH**

The safe working load plus the weight of the hook and load block.

**3.1.103****seismic load**

A load induced by an earthquake.

**3.1.104****self-elevating vessel**

A type of mobile platform that consists of a buoyant hull fitted with a number of movable legs and its normal operations mode is bottom supported when the hull is elevated above the sea.

NOTE Examples include jackup, lift boat, turbine installation vessel, etc.

**3.1.105****semi-submersible**

A column stabilized vessel dependent on the buoyancy of widely spaced columns for floatation and stability.

**3.1.106****sheave**

A round object with a groove to retain wire rope that is used to change the direction of the rope.

**3.1.107****sheave bearing**

A plain or roller bearing that allows the sheave to spin freely on a shaft.

**3.1.108****sheave groove**

A cutout in a sheave used to retain the wire rope.

**3.1.109****sheave guard**

A device to prevent the rope from leaving the groove in a sheave.

**3.1.110****sidelead angle**

The angle to vertical in the plane perpendicular to the boom caused by a load being not directly underneath the load sheave.

NOTE See Figure 2.

**3.1.111****sideload**

A load applied at the boom tip perpendicular to the boom and parallel to the horizontal plane.

**3.1.112****sideload force**

A load applied to the boom tip perpendicular to the vertical load and in the plane perpendicular to the boom.

NOTE See Figure 2 and Figure 3.

**3.1.113****significant wave height**

$H_{sig}$

The mean wave height of the highest one-third of the waves, which is typically associated with the load chart, ratings, or other conditions.

**3.1.114****single degree of freedom****single DOF**

A model where only one parameter is allowed to vary while all others remain constant.

**3.1.115****sling**

An assembly that connects the load to the material-handling equipment.

**3.1.116****spar**

A deep-draft, small water-plane area floating structure.

**3.1.117****standing wire rope****pendant line**

A supporting, non-running wire rope that maintains a constant distance between the points of attachment to the two components connected by the wire rope with fixed end connections.

NOTE See Figure 1, Item 24.

**3.1.118****static inclinations**

The constant angle (list and trim) of a platform or vessel from level.

**3.1.119****stiff-leg crane**

A crane that utilizes one or more diagonal struts to connect the top of its mast to the deck for the purpose of spreading, and thereby reducing, the magnitude of the reactions due to the crane's overturning moment.

NOTE See Figure 1.

**3.1.120****stowed**

The boom is placed in a boom rest or other similar arrangement in extreme environmental conditions.

**3.1.121****subsea lift**

A lift in which the load is submerged.

**3.1.122****swing****slewing**

Rotation of the upper structure about the axis of rotation.

**3.1.123****swing bearing****swing-circle**

A combination of rings with balls or rollers capable of sustaining radial, axial, and moment loads of the revolving upper structure with boom and load.

NOTE Common types include roller, ball, and hook roller bearings.

**3.1.124****swing-circle assembly**

The connecting component between the crane revolving upper structure and the pedestal for some cranes.

NOTE 1 The swing-circle assembly allows crane rotation and sustains the moment, axial, and radial loads imposed by crane operation.

NOTE 2 See Figure 1, Item 25.

**3.1.125****swing mechanism**

The machinery involved in rotating the revolving upper structure about the axis of rotation in both directions.

**3.1.126****swivel**

A load-carrying member with thrust bearings that allows the load to rotate.

**3.1.127****telescoping boom**

Consists of a base boom from which one or more boom sections are moved axially in relation to each other to increase the boom length.

NOTE See Figure 1, Item 2, Item 10, and Item 11.

**3.1.128****temporary installation crane****TIC**

A crane that is purposefully designed to be repeatedly installed, uninstalled, and moved to different locations, i.e. not permanently installed.

NOTE A rental crane is an example of a TIC.

**3.1.129****tension leg platform****TLP**

A floating production facility that is vertically tethered to permanent moorings.

**3.1.130****trim**

The static angle of a vessel about its latitudinal axis.

**3.1.131****two-block**

The condition when the lower load block or hook assembly contacts the upper load block or boom-point sheave assembly.

**3.1.132****ultrasonic**

A nondestructive form of testing that detects flaws in materials using ultrasonic pulse waves.

**3.1.133****vertical boom tip dynamic acceleration**

The change in velocity of the boom tip caused by vessel motions.

**3.1.134****vertical dynamic coefficient** $C_v$ 

A coefficient that is multiplied by the safe working load (SWLH) to provide the vertical factored load (FL).

**3.1.135****vertical load**

A load applied perpendicular to the horizontal plane.

**3.1.136****vessel response amplitude operators****vessel RAOs**

The response amplitude operators (RAOs) or a set of statistics that model a ship's behavior at sea.

**3.1.137****wind load**

A load applied by air at a certain velocity passing over the crane structure.

**3.1.138****wire rope**

A flexible, multi-wired member usually consisting of a core member around which a number of multi-wired strands are "laid" or helically wound.

**3.1.139****working load**

The external load in pounds (kilonewtons) applied to the crane including the weight of load-attaching equipment (i.e. load block, shackles, and slings).

NOTE The maximum allowable working load for a given condition is the SWL.

**3.2 Acronyms and Abbreviations**

For the purposes of this document, the following acronyms and abbreviations apply.

|      |                                        |
|------|----------------------------------------|
| CG   | center of gravity                      |
| CM   | crane motion                           |
| DOF  | degree of freedom                      |
| FL   | factored load                          |
| FPSO | floating production storage offloading |
| GOPS | gross overload protection system       |
| IMR  | inspection, maintenance, and repair    |
| LIS  | load indicator system                  |
| LMIS | load-moment indicator system           |
| LRFD | load and resistance factor design      |
| MODU | mobile offshore drilling unit          |

|      |                              |
|------|------------------------------|
| MSL  | mean sea level               |
| PF   | pedestal load factor         |
| RAO  | response amplitude operators |
| SLE  | strength level event         |
| SWL  | safe working load            |
| SWLH | safe working load hook       |
| TBO  | time between overhaul        |
| TBR  | time between replacement     |
| TIC  | temporary installation crane |
| TLP  | tension leg platform         |
| WSD  | working stress design        |

### 3.3 Units and Symbols (Table 1)

Many of the equations in this publication depend on the input quantities having the proper units to calculate the correct result. The equation given in this publication are given in the U.S. customary (USC) system of units. Primary units used are ft (length), lb (force), s (time), and degrees (angles). These results may be converted to the International System of Units (SI) metric equivalents, if desired. Since some of the equations are “unit dependent,” the USC units are intended to be input in the equations and USC unit results obtained; results may then be converted to SI units. Conversion factors from USC to SI units are given as follows. For additional conversions, refer to ASTM SI10 or IEEE Standard 268:

- 1 meter = 3.2808 ft;
- 1 kilogram = 2.2046 lb force;
- 1 Newton = 0.2248 lb force;
- 1 Joule = 0.737557 ft-lb force;
- 1 megapascal (MPa) = 145.0377 lb/in.<sup>2</sup> (psi);
- °Celsius =  $5/9 \times (°\text{Fahrenheit} - 32)$ .

