ASME B30.3-2004

(Revision of ASME B30.3-1996)

Construction 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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The next edition of this Standard is scheduled for publication in 2007. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://www.asme.org/codes/ as they are issued, and will also be published within the next edition of the Standard.

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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 (formerly the United States of America Standards Institute). 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 to 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 (later changed to American Standards Association and subsequently to the USA Standards Institute), 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, the American Engineering Standards Committee 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. The Safety Code for Cranes, Derricks, and Hoists, ASA B30.2-1943, was created from the eight-page document referred to in the first paragraph. This document was reaffirmed in 1952 and widely accepted as a safety standard.

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 Naval Facilities Engineering Command, U.S. Department of the Navy, was reorganized as an American National Standards Committee on January 31, 1962, with 39 members representing 27 national organizations.

The format of the previous code was changed so that separate volumes (each complete as to construction and installation; inspection, testing, and maintenance; and operation) would cover the different types of equipment included in the scope of B30.

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

This volume of the Standard, which was approved by the B30 Committee and by ASME, was approved by ANSI and designated as an American National Standard on January 22, 2004.

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.

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

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

(04)

B30 SERIES INTRODUCTION

GENERAL

This Standard is one of a series of safety standards on various subjects which have been formulated under the general auspices of the American National Standards Institute. One purpose of the Standard is to serve as a guide to governmental authorities having jurisdiction over subjects within the scope of the Standard. It is expected, however, that the Standard will find a major application in industry, serving as a guide to manufacturers, purchasers, and users of the equipment.

For the convenience of the user, the Standard has been divided into separate volumes:

B30.1 Jacks
B30.2 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
B30.3 Construction Tower Cranes
B30.4 Portal, Tower, and Pedestal Cranes
B30.5 Mobile and Locomotive Cranes
B30.6 Derricks
B30.7 Base Mounted Drum Hoists
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
Note: B30.15-1973 has been withdrawn. The revision of B30.15 is included in the latest edition 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[1]
B30.25 Scrap and Material Handlers
B30.26 Rigging Hardware[1]
B30.27 Material Placement of Systems[1]
B30.28 Balance-Lifting Units[1]

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.

The use of cableways, cranes, derricks, hoists, hooks, jacks, and slings is subject to certain hazards that cannot be met 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 safe operation of the equipment and the handling of the loads. Serious hazards are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstructing the free passage of the load, and using equipment for a purpose for which it was not intended or designed.

The Standards Committee fully realizes the importance of proper design factors, minimum or maximum sizes, and other limiting dimensions of wire rope or chain and their fastenings, sheaves, sprockets, drums, 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 the condition of the equipment or material; on the loads; on the acceleration or speed of the ropes, chains, sheaves, sprockets, or drums; on the type of attachments; on the number, size, and arrangement of sheaves or other parts; on environmental conditions causing corrosion or wear; and on many variables that must be considered in each individual case. The rules given in the Standard must be interpreted accordingly, and judgment used in determining their application.

Some of the provisions of this Standard require compliance with information found in manuals or other

[1] B30.24, B30.26, B30.27, and B30.28 are in the developmental stage.

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documents supplied by the manufacturer with the equipment. This information includes recommendations, requirements, and instructions (e.g., "the reeving shall be checked for compliance with the recommendations of the manufacturer").

Compliance with the provisions should not preclude the possibility of consulting a qualified person. This is true particularly when: the equipment has been altered, repaired, or modified; the manuals or documents supplied by the manufacturer are no longer available; or the manufacturer or a successor is no longer in business and the manuals are no longer available. However, the purpose of consulting a qualified person shall not be to avoid contacting the manufacturer and using the information supplied by the manufacturer.

The Standards Committee will be glad to receive criticisms of this Standard's requirements and suggestions for its improvement, especially those based on actual experience in application of the rules.

Suggestions for changes to the Standard should be submitted to the Secretary of the B30 Committee, ASME, Three Park Avenue, New York, NY 10016, and should be in accordance with the following format:

(a) cite the specific paragraph designation of the pertinent volume;

(b) indicate the suggested change (addition, deletion, revision, etc.);

(c) briefly state the reason and/or evidence for the suggested change;

(d) submit suggested changes to more than one paragraph in the order that the paragraphs appear in the volume.

The B30 Committee will consider each suggested change in a timely manner in accordance with its procedures.

SECTION I: SCOPE

This Standard applies to the construction, installation, operation, inspection, and maintenance of jacks; power-operated cranes, monorails, and crane runways; power-operated and manually operated derricks and hoists; lifting devices, hooks, and slings; and cableways.

This Standard does not apply to track and automotive jacks, railway or automobile wrecking cranes, shipboard cranes, shipboard cargo-handling equipment, well-drilling derricks, skip hoists, mine hoists, truck body hoists, car or barge pullers, conveyors, excavating equipment, or equipment falling within the scope of the following Committees: A10, A17, A90, A92, A120, B20, B56, and B77.

SECTION II: PURPOSE

This Standard is designed to:

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

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

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

SECTION III: INTERPRETATIONS

Upon request, the B30 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B30 Committee, ASME, Three Park Avenue, New York, NY 10016.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his request utilizing the following format.

Subject: Cite the applicable paragraph number(s) and provide a concise description.

Edition: Cite the applicable edition of the pertinent volume for which the interpretation is being requested.

Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for approval of a proprietary design or situation. The inquirer may also include any plans or drawings which are necessary to explain the question; however, they should not contain any proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which could change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information which might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

SECTION IV: NEW AND EXISTING INSTALLATIONS

(a) Effective Date. The effective date of this volume for the purpose of defining new and existing installations shall be 1 year after its date of issuance.

(b) New Installations. Construction, installation, inspection, testing, maintenance, and operation of equipment manufactured and facilities constructed after the effective date of this volume shall conform with the mandatory requirements of this volume.

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(c) Existing Installations. Inspection, testing, maintenance, and operation of equipment manufactured and facilities constructed prior to the effective date of this volume shall be done, as applicable, in accordance with the requirements of this volume.

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

SECTION V: MANDATORY AND ADVISORY RULES

Mandatory rules of this volume are characterized by use of the word *shall*. If a provision is of an advisory nature, it is indicated by use of the word *should* and is a recommendation to be considered, the advisability of which depends on the facts in each situation.

SECTION VI: METRIC CONVERSIONS

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

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ASME B30.3-2004
SUMMARY OF CHANGES

Following approval by the ASME B30 Committee and ASME, and after public review, ASME B30.3-2004 was approved by the American National Standards Institute on January 22, 2004.

ASME B30.3-2004 includes editorial changes, revisions, and corrections introduced in ASME B30.3a-1997, B30.3b-1998, and B30.3c-1999, as well as the following changes identified by a margin note, **(04)**.

Page	*Location*	*Change*
viii, x	B30 Series Introduction	General and Section VI revised
1–3, 6, 8	3-0.2.2	(1) Definitions of *base, tower crane*; *climbing*; *climbing frame*; *pitch diameter*; *service, heavy*; *service, light*; *service, normal*; and *trolley* revised (2) Definitions of *base, fixed* and *telescoping* deleted
11	3-1.1.1(e)	Revised
12	3-1.1.3	Revised in its entirety
	3-1.1.4(i)	Revised
13	3-1.1.6(c)	Revised
	3-1.1.6(d)	Revised
14	3-1.2.1(c)	Revised
16	3-1.5.1	Revised in its entirety
	3-1.5.2	Revised in its entirety
17	3-1.5.3(a)	Revised
	3-1.5.4(a)	Revised
18	Section 3-1.8	(1) Title revised (2) Subparagraphs 3-1.8(a), (b), (c), and (e) revised
19	Section 3-1.11	(1) Title revised (2) Revised in its entirety
	3-1.13(d)	Last sentence added
20	3-1.15.1(j)	Added
24	3-2.1.6	Added
25	3-2.3.3(a)	Revised

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Page	*Location*	*Change*
28–30	3-3.1.3	(1) New subparagraph (l) added (2) Former subparagraphs (l) through (p) redesignated as (m) through (q), respectively (3) Subparagraphs (m) and (n) revised
	3-3.2.1	(1) New subparagraph (b) added (2) Former subparagraphs (b) through (d) redesignated as (c) through (e), respectively

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CONSTRUCTION TOWER CRANES

Chapter 3-0
Scope, Definitions, and References

SECTION 3-0.1: SCOPE OF B30.3

Within the general scope as defined in Section I, B30.3 applies to construction tower cranes, powered by electric motors or internal combustion engines, and any variations thereof which retain the same fundamental characteristics. The scope includes cranes of the above type that adjust operating radius by means of a boom luffing mechanism, or by means of a trolley traversing a horizontal boom, or by means of a combination of the two. Construction tower cranes may be mounted on fixed or traveling bases. Additional mounting means may include arrangements that permit the crane to climb in the structure being built, or that permit increasing the tower height as the structure rises and utilizing braces attached to the host structure as needed.

The requirements of this volume are applicable only to cranes when used in lifting work. Permanently mounted tower cranes (refer to ASME B30.4) and mobile crane tower attachments (refer to ASME B30.5) are not within the scope of this volume.

SECTION 3-0.2: DEFINITIONS

3-0.2.1 Types of Cranes

(a) 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, (five years or more). The configuration of the crane usually remains unchanged during the entire installation period. Permanently mounted tower cranes are covered under ASME B30.4.

(b) By Type of Boom

hammerhead tower crane: a tower crane with a horizontal boom and a load trolley that traverses the boom to change load radius (see Figs. 1 and 5).

luffing 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 Figs. 2 and 6).

(c) By Support Arrangement

braced or guyed tower crane: a tower crane with braces or guys attached to the tower (mast) to permit the crane to be erected to greater than the maximum free-standing height (see Figs. 5 and 6).

free-standing tower crane: a tower crane that is supported on a foundation or structural frame without assistance from braces, guys, or other means (see Figs. 1 and 2).

internal climbing tower crane: a tower crane arranged to raise itself from floor to floor in a building as construction advances (see Fig. 7).

(d) By Ability to Travel

fixed-base tower crane: a free-standing, braced, or guyed tower crane that is mounted on a foundation or structural frame and does not travel (see Figs. 1 and 2).

traveling tower crane: a free-standing tower crane mounted on a ballasted platform furnished with trucks that ride along rails (see Fig. 3).

3-0.2.2 General (04)

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 governmental jurisdiction.

appointed: assigned specific responsibilities by the employer or the employer's representative.

authorized: approved as satisfactory by a duly constituted administrative or regulatory authority.

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

balance: the condition of the superstructure of a tower crane necessary for telescoping and climbing; the load or the boom is positioned at that radius which causes the

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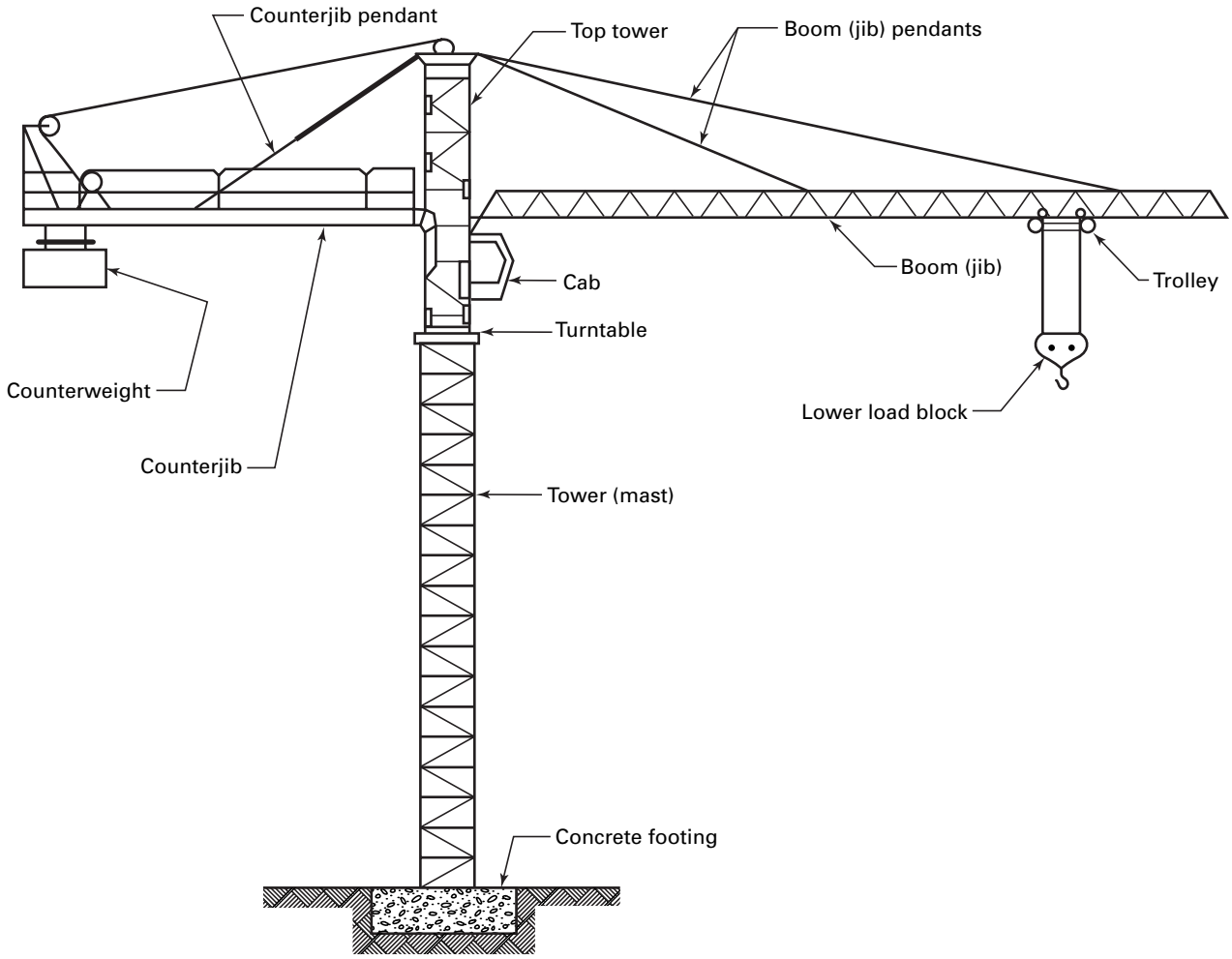


