Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment

API RECOMMENDED PRACTICE 7L
FIRST EDITION, DECEMBER 1995

ADDENDUM 1: FEBRUARY 2006
ADDENDUM 2: MARCH 2006

REAFFIRMED, AUGUST 2012

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Exploration and Production Department

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Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment

1 Scope

1.1 OBJECTIVE

The objective of this publication is to provide owners and users of equipment listed below guidelines for inspection, maintenance, repair, and remanufacture procedures that may be utilized to maintain serviceability of the covered equipment.

This recommended practice covers the following drilling equipment:

a. Rotary tables.
b. Rotary bushings.
c. Rotary slips.
d. Rotary hoses.
e. Slush pump components.
f. Drawworks components.
g. Spiders not capable of use as elevators.
h. Manual tongs.
i. Safety clamps not used as a hoisting device.

1.2 PROCEDURE DEVELOPMENT

The owner or user, together with the manufacturer should jointly develop and update inspection, maintenance, repair, and remanufacture procedures consistent with equipment application, loading, work environment, usage, and other operational conditions. These factors may change from time to time as a result of new technology, equipment history, product improvements, new maintenance techniques, and change in service conditions.

1.3 PERSONNEL QUALIFICATIONS

Inspection, maintenance, and repair procedures should be carried out by personnel qualified by professional trade and verified by widely accepted or recognized standards covering the specific skills or knowledge required.

1.4 DOCUMENTATION

1.4.1 Records

The equipment owner or user should maintain a recordkeeping system that contains pertinent information regarding equipment. Records may include the following:

a. Information provided by the manufacturer.
b. Inspection records.
c. Maintenance records.
d. Repair records.
e. Remanufacture records.

1.4.2 Identification

Unit serial number or identification marking provided by the manufacturer should be maintained on the equipment and recorded in the equipment record. Identification marking should be provided by the owner or user for unidentified equipment that required the maintenance of records.

1.4.3 History

Changes in equipment status, which could affect equipment serviceability or maintenance, should be recorded in the equipment record.

1.4.4 Record Identification

Entries in the equipment record should include the date and the name of the responsible person(s) involved in the inspection, maintenance, repair, or remanufacture.

2 References

Unless otherwise specified, the most recent editions or revisions of the following standards, codes, and specifications shall, to the extent specified herein, form a part of this standard.

API

Spec 8A *Specification for Drilling and Production Hoisting Equipment*

IADC[1]

Drilling Manual

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 critical area: A highly stressed region of a primary load carrying component.

3.2 equipment performance: Operational capability of a piece of equipment relative to expected or predetermined parameters or standards.

[1]International Association of Drilling Contractors, P.O. Box 4287, Houston, Texas 77210.

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3.3 expendable parts: Parts normally used up or consumed in service, such as seals, gaskets, filters, packing, covers, guards, breathers, drains, break/clutch linings, drive chains, dies, and miscellaneous hardware and fasteners.

3.4 inspection: Comparison of equipment conformity to predetermined standards, followed by a determination of action required.

3.5 load test: A procedure wherein a load is applied to verify the serviceability of equipment.

3.6 maintenance: Action, including inspection, adjustments, cleaning, lubrication, testing, and expendable parts replacement, necessary to maintain the serviceability of the equipment.

3.7 manufacturer: A term denoting individuals or companies, who make or process equipment or material for which API Standards have been or are being formulated.

3.8 owner: An individual, legal entity, or organization holding legal title to the equipment.

3.9 primary load: The primary load to which the equipment is subjected during normal operations, which results in stress to the critical areas.

3.10 primary load carrying components: Those components of the covered equipment through which the primary load is carried.

3.11 remanufacture: Actions performed on equipment that involve a special process or machining.

3.12 repair: Actions performed on equipment that involve replacement of parts (other than expendables), but exclude remanufacturing operations.

3.13 serviceability: The condition of a piece of equipment at any point in time that affects the ability of the equipment to perform its function(s) as intended.

3.14 special process: An operation that may change or affect the mechanical properties, including toughness of the materials used in equipment.

3.15 testing: Actions that are carried out on a piece of equipment to ensure that it can perform a required function.

3.16 users: A term denoting individuals or companies, who use equipment or material, or implement recommended practices.

4 Inspection

4.1 INSPECTION CATEGORIES

4.1.1 Category I

Observation of equipment during operation for indications of inadequate performance.

4.1.2 Category II

Category I inspection, plus further inspection for corrosion, deformation, loose or missing components, deterioration, proper lubrication, visible external cracks, and adjustment.

4.1.3 Category III

Category II inspection, plus further inspection, which should include nondestructive examination (NDE) of exposed critical areas and may involve some disassembly to access specific components, and identify wear that exceeds the manufacturer's allowable tolerances.

4.1.4 Category IV

Category III inspection, plus further inspection where the equipment is disassembled to the extent necessary to conduct NDE of all primary load carrying components as defined by the manufacturer.

4.2 FREQUENCY

The owner or user of the equipment should develop his own schedule of inspections based on experience, manufacturers recommendations, and consideration of one or more of the following factors: environment, load cycles, regulatory requirements, operating time, testing, repairs, and remanufacture.

4.3 RESULTS OF INSPECTION

4.3.1 Acceptance Criteria

Acceptance criteria should be established based on experience and manufacturer's recommendations. Worn equipment that does not meet acceptance criteria should not be accepted for operation at reduced load unless an analysis is made in accordance with the governing API Equipment Specification, or by the manufacturer if no API Specification exists.

4.3.2 Rejected Equipment

Rejected equipment should be marked and removed from service for further evaluation or until deficiencies are corrected.