Table 1—Description of Symbols

| Symbol      | Units               | Equation or Section Used                          | Description                                                                                 |
|-------------|---------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------|
| $A_n$       | in. <sup>2</sup>    | E.1                                               | Internal thread shear area                                                                  |
| $A_s$       | in. <sup>2</sup>    | E.1                                               | External thread shear area                                                                  |
| $A_t$       | in. <sup>2</sup>    | F.5                                               | Tensile stress area of threaded fastener                                                    |
| $A_v$       | g                   | Equation (7)                                      | Boom tip vertical acceleration                                                              |
| $BL_{load}$ | lb                  | Equation (31)                                     | Minimum nominal breaking load for wire rope (load line)                                     |
| $BL_{boom}$ | lb                  | Equation (32)                                     | Minimum nominal breaking load for wire rope (boom line)                                     |
| $C_1$       |                     | E.2                                               | Substitution variable for $P_{cr}$ equation                                                 |
| $C_2$       |                     | E.2                                               | Substitution variable for $P_{cr}$ equation                                                 |
| $C_f$       |                     | E.1                                               | Factor for flat head attachment on cylinder                                                 |
| $C_n$       | hr                  | Equation (38)                                     | Hours of exposure to a specific noise level                                                 |
| $C_s$       |                     | Equation (23)                                     | Member shape coefficient for wind loading                                                   |
| $C_v$       |                     | 5.4.5                                             | Vertical dynamic coefficient                                                                |
| $D$         | ft                  | F.5                                               | Pitch circle diameter of swing-bearing elements                                             |
| $D_b$       | ft                  | Equation (35)                                     | Pitch circle diameter of swing-bearing fasteners                                            |
| $D_r$       | ft                  | Equation (36)                                     | Pitch circle diameter of weakest swing-bearing element                                      |
| $D_s$       | in.                 | E.1                                               | Minimum major diameter of external thread                                                   |
| $D_{sh}$    | in.                 | 7.2.4.2                                           | Pitch diameter of sheave wheel                                                              |
| $DF$        |                     | E.1, Equations (26), (27), (28), (29), (33), (34) | Design factor for rigging, load blocks, and cylinders (may be different for each component) |
| $d$         | in.                 | 7.2.4.2                                           | Nominal diameter of wire rope                                                               |
| $d_{cyl}$   | in.                 | E.1                                               | Inside diameter of cylinder tube                                                            |
| $E_1$       | lb/in. <sup>2</sup> | E.2                                               | Elastic modulus of cylinder body material                                                   |
| $E_2$       | lb/in. <sup>2</sup> | E.2                                               | Elastic modulus of cylinder rod material                                                    |
| $E_n$       | in.                 | E.1                                               | Maximum pitch diameter of internal thread                                                   |

| Symbol     | Units                  | Equation or Section Used | Description                                                                               |
|------------|------------------------|--------------------------|-------------------------------------------------------------------------------------------|
| $E_{rs}$   |                        | Equations (31) and (32)  | Efficiency of reeving system for running rigging (accordingly for load line or boom line) |
| $E_s$      | in.                    | E.1                      | Minimum pitch diameter of external thread                                                 |
| $E_{weld}$ |                        | E.1                      | Tube joint weld efficiency for cylinder                                                   |
| $F_{buc}$  | lb                     | E.2                      | Elastic buckling force for cylinder                                                       |
| $FL$       | lb                     |                          | Vertical factored load                                                                    |
| $g$        | 32.2 ft/s <sup>2</sup> | Equation (2)             | Acceleration due to gravity                                                               |
| $H$        | lb                     | Equation (35)            | Axial load on swing bearing                                                               |
| $H_{sig}$  | ft                     |                          | Significant wave height                                                                   |
| $H_{tip}$  | ft                     | Equation (10)            | Vertical distance from boom tip to supply boat deck                                       |
| $I_1$      | in. <sup>4</sup>       | E.2                      | Second moment of area of cylinder body                                                    |
| $I_2$      | in. <sup>4</sup>       | E.2                      | Second moment of area of cylinder rod                                                     |
| $K$        | lb/ft                  | Equation (2)             | Vertical spring rate of crane                                                             |
| $K_b$      |                        | Equation (30)            | Bearing constant for reeving system efficiency                                            |
| $K_{eb}$   |                        | B.6.1                    | Effective length factor for elastic buckling                                              |
| $K_n$      | in.                    | E.1                      | Maximum minor diameter of internal thread                                                 |
| $L$        | ft                     | F.5                      | Length of moment arm                                                                      |
| $L_1$      | in.                    | E.2                      | Length of cylinder body                                                                   |
| $L_2$      | in.                    | E.2                      | Length of piston extension                                                                |
| $L_e$      | in.                    | E.1                      | Length of thread engagement                                                               |
| $M$        | ft-lb                  | Equation (35)            | Overturning moment reaction at swing bearing                                              |
| $N$        |                        | Equation (30)            | Number of parts of line in reeving system                                                 |
| $N_b$      |                        | Equation (35), F.5       | Number of swing-bearing fasteners or elements                                             |
| $NE$       | dB(A)                  | Equation (37)            | Permissible noise exposure                                                                |
| $n$        | 1/in.                  | E.1                      | Threads per inch                                                                          |
| $OL$       |                        | Equation (10)            | Substitution variable for Equation (9)                                                    |