Fig. 1 Hammerhead Tower Crane — Fixed-Base, Free-Standing Crane

vertical moment of the superstructure about the balance point to go to zero.

ballast: weight added to a crane base to create additional stability; it does not rotate when the crane swings. Also used to refer to materials placed under rails, such as crushed stone, to support the rail ties or sleepers, to provide drainage, and to distribute the applied loads.

base, anchor bolt: a crane base that is bolted to a footing [see Fig. 4(a)].

base, expendable: for static-mounted cranes, a style of bottom mast section or member that is cast into a concrete footing block; all or part of this component is lost to future installations [see Fig. 4(b)].

base, knee brace: a crane base that uses diagonal members to spread the loading [see Fig. 4(c)].

base, tower crane: a mounting accessory to secure the bottom of the tower (mast) to a foundation, structural frame, or travel base.

base, travel: a crane base that is a ballasted platform mounted on trucks that ride along rails (see Fig. 3).

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

boom (jib): on hammerhead tower cranes, the horizontal structural member attached to the rotating superstructure of a crane on which the load trolley travels when changing load radius; on luffing and other types of tower crane, a member hinged to the rotating superstructure and used for supporting the hoisting tackle.

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 free-standing height (see Fig. 6).

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

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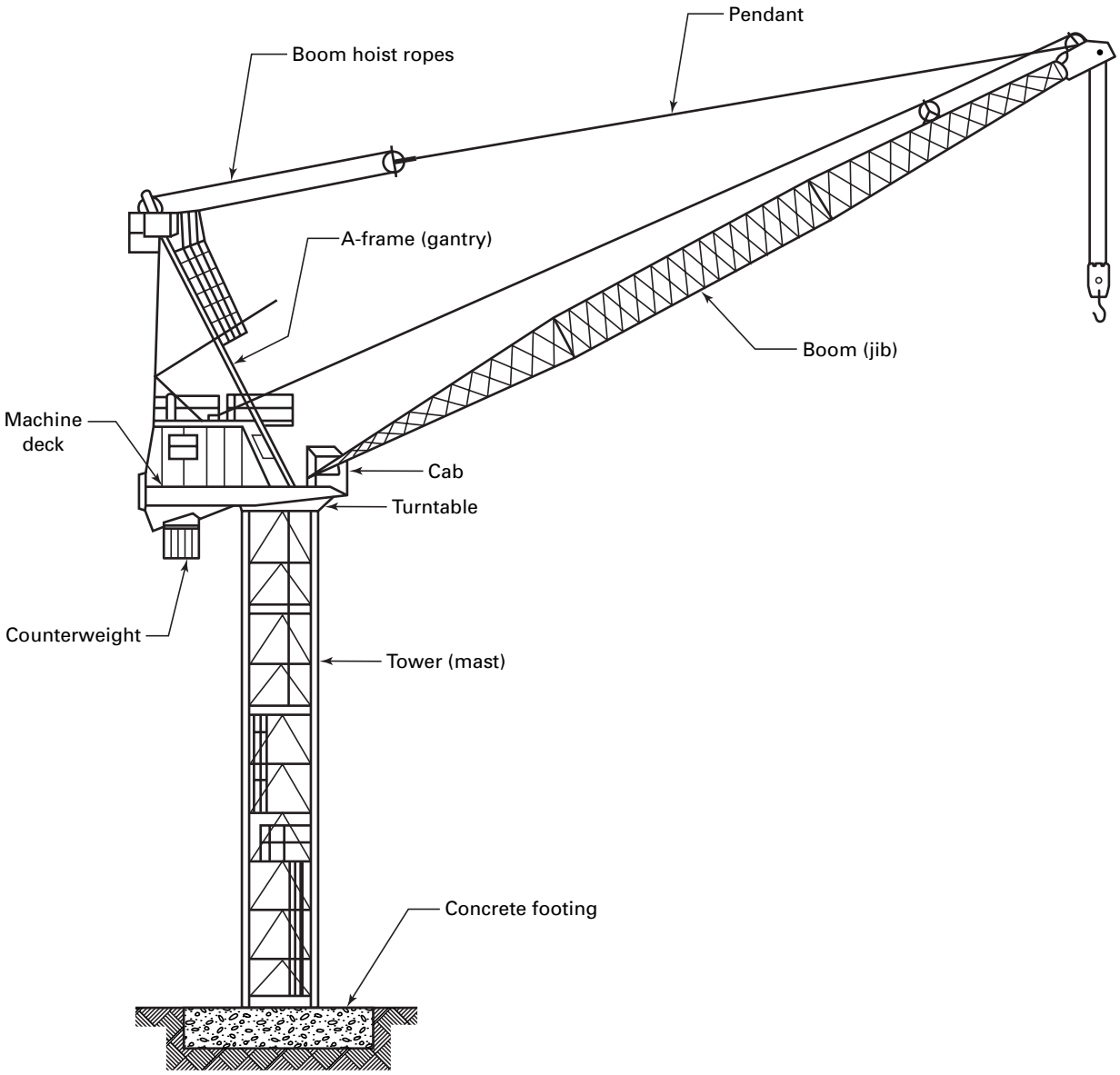


Fig. 2 Luffing Tower Crane — Fixed-Base, Free-Standing Crane

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 free-standing, braced, or guyed cranes, the process whereby the height of the tower (mast) is increased by adding sections at the top (see Fig. 6); for internal climbing cranes, the process whereby the entire crane is raised on or within a structure which is under construction as the height of that structure increases (see Fig. 7).

climbing frame: for free-standing, braced, or guyed cranes, a structural frame supporting the superstructure which surrounds the tower (mast) and contains arrangements to raise the frame and superstructure of the crane for insertion 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.

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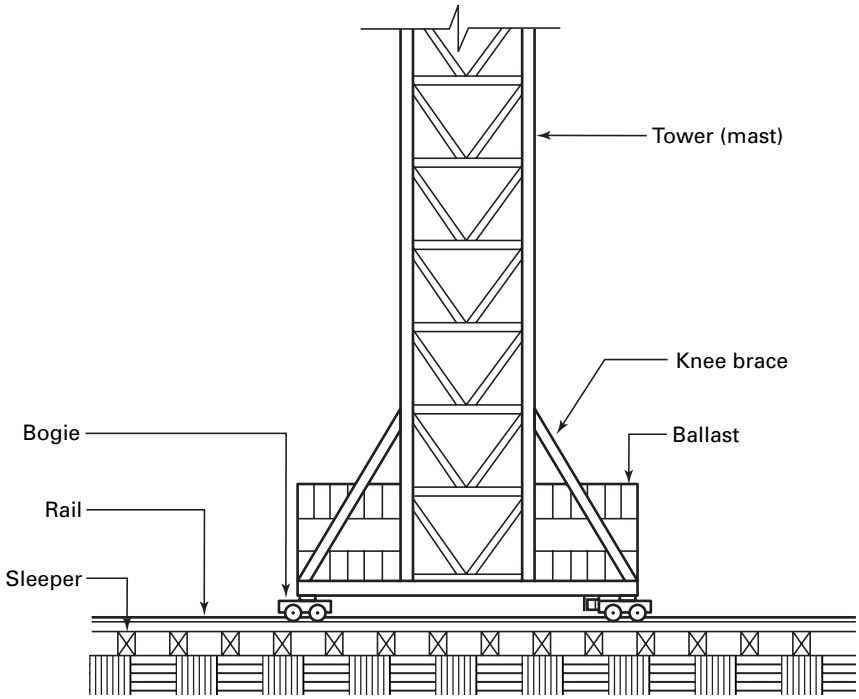


Fig. 3 Travel Base for Free-Standing Crane

clutch: a means for engagement or disengagement of power.

counterjib (counterweight jib): 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 construction tower cranes, which are lifting machines consisting of a tower (mast) with a superstructure that rotates and includes a load boom (jib) and, on some cranes, a counterjib extending in the opposite direction to the load boom (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.

designated person: a person selected or assigned by the employer or the employer's representative as being competent to perform specific duties.

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.

free-standing height: that height of a crane which is supported by the tower (mast) 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. 5).

high strength (traction) 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 (boom): see *boom (jib)*.

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

limiting device: a mechanical device which is operated by some part of a power driven machine or equipment to control loads, or motions of the machine or equipment.

load: the total superimposed weight on the load block or hook.

