Operation and Maintenance of Offshore Cranes

API RECOMMENDED PRACTICE 2D
FIFTH EDITION, JUNE 2003

American Petroleum Institute

Helping You Get The Job Done Right.SM

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Upstream Segment

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FOREWORD

This Recommended Practice is under the jurisdiction of the API Executive Committee on Drilling and Production Operations and was developed in cooperation with the Offshore Operators Committee. Detailed requirements for the design and construction of offshore cranes are given in API Specification 2C *Specification for Offshore Cranes* (latest edition).

Guidelines provided herein on the operation, inspection and maintenance of offshore cranes are based in part on an understanding of the cranes' design and construction. Therefore, this document should be read in conjunction with API Specification 2C.

The material in this publication represents the contribution of industry representatives of crane users, crane manufacturers, wire rope manufacturers and ancillary crane device or component manufacturers. It is based on industry experience and expertise involving worldwide operations.

This publication is organized into Text Sections and associated supporting Commentary Sections. In the Text Sections, recommended practices and procedures considered to be mandatory; standards and qualifications that are deemed necessary minimum; and the overall intent, goals and objectives of crane operating, inspection and maintenance practices, programs and procedures, are defined.

In the Commentary Sections, the basis for the recommended mandatory practices, minimum standards and program goals, are substantiated; non-mandatory practices are discussed and illustrated; and examples of programs, which meet the intent of the guidelines, are given.

Commentary Sections, numbered for example CX.X when referenced by Text Section X.X can be found in Appendices A through G.

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

This recommended practice shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

This publication includes use of the verbs shall and should, whichever is deemed the most applicable for the specific situation. For the purposes of this publication, the following definitions are applicable:

Shall: Indicates that the recommended practice has universal applicability to that specific activity.

Should: Denotes a recommended practice a) where a safe comparable alternative practice is available; b) that may be impractical under certain circumstances; or c) that may be unnecessary under certain circumstances or applications.

Changes in the uses of these verbs are not to be effected without risk of changing the intent of recommendations set forth herein.

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Suggested revisions are invited and should be submitted to the Upstream General Manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Recommended Practice for Operation and Maintenance of Offshore Cranes

1 Scope

This Recommended Practice is intended to serve as a guide to crane owners and operators in developing operating and maintenance practices and procedures for use in the safe operation of pedestal-mounted revolving cranes on fixed or floating offshore platforms, jackup drilling rigs, semi-submersible drilling rigs and other types of mobile offshore drilling units (MODUs). Guidelines are also given for the pre-use inspection and testing of temporary cranes (also called self-erecting, leapfrog or bootstrap cranes) that are erected offshore. These minimum practices are presented on the premise that:

a. Inspections are intended to identify all deficiencies or items which would affect the safe operation or reduce the lifting capability of the crane. Inspections should utilize methods and procedures appropriate for the crane type and its past and anticipated usage, as determined by the owner.

b. Action taken to correct a deficiency should be made as soon as practicable.

c. Limited (restricted) service may, in some cases, be continued after the identification and before correction of a deficiency. In such cases, it is the responsibility of the *qualified operator* or *qualified inspector* to document the deficiency, reporting it to the owner. Based on this information, the owner should define the appropriate restriction and post necessary cautionary notices, after consultation with the crane manufacturer, authorized surveyor, certifying authority or other qualified source (such as an API licensed 2C crane manufacturer, or an engineer experienced in the design of the crane, as determined by the owner).

d. Conformance to the intent of the programs and practices recommended herein is intended to result in cranes that operate safely and efficiently between inspection periods.

Each owner, *qualified operator*, *qualified inspector*, and *qualified rigger* is encouraged to follow the recommendations outlined herein, and to modify or supplement them with any practices or procedures which are more appropriate for the type and duty cycle—both past and future—of the crane, provided the minimum recommendations and the intent of the programs stated herein are met.

2 Definitions

2.1 qualified operator: A person so designated by the employer who has appropriate offshore experience and training. Such appropriate experience and training must comprise minimum amounts of classroom-type sessions and hands-on field training, on cranes specific to the type of crane to be operated by the qualifying operator. These minimum requirements are outlined in detail in 3.1.2 and Appendix A1, Commentary on Crane Operator Training.

This recommended practice should be followed to qualify operators of two crane types: 1) operation of non-mechanical cranes and/or 2) operation of mechanical cranes (those with free-fall capability).

With this minimum training, qualifying operators should be qualified to safely operate the crane(s) on which they have been trained. Also, with this minimum training, the qualifying operator should also be sufficiently qualified to perform the crane inspections outlined in 4.1.2, with the exception of the initial, quarterly, and annual inspections.

Operators will remain qualified to operate the cranes on which they have been trained, provided they successfully complete the refresher training requirements outlined in 3.1.2d.

2.2 qualified inspector: A person so designated by the employer who by reason of appropriate experience and training, has successfully completed classroom-type training on crane maintenance and troubleshooting; on hoist troubleshooting and overhaul; and on the structural aspects of offshore cranes, which gives a knowledge of structurally critical components and critical inspection areas. These minimum training requirements are outlined in Appendix A2. Additionally, individuals recognized by regulatory authorities ("authorized surveyors" or "certifying authorities") may conduct inspections of cranes pursuant to this edition, provided they meet the requirements of Appendix A2.

With successful completion of this minimum training supplemented with appropriate refresher training at a minimum of every four (4) years, the inspector is considered qualified to perform the initial, pre-use, monthly, quarterly, and annual inspections. The scope of these inspections is outlined in 4.1.2. It is not a requirement for a *qualified inspector* to also be a *qualified operator*. However, a *qualified inspector* is not a *qualified operator* unless they have also completed the requirements of a *qualified operator*, Section 3.1.2, including the physical qualifications outlined in 3.1.2(b) and the requirements of Appendix A1.

2.3 qualified rigger: A rigger is anyone who attaches or detaches lifting equipment to loads or lifting devices. In order to be considered a *qualified rigger*, the person shall have successfully completed a rigger-training program in accordance with Appendix A3. The minimum requirements for a *qualified rigger* are outlined in detail in 3.1.4 and Appendix A3. A *qualified operator* is also a *qualified rigger*. Riggers will remain qualified provided they successfully complete the refresher training requirements outlined in 3.1.4.

2.4 shall: For the purposes of this publication, the term shall indicates that the recommended practice has universal applicability to that specific activity.

2.5 should: For the purposes of this publication, the term should denotes a recommended practice a) where a safe comparable alternative practice is available; b) that may be impractical under certain circumstances; or c) that may be unnecessary under certain circumstances or applications.

3 Operation

3.1 OPERATOR AND RIGGER QUALIFICATIONS AND OPERATING PRACTICES

3.1.1 Operators

Only the following personnel should operate cranes:

a. Qualified operators who have met and passed the requirements of 2.1 and 3.1.2.
b. Trainees under the direct supervision of a *qualified operator.*
c. Appropriate maintenance and supervisory personnel, when it is necessary for them to do so in the performance of their duties.
d. Qualified inspectors in the performance of their inspection duties.

No one other than personnel specified above should enter a crane cab.

3.1.2 Qualifications for Operators

a. Operators shall meet the requirements of a *qualified operator* as defined in 2.1 and as detailed below.
b. Operators shall meet the following physical qualifications:
   1. Have vision of at least 20/30 Snellen in one eye and 20/50 in the other with or without glasses, and have depth perception.
   2. Be able to distinguish red, green and yellow, regardless of position of colors, if color differentiation is required for crane operation.
   3. Have hearing, with or without a hearing aid, adequate for the specific operation.
   4. Have no history of a disabling medical condition, which may be sufficient reason for disqualification.
c. The following are recommended minimum requirements for operator training:

Classroom-type sessions with written and hands-on examinations on the type of crane to be operated by the qualifying operator. If a mechanical (as opposed to non-mechanical) crane is to be operated, the necessary experience and training a) shall be focused on this type of crane, and b) shall be more intense than for non-mechanical cranes, due to the greater skill required to safely operate mechanical cranes. Such classroom-type sessions and examinations shall cover all major crane components: the operational and maintenance procedures appropriate for the type and capacity of crane to be operated; and all major issues and guidelines addressed in this Recommended Practice, as well as in API Specification 2C, latest edition. The qualifying operator shall demonstrate by written examination an appropriate understanding of the significant requirements of this Recommended Practice and API Specification 2C, latest edition.

Training shall also cover lubricating points; adjustments; principles of crane operation, especially boom operating procedures; safety devices and anti-two blocking systems; the proper use and care of all running cables and pendants; and the proper reading and understanding of crane lifting capacity and reeving charts, boom and indicator charts and hand signal charts.

Further, the qualifying operator shall attend hands-on training on the proper inspection, use and maintenance of rigging gear (slings, shackles, hooks, nylon slings, etc.) and be trained in all rigger requirements in 3.1.4.

Before a person can be designated a *qualified operator*, the person shall also be required to demonstrate hands-on proficiency in the safe operation of cranes he or she is to operate. See C.3.1.2c for suggested requirements on hands-on proficiency.
d. The employer shall assure that operator qualifications are maintained, at a minimum every four (4) years, through appropriate refresher training. This shall also include current vision and medical condition evaluations as per 3.1.2b.

3.1.3 Riggers

Crane load rigging shall only be performed by a *qualified rigger.*

3.1.4 Qualification for Riggers

Training should incorporate familiarization with rigging hardware, slings, and safety issues associated with rigging, lifting loads, and lift planning.

Training should include classroom-type, hands-on training, and examination. Hands-on training should include proper inspection, use, selection, and maintenance of rigging gear (slings, shackles, hooks, etc.). The employer should assure that rigger qualifications are maintained, at a minimum every four (4) years, through appropriate refresher training. Additionally, the individual should have no history of a disabling medical condition, which may be sufficient reason for disqualification.

3.1.5 Operating Practices

a. The *qualified operator* (herein also called operator) is responsible for those operations under his or her direct control. Whenever there is any doubt as to safety, the operator should have the authority to stop and refuse to handle loads or

continue operations as safety dictates. See C.3.1.3a for additional safety considerations.

b. The operator should be aware of the operating characteristics of the crane. Mechanical and nonmechanical cranes will require different operating techniques, especially with regards to engine speed, control operation, control arrangement and braking. The crane manufacturer should provide operating instructions or be consulted for specific information.

c. The operator should be familiar with the equipment and its proper care. If adjustments or repairs to the crane are necessary, or any deficiencies that impair safe operation are known, the crane should be taken out of service or its operations restricted to eliminate the unsafe condition. See section 1c for restricted service conditions.

d. Before starting the crane, the operator should verify the following:

1. The pre-use inspection outlined in sections 4.1.2 and C.4.1.2a has been completed.
2. All controls are in the "off" or "neutral" position.
3. All personnel are in the clear.

e. For mechanical cranes, the operator should operationally test the brakes each time a load approaching the rated load is to be handled. Prior to raising the load, exposed brakes should be warmed and rusted surfaces on the drums cleaned by raising and lowering the boom and load lines under slight brake pressure.

f. When handling loads, the operator should never start machine movement unless the load is within his range of vision or the appointed signal person is within his range of vision and has given the appropriate signal.

g. The operator should respond to signals only from the appointed signal person but should obey an emergency stop signal at any time, no matter who gives the signal.

h. The operator should verify that the appropriate static and dynamic load rating charts are in place for the crane configuration in use (i.e., boom length, load line reeving, counterweight, jib, etc.).

i. Before leaving the control station unattended for a prolonged period, the operator should:

1. Land any attached load.
2. Disengage the master clutch, where applicable.
3. Set all locking devices.
4. Put controls in the off or neutral position.
5. Stop the prime mover.
6. Assure that no component of the crane will interfere with normal helicopter flight operations.

j. The crane should be secured against swinging when not in use.

k. The operator should be aware of heat sources such as natural gas engines, flares, or any other heat source that exhausts near the crane. Stress corrosion cracking, paint damage, accelerated corrosion, and loss of lubricant can result in reduced service life of components.

l. If power or a necessary control function fails during operation, the operator should:

1. Set all brakes and locking devices.
2. Move all clutch or other power controls to the off or neutral position.
3. If practical, land the suspended load by controlled lowering and stopping.

m. Where cranes are positioned in the proximity of helidecks or approach/take-off zones, they should not be operated while the helicopter is landing or taking off. The boom should be positioned and secured against swinging so there will be no interference with flight operations. The operator should not be at the control station during helicopter landing/take-off operations, unless the crane operator is in direct voice communication with the helicopter pilot.

n. Where cranes are to be used at night, the operator should insure that there is sufficient lighting for safe operation. The load and landing area should be illuminated.

o. Field welding shall not be performed on load hooks or sling hooks. Hooks should not be exposed to excessive heat.

p. The operator should keep and maintain a log of the pre-use inspection with the name, date, and time of inspection. This record should be kept in an appropriate location. See C.3.1.3o for examples of log type and appropriate location.

3.2 HANDLING THE LOAD

3.2.1 The Load

a. Crane lifting capacities are based on relative motion conditions between the crane and the load to be handled. All cranes shall have one static and at least one dynamic load rating chart, derived in accordance with the procedures outlined in API Specification 2C, latest edition.

b. The appropriate load-rating chart for the configuration in use shall be visible to the operator at the control station.

c. The operator should verify that the hook load is within the crane's applicable Static or Dynamic Rated Load at the radius at which the load is to be lifted. See C.3.2.1c for clarification of 'hook load."

3.2.2 Attaching the Load

a. The load should be attached to the hook by means of slings or other suitable devices. The latch should be closed to secure loose slings.

b. The hoist rope should not be wrapped around the load.

c. Sling use should be in accordance with the guidelines of C.3.2.2c and 5.2.1.

