ASME B30.3-2016
(Revision of ASME B30.3-2012)

Tower Cranes

Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

This American National Standard, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, has been developed under the procedures accredited by the American National Standards Institute (ANSI). This Standard had its beginning in December 1916 when an eight-page "Code of Safety Standards for Cranes," prepared by an ASME Committee on the Protection of Industrial Workers, was presented at the annual meeting of the ASME.

Meetings and discussions regarding safety on cranes, derricks, and hoists were held from 1920 to 1925, involving the ASME Safety Code Correlating Committee, the Association of Iron and Steel Electrical Engineers, the American Museum of Safety, the American Engineering Standards Committee (AESC) [later changed to American Standards Association (ASA), then to the United States of America Standards Institute (USASI), and finally to ANSI], Department of Labor — State of New Jersey, Department of Labor and Industry — State of Pennsylvania, and the Locomotive Crane Manufacturers Association. On June 11, 1925, AESC approved the ASME Safety Code Correlating Committee's recommendation and authorized the project with the U.S. Department of the Navy Bureau of Yards and Docks and ASME as sponsors.

In March 1926, invitations were issued to 50 organizations to appoint representatives to a Sectional Committee. The call for organization of this Sectional Committee was sent out October 2, 1926, and the committee organized November 4, 1926, with 57 members representing 29 national organizations.

Commencing June 1, 1927, and using the eight-page code published by ASME in 1916 as a basis, the Sectional Committee developed the "Safety Code for Cranes, Derricks, and Hoists." The early drafts of this safety code included requirements for jacks but, due to inputs and comments on those drafts, the Sectional Committee decided in 1938 to make the requirements for jacks a separate code. In January 1943, ASA B30.2-1943 was published, addressing a multitude of equipment types, and in August 1943, ASA B30.1-1943 was published, just addressing jacks. Both documents were reaffirmed in 1952 and widely accepted as safety standards.

Due to changes in design, advancement in techniques, and general interest of labor and industry in safety, the Sectional Committee, under the joint sponsorship of ASME and the Bureau of Yards and Docks (now the Naval Facilities Engineering Command) was reorganized on January 31, 1962, with 39 members representing 27 national organizations.

The new Committee changed the format of ASA B30.2-1943 so that the multitude of equipment types it addressed could be published in separate volumes that could completely cover the construction, installation, inspection, testing, maintenance, and operation of each type of equipment that was included in the scope of the ASA B30.2. This format change resulted in the initial publication of B30.3, B30.5, B30.6, B30.11, and B30.16 being designated as "Revisions" of B30.2, with the remainder of the B30 volumes being published as totally new volumes. ASA changed its name to USASI in 1966 and to ANSI in 1969, which resulted in B30 volumes from 1943 to 1968 being designated as either ASA B30, USAS B30, or ANSI B30, depending on their date of publication.

In 1982, the Committee was reorganized as an Accredited Organization Committee, operating under procedures developed by ASME and accredited by the American National Standards Institute.

This Standard presents a coordinated set of rules that may serve as a guide to government and other regulatory bodies and municipal authorities responsible for the guarding and inspection of the equipment falling within its scope. The suggestions leading to accident prevention are given both as mandatory and advisory provisions; compliance with both types may be required by employers of their employees.

In case of practical difficulties, new developments, or unnecessary hardship, the administrative or regulatory authority may grant variances from the literal requirements or permit the use of other devices or methods, but only when it is clearly evident that an equivalent degree of protection is thereby secured. To secure uniform application and interpretation of this Standard,

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administrative or regulatory authorities are urged to consult the B30 Committee, in accordance with the format described in Section IX of the Introduction, before rendering decisions on disputed points.

Safety codes and standards are intended to enhance public safety. Revisions result from committee consideration of factors such as technological advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate.

The first edition of B30.3 Construction Tower Cranes was published in 1975 as a "partial revision" to B30.2-1943 (R1952) and was the first volume dedicated to tower cranes. New editions were published, in 1975, 1984, 1990, 1996, 2004, and 2009, with the 2009 edition revising the title of B30.3 to Tower Cranes and reflecting the revised scope that now included both construction and permanently mounted tower cranes (formerly addressed in B30.4). Responsibilities for members of the lifting team were also added in that edition. The 2012 edition was a complete rewrite of the 2009 edition and included many new subjects and requirements updated to reflect the changing work environment in which tower cranes operate. Major changes were made to the scope of work for erecting, dismantling, and climbing and takes into account wind zone regions across the United States. Strength and stability requirements were modified to align with the new European standard EN 14439. This 2016 Edition includes minor revisions throughout the book, including the addition of personnel competence.

The edition of the B30.3 Volume was approved by the B30 Committee and by ASME, and was approved by ANSI and designated as an American National Standard on February 3, 2016.

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Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

(The following is the roster of the Committee at the time of approval of this Standard.)

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SAFETY STANDARD FOR CABLEWAYS, CRANES, DERRICKS, HOISTS, HOOKS, JACKS, AND SLINGS

B30 STANDARD INTRODUCTION (16)

SECTION I: SCOPE

The ASME B30 Standard contains provisions that apply to the construction, installation, operation, inspection, testing, maintenance, and use of cranes and other lifting and material-movement related equipment. For the convenience of the reader, the Standard has been divided into separate volumes. Each volume has been written under the direction of the ASME B30 Standard Committee and has successfully completed a consensus approval process under the general auspices of the American National Standards Institute (ANSI).

As of the date of issuance of this Volume, the B30 Standard comprises the following volumes:

B30.1 Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries
B30.2 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
B30.3 Tower Cranes
B30.4 Portal and Pedestal Cranes
B30.5 Mobile and Locomotive Cranes
B30.6 Derricks
B30.7 Winches
B30.8 Floating Cranes and Floating Derricks
B30.9 Slings
B30.10 Hooks
B30.11 Monorails and Underhung Cranes
B30.12 Handling Loads Suspended From Rotorcraft
B30.13 Storage/Retrieval (S/R) Machines and Associated Equipment
B30.14 Side Boom Tractors
B30.15 Mobile Hydraulic Cranes (withdrawn 1982 — requirements found in latest revision of B30.5)
B30.16 Overhead Hoists (Underhung)
B30.17 Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
B30.18 Stacker Cranes (Top or Under Running Bridge, Multiple Girder With Top or Under Running Trolley Hoist)
B30.19 Cableways
B30.20 Below-the-Hook Lifting Devices
B30.21 Manually Lever-Operated Hoists
B30.22 Articulating Boom Cranes
B30.23 Personnel Lifting Systems
B30.24 Container Cranes
B30.25 Scrap and Material Handlers
B30.26 Rigging Hardware
B30.27 Material Placement Systems
B30.28 Balance Lifting Units
B30.29 Self-Erecting Tower Cranes
B30.30 Ropes[1]

SECTION II: SCOPE EXCLUSIONS

Any exclusion of, or limitations applicable to the equipment, requirements, recommendations or operations contained in this Standard are established in the affected volume's scope.

SECTION III: PURPOSE

The B30 Standard is intended to

(a) prevent or minimize injury to workers, and otherwise provide for the protection of life, limb, and property by prescribing safety requirements

(b) provide direction to manufacturers, owners, employers, users, and others concerned with, or responsible for, its application

(c) guide governments and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives

SECTION IV: USE BY REGULATORY AGENCIES

These volumes may be adopted in whole or in part for governmental or regulatory use. If adopted for governmental use, the references to other national codes and standards in the specific volumes may be changed to refer to the corresponding regulations of the governmental authorities.

SECTION V: EFFECTIVE DATE

(a) Effective Date. The effective date of this Volume of the B30 Standard shall be 1 yr after its date of issuance.

[1] This volume is currently in the development process.

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Construction, installation, inspection, testing, maintenance, and operation of equipment manufactured and facilities constructed after the effective date of this Volume shall conform to the mandatory requirements of this Volume.

(b) Existing Installations. Equipment manufactured and facilities constructed prior to the effective date of this Volume of the B30 Standard shall be subject to the inspection, testing, maintenance, and operation requirements of this Standard after the effective date.

It is not the intent of this Volume of the B30 Standard to require retrofitting of existing equipment. However, when an item is being modified, its performance requirements shall be reviewed relative to the requirements within the current volume. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within 1 yr.

SECTION VI: REQUIREMENTS AND RECOMMENDATIONS

Requirements of this Standard are characterized by use of the word *shall*. Recommendations of this Standard are characterized by the word *should*.

SECTION VII: USE OF MEASUREMENT UNITS

This Standard contains SI (metric) units as well as U.S. Customary units. The values stated in U.S. Customary units are to be regarded as the standard. The SI units are a direct (soft) conversion from the U.S. Customary units.

SECTION VIII: REQUESTS FOR REVISION

The B30 Standard Committee will consider requests for revision of any of the volumes within the B30 Standard. Such requests should be directed to

Secretary, B30 Standard Committee
ASME Codes and Standards
Two Park Avenue
New York, NY 10016-5990

Requests should be in the following format:

Volume:	Cite the designation and title of the volume.
Edition:	Cite the applicable edition of the volume.
Subject:	Cite the applicable paragraph number(s) and the relevant heading(s).
Request:	Indicate the suggested revision.
Rationale:	State the rationale for the suggested revision.

Upon receipt by the Secretary, the request will be forwarded to the relevant B30 Subcommittee for consideration and action. Correspondence will be provided to the requester defining the actions undertaken by the B30 Standard Committee.

SECTION IX: REQUESTS FOR INTERPRETATION

The B30 Standard Committee will render an interpretation of the provisions of the B30 Standard. Such requests should be directed to

Secretary, B30 Standard Committee
ASME Codes and Standards
Two Park Avenue
New York, NY 10016-5990

Requests should be in the following format:

Volume:	Cite the designation and title of the volume.
Edition:	Cite the applicable edition of the volume.
Subject:	Cite the applicable paragraph number(s) and the relevant heading(s).
Question:	Phrase the question as a request for an interpretation of a specific provision suitable for general understanding and use, not as a request for approval of a proprietary design or situation. Plans or drawings that explain the question may be submitted to clarify the question. However, they should not contain any proprietary names or information.

Upon receipt by the Secretary, the request will be forwarded to the relevant B30 Subcommittee for a draft response, which will then be subject to approval by the B30 Standard Committee prior to its formal issuance.

Interpretations to the B30 Standard will be published in the subsequent edition of the respective volume, and will be available online at http://cstools.asme.org.

SECTION X: ADDITIONAL GUIDANCE

The equipment covered by the B30 Standard is subject to hazards that cannot be abated by mechanical means, but only by the exercise of intelligence, care, and common sense. It is therefore essential to have personnel involved in the use and operation of equipment who are competent, careful, physically and mentally qualified, and trained in the proper operation of the equipment and the handling of loads. Serious hazards include, but are not limited to, improper or inadequate maintenance, overloading, dropping or slipping of the load, obstructing the free passage of the load, and using equipment for a purpose for which it was not intended or designed.

The B30 Standard Committee fully realizes the importance of proper design factors, minimum or maximum dimensions, and other limiting criteria of wire rope or chain and their fastenings, sheaves, sprockets, drums,

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and similar equipment covered by the standard, all of which are closely connected with safety. Sizes, strengths, and similar criteria are dependent on many different factors, often varying with the installation and uses. These factors depend on

(a) the condition of the equipment or material

(b) the loads

(c) the acceleration or speed of the ropes, chains, sheaves, sprockets, or drums

(d) the type of attachments

(e) the number, size, and arrangement of sheaves or other parts

(f) environmental conditions causing corrosion or wear

(g) many variables that must be considered in each individual case

The requirements and recommendations provided in the volumes must be interpreted accordingly, and judgment used in determining their application.

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ASME B30.3-2016
SUMMARY OF CHANGES

Following approval by the ASME B30 Committee and ASME, and after public review, ASME B30.3-2016 was approved by the American National Standards Institute on February 3, 2016.

ASME B30.3-2016 includes editorial changes, revisions, and corrections, as well as the following changes identified by a margin note, **(16)**.

Page	*Location*	*Change*
ix-xi	B30 Standard Introduction	Updated
1, 7, 9–11	Chapter 3-0	Title revised
	3-0.2.1.4	Definition for *traveling tower crane* revised
	3-0.2.2	(1) Definitions for *appointed*; *authorized*; *designated person*; and *truck, travel* deleted (2) Definitions for *base, traveling*; *climbing*; *counterjib*; and *operational aid* revised (3) Definitions for *climbing cross member* and *normal operating condition* added
	Section 3-0.3	Updated
	Section 3-0.4	Added
4	Figure 3-0.2.1.2-3	Revised
5	Figure 3-0.2.1.3-1	Revised
6	Figure 3-0.2.1.3-2	Revised
7	Figure 3-0.2.1.4-1	Revised
8	Figure 3-0.2.2-1	Revised
15	Section 3-1.5	Subparagraphs (i), (j)(1)(-c), and (j)(1)(-f) revised
21	3-1.13.2	Revised in its entirety
22	3-1.17	Subparagraph (a)(2) revised
31	3-3.1.1	Subparagraph (a)(2) revised
32	3-3.1.3	(1) Subparagraph (c) revised (2) Subparagraphs (m), (n), (o), and (q) deleted, and subpara. (p) redesignated
33, 34	3-3.1.4.1.1	Subparagraph (a) revised
	3-3.1.4.1.2	Subparagraphs (k) through (n) added
	3-3.1.4.2.1	Subparagraph (j) revised
	3-3.1.4.3	Title revised

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Page	*Location*	*Change*
35, 36	3-3.2.1	Subparagraphs (a)(3), (b)(4)(-a), and (e)(1) revised
	3-3.3.1	Subparagraph (a) revised
37	3-3.3.5	First paragraph revised

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TOWER CRANES

Chapter 3-0
Scope, Definitions, References, and Personnel Competence (16)

SECTION 3-0.1: SCOPE OF B30.3

Within the general scope of the B30 Standard, as defined in Section I of the B30 Standard Introduction, the B30.3 Volume applies to "construction tower cranes" and "permanently mounted tower cranes" that are powered by electric motors or internal combustion engines and that adjust their operating radius by means of a luffing boom mechanism, a trolley traversing a horizontal jib, or a combination of the two. The cranes may be mounted on "fixed bases" or "traveling bases" and may have tower and supporting structure arrangements that permit the crane to climb in a structure being built or that permits increasing the crane's tower height as the structure rises. Variations of the above physical characteristics that provide the same fundamental operating characteristics are included in the scope of this Volume; however, the requirements of this Volume are only applicable to the cranes within this scope when they are used in lifting operations. Mobile cranes configured with tower attachments (refer to ASME B30.5) and self-erecting tower cranes (refer to ASME B30.29) are not within the scope of this Volume.

SECTION 3-0.2: DEFINITIONS

3-0.2.1 Types of Cranes

3-0.2.1.1 By Type of Application

construction tower crane: a hammerhead, luffing, or other type of tower crane that is regularly assembled and disassembled for use at various sites. It is usually characterized by provisions to facilitate erection and dismantling and may include features to permit climbing or telescoping.

permanently mounted tower crane: a hammerhead, luffing, or other type of tower crane that is erected for longer term use at one location (5 yr or more). The configuration of the crane usually remains unchanged during the entire installation period.

3-0.2.1.2 By Method of Load Positioning

hammerhead tower crane: a tower crane with a horizontal jib and a load trolley that traverses the jib to change load radius (see Figs. 3-0.2.1.2-1 and 3-0.2.1.2-2).

luffing boom tower crane: a crane with a boom pinned to the superstructure at its inner end and containing load hoisting tackle at its outer end, and with a hoist mechanism to raise or lower the boom in a vertical plane to change load radius (see Fig. 3-0.2.1.2-3).

3-0.2.1.3 By Support Arrangement

braced or guyed tower crane: a tower crane with tie-ins or guys attached to the tower to permit the crane to be erected or climbed to greater than the maximum freestanding height (see Figs. 3-0.2.1.2-2 and 3-0.2.1.3-1).

freestanding tower crane: a tower crane that is supported on a foundation or structural support without assistance from braces, guys, or other means (see Figs. 3-0.2.1.2-1 and 3-0.2.1.2-3).

internal climbing tower crane: a tower crane arranged to raise itself from floor to floor in a building as construction advances (see Fig. 3-0.2.1.3-2).

3-0.2.1.4 By Ability to Travel (16)

fixed-base tower crane: a freestanding, braced, guyed, or ballasted platform tower crane that is mounted on a foundation or structural support and does not travel (see Figs. 3-0.2.1.2-1 and 3-0.2.1.2-3).

traveling tower crane: a freestanding tower crane mounted on a ballasted platform furnished with bogies that ride along rails (see Fig. 3-0.2.1.4-1).

3-0.2.2 General (16)

accessory: a secondary part or assembly of parts that contributes to the overall function and usefulness of a machine.

administrative or regulatory authority: governmental agency, or the employer in the absence of applicable governmental jurisdiction.

axis of rotation: the vertical line about which a crane swings.

balance: the condition of the superstructure of a tower crane necessary for climbing; the load or the luffing boom is positioned at that radius which causes the vertical moment of the superstructure about the balance point to go to zero.

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Fig. 3-0.2.1.2-1 Hammerhead Tower Crane — Fixed-Base, Freestanding Crane