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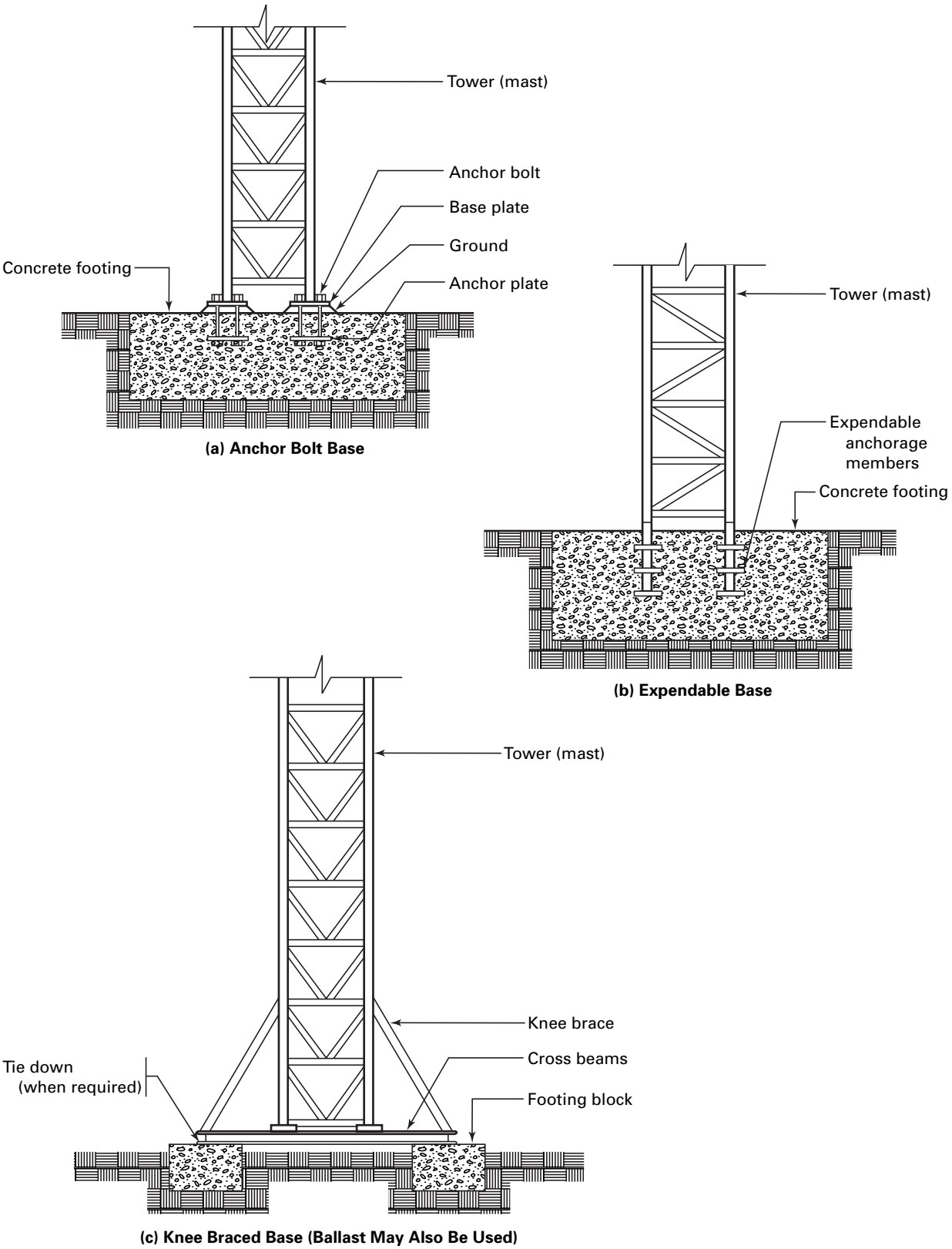
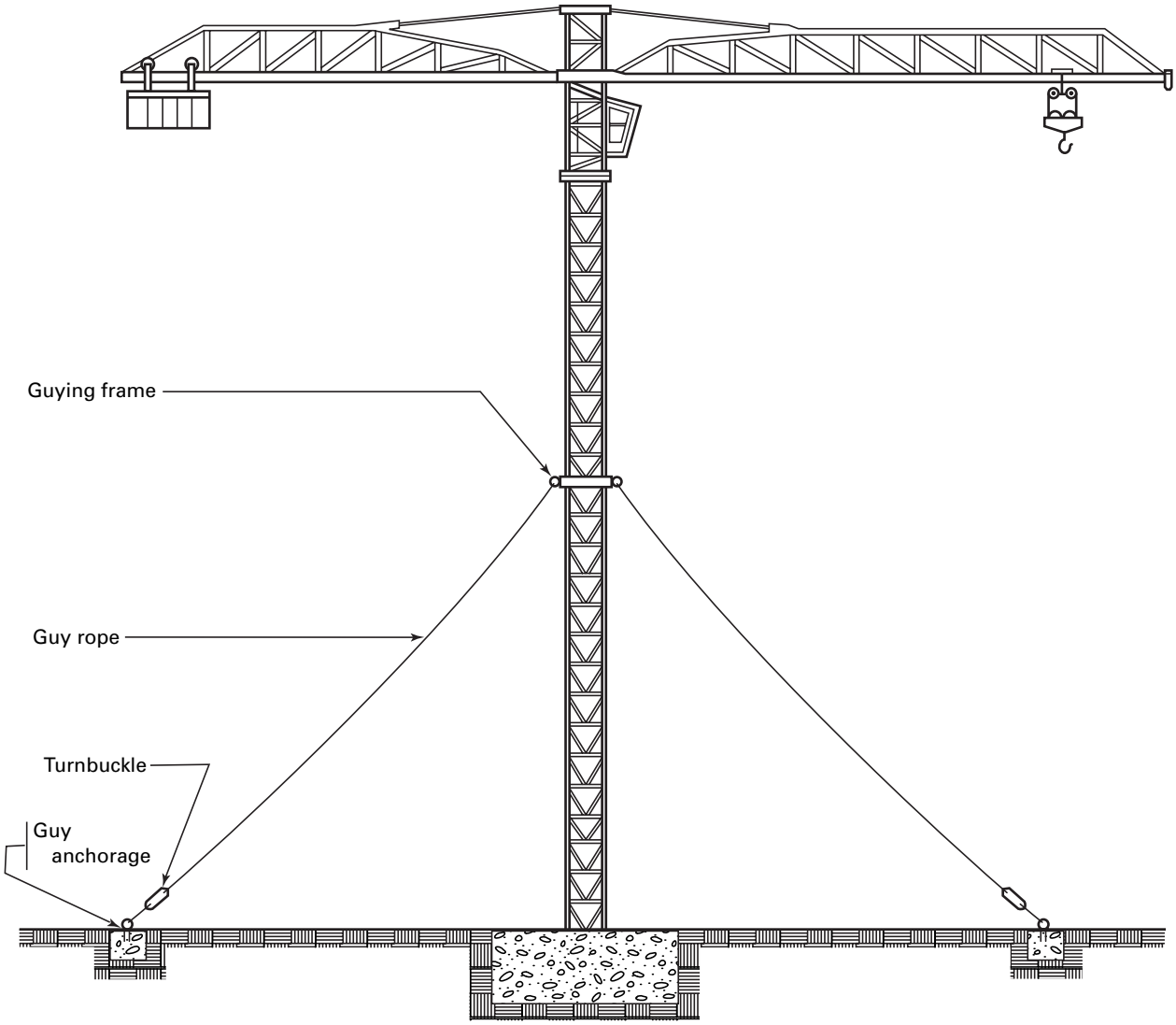


Fig. 4 Types of Fixed Bases

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GENERAL NOTE: Three or more guys to be provided, symmetrically arranged.

Fig. 5 Guyed Tower Crane

load, working: the external load applied to the crane including the weight of load attaching equipment such as ropes, shackles, hooks, slings, and load blocks (unless the load block is considered a part of the rating by the manufacturer).

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

load block, upper: the assembly of sheaves, pins, and frame attached to the boom or mounted in the load trolley.

load hoist: a hoist drum and rope reeving system used for hoisting and lowering loads.

mast: see *tower*.

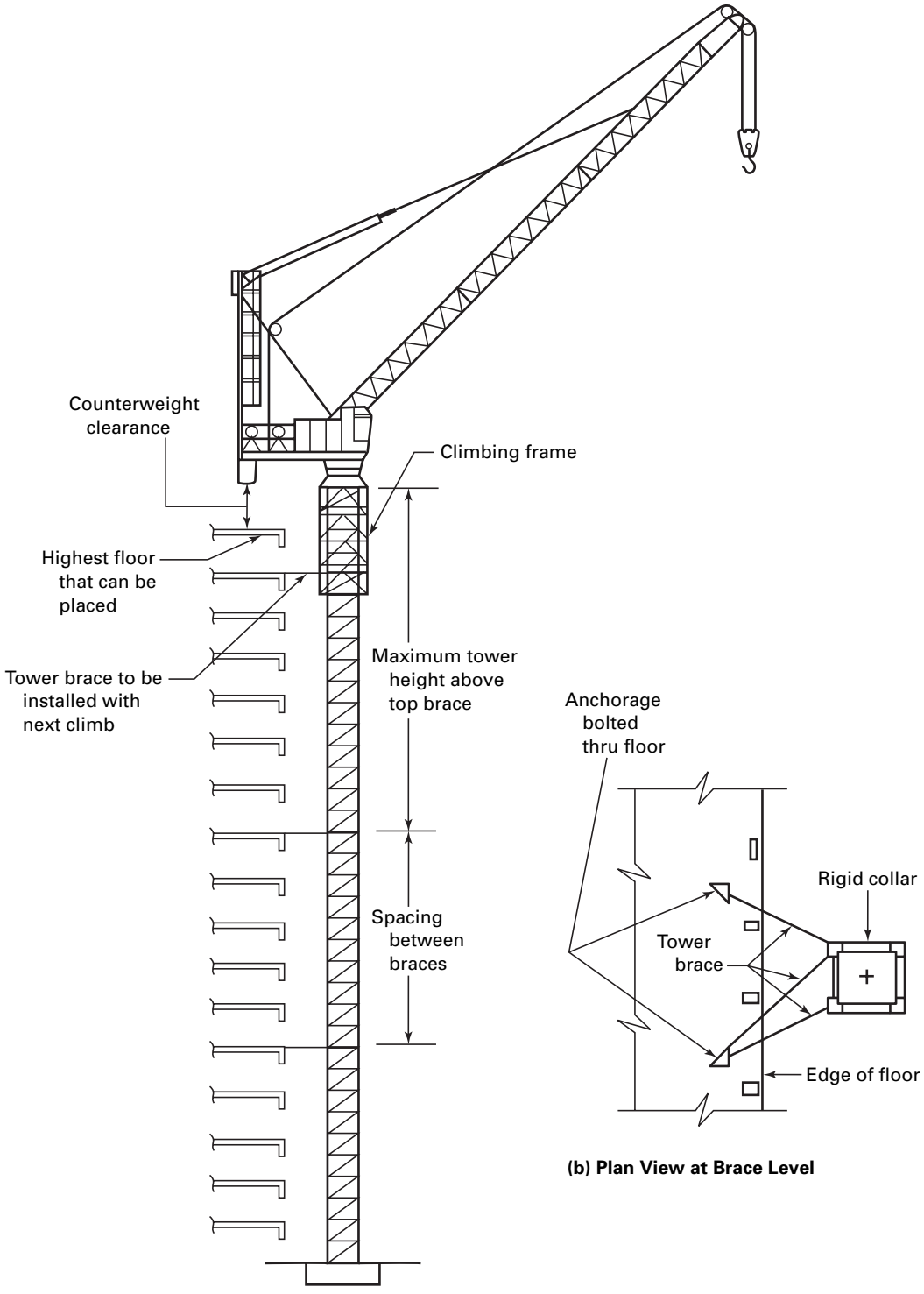
out-of-service: the condition of a crane when unloaded, without power and with the controls unattended, and prepared to endure winds above the in-service level.

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.

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

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(a) Elevation

(b) Plan View at Brace Level

Fig. 6 Braced Crane

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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.

remote control station: a location, not on the crane, from which the operator can control all the crane movements.

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.

service, heavy: service that involves operating at 85% to 100% of the rated load or in excess of 10 lift cycles per hour as a regular specified procedure. Cranes regularly engaged in rapid concrete placement operations may fall into this category.

service, light: service that involves irregular operation with loads generally about one-half or less of the rated load.

service, normal: service that involves operating occasionally at rated load but normally at less than 85% of the rated load and not more than 10 lift cycles per hour, except for isolated instances.

service life: the time, expressed as the sum of the periods of operation, over which a stressed component can function without undue risk of failure when the crane is operated in accordance with the manufacturer's instructions under either light, normal, or heavy service.

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.

stabilizers: auxiliary devices for increasing stability of a crane, such as guys, for example.

structural competence: the ability of the machine and its components to withstand the stresses imposed by applied rated and dynamic loads.

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.

tower (mast): 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.

traction (high strength) bolts: see *high strength bolts*.

trolley: the component of the crane that travels along the boom (jib) of a hammerhead tower crane and contains the upper load block.

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

truck, travel: the assembly that includes a pivot, frame axle(s), and wheel(s) on which a crane rides on rails; see also *bogie*.

two-blocking: the condition when the lower load block or hook assembly comes in contact with the upper load block.

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

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

wedge: a tapered wood or steel device used to provide stability to cranes during use as a climber. When the wedges are tightened against the four main legs of the tower, they convert overturning moments into horizontal forces to be resisted by the floor framing or slab (see Fig. 7).

SECTION 3-0.3: REFERENCES

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

ANSI A14.3-1992, Safety Requirements for Ladders — Fixed[1]

ANSI A1264.1-1995, Safety Requirements for Workplace Floor and Wall Openings, Stairs, and Railings Systems[1]

Publisher: American Society of Safety Engineers, 1800 East Oakton Street, Des Plaines, IL 60018-2187

ANSI Z26.1-1990, Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways

Publisher: American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036

ANSI/ASCE 7-98, Minimum Design Loads for Buildings and Other Structures[1]

Publisher: American Society of Civil Engineers (ASCE), 1801 Alexander Bell Drive, Reston, VA 20191-4400

[1] May also be obtained from the American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036.