3.2.3 Moving the Load

a. Guidance on procedures for moving the load can be found in C.3.2.3.

b. No external forces should be applied to suspended loads that will create significant side loading of the boom. Care

should be taken when swinging the crane so as to minimize the pendulum action of the hook and suspended load.

c. Cranes should not be used for dragging loads unless properly rigged for a vertical pull not exceeding the rated capacity.

d. The operator should be aware of the effect of velocity and weight of the load when lowering to minimize shock load.

e. The operator shall not hoist, lower or swing while any personnel are on the load or hook (other than in a personnel carrier or basket).

f. The operator should avoid moving loads over personnel. Loads that are suspended by use of slings or hoists should be blocked or cribbed before personnel are permitted to work beneath or between them.

g. No fewer than five (5) full wraps of rope should remain on the drum(s) in any operating condition. Due consideration should be given to hoist manufacturer's recommended practices, especially for breakaway anchor-type hoists.

h. When two or more cranes are used to lift one load, one *qualified operator* should be responsible for the operation. The responsible operator should analyze the operations, and instruct all personnel involved in the proper positioning, rigging of the load and the movements to be made.

i. Appropriate tag or restraining lines should be used where necessary to control the load.

j. When a crane is to be operated at a fixed radius, the boom hoist auxiliary holding device, where fitted, should be engaged, especially in the case of mechanical cranes or those without automatic pawl control.

3.3 SIGNALS

3.3.1 Standard Signals

Signals between the crane operator and the designated signal person should be discernible, audibly or visually, at all times. The operator should not respond unless signals are clearly understood.

3.3.2 Hand Signals

Recommended standard hand signals are identified in Figure 1. The use of these recommended standard hand signals is encouraged.

3.3.3 Special Signals

For operations not covered in Figure 1, or for special conditions, additions or modifications to the recommended standard signals may be required. In such cases, these special signals should be agreed upon in advance by the operator and the designated signal person and should not be in conflict with, or have the potential to be confused with, standard signals.

3.3.4 Instructions

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

3.3.5 Signaling

When operations are required to be controlled by signals, a designated signal person should be assigned to work with the crane. The designated signal person should:

a. Be qualified by experience with the operations and knowledgeable of the standard hand signals as shown in Figure 1.

b. Be in clear view of the operator to ensure that their signals can be seen. Their position should give them a clear view of the load, crane, personnel, and area of operation. If the operator's view of the primary signal person is obstructed, an additional signal person should be provided.

3.4 PERSONNEL TRANSFER

3.4.1 All hooks used for support of personnel shall have an operable latch. A crane hook that can be closed and locked, with a pinned or positive locking device, eliminating the hook throat opening, shall be used for any personnel lifts. Additionally a hook with a purposefully designed lifting eye integral to the hook can be used in conjunction with a shackle that can be pinned to prevent opening. These hooks are designed to prevent the personnel basket sling from coming off the hook accidentally.

3.4.2 When making personnel lifts, the load shall be under control in both up and down directions.

3.4.3 All personnel to be lifted on a personnel carrier or basket shall use approved personal flotation devices (PFD) when being lifted over water. Personnel riding on net type personnel baskets should stand on the outer rim facing inward. For other carrier types, personnel should follow local instructions.

3.4.4 The weight of the loaded personnel carrier or basket should not exceed the Personnel Rated Load as defined by API Specification 2C, latest edition.

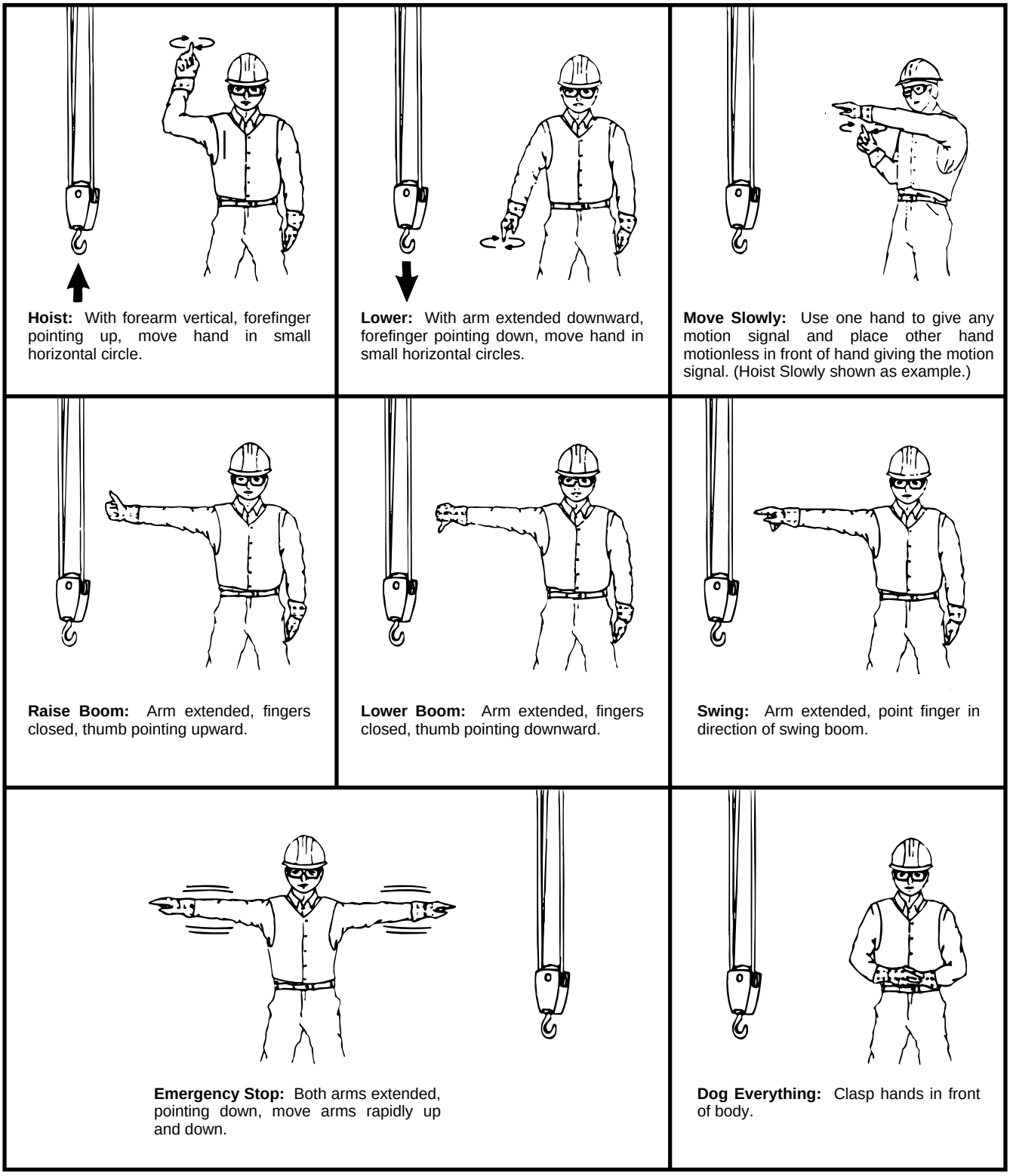
Refer to section C.3.4 for additional comments.

3.5 MISCELLANEOUS

3.5.1 Refueling

a. Cranes should not be refueled with the engine running.

b. Fuel tanks shall be filled in a manner that fuel spills or overflows will not run onto engine, exhaust, or electrical equipment, and should have spill containment to provide environmental protection.



Hoist: With forearm vertical, forefinger pointing up, move hand in small horizontal circle.

Lower: With arm extended downward, forefinger pointing down, move hand in small horizontal circles.

Move Slowly: Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly shown as example.)

Raise Boom: Arm extended, fingers closed, thumb pointing upward.

Lower Boom: Arm extended, fingers closed, thumb pointing downward.

Swing: Arm extended, point finger in direction of swing boom.

Emergency Stop: Both arms extended, pointing down, move arms rapidly up and down.

Dog Everything: Clasp hands in front of body.

Figure 1—Standard Hand Signals for Controlling Crane Operations

3.5.2 Fire Extinguishers

a. Fire extinguishers shall be kept in the cab or vicinity of the crane and be of a size and type not less than specified by the proper authorities.
b. Personnel who are expected to respond to fires should be trained in the use of fire extinguishers required in 3.5.2a.

3.5.3 Load Test

a. A crane load test is required under the following conditions:

1. New cranes being placed into service.
2. Cranes that are being permanently relocated.
3. Temporary cranes after each rig-up or relocation.

Refer to Appendix E for additional information on load testing.

3.5.4 Pull Test

a. A pull test is conducted at the owner or owner representative's discretion and is not a requirement of this recommended practice.
b. A pull test is defined as a load that is applied to the crane structure that will not exceed 100% of the crane's static rated capacity as identified on the crane's load chart. THIS IS NOT A LOAD TEST AS DESCRIBED IN 3.5.3 AND APPENDIX E.
c. When the crane owner or owner's representative elects to have a crane pull tested a calibrated dynamometer or a known suspended weight should be used and the pull test should be held for a minimum of 5 minutes. Upon the completion of the pull test a *qualified operator* or *qualified inspector* should perform a pre-use inspection of the crane to assure no damage occurred during the test.

4 Inspection, Testing, and Maintenance

4.1 USAGE AND INSPECTION

4.1.1 Crane Usage Categories

Inspection procedures for cranes in service are divided into three general categories based upon their usage or duty cycle, which in turn determines different, appropriate intervals at which inspections are to be performed. The usage categories should be assigned by the users on a consistent crane-by-crane basis. The intent is to measure their duty cycle as the duration of time for which the crane is in actual use. For further guidance, see C.4.1.1. The three crane usage categories are as follows:

4.1.1.1 Infrequent Usage

Infrequent Usage applies to those cranes that are used for 10 hours or less per month, based on the averaged use over a quarter. These cranes are subject to a pre-use inspection and an annual inspection. Crane usage should be reviewed on a periodic basis by the owner to ensure proper inspection intervals. Note: Special attention should be given to wire rope on these cranes during pre-use inspections.

4.1.1.2 Moderate Usage

Moderate usage applies to those cranes that are used for more than 10 hours but for less than 50 hours per month, based on the averaged use over a quarter. These cranes are subject to pre-use, quarterly, and annual inspections. Crane usage should be reviewed on a periodic basis by the owner to ensure proper inspection intervals.

4.1.1.3 Heavy Usage

Heavy usage applies to those cranes that are used for 50 hours or more per month. These cranes are subject to pre-use, monthly, quarterly, and annual inspections. Cranes assigned to this category need not be reviewed to determine the number of hours used each month unless otherwise specified by the owner.

4.1.2 Inspection Categories

All cranes should receive inspections in accordance with the categories described below. These inspections are more clearly defined in Appendix C of this Recommended Practice. These inspection requirements apply to all cranes including those installed for temporary use. These inspection guidelines are minimum requirements. The owner should determine the actual scope of the inspections, with input from manufacturers and other relevant sources, as appropriate.

4.1.2.1 Initial Inspection

Initial inspections apply to cranes that are new and are being placed into service, cranes that are being permanently relocated, and temporary cranes. A *qualified inspector* shall perform these inspections. Every initial inspection shall include a load test performed per the procedures given in Appendix E.

4.1.2.2 Pre-use Inspection

The pre-use inspection shall be performed prior to the first crane use of the day, prior to or during each change in operator, and then as the *qualified operator* deems necessary during the day for extended operations. A *qualified operator* shall perform this inspection, and it applies to all cranes, regardless of usage category. A *qualified inspector* may also perform these inspections.

4.1.2.3 Monthly Inspection

The monthly inspection shall be performed once per month, for all cranes assigned a heavy usage category. A *qualified operator* shall perform this inspection. A *qualified inspector* may also perform these inspections.

4.1.2.4 Quarterly Inspection

The quarterly inspection shall be performed once every three months for all cranes assigned a moderate or heavy usage category. A *qualified inspector* shall perform this inspection.

4.1.2.5 Annual Inspection

The annual inspection shall be performed once every twelve months. A *qualified inspector* shall perform this inspection, and it applies to all cranes, regardless of usage category.

Recommended guidelines for the scope of each of these inspections can be found in C.4.1.2.

a. A crane that is taken out of service for more than 12 months should have an OUT OF SERVICE sign placed over the primary controls. Before the crane can be placed into service, it shall be given an annual inspection.
b. Temporary cranes are subject to the appropriate inspections as per 4.1.2. After each rig-up or relocation, they shall also be load tested in accordance with the procedures in Appendix E.
c. Before installation of temporary cranes, a new crane, or a refurbished replacement crane, the structure and deck of the fixed platform should be evaluated to insure that it can accommodate the proposed crane installation and operation. The crane may be derated in accordance with the platform's limitation; and appropriate load rating charts shall be installed on the crane, readily visible to the crane operator.
d. Figure 2 shows a Usage/Inspection/Inspector Qualification Matrix that summarizes the recommended minimum crane maintenance requirements discussed above.

4.2 INSPECTION AND LOAD TEST RECORDS

4.2.1 A log of pre-use inspections should be maintained per 3.1.5p and C.3.1.3o.

4.2.2 Written, dated and initialed initial, monthly, quarterly and annual inspection reports, as well as records of repairs and modifications carried out on cranes in accordance with this Recommended Practice, should be kept readily available for a period of 2 years at an appropriate location. The person performing the inspection should be identified on the inspection record.

4.2.3 When a load test is performed, written reports should be furnished to the owner by a *qualified inspector* showing load test procedures and the results. Additional guidance on load testing is given in Appendix E.