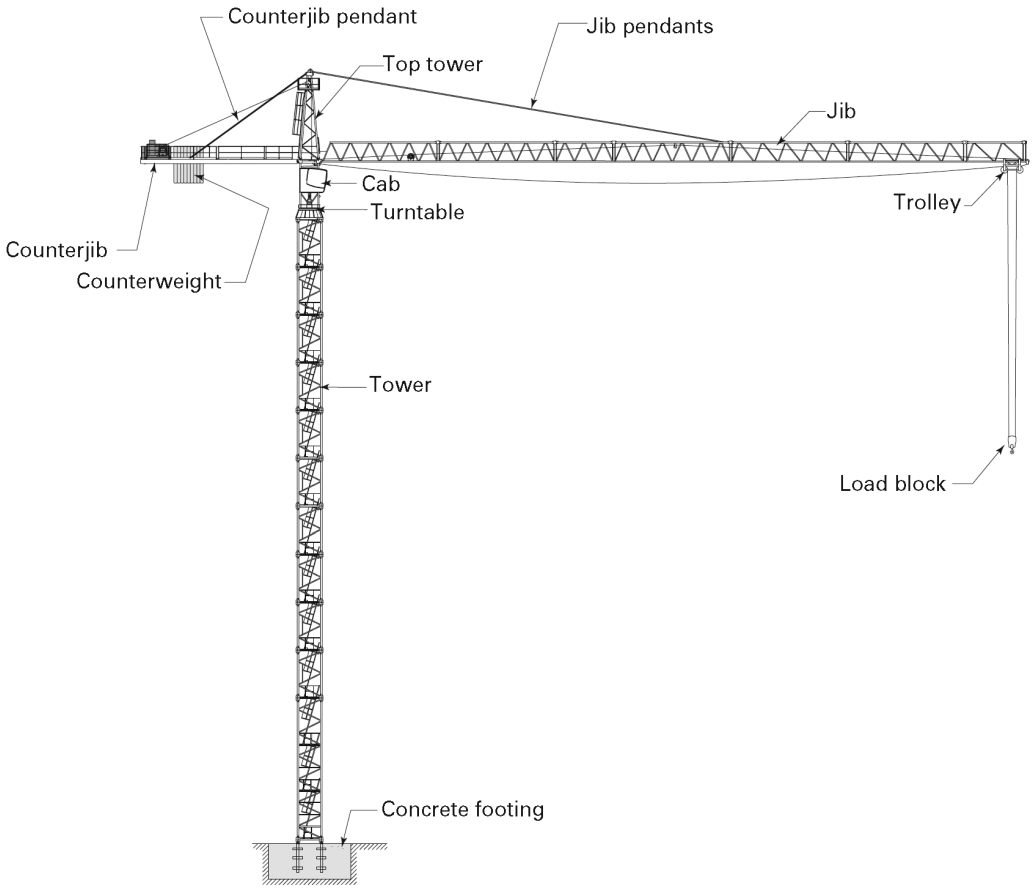

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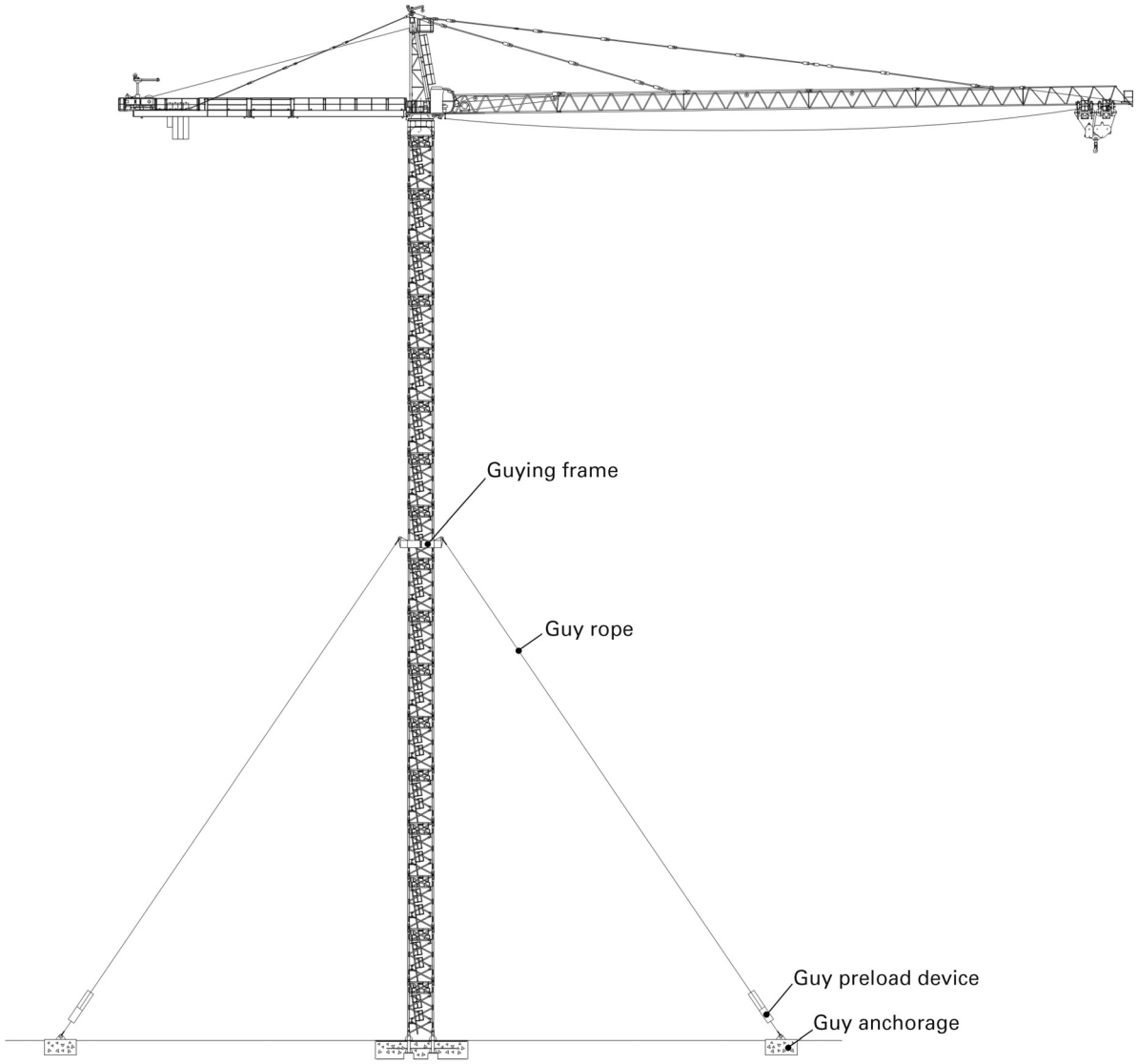
Fig. 3-0.2.1.2-2 Guyed Tower Crane



GENERAL NOTE: Three or more guys to be evenly spaced.

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(16) **Fig. 3-0.2.1.2-3 Luffing Boom Tower Crane — Fixed-Base, Freestanding Crane**

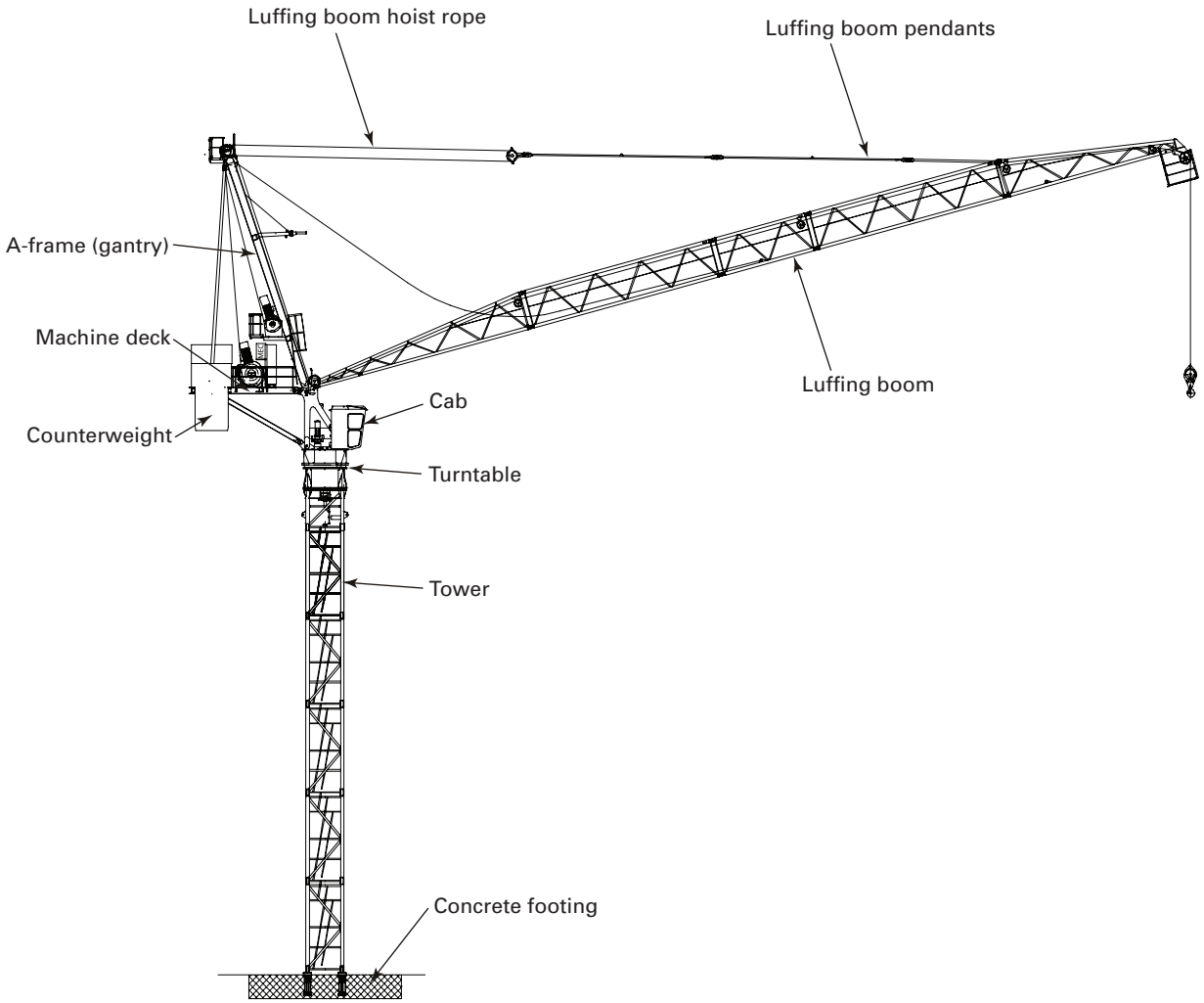

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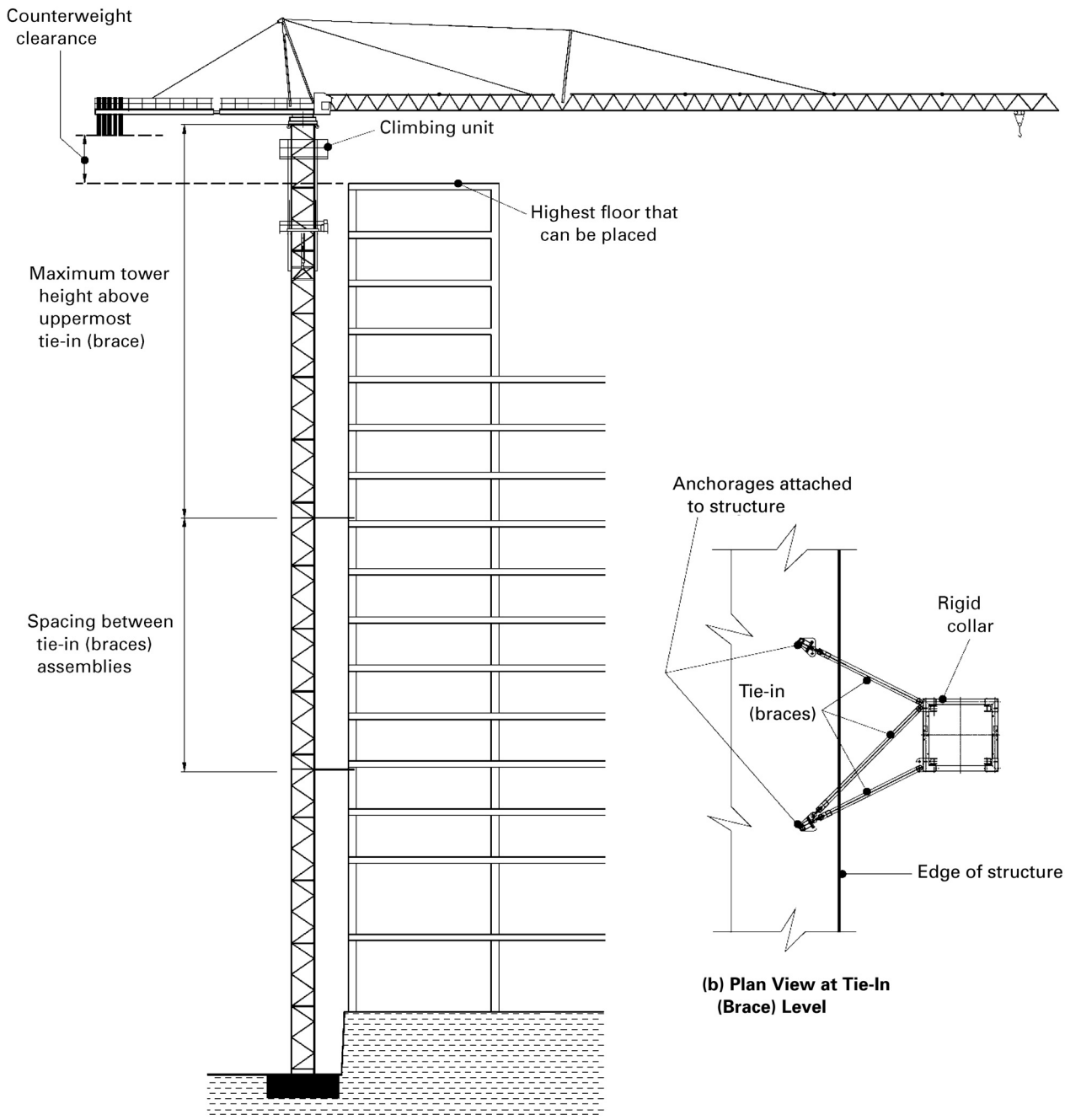
Fig. 3-0.2.1.3-1 Braced Crane (16)



(a) Elevation View

(b) Plan View at Tie-In (Brace) Level

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(16)

Fig. 3-0.2.1.3-2 Internal Climbing Crane

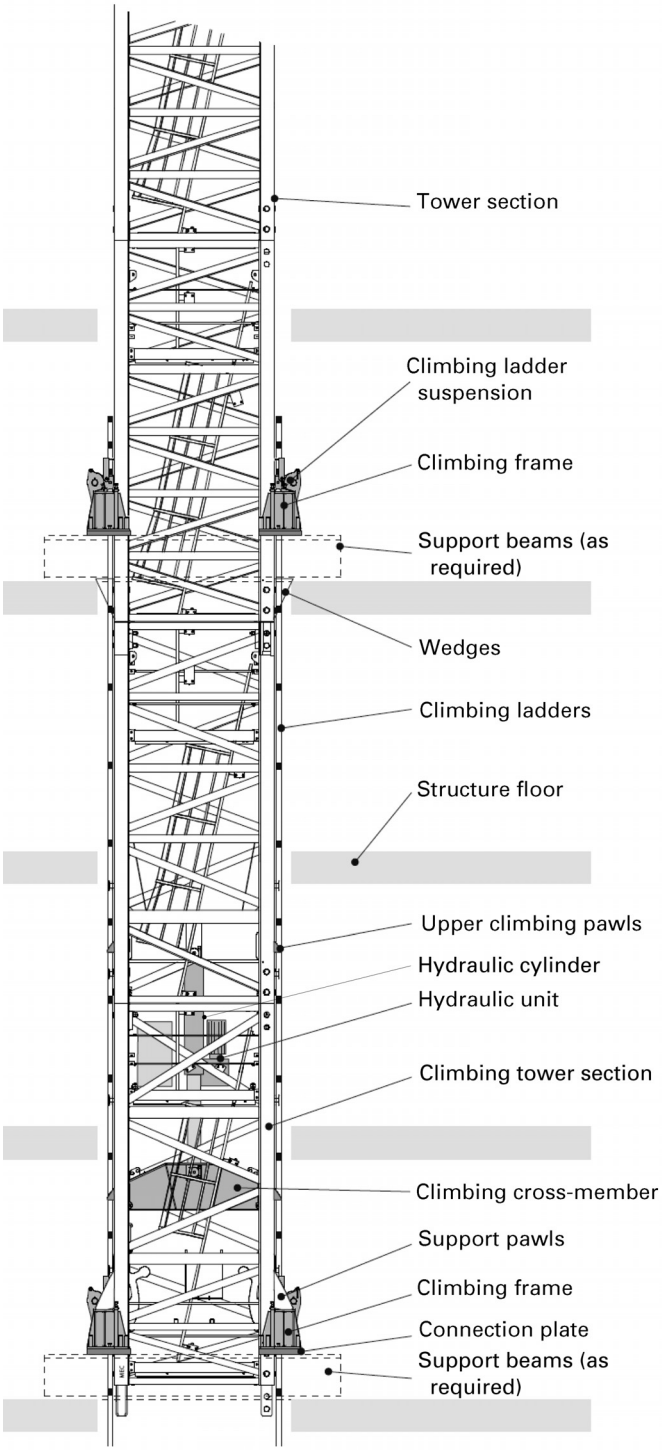

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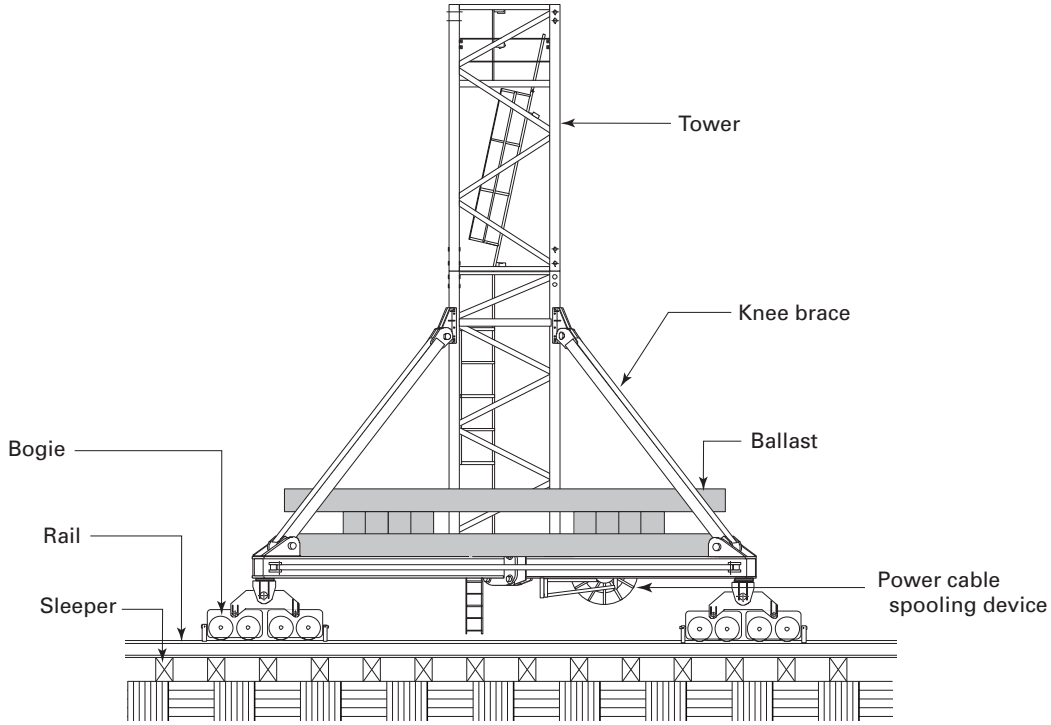
Fig. 3-0.2.1.4-1 Travel Base for Freestanding Crane (16)



ballast: weight added to a crane base to create additional stability; it does not rotate when the crane swings.

base, anchor bolt: a crane base that is bolted to a footing [see Fig. 3-0.2.2-1, illustration (a)].

base, expendable: for static-mounted cranes, a style of bottom tower section or member that is cast into a concrete footing block; all or part of this component is lost to future installations [see Fig. 3-0.2.2-1, illustrations (a) and (b)].

base, fixed ballasted: a crane base that is a ballasted platform that does not travel.

base, knee-braced: a crane base that uses diagonal members to spread the loading [see Fig. 3-0.2.2-1, illustration (c)].

base tower: a mounting accessory to secure the bottom of the tower to a foundation, structural support, travel, or ballasted base.

base, traveling: a crane base that is a ballasted platform mounted on bogies that ride along rails (see Fig. 3-0.2.1.4-1).

bogie: an assembly of two or more axles arranged to permit both vertical wheel displacement and an equalization of loading on the wheels.

brace, tower: a structural attachment placed between a crane tower and an adjacent structure to pass loads to the adjacent structure and permit the crane to be erected to greater than freestanding height (see Fig. 3-0.2.1.3-1).

brake: a device, other than a motor, used for retarding or stopping motion by friction or power means.

braking means: a method or device for retarding or stopping motion.

buffer: an energy-absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel.

cab: a housing provided for the operator and containing the crane controls.

climbing: for freestanding, braced, or guyed cranes, the process whereby the height of the tower is increased by adding sections at the top (see Fig. 3-0.2.1.3-1); for internal climbing cranes, the process whereby the entire crane is raised or lowered on or within a structure which is under construction (see Fig. 3-0.2.1.3-2).

climbing cross-member: a structural member attached to the end of the hydraulic cylinder used to engage the climbing ladders or lugs via pawls to raise or lower the crane structure.

climbing frame: for freestanding, braced, or guyed cranes, a structural frame supporting the superstructure which surrounds the tower and contains arrangements to raise the frame and superstructure of the crane for insertion