| Symbol     | Units               | Equation or Section Used | Description                                                                                      |
|------------|---------------------|--------------------------|--------------------------------------------------------------------------------------------------|
| $P$        | lb/in. <sup>2</sup> | E.1                      | Pressure in cylinder                                                                             |
| $P_b$      | lb                  | Equation (35), F.5       | Load on individual swing-bearing fastener or element                                             |
| $P_n$      | lb                  | Equation (36), F.5       | Ultimate capacity of load element of swing-circle assembly                                       |
| $P_{wind}$ | lb/ft <sup>2</sup>  | Equation (23)            | Wind pressure acting on the projected area                                                       |
| $P_b N_b$  | lb                  | F.5                      | Maximum swing-bearing load multiplied by number of load elements                                 |
| $P_n N_b$  | lb                  | F.5                      | Ultimate capacity of swing-bearing load elements                                                 |
| $PF$       |                     | Equation (25)            | Factor applied to vertical and horizontal loads on the pedestal in addition to the factored load |
| $p$        | in.                 | E.1                      | Screw thread pitch                                                                               |
| $q_1$      | in.                 | E.2                      | Substitution variable for $P_{cr}$ equation                                                      |
| $q_2$      | in.                 | E.2                      | Substitution variable for $P_{cr}$ equation                                                      |
| $S$        |                     | Equation (30)            | Number of sheave wheels in reeving system                                                        |
| $S_a$      | lb/in. <sup>2</sup> | E.1                      | Maximum allowable tensile stress in cylinder                                                     |
| $S_t$      | lb/in. <sup>2</sup> | E.1                      | Maximum allowable thread shear stress in cylinder                                                |
| $SF$       |                     | F.3.2, F.4.5             | Factor relating load in the boom suspension to a load on the hook                                |
| $s_1$      |                     | E.2                      | Substitution variable for $P_{cr}$ equation                                                      |
| $s_2$      |                     | E.2                      | Substitution variable for $P_{cr}$ equation                                                      |
| $T$        | hr                  | Equation (37)            | Duration of noise exposure                                                                       |
| $T_n$      | hr                  | Equation (38)            | Total permitted hours of exposure to a specific noise level                                      |
| $T_s$      | lb/in. <sup>2</sup> | E.1, F.5                 | Ultimate tensile stress of material                                                              |
| $t$        | in.                 | F.5                      | Height/thickness of swing-bearing geometry                                                       |
| $t_{head}$ | in.                 | E.1                      | Minimum cylinder head thickness                                                                  |
| $t_{wall}$ | in.                 | E.1                      | Minimum cylinder tube wall thickness                                                             |
| $U$        | knot                | Equation (23)            | Wind velocity                                                                                    |
| $V_c$      | ft/s                | Equation (5)             | Crane boom tip vertical velocity                                                                 |
| $V_d$      | ft/s                | Equation (5)             | Supply boat deck vertical velocity                                                               |

| Symbol             | Units | Equation or Section Used | Description                                                                                           |
|--------------------|-------|--------------------------|-------------------------------------------------------------------------------------------------------|
| $V_h$              | ft/s  | Equation (5)             | Maximum possible steady hoisting velocity                                                             |
| $V_{hmin}$         | ft/s  | Equation (6)             | Required minimum steady hoisting velocity                                                             |
| $V_r$              | ft/s  | Equation (2)             | Relative velocity between hook and supply boat                                                        |
| $W$                | lb    | Equations (31) and (32)  | Total applied load in a wire rope system (accordingly for load line or boom line)                     |
| $W_{horizontalCM}$ | lb    | Equation (16)            | Horizontal load acting on suspended load due to crane base motion                                     |
| $W_{offCM}$        | lb    | Equation (17)            | Horizontal offlead load acting on crane components due to crane base motion                           |
| $W_{offdyn}$       | lb    | Equation (20)            | Total induced horizontal dynamic offlead load due to crane base and supply boat motions               |
| $W_{offSB}$        | lb    | Equation (9)             | Offload force on boom tip due to supply boat motion or subsea lifting                                 |
| $W_{off(wind)}$    | lb    | Equation (21)            | Horizontal offlead load acting on crane due to wind                                                   |
| $W_p$              | lb    | F.4.5                    | Load in boom hoist wire rope due to boom weight                                                       |
| $W_{sideCI}$       | lb    | Equation (14)            | Static sidelead load acting at the boom tip by the factored load due to static crane base inclination |
| $W_{sideCM}$       | lb    | Equation (18)            | Horizontal sidelead load acting on crane components due to crane base motion                          |
| $W_{sidedyn}$      | lb    | Equation (19)            | Total induced horizontal dynamic sidelead load due to crane base and supply boat motions              |
| $W_{sideSB}$       | lb    | Equation (13)            | Sideloading force on boom tip due to supply boat motion or subsea lifting                             |
| $W_{side(wind)}$   | lb    | Equation (22)            | Horizontal sidelead load acting on crane due to wind                                                  |
| $W_{sus}$          | lb    | F.3.2                    | Total load in boom hoist wire rope                                                                    |
| $\alpha$           |       | Equation (3)             | Substitution variable for Equation (4)                                                                |

## 4 Documentation

### 4.1 Manufacturer-supplied Documentation Upon Purchase

The manufacturer shall have and supply upon request to the purchaser certain documentation for each crane manufactured. The documentation shall include:

- a) load and information charts according to 8.2;
- b) information for crane foundation support structure design including:
  - 1) kingpost or pedestal-mounting dimensions at the crane and supporting structure interface;
  - 2) maximum overturning moment with corresponding axial and radial load, and torque and side moments at the crane and supporting structure interface in accordance with 6.4;
  - 3) maximum axial load with corresponding overturning moment and radial load, and torque and side moments at the crane and supporting structure interface in accordance with 6.4;
  - 4) fatigue design moment and corresponding other loads to be used to design supporting structure for 1,000,000 cycles in accordance with 6.6;
- c) list of all critical components in accordance with 5.2 and certification that these components meet the API 2C material, traceability, welding (as applicable), and nondestructive examination requirements;
- d) operations, parts, and maintenance manual(s); and
- e) failure-mode assessment results for unintended gross overloads according to Section 9.