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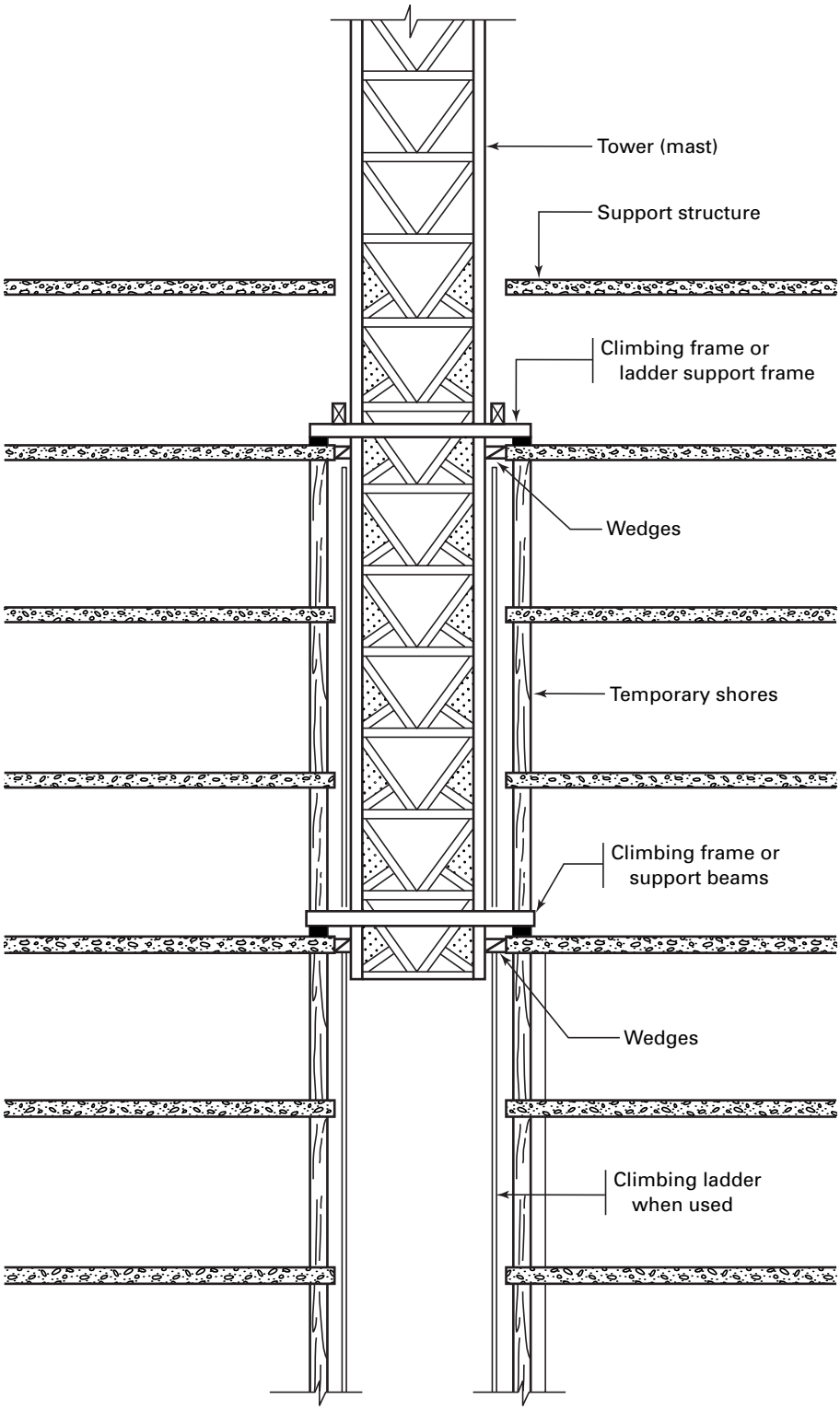


Fig. 7 Internal Climbing Crane

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ANSI/AWS D1.1-94, Structural Welding Code — Steel[1]

ANSI/AWS D14.3-93, Specification for Welding Earthmoving and Construction Equipment[1]

Publisher: American Welding Society (AWS), 550 NW LeJeune Road, Miami, FL 33126

ASME B30.10-1993, Hooks[1]

Publisher: The American Society of Mechanical Engineers (ASME International), Three Park Avenue, New York, NY 10016-5990; Order Department: 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300

[1] May also be obtained from the American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036.

ANSI/NEMA Publication ICS-3-1988, Industrial Systems[1]

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

ANSI/NFPA 70-1993, National Electrical Code[1]

Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101

ANSI/SAE J185 — Jun81: Access Systems for Off Road Machines[1]

Publisher: Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096-0001

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

SECTION 3-1.1: SITE PREPARATION AND ERECTION

3-1.1.1 Crane Supports

(a) All load bearing foundations, supports, and rail tracks shall be constructed or installed to support the crane loads and to transmit them to the soil or other support medium. In addition to supporting vertical load, foundations and supports, rail supports excepted, should be designed to provide a moment resisting overturning equal to a minimum of 150% of the maximum crane overturning moment. This requirement may be met by means of structural anchors or ballast.

(b) Anchorage blocks for guys, when used, should be arranged so that resistance to sliding or other lateral movement, to pullout, and to overturning is a minimum of 150% of the force applied, or shall be structurally anchored.

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

(d) Splices in rail tracks (bolted or welded) shall have smooth joints.

(04) *(e)* When required, a designated portion of track, or a designated portion of the working track, shall be arranged and constructed as an out-of-service parking area complete with means needed for supporting the crane against storm wind effects and anchoring it against unwanted movement along the track; the parking track should be in place before erection commences.

(f) The crane manufacturer or a qualified person shall provide maximum resulting loads at the base of the crane, or wheel loads, for use in design of the supports [see para. 3-1.4.1(a)(1)].

3-1.1.2 General Erection and Dismantling Requirements

(a) When cranes are erected/dismantled, written instructions by the manufacturer or qualified person and a list of the weights of each sub-assembly to be erected/dismantled shall be at the site.

(b) Erection and dismantling shall be performed under the supervision of a qualified person.

(c) Procedures shall be established before erection/dismantling work commences to implement the erection/dismantling instructions and to adapt them to the particular needs of the site. The need for temporary or permanent guying or bracing should be considered.

(d) Since crane masts or other components utilize connections with special devices or high strength bolts, a qualified person shall instruct the erection personnel in the means of identifying and installing these special devices and high strength bolts.

(e) When assembling mast sections connected by high strength (traction) bolts, the bolts should not be tensioned to provide full prestress until the crane is completely erected, unless the manufacturer's instructions state otherwise. At that time, before fully tensioning bolts in any one mast leg, the crane superstructure should be rotated to place the counterweight above that leg.

(f) Before reusing bolts, pins, or other connection parts, they should be inspected for condition. Visible cracks, difficulty in threading a nut by hand, or visible necking down of the shank are indications of yielding or damage and reason for rejection.

(g) Before crane components are erected, they shall be visually inspected for damage from shipping and handling. Dented, bent, torn, gouged, or otherwise damaged structural members shall not be erected until repaired in accordance with the manufacturer's or a qualified person's instructions, or replaced.

(h) Slings and lifting accessories should be selected and arranged so as to avoid damaging or marring crane members during erection and dismantling.

(i) Wind velocity at the site at the time of erection/dismantling should be considered as a limiting factor that could require suspending the erection/dismantling operation.

(j) Crane masts should be erected plumb to a tolerance of 1:500 (about 1 in. in 40 ft) unless the manufacturer specifies otherwise.

(k) Cranes required to weathervane when out-of-service shall be installed with clearance for boom (jib) and superstructure to swing through a full 360 deg. arc without striking any fixed object or other weathervaning crane.

(l) Advertising signs or similar panels shall not be installed on booms (jibs) or counterjibs (counterweight jib) unless size and positioning satisfy the manufacturer's or a qualified person's limitations.

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(04) 3-1.1.3 Free-Standing Cranes

(a) Cranes shall be mounted to bases in compliance with the manufacturer's or a qualified person's instructions. Unless instructed otherwise, leveling nuts shall not be used under base plates when the anchor bolts are to be prestressed. The anchor bolts should be checked and torqued in accordance with the manufacturer's or a qualified person's instructions, or tensioning should proceed as in para. 3-1.1.2(e).

(b) Expendable-type bases should be installed level to a tolerance of 1:500 (about $^1/_4$ in. in 10 ft) or better. It is recommended that loose expendable base leg sections be installed while bolted or pinned to the lowermost tower (mast) section. The base should be securely held in place before the foundation concrete is poured.

(c) When templates are used to position expendable-type bases, they should be rigid and built to tolerances that place all tower (mast) leg bearing surfaces in the same plane.

(d) Cranes shall be erected free standing to no greater height than that recommended by the manufacturer or by a qualified person; wind conditions of the geographic area should be considered.

(e) If the manufacturer's recommendations indicate erection of counterweight before the boom (jib) is in place, care should be taken both to limit impact during setting counterweights and to install no more counterweight at this time than the tower (mast) or other components can support.

(f) Traveling crane bases shall be ballasted, in accordance with the manufacturer's instructions, before erecting those portions of the crane above the tower.

(g) Provisions shall be made to prevent traveling bases from rolling on the track in the event of high winds.

(h) Rails should be level and straight, unless specifically designed for curves or grades, and properly spaced for the crane trucks in accordance with the manufacturer's specifications. The track and support system should have sufficient rigidity to limit dynamic oscillations and deviations from plumb.

(i) Rails shall be electrically grounded when they carry cranes electrically powered from an outside source.

(j) Both ends of all tracks shall be provided with stops or buffers adjusted for simultaneous contact with both sides of the travel base. Stops attached to rails shall be mounted not less than 3 ft (1 m) inboard of the last rail support [see para. 3-1.7.1(a) for additional requirements].

(k) Telescoping operations shall be performed under the supervision of a qualified person and in accordance with the manufacturer's instructions. The instructions should be at the site.

(l) Load bearing members of the climbing and support system shall be inspected before each climbing operation. Deficiencies impairing the ability of a member to support load shall be repaired, or the member replaced, before climbing begins.

(m) Before climbing, an inspection shall be made to determine if there are obstructions to free movement. Obstructions shall be cleared before the climbing operation commences.

(n) Before climbing, cranes shall be balanced in accordance with the manufacturer's or a qualified person's instructions.

(o) At the time of climbing, wind velocity at the crane superstructure shall not exceed the limit set by the manufacturer or a qualified person. Absent such limit, climbing can be performed at wind gust speeds not exceeding 20 mph (9 m/s) at the crane superstructure. The characteristics of the gusts should be considered for their effect on the climbing operation.

3-1.1.4 Guyed or Braced Cranes

(a) A bracing schedule should be prepared in advance of the installation. The schedule should indicate each level at which the crane is to be braced, the maximum tower height to be erected above each brace, and the maximum height to which construction can be carried before the crane must be increased in height.

(b) The vertical spacing between the braces and the free standing height of the crane above the topmost brace shall be in accordance with the manufacturer's or a qualified person's recommendations; wind conditions of the geographic area per ANSI/ASCE 7 should be considered.

(c) Braces should be designed and anchored to the bracing structure to resist the forces given by the manufacturer or by a qualified person when applied in any horizontal direction.

(d) Cranes should not be guyed when prohibited by the manufacturer.

(e) Guys shall be preloaded to a predetermined force level and means to verify preload should be provided. Guys shall include means to adjust tension and to plumb the crane tower (mast) (balanced and in calm air). Installations requiring guys should be designed by a qualified person.

(f) Flags or markers of high visibility color should be placed on guys to make them visible to the operator.

(g) Guy attachment at the tower (mast) shall be made so as not to damage tower (mast) members, not to introduce eccentric loadings, nor to distort the tower (mast) cross section. Cross bracing, if used, shall be attached in a manner that will not permit dislodgement from elastic movements of the tower (mast).

(h) Guys shall be attached at their lower ends to anchorages [see para. 3-1.1.1(b)].

(i) For telescoping, see paras. 3-1.1.3(k) through (o). (04)

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3-1.1.5 Climbing Cranes

(a) A climbing schedule should be prepared in advance of the installation. The schedule should indicate each level at which the crane will be mounted for operation giving the locations of supports for both horizontal and vertical crane reactions and the maximum height to which construction can be carried before the crane must climb again.

(b) The means of transferring horizontal and vertical crane reactions to the host structure shall be reviewed by a qualified person. Wind effects for the height of crane mounting should be considered.

(c) Cranes shall not be climbed in concrete structures until the concrete at the levels at which horizontal and vertical supports are to be placed has reached sufficient strength to resist the crane reactions. It may be necessary to test concrete cylinders or cores or to use on-site testing techniques for this purpose.

(d) When climbing cranes are used, the integrity of the host structure shall be reviewed by a qualified person, for the effects of crane, load, and wind forces at each level of the structure.

(e) Wedging systems, when used to plumb the crane and to transmit horizontal reactions, shall be provided with means to prevent the wedges from working loose. Wooden wedges shall not be used unless recommended by the manufacturer. When wooden wedges are used, they shall be of hardwood.

(f) Wedges shall be installed only at those portions 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. See para. 3-1.4.1(f)(6).

(g) Initially, and after each climb, the crane shall be plumbed while balanced and then held in the plumbed condition by wedges or other means. Cranes should be plumbed to 1:500 (about 1 in. in 40 ft).

(h) Written climbing instructions should be kept at the site and all climbing operations shall be performed under the supervision of a qualified person.

(i) Before initial use and before each climb, load bearing members of the climbing and support system shall be inspected. Defects impairing the ability of a member to support load shall be repaired, or the member replaced.

(j) Before climbing, cranes shall be balanced in accordance with the manufacturer's or a qualified person's instructions. Wind velocity should not exceed the limit set by the manufacturer, or 20 mph (9 m/s) at the crane superstructure if no such limit has been set.

(k) Before climbing, an inspection shall be made to determine that there are no obstructions to the free movement of the tower (mast). Climbing shall not be done if any obstructions are observed.

3-1.1.6 Preoperation Tests

(a) When cranes are erected, and after each climbing operation, before placing the crane in service, all functional motions, motion limiting devices, and brakes shall be tested for operation.

(b) When cranes are erected, load-limiting devices shall be tested for proper setting and operation before the crane is placed in service.