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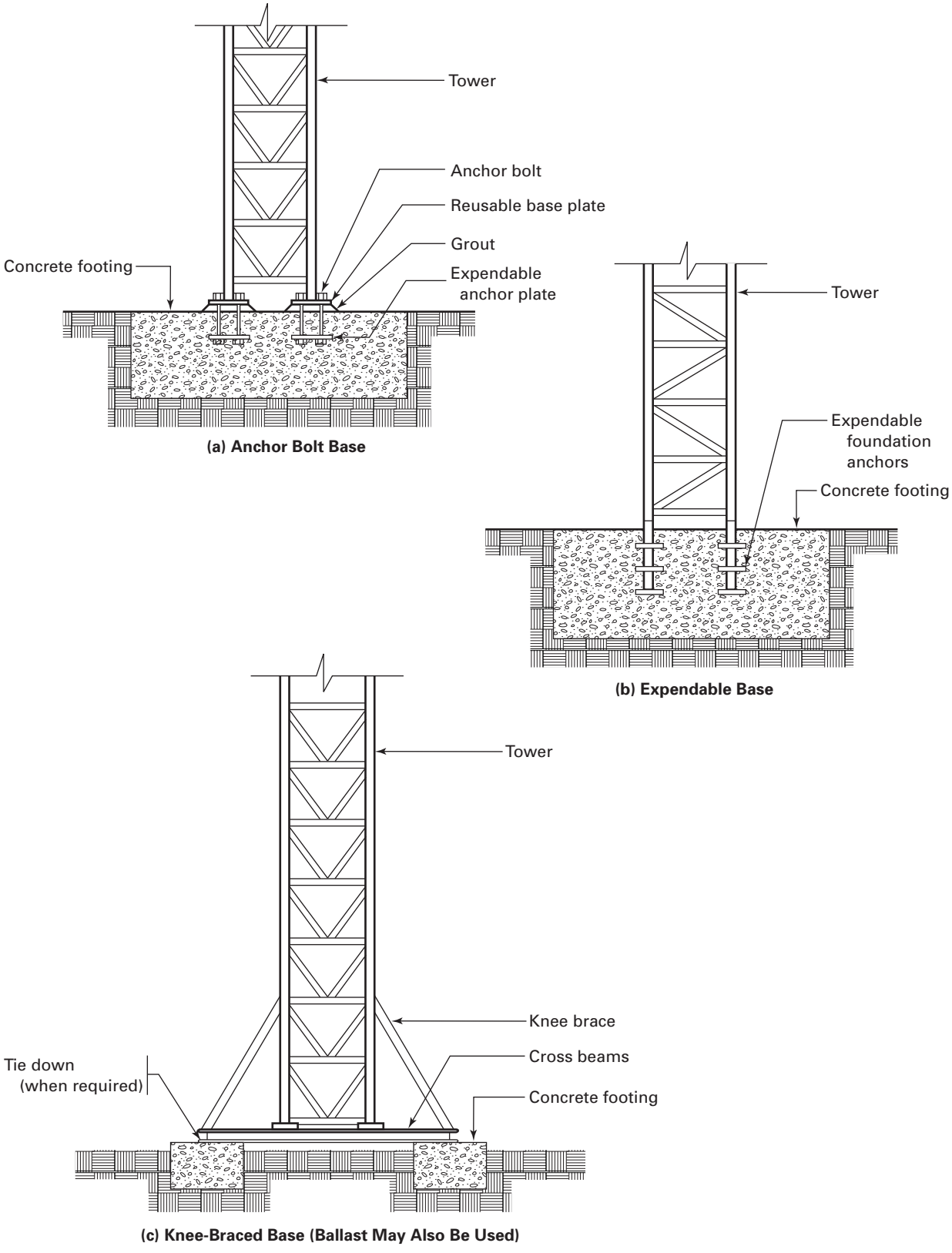
Fig. 3-0.2.2-1 Types of Fixed Bases



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of an additional tower section; for internal climbing cranes, a frame used to transmit operational and climbing reactions to the host building frame.

climbing ladder: a steel member with crossbars (used in pairs) suspended from a climbing frame and used as jacking support points when some cranes climb.

clutch: a means for engagement or disengagement of power.

control station: the location of the crane function controls, either cab mounted or by remote control.

counterjib: a horizontal member of a crane on which the counterweights and usually the hoisting machinery are mounted.

counterweight: weights added to a crane superstructure to create additional stability or to counter the effects of the lifted load; they rotate with the crane as it swings.

crane: in this Volume, the use of the word crane refers to tower cranes, which are lifting machines consisting of a tower with a superstructure that rotates and includes a load, luffing boom, or jib, and, on some cranes, a counterjib extending in the opposite direction to the load, luffing boom, or jib.

crane, standby: a crane that is not in regular service but that is used occasionally or intermittently as required.

crossover points: points of rope contact where one layer of rope on a rope drum crosses over the previous layer.

documentation: The organized collection of information that describes the structure, design, purpose, operation, maintenance, and safety requirements for the crane and includes the stickers, placards, and labels that provide operational or safety-related information.

drum: the cylindrical member around which rope is wound for lifting or lowering a load.

dynamic loading: loads introduced into the machine or its components by forces in motion.

equalizer: a device that compensates for unequal length or stretch of a rope.

flange point: the point of contact between the rope and drum flange where the rope changes layers on a rope drum.

freestanding height: that height of a crane which is supported by the tower alone without assistance from braces, guys, or other means.

gage, track: the horizontal distance between two rails, measured perpendicular to the direction of travel.

guy rope: a fixed-length supporting rope intended to maintain a nominally fixed distance between the two points of attachment; may also be called a stay rope, standing rope, or pendant (see Fig. 3-0.2.1.2-2).

high strength bolts: high strength tensile bolts used in the assembly of crane sections. The bolts are installed in tension, by torquing or other means, at a level greater than that produced by in- or out-of-service loads, for the purpose of reducing the likelihood of bolt fatigue failure.

in-service: the condition of a crane ready for or engaged in work; an operator is at the controls.

jib: the horizontal structural member attached to the rotating superstructure of a crane on which the load trolley travels when changing load radius.

jib point: the outward end of the load-bearing jib.

limiting device: a device that is operated by some part of a power-driven machine or equipment to restrict loads, or motions of the machine or equipment.

load: the total superimposed weight on the hook.

load block: the assembly of hook, swivel, sheaves, pins, and frame suspended by the hoisting rope.

luffing boom: a member hinged to the rotating superstructure that raises and lowers to change load radius and is used for supporting the hoisting tackle.

luffing boom stop: a device used to limit the angle of the luffing boom at the highest recommended position.

normal operating condition: a condition during which a crane is performing functions within the manufacturer's operating recommendations. Under these conditions, the operator is at the operating controls, and no persons other than those appointed are on the crane.

operational aid: a device that provides information to facilitate operation of a crane. Examples of such devices include, but are not limited to, the following: luffing boom angle or hook radius indicator, trolley radius indicator, load moment indicator, and wind velocity device.

out-of-service: the condition of a crane when unloaded, without power, with the controls unattended, and prepared to endure winds above the in-service level.

overturning moment: the summation of the individual moments that add to the tipping tendency of a crane about its fulcrum.

parking track: for rail-mounted cranes, a section of track supported so that it is capable of sustaining storm-induced bogie loads; it is provided with storm anchorages when required.

pawl (dog): a device for positively holding a member against motion in one or more directions.

pendant: a rope or bar of specified length with fixed end connections.

pitch diameter: the diameter of a sheave or rope drum measured at the centerline of the rope.

qualified person: a person who, by possession of a recognized degree in an applicable field or a certificate of professional standing, or by extensive knowledge, training, and experience, has successfully demonstrated the

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ability to solve or resolve problems relating to the subject matter and work.

radius (load): the horizontal distance from a projection of the axis of rotation to the base of the crane, before loading, to the center of the vertical hoist line or tackle with load applied.

rail clamp: a device for fastening a traveling crane to its rails to limit wind-induced travel.

rated load (load rating): the maximum allowable working load designated by the manufacturer; rated loads are expressed in pounds, kilograms, short tons, or metric tons.

reconfigure: the addition or deletion of jib, luffing boom, or counterjib sections while the crane is erected.

remote control: a radio or cable control device used to activate the crane control functions.

rope: refers to wire rope unless otherwise specified.

rotation-resistant rope: wire rope consisting of an inner layer of strands laid in one direction, covered by a layer of strands laid in the opposite direction; this has the effect of counteracting torque by reducing the tendency of the finished rope to rotate.

running ropes: rope that spools on/off drums.

shall: this word indicates that the rule is mandatory and must be followed.

sheave: a grooved wheel or pulley used with a rope to change the direction and point of application of a pulling force.

should: this word indicates that the rule is a recommendation, the advisability of which depends on the facts in each situation.

slewing moment: moment acting in a horizontal plane about the centerline of rotation, induced by the slewing and brake mechanisms of the crane.

structural competence: the ability of the machine and its components to withstand imposed stresses.

superstructure: that portion of the crane that rotates.

swing (slew): rotation of the superstructure for movement of loads in a horizontal direction about the axis of rotation.

tie-in: a structural support consisting of a collar that surrounds the tower that utilizes bracing to attach to the host structure.

tower: a vertical structural frame consisting of columns and bracing capable of supporting a superstructure with its working and dynamic loads and transmitting them to the supporting surface or structure.

trolley (load): the component of the crane that moves along the jib of a hammerhead tower crane and positions the load radially.

trolleying: the motion of the trolley on the jib to locate the load at a working radius.

two-blocking: the condition when the load block or hook assembly comes in contact with the trolley or luffing boom tip sheave.

unattended: a condition in which the operator of a crane is not at the operating controls.

weathervaning: releasing of the swing brakes to allow wind-induced rotation of a crane superstructure, when out-of-service, to expose minimal surface area to the wind.

wedge: a tapered device used to provide stability.

SECTION 3-0.3: REFERENCES (16)

The following is a list of standards and specifications mentioned in this Standard, showing the year of approval:

ANSI/ALI A14.3-2008, American National Standard for Ladders — Fixed — Safety Requirements

Publisher: American Ladder Institute (ALI), 330 North Wabash Avenue, Chicago, IL 60611 (www.americanladderinstitute.org)

ANSI/ASSE A1264.1-2007, Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrails Systems

Publisher: The American Society of Safety Engineers (ASSE), 520 N. Northwest Hwy, Park Ridge, IL 60068 (www.asse.org)

ANSI/NEMA Publication ICS-18-2001, Motor Control Centers

Publisher: National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Rosslyn, VA 22209 (www.nema.org)

ANSI/NFPA 70-2011, National Electrical Code

Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169 (www.nfpa.org)

SAE J2703, Oct 2008, Cranes Access and Egress

ANSI/SAE Z26.1-1996, American National Standard and Motor Vehicle Equipment for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways — Safety Standard

Publisher: SAE International, 400 Commonwealth Drive, Warrendale, PA 15096 (www.sae.org)

ASCE SEI 7-2010, Minimum Design Loads for Buildings and Other Structures

ASCE SEI 37-2002, Design Loads on Structures During Construction

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Publisher: American Society of Civil Engineers (ASCE), 1801 Alexander Bell Drive, Reston, VA 20191 (www.asce.org)

ASME B30.4-2015, Portal and Pedestal Cranes
ASME B30.5-2014, Mobile and Locomotive Cranes
ASME B30.9-2014, Slings
ASME B30.10-2014, Hooks
ASME B30.20-2013, Below-the-Hook Lifting Devices
ASME B30.23-2011, Personnel Lifting Systems
ASME B30.26-2015, Rigging Hardware
Publisher: The American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990 (www.asme.org)

AWS D1.1-2010, Structural Welding Code — Steel
AWS D14.3/D14.3M-2010, Welding Specifications for Earth Moving and Construction Equipment
Publisher: American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org)

EN 14439:2006+A2: 2009, Cranes — Safety — Tower Cranes
Publisher: DIN Deutsches Institut für Normung e. V., Am DIN-Platz, Burggrafenstraße 6, 10787 Berlin, Germany (www.din.de)

ISO 7296-1:1991, Cranes — Graphic symbols — Part 1: General
ISO 7296-2:1996, Cranes — Graphical symbols — Part 2: Mobile cranes
ISO 7296-3:2006, Cranes — Graphical symbols — Part 3: Tower cranes
ISO 7752-1:2010, Cranes — Control layout and characteristics — Part 1: General principles
Publisher: International Organization for Standardization (ISO), Central Secretariat, Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland (www.iso.org)

SECTION 3-0.4: PERSONNEL COMPETENCE (16)

Persons performing the functions identified in this Volume shall meet the applicable qualifying criteria stated in this Volume and shall, through education, training, experience, skill, and physical fitness, as necessary, be competent and capable to perform the functions as determined by the employer or employer's representative.

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Chapter 3-1
Erection, Climbing and Dismantling, Characteristics, and Construction

SECTION 3-1.1: DESIGN REQUIREMENTS FOR THE LOAD BEARING STRUCTURE

3-1.1.1 Verification of Strength and Stability

Calculation for proof of strength and stability of load-bearing tower crane structures shall be per EN 14439:2006+A2 Section 5.2.

3-1.1.2 Where Stability Governs Lifting Performance

(a) Each load rating shall be determined for the least stable configuration covered by the rating. For loads at any operating radius, stability is affected by the length of the jib or luffing boom, counterweight arrangement, and tower height and arrangement. The manufacturer shall take these configurations into account when establishing load ratings.

(b) Wind forces shall be determined using the maximum in-service wind velocity, as specified by the manufacturer or by a qualified person, and shall be applied in the direction least favorable to stability.

(c) For cranes designed to travel with load, inertial forces and forces induced by the maximum allowable track variation from level, as specified by the manufacturer or by a qualified person, shall be considered in establishing the load ratings.

(d) In addition to the above, the following stipulations shall apply to establishing the load ratings:

(1) Incipient tipping exists when the algebraic sum of the overturning (tipping) moments equals the sum of the stabilizing moments.

(2) The crane is mounted level, except as in para. 3-1.5(j)(1)(-c), but for those cranes that exhibit significant elastic deflection due to dead, live, wind, or dynamic loads, the effect of such deflections on stability shall be taken into account.

(3) Lifting attachments that are a permanent part of the crane in its working condition shall be considered part of the load for stability calculations, whether or not such attachments are a part of the published load ratings.

(4) The manufacturer or a qualified person may specify use of stabilizers or ballast to achieve stability.

(5) When stabilizers are required, the manufacturer's documentation for the crane shall describe the type of stabilizer to be installed, the means to install them, and whether they are for in-service, out-of-service, or backward stability needs.

(6) Out-of-service stability requirements may be satisfied by using ballast, but rail clamps shall not be used for this purpose.

3-1.1.3 Where Structural Competence Governs Lifting Performance

(a) For each stipulated operating radius, the manufacturer or a qualified person shall ascertain that the crane is capable of supporting the rated loads without stresses exceeding predetermined acceptable values. Dynamic effects associated with hoisting and slewing shall be considered. Wind shall be taken in the least favorable direction and at the maximum in-service velocity, as specified by the manufacturer or a qualified person.

(b) The manufacturer or a qualified person shall evaluate structural competence for the least favorable configuration and operating conditions covered by given load ratings. Under any condition of loading, stresses may also be affected by the jib or luffing boom length, counterweight arrangement, tower height and arrangement, hoist line reeving, and hoisting speed range.

(c) For cranes designed to travel with load, inertial forces and forces induced by maximum allowable track variation from level, as specified by the manufacturer or a qualified person, shall be considered in establishing structural competence.

(d) In addition to the above, the following stipulations shall apply to proof of competence determinations:

(1) The crane is mounted level, except as in para. 3-1.5(j)(1)(-c), but for those cranes that exhibit significant elastic deflection due to dead, live, wind, or dynamic loads, the effects of such deflections shall be taken into account.

(2) Lifting attachments that are a permanent part of the crane in its working condition shall be considered part of the load for rating calculation purposes, whether or not such attachments are a part of the published load ratings.

3-1.1.4 Out-of-Service Stability Requirements for Rail-Mounted Cranes

(a) Stability. The manufacturer or a qualified person shall demonstrate by calculation that in each permitted configuration, traveling cranes shall not become unstable when exposed to out-of-service wind forces.

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(b) Sliding. Cranes shall be evaluated for resistance to sliding along rails by the manufacturer or a qualified person with wind acting in the least favorable direction. Calculations shall demonstrate crane traveling resistance sufficient to forestall sliding. Rail clamps or other wind anchorage mechanisms may be provided to forestall sliding.

3-1.1.5 Design Wind Velocity

(a) Temporary Construction Tower Cranes (Less Than 5 yr)

(1) The design out-of-service wind velocity shall be appropriate to the installation site as given in ASCE/SEI 7. Reductions for the short-term duration of a temporary installation can be taken into account per ASCE/SEI 37.

(2) The manufacturer shall furnish recommendations on permitted crane configurations at the various wind velocity levels specified in ASCE/SEI 7 for the geographical region.

(3) Out-of-service stability requirements may be satisfied by using stabilizers or ballast when necessary, but rail clamps shall not be used for this purpose on rail traveling cranes.

(b) Permanently Mounted Tower Cranes (Longer Than 5 yr)

(1) The design out-of-service wind velocity shall be appropriate to the installation site as given in ASCE/SEI 7.

(2) The manufacturer shall furnish recommendations on permitted crane configurations at the various wind velocity levels specified in ASCE/SEI 7 for the geographical region.

(3) Out-of-service stability requirements may be satisfied by using stabilizers or ballast when necessary, but rail clamps shall not be used for this purpose on rail traveling cranes.

SECTION 3-1.2: SITE PLANNING

(a) Prior to erection, a qualified person shall prepare a site plan, including drawings, that defines the following for each crane:

(1) location of the crane base support, indicating the centerline of the tower and elevation of the top of the base support

(2) orientation of the base tower, if applicable, for climbing

(3) lengths of the jib or luffing boom, counterjib, and tail swing

(4) maximum working radius of the jib or luffing boom

(5) structures that are inside of or within 6 ft, 6 in. (2 m) of the end of the jib or luffing boom

(6) known hazards, including, but not limited to, power lines, train or light rail tracks, occupied structures within the working radius of the crane, restricted air space, areas accessible to pedestrians, public roadways and streets, and subsurface constructions

(7) working radii of other tower cranes and material placement booms, and the location of construction hoists, on the same site or adjacent sites that may interfere with the planned operation of the crane

(8) the crane's electrical requirements, indicating the voltage, amperage, phasing, grounding, and any other electrical information specific to the crane

(b) Consideration shall be given to the geographic location at which the crane is to be erected with regards to

(1) wind in accordance with para. 3-1.1.5.

(2) ambient temperatures, both minimum and maximum.

(3) salinity, chemical, or other adverse environmental conditions.

(4) soil and ground conditions.

(5) The location and size of all excavations in the proximity of foundations, supports, and rail supports that could affect the stability of the crane shall be evaluated and approved by a qualified person.

SECTION 3-1.3: CRANE BASE SUPPORTS

(a) Crane base supports shall be designed, constructed, and installed to support the loads applied by the crane during in-service and out-of-service conditions and be able to transmit these loads to the supporting medium. With the exception of cranes mounted on static or traveling undercarriages, all supports shall be designed to resist the maximum overturning moment created by the crane operations and out-of-service conditions, when acting at the support.

(b) Anchoring blocks for guys, when used, shall be anchored or arranged so that their resistance to lateral movement, pullout, or overturning is a minimum of 150% of the anticipated force applied by the crane operations.

(c) Rails shall be attached to their supports in a manner that is capable of resisting the horizontal loads as determined by the crane manufacturer or by a qualified person.

(d) Splices in rail tracks shall have rail head mating surfaces that are sufficiently smooth so as to not adversely impact the operation of the crane.

(e) When required by the site plan, a section of the track shall be designated, arranged, and constructed as an out-of-service parking area. This track section shall have the means needed for supporting the crane against storm wind effects as well as anchoring it against unwanted movement along the track. The out-of-service parking area shall be constructed before erection commences.

(f) The crane manufacturer or a qualified person shall provide the crane's maximum resulting loads at the base

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of the crane, or corner loads, for use in design of the crane base supports [see para. (a) above].

(g) Crane base supports shall be designed by a qualified person. Prior to finalizing the base support design, the crane support designer shall communicate with the crane manufacturer or qualified person who provided the crane loading data and determine that they have a correct understanding of the nature, source, and variability of the loads to be used in the final design if not provided under para. (f) above.

(h) Foundations and supports shall be designed to withstand the vertical and horizontal loads created by the crane, as well as overturning and slewing moments provided under para. (f) above. Consideration shall be given to the bearing capacity of the supporting medium and the ability of the medium to support loads that vary in direction and magnitude. The potential for differential settlement or structure deflections shall be considered in the design of the support to ensure the crane remains within specified vertical tolerances. Except when specifically designed for submerged applications, supports shall be above the water table and shall have sufficient drainage.