4.4 RECORDS

Records of Category III and Category IV inspections should be entered in the equipment record. Testing related to or indicating the load carrying capacity of the equipment should be entered in the equipment record.

5 Maintenance

5.1 PROCEDURES

In addition to the procedures developed in accordance with 1.2, the manufacturer should define any special tools,

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materials, measuring or inspection equipment, and personnel qualification necessary to perform the maintenance procedures. The manufacturer should also specify those procedures that should be performed solely by the manufacturer's representative, within the manufacturer's facility or by other qualified facilities.

5.2 METHODS

Maintenance actions may include any of the following: inspections, adjustments, cleaning, lubrication, testing, and parts replacement.

5.3 CRITERIA

Maintenance actions may be initiated based on, but not limited to, one or more of the following criteria: specific time intervals, measurable wear limits, load cycle accumulation, nonperformance of equipment, environment, experience (history), regulatory requirements, and other measurable limits.

5.4 RECORDS

Maintenance activities involving the replacement of any primary load carrying component should be entered in equipment record. Testing related to or indicating the load carrying capacity of the equipment should be entered in the equipment record.

6 Repair

6.1 PROCEDURES

Manufacturers should provide adequate inspection criteria to allow the equipment owner or user to identify the nature of repairs that may be required. If repairs are not performed by the manufacturer, they should be performed using methods or procedures established in accordance with 1.2.

6.2 SURFACE INDICATIONS

Surface indications identified by NDE may be allowable or nonallowable, depending on the size, shape, and location as defined by the manufacturer.

6.2.1 Allowable Surface Indications

Allowable surface indications are surface indications of size, shape, and location that need not be removed.

6.2.2 Nonallowable Surface Indications

Nonallowable surface indications may be classified as follows:

a. **minor surface indications:** Minor surface indications may be removed by a limited degree of filing or grinding within limits specified by the manufacturer. Caution should be exercised to prevent heating to an extent that could change the mechanical properties, including toughness, of the material.

b. **major surface indications:** Major surface indications, which require material removal beyond the limits specified by 6.2.2.a, should be corrected by remanufacture.

6.3 BEARINGS

Bearings play an important part in the serviceability of equipment. The most likely causes for bearing replacement are: loose or bent cages (rolling element retainers); corrosion, abrasion, lubrication problems; and spalling from fatigue. Internal clearance in excess of manufacturer's allowance may indicate improper adjustment or assembly, which should be corrected. Repair of antifriction bearings should not be attempted by field or shop personnel. Consultation with the equipment manufacturer is recommended in the event of unexplained or repeated bearing failure.

6.4 REPLACEMENT PARTS

Replacement parts should meet or exceed the original equipment manufacturer's criteria.

6.5 RECORDS

Entries describing all repair activity, with the exception of those under 6.2.1 and 6.2.2.a should be included in the equipment record.

7 Remanufacture

7.1 PROCEDURES

Remanufacture of equipment should be performed using methods and procedures developed in accordance with 1.2. Equipment found to be unsuitable for remanufacture should be destroyed.

7.2 VERIFICATION

Following remanufacture, a load test or NDE should be performed to verify the serviceability of the equipment.

7.3 RECORDS

Entries describing all remanufacture activity should be included in the equipment record.

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APPENDIX A—RECOMMENDED PRACTICE FOR CARE AND USE OF ROTARY HOSE

Note: Where applicable, the following recommended practices should also be used for vibrator hose.

A.1 Hose Length

In order to avoid kinking of hose, the length of hose and height of standpipe should be such that while raising or lowering, as in making mousehole connections, the hose will have a normal bending radius at the swivel when the hose is in its lowest drilling position and at the standpipe when the hose is in its highest drilling position. The recommended length of hose is given by the following equation (see Figure A-1).

$$L_H = \frac{L_T}{2} + \pi R + S \qquad \text{(A-1)}$$

Where:

L_H = length of hose, ft (m).

L_T = length of hose travel, ft (m).

R = minimum radius of bending of hose, ft (m).

= 3 ft (0.9 m) for 2-in. hose.

= 4 ft (1.2 m) for $2^1/_2$ and 3-in. hose.

= $4^1/_2$ ft (1.4 m) for $3^1/_2$ in. hose.

S = allowance for contraction in L_H due to maximum recommended working pressure, ft, which is 1 ft (0.3 m) for all sizes of hose.

A.2 Standpipe Height

The recommended standpipe height is given by the following equation (see Figure A-1).

$$H_S = \frac{L_T}{2} + Z \qquad \text{(A-2)}$$

Where:

H_S = vertical height of standpipe, ft (m).

L_T = length of hose travel, ft (m).

Z = height, ft, from the top of the derrick floor to the end of hose at the swivel when the swivel is in its lowest drilling position.

Note: When the actual length of hose is greater than the length calculated in A.1, the standpipe height should be increased by one-half the difference between the actual length and the calculated length.

A.3 Hose Connections

The threaded connection on rotary hose is capable of handling the rated pressure and should not be welded to its connector as this will damage the hose. The connections between the rotary hose, standpipe, and swivel should be consistent with the design working pressure of the system. The connections attaching the hose to the swivel and to the standpipe should be as nearly tangential as possible. The use of a standard connection on the swivel gooseneck (see Section 5 of API Specification 8A) will ensure this relationship at the top of the hose. It is recommended that a 180-degree gooseneck be used on the standpipe connection if the standpipe is vertical. A 160-degree gooseneck should be used if the standpipe has the same slope as the derrick leg.