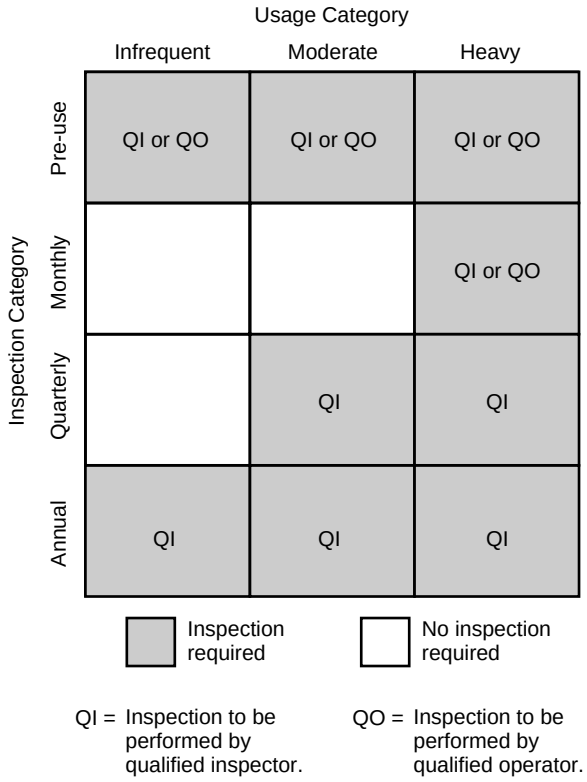


Figure 2—Usage/Inspection/Inspector Qualification Matrix

4.3 MAINTENANCE

4.3.1 Preventive Maintenance

A preventive maintenance program should be established by the owner, taking into consideration crane type, frequency of usage, history of maintenance, and manufacturer's recommendations. Written and dated maintenance records should be readily available for a period of two years.

4.3.2 Maintenance Procedure

a. The following precautions, where applicable, should be taken before adjustments, repairs and maintenance are started on a crane.

1. Means of starting should be rendered inoperative.
2. Appropriate out-of-service signs should be placed at the control station and/or on the prime mover.
3. Additional precautions can be found in C.4.3.2.

b. Adjustments should be made to assure correct functioning of components per the manufacturer's recommendations. See also C.4.3.2b.

4.3.3 Repairs and Replacements

a. If unsafe conditions are disclosed by the inspection requirements as outlined in 4.1 of this Recommended Prac-

tice, the crane shall be taken out of service or its operation restricted to eliminate the unsafe condition.
b. Repairs or replacements of critical components should be made as soon as practical. See also C.4.3.3b.
c. Written reports should be maintained by the owner, confirming the adequacy of major repairs or alterations as implemented.
d. All major replacement parts should equal or exceed the original equipment manufacturer's recommendations.
e. No welding repairs shall be made to critical components, such as booms and swing circle assemblies, without specific repair procedures and recommendations from the original crane manufacturer, or other qualified source (such as an API licensed 2C crane manufacturer, authorized surveyor, or an engineer experienced in the design of the crane, as determined by the owner). Care should be taken to ensure that arcing does not occur across the bearings.
f. Field welding shall not be performed on load hooks or sling hooks. Hooks should not be exposed to excessive heat.

4.4 LUBRICATION

The owner shall consider the crane or component manufacturer's recommendations as to points and frequency of lubrication, maintenance of lubricant levels, and compatibility of lubricants.

4.5 CRANE RERATING

4.5.1 Where rerating of a crane is necessary, it should be conducted in accordance with the recommendations of the crane manufacturer, or other qualified source (such as an API licensed 2C crane manufacturer, authorized surveyor, or an engineer experienced in the design of the crane, as determined by the owner). Rerating reports should be readily available.

4.5.2 No cranes should be rerated in excess of the original load ratings unless such rating changes are approved by the crane manufacturer, or other qualified source (such as an API licensed 2C crane manufacturer, authorized surveyor, or an engineer experienced in the design of the crane, as determined by the owner), and a new load-rating chart is available.

5 Wire Rope and Sling Inspection, Replacement and Maintenance

5.1 WIRE ROPE

5.1.1 Introduction

Wire rope is a structural component of the crane requiring periodic replacement. Possible loss of strength can result from wear, abuse and other forms of deterioration. The wire rope shall be carefully selected, inspected and maintained. Rotation-resistant wire rope has special characteristics that require additional precautions. Appendix G, Commentary on Wire Rope and Sling Inspection, Replacement and Maintenance, of this Recommended Practice and API Specification 9A, latest edition, provides further information. Refer to C.5.1.1 for basic information on wire rope construction.

The qualified operator or inspector who determines whether replacement is necessary shall be knowledgeable in the inspection and maintenance of wire rope.

5.1.2 Inspection

a. The wire rope inspection program should be established taking into consideration crane type, frequency of usage, history of maintenance, wire rope manufacturers' recommendations, and the crane manufacturer's recommendations.
b. Visual inspections of wire rope should be performed by *qualified operators* in pre-use and monthly inspections. Additional wire rope inspection, per C.5.1.2b, should be performed by *qualified inspectors* during quarterly and annual inspections, and as the results of pre-use and monthly inspections may warrant.
c. inspection tools to determine the condition of the wire rope should include, but not be limited to, the following:

1. Steel tape.
2. Sheave groove gauges for worn sheaves used in accordance with API Recommended Practice 9B, latest edition.
3. Quality calipers and/or micrometers with at least 1/1,000th of an inch resolution.
4. Chalk or tape measure.

d. During quarterly and annual inspections, or when ropes are changed on a crane, a number of areas affecting performance and rope life should be checked and corrective action taken as appropriate. Refer to C.5.1.2b and C.5.1.2d.

5.1.3 Rope Replacement

a. The various rope conditions noted upon inspection should be used to determine continued use or retirement of the rope in question.
b. Inspection records should be maintained per 4.2 to determine the time interval for retirement of the rope. Records should be readily available until the specific wire rope is retired. All observed rope deterioration as listed in C.5.1.2b should be recorded on these inspection records.
c. Wire rope unfit for use on cranes, slings or other load carrying devices should be removed from service and identified as unfit for use.
d. Wire rope replacement criteria are provided in C.5.1.3.

5.1.4 Rope Maintenance

a. Wire rope is a machine with many parts that move and integrate with each other. Care and maintenance of this machine is as important as the other components of the crane.

b. Rope should be stored and handled to prevent damage and deterioration. Refer to C.5.1.4b, for recommended storage and handling procedures.

c. Unreeling or uncoiling of rope should be done as recommended by the rope manufacturer. Refer to Figure G.7 for an example. When unreeling or uncoiling rope, attention should be given to avoid the introduction of kinks or twists into the rope. Rotation-resistant rope may be more susceptible to this type of damage than other rope types.

d. Wire rope in the boom hoist and load hoist systems should be installed as recommended by the crane and/or wire rope manufacturer. See C.5.1.4d for an example of installation guidelines.

e. Before cutting a rope, seize the rope at either side of the cut location to prevent unlaying of the strands.

f. Care should be taken during installation to avoid contaminating, scraping or nicking the wire rope. Do not bend the rope about small pipe or crane components that might induce kinks or curling.

g. Wedge socketing or terminating of the wire rope should be performed or supervised by a *qualified operator* or *qualified inspector.*

h. Wire rope clips shall be drop-forged steel and shall be single saddle (U-bolt) or double saddle type clips. Malleable cast iron clips shall not be used. For spacing, number of clips, and torque values, refer to the clip manufacturer's recommendations. 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.

i. Wedge type sockets should be properly installed, per the guidelines of C.5.1.4i.

j. Rope should be maintained in a well-lubricated condition to minimize internal and external corrosion or friction. The best penetration of lubricant is obtained when the lubricant is applied as the rope passes over a sheave. Lubricants applied in the field should be compatible with the lubricant applied by the rope manufacturer following the recommendations of the rope and/or a crane manufacturer. Do not apply used oil because of contamination. Refer to C.5.1.4j for recommended methods of lubrication.

5.1.5 Crane Operation

Operation of the crane will affect rope service life. Guidance in C.5.1.5 should be followed when operating the crane.

5.1.6 Wire Rope Testing

A wire rope manufacturer's break test certificate shall be supplied to the owner for all running ropes. Tests shall be performed as outlined in API Spec 9A, latest edition.

5.1.7 Pendant Lines

a. Each leg of a set of pendant lines should be proof loaded by the pendant line manufacturer in accordance with recognized industry standards.

b. Proof test certification documentation should be supplied to the owner.

5.2 SLINGS

Due to the numerous types of material, construction, combinations and various types of hitches, it is beyond the scope of this Recommended Practice to list the load ratings of each individual sling type. The sling manufacturer should be consulted when a question arises concerning sling ratings, use, care and/or inspection. Section C.5.2.lists types of common slings.

5.2.1 Sling Use and Inspection

C.5.2.1 provides guidelines on the proper use of slings. Slings shall be inspected and tested in accordance with the Wire Rope Sling Users Manual, Recommended Standard Specifications for Synthetic Polyester Roundslings, Recommended Standard Specifications for Synthetic Web Slings, ASME B30.9., latest edition, or other applicable standards. See Appendix H.

a. All slings shall be visually checked prior to use by a *qualified operator* or *qualified rigger.*

b. The frequency of sling inspections should be determined by the owner based on the following:

1. Frequency of sling use.
2. Severity of service conditions.
3. Nature or type of lifts being made.
4. Experience based on service life of slings used in similar applications.

Minimum guidelines for sling inspection frequencies are included within C.4.1.

5.2.2 Sling Fabrication and Lifting Procedures

Refer to section C.5.2.2 for guidelines on sling fabrication and lifting procedures.

5.2.3 Wire Rope Sling Replacement

Deterioration that contributes to loss of the original strength should be taken into consideration and the sling retired as appropriate. Refer to the removal criteria of ASME B30.9 and C.5.2.3. Reasons for replacing the sling should include, but not be limited to, the conditions outlined in C.5.2.3. If there is any question relative to the integrity of the sling, the sling should be removed from service and properly disposed of.

5.2.4 Sling Proof Loading and Labeling

a. Slings of all types shall be proof loaded by the sling manufacturer per industry recommendations. See C.5.2.4 for further details.

b. All slings, regardless of grade and construction, shall be labeled showing sling manufacturer and the pertinent working load limits, proof test certification number, length, diameter, and date of proof test.

c. Slings of other than wire rope construction shall be used, inspected and tested in accordance with the sling manufacturer and industry recommendations.

APPENDIX A1—COMMENTARY ON CRANE OPERATOR TRAINING

C.2.1 Many crane accidents or failures are the result of operational errors. These errors range from not checking control functions to overloading the crane. While no amount of training will prevent human error, training should be provided to minimize the occurrence of operational errors. Section 2.1, in defining the term *qualified operator*, references a formalized, written employer training program. An outline of the major items that could be included in this training program is listed following this paragraph. The training program should be tailored to the particular crane(s) or crane type(s) for which the operator is to be qualified. The program should also include a full review of this API Recommended Practice 2D document.

C.2.1.1 Training Outline

a. Types of Cranes Used Offshore:
   1. Mechanical cranes.
   2. Non-mechanical cranes.
   3. Electric powered cranes.
   4. Other crane types.

b. Crane Components and Lifting Capacities:
   1. Components of a stationary mounted crane.
   2. Boom Angle and Load Radius, reading a range diagram or load rating chart.
   3. Number of parts of line and relationship to rated load.
   4. Limitations of the size and type of wire ropes used in boom hoist lines, pendants and load hoist line.
   5. Lifting capacity of the auxiliary hook.
   6. Lifting capacity of load and boom hoist drums.

c. Wire Rope Construction and Use:
   1. Mechanics of wire rope.
   2. Classes, designation and characteristics of wire rope.
   3. Handling of wire rope.
   4. Guidelines for replacement of wire rope.
   5. Wire rope slings.

d. Mounting Features of the Revolving Upperstructure:
   1. Hookrollers.
   2. Ball ring.
   3. King post.
   4. Others.

e. Boom Structure:
   1. Types of boom construction (lattice, box, etc.).
   2. Wire rope guides.
   3. Boom bolts.
   4. Pin connections.

f. Limit Devices:
   1. Boom-hoist limit.
   2. Load hoist limits.
   3. Boom stops.
   4. All locking devices.
   5. Anti-two block devices.

g. Additional Items:
   1. Sheaves.
   2. Hand signals.
   3. Control markings.
   4. Engine emergency stop.
   5. Gauges and indicators.

APPENDIX A2—COMMENTARY ON CRANE INSPECTOR TRAINING

C.2.2 Crane inspector training is a critical part of the prevention of crane accidents due to mechanical component failure. Section 2.2, in defining the term *qualified inspector*, references a formalized, written training program. An outline of the major items that should be included in this training program is listed following this paragraph. In addition to the recommended training for *qualified operators* (Appendix A1) the inspector training program should be tailored to the particular crane(s) or crane type(s) for which the inspector is to be qualified.

C.2.2.1 Training Outline

1. Crane Operator Training (in accordance with applicable elements of Appendix A1)
2. A review of API SPEC 2C
3. A review of API RP 2D, with emphasis on Appendix C.
4. Crane Component Inspections (as applicable):
   - Crane maintenance and troubleshooting
   - Hoist troubleshooting and overhaul
   - Structural aspects of offshore cranes
   - Knowledge of structurally critical components
   - Knowledge of critical inspection areas

APPENDIX A3—COMMENTARY ON RIGGER TRAINING

C.2.3 An important part of crane safety is proper training of rigger personnel. Accidents and injuries can occur as a result of rigging errors. An outline of items that should be considered for a *qualified rigger* training program is listed in C.2.3.1.

C.2.3.1 Training Outline

a. Rigging Hardware:
   1. Sheaves, blocks.
   2. Hooks, latches.
   3. Rings, links, swivels.
   4. Shackles.
   5. Turnbuckles.
   6. Spreader and equalizer beams.
   7. Cable clips.
   8. Pad eyes, eyebolts, and other attachment points.

b. Slings:
   1. Sling configuration.
   2. Sling angle.
   3. Rated Load
   4. Sling types (synthetic, wire, chain, etc.).
   5. Cargo nets, personnel baskets, and other basket types.

c. Procedures and Precautions:
   1. Load control/taglines.
   2. Lift planning (load weight, center of gravity, etc.).
   3. Sling inspection/rejection criteria.
   4. Unbinding loads.
   5. Personnel transfer.
   6. Sling handling and storage.

d. Rigging Basics:
   1. Pinch points/body position.
   2. Personal Protective Equipment (PPE).
   3. Signals/communications.
   4. Load stability.