(i) The base support shall be accessible and free of debris, materials, and standing water. No materials shall be stored on the support unless approved by a qualified person.

SECTION 3-1.4: GENERAL ERECTION AND DISMANTLING REQUIREMENTS

(a) When cranes are erected/dismantled, written instructions by the manufacturer or qualified person, including a list of the weights of each crane component to be erected/dismantled, shall be available at the site.

(b) Dismantling of the crane and its tie-ins shall be planned by a qualified person prior to the initial crane erection to ensure sufficient clearance is available for dismantling once the building structure is completed.

(c) Crane erection and dismantling shall be performed under the direct supervision of a designated person.

(d) Written procedures shall be developed before erection/dismantling work commences that implement the erection/dismantling instructions and adapt them to the particular needs of the site. The need for temporary or permanent guying or bracing shall be considered in these procedures.

(e) A designated person shall instruct the erection personnel in the means of identifying and installing special devices, hardware, and high strength bolts used in the crane's erection.

(f) High strength bolts used in connections shall be installed and tensioned in accordance with the crane manufacturer's or a qualified person's instructions.

(g) Bolt tensioning and torquing devices used in the crane erection shall be calibrated in accordance with the device manufacturer's instructions.

(h) Before installing fasteners such as bolts, nuts, or pins, they shall be visually inspected for cracks, necking down, thread deformation, and difficulty in threading a nut by hand. The existence of any of these conditions is reason for rejection of the fastener for further use. Nondestructive testing should be considered to determine if cracks are present in connecting material. Proper size and grade markings shall be verified and the fastener rejected if these are not present and legible.

(i) Crane components shall be loaded for shipping using rigging, blocking, and truck securement methods defined by the manufacturer or a qualified person. Softeners shall be used where appropriate to minimize the possibility of damage to crane components.

(j) Before crane components are erected, they shall be visually inspected by a designated person for damage from shipping and handling. Damaged structural members shall not be erected until evaluated by a qualified person and, if necessary, repaired or replaced in accordance with the manufacturer's or a qualified person's instructions.

(k) Slings and lifting accessories shall be selected and arranged so as to avoid damaging crane components during erection and dismantling. The attachment points, lifting slings, and accessories shall be in accordance with the manufacturer's or a qualified person's instructions. Lifting devices specified and provided by the manufacturer shall be used unless an alternate method is approved by the manufacturer or a qualified person. Rigging components used shall be in accordance with ASME B30.9, B30.10, B30.20, and B30.26, as applicable.

(l) Prior to and during erection/dismantling operations, consideration shall be given to conditions that may adversely affect the operation. These conditions include but are not limited to the following:

(1) poor ground support conditions for any support crane

(2) wind velocity and gusting winds

(3) rain

(4) lightning

(5) ice or snow

(6) fog

(7) excessive temperatures

(8) inadequate lighting

(m) The base tower section shall be erected to meet the plumbness tolerance specified in the manufacturer's or a qualified person's instructions. Freestanding tower sections shall be verified as plumb before erecting components of the crane above the top tower section. Shims shall not be used to achieve plumbness unless they are approved by and installed in accordance with the manufacturer's or a qualified person's instructions.

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(n) Unless provisions to secure the crane's swing are provided and approved by the manufacturer or a qualified person, the crane shall be configured to weathervane when placed out-of-service. The freely rotating crane shall be able to swing through a complete 360-deg arc with a minimum clearance from obstructions of 6 ft, 6 in. (2 m).

(o) Signs, panels, storage boxes, structures, or enclosures not provided by the manufacturer shall not be installed on the crane unless their size and positioning are in accordance with the manufacturer's or a qualified person's instructions.

(16) SECTION 3-1.5: FREESTANDING CRANES

(a) Cranes shall be installed on bases that comply with the manufacturer's or a qualified person's instructions.

(b) Crane base supports shall be installed in accordance with the manufacturer's or a qualified person's instructions.

(c) The base tower section should be installed with the foundation anchors attached to the section. Shims shall not be used to achieve plumbness unless they are approved by and installed in accordance with the manufacturer's or a qualified person's instructions.

(d) When templates are used to position foundation anchors, they shall be rigid and built within tolerances that replicate the base tower section.

(e) The base section or template shall be oriented as established in the erection plan.

(f) Leveling nuts shall not be used under base plates when the anchor bolts are to be prestressed.

(g) Before the placing of concrete for the crane support, a qualified person shall inspect the location and verify the installed reinforcement and the placement of crane support anchors conform with the foundation design.

(h) Support anchors used shall be supplied by the crane manufacturer or they shall be designed and manufactured by qualified persons. When support anchors are designed and/or fabricated by entities other than the crane manufacturer, the entities that design and fabricate the foundation anchors shall

(1) verify by analysis that the anchors meet the configuration and strength specified by the crane manufacturer

(2) permanently mark each anchor with the following information:

(-a) the manufacturer's name and address

(-b) the date of manufacture

(-c) a unique serial number

(3) nondestructively test each support anchor in accordance with the instructions of the qualified person and retain on file the records of this test, including the mill test reports for the steel used for fabrication

(i) Embedded concrete support anchors shall not be excavated and reused. Cranes can be re-erected on existing embedded concrete support anchors when approved by the manufacturer or a qualified person.

(j) Crane base supports made of steel or rails shall be designed and installed in accordance with the crane manufacturer's or a qualified person's instructions.

(1) For rail traveling cranes,

(-a) traveling crane bases shall be ballasted in accordance with the manufacturer's instructions.

(-b) provisions shall be made to prevent traveling bases from rolling on the track during out-of-service wind conditions.

(-c) rails shall be level and straight in accordance with the manufacturer's or a qualified person's specifications, unless designed for curves or grades. Rails shall be spaced for the crane bogies in accordance with the manufacturer's or a qualified person's specifications.

(-d) the track and support system shall have sufficient rigidity to limit dynamic oscillations, lateral displacement, and deviations from plumb to within the manufacturer's allowable limits.

(-e) rails shall be electrically grounded.

(-f) both ends of all rail runways shall be provided with stops or buffers adjusted to ensure simultaneous contact with both rail travel bogies. Stops attached to rails shall be in accordance with the manufacturer's or a qualified person's specifications.

(2) For cranes mounted to steel structures,

(-a) the base tower section should be installed with the steel framework to ensure proper alignment. Use of shims is not permitted to achieve plumbness unless they are approved by and installed in accordance with the manufacturer's or a qualified person's instructions.

(-b) when templates are used to position steel frame attachments, they should be rigid and built to tolerances that place all tower leg bearing surfaces in the same horizontal plane.

(-c) the base section or template shall be oriented as specified in the erection plan.

(-d) before erecting the crane, a qualified person shall inspect the installed steel structure to ensure conformity with the design of the support system.

(k) Cranes shall be erected to a freestanding height no greater than that specified by the crane manufacturer or a qualified person. A reduction in the freestanding height should be considered when erected in seasonal high wind zones as specified by ASCE/SEI 7. The manufacturer or qualified person shall determine acceptable heights that conform to codified wind loads as prescribed in para. 3-1.1.5.

(l) Climbing operations, when required as part of the initial crane erection, shall be in accordance with the manufacturer's written instructions and performed under the direct supervision of a designated person.

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SECTION 3-1.6: CLIMBING CRANES

Climbing operations shall be performed in accordance with the manufacturer's or a qualified person's instructions and under the direct supervision of a designated person.

(a) All-load bearing members of the climbing and support system shall be visually inspected before each climbing operation. Deficiencies found that may impair the ability of a member to support all loads to which it will be subjected shall be repaired or replaced in accordance with the manufacturer's or a qualified person's instructions before climbing operations begin.

(b) Before climbing, an inspection shall be made of the tower to confirm that there are no obstructions to the free movement of the crane. Obstructions shall be cleared before the climbing operation commences.

(c) Before climbing, cranes shall be placed in the configuration for climbing and balanced as specified by the manufacturer or a qualified person.

(d) At the time of climbing, the maximum wind velocity above the highest tower section shall not exceed the limit set by the crane manufacturer or a qualified person. The effects of wind gusts on climbing operations shall be considered.

(e) Before climbing operations commence, the weather forecast shall be considered by a designated person and a determination made as to the advisability of starting the operation.

(f) Where specific measures are needed to protect the crane from extreme adverse weather, such as hurricanes, the manufacturer or a qualified person shall prepare detailed written instructions as part of the erection plan. This plan shall be on the job-site and shall address the time and personnel requirements needed to carry out the specified protection measures.

3-1.6.1 Top Climbing Cranes

(a) A climbing and tie-in schedule shall be prepared prior to the crane's installation and shall be in accordance with the crane manufacturer's or a qualified person's instructions. This schedule shall indicate

(1) each level at which the crane is to be tied-in

(2) the number of tower sections to be installed at each climb

(3) the maximum tower height to be erected above each tie-in

(4) the operational crane height after each climb

(5) the maximum height to which construction can reach at each crane height before the crane must be climbed

(6) there is sufficient clearance for the climb-down procedure once the structure is completed

(7) the in-service and out-of-service wind conditions

(b) The maximum and minimum vertical spacing between the tie-ins, and the freestanding height of the crane above the topmost tie-in, shall be in accordance with the manufacturer's or a qualified person's instructions. Wind loads for in-service as well as out-of-service conditions shall be in accordance with para. 3-1.1.5(b)(1).

(c) A qualified person shall verify that the host structure to which the crane is attached is strong enough to sustain the forces imposed through the tie-ins and anchorages.

(d) Areas to which the tie-ins are to be anchored shall be inspected for conformity with the planned design prior to the placing of concrete.

(e) If the concrete material used at the tie-in anchor differs in structural properties from adjacent parts of the structure where the tie-in is anchored, the concrete strength shall be tested prior to installing the tie-in to verify it conforms to that specified in the plans.

(f) Cranes shall not be tied-in to concrete structures until the concrete at the areas where the crane's forces are introduced has been verified by testing to have sufficient strength.

(g) Before climbing the crane, a qualified person shall inspect installed structural steel used to attach the tie-in to the structure to ensure conformity with the design.

(h) Rigid collars for tie-ins shall be installed only at those locations on a tower section that have been designated or approved by the manufacturer to receive them. If reinforcing of the tower is required, it shall be in accordance with the manufacturer's or a qualified person's instructions. Horizontal cross bracing of the tower section, if used, shall be attached so as not to be dislodged due to the movements of the tower during normal operating conditions.

(i) Wedging systems shall be provided with means to prevent the wedges from working loose or from falling from the crane.

(j) Supports made of wire rope or steel shall be installed to prevent the tie-in collar from sliding down the tower. The supports shall be secured at designated locations on the tower and in accordance with the instructions of the crane manufacturer or qualified person.

(k) Tie-ins shall be designed and anchored to the host structure to resist the horizontal forces applied in any direction, as specified by the crane manufacturer or a qualified person.

(l) If load-bearing connections are used to anchor the tie-ins to a concrete structure, the bearing capacity of the structure shall remain within its allowable bearing capacity limits. This condition shall be verified prior to the installation of the connection.

(m) The bolts or threaded rods of a load-bearing connection shall be pretensioned to the value specified by the manufacturer or a qualified person.

(n) If a friction connection is used to anchor a tie-in to a concrete structure, the instructions for the connection installation shall specify the required bolt tensions

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and/or torque values, inspection procedures, inspection schedules, and re-torquing procedures required to ensure that the necessary clamping force is maintained.

(o) During installation of a tie-in, the crane shall be balanced in accordance with the manufacturer's or a qualified person's instructions.

(p) After the installation of a tie-in, the crane's plumbness shall be verified for its compliance with the manufacturer's or a qualified person's specifications.

(q) Installations requiring guys shall be designed by the crane manufacturer or a qualified person.

(r) Guys, when used as tie-ins, shall be pretensioned to the force level specified by the crane manufacturer or a qualified person and a means to verify the tension shall be provided.

(s) Guys, when used, shall have a means to adjust their tension and to plumb the crane tower while the crane is balanced.

(t) Markers shall be placed on guys to make them clearly visible to ground personnel and from the operator's station.

(u) Guy attachments at the tower shall be accomplished so as not to

(1) damage tower members.

(2) introduce eccentric loadings to the tower.

(3) distort the tower cross section. Cross-bracing in the tower section, if used, shall be attached in a manner that will not permit dislodgement.

(v) Guys shall be attached at their lower ends to anchorages designed by the crane manufacturer or a qualified person. [see para. 3-1.3(b)].

(w) Climbing frames, when left installed on the tower, shall be kept at the lowest point above the uppermost tie-in when not in use, unless other locations are approved by the crane manufacturer or a qualified person.

3-1.6.2 Internal Climbing Cranes

(a) A climbing and support system schedule shall be prepared in advance of the crane's installation and be in accordance with the manufacturer's or a qualified person's instructions. This schedule shall include

(1) each level of the host structure at which the crane is to be supported

(2) wedging locations on the tower

(3) the maximum tower height permitted above the upper brace

(4) the operational hook height after each climb

(5) the minimum permissible clearance to the structure before the crane must be climbed

(6) shoring and reinforcing requirements, if necessary

(7) floor opening dimensions

(b) The means of transferring horizontal and vertical crane reaction forces to the host structure shall be approved by a qualified person.

(c) The maximum and minimum vertical spacing between the crane tower supports, and the height of the crane above the uppermost support, shall be in accordance with the manufacturer's or a qualified person's instructions.

(d) Cranes in concrete structures shall not be climbed until the concrete at the areas where the crane's forces are introduced has been verified by testing to have sufficient strength.

(e) Cranes in steel structures shall not be climbed until the required supports and bracing, at all levels where the crane's forces are introduced, have been verified for proper installation by a qualified person.

(f) Prior to climbing, the integrity of the host structure shall be reviewed by a qualified person for the effects of the crane, load, and wind forces at each level of the structure.

(g) Wedging systems shall be provided with means to prevent the wedges from working loose or from falling from the crane. Wedging systems shall be installed in accordance with the manufacturer's or a qualified person's instructions.

(h) Wedges shall be installed only at those locations of the tower that are designed to receive them or where provisions have been made for wedging in accordance with the manufacturer's or a qualified person's instructions.

(i) Initially, and after each climb, the crane tower shall be plumbed while balanced as specified by the crane manufacturer or a qualified person and then secured in the plumbed condition.

SECTION 3-1.7: PREOPERATION TESTS

Preoperation tests shall be performed after a crane is erected, climbed, altered, or modified and before the crane is placed into service. During preoperation tests, if an indication of unsatisfactory performance of any function is observed, further testing should be discontinued until a qualified person has determined that the crane's performance and condition are satisfactory for continued testing. If load testing is required, the load shall be freely suspended.

(a) After a crane is erected and before being placed into service, the folowing is required:

(1) Functional motions, motion limiting devices, and brakes shall be tested for satisfactory operation.

(2) Functional motion tests made after erection shall be performed in the following order:

(-a) functional motion tests without load

(-b) functional motion tests at rated load [for other-than traveling cranes, this may be combined with tests of supports per para. (b) below]

(b) The structural supports or foundation to which the crane base is attached shall be tested. If any part of the support structure becomes displaced or distressed

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during testing, all crane operations shall stop- until an evaluation is made by a qualified person.

(1) For static mounted cranes, the test shall be conducted with a rated load along the load curve, placed at the maximum radius permitted by site conditions, and the crane rotated slowly through 360 deg. If site conditions do not permit a 360-deg rotation with load, those portions of the test shall be performed with no load (luffing boom cranes with luffing boom at minimum radius).

(2) For traveling cranes, load tests shall be conducted with the jib, luffing boom, or counterjib in the position creating the maximum loading on a single wheel or bogie. The test shall comprise traveling the entire length of the runway so as to test each rail with a single wheel or bogie under maximum load. If any runway support becomes displaced or damaged, crane operations shall stop until a qualified person determines that the condition or repair is satisfactory before proceeding.

(3) The testing shall continue until all controls, drives, and braking means have been verified as having functioned correctly. Devices tested shall include

(-a) load block hoisting and lowering

(-b) luffing boom hoisting and lowering, or trolley traversing

(-c) swinging of the upper structure

(-d) brake and clutch functioning

(-e) limit, locking, and safety device functioning

(-f) load-limiting devices to verify their proper setting and operation

(4) After a crane is climbed and before being placed into service, the following is required:

(-a) Functional motions, motion limiting devices, and brakes shall be tested for satisfactory operation.

(-b) Functional motion tests made after climbing shall be performed without load.

(-c) Testing shall verify that all controls, drives, and braking means function correctly. Devices tested shall include

(-1) load block hoisting and lowering

(-2) luffing boom hoisting and lowering, or trolley traversing

(-3) swinging of the upper structure

(-4) brake and clutch functioning

(-5) limit, locking, and safety device functioning

(-6) load-limiting devices to verify their proper operation

(5) The structural supports to which the crane is attached shall be tested. If any part of the support structure becomes displaced or distressed during testing, all crane operations shall stop until an evaluation is made by a qualified person. The test shall be conducted with a rated load along the load curve, placed at the maximum radius permitted by site conditions, and the crane rotated slowly through 360 deg. If site conditions do not permit a 360-deg rotation with load, those portions of the test shall be performed with no load and the counterjib over the side being tested (luffing boom cranes with luffing boom at minimum radius).

SECTION 3-1.8: ALTERED OR MODIFIED CRANES

The following requirements shall be met when cranes are altered or modified:

(a) The alteration or modification shall be performed by or approved by the manufacturer or, in the absence thereof, a qualified person.

(b) The manufacturer should reply in writing to requests for modifications, alterations, or deviations. If the manufacturer reviews the request and provides a written denial based on technical merit, approval from a qualified person shall not be obtained to override the manufacturer's denial. The written denial shall include details specific to the technical reasoning supporting the denial.

(c) Signed and dated copies of the calculations, drawings, and other documents prepared for the alteration or modification shall be maintained by the owner of the crane.

(d) The alteration or modification shall comply with the applicable requirements of this Volume.

(e) The crane shall be tested in accordance with paras. 3-1.7(a) and (b), with records kept. The records shall include a description of the tests performed, the rationale for selecting those test conditions, the date and weather conditions at the time of testing, and the signature of the qualified person who supervised the tests.

SECTION 3-1.9: DOCUMENTATION

(a) Documentation shall be provided in English. Non-English documentation shall be translated into English in accordance with the following guidelines:

(1) The wording of written non-English safety information and manuals regarding use, inspection, and maintenance shall be translated by professional translation industry standards, which include, but are not limited to

(-a) translation of the complete paragraph message, instead of word by word

(-b) grammatically accurate

(-c) respectful of the source document content without omitting or expanding the text

(-d) accurate translation of terminology

(-e) reflecting the level of sophistication of the original document

(2) The finished translation shall be verified for compliance to paras. (a)(1)(-a) through (a)(1)(-e) by a qualified person having an understanding of the technical content of the subject matter.

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(3) Pictograms used to identify controls shall be described in the manuals. The pictograms should comply with ISO 7000, ISO 7296, or other recognized source, if previously defined. The text of the description shall meet the criteria of paras. (a)(1) and (a)(2).

(b) Any non-English documentation provided in addition to English shall be translated and reviewed in accordance with the requirements listed above.

3-1.9.1 Informational Literature

Each crane shall be provided with informational literature in accordance with Section 3-1.9 including, but not limited to, information on the following:

(a) installation preparation instructions, which shall provide

(1) vertical and horizontal component forces, and torsional and overturning moments applicable to each recommended configuration. The data shall indicate whether governing forces are due to in-service or out-of-service winds in accordance with para. 3-1.1.5. For traveling cranes, the data can be stated in terms of wheel or bogie loads.

(2) maximum wind velocity for which traveling cranes possess adequate resistance to sliding in each permitted configuration and precautions that must be taken to secure cranes installed in geographical areas of higher wind velocity.

(3) stabilizer, counterweight, and ballast requirements.

(4) the minimum and maximum distance between horizontal reaction support levels for internal climbing cranes.

(5) the minimum and maximum distance between tie-ins for top climbing cranes, including the maximum height above the uppermost tie-in.

(6) locations where internal climbing, wedging, and external climbing tie-in collar installations can be accommodated, including any required internal bracing of the tower.

(7) rail track installation requirements and tolerances for traveling cranes.