(c) After erection, the structural support or foundation to which the crane base is attached shall be tested before placing the crane in service. The test shall be conducted with the rated load placed at maximum radius permitted by site conditions. For free-standing cranes, when the crane support (base) is symmetrical, the superstructure shall be rotated through 90 deg with 10 min stops at the starting position and at each 45 deg position. When the support is asymmetrical, the superstructure shall be rotated through 360 deg with 10 min stops at the starting position and at each 45 deg position. If any part of the support structure becomes displaced or distressed, all crane operations shall stop until an evaluation is made by a qualified person. (04)

(d) For traveling cranes, a load test shall be conducted with the boom (jib) in the position causing maximum loading on one wheel or bogie. The test shall comprise traveling the entire length of the runway, then returning with the same load on the other rail. If a sleeper or support becomes displaced or damaged, crane operations shall stop until an evaluation is made by a qualified person or until track ballast has been reset, or repairs made and a satisfactory test performed. (04)

(e) Initial functional motion tests, shall be performed at rated load. Functional motion tests made after climbing or telescoping may be performed without load. Each test shall include:

(1) load hoisting and lowering;

(2) boom hoisting and lowering, or traversing the trolley;

(3) swing motion;

(4) brakes and clutches;

(5) limit, locking, and safety devices.

The test should continue until all controls, drives, and braking means have been engaged and they shall have functioned correctly.

(f) The order in which tests of a newly erected crane are to be performed is as follows:

(1) functional motion tests without load;

(2) functional motion tests at rated load (for other than traveling cranes, this may be combined with tests of supports);

(3) tests of supports per clause (c).

During functional motion tests, the crane supports shall be checked. Any observed displacement is reason to refrain from continuing testing until an evaluation is made by a qualified person.

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SECTION 3-1.2: LOAD RATINGS

3-1.2.1 Load Ratings Where Stability Governs Lifting Performance

(a) For each stipulated operating radius, the load rating is established by taking a percentage of the load which by calculation produces a condition of incipient tipping when the boom (jib) is in the least stable direction. Under static conditions, load ratings shall not exceed 63% of the calculated tipping loads. When wind is considered, the combined effects of static, inertial, and wind loads shall not exceed 77% of the tipping load.

(b) For a load at any operating radius, stability is affected by the length of boom (jib) mounted, counterweight arrangement and tower (mast) height and arrangement; the manufacturer shall take these conditions into account when establishing load ratings. Each load rating shall therefore be determined for the least stable permitted configuration covered by the rating.

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

(d) 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 load ratings.

(e) In addition to the above, the following stipulations shall apply to the establishment of 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. 3-1.2.1(d), but for those cranes that exhibit significant elastic deformation due to dead, live, wind, or dynamic loads, the effect of such deformations on stability shall be taken into account;

(3) lifting attachments which 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 part of published load ratings;

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

3-1.2.2 Load Ratings 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 rated loads without stresses exceeding predetermined acceptable values. Dynamic effects associated with hoisting and slewing shall be considered and 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) Under any condition of loading, stresses may also be affected by boom (jib) length, counterweight arrangement, tower (mast) height and arrangement, hoist line reeving, and hoisting speed range. Therefore, the manufacturer or a qualified person shall evaluate structural competence for the least favorable configuration and operating conditions covered by given load ratings.

(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 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. 3-1.2.2(c), but for those cranes that exhibit significant elastic deformation due to dead, live, wind, or dynamic loads, the effects of such deformations shall be taken into account;

(2) lifting attachments which 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 part of published load ratings.

3-1.2.3 Load Rating Chart

A durable rating chart with legible letters and figures shall be provided with each crane and attached in a location visible to the operator while seated at the controls and at remote control stations. The content of these charts shall include, but not be limited to, the following:

(a) a full and complete range of crane load ratings at all stated operating radii, boom (jib) lengths, hoist line reevings, and where appropriate, for each available hoist line speed range and recommended counterweight arrangement;

(b) precautionary or warning notes relative to limitations on equipment, and operating procedures;

(c) maximum permissible in-service wind velocity;

(d) advice that slings and lifting attachments are part of the load. If the lower load block is considered as part of the load, the rating chart shall so state.

(e) advice that the weight of hoist ropes beyond a stated suspended length are to be taken as part of the load.

SECTION 3-1.3: STABILITY

3-1.3.1 Backward Stability

The manufacturer or a qualified person shall demonstrate by calculation that in each recommended configuration an unloaded crane exposed to in-service wind forces in the unfavorable direction, and to an upward force at the load trolley or boom (jib) tip equal to 30% of the load rating at any operating radius, will not tip over backwards. Additionally, a calculation using 90% of

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the weight of the boom (jib) plus the fixed load handling attachments, and the full unfavorable in-service wind, shall not indicate instability. Stabilizers or ballast may be specified to achieve backward stability.

3-1.3.2 Out-of-Service Stability

(a) The manufacturer or a qualified person shall demonstrate by calculation that in each recommended configuration traveling cranes shall not become unstable when exposed to 120% of the force induced by out-of-service winds. For weathervaning booms (jibs), the boom shall be taken in the attitude dictated by its wind area balance. Nonweathervaning boom (jibs) shall be taken in the least favorable attitude. Traveling cranes shall also resist design wind level induced sliding.

(b) The design out-of-service wind velocity shall be specified. Recommendations on permitted configurations at several wind velocity levels should be given [see para. 3-1.4.1(a)(2)].

(c) 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.

3-1.3.3 Stabilizers

(a) 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 required for in-service, out-of-service, or backward stability needs.

(b) In the design of stabilizers for out-of-service protection which are intended to be installed before impending storms, and that will not remain in place during operations, consideration shall be given to the time required for installation.

3-1.3.4 Altered or Modified Cranes

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

(1) The alteration or modification shall be done by or under the direction of the original manufacturer or under the direction of a qualified person.

(2) If done under the direction of a qualified person, 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. If done by the original manufacturer, the manufacturer should retain the records. If done under the direction of the original manufacturer, both the manufacturer and the owner should retain the drawings and specifications.

(3) The alteration or modification shall comply with the applicable requirements of this volume.

(4) The crane shall be tested in accordance with para. 3-2.2.1(a) 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 3-1.4: DOCUMENTATION

3-1.4.1

Each crane shall be provided with informational literature written in English including, but not limited to, the following.

(a) Installation preparation instructions which should provide:

(1) vertical and horizontal forces and torsional and overturning moments applicable to each recommended configuration; the data should indicate whether governing forces are due to in-service or out-of-service winds, the applicable wind velocity, and whether the wind has been taken perpendicular or diagonal to the tower (mast); for traveling cranes, the data can be stated in terms of wheel or bogie loads;

(2) data or tower (mast) height limitations based on several wind velocity levels for out-of-service conditions;

(3) 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;

(4) stabilizer or ballast requirements, when applicable;

(5) the minimum distance between horizontal reaction support levels for internal climbing cranes;

(6) locations where tower (mast) sections have sufficient strength for internal climbing wedging and external climbing collar installation.

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

(8) anchorage arrangements for cranes to be installed on fixed bases;

(9) crane dimensional data.

(b) Erection and dismantling instructions which should provide:

(1) weight and dimensions for components and subassemblies;

(2) recommended lifting attachment points;

(3) center of gravity location for nonuniform components and subassemblies;

(4) the method and recommended sequence of assembly and disassembly of components and subassemblies; warnings should be given alerting erection personnel when member strength or stability requires particular methods or sequencing;

(5) 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 (traction) bolts, the point in time

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in the erection process for applying torque or tension, and the means for retaining pins, etc.;

(6) means for installing stabilizers (see para. 3-1.3.3).

(c) Operating instructions, limitations, and precautions.

(d) Maintenance requirements and recommendations including identification of those members or locations that should be periodically observed, or tested, for the purpose of detecting the onset of metal fatigue, the loosening of prestressed (traction) bolts, or wear affecting the ability of the crane to support rated loads.

(e) Repair recommendations including advice on welding procedures. The type of metal used for load sustaining members shall be identified (see para. 3-1.18.5).

(f) 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) permitted variations in electrical supply and circuit parameters;

(4) location and required settings of hydraulic or pneumatic pressure relief valves and locations of points where circuit pressures can be checked (see para. 3-1.18.9).

(5) limitations on service life of load bearing members and mechanisms including recommendations of frequency of inspection as a function of severity of service;

(6) for internal climbing cranes, identification of those portions of the tower (mast) intended to accommodate wedge reactions, or means to be employed at wedge reaction points.

SECTION 3-1.5: LOAD HOISTING AND BOOM LUFFING (BOOM HOIST) EQUIPMENT

(04) 3-1.5.1 General Requirements

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

(b) Electric motor operated cranes which are capable of overspeeding the power plant shall be provided with overspeed protection.

(c) Load Hoists

(1) The load hoist shall be capable of hoisting and lowering rated loads when fitted with recommended reeving.

(2) Hooks shall be equipped with latches unless the application makes the use of the latch impractical. When provided, the latch shall bridge the throat of the hook for the purpose of retaining slings, chains, etc., under slack conditions. Refer to ASME B30.10.

(d) Boom Hoists

(1) The boom hoist may use a rope drum for its drive or hydraulic cylinder(s), and the supporting structure may be a gantry (A-frame) or the same cylilnder(s) used to elevate the boom.

(2) With rated load suspended, boom hoist systems shall be capable of raising the boom and holding it stationary without attention from the operator.

(3) Boom hoist systems shall be capable of lowering the boom only under power control, or under hydraulic cylinder control; boom free-fall lowering capability shall not be furnished.

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

(5) Boom stops shall be provided to resist luffing booms falling backwards. Boom stops should be of one of the following types:

(a) a fixed or telescoping bumper;

(b) a shock absorbing bumper;

(c) hydraulic boom elevation cylinder(s).

(6) A boom hoist disconnect, shutoff, or hydraulic relief shall be provided to automatically stop the boom hoist when luffing booms reach a predetermined high angle. Similar limiting devices shall be furnished where necessary to guard against low angle damage.

3-1.5.2 Hoist Drums (04)

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

(b) The drum flanges shall extend a minimum of $\frac{1}{2}$ in. (13 mm) over the top of the 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 two full wraps of rope shall remain on the load hoist drum(s) when the hook is in its extreme low position.

(e) No less than two full wraps of rope shall remain on the boom hoist drum(s) when the boom is in its lowest operational position.

(f) Load hoist drums and boom hoist drums shall be provided with positive holding devices, 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 boom and rated load indefinitely, as applicable, without further attention from the operator.

(h) Boom hoist drums shall be arranged so that boom lowering shall be done only under power control. Boom

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free-fall lowering capability shall not be furnished.

(i) Load hoist drums shall be arranged so that load lowering shall be done only under power control. Load free-fall lowering capability shall not be furnished.

3-1.5.3 Hoist Brakes

(04) *(a)* Boom hoists that utilize ropes, and 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.

(b) Each load hoist and 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 boom and load, in the case of 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 boom hoist, an automatic means shall be provided to stop and hold the load (or the boom and load, in the case of the boom hoist) in the event of loss of brake actuating power.

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

(e) When automatic braking means are provided, a means, such as a manual release, should be furnished to permit controlled lowering of the load (or the boom and load in the case of a 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.

3-1.5.4 Hoist Sheaves

(04) *(a)* Sheave grooves shall be free from surface conditions which 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 which 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) All sheave bearings shall be provided with means for lubrication, except for those with permanently lubricated bearings.

(d) The pitch diameters of the upper and lower load block sheaves shall not be less than 18 and 16 times the nominal diameter of the rope used, respectively. The pitch diameters of boom hoists sheaves shall not be less than 15 times the nominal diameter of the rope used.

(e) The sheaves in the lower 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.

3-1.5.5 Hoist 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 boom hoist ropes shall not be less than 3.55.

(d) Design factors shall be the total nominal breaking strength 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) Rotation resistant rope shall be given special care during installation as it is more easily damaged than other rope.

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

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

SECTION 3-1.6: SLEWING (SWING) MECHANISM

3-1.6.1 General Requirements

(a) The swing mechanism shall be capable of smooth starts and stops, and of providing varying 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.

3-1.6.2 Slewing Brakes

A braking means with holding power in both directions shall be provided to prevent movement of the rotating superstructure during operation, and shall be capable of being set in the holding position and

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remaining so without further action on the part of the operator.

SECTION 3-1.7: TRAVEL EQUIPMENT

3-1.7.1 General Requirements

(a) Cranes shall be equipped with means to prevent running into the buffers or stops while under power.

(b) Drives shall be capable of smooth starts and stops, and of providing varying degrees of acceleration and deceleration.

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

3-1.7.2 Travel Trucks

(a) Crane trucks shall be fitted with sweeps extending below the top of the rail, unless the construction of the rail foundation prohibits such extension, and placed in front of the leading wheels in either direction.

(b) Truck wheels shall be guarded.

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

3-1.7.3 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 power or actuating pressure to the brake, and when power is not applied to the travel drive.

(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, other means shall be provided or recommended by the manufacturer or a qualified person.

(04) SECTION 3-1.8: 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 or pressure failure or of a ruptured line.

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

(3) The hydraulic system shall be provided with pressure gauge(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 a climbing intermediate step and at the position where the crane will be put back into service.

(d) Steel wedges, when used, shall be provided with means to hold them in the engaged position and prevent their dropping when disengaged.