APPENDIX B—COMMENTARY ON OPERATION

C.3.1.2c "Hands On" proficiency is defined as a physical means of verifying the following:

1. Operator's dexterity and coordination.
2. Operator's familiarity with overall machine functions and characteristics.

"Hands On" proficiency is the last segment of crane operator qualification training. It should be held on a crane similar to the type of crane to be operated by the qualifying operator, in order to allow the qualifying operator to demonstrate his or her ability.

C.3.1.3a During periods of bad weather, such as lightning or high winds, or where the Operator's ability to see the signal person is impaired by darkness, fog, rain, etc., crane operations should be restricted, at the operator's discretion.

C.3.1.3o A "log" is defined as: A record, a record book, a logbook, a computerized database or an electronic data collector.

Note: This log should be used for Pre-use Inspection reporting, and could also be used for documenting crane usage.

The crane cab, a weather tight enclosure on the crane, or inside the nearest building are examples of appropriate locations for storage of logs.

C.3.2.1c "Hook load" is defined as the load being lifted plus the weight of the slings and rigging. Hook load may or may not include the weight of the hook block and wire rope. This can be determined from the crane's load rating chart. Examples of ways to determine loads are: Weight indicators, scales, and shorebase weighing.

C.3.2.2c Sling use guidelines are:

1. Slings, their fittings and fasteners, prior to use, should be inspected and retired in accordance with 5.2.1.
2. Suitable protection should be provided between the sling and sharp surfaces of the load to be lifted.
3. Proper storage should be provided for slings while not in use. Special considerations should be given in high heat areas where elevated corrosion and loss of lubrication can contribute to reduced service life.
4. Slings should never be choked in the splice.
5. Sharp kinks or knots should not be permitted in wire rope slings.
6. Loads should not be lifted with one leg of a multi-leg sling until the unused legs are secured.

C.3.2.3 Moving the Load

Guidelines for moving the load are as follows:

The *qualified operator* and the designated signal person directing the lift, if utilized, should determine that:

1. The load is secured and properly balanced in the appropriate sling or lifting device before it is lifted.
2. The lift and swing paths are clear of obstructions and personnel.

Before starting to lift, the following conditions shall be verified:

1. The correct slings have been selected for the weight to be lifted.
2. The load is free to be lifted.
3. Multiple part lines are not twisted around each other in such a manner that all of the lines will not separate upon application of load.
4. The hook is brought over the load in such a manner as to minimize swinging.
5. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves.

During lifting, care shall be taken that:

1. Acceleration or deceleration of the moving load is accomplished in a smooth manner.
2. The operator should be aware of the effect of the velocity and weight of the load when lowering at high speeds to minimize shock loading.
3. Load, boom, or other parts of the machine do not contact any obstruction.

The operator should engage the controls smoothly to avoid excessive stress on crane machinery.

When rotating the crane, sudden starts and stops should be avoided. Rotational speed should be such that the load does not swing out beyond the radius at which it can be controlled.

C.3.4 PERSONNEL TRANSFER

The crane operator, while transferring personnel between vessels or from a vessel to a platform, should raise the personnel carrier only high enough off the deck to clear all obstructions: swing the personnel carrier over the water; raise or lower it in such a manner as to minimize swinging; position it slightly above the landing area; and gently lower it to the deck.

A loaded personnel carrier should not be raised or lowered directly over a vessel. If the crane cannot swing the loaded personnel carrier clear of the vessel beneath, the vessel, where practical, should be moved out from under the personnel carrier.

Personnel carriers should be of a design and in a condition suitable for the intended purpose.

APPENDIX C—COMMENTARY ON USAGE, INSPECTION, TESTING, AND MAINTENANCE

C.4.1 USAGE AND INSPECTION GUIDELINES

The following are the minimum guidelines and considerations that should be given to the type of crane usage, manufacturer's recommendations, and any other pertinent criteria. It is the responsibility of the crane owner to develop a preventive maintenance program in accordance with this recommended practice.

C.4.1.1 Crane Usage Categories: Crane usage categories have been developed for the owner to maintain and inspect their equipment based on a duty cycle versus a strict time limit. In order to categorize a crane in the infrequent or moderate usage category, a certain amount of usage documentation should be required of the owner. This documentation is different from and in addition to the pre-use log described in C.3.1.3o. The owner has the option of not documenting crane usage, in which case the crane should default to the heavy usage category.

Determining Crane Usage: The duty cycle or usage on a crane can be determined by keeping a log of actual crane use. See C.3.1.3o for different types of logs. The type of log used is at the discretion of the owner. Keeping track of engine run time could also be used, but this would overestimate the actual crane use time. Other types of usage recording devices, such as drum counters, hourmeters, etc. could be used. It should be the crane owner's responsibility to keep track and document the duty cycle of each crane.

A quarterly inspection should be performed in the event a crane's duty cycle increases from infrequent usage to a higher usage category. However, the annual inspection should not exceed twelve months from the last time it was performed.

C.4.1.2 The following recommendations provide guidance on suggested work scopes for each of the inspection categories listed:

C.4.1.2a Pre-use inspection (performed by a *qualified operator* or *qualified inspector*) may include but not be limited to the following actions:

1. Check all fluid levels of prime mover.
2. Check control mechanisms including brakes and clutches for proper operation.
3. Visually check for hoist lubricant oil leakage. In hoists where a sight glass is provided, also check the fluid level.
4. Visually check for leakage or damage in the air and non-mechanical systems.
5. Check the following devices where applicable:

a. Boom Hoist Pawl.
b. Helicopter Warning Light.
c. Crane Hook Latch.

6. Perform a walk-around visual examination of the crane boom and support structure to ensure that no visible damage exists.
7. Ensure the correct load-rating chart for the configuration in use is visible to the crane operator at the primary control station.
8. Visually check wire rope for evident deterioration and damage, or improper reeving.
9. Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.
10. Visually check rigging gear to be used, such as slings, sling hooks and shackles.

Lubricate components and correct deficiencies as required based on the results of these inspections.

C.4.1.2b Monthly inspections (performed by a *qualified operator* or *qualified inspector*) may include but not limited to the following actions:

1. Check all fluid levels of prime mover.
2. Check control mechanisms including brakes and clutches for proper operation.
3. Visually check for hoist lubricant oil leakage. In hoists where a sight glass is provided, also check the fluid level.
4. Visually check for leakage or damage in the air and non-mechanical systems.
5. Check the following devices where applicable:

a. Boom Hoist Pawl.
b. Helicopter Warning Light.
c. Crane Hook Latch.

6. Perform a walk-around visual examination of the crane boom and support structure to ensure that no damage exists.
7. Ensure the correct load-rating chart for the configuration in use is visible to the crane operator at the primary control station.
8. Visually check wire rope for evident deterioration and damage, or improper reeving.
9. Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.
10. Visually check rigging gear to be used, such as slings, sling hooks and shackles.
11. Further check all control mechanisms for proper adjustment, excessive wear of components, and contamination by foreign matter.
12. Check appropriate electrical apparatus for proper function.
13. Check boom hoist limit and anti-two block devices for proper operation. Care should be exercised to prevent damage to crane components.

Lubricate components and correct deficiencies as required based on the results of these inspections. Document these results per section 4.2.2.

C.4.1.2c Quarterly inspections (performed by a *qualified inspector*) may include but not be limited to the following actions:

1. Check all fluid levels of prime mover.
2. Check control mechanisms including brakes and clutches for proper operation.
3. Visually check for hoist lubricant oil leakage. In hoists where a sight glass is provided, also check the fluid level.
4. Visually check for leakage or damage in the air and non-mechanical systems.
5. Check the following devices where applicable:

a. Boom Hoist Pawl.
b. Helicopter Warning Light.
c. Crane Hook Latch.

6. Perform a walk-around visual examination of the crane boom and support structure to ensure that no visual damage exists.
7. Ensure the correct load-rating chart for the configuration in use is visible to the crane operator at the primary control station.
8. Visually check wire rope for evident deterioration and damage, or improper reeving.
9. Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.
10. Visually check rigging gear to be used, such as slings, sling hooks and shackles.
11. Further check all control mechanisms for proper adjustment, excessive wear of components, and contamination by foreign matter.
12. Check appropriate electrical apparatus for proper function.
13. Check boom hoist limit and anti-two block devices for proper operation. Care should be exercised to prevent damage to crane components.
14. Boom should be inspected for bent chord members, missing or broken lacing and cracked welds on critical members. Boom section end connections should be inspected for cracked welds, deformation and corrosion.
15. Check boom angle/radius indicators over full range for accuracy.
16. Sheaves should be inspected for wear, cracks, and rope path alignment and bearing condition.
17. Check power plants for proper performance and compliance with safety requirements.
18. Check belts and chains for proper adjustment.
19. Visually check crane hooks for deformation, and discard if deformations exceed the manufacturer's recommendations.
20. Inspect wire rope as per 5.1.2.
21. Check lubricant level in all hoists and slew drives, including those not fitted with sight glasses.

Lubricate components and correct deficiencies as required based on the results of these inspections. Document these results per section 4.2.2. Oil sample analysis, as suggested by the hoist manufacturer, is intended primarily to evaluate its mechanical integrity. Oil sample analysis need not necessarily mean a laboratory analysis. It can be effectively achieved by qualitative tests performed in the field by a *qualified inspector* or operator (such as cheese cloth, smell and texture tests).

C.4.1.2d Annual inspections (performed by a *qualified inspector*) will include pre-use, monthly, and quarterly Inspections, as well as inspections of critical crane components. A basic guideline for annual inspections should consider, but not be limited to, the following actions:

1. Check all fluid levels of prime mover.
2. Check control mechanisms including brakes and clutches for proper operation.
3. Visually check for hoist lubricant oil leakage. In hoists where a sight glass is provided, also check the fluid level.
4. Visually check for leakage or damage in the air and non-mechanical systems.
5. Check the following devices where applicable:

a. Boom Hoist Pawl.
b. Helicopter Warning Light.
c. Crane Hook Latch.

6. Perform a walk-around visual examination of the crane boom and support structure to ensure that no visible damage exists.
7. Ensure the correct load-rating chart for the configuration in use is visible to the crane operator at the primary control station.
8. Visually check wire rope for evident deterioration and damage, or improper reeving.
9. Visually check for loose, missing, or corroded bolts, pins, keepers or cotter pins.
10. Visually check rigging gear to be used, such as slings, sling hooks and shackles.
11. Further check all control mechanisms for proper adjustment, excessive wear of components, and contamination by foreign matter.
12. Check appropriate electrical apparatus for proper function.
13. Check boom hoist limit and anti-two block devices for proper operation. Care should be exercised to prevent damage to crane components.
14. Boom should be inspected for bent chord members, missing or broken lacing and cracked welds on critical members. Boom section end connections should be inspected for cracked welds, deformation and corrosion.

15. Check boom angle/radius indicators over full range for accuracy.
16. Sheaves should be inspected for wear, cracks, and rope path alignment and bearing condition.
17. Check power plants for proper performance and compliance with safety requirements.
18. Check belts and chains for proper adjustment.
19. Visually check crane hooks for deformation, and discard if deformations exceed those manufacturers' recommendations.
20. Inspect wire rope as per 5.1.2.
21. Check lubricant level in all hoists and slew drives, including those not fitted with sight glasses.

Lubricate components and correct deficiencies as required based on the results of these inspections. Document these results per section 4.2.2. Oil sample analysis, as suggested by the hoist manufacturer, is intended primarily to evaluate its mechanical integrity. Oil sample analysis need not necessarily mean a laboratory analysis. It can be effectively achieved by qualitative tests performed in the field by a *qualified inspector* or operator (such as cheese cloth, smell and texture tests).

Inspection of critical crane components: The annual inspection of critical components appropriate for an individual machine will differ, depending on the crane type and design of the individual components. A basic guideline for inspection of critical crane components should consider but not be limited to the following:

22. Hoist Assemblies—Annual inspection and maintenance of the hoist should be determined by the owner as a function of the hoist type, past and anticipated duty cycle, and condition. The quality of the hoist lubricant is considered a primary indicator of the mechanical integrity of the hoist. Brakes should be tested by stalling the drive. See Appendix D, Commentary on Spring-Set Hoist Brakes, for additional recommendations for spring-set hoist brakes.
23. Foundation—Weldments in the crane's pedestal and supporting deck structure should be visually examined for fracture, deformation and corrosion. Special attention should be paid to areas of rust and cracked paint.
24. Swing Circle Assembly—The swing circle assembly is the connecting component between the crane revolving upperstructure and the pedestal. Consequently, regular inspections are paramount to insure a long and safe operational life.

There are three (3) main types of swing circle assemblies typically used on pedestal-mounted cranes:

- Hook and roller assemblies
- King posts
- Ball/roller bearings

The inspection procedure for each varies significantly and should be tailored, not only to fit the type of swing circle assembly, but also for the physical and operational environment of each particular crane and platform.

Regardless of the type of swing circle assembly, the objective of any inspection is to determine and monitor wear, fatigue, corrosion, and the overall operational condition. The crane and swing circle assembly manufacturers are the best sources for information in developing the inspection program. The following are suggested inspection guidelines for each type of swing circle assembly.

Hook and Roller Assemblies

Ring Gear:

a. Center pin and bushing condition should be verified and monitored for wear. Center pin wear is generally due to improperly or unevenly adjusted hook rollers.
b. Proper lubrication of center pin bushing should be verified.
c. Obvious wear between ring gear teeth and swing pinion gear would indicate center pin wear and improperly adjusted hook rollers.
d. Excessive lateral wallowing, wobbling, or loud popping noise of machine base or frame indicates center pin bushing wear.

Hook Rollers:

a. Hook rollers to turntable clearance should not exceed manufacturer specifications.
b. Hook rollers should be evenly adjusted to minimize uneven stress and wear on center pin and center pin bushing.
c. Hook roller path should be smooth, flat, and have no ridges or dents that would cause uneven load distribution.
d. Hook rollers should be concentric with no flat spots.
e. Bearings should be well lubricated and should roll smoothly with no noticeable popping or grinding noise.

Hook Roller Brackets, Bracket Pads, and Bolts:

a. Machine should be tilted fully in both directions noting any deflection between the hook roller bracket and the machined surface of the main frame pad where the hook roller bracket mounts. Consult manufacturer for tolerances.