(8) foundation anchorage arrangements for cranes to be installed on fixed concrete bases.

(9) crane dimensional data including component weights.

(b) erection, climbing, and dismantling instructions that provide

(1) weights and dimensions for components and subassemblies

(2) tower height limitations based on out-of-service wind conditions in accordance with para. 3-1.1.5

(3) available jib configurations

(4) specific counterweight and ballast requirements for each configuration

(c) recommended lifting attachment points.

(d) the method and sequence of assembly and disassembly of components and subassemblies. Warnings shall be given alerting erection personnel when member strength or stability requires particular methods or sequencing.

(e) details, including diagrams where necessary, of critical component connections, describing and identifying bolts, pins, and other parts needed, the method of assembling the joint, the torque or tension to be applied to prestressed bolts, the specific step in the erection process for applying torque or tension, and the means for retaining pins in their installed location.

(f) the method and sequence for installing structural supports, braces, counterweights, and ballast.

(g) operating instructions, limitations, and precautions.

(h) proper use of radio remote controls if so equipped.

(i) maintenance requirements and recommendations, including proper settings, adjustments, and functioning of all mechanical drives and systems, and identification of those members or locations that require periodic observation, or testing, for the purpose of detecting the onset of metal fatigue, the loosening of prestressed bolts, or wear affecting the ability of the crane to support rated loads.

(j) repair instructions including specific welding procedures. The type of material used for load-sustaining members shall be specified (see para. 3-1.24.5).

(k) design characteristics affecting safety, such as

(1) location, proper settings and adjustments, and functioning of limiting and indicating devices

(2) high and low ambient temperature limitations

(3) electrical power supply requirements, including permitted variations in electrical supply

(4) location and required settings of hydraulic or pneumatic pressure relief valves and locations of points where circuit pressures can be checked (see para. 3-1.24.9)

3-1.9.2 Load Rating Chart

A durable load rating chart in accordance with Section 3-1.9 with legible letters and figures shall be provided with each crane and attached in a location visible to the operator while at the controls. These charts shall contain the following at a minimum:

(a) For each jib or luffing boom configuration

(1) load ratings throughout the permissible range of operating radii

(2) jib or luffing boom lengths

(3) hoist line reevings

(4) capacity for each available hoist gear

(5) counterweight arrangement

(b) Cautions, warnings, and notes relative to crane limitations and operating procedures.

(c) Maximum permissible in-service wind velocity.

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(d) If the load block is considered a part of the load, the load rating chart shall so state.

(e) If the weight of hoist ropes beyond a stated suspended length is to be considered as part of the load, the load rating chart shall so state.

SECTION 3-1.10: LOAD HOIST AND LUFFING BOOM HOIST MECHANISMS

3-1.10.1 General Requirements

(a) Load and luffing boom hoist drives shall be provided with a clutch or power-disengaging device unless directly coupled to an electric or hydraulic motor power source.

(b) Generators used to power electric motor operated cranes shall be properly sized, or other means provided, to prevent an uncontrolled lowering of the luffing boom or load.

(c) Overspeed protection shall be provided for hoist and luffing boom mechanisms.

(d) Luffing Boom Hoists

(1) Luffing boom hoist systems shall be capable of raising the luffing boom and holding it stationary without attention from the operator under all operating conditions.

(2) Luffing boom hoist systems shall be capable of lowering the luffing boom and rated load only under power control; luffing boom free-fall lowering capability shall not be furnished.

(3) Luffing boom hoists powered by hydraulic cylinders shall be provided with an integrally mounted holding device (such as a load hold check valve) to prevent uncontrolled lowering of the luffing boom in the event of a hydraulic system failure (e.g., supply hose rupture).

(4) Luffing boom stops shall be provided to prevent luffing booms from exceeding the maximum luffing boom angle. An alternate means shall be provided to move the luffing boom forward from this position if gravity is not sufficient.

3-1.10.2 Hoist Drums

(a) The end of the rope shall be securely attached to the drum as recommended by the crane or rope manufacturer or by a qualified person.

(b) Drum flanges shall extend a minimum of one-half rope diameter but not less than $\frac{1}{2}$ in. (13 mm) above the top layer of rope during operation.

(c) The diameter of the drum shall be sufficient to provide a first layer rope pitch diameter of not less than 18 times the nominal diameter of the rope used.

(d) No less than three full wraps of rope shall remain on the load hoist drum(s) when the hook is in its extreme lowest position.

(e) No less than three full wraps of rope shall remain on the luffing boom hoist drum(s) when the luffing boom is at maximum permissible radius.

(f) Load hoist drums and luffing boom hoist drums shall be provided with a positive holding device, such as ratchets and pawls, unless directly coupled to electric or hydraulic drives.

(g) Positive holding devices shall be controllable from the operator's station, hold the drums from rotating in the lowering direction, and be capable of holding the rated load indefinitely, or holding the luffing boom and rated load indefinitely, as applicable, without further attention from the operator.

(h) Load hoist drums and luffing boom hoist drums shall be provided with drive mechanisms to ensure that lowering shall be done only under power control.

3-1.10.3 Brakes

(a) Luffing boom hoists that utilize ropes, and all load hoists, shall be equipped with at least one braking means that is capable of providing a minimum of 125% of the full load hoisting torque at the point where the braking is applied. A secondary emergency brake shall be provided on the luffing boom hoist drum for use in the event of a main drive failure or overspeed condition.

(b) Each load hoist and luffing boom hoist mechanism shall be equipped with braking means capable of providing controlled lowering speeds. Worm-geared hoists with a worm angle adequate to prevent the load (or the luffing boom and load, in the case of luffing boom hoists) from accelerating in the lowering direction are exempted from this requirement.

(c) When power operated brakes having no continuous mechanical linkage between the actuating and the braking means are used for controlling the load hoist or the luffing boom hoist, an automatic means shall be provided to stop and hold the load (or the luffing boom and load, in the case of the luffing boom hoist) in the event of loss of brake actuating power.

(d) When directly coupled electric or hydraulic motor(s) is used for controlling the load hoist or the luffing boom hoist, an automatic means shall be provided to stop and hold the load (or the luffing boom and load, in the case of luffing boom hoist) in the event of loss of power or pressure.

(e) When automatically applied braking means are provided, a means, such as a manual release, should be furnished to permit controlled lowering of the load (or the luffing boom and load in the case of a luffing boom hoist) in the event of loss of power or pressure.

(f) If provided, foot brake pedals shall be constructed so that the operator's feet will not readily slip off, and a means shall be provided for holding the brakes in the applied position without further attention by the operator.

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3-1.10.4 Sheaves

(a) Sheave grooves shall be free from surface conditions that could cause rope damage. The cross-sectional radius at the bottom of the groove should be such as to form a close-fitting saddle for the size of rope used. The sides of the groove shall be tapered outward and rounded at the rim to facilitate entrance of the rope into the groove. Flange rims shall run true about the axis of rotation.

(b) Sheaves carrying ropes that can become momentarily unloaded shall be provided with close-fitting guards or other suitable devices to guide the rope back into the groove when a load is reapplied.

(c) Sheave bearings shall be provided with means for lubrication, except for those with permanently lubricated bearings.

(d) The pitch diameters of the load block sheaves shall not be less than 18 times the nominal diameter of the rope used. The pitch diameters of luffing boom hoist sheaves shall not be less than 15 times the nominal diameter of the rope used.

(e) The sheaves in the load block shall be equipped with close-fitting guards that will guard against ropes becoming fouled when the block is lying on the ground with ropes loose.

3-1.10.5 Running Ropes

(a) All ropes shall be of constructions recommended for their service by the crane or rope manufacturer or by a qualified person.

(b) The design factor for load hoist ropes shall not be less than 5.

(c) The design factor for luffing boom hoist ropes shall not be less than 3.5.

(d) Design factors shall be the total minimum breaking force of all the supporting ropes divided by the static load imposed on those ropes when supporting their maximum loads.

(e) For ambient temperatures at the rope in excess of 180°F (82°C), rope having an independent wire rope or wire strand core, or other temperature damage resistant core, shall be used.

(f) If a load is supported by more than one part of rope, the tension in the parts shall be equalized.

(g) Socketing shall be done in the manner specified by the manufacturer of the wire rope or fitting.

(h) Rotation-resistant ropes shall not be used for luffing boom hoists.

SECTION 3-1.11: HOOKS

(a) Load hooks shall meet the requirements of ASME B30.10.

(b) Hooks shall be equipped with latches unless the application makes the use of the latch impractical. When provided, the latch shall be designed to retain such items as, but not limited to, slings and rigging hardware under slack conditions in accordance with ASME B30.10.

SECTION 3-1.12: SLEWING (SWING) MECHANISM

3-1.12.1 General Requirements

(a) The swing mechanism shall be capable of smooth starts and stops and of providing variable degrees of acceleration and deceleration.

(b) Cranes required to weathervane when out-of-service shall be equipped with means to render the rotating superstructure free to rotate. Those means shall be accessible to the operator while on the superstructure or, if so equipped, at a station at the base of the crane.

3-1.12.2 Slewing Brakes

(a) A braking means with holding power in both directions shall be provided to prevent movement of the rotating superstructure against in-service winds and shall be capable of being set in the holding position and remaining so without further action on the part of the operator.

(b) Brakes shall apply automatically if electrical power or actuating force to the brake is lost.

SECTION 3-1.13: TRAVEL EQUIPMENT

3-1.13.1 General Requirements

(a) Travel drives shall be capable of smooth starts and stops, and of providing variable degrees of acceleration and deceleration.

(b) Cable spooling devices shall be provided to prevent the power cable from being dragged along the ground.

(c) An audible signal shall automatically sound continuously whenever the crane travels, in order to warn persons in the vicinity.

3-1.13.2 Travel Bogies (16)

(a) Crane bogies shall be fitted with sweeps placed at each end of the bogie and extending below the top of the rail, unless the construction of the rail foundation prohibits such extension.

(b) Bogie wheels shall be guarded.

(c) Means shall be provided to limit the drop of bogie frames to a distance that will not cause the crane to overturn in case of wheel or axle breakage.

3-1.13.3 Travel Brakes

(a) Braking means shall be provided to hold the crane in position when not traveling and to lock the wheels against rotation to resist the effects of in-service wind and operational forces.

(b) Brakes shall automatically engage on loss of electrical power or actuating force to the brake.

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(c) When a crane is out-of-service, means shall be provided to lock the wheels against rotation to resist the effects of wind as stipulated by the manufacturer or a qualified person. In the event that friction between locked wheels and rails is insufficient to restrain the crane from movement, rail clamps or other means shall be provided as recommended by the manufacturer or a qualified person.

SECTION 3-1.14: CLIMBING EQUIPMENT

(a) Cranes that climb on ladders shall be provided with guides to hold the ladders in position for engagement of the climbing dogs.

(b) Hydraulic Systems

(1) Hydraulic cylinders used to support the crane during climbing shall be equipped with check valves to hold the crane in the event of power failure, pressure failure, or a ruptured line.

(2) Check valves shall be integrally mounted to the cylinder.

(3) The hydraulic system shall be provided with pressure gage(s) and overpressure relief valve(s).

(c) Positive means shall be provided to hold the raised portion of the crane in position at the completion of an intermediate climbing step and at the position where the crane will be put back into service. Pressurized hydraulic cylinders shall not be used to support the crane when in service.

(d) Wedges, when used, shall be provided with means to hold them in place and prevent them from becoming dislodged.

(e) Ropes, when used for, or in conjunction with, climbing shall be equalized and shall have a minimum breaking force not less than 3.5 times the load applied to the rope. Means shall be provided to minimize the possibility of the climbing motion being hindered during raising and lowering.

SECTION 3-1.15: TROLLEYS (LOAD)

(a) Trolleys shall be capable of smooth starts and stops, and of providing variable degrees of acceleration and deceleration when traversing the jib during operations.

(b) Both ends of the jib shall be equipped with trolley stops or buffers.

(c) The body or frame of the trolley shall be fitted with means to restrain the trolley from becoming detached from its guide rail(s) in the event of trolley wheel or axle breakage or side loading.

(d) The trolley shall be provided with an operating brake capable of stopping the trolley in either direction. The braking system shall include means for holding the trolley without further action on the part of the operator, and shall engage automatically if power or pressure to the brake is lost.

(e) In addition to the operating brake, the trolley shall be equipped with an automatic braking device capable of stopping the outward movement of the trolley in the event of trolley drive rope breakage.

SECTION 3-1.16: BRAKES

(a) Brakes shall be arranged to permit adjustment, where necessary, to compensate for lining wear and to maintain force in springs, where used.

(b) Braking means, whether functioning mechanically, pneumatically, hydraulically, or electrically, shall have heat dissipation capability consistent with service needs.

(c) Brakes shall be protected from the weather and from contaminants such as lubricants, hydraulic fluid, or other such liquids.

(d) Where springs comprise part of the braking mechanism, they shall be subject to compression only.

SECTION 3-1.17: OPERATOR AIDS (16)

(a) Indicating devices shall be provided to

(1) display the weight of the load on the hook

(2) display the luffing boom angle, hook radius, or trolley operating radius, as appropriate

(3) display ambient wind velocity (see para. 3-1.24.7)

(b) Limiting devices shall be provided to

(1) decelerate the trolley travel at both ends of the jib prior to final limit activation

(2) decelerate the luffing boom travel at minimum and maximum radius prior to final limit activation

(3) limit trolley travel at both ends of the jib

(4) stop luffing boom travel at minimum and maximum radius of luffing boom

(5) decelerate the load block travel prior to final limit activation

(6) stop load block upward motion before two-blocking occurs

(7) stop load block downward motion to prevent the last three wraps of wire rope from spooling off the hoist drum

(8) limit crane travel at both ends of the running tracks

(9) limit the weight of the load lifted

(10) limit operating radius in accordance with crane's rated capacity, i.e., load moment

(11) limit pressures in hydraulic or pneumatic circuits (see para. 3-1.24.9)

(c) Motion limiting devices, such as in para. (b) above, should be provided with means to permit the operator to override them under controlled conditions.

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SECTION 3-1.18: PENDANTS, STAY ROPES, AND GUYS

(a) For standing ropes, the minimum design factor shall be 3.0. Fiber core ropes with swaged fittings and rotation-resistant ropes shall not be used for pendants, stay ropes, or guy ropes.

(b) Standing ropes that are used as live ropes during erection, and luffing boom hoist running ropes, shall have a minimum design factor of 3.0 for the loads occurring during erection, but shall comply with para. 3-1.10.5 for the erected condition. Rotation-resistant ropes shall not be used for luffing boom hoists.

(c) The design factors in paras. 3-1.10.5(b) and (c) shall be the total minimum breaking force of all the supporting ropes divided by the static load imposed on those ropes when supporting their maximum loads.

(d) Sheaves used during erection and dismantling that remain in the support system shall comply with para. 3-1.10.4.

(e) New pendants utilizing poured sockets or swaged sockets shall be proof tested to the crane or fitting manufacturer's recommendation but in no case greater than 50% of the component wire rope's or structural strand's minimum breaking force.

SECTION 3-1.19: REEVING ACCESSORIES

(a) Eye splices shall be made in a manner recommended by the rope or crane manufacturer and rope thimbles should be used in the eye.

(b) Wire rope clips shall be drop-forged steel of the single saddle (U-bolt) or double saddle type clip. Malleable cast iron clips shall not be used.

(c) Swaged, compressed, or wedge socket fittings shall be applied as recommended by the rope, crane, or fitting manufacturer.

(d) Wire rope clips, wedge sockets, and compression hardware shall be installed in accordance with ASME B30.26, Section 26-3.1.

SECTION 3-1.20: COUNTERWEIGHT AND BALLAST BLOCKS

(a) Superstructures and counterjibs shall be arranged to receive counterweights, made in accordance with the crane manufacturer's specifications, and to hold them in position. Means shall be provided to prevent shifting or dislodgement during crane operation.

(b) Counterweights and ballast blocks shall be individually marked with the actual weight. The markings shall be visible when the weights are in the installed position.

(c) Only steel-framed concrete or solid steel counterweights suspended from the superstructure shall be used.

(d) Movable counterweights, if provided, shall move automatically.

(1) When counterweight position is controlled by ropes, means shall be provided to prevent uncontrolled movement in the event of rope failure.

(2) When counterweight position is controlled by ropes and/or linkages between the counterweight and the luffing boom, provision shall be made to prevent structural damage if the luffing boom is moved beyond its normal operating limits.

(e) For cranes utilizing ballast, bases shall include provisions to support and position the ballast. Means shall be provided to secure the ballast against shifting or dislodgement during crane operation.

SECTION 3-1.21: CONTROLS

3-1.21.1 Crane Function Controls

(a) At the operator's station, controls used during the crane operating cycle shall be located within reach of the operator.

(b) Controls shall be labeled in accordance with Section 3-1.9 or symbols in accordance with ISO 7296-1, 7296-2, and 7296-3 to indicate their function and, where appropriate, the direction of the motion imparted.

(c) Hoisting, trolleying, luffing, slewing, and travel motions shall stop when control actuation pressure is released. Controls shall be provided with an interlock that prevents re-actuation except from the neutral position.

(d) Remote operated cranes shall function so that if the control signal for any crane motion becomes ineffective, that crane motion shall stop.

(e) Cranes powered by electric motors shall be provided with a device that will disconnect all motors from the line on failure of power and will not permit any motor to be restarted until the operational control is brought to the neutral position and a manual reset is activated.

(f) Cranes powered by electric motors shall be provided with means for the operator to interrupt the main power circuit from the operating position.

(g) Remote control stations shall include provisions for an emergency stop in the event of a device malfunction.

(h) Provisions shall be made to prevent simultaneous activation of controls when more than one operator's station (remote control) is provided.

(i) Where cranes are powered by hydraulic motors, means shall be provided to automatically stop the main power supply system on loss of hydraulic pressure.

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3-1.21.2 Main Power Supply System Controls

(a) Controls for operating the main power supply system shall be within reach of the operator and shall include, as applicable, the following:

(1) means to start and stop with provision to lock in the stop position

(2) means to control speed of internal combustion engines

(3) means to stop internal combustion engines under emergency conditions

(4) means for shifting selective transmissions

(b) All cranes powered by internal combustion engines with a direct mechanical or hydrodynamic (such as a torque converter or fluid coupling) drive to any crane function shall be provided with a clutch or other means for disengaging power. The control shall be within reach from the operator's station.

3-1.21.3 Control Forces and Movements

Control levers and pedals shall be in accordance with ISO 7752-1:2010.

SECTION 3-1.22: ELECTRICAL EQUIPMENT

3-1.22.1 General Requirements

(a) Each electrically powered crane shall have an overcurrent protected main disconnect switch mounted at or near the initial base of the crane. This switch shall have provisions for locking in the off position.

(b) Electrical equipment shall be so located or guarded that energized parts are not exposed to inadvertent contact under normal operating conditions.

(c) Electrical equipment shall be protected from contaminants such as dirt, grease, oil, and moisture. Fixtures, wiring, and connections exposed to the weather shall be of weather resistant type.

(d) Wiring shall comply with the provisions of ANSI/NFPA 70 for temporary wiring. Motors, controls, switches, and other electrical equipment shall meet the applicable requirements of ANSI/NFPA 70.

(e) Provision shall be made to guard against reversing of each motor's direction due to reversed phase connections.

(f) Electrical circuits between the fixed and rotating portions of the crane shall pass through connections that permit continuous rotation in either direction.

(g) Individual overload protection shall be provided for each motor.

(h) Lightning protection should be provided to protect the crane's electrical system.

(i) Electric motor operated cranes that are powered by a generator to provide electrical power shall be provided with overspeed protection, or the generator shall be sized appropriately to absorb the regenerative braking produced by the crane.

3-1.22.2 Resistors

(a) Resistor units shall be supported in such a manner to minimize detrimental vibration effects.

(b) Provisions shall be made to prevent broken parts or molten metal falling on the operator or from the crane.

(c) Enclosures shall be installed so as to minimize the accumulation of combustible matter and debris.

SECTION 3-1.23: OPERATOR'S CABS

3-1.23.1 Construction

(a) Cabs shall be provided for the operator's stations. They shall be constructed of material that will not support combustion and shall have means for ventilation.