A.4 Handling

In order to minimize the danger of kinking, the hose should preferably be removed from its crate by hand, laid out in a straight line, then lifted by means of a catline attached near one end of the hose. If a catline is used to remove the hose from its crate, the crate should be rotated as the hose is removed. The use of a carrier to protect the hose in moving to a new location is recommended practice. It is considered bad practice to handle hose with a winch, to hang the hose from a truck gin pole, or to place heavy pieces of equipment on the hose.

A.5 Twisting

Hose should not be intentionally back twisted. Twisting is sometimes employed to force the swivel bail out of the way. This places injurious stresses in the structural members of the hose body, because one spiral of reinforcing wires is opened and the other is tightened, thus reducing the resistance of the hose to bursting and kinking. In order to prevent twisting, it is suggested that a straight swivel be installed on one end of the hose. Each length of hose has a longitudinal lay line of a different color than the hose cover. This should be used as a guide in making certain the hose is installed in a straight position.

A.6 Clearance

The hose installation should be such as to give adequate clearance between the hose and the derrick or mast.

A.7 Safety Chain

All rotary hose and all vibrator hose 8 feet (2.4 meters) or longer shall have Safety Clamps installed at the locations specified in Spec 7K, but such clamps will not necessarily

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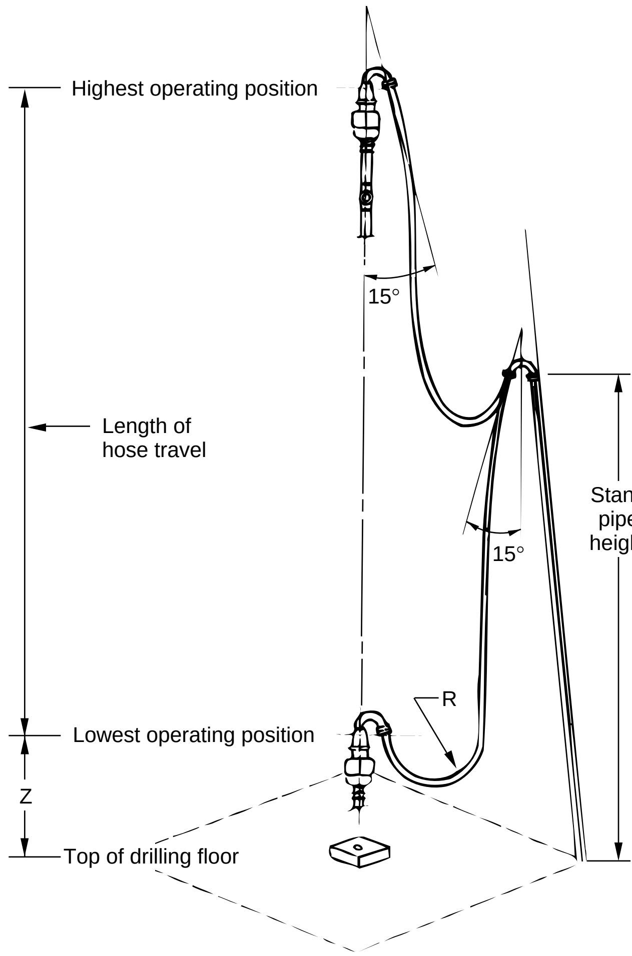

Figure A-1—Layout for Rotary Hose

be installed by the hose manufacturer. The hose manufacturer shall mark the hose as specified in Spec 7K to indicate the location at which Safety Clamps shall be installed. The Safety Clamps, Clevis, and Chain shall be installed. The Safety Clamps, Clevis, and Chain shall have a minimum breaking strength of 16,000 pounds (7264 kilograms) and the clamp shall incorporate a $1^1/_8$ in. (28.6 millimeters) minimum diameter hole for attaching clevis/chain and will be so designed as to allow adequate clearance from the hose. The clamp should be of the proper size, and should be tightened securely but not to such extent as to injure the hose or reduce the inside bore diameter. In the case of rotary hose, the safety chain should be attached to a derrick upright at the standpipe end, rather than a transverse girt, so that the chain will be free to move upward, without restricting the movement of the hose, should the traveling block be raised too high.

A.8 Vibration and Pulsation

Continual flexing is injurious to rotary hose and reduces its service life. Surge chambers and pulsation dampeners of the proper size should be used in the mud line after the pumps to minimize vibration in the mud lines and hose. The pulsation dampener should be set at 10 percent of the maximum pump pressure. The lines on the suction side of the pump should be precharged or operated with a flooded suction. The use of a suction hose is recommended to minimize pulsation.

A.9 Working Temperature

Working temperature should not exceed 180°F (82°C). High temperatures in combination with abrasive conditions such as encountered in gas or air drilling should be avoided.

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A.10 Working Pressure

The recommended maximum working pressure for rotary hose is one-half the specified test pressure. Working pressure includes the pressure surges that occur in the system. See A.8, Vibration and Pulsation.

A.11 Oil Base Muds

The use of oil base muds having an excessively high aromatic content will cause the hose inner liner to swell and shorten its service life. It is recommended that oil base muds be held to a minimum aniline point of 150°F (66°C).

A.12 Barge Attended Offshore Rigs

Where rotary hose is used as a flexible line between barges and offshore drilling rigs, care must be used so the hose is in alignment between both end connections. It is recommended that swivel joints be used at both ends. Drilling in rough weather and high seas resulting in abnormal flexing and jerking of the hose will cause premature failures.