(e) Ropes, when used for or in conjunction with climbing, shall be equalized and shall have a nominal breaking strength not less than three and one half times the load applied to the rope. Means shall be provided to minimize the possibility of the crane jamming during raising and lowering or to protect the rope from being excessively loaded.

SECTION 3-1.9: LOAD TROLLEYS

(a) Load trolleys shall be under control when traversing the boom (jib) during operations.

(b) 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.

(c) The trolley shall be provided with an operating brake capable of stopping the trolley in either direction. The 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.

(d) In addition to the operating brake, the trolley shall be equipped with an automatic braking device capable of stopping the outward movement of the load trolley in the event of trolley drive rope breakage, if such ropes are used.

(e) The jib point sheave, if provided, shall have at least one broad stripe of bright, contrasting color painted on each side so that it can be determined whether or not the sheave is turning.

SECTION 3-1.10: 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 lubricants, hydraulic fluid, or other such liquids, and dirt.

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

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(04) SECTION 3-1.11: OPERATOR AIDS

(a) Indicating devices shall be provided to:

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

(2) display the boom angle or operating radius, as appropriate. On hammerhead booms (jibs), radius indication may be by means of flags or markers placed along the length of the boom (jib) so as to be visible to the operator.

(3) display ambient wind velocity (see para. 3-1.18.7).

(b) Limiting devices shall be provided to:

(1) limit trolley travel at both ends of the boom (jib);

(2) stop boom luffing at lower and upper limits of boom movement [see para. 3-1.5.1(d)(5)];

(3) stop load block upward motion before two-blocking occurs or warn of an impending two-block condition;

(4) limit crane travel at both ends of the runway tracks;

(5) limit lifted load;

(6) limit operating radius in accordance with lifted load, i.e., limit moment; and

(7) limit pressures in hydraulic or pneumatic circuits (see para. 3-1.18.9).

(c) Load limiting devices, and acceleration/deceleration limiters when provided, shall be installed in enclosures that can be locked or sealed to inhibit tampering and unauthorized adjustment.

(d) Motion limiting devices, such as in paras. 3-1.11(b)(1), (2), (3), and (4), should be provided with means to permit the operator to override them under controlled conditions.

SECTION 3-1.12: 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 guys.

(b) Standing ropes that are used as live ropes during erection, and boom hoist running ropes, shall have a minimum design factor of 3.0 for the loads occuring during erection, but shall comply with para. 3-1.12(a) for the erected condition. Rotation resistant ropes shall not be used for boom (luffing) hoists.

(c) The design factors in paras. 3-1.12(a) and (b) shall be the total nominal breaking strengths 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. 3-1.5.4.

(e) New poured socket or swaged socket assembly used as a boom pendant 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 nominal strength.

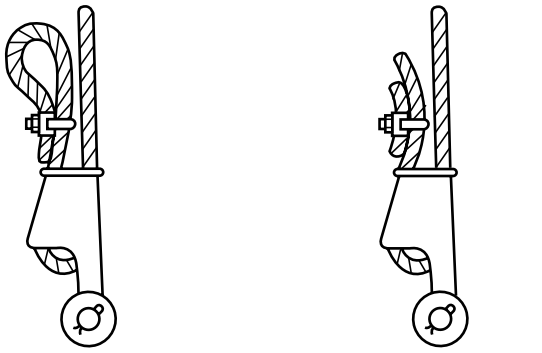


Fig. 8 Dead Ending Rope in a Socket

SECTION 3-1.13: 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. For spacing, number of clips, and torque values, refer to the clip manufacturer's recommendation. Wire rope clips attached with U-bolts shall have the U-bolt over the dead end of the rope and the live rope resting in the clip saddle. Clips shall be tightened evenly to the recommended torque. After the initial load is applied to the rope, the clip nuts shall be retightened to the recommended torque to compensate for any decrease in rope diameter caused by the load. Rope clip nuts should be retightened periodically to compensate for any further decrease in rope diameter during usage.

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

(d) Wire rope clips used in conjunction with wedge sockets shall be attached to the unloaded dead end of the rope only (see Fig. 8). This does not preclude the use of devices specially designed for dead ending rope in a wedge socket. (04)

SECTION 3-1.14: COUNTERWEIGHTS AND BALLAST

(a) Superstructures and counterjibs (counterweight jib) shall be arranged to receive counterweights, made in accordance with the crane manufacturer's specifications,

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and to hold them in position. Means shall be provided to guard against shifting or dislodgement during crane operation.

(b) Movable counterweights, if provided, shall either move automatically or shall be equipped with a position indicator with readout at the operator's station(s).

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

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

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

SECTION 3-1.15: CONTROLS

3-1.15.1 Crane Function Controls

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

(b) Controls shall be labeled in words or symbols to indicate their function, and where appropriate, the direction of the motion imparted.

(c) Controls for hoisting, trolleying, luffing, slewing, and travel shall discontinue operating motions when engagement pressure is released. Controls that are not provided with an interlock that prevents restart unless in the neutral position shall return to the neutral position when released unless intentionally restrained for functional purposes.

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

(e) Electric motor operated cranes shall be provided with a device which will disconnect all motors from the line on failure of power and will not permit any motor to be restarted until the control is brought to the *off* position, or a reset switch or button is operated.

(f) Electric motor operated cranes 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 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 power plant on loss of hydraulic pressure.

(04) *(j)* Drum rotation indicators should be provided so as to afford a sensing means for the operator.

3-1.15.2 Power Plant Controls

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

(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; and

(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.

3-1.15.3 Control Forces and Movements

(a) Forces to operate shall not be greater than 35 lb (156 N) on hand levers and not greater than 50 lb (225 N) nor less than 8 lb (35 N) on foot pedals.

(b) Travel distance on hand levers shall not be greater than 14 in. (360 mm) from the neutral position on two-way levers and shall not be greater than 24 in. (610 mm) on one-way levers. Travel distance on foot pedals shall not be greater than 10 in. (260 mm).

SECTION 3-1.16: ELECTRICAL EQUIPMENT

3-1.16.1 General Requirements

(a) Each electrically powered crane shall have a 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 live parts are not exposed to inadvertent contact under normal operating conditions.

(c) Electrical equipment shall be protected from 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. Hoist, swing, trolley, and travel controllers shall conform to ANSI/NEMA publications ICS-3.

(e) Provision shall be made to guard against reversing of each motor 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 unless other means are provided to prevent damage to the electrical conductors.

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

(h) Lightning protection shall be provided.

3-1.16.2 Resistors

(a) Resistor units shall be supported to minimize vibration effect.

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

(c) If ventilated or nonventilated resistor enclosures are provided, the enclosures shall be installed so as to minimize the accumulation of combustible matter.

SECTION 3-1.17: OPERATOR'S CABS

3-1.17.1 Construction

(a) Cabs shall be provided for the operator's stations of all construction tower cranes. 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 necessary, areas of the cab roof shall be capable of supporting, without permanent distortion, the weight of a 200 lb (90 kg) person.

(d) Cab doors, whether of the sliding or swinging type, shall be restrained from inadvertently opening or closing during travel or operation of the crane.

(e) All cab glazing shall be safety glazing material as defined in ANSI 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 pick-up points on the ground. Windows provided with openable portions shall be arranged to prevent inadvertent closure during operation. A windshield wiper should be provided on the front window.

(f) Means shall be provided for cleaning windows from inside the cab unless exterior platforms are provided.

(g) Cab lighting, either natural or artificial, shall provide a level of illumination that enables the operator to observe the operating controls.

(h) The operator's cab shall be mounted on the rotating portion of the crane. When applicable, it shall be positioned so as to protect the operator and be clear of the boom (jib) when lowered to vertical.

3-1.17.2 Access

(a) Access ladders to the cab, machinery platforms, and tower (mast) shall be provided and shall conform to ANSI A14.3 or to SAE J185, 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 it is necessary to climb more than 120 ft (37 m) of vertical ladder in the crane tower to reach the cab or machinery deck, consideration should be given to providing a powered means of access in addition to ladders.

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

3-1.17.3 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.

3-1.17.4 Fire Extinguisher

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

3-1.17.5 Signal Device

An audible signal device should be provided with the control located within reach of the operator.

SECTION 3-1.18: GENERAL REQUIREMENTS

3-1.18.1 Footwalks and Ladders

(a) To provide access to the boom (jib) and its attachments such as connections, limiting devices, sheaves, rope, and fittings, a footwalk with slip resistant surface and with handrails or holding lines shall be provided. Other means for access should be provided on booms (jibs) too small for footwalks; booms (jibs) that can be readily lowered to provide access for inspection need not be provided with footwalks. Footwalks, when provided, should be 18 in. (450 mm) or more in width.

(b) When top towers or gantries include items requiring inspection or require access for erection/disassembly, ladders, handgrips, and, if necessary, platforms with slip resistant surfaces and railings shall be provided.

(c) When it is necessary to check or adjust the tension of slewing ring bearing attachment bolts, access shall be provided including work platforms with railings, where needed.

(d) Footwalks, platforms, ladders, and railings shall be capable of supporting the weight of a 200 lb (90 kg) person without permanent distortion. Holding lines should be installed so as not to deflect laterally more than 6 in. (150 mm) when a 200 lb (900 N) lateral force is applied.

3-1.18.2 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

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a hazard under normal operating conditions, shall be guarded.

(b) Each guard shall be capable of supporting the weight of a 200 lb (90 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.

3-1.18.3 Lubrication Points

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

3-1.18.4 Exhaust Gases

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

3-1.18.5 Welded Construction

Welding procedures and welding operator qualifications for use in repair or alteration of load sustaining members shall be in accordance with ANSI/AWS D14.3 or ANSI/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. 3-1.4.1(e)].

3-1.18.6 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 arranged to permit adjustments where necessary to compensate for wear.

3-1.18.7 Wind Velocity Device

A wind velocity indicating 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.

3-1.18.8 Fuel Filler Pipes

Fuel tank filler pipes shall be located or protected so as not to allow spillage or overflow to run onto the engine, exhaust, or electrical equipment of the machine being fueled.

3-1.18.9 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 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

The manufacturer shall furnish operation and maintenance information [see paras. 3-1.4.1(c) to (f)].

3-2.1.2 Inspection Classification

(a) Initial Inspection. Prior to initial use, all new, reinstalled, altered, or modified construction tower cranes shall be inspected by a qualified person to verify compliance with the applicable provisions of this volume.

(b) Regular Inspection. Inspection procedures for cranes in regular service are divided into two general classifications based on the intervals at which inspection should be performed. The intervals in turn are dependent upon the nature of the critical components of the crane and the degree of their exposure to wear, deterioration, or malfunction. The two general classifications are designated as *frequent* and *periodic* with respective intervals between inspection as defined below.

(1) Frequent Inspection. Visual examination by the operator or other designated person with records not required:

(a) light service — monthly;

(b) normal service — weekly to monthly;

(c) heavy service — daily to weekly.

(2) Periodic Inspection. Visual inspection by an appointed person at 1 to 12 month intervals or as specifically recommended by the manufacturer or by a qualified person. Records shall be kept of apparent external conditions to provide a basis for continuing evaluation.

3-2.1.3 Frequent Inspection

Items such as the following shall be inspected at intervals defined in para. 3-2.1.2(b)(1) or as specifically indicated, including observation during operation for any deficiencies that might appear between regular inspections. Any deficiencies shall be examined and determination made by a designated person as to whether they constitute a hazard:

(a) all control mechanisms for maladjustment interfering with proper operation — daily, when in use;

(b) all control mechanisms for excessive wear of components and contamination by lubricants or other foreign matter;

(c) all crane function operating mechanisms for maladjustment interfering with proper operation and excessive wear of components;

(d) motion limiting devices for proper operation with the crane unloaded; each motion should be inched into its limiting device or run in at slow speed with care exercised;

(e) load limiting devices for proper operation and accuracy of settings;

(f) all hydraulic and pneumatic hoses, particularly those that flex in normal operation;

(g) electrical apparatus for malfunctioning, signs of excessive deterioration, dirt, and moisture accumulation.

(h) hooks and latches for deformation, chemical damage, cracks, and wear. Refer to ASME B30.10.

(i) wedges and supports of climbing cranes for looseness or dislocation — daily, when in use;

(j) braces or guys supporting crane masts (towers) and anchor bolt base connections for looseness or loss of preload; braces and bolts after the first day and the first week of operation and then monthly; guys daily until preload stabilizes, then weekly until preload stability indicates that monthly checking will be adequate;

(k) hydraulic system for proper fluid level — daily, when in use.

3-2.1.4 Periodic Inspection

(a) Complete inspections of the crane shall be performed at intervals, as generally defined in para. 3-2.1.2(b)(2) depending upon its activity, severity of service, and environment, or as specifically indicated below:

(1) light service — annually;

(2) normal service — semi-annually to annually;

(3) heavy service — quarterly.