(b) An adjustable operator's seat with backrest shall be provided. The seat should be arranged and constructed to minimize operator fatigue.

(c) Where standing on the roof of the cab is permitted, those areas of the cab roof shall be capable of supporting, without permanent distortion, the weight of a 300-lb (136-kg) person.

(d) Cab doors and hatches, whether of the sliding or swinging type, shall be equipped with means to prevent inadvertently opening or closing during travel or operation of the crane.

(e) Cab glazing shall be safety glazing material as defined in ANSI/SAE Z26.1. Windows shall be provided in the front and on both sides of the cab for visibility forward and to both sides. Forward visibility should include both the trolley and pickup points on the ground. Windows provided with opening portions shall be arranged to prevent inadvertent closure during operation. A windshield wiper shall be provided on the front window.

(f) Either natural or artificial cab lighting shall be provided. The minimum level of illumination shall be 5 lumens (50 lux).

(g) The operator's cab shall be mounted on the rotating portion of the crane.

3-1.23.2 Access

(a) Access ladders to the cab, machinery platforms, and tower(s) shall be provided and shall conform to ANSI A14.3 or to SAE J2703, as applicable.

(b) Outside platforms shall have walking surfaces of a skid resistant type, shall be provided with standard handrails, and shall conform to ANSI A1264.1.

(c) When access to the operator's cab requires a climb of 100 ft (30 m) or more, sanitary facilities should be provided.

3-1.23.3 Tool Box

A metal receptacle should be provided for the storage of small hand tools and lubricating equipment. It should be secured in the cab or on the machinery platform.

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3-1.23.4 Fire Extinguisher

A portable fire extinguisher, with a basic minimum extinguisher classification of 10-ABC, shall be installed in the cab or at the machinery housing.

3-1.23.5 Signal Device

An audible signal device shall be provided with the control located within reach of the operator while at the operator's station.

SECTION 3-1.24: GENERAL REQUIREMENTS

3-1.24.1 Footwalks and Ladders

(a) Means shall be provided for access to the jib or luffing boom and its attachments such as connections, limiting devices, sheaves, rope, and fittings. Means for access may be a footwalk 18 in. (450 mm) or more in width with a slip resistant surface and with handrails, or a platform attached to the trolley having a slip resistant surface and handrails, or the equivalent.

(b) Footwalks, platforms, ladders, and railings shall be capable of supporting the weight of a 300-lb (136-kg) person without permanent distortion.

3-1.24.2 Guards for Moving Parts

(a) Exposed moving parts such as gears, projecting set screws and keys, drive chains and sprockets, and reciprocating or rotating parts, which might constitute a hazard under normal operating conditions, shall be guarded.

(b) Each guard shall be capable of supporting the weight of a 300-lb (136-kg) person without permanent distortion unless the guard is located where it is not reasonable to expect a person to step during operation or maintenance.

3-1.24.3 Lubrication Points

Lubrication points should be accessible without the necessity of removing guards or other parts with tools unless equipped for centralized lubrication.

3-1.24.4 Exhaust Gases

Engine exhaust gases shall be piped and discharged away from the operator's cab. Exhaust pipes shall be guarded or insulated to prevent contact by personnel when performing normal duties.

3-1.24.5 Welded Construction

Welding procedures and welding operator qualifications for use in repair or alteration of load sustaining members shall be in accordance with AWS D14.3 or AWS D1.1. Where special steels or other materials are used, the manufacturer or a qualified person shall provide welding procedure instructions. The type of metal used for load-sustaining members shall be identified by the manufacturer [see para. 3-1.9.1(j)].

3-1.24.6 Clutch Protection and Adjustment

(a) Dry-friction clutches shall be protected against rain and other liquids, such as oil and lubricants.

(b) Clutches shall be configured to permit adjustments, where necessary, to compensate for wear.

3-1.24.7 Wind Velocity Device

A wind velocity measuring device shall be mounted at or near the top of the crane. A velocity readout shall be provided at the operator's station in the cab, and a visible or audible alarm shall be triggered in the cab and at remote control stations when a preset wind velocity has been exceeded.

3-1.24.8 Fuel Filler Pipes

Fuel tank filler pipes shall be located or protected so as to prevent spillage or overflow from running onto the engine, exhaust, or electrical equipment of the machine being fueled.

3-1.24.9 Hydraulic and Pneumatic Pressures

(a) Relief valves shall be provided in hydraulic and pneumatic circuits carrying fluid pressurized by a power driven pump in order to limit the maximum pressure in the circuit. The magnitude of the relief settings shall permit operation under rated load conditions, and means shall be provided to prevent unauthorized adjustment or tampering.

(b) Means shall be provided for checking the manufacturer's specified pressure settings in each circuit.

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Chapter 3-2
Inspection, Testing, and Maintenance

SECTION 3-2.1: INSPECTION

3-2.1.1 General

(a) Where inspection criteria provided by the manufacturer [see para. 3-1.9.1(i)] differ from the information provided in this Section, the manufacturer's criteria shall take precedence.

(b) Inspections shall be performed by a designated person. Any deficiencies identified shall be examined and a determination made by a qualified person as to whether they constitute a hazard.

3-2.1.2 Inspection Classification

(a) Initial Inspection. Tower cranes shall undergo a Periodic or Major Inspection as defined in paras. 3-2.1.4 and 3-2.1.5 prior to being erected. In addition, prior to being placed into service, newly erected or modified tower cranes shall be inspected to verify compliance with the applicable provisions of this Volume.

(b) Regular Inspection. Inspection occurrences for cranes in service are divided into three classifications, based on the time intervals at which the inspections should be performed and the level of inspection. The time intervals are dependent upon the service required from the crane and the degree of wear, deterioration, or malfunction a crane part may experience in that service. These regular inspection classifications are designated as Frequent Inspection, Periodic Inspection, and Major Inspection, and their respective occurrence intervals are defined below.

(1) Frequent Inspections shall be conducted prior to use each day, or at intervals recommended by the manufacturer or by a qualified person.

(2) Periodic Inspections shall be conducted annually, or at intervals recommended by the manufacturer or by a qualified person.

(3) Major Inspections shall be conducted at 60-mo intervals, or as recommended by the manufacturer or by a qualified person.

3-2.1.3 Frequent Inspection

Items and conditions such as those listed shall be inspected at the intervals defined in para. 3-2.1.2(b)(1) or as specifically indicated for an item or condition. Observations made during operation shall be used to identify deficiencies that might appear between inspections.. Deficiencies determined to constitute a hazard shall be corrected before the crane is placed back into service. Inspect

(a) all control mechanisms for proper crane operation.

(b) bent or missing lacings or other structural members in the tower, jib, counterjib, or luffing boom.

(c) tower wedges and braces for looseness or dislocation.

(d) wire rope as required in para. 3-2.4.

(e) indicating devices for load, radius, luffing boom angle, and wind velocity. Calibration verification is not required unless specified by the manufacturer or a qualified person. If any indicating device is found to be defective and its repair cannot be made immediately, refer to paras. 3-2.3.3 and 3-3.2.1(b)(4). See para. 3-2.2.2 for additional requirements.

(f) limiting systems such as trolley travel and deceleration, luffing boom upper and lower limits and deceleration, crane travel, two-block protection, and hoist-up deceleration systems for proper operation and accuracy. See para. 3-2.2.2 for additional requirements.

(g) reservoirs for systems such as hydraulic, lubrication, and cooling, for proper fluid levels.

(h) crane motion operating mechanisms for proper adjustment with regard to the speed, smoothness, or operation of the crane.

(i) hooks and latches for hazardous conditions. Refer to ASME B30.10.

(j) foundations and structural supports for settlement, movement, deformations, accumulation of standing water or debris, or other signs of abnormal conditions.

(k) hydraulic and pneumatic hoses.

(l) documentation (see Section 3-1.9), charts, placards, and control markings for legibility and presence.

3-2.1.4 Periodic Inspection

(a) Items and conditions such as those listed shall be inspected at the intervals defined in para. 3-2.1.2(b)(2) or as specifically indicated for an item or condition. Observations during operation shall be used to identify deficiencies that might appear between inspections. Deficiencies determined to constitute a hazard shall be corrected before the crane is placed back into service. Records shall be kept of the inspected items and conditions to provide a basis for continuing evaluation. Inspect

(1) items and conditions contained in para. 3-2.1.3.

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(2) deformed, cracked, or corroded members in the crane structure or crane support systems. If indications of possible damage are observed, the need to remove paint or to use a higher level of nondestructive examination technique, to determine if a hazard exists, shall be made by a qualified person.

(3) damaged sheaves and drums in all rope systems.

(4) loose, worn, cracked, or distorted parts, such as bolts, pins, bearings, shafts, gears, rollers, locking and clamping devices, sprockets, and drive chains or belts.

(5) brake and clutch system parts, linings, pawls, and ratchets for wear that exceeds the manufacturer's allowable tolerances.

(6) load, wind, radius, and other indicators for inaccuracies outside the tolerances recommended by the manufacturer.

(7) electrical systems for deterioration in controllers, master switches, contacts, components, wires, cables, and controls.

(8) load hoist, luffing, trolley, swing, and travel mechanisms for malfunction, wear, or damage.

(9) pumps, motors, valves, hoses, fittings, and tubing for wear or damage.

(10) wire rope as required in Section 3-2.4.

(11) walkways, ladders, and access systems for deficiencies.

(12) guarding for missing or damaged components.

(13) electrical grounding of crane structure for missing or improper connections.

(b) Cranes that have been idle for a period of 1 month or more shall be inspected in accordance with (a) above before being placed back into service.

(c) For cranes with 5 or more years of service, inspections performed in accordance with (a) above are recommended at more frequent intervals, unless the manufacturer recommends other intervals.

3-2.1.5 Major Inspection

(a) Items and conditions such as those listed shall be inspected at the intervals defined in para. 3-2.1.2(b)(3) or as specifically indicated for an item or condition. In addition to those items listed, the manufacturer's inspections and maintenance requirements shall be accomplished. Observations made during operation shall be used to identify deficiencies. Deficiencies determined to constitute a hazard shall be corrected before the crane is placed back into service. Records shall be kept of the inspected items and conditions to provide a basis for continuing evaluation.

(1) Inspect items and conditions contained in paras. 3-2.1.3 and 3-2.1.4.

(2) Verify completion of any safety upgrades recommended by the crane manufacturer.

(3) Verify presence of the most recent applicable documentation published by the crane manufacturer.

(4) Verify proper operation of fluid system reliefs and accumulator conditions.

(5) Consideration should be given to nondestructive testing of all tower and slewing ring connection material, or replacement in accordance with the manufacturer's instructions.

(6) Inspect for deformed, cracked, or corroded members in the crane structure. If indications of possible damage are observed, a higher level of nondestructive examination or the removal of paint shall be performed to determine if a hazard exists.

(7) Disassemble and inspect drive systems, motors, and gear boxes in accordance with the manufacturer's frequency requirements.

(8) Inspect and test all electrical components, including wiring, drives, controls, and connections.

(9) Inspect sheaves, including bearings and corrugation.

(10) Inspect the slewing ring, including disassembly as required in accordance with the manufacturer's requirements for inspection, cleaning, and servicing.

(b) For permanently mounted tower cranes with 10 or more years of service, the inspection specified in (a) above shall be performed at annual intervals. Disassembly requirements under paras. (a)(7) and (a)(10) are only required when specified by the manufacturer.

SECTION 3-2.2: TESTING

(a) Where testing criteria provided by the manufacturer [see para. 3-1.9.1(i)] differ from the information provided in this Section, the manufacturer's criteria shall take precedence.

(b) Tests shall be performed by a designated person. Any deficiencies identified shall be examined and a determination made by a qualified person as to whether they constitute a hazard.

3-2.2.1 Operational Tests

(a) Each time a crane is erected or reconfigured, prior to initial use it shall be tested in accordance with Section 3-1.7.

(b) After a repair, cranes shall be tested if a qualified person determines that testing is required prior to returning the crane to service. If a load test is required, it shall be in accordance with Section 3-1.7.

(c) A record of the operational tests when a crane is erected, reconfigured, or repaired shall be completed and retained until a subsequent test is completed. At a minimum the record shall indicate test dates, tests performed, and results obtained.

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3-2.2.2 Operational Test Procedures for Crane Limit Devices

The actuating settings of limit devices shall be determined by the following tests:

(a) The hoist limit (anti two-block) shall be tested with an empty hook and be comprised of a series of runs, each at increasing hook speeds, up to the maximum speed. The actuating mechanism of the deceleration and limit device shall be adjusted so that it will prevent two-blocking.

(b) The trolley travel and deceleration, luffing boom limits and deceleration, and crane travel limit testing shall be done with an empty hook, and be comprised of a series of runs of each motion at increasing speeds up to the maximum speed.

(c) Load limit device settings shall be verified by means of a load test using freely suspended loads, as specified by the crane manufacturer or, in the absence thereof, the instructions of a qualified person. If not functional or improperly functioning, and repairs cannot be made immediately, refer to paras. 3-2.3.2 and 3-3.2.1(b)(4).

SECTION 3-2.3: MAINTENANCE

Parts used in the repair and maintenance of the equipment should be obtained from the original equipment manufacturer. Parts shall be at least equal to the original manufacturer's specifications.

3-2.3.1 Preventive Maintenance

A preventive maintenance program based on the crane manufacturer's documentation and recommendations shall be established. Dated records of maintenance, adjustments, and repairs performed shall be maintained.

3-2.3.2 Maintenance, Adjustments and Repair Procedures

Maintenance, adjustments, and repair requirements identified by inspection in accordance with Section 3-2.1 that create a hazardous condition shall be corrected before operation of the crane is resumed. Adjustments and repairs shall be performed only by designated personnel.

(a) Before maintenance, adjustments, or repairs are started, the following precautions shall be taken:

(1) Move traveling-type cranes to a location where they will cause the least interference with other cranes and operations in the area.

(2) Set all controllers to the off position.

(3) Open and lock the main or emergency switch, except for test purposes.

(4) Place warning or Out of Order signs, or use the appropriate lock-out/tag-out procedures.

(5) Where other cranes are in operation on the same runway, provide rail stops to prevent interference with the idle crane, or place a signal person at a visual vantage point for observing the approach of an active crane and warning its operator.

(6) Machinery shall be stationary while lubricants are being applied and appropriate personnel protection provided unless equipped for automatic lubrication.

(b) Adjustments shall be maintained to ensure correct functioning of components. The following are examples:

(1) functional operating mechanisms

(2) limit devices

(3) control systems

(4) braking systems

(5) power plants

After maintenance, adjustments, or repairs have been completed, the crane shall not be returned to service until all guards have been reinstalled, limit and protective devices reactivated, maintenance equipment removed, and the precautions established in (a) above have been appropriately removed.

SECTION 3-2.4: ROPE INSPECTION, REPLACEMENT, AND MAINTENANCE

3-2.4.1 General

All inspections shall be performed by a designated person. Any deficiencies identified shall be examined and a determination made by a qualified person as to whether they constitute a hazard.

3-2.4.2 Inspection

(a) Frequent Inspection

(1) Load hoist and luffing boom hoist ropes shall be visually inspected each working day.

(2) The load trolley rope, and counterweight movement ropes if provided, shall be visually inspected at least once a month. A visual inspection shall consist of observation of all rope that can reasonably be expected to be in use during the day's operations. These visual observations should be concerned with discovering gross damage, such as listed below, that may be an immediate hazard. When such damage is discovered, the rope shall either be removed from service or inspected as outlined in para. 3-2.4.2(b).

(-a) distortion of the rope such as kinking, crushing, unstranding, birdcaging, main strand displacement, or core protrusion; loss of rope diameter in a short rope length or unevenness of outer strands provide evidence that rope replacement should be considered

(-b) general corrosion

(-c) broken or cut strands

(-d) number, distribution, and type of visible broken wires [see paras. 3-2.4.3(b)(1), (b)(2), and (b)(7) for further guidance]

(-e) core failure in rotation-resistant ropes (see Fig. 3-2.4.2-1)

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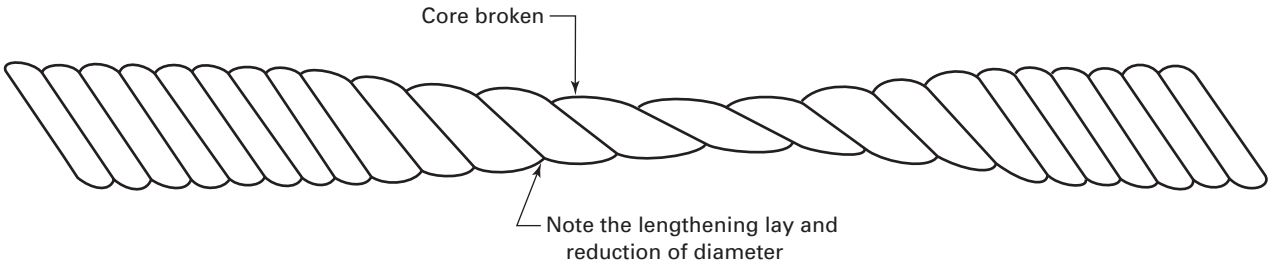
Fig. 3-2.4.2-1 Core Failure in Rotation-Resistant Rope



(3) Particular care shall be taken when inspecting sections of rope subject to rapid deterioration, such as flange points, crossover points, and repetitive pickup points on drums.

(4) Particular care shall be taken when inspecting rotation-resistant ropes because of their susceptibility to damage from handling and misuse, and potential for deterioration when used on equipment with limited design parameters. Internal deterioration of rotation-resistant ropes may not be readily observable.

(b) Periodic Inspection

(1) Inspection frequency shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of lifts at maximum rating, frequency rates of operation, and exposure to shock loads. Inspections need not be at equal calendar intervals and should be more frequent as the rope approaches the end of its useful life. However, this inspection shall be made at least annually.

(2) Periodic inspections shall be performed. These inspections shall cover the entire length of the rope. Any deterioration resulting in appreciable loss of original strength, such as described below, shall be noted and determination made as to whether further use of the rope would constitute a hazard:

(-a) points listed in para. 3-2.4.2(a)

(-b) reduction of rope diameter below nominal diameter [see para. 3-2.4.3(b)(7)]

(-c) severely corroded or broken wires at end connections

(-d) severely corroded, cracked, bent, worn, or improperly applied end connections

(3) Care shall be taken when inspecting rope sections subject to rapid deterioration, such as the following:

(-a) sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited

(-b) sections of the rope at or near terminal ends

(-c) where corroded or broken wires may protrude

(-d) sections subject to reverse bends

(-e) sections of rope that are normally hidden during routine visual inspection, such as parts passing over sheaves

3-2.4.3 Rope Replacement

(a) No precise rules can be given for determination of the exact time for rope replacement, since many variable factors are involved. Once a rope reaches any one of the specified removal criteria, it may be allowed to operate to the end of the work shift, based on the judgment of a qualified person. The rope shall be replaced after that work shift, at the end of the day, or, at the latest, prior to the equipment being used by the next work shift.

(b) Removal criteria for rope replacement shall be as follows:

(1) in running ropes, 12 randomly distributed broken wires in one lay, or four broken wires in one strand in one lay.

(2) in rotation-resistant ropes, two randomly distributed broken wires in six rope diameters, or four randomly distributed broken wires in 30 rope diameters.

(3) one outer wire broken at the contact point, with the core of the rope indicated by an externally protruding wire or loop of loose wires.

(4) wear of one-third the original diameter of outside individual wires.

(5) kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.

(6) evidence of heat damage from any cause.

(7) reductions from nominal diameter greater than 5%.

(8) attention shall be given to end connections. Upon development of more than two broken wires adjacent to a socketed end connection, the rope shall be resocketed or replaced. Resocketing shall not be attempted if the resulting rope length will be insufficient for proper operation.

Deviation shall be allowed from the removal criteria listed in paras. (b)(1) through (b)(7) above only with written approval of the manufacturer of the wire rope.

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(c) Broken wire removal criteria cited in this Volume apply to wire rope operating on steel sheaves and drums. The user shall contact a qualified person, or the sheave, drum, or crane manufacturer for broken wire removal criteria for wire ropes operating on sheaves and drums made of material other than steel.