A.13 Field Test Pressure

Field testing of rotary hose, when required for establishing periodic safety levels of continued operation, should be conducted with these factors as a guide:

a. Visual inspection should include examination of any external damage to the body, end structure, and couplings. Safety chain should be checked and properly attached for complete safety compliance.
b. All back twist (see A.5) must be avoided.
c. Hose to be suspended in normal unstressed position from standpipe to swivel.
d. Rate of pressure rise not less than 1,000 pounds per square inch (6.9 megapascals) nor greater than 10,000 pounds per square inch (68.9 megapascals) per minute.
e. Permissible test medium: mud, oil, or water with precaution that all air be bled off.
f. Duration of test pressure limit not to exceed 10 minutes.
g. Field test pressure not to exceed 1.25 times the maximum rated working pressure.
h. Field testing to be conducted under full responsibility of user.

Note: Because of the manufacturer's trend to higher test pressures on delivery (in excess of 5,000 pounds per square inch [34.5 megapascals]) it should be understood that field testing recommendations are limited to a maximum test pressure of 1.25 times the maximum rated working pressure, regardless of the delivery test pressure involved.

A.14 Operating Limits

Operating personnel should be advised as to the highest and lowest drilling positions, length of standpipe, and so forth, for which the hose was selected, and drilling operations should be carried out within such limits.

A.15 Aftercoolers

Air or gas compressors should always be equipped with aftercoolers to lower the temperature to tolerable limits. When aftercoolers are not used, air or gas entering the hose is at excessively high temperature. The hose inner liner is aged at an accelerated rate, thus reducing resistance to abrasion.

Note: When used hoses are recoupled, or when used rotary drilling hoses are cut and recoupled to make vibrator hoses, the API monogram and the original manufacturer's label shall be removed.

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APPENDIX B—RECOMMENDED PRACTICE FOR SLUSH PUMP NOMENCLATURE AND MAINTENANCE

B.1 Slush Pump Maintenance

The International Association of Drilling Contractors *Drilling Manual*, Sections J3, J4, J5, and J6, establish maintenance practices for assistance in solving fluid end problems. The *Drilling Manual* is available from The International Association of Drilling Contractors, P. O. Box 4287, Houston, Texas 77210.

B.2 Slush Pump Nomenclature

The intent is to standardize nomenclature for principle parts of slush pumps, but not including a relatively small number of associated parts. This will provide a common language for the industry, to be particularly valuable for communications.

B.3 Old Designs

This language is to be used for old pumps as well as newly designed pumps even though the manufacturer's literature might not be consistent with the standard. Manufacturers are expected to comply with this standard on newly designed pumps. For old designs, their literature should be made to comply when it is opportune to do so. In communications between user and manufacturer, the part number must be used as positive identification where nomenclature inconsistencies occur.

B.4 Types

The type pumps included in this nomenclature standard are duplex and triplex power slush pumps.

B.5 Designation

Power end (Table B-1 and Figures B-1, B-2, and B-3) and fluid end parts (Table B-2 and Figure B-4, and Table B-3 and Figure B-5) will be grouped in separate categories. Right- and left-hand parts for all groups will be determined by the same rule. The rule is: when standing at the power end and looking over the power end toward the fluid end, those parts to the right of the centerline are designated as right hand when needed to differentiate from other like parts; and, similarly, those to the left are designated as left hand. For triplex pumps, those parts on the centerline needing differentiation from like parts are designated center.

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Table B-1—Power End Parts, Duplex and Triplex Pumps

Part No.	Description	Part No.	Description	Part No.	Description
101	Frame	106	Connection Rod[a]	111	Crankshaft Bearing Housing[a]
102	Crankshaft	107	Crosshead[a]	112	Pinion Shaft Bearing[a]
103	Main Gear	108	Crosshead Pin[a]	113	Crosshead Pin Bearing[a]
104	Pinion	109	Connecting Rod Bearing[a]	114	Crosshead Extension Rod (Pony)[a]
105	Pinion Shaft	110	Crankshaft Bearing (Main)[a]	115	Crosshead Extension Rod Wiper[a]

[a] Exact location of these parts designated as right, or left, and center if for triplex pump.

Table B-2—Fluid End Parts, Duplex Pumps

Part No.	Description
101	Fluid End—When Fluid End is sectionalized, refer to Right or Left.
102[a]	Cylinder Head
103[a]	Cylinder Head Cover
104[b]	Valve Cover
105[b]	Valve Guide
106[b]	Valve Spring
107[b]	Valve Seat
108[a]	Liner
109[a]	Liner Packing
110[a]	Piston
111[a]	Piston Rod
112[a]	Stuffing Box
113[a]	Junk Ring
114[a]	Stuffing Box Packing
115[a]	Gland
116[a]	Gland Nut

Note: For further detailed nomenclature see IADC *Drilling Manual*.

[a] Exact location of these parts designated as right or left.

[b] Exact location of these parts designated as right or left, or when more convenient, the IADC *Drilling Manual* numerals may be used.

Table B-3—Fluid End Parts, Triplex Pumps

Part No.	Description
101	Fluid End—When Fluid End is sectionalized, refer to Right, Left, or Center.
102[a]	Valve Cover
103[a]	Valve Guide
104[a]	Valve Spring
105[a]	Valve Seat
106[b]	Liner
107[b]	Liner Packing
108[b]	Piston
109[b]	Piston Rod
110[b]	Liner Spray

Note: For further detailed nomenclature see IADC *Drilling Manual*.

[a] Exact location of these parts designated as right, left, or center; or when more convenient, the IADC *Drilling Manual* numerals may be used.

[b] Exact location of these parts designated as right, left, or center.