Note: Forged castings that comprises hook roller brackets very seldom bend or distort; i.e. the main frame generally yields, thus causing obvious deflection or gap.

b. Hook roller bracket bolts should be checked for proper bolt torque, excess stretching, excess rust pitting, improper size, etc.

King Post

Bearing areas of the crane should be inspected to assure that there is no significant wear or damage to either the rotating or stationary load bearing members, that left uncorrected, might result in a loss of structural integrity of the mounting system. The king post crane inspection procedure will depend on the design of the crane being inspected. The inspection should include but not be limited to the following:

- Upper thrust bearing
- Upper radial bearing
- Lower thrust bearings or wear bands
- King pin wear and condition
- Lower king post wear band: The wear band condition is critical as it protects the king post from the lower thrust rollers or wear bands. On cranes not equipped with a wear band or if the wear band is excessively worn, the wear zone on the king post shall be carefully monitored to ensure the structural integrity of the king post.
- King post-to-platform structural connection.

Ball/Roller Bearing

This type of swing circle assembly is either bolted and/or welded to the pedestal and rotating crane turntable.

The three (3) major inspections that should be performed are for a) bearing wear, b) crane/bearing connection integrity, and c) operating characteristics.

1. Bearing Wear

The wear in the bearing must be monitored to determine its expected service life. The wear measurement can be performed in a number of ways. Some of which are as follows:

Tilt Method. In order to perform this procedure, it must be possible to fully tilt the bearing forward and rearward using the counterweight of the crane, jacks, boom luffing cylinder, etc. The objective is to measure the total internal bearing raceway to rolling element clearance with no substantial moment on the bearing that could cause elastic deformation.

It is strongly recommended the tilt procedure be performed at a minimum of four locations every 90° around the circumference of the bearing.

This procedure involves positioning a dial indicator between the rotating and nonrotating bearing races. The crane boom is positioned to fully tilt the bearing forward using a light hook load if necessary. The dial indicator is either positioned under the boom or under the rear of the crane in line with the boom centerline and zeroed. The boom is then raised to its highest position to fully tilt the bearing rearward. The bearing clearance is then measured on the dial indicator. (Refer to Figure C.1.)

The bearing should again be tilted forward to its original position to verify the accuracy of the measurement by the dial indicator again reading zero.

CAUTION: This tilt procedure can only be used if the crane has sufficient counterweight to fully tilt rearward when the boom is raised to its highest position. If the crane/bearing is not tilted fully, highly inaccurate and misleading clearance measurements will result.

For cranes with insufficient counterweight, jacks can be used to fully tilt the bearing rearward or on box boom cranes, the luffing cylinder can be used to lightly power down against an adequate support to tilt the bearing rearward.

Depression Measurement Method. This system involves the monitoring of bearing wear by periodically measuring the distance between two machined surfaces on the front or rear of the crane with the bearing fully tilted forward with no excessive moment load. In order for the procedure to be accurate, the measurements must be taken between the exact same surfaces at the exact same point each time with the boom at the same position with the same moment load.

The first measurement must be performed when the bearing is new and the crane is first put into service to obtain a base value for subsequent repeat measurement comparisons. Without having this base value, the depression measurement method cannot be used to determine the total wear in the bearing as the bearing is never tilted rearward. (Refer to Figure C.2.)

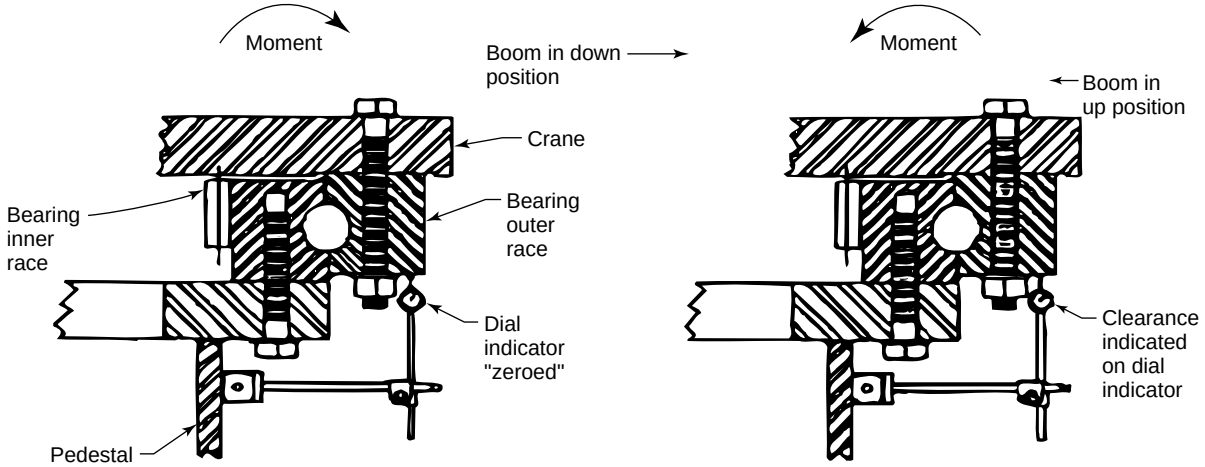


Figure C.1—Tilt Method

Rotation Method. When the Tilt Method cannot be used due to insufficient crane counterweight and when no base value reading was ever taken for use with the Depression Measurement Method, a third method must be used. One possible third method is the Rotation Method.

The Rotation Method is based on the fact that a bearing can always be fully tilted forward in the direction of the boom and the tilt will follow the rotation of the crane. A dial indicator, with a magnetic base, can be fixed to the crane or pedestal with the needle of the indicator positioned on a clean, rust free, machined horizontal surface of the bearing or crane. The dial indicator is positioned in the front or rear of the crane in line with the boom. The boom must be positioned such that the bearing is fully tilted forward with no excessive moment load.

After the indicator is zeroed, the crane is slowly rotated 360° with the dial indicator reading recorded every 45° of crane rotation. The dial indicator should return to zero when the crane is rotated 360° back to its original position. (Refer to Figure C.3.)

The dial indicator should be repositioned every 90° in order to perform four (4) individual tests.

This method may not be as precise as the tilt and depression measurement methods as the machined surface of the bearing opposite where it contacts the crane and pedestal flange may not be machined perfectly true to the rolling element raceway diameter.

However, the Rotation Method does produce reasonably accurate results when performed on a periodic, consistent basis and may be the only method that can be used.

Wear Assessment by Grease Sample Analysis. Wear can be monitored by periodic grease sample analysis and/or a physical inspection of the grease. Grease samples should be collected every twelve (12) months as a minimum; and this period should be shortened if obvious metal or contaminants are present.

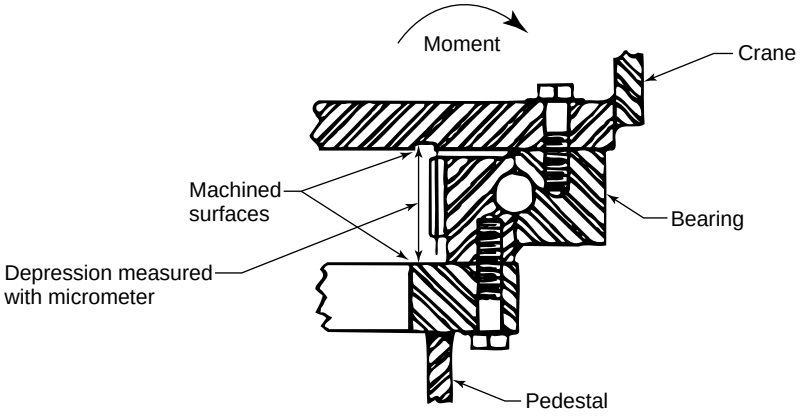


Figure C.2—Depression Measurement Method

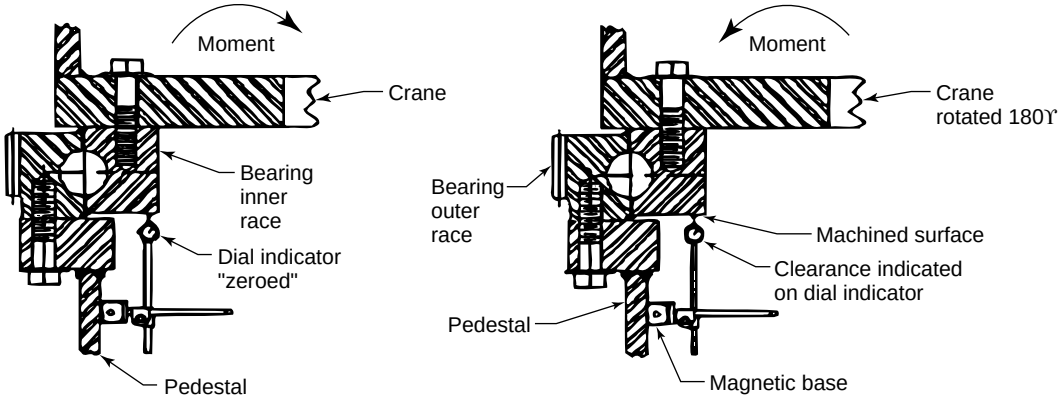


Figure C.3—Rotation Method

2. Crane/Bearing Connection Integrity

The crane/bearing can be connected using bolts, welding or combinations of the two. The integrity of this connection is crucial to the life of the swing circle assembly. The crane and/or swing circle assembly manufacturer should be contacted for guidance when developing the inspection procedures, as each crane is unique.

Bolts must be correctly preloaded to function properly and the crane manufacturer may be the only source for proper torque/preload procedures and values. General purpose bolt torque charts may not be applicable due to the various bolt materials, platings, surface finishes, joint designs, etc. found in use. Loose or incorrectly preloaded mounting bolts is one of the major causes of swing circle assembly failure.

3. Operating Characteristics

The operating characteristics of a bearing are another factor to be considered in an inspection.

The crane should be rotated 360° in each direction at slow, intermediate and full speed and the smoothness of rotation monitored. Any irregular, jerky, bumpy, etc. motions should be recorded and further inspection may be in order.

APPENDIX D—COMMENTARY ON SPRING-SET HOIST BRAKES

Spring-Set Hoist Brake Test Procedures

The following are recommended methods for spring-set brake testing. Consult the crane manufacturer for additional information relative to the proper method and desired torque ratings.

1. Apply torque with a suitable torque wrench at the end of the shaft for hoists with an integral motor and brake.
2. For hoist with a band brake or internal load brake detach the motor without disconnecting the non-mechanical lines. Apply torque with a suitable torque wrench at the exposed countershaft end.
3. Power hoist motor with the brake applied.

APPENDIX E—COMMENTARY ON LOAD TESTING

A crane load test is required under the following conditions:

1. New cranes being placed into service.
2. Cranes that are being permanently relocated.
3. Temporary cranes after each rig-up or relocation.

Crane load testing is not required to determine the fitness of repairs or alterations, provided the repair and replacement procedures outlined in 4.3.3 are followed.

The load applied to the crane during the test should be carefully chosen by the designated *qualified inspector*. Since the test loads are based on the crane rating chart, the *qualified inspector* must be familiar with the applicable load-rating chart. Figure E.1 is a graph of capacity vs. radius for a typical crane. The rating for the crane is always limited by the lowest point of all the curves as shown in Figure E.1. The load-rating chart should show the maximum capacity for each radius. Note the shaded area for the typical crane rigged with two-part line and the transition points A and B. To the left of point A, the rated load is limited by the available hoist line pull and wire rope strength. Between points A and B, the rated load is limited by the over turning moment (OTM); and to the right of point B, the rated load is limited by the boom suspension system. This graph has been greatly simplified for this illustration and the *qualified inspector* should be aware that curves for the boom, gantry, swing bearing, etc., have been omitted for clarity. Since it is obviously impossible to test all of the crane components at the same time, the *qualified inspector* should choose test loads that specifically stress the repaired or altered component. Since the crane's hoists and ropes will be used to impose the overload on the crane, the *qualified inspector* should choose a test load that is within the capacity of the hoist(s) and rope(s) as normally rigged. The crane should not be rigged with extra parts of line to lift a greater test load at a closer radius. The test load can be imposed on the crane with a lesser load at a greater radius.

Using Figure E.1 as an example, the rated load for a four-part line at 20 feet has the same OTM as a two-part line at 40 feet. To the right of point A, a two-part line is capable of overloading the crane while the auxiliary line cannot overload the crane at any radius. The *qualified inspector* should be aware that line pull on many nonmechanical and electric hoists may be self-limiting. The load test requires only that these hoists when self-limiting lift at least 100% of rated load.

The *qualified inspector* should also take into consideration the maximum and minimum boom angles that are usually employed in material transfer over the side of the unit. Consideration should be given to the maximum parts of line that the crane would reasonably be expected to use. For example, a test conducted with a two-part main line may be valid for four-part reeving if the altered component is the boom point sheave shaft. It is therefore the responsibility of the *qualified inspector* to select the load test procedures best suited for the requirements and conditions of each test.

Recommended Load Test Procedures

Date: _____

Crane Owner: _____

Platform or Vessel Name: _____

Crane Manufacturer: _____

Crane Model: _____

Crane Serial Number: _____

Boom Length, Main: _____ Boom Length, Auxiliary: _____

Parts of line, Main Hoist: _____ Auxiliary Hoist: _____

Owner's Representative:* _____

Qualified Inspector:* _____

Inspector's Company/Agency: _____

Notes:

1. Crane shall be operated during test in accordance with API Recommended Practice 2D, latest edition.
2. Crane shall be thoroughly inspected per API Recommended Practice 2D, 4.1.2 "Annual Inspection," before and after the test. Attention should be given to rigging used to attach loads. Tag lines should be used on test loads.
3. Test weights or dynamometer should be verified for accuracy by qualified inspector.
4. All lifts should be planned in advance taking into account the crane's physical location, the available space for staging and assembling the test loads and the hazardous areas to be avoided.
5. Crane load indicators shall not be used to test cranes, but the readings should be recorded on each lift where load indicators are installed on the crane.