Respective of Item b) 2) and Item b) 3) above, when load and resistance factor design (LRFD) design is used in accordance with 6.2.3, the reaction shall be split in accordance with the sections defined in Table 7 to allow for proper LRFD pedestal design. The loads provided shall clearly define whether the load factors have or have not already been applied.

The manufacturer shall certify that the crane furnished to this standard meets the material and dimensional specifications used in the calculations.

### 4.2 Purchaser-supplied Information Prior to Purchase

Unlike land-based cranes, offshore cranes have a fixed location on a structure and are not capable of moving relative to the load. The capacity of all offshore cranes depends on the structure the crane is mounted on, the environmental conditions, and the location of the load relative to the structure. For these reasons, it is not possible to define a crane using a single parameter or load (i.e. a 50-ton crane). To define a crane's capability, many parameters are provided to the crane manufacturer. The purchaser shall supply the crane manufacturer with the minimum information listed below for each crane required to be purchased.

- a) SWL at desired lifting radius;
- b) type of lift—onboard and offboard lifts;
- c) boom length and configuration—fixed length, minimum and maximum for telescopic or folding and articulating boom crane;
- d) type of vessel the crane is installed on—bottom-supported structure, ship and barge in calm water, TLP, spar, semi-submersible, drillship, or FPSO in accordance with Table 3, Table 4, and Table 5;

- e) crane elevation from heel pin to mounting deck and from mounting deck to mean sea level (MSL);
- f) significant wave height(s) for crane operation;
- g) wind speed(s) for crane operation;
- h) crane calculation and ratings method—General Method, Vessel-specific Method, or Legacy Method in accordance with Section 5 loads and all associated design parameters specific to the chosen method of calculation;
- i) crane duty cycle classification—in accordance with Section 7;
- j) hazardous area classification for crane and crane boom in accordance with 7.5.4;
- k) lowest design temperature; and
- l) when the purchaser specifies a subsea rating, the desired SWL and water depth for subsea lifts.

See Annex A for additional information the purchaser can supply.

### 4.3 Record Retention

The manufacturer shall maintain all inspection and testing records for a minimum of 20 years. These records shall be employed in a quality audit program of assessing malfunctions and failures for the purpose of correcting or eliminating design, manufacturing, or inspection functions that may have contributed to the malfunction or failure.

### 4.4 References to Annexes

For other requirements or information concerning the manufacturing of offshore pedestal-mounted cranes, as referenced, see the following annexes for implementation as appropriate.

- Commentary on the utilization of this standard; see Annex B (informative).
- Examples of critical components; see Annex C (informative).
- Rating for subsea lifts; see Annex D (normative).
- Calculation methods for cylinders; see Annex E (normative).
- Calculation examples; see Annex F (informative).

## 5 Loads

### 5.1 Safe Working Limits (SWLs)

The intent of this standard is to establish SWLs for the crane in anticipated operations and conditions. This is accomplished by establishing SWLs based on allowable unit stresses, FLs, and design factors. Operation of the crane outside of the limits established by the manufacturer in accordance with the guidelines set forth in this document can result in catastrophic failure up to and including separating the entire crane and operator from the foundation. Compliance with allowable stresses and design factors set forth in this standard does not guarantee that the crane shall stay mounted on its foundation in the event of a gross overload that may occur in the event of snagging the supply boat. Protection for the crane operator in the event of a gross overload is also required as defined in Section 9.

## 5.2 Critical Components

A critical component is any component of the crane assembly devoid of redundancy and auxiliary restraining devices whose failure shall result in an uncontrolled descent of the load or uncontrolled rotation of the upper structure. Due to their critical nature, these components are required to have stringent design, material, traceability, and inspection requirements. The manufacturer shall prepare a list of all critical components for each crane. Annex C contains an example list of critical components.

## 5.3 Forces and Loadings

Offshore pedestal-mounted cranes are subjected to forces and loadings due to many factors. These vary significantly depending on whether the crane is in service or out of service (and whether the boom is stowed in the boom rest in this condition). These applied forces also vary significantly depending on whether the crane is performing an onboard lift, an offboard lift, or a subsea lift.

The forces and loads that are applied to the crane during various operations and conditions are defined in 5.4, 5.5, and 5.6. These shall be assessed in the evaluation of the crane to determine safe working envelopes for each condition. Applied forces and loads shall not cause stresses or component loadings that exceed the allowables specified throughout the rest of this standard (i.e. allowable stresses, load line pulls, and pedestal overturning moments).

Table 2 summarizes the forces and loadings that apply for various operating conditions. As an aid in understanding these parameters, Figure 2, Figure 3, and Figure 4 show these forces and loadings acting on a crane.

## 5.4 In-service Loads

### 5.4.1 General

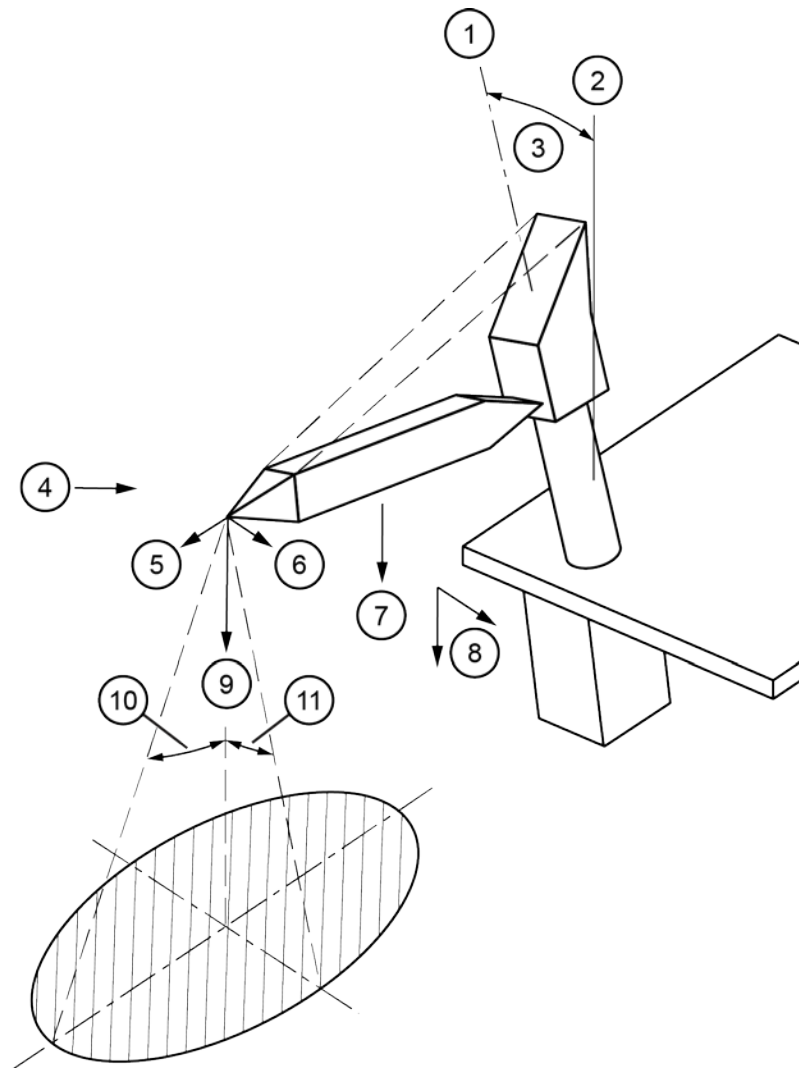
**5.4.1.1** During use, the crane is subjected to loads due to its own weight, the lifted load, environment, motions of the platform and vessel, dynamic forces caused by movements (i.e. hoisting), and, for offboard lifts, motions of the supply vessel the load is being lifted from or subsea load-water interaction.