These inspections shall include the requirements of para. 3-2.1.3 and, in addition, items such as the following. Any deficiencies, such as listed below, shall be examined and determination made by a designated person as to whether they constitute a hazard:

(1) deformed, cracked, or corroded members in the crane structure and boom (jib);

(2) loose bolts or rivets;

(3) cracked or worn sheaves and drums;

(4) worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers, locking and clamping

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devices, sprockets, and drive chains or belts;

(5) excessive wear on brake and clutch system parts, linings, pawls, and ratchets;

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

(7) power plants for performance and compliance with safety requirements;

(8) electrical apparatus for signs of deterioration in controllers, master switches, contacts, limiting devices, and controls;

(9) crane hooks inspected per ASME B30.10;

(10) travel mechanisms for malfunction, excessive wear or damage;

(11) hydraulic and pneumatic pumps, motors, valves, hoses, fittings, and tubing for excessive wear or damage.

(b) For cranes used in service involving periodic reerection, advantage can be taken of the ease of performing detailed inspection when the crane is disassembled. During visual inspection of members and their connections [see para. 3-1.4.1(d)], observed signs of possible damage may indicate the need to remove paint or to use other than visual nondestructive examination techniques to permit determination as to whether a hazard exists. For cranes with 5 or more years of service, other than light service, such disassembled inspection at nominally semiannual to annual intervals is recommended unless the manufacturer recommends other intervals.

(c) High strength (traction) bolts used in mast (tower) connections and in connection of the slewing bearing shall be checked for proper tension (torque) at intervals recommended by the manufacturer or as suggested in (a) above. Bolts that loosen should be checked for permanent deformation or other damage. Visible cracks, difficulty in threading or unthreading a nut by hand, or observable necking are reasons for replacement.

(d) Sheaves used in the load and boom hoisting systems shall be checked for cracks in the flanges and spokes. When external evidence of possible damage is found, it may be necessary to remove the sheave from its mounting for further examination.

3-2.1.5 Cranes Not in Regular Use

(a) A crane that has been idle for a period of 1 month or more, but less than 6 months, shall be inspected in accordance with paras. 3-2.1.3 and 3-2.4.2(a) before being placed in service.

(b) A crane that has been idle for more than 6 months shall be inspected in accordance with paras. 3-2.1.4 and 3-2.4.2(b) before being placed in service.

(c) Standby cranes, before being used, shall be inspected in accordance with the requirements of para. 3-2.1.5(a) or (b), depending on the interval since they were last used. When such cranes are exposed to adverse environments, they should be inspected more frequently.

3-2.1.6 Operator Aids (04)

(a) Prior to daily operation, indicating devices for load, drum rotation, radius, boom angle, and wind velocity shall be checked to determine if they are operating (daily calibration checks are not required unless called for in the operator's manual). If not functional, and repairs cannot be made immediately, refer to paras. 3-2.3.3 and 3-3.2.1(b)(4).

(1) Load limiting device accuracy (calibration) is a frequent inspection item under para. 3-2.1.3(e).

(2) Load, wind, and other indicator accuracy (calibration) are periodic inspection items under para. 3-2.1.4(a)(6).

(b) Limiting devices for trolley travel, boom luffing upper and lower limits, crane travel, and two-block protection are frequent inspection items under para. 3-2.1.3(d). If not functional, and repairs cannot be made immediately, refer to paras. 3-2.3.3 and 3-3.2.1(b)(4).

SECTION 3-2.2: TESTING

3-2.2.1 Operational Tests

(a) Prior to initial use, newly erected cranes shall be tested in accordance with para. 3-1.1.6. Altered or modified cranes shall be tested, under the direction of a qualified person, to verify compliance with the applicable portions of this volume, including functional tests in accordance with paras. 3-1.1.6(a) and (e).

(b) The trip setting of hoist limit devices should be determined by tests, with an empty hook, comprising a series of runs each at increasing hook speed up to the maximum speed. The actuating mechanism of the limit device shall be located so that it will trip the device, under all conditions, in sufficient time to prevent contact of the lower load block with the upper load block or boom point sheaves.

3-2.2.2 Load Limit Device Test

Load limit device settings shall be verified by means of a static test using test loads of 102.5% to 110% of the applicable ratings as recommended by the crane manufacturer. Test loads are to be lifted at creep speed until just clear of the ground.

3-2.2.3 Test Records

Dated test records should be made for all tests required under paras. 3-2.2.1(a) and 3-2.2.2, and kept available.

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SECTION 3-2.3: MAINTENANCE

3-2.3.1 Preventive Maintenance

(a) A preventive maintenance program based on the crane manufacturer's recommendations should be established. Dated records should be kept available.

(b) Replacement parts should ordinarily be obtained from the original equipment manufacturer. Replacement parts shall be at least equal to the original manufacturer's specifications.

3-2.3.2 Maintenance Procedure

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

(1) A traveling-type crane to be repaired should be moved to a location where it will cause the least interference with other cranes and operations in the area.

(2) All controllers should be at the *off* position.

(3) The main or emergency switch shall be open and locked in the *open* position, except for test purposes.

(4) Warning or *Out of Order* signs shall be placed by appointed personnel.

(5) Where other cranes are in operation on the same runway, rail stops or other suitable means shall be provided to prevent interference with the idle crane.

(6) Where temporary protective rail stops are not available, or practical, a signalperson shall be placed at a visual vantage point for observing the approach of an active crane and warning its operator.

(b) After adjustments or repairs have been made, the crane shall not be returned to service until all guards have been reinstalled, limit and protective devices reactivated, trapped air removed from hydraulic systems, and maintenance equipment removed. Warning or *Out of Order* signs shall be removed by appointed personnel only.

3-2.3.3 Adjustments and Repairs

(04) *(a)* Any hazardous condition disclosed by the inspection requirements of Section 3-2.1 shall be corrected before operation of the crane is resumed. However, in the limited case of a non-functional indicating device or limiting device, operation may continue until such time as repairs can be made provided the specific conditions under para. 3-3.2.1(b)(4) are satisfied. Adjustments and repairs shall be performed only by designated personnel.

(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

(c) Repairs or replacements shall be provided as needed for operation. The following are examples:

(1) crane hooks showing defects described in para. 3-2.1.3(h) shall be taken out of service; repairs by welding or reshaping are not recommended;

(2) critical parts which are cracked, broken, bent, or excessively worn or corroded;

(3) pitted or burned electrical contacts should be corrected only by replacement and in sets. Controller parts should be lubricated as recommended by the manufacturer.

(d) Remote control stations shall be kept clean with function identification labels legible.

3-2.3.4 Lubrication

(a) All moving parts of the crane, for which lubrication is specified, should be regularly lubricated. Lubricating systems should be checked for delivery of lubricant. Care should be taken to follow manufacturer's recommendations as to points of lubrication, maintenance of lubricant levels, and types of lubricant to be used.

(b) Machinery shall be stationary while lubricants are being applied and protection provided as called for in paras. 3-2.3.2(a)(1) through (6), unless equipped for automatic lubrication.

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

3-2.4.1 General

Due to practical crane design configuration requirements, sheaves diameters, drum diameters, and rope design factors are limited. Because of these limited design parameters, inspection in accordance with para. 3-2.4.2 to detect deterioration, and timely replacement in accordance with para. 3-2.4.3, is essential.

3-2.4.2 Inspection

(a) Frequent Inspection

(1) Load hoist and boom hoist rope should be visually inspected each working day.

(2) The load trolley rope, and counterweight movement ropes if provided, should be visually inspected at least once a month.

A visual inspection shall consist of observation of all rope which 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, which 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

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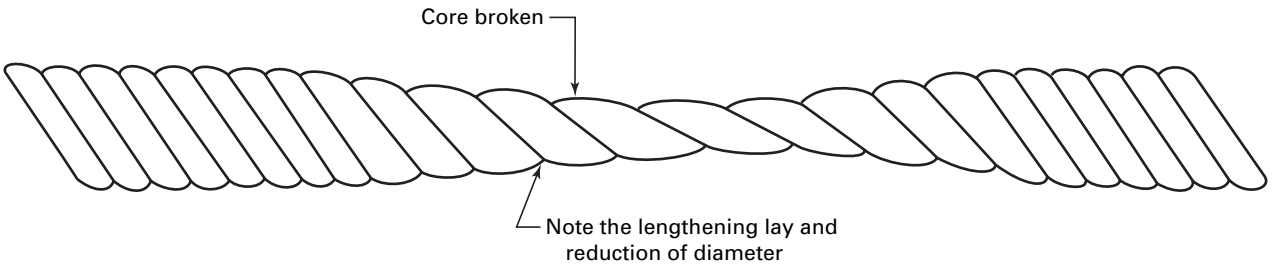


Fig. 9 Core Failure in Rotation-Resistant Rope

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), (2), and (7) for further guidance];

(e) core failure in rotation resistant ropes (see Fig. 9).

(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 by an appointed or authorized person. 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 where corroded or broken wires may protrude;

(c) sections subject to reverse bends;

(d) sections of rope which 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 judgement 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 1 lay, or 4 broken wires in 1 strand in 1 lay;

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

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(7) reductions from nominal diameter greater than those shown below:

Rope Diameter	Maximum Allowable Reduction from Nominal Diameter
Up to $^5/_{16}$ in. (8 mm)	$^1/_{64}$ in. (0.4 mm)
Over $^5/_{16}$ in. to $^1/_2$ in. (13 mm)	$^1/_{32}$ in. (0.8 mm)
Over $^1/_2$ in. to $^3/_4$ in. (19 mm)	$^3/_{64}$ in. (1.2 mm)
Over $^3/_4$ in. to $1^1/_8$ in. (29 mm)	$^1/_{16}$ in. (1.6 mm)
Over $1^1/_8$ in. to $1^1/_2$ in. (38 mm)	$^3/_{32}$ in. (2.4 mm)

(8) attention shall be given to end connections. Upon development of more than 2 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.

(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, 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 hoist manufacturer, or a qualified person.

(e) Ropes Not in Regular Use. All rope which has been idle for a period of a 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 which 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 which does not hinder visual inspection. Those sections of rope which 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

3-3.1.1 Operators

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

(1) designated persons;

(2) trainees under the direct supervision of a designated 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. 3-3.1.1(a), 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

(a) Operators shall be required by the employer to pass a practical operating examination unless able to furnish satisfactory evidence of qualifications and experience. Qualifications shall be limited to the specific type of equipment which will be operated.

(b) Operators and operator trainees shall meet the following physical qualifications:

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

(2) be able to distinguish colors, regardless of position, if color differentiation is required for operation;

(3) hearing, with or without hearing aid, must be adequate for the specific operation;

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

(c) Evidence of physical defects, or emotional instability which could pose a hazard to the operator or others, or which in the opinion of the examiner could interfere with the operator's performance, may be sufficient cause for disqualification. In such cases, specialized clinical or medical judgments and tests may be required.

(d) Evidence that an operator is subject to seizures or loss of physical control shall be sufficient reason for disqualification. Specialized medical tests may be required to determine these conditions.

(e) Operators and operator trainees should have good depth perception, field of vision, reaction time, manual dexterity, coordination, and no tendencies to dizziness or similar characteristics.

3-3.1.3 Conduct of Operators (04)

(a) The operator shall not engage in any practice which 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 person who is directing the lift, or an appointed signalperson. When a signalperson 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;

(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.

An exception to para. 3-3.1.3(e)(6) 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.

(f) If there is a warning sign on the power disconnecting means or starting controls, the operator shall

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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) if practical, the suspended load should be landed under brake control.

(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. 3-2.1.6.

(m) Cranes shall not be raised (climbed) to a new operating level 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.

(n) The crane operator should be present during climbing operations. See paras. 3-1.1.5 and 3-1.1.6.

(o) Climbing operations shall not be commenced until all support provisions required at the new support level are in place and as specified by a qualified person.

(p) 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.

(q) For night operations, lighting shall be adequate to illuminate the working areas while not interfering with the operator's vision.

SECTION 3-3.2: OPERATING PRACTICES

(04) 3-3.2.1 Handling the Load

(a) Size of Load

(1) No crane shall be loaded beyond the rated loads given in the rating chart except for test purposes as provided in paras. 3-1.1.6 and 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 person responsible for the lift 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) Operator Aids

(1) Indicating devices shall be checked daily before the crane is put in operation. See para. 3-2.1.6.

(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) 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, boom angle, or radius indicator, or boom luffing, trolley travel, crane travel, or two-block limiter 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 direct supervision of a qualified person other than a signal 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, are 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.

(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

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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. 3-3.2.1(d)(1), 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 person directing the lift shall see that:

(a) proper slings or other lifting attachments are being 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 shall not be kinked;

(b) multiple part lines shall not be twisted around each other;

(c) the hook shall be brought over the load in such a manner as to minimize swinging;

(d) if there is a slack rope condition, it shall be determined that 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;

(f) the load is free to be lifted; 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 (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 two full wraps of rope remain on the drum.

(8) When swinging the boom (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 construction tower cranes are designed and intended for handling materials and not personnel. Personnel are only permitted to ride in a personnel platform as described in para. 3-3.2.2(b) supported from the crane's hook. The crane shall not be used for other purposes while handling personnel.