* May be one individual.

6. Relief valves on hydraulic cranes should not be adjusted above manufacturer's recommended pressures and current limiting devices on electric cranes should not be bypassed or adjusted to increase available hoist line pull. The test can be conducted with the highest load the hoist can lift as long as it is in excess of the static rated load.
7. The test load for all lifts shall be based on crane rating chart, wire rope strength, available hoist line pull and number of parts of line. The static test load and the test radius should be calculated to load the crane as follows:

Static Rated Load in Pounds at a Specific Radius	Test Loads in Excess of Static Rated Load at a Specific Radius
Up to 40,000	25%
40,000 to 100,000	10,000 pounds
over 100,000	10%

8. All cranes should be tested as they are normally rigged. Cranes should not be rigged with extra parts of line or have their hydraulic pressures, electric currents, or engine output increased unless the test radius is restricted by physical location. The correct test load should not necessarily be based on the highest load shown on the rating chart.
9. In the case of cranes that do not conform to API Specification 2C, Third or later Edition, the crane manufacturer should be consulted, as required, to determine test loads based on the crane's normal rigging arrangement.
10. The test load should be applied by one of the following methods:
    A. Suspended Weight Method—Select a suitable test load per note 7 of this appendix. Assemble the load, lift the load and boom out to the desired radius. With the load suspended, set the load hoist and boom hoist brakes and check for drum rotation (The load test does not require that the test load be boomed or swung).
    B. Dynamometer Method—Determine the available dynamometer tie-down locations. Measure and record the radius value. Align the boom point with the tie-down and attach the dynamometer. Verify that the load hoist line is vertical, pull with the load hoist until the desired test load is indicated on the dynamometer. Set the load hoist brake and check for drum rotation.
11. The load test report should include, but not be limited to, the following information.
    A. Auxiliary Line, select appropriate load for component(s) being tested.
        (1) Actual Test Load _____
        (2) Actual Test Radius _____
        (3) Indicated Load _____
        (4) Hydraulic Hoist Pressure _____
    B. Main Hoist Line, select appropriate load for component(s) being tested.
        (1) Actual Test Load _____
        (2) Actual Test Radius _____
        (3) Indicated Load _____
        (4) Hydraulic Hoist Pressure _____
12. Check Radius or Boom Angle Indicator at four (4) values including maximum and minimum.
    A. Actual Radius, measured — Indicated Radius
        Minimum, _____ ft. _____
        Intermediate, _____ ft. _____
        Intermediate, _____ ft. _____
        Maximum, _____ ft. _____
    B. Actual Boom Angle, Measured — Indicated Boom Angle
        Maximum, _____ ° _____
        Intermediate, _____ ° _____
        Intermediate, _____ ° _____
        Maximum, _____ ° _____
13. Functionally test the following; record test results.
    A. Main hoist anti-two block _____
    B. Auxiliary hoist anti-two block _____
    C. High boom angle limit _____
    D. Low boom angle limit _____
    E. Prime mover shutdown _____
    F. Emergency shutdown _____
    G. Rotate crane _____
14. Record relief valve pressure setting on the following hydraulic functions:
    A. Hoist circuits _____
    B. Boom circuits _____
    C. Swing circuits _____

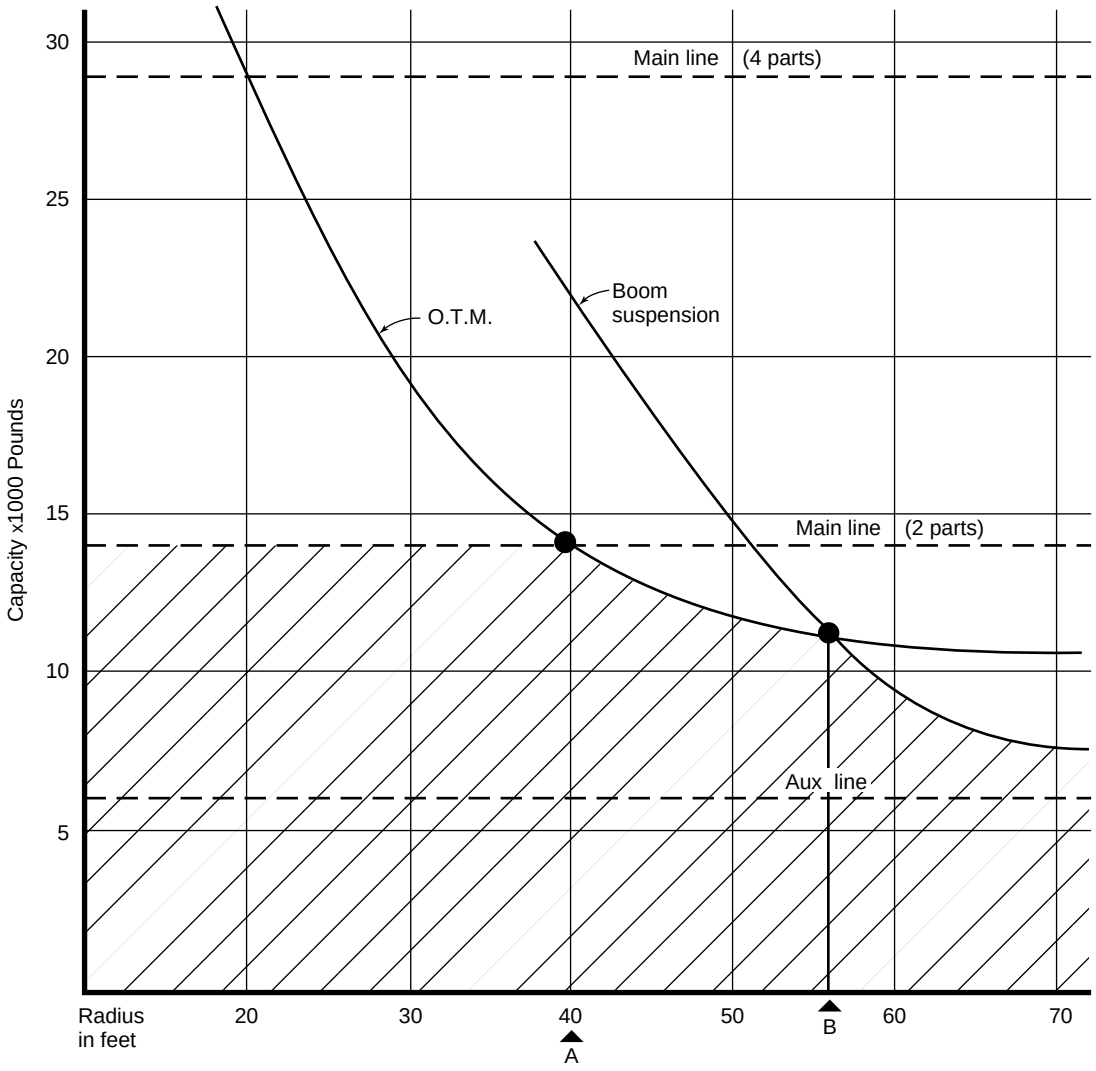


Figure E.1—Capacity versus Radius for a Typical Crane

APPENDIX F—COMMENTARY ON MAINTENANCE

C.4.3.2 Maintenance Procedure

a. The following additional precautions, where applicable, should be taken, before adjustments, repairs and maintenance are started on a crane.

1. Boom shall be lowered to the deck or boom rest or otherwise secured against dropping and swinging.
2. Blocks shall be lowered to the deck or otherwise secured against dropping and swinging.
3. All controls shall be in the off or neutral position.

b. Adjustments should include the following:

1. All operating mechanisms and control systems.
2. Limit devices.
3. Swing circle assembly.
4. Prime mover.
5. Non-mechanical System—Appropriate out of service signs should be placed at the control station and/or prime mover by a *qualified operator* or *qualified inspector.* Corrective action should be taken by the owner.

After adjustments, repairs and maintenance have been completed, the crane should not be put in service until all guards have been reinstalled, limit devices reactivated and maintenance equipment removed.

C.4.3.3 Repairs and Replacements

a. Booms which are being assembled or disassembled on the deck, with or without support of the boom harness, shall be securely blocked to prevent dropping of the boom and/or boom sections.

b. No welding repairs shall be made to critical components, such as booms and swing circle assemblies, without specific repair procedures and recommendations from the original crane manufacturer, or other qualified source (such as an API licensed 2C crane manufacturer, authorized surveyor, or an engineer experienced in the design of the crane, as determined by the owner).

APPENDIX G—COMMENTARY ON WIRE ROPE AND SLING INSPECTION, REPLACEMENT AND MAINTENANCE

C.5.1.1 Wire rope, also called rope, consists of three basic components: (1) the core, (2) the individual wires that form the strands and (3) the multi-wire strands that are helically laid around the core. See Figure G.1. For further information, refer to API Specification 9A, latest edition.

A rope lay or lay length is the distance measured parallel to the axis of the rope in which a strand makes one complete helical revolution about the core. See Figure G.2.

C.5.1.2b Wire Rope Inspection Criteria

1. Reduction of rope diameter below the nominal diameter due to wear of outside wires, loss of core support or internal or external corrosion. Core failure in rotation-resistant rope may be difficult to observe. Typical methods to check core failure are:

   a. Diameter measurement; diameter is reduced with core deterioration. See Figure G.3.

   b. Length of lay measurement; core failure results in an increase in the lay length. See Figure G.4.

2. The number of broken outside wires and the concentration of the broken wires. Attention should be given to valley breaks where the breaks are at the strand to contact points. See Figure G.5.

3. Worn outside wires.

4. Corroded or broken wires at the end connections. Corroded, cracked, bent, worn or improperly applied end connections.

5. Kinking, crushing, cutting or unstranding.

6. Improper spooling on hoist drum such as:
   - Strand Crushing
   - Core Protrusion
   - Abrasion
   - Excessive Strand Gaps
   - Loose and Uneven Spooling

7. Heavy wear and/or broken wires occur in rope sections in contact with certain components of the crane. Care shall be exercised in inspecting the rope at these points. Inspection shall include, but not be limited to, the following areas:

   a. Equalizer sheaves or saddles, also referred to as fixed guides, or other sheaves.

   b. End connections including socket or end attachments to running ropes, boom pendants and other standing ropes.

   c. Sections of the rope where the rope is continually running over sheaves within the various hoist systems. This inspection is of particular importance where boom angle and load block changes are frequent and limited to short distances.

   d. At crossover and flange points of the rope on the hoist drums.

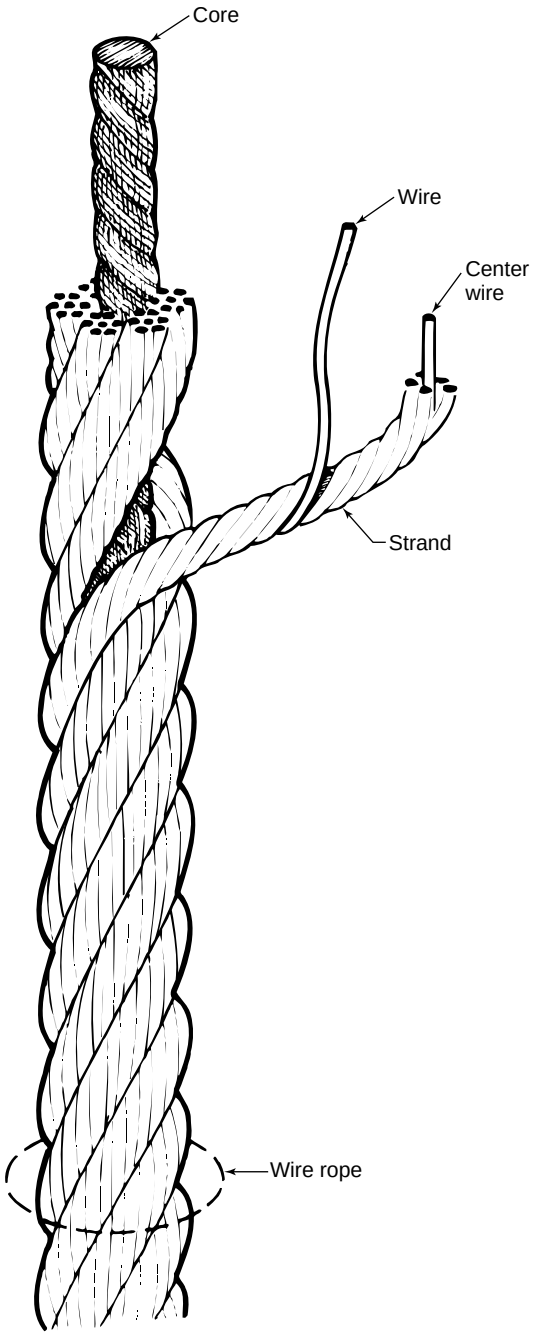


Figure G.1—The Three Basic Components of Wire Rope

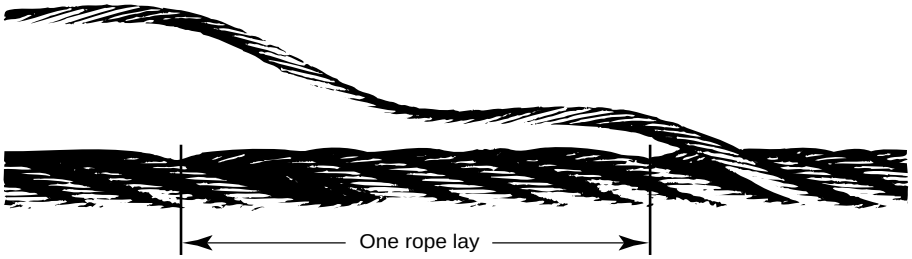
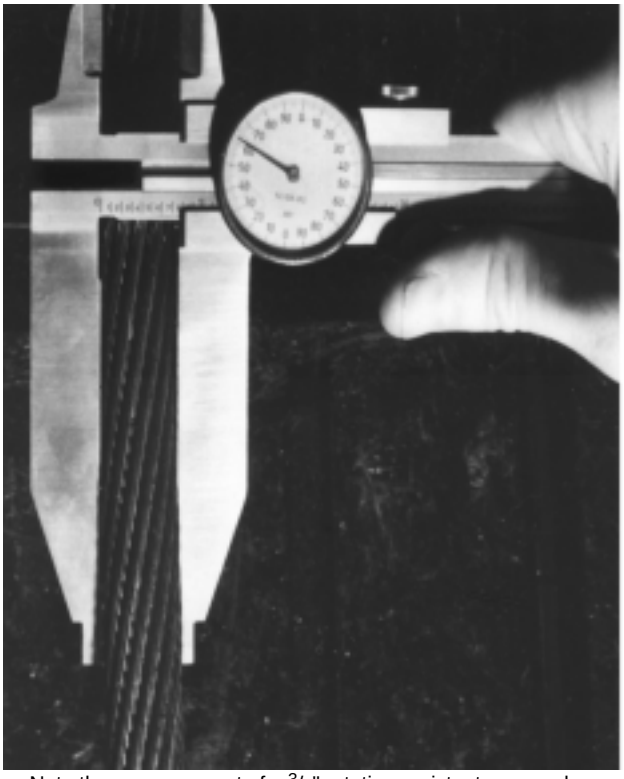