**5.4.1.2** Dynamic forces acting on the SWL are assumed to also act on the crane hook block or overhaul ball used during the lift. The dynamic load factors used herein are applied to the SWLH, defined as the SWL plus the weight of the hook block or overhaul ball in use.

The crane vertical FL shall equal the SWLH multiplied by the dynamic coefficient  $C_v$  determined in 5.4.5. Offlead and sidelead loads, loads due to supply boat motion or subsea lifting, and the static inclination and motion of the crane base on floating installations shall be in accordance with 5.4.6 and 5.4.7. Wind, ice, and other environmental loads acting on the crane shall be in accordance with 5.6. For the specified lift conditions, the SWLH shall satisfy the requirements of 8.1.2 when the worst combination of all loads defined herein is applied to the crane.

Table 2—Summary of Design Parameter

| ID                             | Design Parameter                                                                           | Design Condition                                           |                                                            |                                                                                    |                                                                                  |
|--------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
|                                |                                                                                            | In-service Offboard Lift                                   | In-service Onboard Lift                                    | Out of Service (Boom Not Stowed)                                                   | Out of Service (Stowed)                                                          |
| A                              | Supply boat deck velocity, $V_d$                                                           | Purchaser specified or Table 3                             | N/A                                                        | N/A                                                                                | N/A                                                                              |
| B                              | Crane boom tip velocity, $V_c$                                                             | Purchaser specified or Table 3                             | N/A                                                        | N/A                                                                                | N/A                                                                              |
| C                              | Hoist velocity $V_h$ used for load calculations                                            | Maximum available—shall exceed or equal Equation (6) value | N/A                                                        | N/A                                                                                | N/A                                                                              |
| D                              | Vertical factored load, $FL$                                                               | Equations (1) and (2)<br>$C_v \times SWLH$                 | Table 4 and Equation (7) and Equation (8)                  | N/A                                                                                | N/A                                                                              |
| E                              | Minimum required hoist velocity for lifting conditions, $V_{hmin}$                         | Equation (6) value                                         | 5.4.5.3 (2 ft/min minimum)                                 | N/A                                                                                | N/A                                                                              |
| F                              | Supply boat offload force, $W_{offSB}$                                                     | Equation (9)                                               | N/A                                                        | N/A                                                                                | N/A                                                                              |
| G                              | Supply boat side load force, $W_{sideSB}$                                                  | Equation (11)                                              | N/A                                                        | N/A                                                                                | N/A                                                                              |
| H                              | Crane inclination side load                                                                | Purchaser specified or Table 5/Equation (14) value         | Purchaser specified or Table 5/Equation (14) value         | Purchaser specified or Table 5/Equation (14) for non-stowed conditions             | Purchaser specified or Table 5/Equation (14) for extreme vessel case             |
| I                              | Crane base horizontal acceleration loads acting on vertical factored load                  | Purchaser specified or Table 5/Equations (16) through (18) | Purchaser specified or Table 5/Equations (16) through (18) | N/A                                                                                | N/A                                                                              |
| J                              | Crane base vertical and horizontal acceleration loads acting on boom and other crane parts | Purchaser specified or Table 4 and Table 5 accelerations   | Purchaser specified or Table 4 and Table 5 accelerations   | Purchaser specified or Table 4 and Table 5 accelerations for non-stowed conditions | Purchaser specified or Table 4 and Table 5 accelerations for extreme vessel case |
| K                              | Environmental loads due to wind and ice or snow                                            | In accordance with 5.6                                     | In accordance with 5.6                                     | In accordance with 5.6 for non-stowed conditions                                   | In accordance with 5.6 for extreme vessel case                                   |
| NOTE N/A means not applicable. |                                                                                            |                                                            |                                                            |                                                                                    |                                                                                  |