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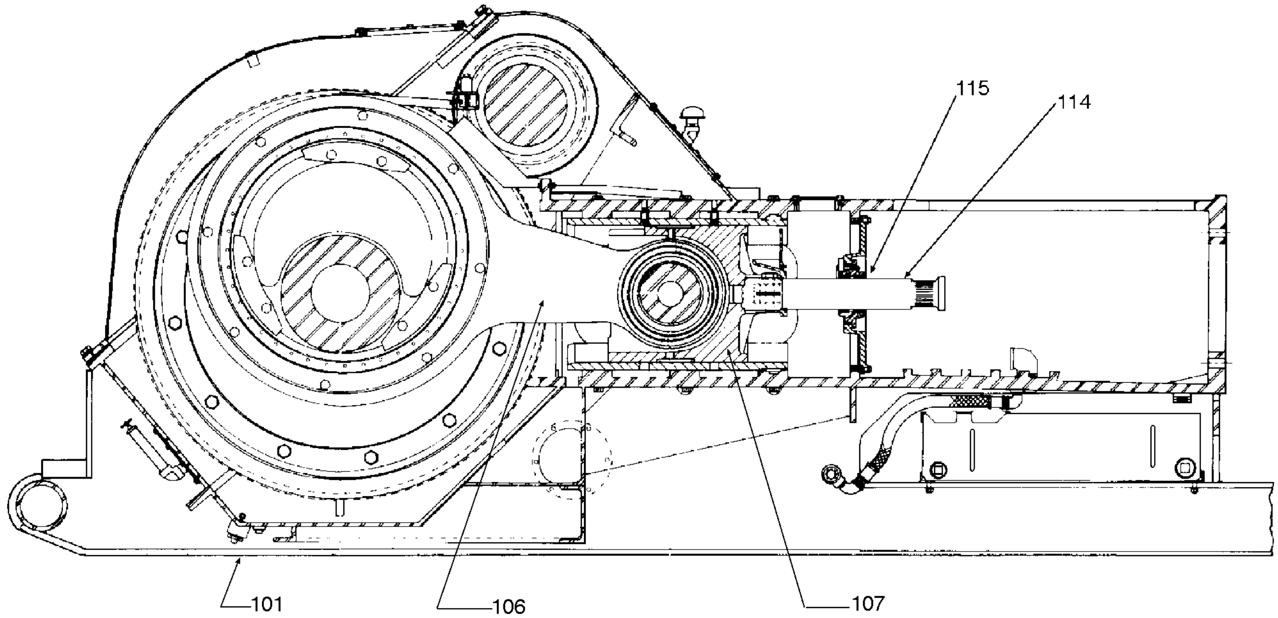

Figure B-1—Section Through Power End

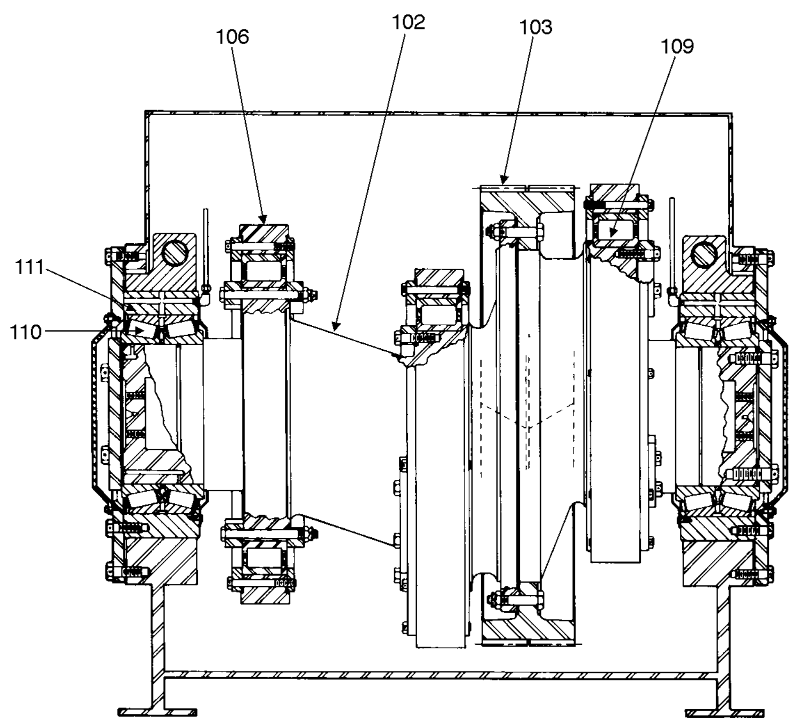

Figure B-2—Section Through Crankshaft
(See Table B-1)

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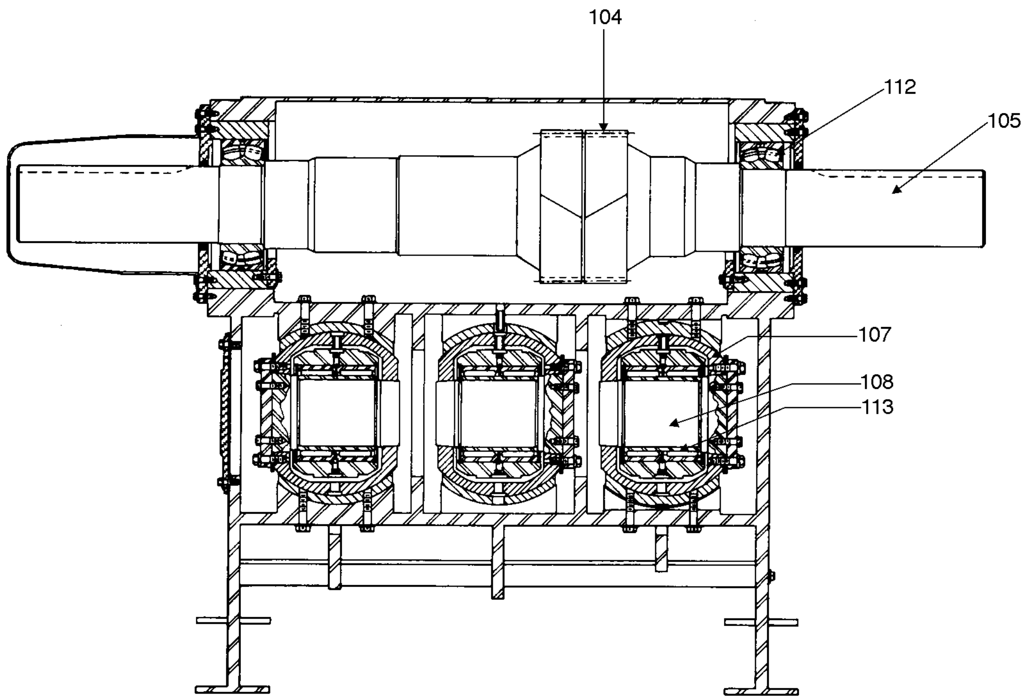