(d) Replacement rope and connections shall have a strength rating at least as great as the original rope and connections furnished by the manufacturer. Any deviation from the original size, grade, or construction shall be specified by a rope manufacturer, the crane manufacturer, or a qualified person.

(e) Ropes Not in Regular Use. All rope that has been idle for a period of 1 month or more due to shutdown or storage of the crane on which it is installed shall be inspected in accordance with para. 3-2.1.5 before it is placed in service. Inspections under para. 3-2.1.5(b) shall be for all types of deterioration and shall be performed by an appointed or authorized person.

(f) Inspection Records

(1) Frequent Inspection. No records required.

(2) Periodic Inspection. In order to establish data as a basis for judging the proper time for replacement, a dated report of rope condition at each periodic inspection shall be kept on file. This report shall cover points of deterioration listed in para. 3-2.4.2(b)(2). If the rope is replaced, only that fact need be recorded.

(g) A long-range inspection program should be established to include records on examination of ropes removed from service, to establish a relationship between visual observation and actual condition of the internal structure.

3-2.4.4 Rope Maintenance

(a) Rope should be stored in such a manner as to minimize damage or deterioration.

(b) Unreeling or uncoiling of rope shall be done as recommended by the rope manufacturer and with care to avoid kinking or inducing twist.

(c) Before cutting rope, seizings shall be placed on each side of the place where the rope is to be cut to prevent unlaying of the strands.

(d) During installation, care should be exercised to avoid dragging the rope in dirt or around objects that will scrape, nick, crush, or induce sharp bends in it.

(e) Rope should be maintained in a well-lubricated condition. Lubricant applied as part of a maintenance program shall be compatible with the original lubricant and to this end the rope manufacturer should be consulted; lubricant shall be of a type that does not hinder visual inspection. Those sections of rope that are located over sheaves or otherwise hidden during inspection and maintenance require special attention during lubrication. The object of rope lubrication is to reduce internal friction and to inhibit corrosion.

(f) When an operating rope shows greater wear at well-defined localized areas than on the remainder of the rope, rope life can be extended, in cases where a reduced rope length is adequate, by cutting off a section at the worn end and thus shifting the wear to different areas of the rope.

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Chapter 3-3
Operation

SECTION 3-3.1: QUALIFICATIONS FOR AND CONDUCT OF OPERATORS AND OPERATING PRACTICES

(16) **3-3.1.1 Operators**

(a) Cranes shall be operated only by the following qualified personnel:

(1) designated persons.

(2) trainees shall be under the supervision of a designated person. The number of trainees permitted to be supervised by a single designated person, the physical location of the designated person while supervising, and the type of communication required between the designated person and the trainee shall be determined by a qualified person.

(3) maintenance and test personnel, when it is necessary in the performance of their duties.

(4) inspectors (crane).

(b) No one, other than personnel specified in para. (a) above, shall enter a crane cab, with the exception of persons such as oilers, supervisors, and those specific persons authorized by supervisors whose duties require them to do so, and then only in the performance of their duties and with the knowledge of the operator or other appointed person.

3-3.1.2 Qualifications for Operators

Operators shall be required to successfully meet the qualifications for the specific type of crane that they are operating.

(a) Operator and operator trainees shall meet the following physical qualifications unless it can be shown that failure to meet the qualifications will not affect the operation of the crane. In such cases, specialized clinical or medical judgments and tests may be required.

(1) vision of at least 20/30 Snellen in one eye and 20/50 in the other, with or without corrective lenses.

(2) ability to distinguish colors, regardless of position, if color differentiation is required.

(3) adequate hearing to meet operational demands, with or without hearing aid.

(4) sufficient strength, endurance, agility, coordination, and speed of reaction to meet the operation demands.

(5) depth perception, field of vision, reaction time, manual dexterity, coordination, and no tendencies to dizziness or similar undesirable characteristics to meet the operational demands.

(6) a negative result for a substance abuse test. The level of testing will be determined by the standard practice for the industry where the crane is employed and this test shall be confirmed by a recognized laboratory service.

(7) no evidence of having physical defects or emotional instability that could render a hazard to the operator or others, or that in the opinion of the medical authority could interfere with the operator's performance. If evidence of this nature is found, it may be sufficient cause for disqualification.

(8) no evidence of being subject to seizures or loss of physical control that cannot be controlled with medication; such evidence shall be sufficient reason for disqualification. Specialized medical tests may be required to determine these conditions.

(b) Operator requirements shall include, but not be limited to, the following:

(1) evidence of successfully passing a physical examination as defined in para. (a) above.

(2) satisfactory completion of a written examination covering operational characteristics, controls, and emergency control skills, such as response to fire, power line contact, or control malfunction, as well as characteristic and performance questions appropriate to the crane types defined in para. 3-0.2.1 for which qualification is being sought. Type of crane means a crane with any combination of the applicable characteristics from each of the four group types defined in para. 3-0.2.1.

(3) demonstrated ability to read, write, and comprehend the crane manufacturer's documentation.

(4) satisfactory completion of a combination written and verbal test on load/capacity chart usage skills that covers a selection of the configurations (the crane may be equipped to handle) for the crane type for which qualification is being sought.

(5) satisfactory completion of an operation test demonstrating proficiency in performing lifting, lowering, trolleying or luffing, swinging, and travel (when so equipped) functions at various radii as well as taking the crane out of service. Testing shall also include proficiency in prestart and post-start inspection, and securing procedures by appropriate written, oral, or practical methods.

(6) demonstrated understanding of the applicable Sections of the B30.3 Standard and applicable regulatory requirements.

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(c) Operators who have successfully qualified for a specific crane type shall be required to be requalified every 5 yr, or sooner if supervision deems it necessary.

(d) Trainee qualification requirements shall include, but not be limited to, the requirements of paras. (b)(1) through (b)(4) above.

(e) Trainee qualification, operator qualification, and operator requalification shall be performed by a qualified person.

(f) Operator physical examinations shall be required every 3 yr as defined in para. (a) above, or more frequently if site supervision deems it necessary.

(16) **3-3.1.3 Conduct of Operators**

(a) The operator shall not engage in any practice that might divert attention while actually engaged in operating the crane.

(b) When physically or mentally unfit, an operator shall not engage in the operation of the equipment.

(c) The operator shall respond to signals from the lift director or an appointed signal person. When a signal person is not required as part of the crane operation, the operator is then responsible for the lifts. However, the operator shall obey a stop signal at all times, no matter who gives it.

(d) Each operator shall be responsible for those operations under the operator's direct control. Whenever there is any doubt as to safety, the operator shall consult with the supervisor before handling the loads.

(e) Before leaving the crane unattended, the operator shall

(1) land any load, bucket, lifting magnet, or other device.

(2) set trolley brakes and other locking devices and bring the hook to the highest position.

(3) disconnect power or disengage the master clutch, as applicable.

(4) place all controls in the off or neutral position.

(5) secure the crane against inadvertent travel.

(6) stop the internal combustion engine, when provided. An exception may exist when crane operation is frequently interrupted during a shift. Under these circumstances, the crane may remain running while the operator remains on the crane superstructure.

(7) leave the superstructure free to weathervane unless provisions for nonweathervaning have been specified by the manufacturer or by a qualified person.

(8) restrain the crane from travel with rail clamps, or other means provided, when a wind alarm is given or on leaving the crane overnight.

(f) If there is a warning sign on the power-disconnecting means or starting controls, the operator shall not close the circuit or start the equipment until the warning sign has been removed by an appointed person.

(g) Before closing the power-disconnecting means or starting the equipment, the operator shall see that all controls are in the off or neutral position and that all personnel are in the clear.

(h) If power fails during operation, the operator shall

(1) set trolley, hoist, and travel brakes and locking devices, as applicable

(2) move all clutch or other power controls to the off or neutral position

(3) land the suspended load under brake control, if practical

(i) The operator shall be familiar with the equipment and its proper care. If adjustments or repairs are necessary, the operator shall report the condition promptly to the appointed person and shall also notify the next operator.

(j) All controls shall be tested by the operator at the start of a new shift. If any controls do not operate properly, they shall be adjusted or repaired before operations are begun.

(k) Cranes shall not be operated when wind speeds exceed the maximum velocity recommended by the manufacturer.

(l) Prior to daily operation, operator aids shall be checked to determine if they are working per para. 3-2.1.3(e).

(m) Operations undertaken during weather conditions that produce icing of the crane structure or reduced visibility should be performed at reduced function speeds and with signaling means appropriate to the situation.

3-3.1.4 Responsibilities

While the organizational structure of various crane work sites may differ, the following roles are described here for purposes of delineating responsibilities. All responsibilities listed below shall be assigned in the work site organization. (A single individual may perform one or more of these roles.)

(a) Crane Owner (Owner). Has control of the crane by virtue of lease or ownership.

(b) Crane User (User). Arranges the crane presence on a work site and controls its use.

(c) Site Supervisor. Exercises supervisory control over the work site on which the crane is being used and over the work that is being performed on that site.

(d) Lift Director. Oversees the work being performed by the crane and the associated rigging crew.

(e) Crane Operator (Operator). Directly controls the crane functions.

3-3.1.4.1 Responsibilities of the Owner and User. At some work sites, the owner and the user may be the same entity and is therefore accountable for all of the following responsibilities. At other work sites, the user may lease or rent the crane from the owner without

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supervisory, operational, maintenance, support personnel, or services from the owner. At all work sites, the owner's and user's responsibilities specified in paras. 3-3.1.4.1.1 and 3-3.1.4.1.2 shall apply.

(16) **3-3.1.4.1.1 Owner's Responsibilities.** Owner's responsibilities shall include

(a) providing a crane that meets the requirements of Chapter 3-1 of the appropriate edition of this Volume

(b) providing crane and all necessary components, specified by the manufacturer, that meet the user's requested configuration and capacity

(c) providing all applicable load rating charts and diagrams

(d) providing additional technical information pertaining to the crane, necessary for crane operation, when requested by the crane user

(e) providing field erection, dismantling, operation, maintenance information, warning decals, and placards, installed as prescribed by the crane manufacturer and regulatory bodies

(f) establishing an inspection, testing, and maintenance program in accordance with Chapter 3-2 and informing the crane user of the requirements of this program

(g) using personnel that meet the requirements for a designated person for the purposes of maintenance, repair, transport, erection, climbing, and dismantling

(h) using personnel that meet the requirements of a qualified or designated person where required within the provisions of this Volume

(16) **3-3.1.4.1.2 User's Responsibilities.** User's responsibilities shall include

(a) complying with the requirements of this Volume, manufacturer's requirements, and those regulations applicable at the work site

(b) using supervisors for crane activities that meet the requirements for a qualified person

(c) ensuring that the crane is in proper operating condition prior to initial use at the work site, by

(1) verifying that the owner has provided documentation that the crane meets the requirements of para. 3-2.1.1

(2) verifying that a frequent inspection has been performed as defined in para. 3-2.1.3

(d) verifying that the crane has the necessary lifting capacity to perform the proposed lifting operations in the planned configuration

(e) using operators that meet the requirements of paras. 3-3.1.1 and 3-3.1.2 and are qualified to perform the tasks that are required with the crane that they are assigned to operate

(f) ensuring the assigned operator has been notified of adjustments or repairs that have not yet been completed, prior to commencing crane operations

(g) using personnel that meet the requirements for inspections in Section 3-2.1

(h) using personnel that meet the requirements of a designated person for the purposes of maintenance, repair, transport, erection, climbing, and dismantling

(i) ensuring that all personnel involved in maintenance, repair, transport, erection, climbing, dismantling, and inspection are aware of their responsibilities, assigned duties, and associated hazards

(j) ensuring that the inspection, testing, and maintenance programs specified by the crane owner are followed

(k) ensuring cranes are not climbed when wind speed at the top of the crane exceeds 20 mph (9 m/s) or as recommended by the manufacturer or a qualified person

(l) ensuring the crane operator is present during climbing operations

(m) ensuring climbing operations are not commenced until all support provisions required at the new support level are in place and as specified by a qualified person

(n) ensuring night operation lighting is adequate to illuminate the working areas while not interfering with the view of the operator

3-3.1.4.2 Responsibilities of Site Supervisor and Lift Director. At some work sites, the site supervisor and the lift director may be the same person.

(16) **3-3.1.4.2.1 Site Supervisor's Responsibilities.** Site supervisor's responsibilities shall include

(a) ensuring that the crane meets the requirements of Chapter 3-2 prior to initial use.

(b) determining if additional regulations are applicable to the crane operations.

(c) ensuring that a qualified person is designated as the lift director.

(d) ensuring that crane operations are coordinated with other job-site activities that will be affected by or will affect lift operations.

(e) ensuring that the area for the crane is adequately prepared. The preparation includes, but is not limited to, the following:

(1) access roads for the crane components and associated equipment

(2) sufficient room to erect and dismantle the crane

(3) a support system that is suitable for the crane with respect to levelness, surface conditions, support capability, proximity to power lines, excavations, slopes, underground utilities, subsurface construction, and obstructions to crane operation

(4) restrict unauthorized access to the hazardous working areas of the crane

(f) ensuring that work involving the erection, dismantling, climbing, and reconfiguring of a crane is performed by a designated person.

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(g) ensuring that work involving the erection, dismantling, climbing, and reconfiguring of a crane is supervised by a qualified person.

(h) ensuring that crane operators meet the requirements of para. 3-3.1.2.

(i) ensuring that conditions which may adversely affect crane operations are addressed. Such conditions include, but are not limited to, the following:

(1) poor support conditions
(2) wind velocity or gusting winds
(3) rain
(4) fog
(5) cold
(6) artificial lighting

(j) determining if any energized conductors in the proximity of the site create a hazard and allowing crane operation near electric power lines only when the requirements of para. 3-3.4.3 have been met.

(k) allowing special lifting operations only when equipment and procedures required by this Volume, the crane manufacturer, or a qualified person are employed. Such operations include, but are not limited to, the following:

(1) multiple crane lifts
(2) lifting personnel
(3) rail traveling under load

(l) ensuring that work performed by the rigging crew is supervised by a qualified person.

(m) ensuring that crane maintenance is performed by a designated person.

3-3.1.4.2.2 Lift Director's Responsibilities. Lift director responsibilities shall include

(a) being present during lifting operations.

(b) stopping crane operations if alerted to an unsafe condition affecting those operations.

(c) ensuring that the preparation of the area needed to support crane operations has been completed before crane operations commence.

(d) verifying that unauthorized access to any hazardous working areas of the crane is restricted.

(e) ensuring that personnel involved in crane operations understand their responsibilities, assigned duties, and the associated hazards.

(f) addressing safety concerns raised by the operator or other personnel, and being responsible if he/she decides to overrule those concerns and directs crane operations to continue. In all cases, the manufacturer's criteria for safe operation and the requirements of this Volume shall be met.

(g) appointing the signal person, if required, that meets the requirements of Section 3-3.3, and conveying that information to the crane operator.

(h) allowing crane operation near electric power lines only when the requirements of para. 3-3.4.3 and any additional requirements determined by the site supervisor have been met.

(i) ensuring precautions are implemented when hazards associated with special lifting operations are present. Such operations include, but are not limited to, the following:

(1) multiple crane lifts
(2) lifting personnel
(3) rail travel under load operations
(4) tower cranes operating on barges
(5) out-of-service conditions

(j) ensuring that the applicable requirements of ASME B30.23 are met when lifting personnel.

(k) informing the crane operator of the weight of loads to be lifted, as well as the lifting, moving, and placing locations for these loads, and obtaining the operator's verification that this weight does not exceed the crane's rated capacity.

(l) ensuring that the crane load rigging is performed by a designated person.

(m) ensuring that the load is properly rigged and balanced before it is lifted more than a few inches.

3-3.1.4.3 Responsibilities of the Operator. The operator shall not be responsible for hazards or conditions that are not under his/her direct control and that adversely affect the lift operations. Whenever the operator has doubt as to the safety of crane operations, the operator shall stop the crane's functions in a controlled manner. Lift operations shall resume only after safety concerns have been addressed or the continuation of crane operations is directed by the lift director. (16)

3-3.1.4.3.1 Operator's Responsibilities. Operator responsibilities shall include

(a) reviewing the requirements for the crane with the lift director before operations.

(b) knowing what types of site conditions could adversely affect the operation of the crane and consulting with the lift director concerning the possible presence of these conditions.

(c) understanding and applying the information contained in the crane manufacturer's operating manual.

(d) understanding the crane's functions and limitations, as well as its particular operating characteristics.

(e) using the crane's load rating chart and diagrams, and applying all notes and warnings related to the charts, to confirm the correct crane configuration to suit the load, site, and lift conditions.

(f) refusing to operate the crane when any portion of the load or crane would enter the danger zone of energized power lines except as defined in para. 3-3.4.3.

(g) performing frequent inspections as specified in para. 3-2.1.3.

(h) promptly reporting the need for any adjustments or repairs to a designated person.

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(i) following applicable lock-out/tag-out procedures as determined by a qualified person.

(j) not operating the crane when physically or mentally unfit.

(k) ensuring that all controls are in the off or neutral position and that all personnel on the crane are in the clear before energizing the crane or starting the engine.

(l) not engaging in any practice that will divert his/her attention while actually operating the crane controls.

(m) testing the crane function controls that will be used and then operating the crane only if those function controls respond properly.

(n) operating the crane's functions, under normal operating conditions, in a smooth and controlled manner.

(o) knowing and following the procedures specified by the manufacturer or approved by a qualified person, for erection, climbing, and dismantling.

(p) ensuring that the load and rigging weight have been provided by the lift director.

(q) calculating or determining the net capacity for all configurations that will be used and verifying, using the load rating chart, that the crane has sufficient net capacity for the proposed lift.

(r) considering all factors known that might affect the crane capacity and informing the lift director of the need to make appropriate adjustments.

(s) knowing the standard and special signals as specified in Section 3-3.3 and responding to such signals from the appointed signal person. When the signal person is not required as part of the lift operation, the operator is then responsible for the movement of the crane. However, the operator shall obey a stop signal at all times, no matter who gives it.

(t) understanding basic load rigging procedures and the provisions of para. 3-3.2.1(c)(1).

(u) if power fails during operations, the following shall apply:

(1) setting all brakes and locking devices

(2) moving all clutches or other power controls to the off or neutral position

(3) landing any load suspended below the hook under brake control if practical

(v) before leaving the crane unattended, the following shall apply:

(1) landing any load suspended below the hook.

(2) bringing the load block to the highest position.

(3) moving controls to the off or neutral position.

(4) setting brakes and other locking devices.

(5) releasing of the slewing brake, unless provisions for nonweathervaning have been specified by the manufacturer or a qualified person.

(6) restraining the crane from travel, if applicable, with rail clamps or other means provided.

(7) disengaging the main control circuit or stopping the engine. An exception to this may exist when crane operation is frequently interrupted during a shift and the operator must leave the control station. Under these circumstances, the engine may remain running or the main control circuit energized and paras. (v)(1) through (v)(3) above shall apply.

SECTION 3-3.2: OPERATING PRACTICES

3-3.2.1 Handling the Load (16)

(a) Size of Load

(1) No crane shall be loaded beyond the rated loads given in the load rating chart except for test purposes as provided in Section 3-1.7 and para. 3-2.2.2.

(2) The load to be lifted is to be within the rated load of the crane in its existing configuration.

(3) For lifts where the load weight is not accurately known, the lift director shall ascertain that the weight of the load does not exceed the crane ratings at the radius at which the load is to be lifted.

(b) Operational Aids

(1) Indicating devices shall be checked daily before the crane is put in operation. See Section 3-1.7 and para. 3-2.2.2.

(2) Load indicator readings shall be used to guide crane operations within the specifications of the load rating chart, except when load weight is accurately known from another source.

(3) Luffing boom angle or radius indicator readings shall be used to guide crane operations within the specifications of the load rating chart; however, measured operating radii shall always govern over indicated boom angles or radii.

(4) When a load limit device, luffing boom angle, or load or radius indicator is not functioning, the crane may be kept in service while awaiting repair, provided all of the following conditions are adhered to. No operations shall be conducted if more than one of the indicating or limiting devices are not functioning.