(a) The following special procedures shall be followed when personnel are to be lifted.

(1) The person specifically responsible for the overall work function to be performed shall determine that there is no practical alternate way to perform the needed work or gain access to the area, and shall authorize its usage.

(2) For each personnel lifting procedure, the person responsible for the task shall attest to the need for the operation by issuing a statement describing the procedure and its time frame. The statement, after being approved by the authorizer, shall be retained at the jobsite.

(3) When used for lifting personnel, the crane shall be inspected daily in accordance with the requirements of paras. 3-2.1.3 and 3-2.4.2(a).

(4) The lifting and supporting shall be made under controlled conditions and under the direction of an appointed signalperson.

(5) A meeting attended by the crane operator, signalperson, person(s) to be lifted, and the persons responsible for the task to be performed shall be held daily to plan and review procedures to be followed, including procedures for entering and leaving the personnel platform and the points at which persons will enter and leave the personnel platform.

(6) The operator and signalperson shall conduct a test lift with the empty personnel platform or basket.

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

(8) When hook supported personnel platforms are lifted, a two-block damage prevention feature shall be provided.

(9) The crane shall be operated so that lowering motion will be power-controlled lowering (no free-fall).

(10) When welding is done by personnel from the platform or basket, the electrode holders shall be protected from contact with metal components of the personnel platform or basket.

(11) Personnel being lifted or supported shall wear safety belts with lanyards attached to designated anchor point(s).

(12) The operator shall remain at the controls when the personnel platform is occupied.

(13) Movement of the personnel platform shall be done in a slow, controlled, cautious manner with no sudden movements of the crane or personnel platform.

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The lifting or lowering speed shall not exceed 100 ft/min (0.51 m/s).

(14) The personnel being lifted or positioned shall remain in continuous sight or in communication with the operator or signalperson.

(15) The total weight of the lifted load (including personnel) shall not exceed 50% of the crane rating under the planned conditions of use.

(16) Suspended personnel platforms shall be used only for personnel, their tools, and sufficient materials to do their work. They shall not be used for transporting bulk materials.

(17) Personnel shall keep all parts of the body inside the suspended personnel platform during raising, lowering, and positioning to avoid pinch points. Personnel shall not stand on or work from the top rail, midrail, or toeboard of the suspended personnel platform.

(18) If the personnel platform cannot be landed, it should be tied to the structure before personnel get off or on.

(19) Personnel platforms should not be used in winds in excess of 15 mph (25 km/h), electric storms, snow, ice, sleet, or other adverse weather conditions which could affect the safety of personnel.

(20) After positioning of the personnel platform, all brakes and locks of the lift crane shall be set before personnel perform any work.

(b) A personnel platform which is designed and constructed in accordance with the following shall be used.

(1) The personnel platform shall be designed by a qualified person.

(2) The personnel platform shall be limited to a capacity of six persons.

(3) The personnel platform and attaching devices shall have a minimum design factor of 5.

(4) The personnel platform shall have a plate specifying the weight of the empty personnel platform and the maximum number of persons and weight for which the personnel platform is rated.

(5) The personnel platform shall have standard railing as defined in ANSI A1264.1.

(6) A grab rail shall be provided inside the suspended personnel platform to minimize hand exposure.

(7) The sides of the personnel platform shall be enclosed from floor to mid-rail.

(8) If access doors are installed, they shall open only to the interior of the personnel platform. Access doors shall be equipped with a device to restrain the door from inadvertent opening.

(9) The personnel platform shall be easily identifiable by high visibility color or marking.

(10) The personnel platform shall be attached by means such as, but not limited to, a bolt type shackle with nut and cotterpin, hook (latched or moused), or wedge and socket attachment. A wedge and socket attachment shall have a clip on the free end of the load line (see Fig. 8).

(11) The suspension system shall minimize inclination of the personnel platform due to the movement of personnel on the personnel platform.

(12) All rough edges shall be ground smooth.

(13) All welding procedures and welding operator qualifications shall be in accordance with ANSI/AWS D1.1 when welding is to be performed on load sustaining members. Where special steels or other materials are used, the manufacturer or a qualified person shall provide welding procedures.

(14) All welding shall be performed by a certified welder.

(c) Suspended Personnel Platform Testing and Inspection.

(1) Prior to use each working shift, the personnel platform and rigging shall be inspected.

(2) At each new jobsite, and at least annually, prior to hoisting personnel in the suspended personnel platform, the personnel platform, rigging, and hook block shall be proof tested to twice the personnel platform's rated capacity by holding it in a suspended position for 5 min with the test load suitably distributed on the personnel platform. After prooftesting, any deficiencies revealed by inspection by a qualified person shall be corrected and another proof test shall be conducted. Any modification to personnel platform or rigging shall require retesting of the personnel platform.

SECTION 3-3.3: SIGNALS

3-3.3.1 Standard Signals

Standard signals to the operator shall be in accordance with the standards prescribed in para. 3-3.3.2, unless voice communication equipment (telephone, radio, or equivalent) is utilized. Signals shall be discernible or audible at all times. No crane motion shall be made unless signals are clearly understood.

3-3.3.2 Hand Signals

Hand signals shall be in accordance with Fig. 10 and shall be posted at the work site.

3-3.3.3 Special Signals

For operations not covered by para. 3-3.3.2, or for special conditions that occur from time to time, additions to or modifications of the standard signals may be required. In such cases, these special signals shall be agreed upon in advance by the operator and the signalperson and should not be in conflict with standard signals.

3-3.3.4 Instructions to the Operator

If it is desired to give instructions to the operator, other than those provided by the established signal system, crane motions shall be stopped.

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Table 1 Required Clearance for Normal Voltage in Operation Near High-Voltage Power Lines

Normal Voltage, kV (Phase to Phase)	Minimum Required Clearance, ft (m)
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)

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:

(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. 11.

EXCEPTIONS:

(1) The danger zone may be entered if the electrical distribution and transmission lines have been de-energized and visibly grounded at the point of work; or

(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 1.

(2) Caution shall be excercised 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 signalperson shall be assigned to observe the clearance when the crane moves to within a boom's (jib's) length of the Table 1 limits. The operator is not in the best position to judge distance between the power line and the crane or its protuberances.

(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. 3-3.4.3(a), even if such devices are required by law or regulation. In view of the complex, invisible, and lethal nature of the electrical 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. 3-3.4.3(a) is the recommended practice of this volume in determining permissible proximity of the crane and its protuberances, including load and load lines to electrical power lines.

(c) Before the commencement of operations near electrical 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 electrical utility authorities verify that it is not an energized line.

(e) Exceptions to this procedure, if approved by the owner of the electrical 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. 3-3.4.3(a)(1). These signs shall be revised when 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.

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(c) Smoking or 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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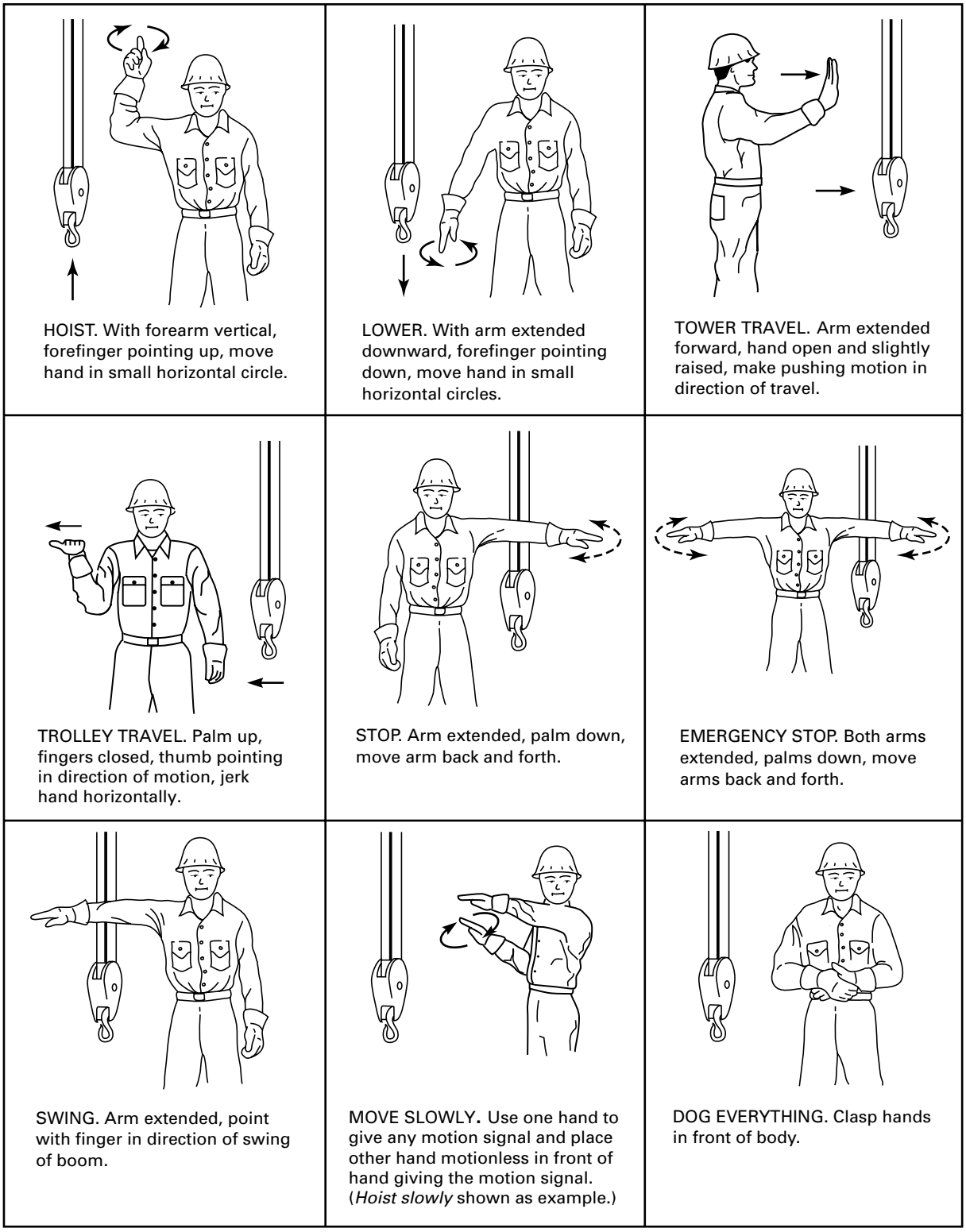
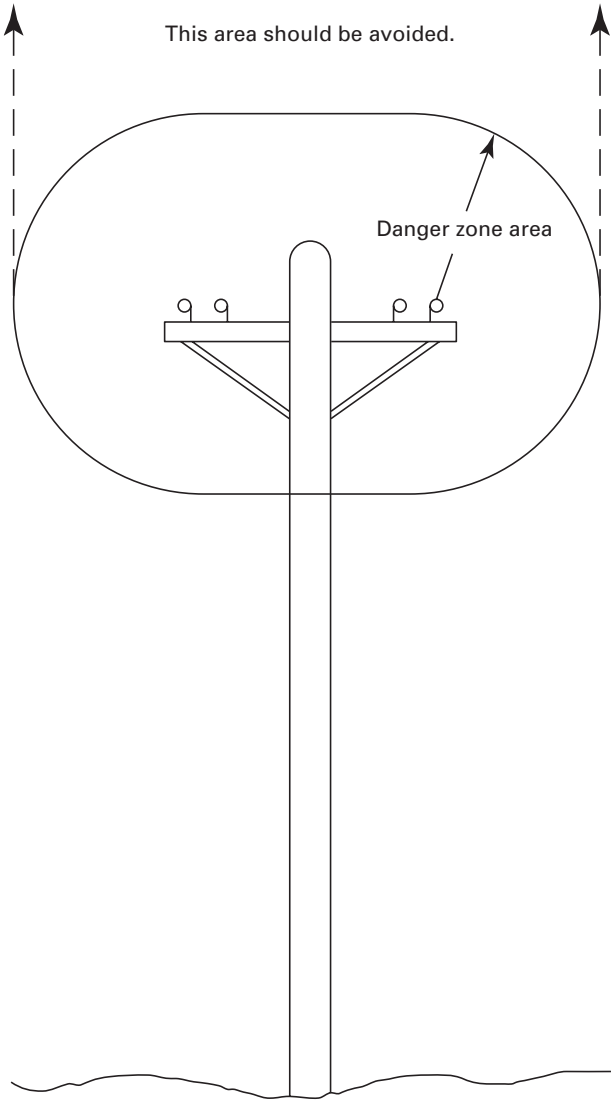


Fig. 10 Standard Hand Signals for Controlling Construction Tower Cranes

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GENERAL NOTE: For minimum radial distance of danger zone, see para. 3-3.4.3.

Fig. 11 Danger Zone for Cranes and Lifted Loads Operating Near Electrical Transmission Lines

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