Figure G.2—Showing Distance of One Rope Lay

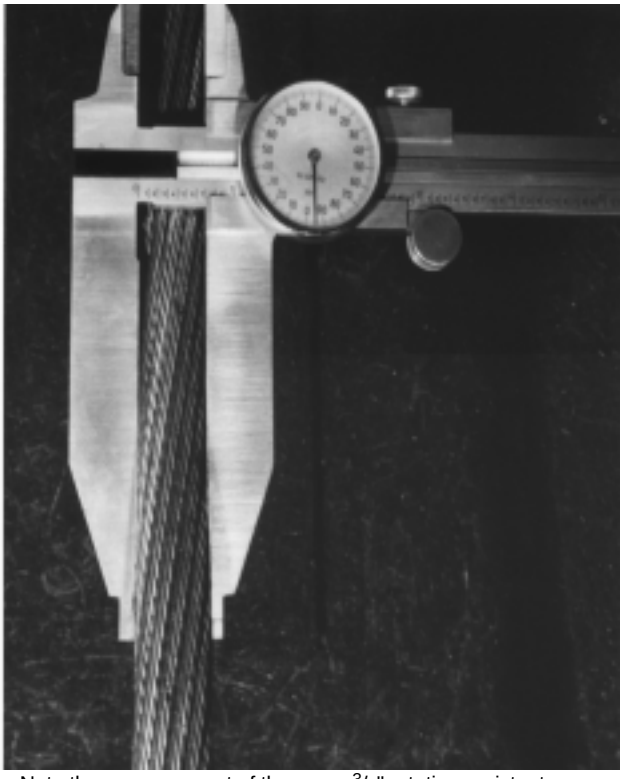
Measurement—Diameter
(Can be detected by inspection and measurement)

Core not Broken



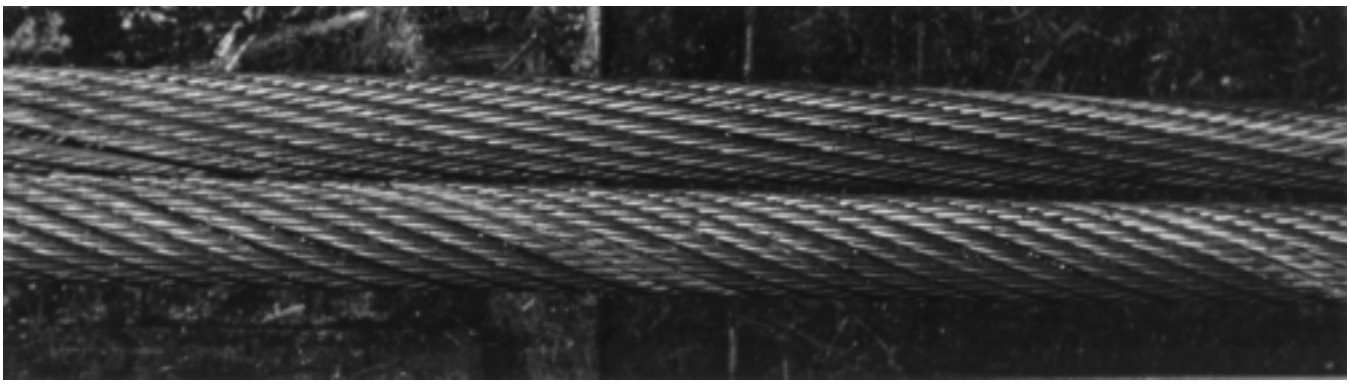
Note the measurement of a $^{3}/_{4}$" rotation-resistant rope under 10,000-lb load away from the break measures 0.762".

Core Broken



Note the measurement of the same $^{3}/_{4}$" rotation-resistant rope under 10,000-lb load at the core failure measures 0.695".

Figure G.3—Measurement—Diameter



Note the top wire rope has the core failure and shows a definite increase in lay length.

Figure G.4—Core Failures in Rotation-Resistant Wire Rope

C.5.1.2d Sheave Inspection Criteria

1. Sheaves checked with a groove gauge for wear and checked for corrugation, the rope imprint in the groove surface.
2. Sheaves checked for broken or chipped flanges.
3. Sheaves checked for cracks in the hub.
4. Sheaves checked for freedom of rotation without drag.
5. Sheaves checked for bearing wear.
6. Drum flange checked for cracks, chips or other deterioration.

C.5.1.3 Wire Rope Replacement Criteria

In general, the following criteria are based on using the wire rope under maximum load conditions. While the wire rope should be retired if any of the conditions are found limited usage may continue until the replacement rope is available. This determination shall be made by a *qualified operator* or a *qualified inspector.*

When broken wires appear, the inspections should be at more frequent intervals as additional broken wires can be anticipated in a short period of time. Valley breaks are more detrimental than surface broken wires.

1. Running ropes used in the boom hoist:

   a. Six (6) randomly distributed broken wires within one (1) lay length.
   b. Three (3) broken wires in one strand within one (1) lay length.

2. Running ropes of rotation-resistant construction used in the main or auxiliary hoist:

   a. Four (4) randomly distributed broken wires within one (1) lay length.
   b. Two (2) broken wires in one strand within one (1) lay length.

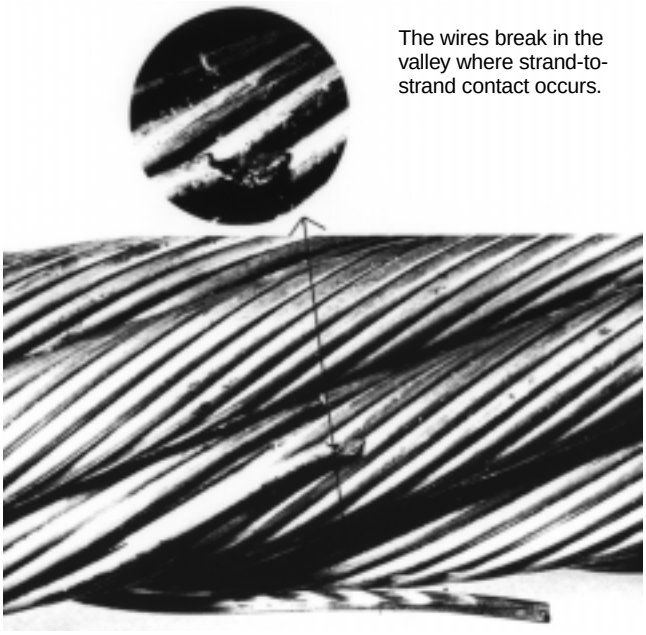
3. Standing ropes such as boom pendants:

   a. Three (3) broken wires within one (1) lay length.
   b. Two (2) broken wires at the end connection.

4. One (1) valley break may indicate internal rope damage requiring close inspection of this section of the rope. See Figure G.5.

   a. When two (2) or more valley breaks are found in one (1) lay length the rope should be retired.

5. More than one-third of the original diameter of the outside wires of the strand are worn.
6. The rope construction has been distorted by kinking, crushing, birdcaging or other distortional damage.
7. There is evidence of heat damage from any source. Heat can be generated by passing a rope over a frozen or nonturning sheave, contact with structural members of the crane, improperly grounded welding leads or lightning strikes.



Check for internal damage after discovering broken wires between strands.

Figure G.5—Valley Breaks

8. Reductions for the rope diameter in a nonworking area (an area away from the sheaves) compared to the lowest diameter of rope measured in three (3) working areas (areas where the rope regularly goes over a sheave) of more than the following is observed:
   - $^{3}/_{64}$ (.047) inch for diameters up to and including $^{3}/_{4}$ inch.
   - $^{1}/_{16}$ (.062) inch for diameters of $^{7}/_{8}$ through $^{11}/_{8}$ inch.
   - $^{3}/_{32}$ (.093) inch for diameter of $^{11}/_{4}$ through $^{11}/_{2}$ inch.

   See Figure G.6 for proper method of measuring rope diameters.
9. Increase in the length of an individual rope lay is observed. This increase in lay length and accompanying reduction in diameter can be caused by failure of the core. This may occur more readily in ropes or rotation-resistant construction. See Figure G.4.
10. Extensive external and/or internal permanent corrosion is cause for rope replacement.

Wire rope replacement should be selected by using the following criteria:

1. Boom hoist rope replaced with rope of the same diameter, length, construction, grade, (EITHER GALVANIZED OR BRIGHT WITH THE SAME MINIMUM BREAK LOAD) as originally furnished or as recommended by the crane manufacturer or other qualified sources (see item 4). Rotation resistant rope should not be used to replace boom hoist ropes.
2. Pendants or standing ropes replaced with rope of the same diameter, length, construction, grade, (EITHER GALVANIZED OR BRIGHT WITH THE SAME MINIMUM

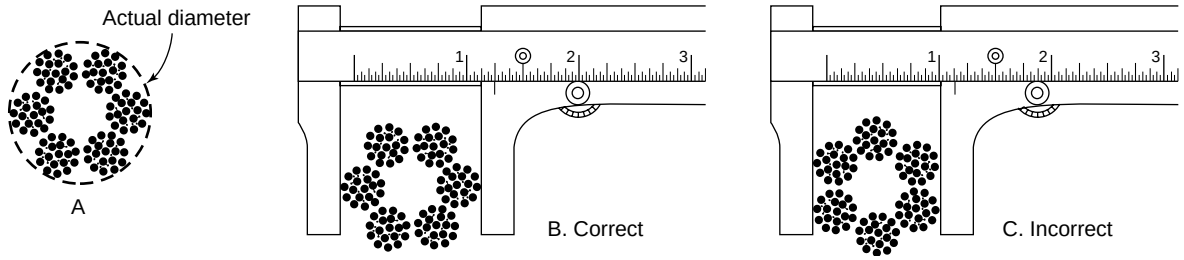


Figure G.6—Right and Wrong Way to Measure Wire Rope Diameter

BREAK LOAD) as originally furnished or as recommended by the crane or rope manufacturer. End connections should be the same as originally furnished or as recommended by the crane manufacturer or other qualified sources (see item 4).

3. Load hoist ropes replaced with rope of the same diameter, length, construction, grade (EITHER GALVANIZED OR BRIGHT WITH THE SAME MINIMUM BREAK LOAD) as originally furnished or as recommended by the crane manufacturer or other qualified sources (see item 4).

4. When the replacement rope is other than the type and grade that was originally furnished, all load rating charts should be reviewed by the original crane manufacturer, an API Specification 2C licensed crane manufacturer, authorized surveyor, or an engineer experienced in crane wire rope applications.

C.5.1.4b Recommended Storage and Handling Procedures

1. Stored rope shall be covered in a well-ventilated area and away from excessive heat.

2. Where covered storage is not available, the rope and reel shall be covered with waterproof material. For long periods of storage, apply a lubricant coating to the outside layer of rope on the reel.

3. On a crane that is to be out of service for long periods of time, apply the proper lubricant to all wire rope.

4. Care shall be taken during shipping and handling of the reel and rope to prevent damage to the rope. The loose end of the rope on the reel shall be secured properly to the reel. Do not drive a nail through the center of the wire rope.

5. Special considerations should be given in high heat areas where elevated corrosion and loss of lubrication can contribute to reduced shelf life.

C.5.1.4d Installation Guidelines

1. To avoid introduction of twist into the rope while reeving, remove the rope from the same side of the reel as it will be operated on the drum, top-to-top or bottom-to-bottom. See Figure G.7.

2. Spool rope under tension to properly seat the rope on the drum. Particular care shall be taken in spooling the first layer.

3. Care shall be taken to assure that the boom, main and auxiliary hoist systems are reeved for the specific crane configuration in use.

4. When reeving through the sheave system, avoid kinks or looping which could damage the rope.

5. Some wire rope manufacturers recommend that welded wire rope ends be left intact, while others recommend that all welded ends be properly cut off. Consult with the crane or wire rope manufacturer on recommended procedures. High performance wire rope, particularly compacted rotation-resistant wire rope, may have special manufacturer recommendations for end preparation prior to cutting which should be followed.

6. Swivels shall not be used at the dead end of multi-part hoist systems with rotation-resistant rope.

7. Swivels shall be installed at the dead end of single part systems following the recommendation of the crane and/or wire rope manufacturer. The swivel is typically an integral part of the overhaul ball and may be of a top or bottom swivel design.

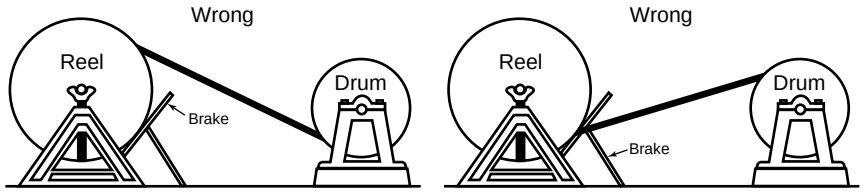
8. New rope, when first installed, shall be broken in by slowly lifting and lowering a light load several cycles through the entire hoist mode. (See section 3.2.3f) BEGIN CYCLING THE ROPE AT 0 DEGREES BOOM ANGLE TO MINIMIZE TWISTS CAUSED BY SHEAVE RESISTANCE.