(-a) All crane operations are conducted under the supervision of a qualified person.

(-b) Radio communications between the qualified person, the signal person(s), and the crane operator are established.

(-c) Each individual lift, and the first of a series of identical repetitious lifts, is specifically approved by the qualified person, before the lift is made, with respect to load weight, operating radii, lift heights, and crane motions.

(5) When the wind velocity indicating device is not functioning, crane operations may continue if another crane on the site is equipped with a functioning wind velocity indicator or if a qualified person determines that ambient wind velocity is within permitted limits.

(6) When drum rotation indicators are not functioning, the crane may be kept in service while awaiting repair.

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(c) Attaching the Load

(1) The hoist rope shall not be wrapped around the load.

(2) The load shall be attached to the hook by means of slings or other devices of adequate capacity.

(d) Holding the Load

(1) The operator shall not leave the controls while the load is suspended.

(2) No person should be permitted to stand or pass under a suspended load.

(3) If the load must remain suspended for any considerable length of time, the operator shall keep the drum from rotating in the lowering direction by activating the drum holding device, if a separate nonautomatic device has been provided.

(4) As an exception to para. (d)(1) above, where a load is to be held suspended for a period of time exceeding normal lifting operations, the operator may leave the controls, provided that prior to that time, the appointed individual and operator shall establish the requirements for restraining the load, swing, travel, and trolleying functions, and provide barricades, or whatever other precautions may be necessary.

(e) Moving the Load

(1) The lift director shall see that

(-a) proper slings or other lifting attachments are used

(-b) the load is well secured and balanced in the sling or lifting device before it is lifted more than a few inches

(-c) the lift and swing path is clear of obstructions

(2) Before starting to lift, the following conditions should be noted:

(-a) hoist rope is not kinked

(-b) multiple part lines are not twisted around each other

(-c) the hook is brought over the load in such a manner as to minimize swinging

(-d) if there is a slack hoist rope condition, the rope is seated on the drum and in the sheaves, as the slack is removed

(-e) the effect of wind on the load and on the crane is not detrimental to the lift operation

(-f) the load is free to be lifted and it is neither caught on nor attached to other objects

(3) During lifting, care shall be taken that

(-a) there is no sudden acceleration or deceleration of the moving load

(-b) the load does not contact any obstructions

(4) Side loading of booms or jibs shall be limited to freely suspended loads. Cranes should not be used for dragging loads.

(5) The operator should avoid carrying loads over people.

(6) The operator shall test the brakes each time a load approaching the rated load is handled, by lifting it a few inches and applying the brakes.

(7) The load shall not be lowered below the point where less than three full wraps of rope remain on the drum.

(8) When swinging the boom or jib, trolleying a load, or traveling the crane, sudden starts and stops shall be avoided. Swing and travel speeds shall be such that the load does not swing out beyond the radius at which it can be controlled. A tag or restraint line shall be used when swinging of the load is hazardous.

(9) Consideration should be given to the effects of wind on loads with large sail area.

3-3.2.2 Personnel Lifting

This Volume recognizes that tower cranes are designed and intended for handling materials and not personnel. Personnel are only permitted to be lifted in a personnel platform under the following conditions:

(a) The person specifically responsible for the overall work function to be performed by the people to be lifted by the crane shall determine that there is no practical alternative way to perform the needed work or to gain access to the area, and shall authorize its usage in writing.

(b) Communication between the crane operator, signal person, and person(s) being lifted shall be maintained.

(c) In all aspects, personnel lifting operations shall be done in accordance with the applicable provisions of ASME B30.23.

SECTION 3-3.3: SIGNALS

3-3.3.1 General (16)

(a) The crane operator and signal person shall continuously maintain communications during all crane operations. If at any time communication is disrupted, the operator shall stop all crane operations until communication is restored and a proper signal is given and understood.

(b) If the operator has any concerns regarding the signaled movement of the crane or needs to communicate with the signal person, the operator shall stop all crane operations. Crane operations shall not resume until the operator and the signal person agree that the issue at hand has been resolved.

(c) If it is desired to give instructions to the operator other than those provided by the established signal system, the crane operation shall be stopped.

3-3.3.2 Standard Signals

Standard signals to the operator shall be in accordance with the standards prescribed in paras. 3-3.3.4 and

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3-3.3.5, unless voice communication equipment (telephone, radio, or equivalent) is utilized. No crane motion or speed change shall be made unless signals are clearly understood.

3-3.3.3 Signal Person Qualifications

Prior to signaling crane operations, all signal persons shall be tested by a qualified person and have demonstrated their qualifications in the following areas:

(a) basic understanding of crane operation and limitations

(b) standard hand signals described in para. 3-3.3.4 whenever hand signals are used

(c) standard voice signals described in para. 3-3.3.5 whenever voice signals are used

3-3.3.4 Standard Hand Signals

Hand signals shall be in accordance with Fig. 3-3.3.4-1 and shall be posted at the work site.

(16) 3-3.3.5 Standard Voice Signals

Prior to beginning lifting operations using voice signals, the signals shall be discussed and agreed upon by the lift director, crane operator, and designated signal person.

(a) Telephones, radios, or equivalent, if used, shall be tested before lifting operations begin.

(b) Prior to commencing a lift, the operator and signal person shall contact and identify each other.

(c) All directions given to the crane operator by the signal person shall be given from the operator's direction perspective (e.g., swing right).

(d) Each series of voice signals shall contain three elements stated in the following order:

(1) function and direction

(2) distance and/or speed

(3) function stop

NOTE: These are some examples of signals.

(a) Swing right 50 ft, 25 ft, 15 ft, 10 ft, 5 ft, 2 ft, swing stop.

(b) Hoist down 100 ft, 50 ft, 40 ft, 30 ft . . . 2 ft, hoist stop.

(c) Hoist up slow, slow, slow, hoist stop.

(e) For lifting operations using voice signals, the lift director shall consider the complexity of the lift, the capabilities of the crane, and the ability to communicate the necessary signals before permitting multiple simultaneous crane functions.

3-3.3.6 Special Signals

For operations not covered by paras. 3-3.3.4 and 3-3.3.5, or for special conditions that could affect operations, additions to or modifications of the standard signals may be required. In these cases, special signals shall be agreed upon in advance by the operator and the signal person, and should not be in conflict with standard signals.

3-3.3.7 Audible Emergency Signal

Emergency signals can be given by anyone. The signal used shall be agreed upon for each job site and meet the requirements of para. 3-3.3.6 (e.g., multiple short audible or a continuous audible signal).

SECTION 3-3.4: MISCELLANEOUS

3-3.4.1 Rail Clamps

Rail clamps, if used, should have slack between the point of attachment to the rail and the end fastened to the crane. Rail clamps shall not be used as a means of restraining tipping of a crane.

3-3.4.2 Ballast or Counterweight

Cranes shall not be operated without the ballast or counterweight in place as specified by the manufacturer. Under specific conditions, such as during crane assembly or disassembly, the manufacturer's recommendations for the amount of partial ballast or counterweight shall be adhered to. The maximum ballast or counterweight approved by the manufacturer for use on a given crane shall not be exceeded. Unauthorized addition of ballast or counterweight constitutes a hazard in two ways as follows:

(a) the structural competence of the various parts of the crane may be exceeded, causing failure

(b) the manufacturer's margin of backward stability may be exceeded and the crane may turn over backwards

3-3.4.3 Operating Near Electric Power Lines

(a) Cranes shall be operated so that no part of the crane or load enters into the danger zone shown in Fig. 3-3.4.3-1.

EXCEPTIONS:

(1) The danger zone may be entered if the electric distribution and transmission lines have been deenergized and visibly grounded at the point of work.

(2) The danger zone may be entered if insulating barriers (not a part of, nor an attachment to, the crane) have been erected to prevent physical contact with the lines.

(1) For lines rated 50 kV or below, minimum clearance between the lines and any part of the crane or load (including handling appendages) shall be 10 ft (3 m). For higher voltages, see Table 3-3.4.3-1.

(2) Caution shall be exercised when working near overhead lines because they can move horizontally or vertically due to wind, moving the danger zone to new positions.

(3) A qualified signal person shall be assigned to observe the clearance when the crane moves to within a boom or jib's length of the Table 3-3.4.3-1 limits. The operator is not in the best position to judge distance between the power line and the crane or its protuberances.

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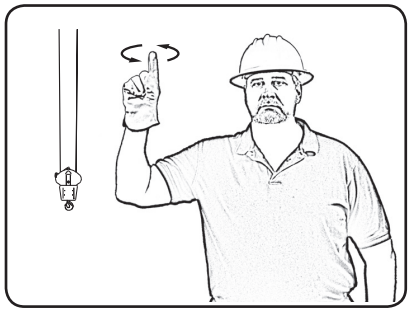
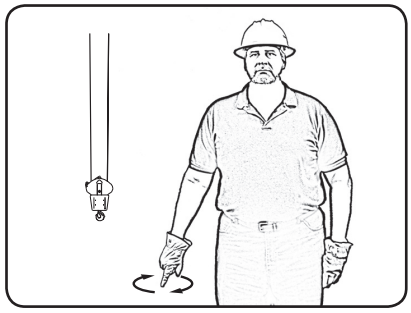
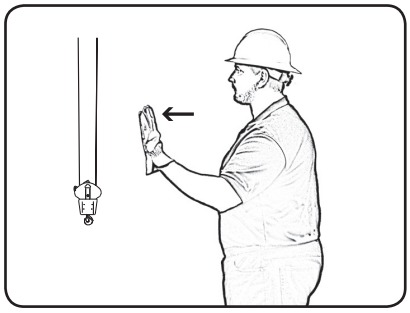
Fig. 3-3.3.4-1 Standard Hand Signals for Controlling Tower Cranes



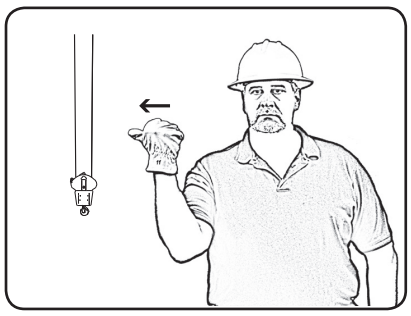
HOIST: With forearm vertical, forefinger pointing up, move hand in small horizontal circle.



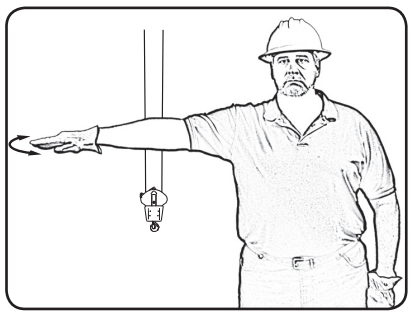
LOWER: With arm extended downward, forefinger pointing down, move hand in small horizontal circles.



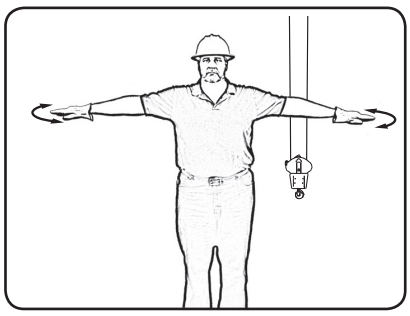
TOWER TRAVEL: Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.



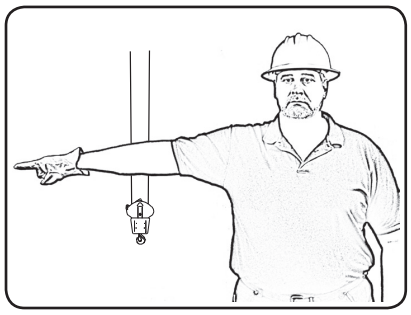
TROLLEY TRAVEL: Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.



STOP: Arm extended, palm down, move arm back and forth.

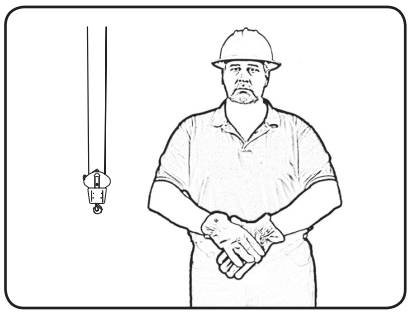


EMERGENCY STOP: Both arms extended, palms down, move arms back and forth.



SWING: Arm extended, point with finger in direction of swing of boom.

MOVE SLOWLY: Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. *(Hoist slowly shown as example.)*



DOG EVERYTHING: Clasp hands in front of body.

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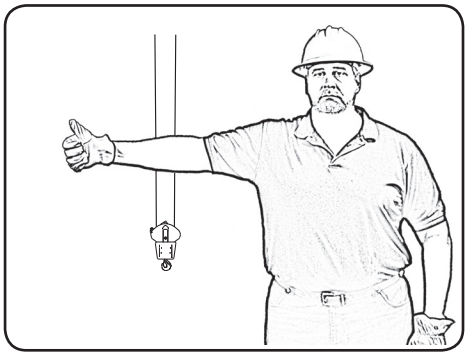
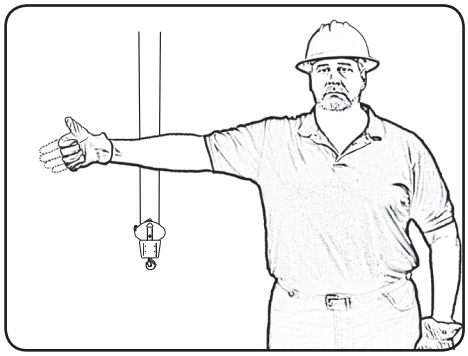
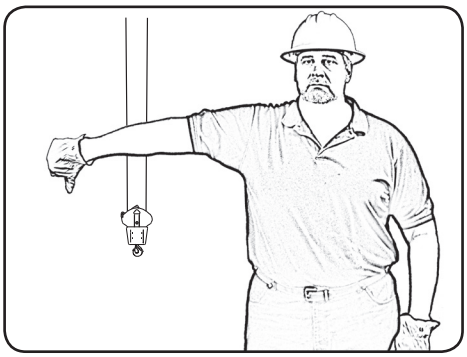
Fig. 3-3.3.4-1 Standard Hand Signals for Controlling Tower Cranes (Cont'd)



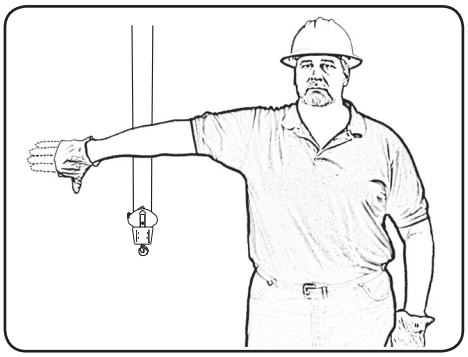
RAISE BOOM: Arm extended, fingers closed, thumb pointing upward.



RAISE BOOM AND LOWER LOAD: With arm extended, thumb pointing upward, flex fingers in and out as long as load movement is desired.



LOWER BOOM: Arm extended, fingers closed, thumb pointing downward.



LOWER BOOM AND RAISE LOAD: With arm extended, thumb pointing downward, flex fingers in and out as long as load movement is desired.

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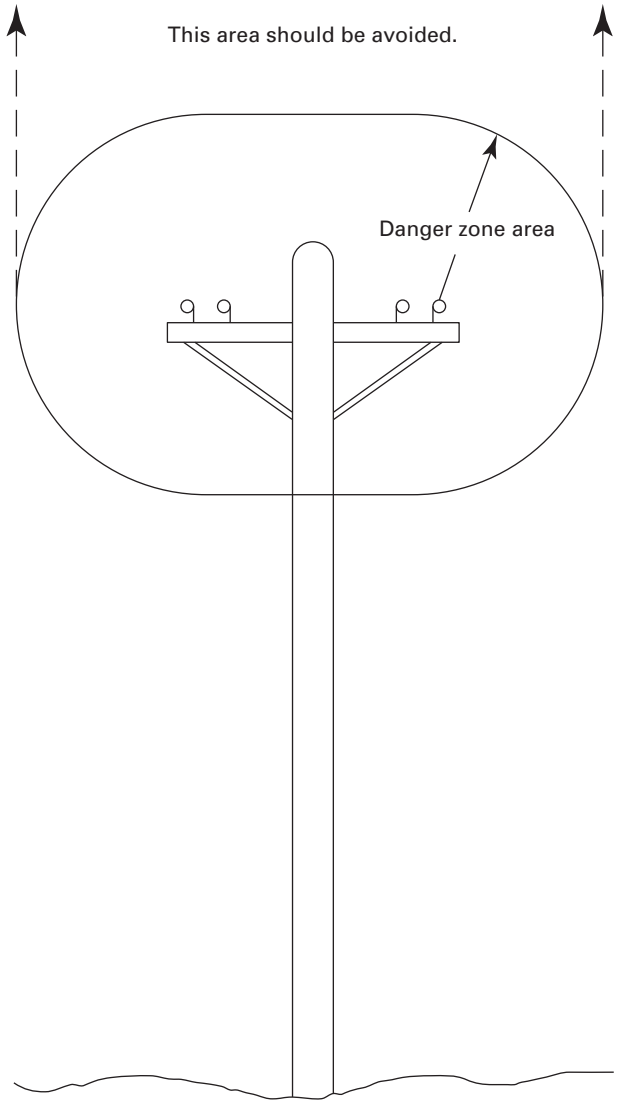
Fig. 3-3.4.3-1 Danger Zone for Cranes and Lifted Loads Operating Near Electric Transmission Lines



GENERAL NOTE: For minimum radial distance of danger zone, see para. 3-3.4.3.

Table 3-3.4.3-1 Required Clearance for Normal Voltage in Operation Near High-Voltage Power Lines

Normal Voltage, kV (Phase to Phase)	Minimum Required Clearance, ft (m)
Up to 50	10 (3.05)
Over 50 to 200	15 (4.60)
Over 200 to 350	20 (6.10)
Over 350 to 500	25 (7.62)
Over 500 to 750	35 (10.67)
Over 750 to 1,000	45 (13.72)

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(b) If cage-type boom guards, insulating links, or proximity warning devices are used on cranes, such devices shall not be a substitute for the requirements of para. (a) above, even if such devices are required by law or regulation. In view of the complex, invisible, and lethal nature of the electric hazard involved, and to lessen the potential of false security, limitations of such devices, if used, shall be understood by operating personnel and tested in the manner and in intervals prescribed by the manufacturer of the device. Compliance with para. (a) above is the recommended practice of this Volume in determining permissible proximity of the crane and its protuberances, including load and load lines, to electric power lines.

(c) Before the commencement of operations near electric lines, the person responsible for the job shall notify the owners of the lines or their authorized representatives, providing them with all pertinent information and requesting their cooperation.

(d) Any overhead wire shall be considered to be an energized line unless and until the person owning such line or the electric utility authorities verify that it is not an energized line.

(e) Exceptions to this procedure, if approved by the owner of the electric lines, may be granted by the administrative or regulatory authority if the alternate procedure provides protection and is set forth in writing.

(f) When a crane is installed in proximity to power lines, durable signs shall be installed at the operator's station and on the base of the crane, warning that electrocution or serious bodily injury may occur unless a minimum clearance of 10 ft (3 m) is maintained between the crane or the load being handled and energized power lines. Greater clearances are required because of higher voltage, as stated in para. (a)(1) above. These signs shall be revised when the local jurisdiction requires greater clearances.

3-3.4.4 Cabs

(a) Necessary clothing and personal belongings shall be stored in such a manner as to not interfere with access or operation.

(b) Tools, oilcans, waste, and other necessary articles shall be stored in the toolbox and shall not be permitted to lie loose in or about the cab.

3-3.4.5 Refueling

(a) When refueling with gasoline using a portable container, it shall be a safety-type can equipped with automatic closing cap and flame arrester.

(b) Machines shall not be refueled with the engine running.

(c) Smoking and open flames shall be prohibited in the refueling area.

3-3.4.6 Fire Extinguishers

(a) A class ABC portable fire extinguisher shall be kept in the cab or on the machinery platform of the crane.

(b) Operating and maintenance personnel shall be familiar with the use and care of the fire extinguishers provided.

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