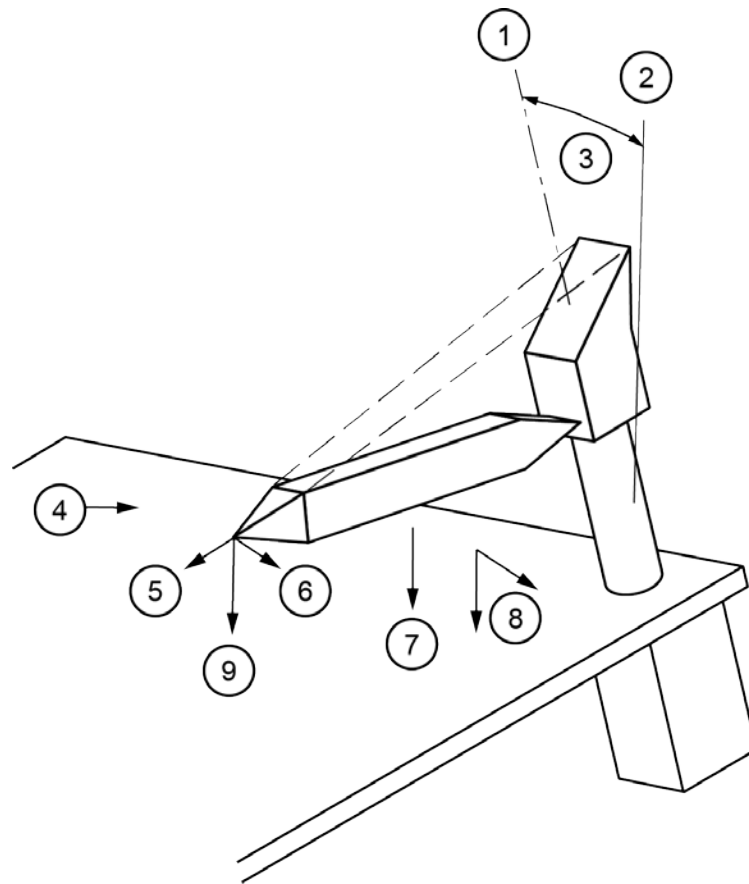


### Key

|                            |                |             |
|----------------------------|----------------|-------------|
| 1 centerline of crane      | 5 F            | 9 D         |
| 2 vertical axis            | 6 G & H        | 10 offlead  |
| 3 crane inclination        | 7 crane weight | 11 sidelead |
| 4 K & I (in any direction) | 8 J            |             |

NOTE See first column in Table 2 for definition of variables.

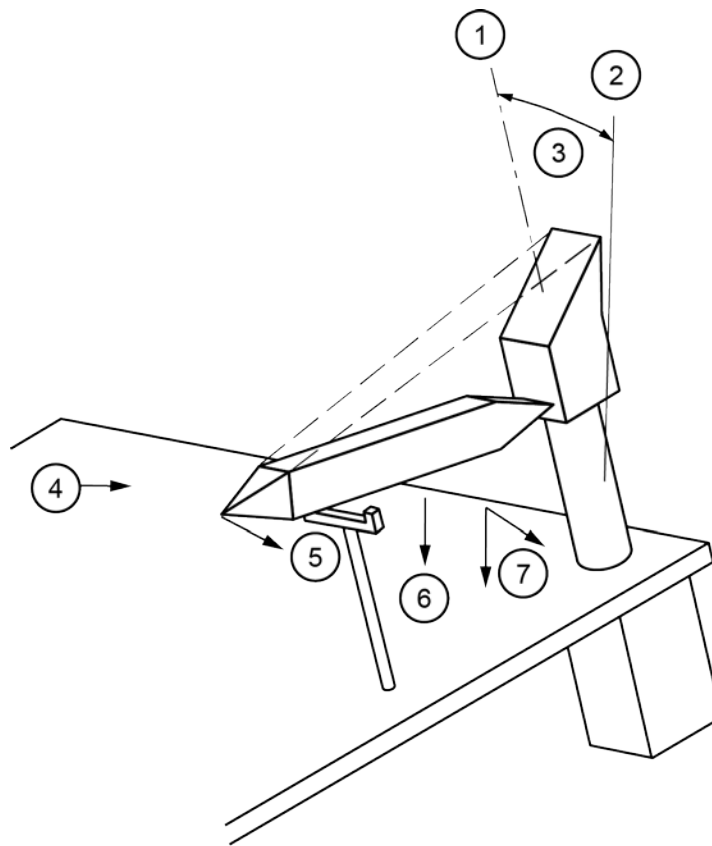
**Figure 2—Offboard Loadings**

**Key**

|                            |                |
|----------------------------|----------------|
| 1 centerline of crane      | 5 F            |
| 2 vertical axis            | 6 G & H        |
| 3 crane inclination        | 7 crane weight |
| 4 K & I (in any direction) | 8 J            |
|                            | 9 D            |

NOTE See first column in Table 2 for definition of variables.

**Figure 3—Onboard Loadings**

**Key**

|                        |                |
|------------------------|----------------|
| 1 centerline of crane  | 5 H            |
| 2 vertical axis        | 6 crane weight |
| 3 crane inclination    | 7 J            |
| 4 K (in any direction) |                |

NOTE See first column in Table 2 for definition of variables.

**Figure 4—Out-of-service Loadings**

**5.4.1.3** Annex D defines how subsea lifting requirements are applied to the crane's design. Three methods are given for calculating the dynamic forces acting on a crane in a specified sea state. These methods and their limitations are discussed in the following paragraphs. The methods are the:

- a) Vessel-specific Method,
- b) General Method, and
- c) Legacy Method (for onboard and offboard lifts on bottom-supported structures only).

**5.4.1.4** Crane ratings shall be determined by either the Vessel-specific Method or the General Method. Bottom-supported crane ratings may alternatively be determined by the Legacy Method.

## 5.4.2 Vessel-specific Method

The Vessel-specific Method is the preferred method for floating platform and vessel crane installations. For the Vessel-specific Method, the purchaser shall supply the velocity  $V_c$  used in Equation (1) through Equation (5) to calculate the dynamic coefficient,  $C_v$ . The  $V_c$  shall be the boom tip velocity for a given operating condition and may be calculated by investigating the motion behavior of the crane and the vessel to which it is mounted. The

accuracy of this method depends on how well the motions of the crane boom tip can be calculated. The  $V_d$  for the supply vessel shall be taken from Table 3 or it may be specified by the purchaser. For the Vessel-specific Method, the purchaser shall specify the  $A_v$  instead of using Table 4 and shall specify the platform and vessel static inclinations and the crane dynamic horizontal accelerations instead of using Table 5. The  $A_v$  shall be determined for the boom tip at a typical lifting position, and this shall be used for the entire crane. Required information for the Vessel-specific Method is discussed in Annex B.

### 5.4.3 General Method

For the General Method, the velocity  $V_d$  and  $V_c$  shall be taken from Table 3 for offboard lifts. These velocities were based on estimates of motions derived for representative platform and vessels of various types. Annex B discusses the basis for the values given in Table 3. For the General Method, the platform and vessel values from Table 4 and Table 5 shall also be used.

### 5.4.4 Legacy Method

The Vessel-specific Method or the General Method are preferred since they provide ratings corresponding to environmental conditions. The Legacy Method persists to accommodate purchasers that use traditional methods to specify cranes, which have successfully performed in the past on similar applications.