C.5.1.4i Wedge Type Socket Installation Guidelines

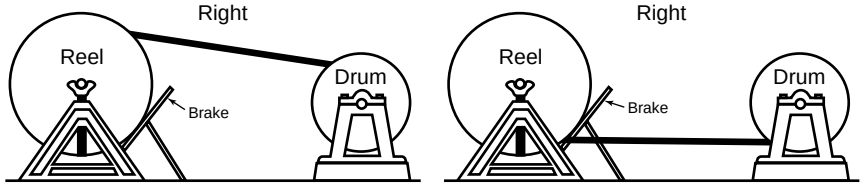
1. Verify that the socket and wedge are the correct size for the rope in use. Sockets may be adaptable to two sizes of rope but the wedge is for one size of rope only. The rope size is cast or stamped in both the socket and wedge. Check the socket eye and pin for roundness and wear. A pin keeper shall always be used with the pin.

2. Check socket and wedge for rough edges or burrs; remove before use.

3. Cut off any welded rope end before application of socket and wedge, unless the wire rope manufacturer requires the welded end to remain.



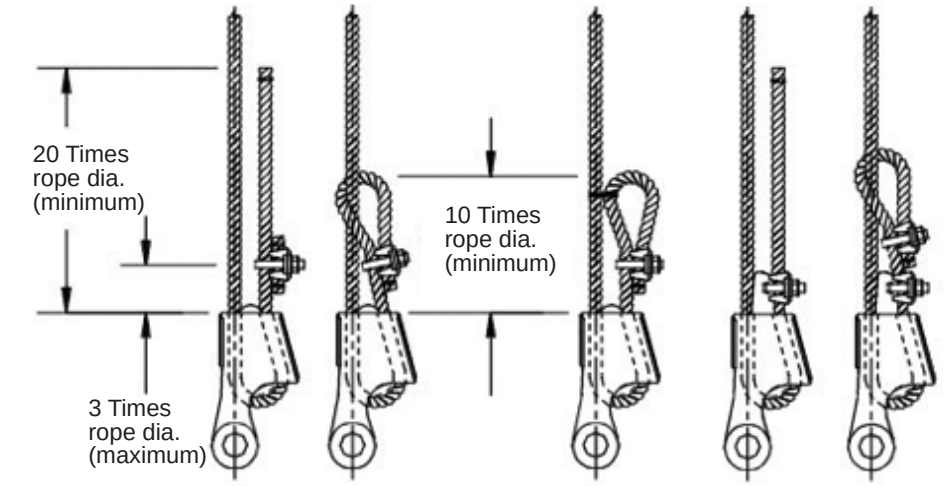
Never reel from top to bottom or from bottom to top.



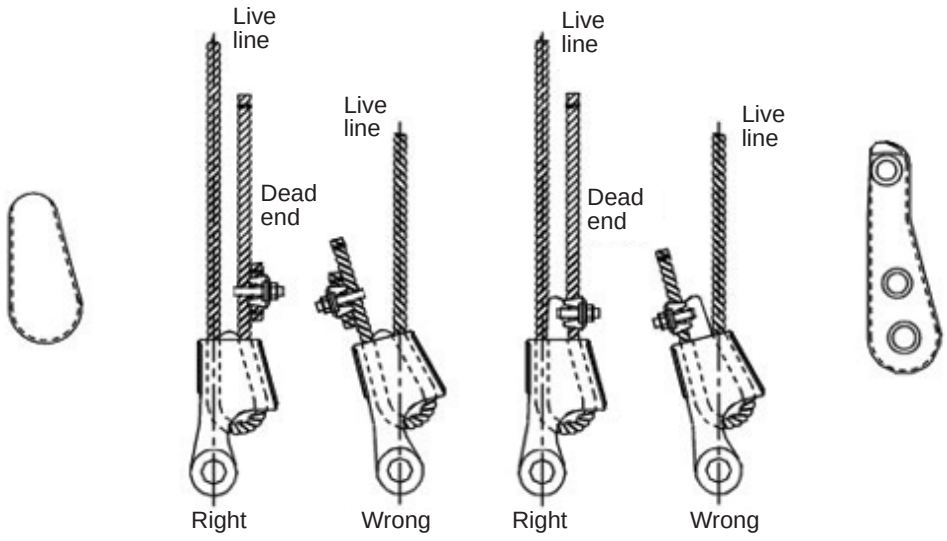
Always reel from top to top or from bottom to bottom.

When transferring rope from a storage reel to a drum, the rope should travel from the TOP of the reel to the TOP of the drum; or from the BOTTOM of the reel to the BOTTOM of the drum. This will avoid a reverse bend in the rope as it is being installed. Installing a rope so that a reverse bend is put into it causes the rope to become "twisty," difficult to handle and spool smoothly on the drum. This is especially true for large diameter wire ropes. A breaking action should be applied to the reel at all times—use a block or timber against the reel flange—in order to get a good smooth wrap on the drum.

Figure G.7—Transferring Rope from Reel to Drum



Allowable methods for securing
dead ends of wedge sockets attachments



Location of live line and dead end in the wedge socket

Figure G.8—Method of Installing Wedge-Socket Attachment

4. .Remove the wedge from the socket, insert the rope into the socket, form a large loop, insert the rope back into the socket.

Note: Ensure that the live end of the rope is on the straight side of the socket and the dead end on the tapered side of the socket.

5. Secure the socket, place the wedge in the socket and take a pull on the live side rope. Pull the wedge and rope into position in the socket. There should be a sufficient length of the dead end side rope out of the socket to permit completion of one of the accepted restraining methods. See Figure G.8.
6. When first put into service, apply an increasing load to ensure that the wedge is properly seated. Do this gradually and avoid shock loads. The wire rope and socket are ready for service.

C.5.1.4j Recommended Methods of Lubrication

1. Pouring of lubricant onto rope as it passes over a sheave. Wipe off excess.
2. Swab the rope when not in motion with lubricant soaked rags.
3. Brush or spray with lubricant.
4. Pressure lubrication.

C.5.1.5 Operations

The following should be observed when operating a crane:
1. Do not allow the rope to become slack and loose on the drum. When the boom is at rest with no load on the hook, maintain a slight tension in the boom hoist system.
2. When hoisting or lowering an empty hook block or overhaul ball, reduce drum speed where applicable before the brake is applied to prevent loosening of the rope on the drum.
3. When a rope is found to be loose on the drum, re-spool the rope under tension as soon as practical while performing a visual inspection of the rope. At all inspections other than the Pre-use Inspection, re-spool the drum under tension where required and practical.

C.5.2 SLINGS

The types of slings typically used are:
1. Wire rope slings
2. Synthetic webbing slings
3. Alloy steel chain slings
4. Synthetic roundslings

C.5.2.1 Use of Slings

The guidelines below should be followed when using slings:
1. Suitable protection shall be provided between the sling and all sharp surfaces of the load to be lifted.
2. Proper storage shall be provided for slings while not in use.
3. Slings shall never be choked in the splice.
4. Sharp kinks or knots shall not be permitted in wire rope slings.
5. Loads shall not be lifted with one leg of a multi-leg bridle sling until the unused legs are secured.
6. Any angle other than vertical at which a sling is rigged increases the loading on the sling.
7. Whenever a sling is found to be deficient, the eyes should be cut, or other end attachments or fittings removed to prevent further use, and the sling body discarded.
8. A sling eye should never be used over a hook or pin with a body diameter larger than the natural width of the eye. Never force an eye on a hook. The eye should always be used on a hook or pin with at least the diameter of the rope.
9. A sling shall be visually inspected before use to determine if it is capable of safely making the intended lift.
10. Rated loads of a sling are different for each of the three basic methods of rigging (vertical, choker, basket, etc.) and the rated loads of a sling are different for each of the methods of rigging based upon the angle of hitch, on construction of the wire rope, web material and width, etc. These rated loads are available from the manufacturer. These rated loads should be indicated on the heavy duty tags attached to each type of sling at the time it is fabricated.

C.5.2.2 Guidelines for Fabrication and Lifting Procedures

Wire rope slings should generally not be field fabricated. If circumstances require field fabrication proper equipment should be available and *qualified inspectors* should supervise or perform this function using accepted standard practices. Zinc or resin poured sockets shall be fabricated in accordance with API Recommended Practice 9B (latest edition).
1. No single-leg hitch shall be used on slings with a load that cannot be controlled. Always rig the sling and load so as not to allow the load or lifting device to rotate and unlay the sling rope. Rotation or twisting of the load can cause excessive stress on the attachment connection and reduce the sling's capacity or pull out.
2. Slings used in choker configurations have a rated capacity of 70% of vertical load limit of a single leg sling if the choke angle is 120° or greater. See Figure G.9.
3. For bridle slings and basket hitches where both legs are not vertical use of the following equation for computation of the sling arrangement rated capacity. Rated Capacity = Single-leg capacity (see Table G.1) times the number of legs times the cosine of angle A.
4. Slings shall not be made using wire rope clips.

C.5.2.3 Sling Replacement

Reasons for replacing slings are as follows:
1. In single part slings constructed of 6X19 class and 6X37 class wire rope in single-part slings, ten (10) randomly dis-

tributed broken wires in one lay length or five (5) broken wires in one strand in one lay length. For other constructions, refer to the Wire Rope Sling Users Manual and/or ASME B30.9.

2. FOR CABLE LAID, CABLE LAID GROMMETS AND MULTI-PART SLINGS, USE THE FOLLOWING. SLING BODY ALLOWABLE BROKEN WIRES PER LAY PER BRAID CABLE LAID
20 LESS THAN 8 PART BRAID
20 8 PART BRAID OR MORE
40 FOR OTHER CONSTRUCTIONS, REFER TO THE WIRE ROPE SLING USERS MANUAL AND/OR ASME B30.9.

3. Severe localized abrasion or scraping.

4. Kinking, crushing, birdcaging or any other damage resulting in distortion of the rope strand, wires, core configuration, eyes and splices.

5. Evidence of heat damage or exposure to severe heat.

6. Cracked, deformed, or worn end attachments.

7. Hooks that have been opened more than 15% of their normal throat opening or twisted more than 10° from the plane of the unbent hook.

8. Severe corrosion of the rope or end attachments.

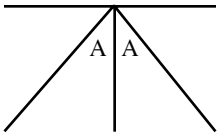
9. Reduction in diameter of the rope.

C.5.2.4 Proof Load of Slings

1. The proof load for single-leg slings with mechanical or poured attachments shall be twice the vertical rated capacity. Slings with hand-tucked splice attachments shall be proofed loaded to the vertical rated capacity.

2. The proof load for multiple-leg bridle slings shall be applied to each of the individual legs.

Table G.1—Rated Sling Capacity Calculation



Angle A	Cosine of Angle A
15°	0.966
30°	0.866
45°	0.707
60°	0.500

Example: Two-legged bridle of 1 inch IPS, IWRC wire rope with zinc poured socket attachments, at 45°.

Rated Capacity = 9.0 tons x 2 x 0.707

- 9.0 tons: Capacity from Table G.1
- 2: Number of Legs
- 0.707: Cosine of Angle A

Rated Capacity = 12.73 tons

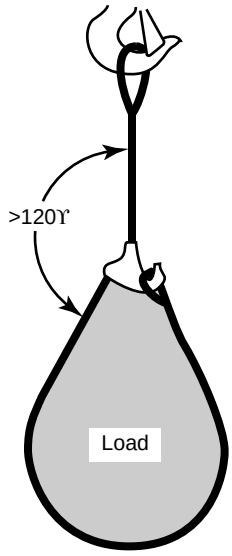


Figure G.9—Choker Configuration

APPENDIX H—REFERENCES

API Specification 2C *Offshore Cranes*
API Specification 9A *Wire Rope*
API Recommended Practice 9B *Application, Care, and Use of Wire Rope for Oil Field Service*
American Petroleum Institute

ASME B30.9 *Slings*
The American Society of Mechanical Engineers (ASME)
3 Park Avenue
New York, New York 10016-5990

Wire Rope Sling Users Manual
Wire Rope Technical Board (WRTB)
801 North Fairfax Street, Suite 211
Alexandria, VA 22314-1757

Recommended Standard Specifications for Synthetic Polyester Roundslings and
Recommended Standard Specifications for Synthetic Web Slings
Web Sling & Tie Down Association, Inc. (WSTDA)
5024-R Campbell Boulevard
Baltimore, MD 21236

ASTM A 906/A 906M *Standard Specification for Forged Grade 80 and Grade 100 Alloy Steel Chain Slings for Overhead Lifting*
American Society for Testing and Materials (ASTM)
P. O. Box C700
West Conshohocken, PA 19428-2959

Federal Specification RR-W-410 Wire Rope and Strand
U. S. Government Printing Office
Washington, DC 20402

The following are other standards and specifications not directly for slings, but related to lifting.

From ASME
ASME B30.5 *Mobile and Locomotive Type Cranes*
ASME B30.10 *Hooks*
ASME B30.20 *Below-the-Hook Lifting Devices*
ASME B30.26 *Rigging Hardware (Under Development)*

From WRTB
Wire Rope Users Manual

Other Associations that are related to the Sling Industry:

Associated Wire Rope Fabricators (AWRF)
P. O. Box 20126
Lehigh Valley, PA 18002-0126

National Association of Chain Manufacturers (NACM)
P. O. Box 22681
Lehigh Valley, PA 18002-2681

Association of Crane and Rigging Professionals (ACRP)
P. O. Box 61589
Vancouver, WA 98666-1589

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	G09A24	Spec 9A, *Wire Rope*		$ 65.00	
	G09B11	RP 9B, *Application, Care, and Use of Wire Rope for Oil Field Service*		$ 83.00	
	G54003	RP 54, *Occupational Safety for Oil and Gas Well Drilling and Servicing Operations*		$ 94.00	
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