Figure B-3—Section Through Pinion Shaft and Crossheads
(See Table B-1)

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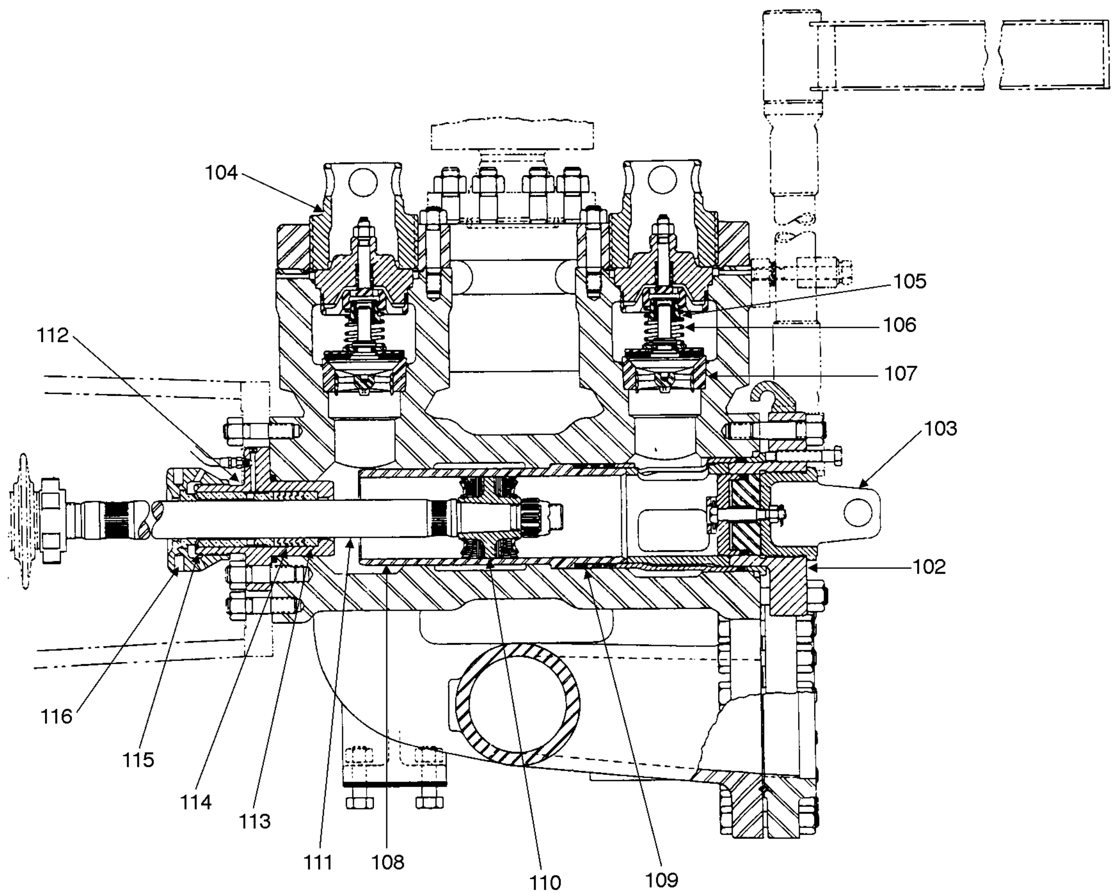

Figure B-4—Fluid End of Duplex Double Acting Mud Pump
(See Table B-2)