**5.4.4.1** The Legacy Method shall only be used where all of the following conditions are present:

- a) the crane-supporting structure is bottom supported,
- b) mild wind conditions are prevalent.

And, for offboard ratings:

- a) mild sea conditions are prevalent (i.e. the Gulf of Mexico),
- b) supply boat position is restrained relative to the crane-supporting structure (such as by tethering to the platform),
- c) the available hook speed  $V_{hmin}$  shall not be less than 0.67 ft/s (40 ft/min).

**5.4.4.2** For the Legacy Method:

- a) the dynamic coefficient is prescribed to be:
  - 1)  $C_v = 1.33$  for onboard ratings,
  - 2)  $C_v = 2.0$  for offboard ratings,
- b) wind speed may be zero or specified by the purchaser;
- c) total offload may be as low as zero but shall include any purchaser specified wind and offlead;
- d) total sidelead may be as low as  $0.02 \times FL$  but shall include any purchaser specified wind and sidelead.

**5.4.4.3** The swing mechanism shall be designed with sufficient strength and capacity to operate with both:

- a) 26 knot wind (minimum) or as specified by the purchaser, and
- b) static sidelead angle of 0.5 degrees (minimum) or as specified by the purchaser.

**Table 3—Vertical Velocity for Dynamic Coefficient Calculations**

| <b>Supply Boat Velocity, <math>V_d</math></b><br>(for Vessel-specific and General Methods)                                                                           |                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| Load being lifted from or placed on:                                                                                                                                 | $V_d$ (ft/s)                             |
| Bottom-supported structure                                                                                                                                           | 0.0                                      |
| Moving vessel (supply boat), $H_{sig} < 9.8$ ft                                                                                                                      | $V_d = 0.6 \times H_{sig}$               |
| Moving vessel (supply boat), $H_{sig} \geq 9.8$ ft                                                                                                                   | $V_d = 5.9 + 0.3 \times (H_{sig} - 9.8)$ |
| <b>Crane Boom Tip Velocity, <math>V_c</math></b><br>(for General Method)                                                                                             |                                          |
| Crane mounted on:                                                                                                                                                    | $V_c$ (ft/s)                             |
| Bottom-supported structure                                                                                                                                           | 0.0                                      |
| Ship and barge in calm water                                                                                                                                         | 0.0                                      |
| TLP                                                                                                                                                                  | $0.05 \times H_{sig}$                    |
| Spar                                                                                                                                                                 | $0.05 \times H_{sig}$                    |
| Semi-submersible                                                                                                                                                     | $0.025 \times (H_{sig})^2$               |
| Drillship                                                                                                                                                            | $0.05 \times (H_{sig})^2$                |
| FPSO                                                                                                                                                                 | $0.05 \times (H_{sig})^2$                |
| NOTE 1 See Annex B for a discussion of how these values were developed.<br>NOTE 2 In accordance with Table 2, $H_{sig}$ is in feet when used in the above equations. |                                          |

Table 4—Crane Vertical Acceleration

| Crane Mounted on                                                                                                                          | Vertical Acceleration, $A_v$<br>g     |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Bottom-supported structure                                                                                                                | 0.0                                   |
| Ship/barge in calm water                                                                                                                  | 0.0                                   |
| TLP                                                                                                                                       | $0.003 \times H_{sig} \geq 0.07$      |
| Spar                                                                                                                                      | $0.003 \times H_{sig} \geq 0.07$      |
| Semi-submersible                                                                                                                          | $0.0007 \times (H_{sig})^2 \geq 0.07$ |
| Drillship                                                                                                                                 | $0.0012 \times (H_{sig})^2 \geq 0.07$ |
| FPSO                                                                                                                                      | $0.0012 \times (H_{sig})^2 \geq 0.07$ |
| NOTE 1 In accordance with Table 2, $H_{sig}$ is in feet when used in the above equations.<br>NOTE 2 $1 \text{ g} = 32.2 \text{ ft/s}^2$ . |                                       |

Table 5—Crane Base Inclinations and Accelerations

| Crane Mounted on                                                                                                                          | Crane Static Inclination Angle (deg) |      | Crane Dynamic Horizontal Acceleration<br>g |
|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------|--------------------------------------------|
|                                                                                                                                           | List                                 | Trim |                                            |
| Bottom-supported structure                                                                                                                | 0.5                                  | 0.5  | 0.0                                        |
| Ship/barge in calm water                                                                                                                  | 5.0                                  | 3.0  | 0.0                                        |
| TLP                                                                                                                                       | 0.5                                  | 0.5  | $0.007 \times H_{sig} \geq 0.03$           |
| Spar                                                                                                                                      | 0.5                                  | 0.5  | $0.007 \times H_{sig} \geq 0.03$           |
| Semi-submersible                                                                                                                          | 1.5                                  | 1.5  | $0.007 \times H_{sig} \geq 0.03$           |
| Drillship                                                                                                                                 | 2.5                                  | 1    | $0.01 \times (H_{sig})^{1.1} \geq 0.03$    |
| FPSO                                                                                                                                      | 2.5                                  | 1    | $0.01 \times (H_{sig})^{1.1} \geq 0.03$    |
| NOTE 1 In accordance with Table 2, $H_{sig}$ is in feet when used in the above equations.<br>NOTE 2 $1 \text{ g} = 32.2 \text{ ft/s}^2$ . |                                      |      |                                            |

### 5.4.5 Vertical Factored Loads

#### 5.4.5.1 General

The vertical factored load,  $FL$ , acting on the crane boom tip shall be the SWLH multiplied by the vertical dynamic coefficient,  $C_v$ .

$$FL = C_v \times SWLH \quad (1)$$

#### 5.4.5.2 Offboard Lifts

For offboard lifts, the vertical dynamic coefficient,  $C_v$ , shall be determined from the following expression.

$$C_v = 1 + V_r \times \sqrt{\frac{K}{g \times SWLH}} \quad (2)$$

Equation (1) and Equation (2) shall be satisfied simultaneously. Alternately, when SWLH is not known, the FL may be used in the following expression:

$$\alpha = \frac{V_r^2 \times K}{g \times FL} \quad (3)$$

$$C_v = \frac{2 + \alpha + \sqrt{4\alpha + \alpha^2}}{2} \quad (4)$$

where

$K$  is the vertical spring rate of the crane at the hook expressed in lb/ft;