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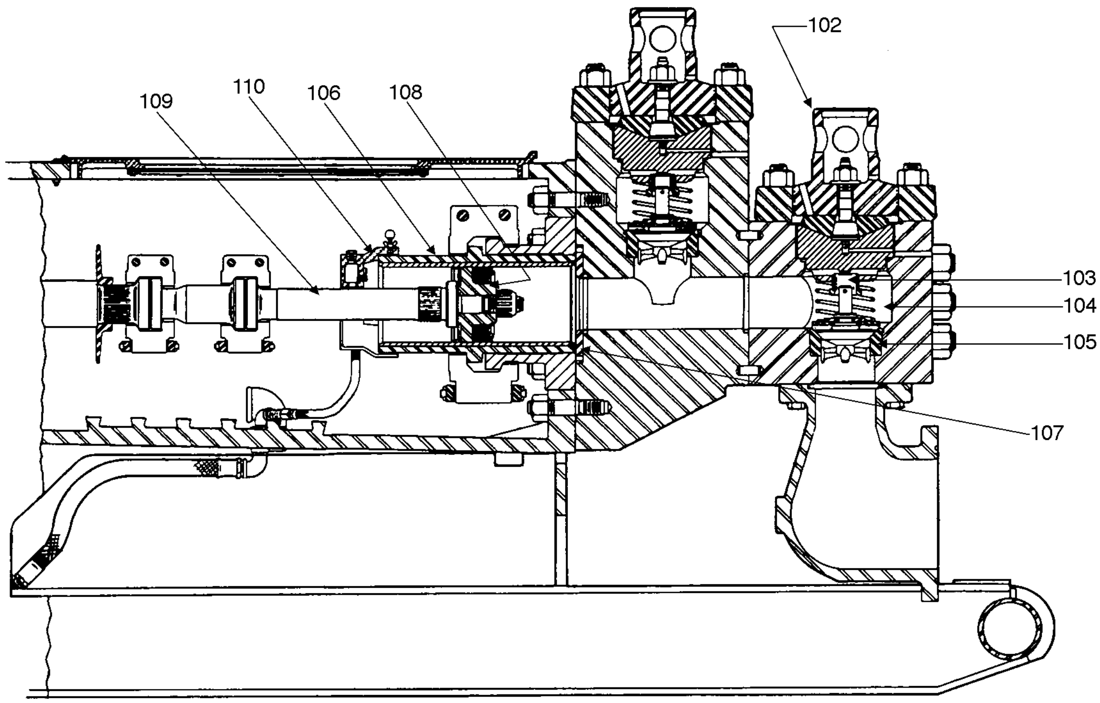

Figure B-5—Fluid End of Triplex Single Acting Mud Pump
(See Table B-3)

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Addendum 1
February 2006

Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment

API RECOMMENDED PRACTICE 7L
FIRST EDITION, DECEMBER 1995

API
American Petroleum Institute

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Addendum 1 to Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment

Add the following Appendix C.

APPENDIX C—USER GUIDELINES FOR BLOWOUT PREVENTER (BOP) HANDLING SYSTEMS

C.1 Purpose

This Appendix provides user guidelines for operating, inspecting, and maintaining BOP handling systems and equipment used for lifting, lowering, transporting, and/or storing BOPs and/or BOP assemblies (commonly known as BOP stacks) to or from the wellhead and storage area on or near the drilling rig. Terminology utilized in these guidelines shall carry the same definitions specified in clause 3.0 of this standard, and as augmented by clauses 3.0 and 9.13.2 of API Spec 7K.

C.2 BOP handling systems and equipment covered by this appendix

C.2.1 Purpose-built systems which shall be considered to be designed and manufactured in accordance with API Spec 7K.

C.2.2 Non-purpose-built systems devised by rig field personnel, whether they be temporarily or permanently installed, which are not monogrammed under API Spec 7K. These may be comprised of various off-the-shelf components and materials that are assembled, fabricated, and installed as a BOP handling system, which could include but are not necessarily limited to:

a. Hydraulic, pneumatic, and electric winches;
b. Electric or hydraulic motors;
c. Hydraulic rams/cylinders;
d. Rack and pinion drives;
e. Gearboxes and various other types of transmission devices;
f. Slings and wire rope;
g. Various loose gear including but not limited to shackles, pear and connecting links, chain of all types, hooks, turnbuckles, binders, sheave blocks, and swivels used in an assembly to suspend, secure, or lift a load;
h. Structural steel plates and shapes used to support such systems and equipment;
i. Pipe materials and fittings, valves, and piping system appurtenances;
j. Pressure vessels of all types;
k. Electrical equipment, enclosures and junction boxes, instrumentation, controls, cabling, and electrical fittings.

Such systems shall be rated in accordance with the requirements C.5 and C.6 and operated and maintained in accordance with this Appendix.

C.2.3 BOP handling systems that are comprised of a combination of a purpose-built system described in C.2.1 and off-the-shelf components as described in C.2.2.

C.2.4 BOP handling systems that are either permanently installed on the rig or are an independently supported system that is not physically attached to the rig.

C.2.5 BOP handling systems that are provided under contract by a third party service organization who represents such equipment and systems as being designed and used specif-

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ically for the purpose of lifting, lowering, transporting, and/or storing BOPs and/or BOP stacks. Such equipment and systems may or may not be designed and manufactured in accordance with API Spec 7K.

C.2.6 All BOP handling systems for BOP stacks that are used on surface or subsea wellhead applications, whether they be top-supporting or bottom-supporting systems or not as described below:

C.2.6.1 Top-supporting systems are defined as systems where the BOP stack is hoisted from a device that is located above the BOP stack. They may incorporate either or both hoisting and transporting devices that include one or more primary load paths. Top supporting BOP handling systems are typically installed and used on land rigs, fixed offshore platforms, non-floating MODUs (Mobile Offshore Drilling Units), and Inland Barge rigs.

C.2.6.2 Bottom-supported BOP handling systems are defined as systems where the BOP stack is supported from the bottom. These are typically designed for subsea BOP stacks. Some land rig BOP stacks are transported within a structure that is also used to handle the BOP stack to well center that also qualifies as a bottom-supported handling system. Some bottom-supported subsea BOP stack handling systems incorporate a storage stump that has a compatible profile to which the wellhead connector is mated. The bottom of the storage stump is then attached to a suitable supporting structure. Other bottom-supporting systems for subsea BOP stacks incorporate a structure to interface with the BOP stack frame.

C.2.7 The following equipment shall not be considered to be BOP handling systems or equipment covered by this Appendix:

a. Offshore cranes as defined by API Spec 2C;
b. Land-based mobile cranes as defined by Crane Manufacturing Association of America (CMAA) specifications;
c. Oil-field winch trucks of all types;
d. Drawworks as defined by API Spec 7K;
e. Riser running tools covered by API Spec 8C.