$SWLH$  is the safe working load (SWL) plus hook block or overhaul ball in use expressed in lb;

$FL$  is the factored load ( $SWLH \times C_v$ ) expressed in lb;

$\alpha$  is a substitution variable in Equation (4);

$g$  is acceleration due to gravity expressed as 32.2 ft/s<sup>2</sup>; and

$V_r$  is the relative velocity expressed in ft/s.

$$V_r = V_h + \sqrt{V_d^2 + V_c^2} \quad (5)$$

where

$V_h$  is the maximum actual steady hoisting velocity for the SWLH to be lifted expressed in ft/s;

$V_d$  is the vertical velocity of the supply boat deck supporting the load expressed in ft/s; and

$V_c$  is the vertical velocity of the crane boom tip due to crane base motion expressed in ft/s.

However,  $C_v$  shall not be less than the onboard dynamic coefficient.

Crane stiffness  $K$  shall be calculated taking into account all elements from the hook through the pedestal structure. Annex B discusses calculation of crane stiffness to be used in this equation.

During offboard lifts, hoisting velocity at the elevation where the lift is initiated (i.e. supply boat deck level) shall be fast enough to avoid re-contact after the load is lifted. The minimum hoisting velocity,  $V_{hmin}$ , for any particular hook load to be lifted shall be:

$$V_{hmin} = 0.033 + 0.098 \times H_{sig}, \text{ for } H_{sig} \leq 6 \text{ ft} \quad (6)$$

$$V_{hmin} = 0.067 \times (H_{sig} + 3.3), \text{ for } H_{sig} > 6 \text{ ft}$$

where

$H_{sig}$  is the significant wave height for the load chart in question in ft;

$V_{hmin}$  is the minimum required steady hoisting velocity in ft/s.

The  $V_h$  used in Equation (5) to calculate  $C_v$  shall be the actual maximum available steady hook speed attainable (when the hook is at the waterline) and shall be equal to or larger than  $V_{hmin}$ .

### 5.4.5.3 Onboard Lifts

For onboard lifts, the velocities  $V_d$  and  $V_c$  shall be taken as zero. For onboard lifts,  $V_{hmin}$  shall not be less than 0.033 ft/s (2 ft/min). For the Vessel-specific and General Methods,  $C_v$  shall be obtained from the following equations where vertical boom tip dynamic acceleration,  $A_v$ , is determined from the vessel motion analysis for the specific operating conditions. For the General Method, this value is found in Table 4.

$$C_v = 1.373 - \frac{SWLH}{1,173,913} + A_v \quad (7)$$

Equation (1) and Equation (7) shall be satisfied simultaneously, or alternately when SWLH (lb) is not known, the following may be used.

$$C_v = 0.6865 + \frac{A_v}{2} + \sqrt{\frac{(1.373 + A_v)^2}{4} - \frac{FL}{1,173,913}} \quad (8)$$

However,  $C_v$  shall not be less than  $1.1 + A_v$  or greater than  $1.33 + A_v$ .

where

$C_v$  is the dynamic coefficient;

$A_v$  is the vertical boom tip acceleration expressed in g's;

$FL$  is the factored load expressed in lb.

## 5.4.6 Horizontal Loads

### 5.4.6.1 General

Horizontal loadings shall be taken into account in establishing the crane ratings. If more specific data are not available from the purchaser, offlead, sidelead, crane base static inclination, and crane base motions shall be calculated in accordance with this section and shall be applied concurrently with vertical loads in crane rating calculations.

### 5.4.6.2 Offlead and Sidelead due to Supply Boat Motion or Subsea Lifting

All offboard lifts shall include the horizontal loads induced by supply boat motion. The radial offlead load,  $W_{\text{offSB}}$ , applied at the boom tip due to supply boat motion shall be:

$$W_{\text{offSB}} = FL \times OL \quad (9)$$

where

$$OL = \frac{2.5 + (0.457H_{\text{sig}})}{0.305H_{\text{tip}}} \leq 0.30 \quad (10)$$

$H_{\text{tip}}$  is the vertical distance from boom tip to supply boat deck expressed in ft;

$FL$  is the factored load expressed in lb.

The horizontal sidelead (expressed in lb) applied at the boom tip due to supply boat motion shall be:

$$W_{\text{sideSB}} = \frac{W_{\text{offSB}}}{2} \quad (11)$$

When the purchaser supplies specific offlead and sidelead angles (Vessel-specific Method), the offlead and sidelead forces shall be a function of the specified angles as follows.

$$W_{\text{offSB}} = FL \times \tan(\text{offlead angle}) \quad (12)$$

$$W_{\text{sideSB}} = FL \times \tan(\text{sidelead angle}) \quad (13)$$

Annex D defines how subsea lifting requirements are applied to the crane's design.

### 5.4.6.3 Loads due to Crane Inclinations (CI Forces) and Crane Motions (CM Forces)

All onboard and offboard lifts shall include the loads induced by crane base static inclination (list or trim) and crane base motions. For the Vessel-specific Method, the boom tip motions resulting from the platform and vessel CMs shall be determined. The boom tip motions shall be defined for the in-service operating conditions and for the worst non-stowed out-of-service conditions. For the General Method in the absence of any specific data for the vessel, the values in Table 5 may be used. Annex B provides information on the size and type of vessels for which the Table 5 values are valid. The Table 5 values are not valid for different types of vessels or smaller vessels than those in Annex B.

Platform and vessel static inclinations (list and trim) cause offlead and sidelead depending on the crane operating direction relative to the inclination. Static offlead results in a static change in position of the hook compared to level lifting conditions. To account for this, the crane boom angle should be adjusted to bring the hook back to the correct radius and the ratings determined for this configuration. Static sidelead results in a sidelead at the boom tip due to the vertical FL equal to:

$$W_{\text{sideCI}} = FL \times \sin(\text{static sidelead angle}) \quad (14)$$

The static sidelead angle is defined as:

$$\text{static sidelead angle} = \sqrt{(\text{list})^2 + (\text{trim})^2} \times \sin(\text{crane swing angle}) \quad (15)$$