C.3 Operating precautions and inspection requirements before or after use

C.3.1 Due to the high probability of personnel working on, near, or under the BOPs or BOP stack being handled, visual inspections (Category II or equivalent) of the components of BOP handling systems that are subjected to the primary load path shall be carried out prior to handling operations to mitigate hazards to personnel in the event of a failure.

C.3.2 Because of the size and weight of subsea BOP stacks used on floating MODUs, BOP handling systems incorporate features to effectively resist dynamic forces induced by weather and/or sea motions acting on a MODU. Therefore, it is extremely important not to attempt to handle the BOP stack if the features provided to resist such forces are compromised by damage or deterioration of the components in the primary load path, or could become overloaded, inadvertently disengaged, or inoperable at any time during the handling process.

C.3.3 When replacing gaskets or seals in wellhead or lower marine riser package connectors, it may be necessary for personnel to perform this task underneath the load suspended by the BOP handling system. Due to the consequences of load path failure, it is important to ensure that all the components in the load path receive a thorough visual inspection (Category II or equivalent) prior to performing this procedure.

C.3.4 Bottom-supported BOP handling systems used to handle subsea BOP stacks typically incorporate features that are designed to maintain control of the top of the BOP stack to prevent excessive overturning moments from being exerted onto the storage stump and other devices or structure upon which the BOP stack rests while it is:

a. in the stored position;
b. being transported from/to the well center position;
c. in the well center position prior to suspending it from the riser running tool.

C.3.5 It is important for the user to ensure that system features used to control the BOP stack during movement are visually inspected (Category II or equal) and confirmed to be in serviceable condition prior to transporting the BOP stack from / to the storage or well center position.

C.3.6 Some subsea BOP handling systems are provided with a moonpool guidance system to prevent uncontrolled motion of the BOP stack as it is lowered through the moonpool area and into the water that could cause damage to the BOP stack and / or adjacent hull structure of the MODU. The user shall ensure that such guidance systems are inspected (Category II or equal) and found to be in serviceable condition prior to transporting the BOP stack to the well center position, and that it is engaged prior to disengagement of any devices used to control the top of the BOP stack during its movement to the well center position.

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C.3.7 The user shall also ensure that procedures for utilizing features designed to control the top of the BOP stack are implemented until either the moonpool guidance system described in C.3.6 (if provided) is engaged, and / or the BOP stack is suspended by the riser running tool.

C.4 Inspection and maintenance routine requirements for all BOP handling systems

C.4.1 In addition to the scope and frequencies of maintenance and inspection activities recommended in Section 4, BOP handling systems should receive an adequate degree of visual inspection and maintenance (Category II or equivalent) of all components in the primary load path either before or after use to ensure that the system is in serviceable condition. The scope and frequency of such inspections and maintenance will depend on a number of factors including but not limited to environmental conditions, equipment age, estimated dynamic loads, and load path component deterioration limits specified by the system manufacturer.

C.4.2 Components in the primary load path shall also be subject to an annual inspection (Category III or equivalent) employing appropriate NDE (non-destructive examination) techniques that will reveal defects that would not otherwise be visible to the naked eye. Such Category III inspections need not be carried out at a repair facility if the system is permanently installed on the rig.

C.4.3 Inspection activities applicable to any of the inspection and maintenance categories specified in this standard shall include some or all of the following, depending on system design and configuration to ensure reliable operation. Intervals for inspection and maintenance shall be determined by the user in accordance with section 4.1 of this standard.

a. Wire rope and/or wire rope slings utilized in the primary load path shall undergo a visual inspection in accordance with API RP's 9B, 2D, and 54 requirements and replaced as required.
b. Chain of all types used in the primary load path shall be inspected for wear, damage, corrosion, and deformation and accepted or rejected from further service based on the chain manufacturer's specifications.
c. Fasteners such as bolts, studs, nuts, clamping devices, clevises and clevis pins, and loose gear as defined in C.2.2.g which are in the primary load path shall be inspected for damage, deformation, cracking, and corrosion and replaced as required.
d. Structures and weld attachments that are in the primary load path, including those designed to ensure that the primary load is adequately distributed to supporting structure shall be visually inspected for deformation, corrosion, and cracking. For installations on MODUs, supporting structures and welds that are a part of a purpose-built BOP handling system that is made to API Spec 7K which are found to be deficient shall be repaired in accordance with repair procedures specified and approved by the BOP handling system manufacturer, or a qualified third party. For fixed platforms or shore-based rigs, repair procedures to supporting structure and welds that are found to be deficient shall be reviewed and approved by a licensed engineer or a person who by education, training, and experience can demonstrate the knowledge and skills required.
e. All installed load monitoring / indicating devices shall be calibrated at certain frequencies to ensure they operate reliably.
f. All installed fail-safe load holding devices, including but not limited to brakes of all types, pawl mechanisms, etc. shall be inspected, tested, and maintained at certain intervals to ensure that they operate reliably.
g. All installed load limiting devices, including but not limited to circuit breakers, pressure regulating valves, and relief valves shall be inspected, tested, and maintained at certain intervals to ensure that they operate reliably.
h. All mechanical devices, including but not limited to gear boxes, rack and pinion drives, level-wind devices, linkages, mechanical braking mechanisms, drum pawls, screw-drive mechanisms, etc. shall be inspected for corrosion, deformation, and damage at certain intervals and repaired or replaced as required.
i. All shafting, keys and keyways, spline drives, hubs, couplings, and bearings shall be inspected for corrosion, deformation, and damage at certain intervals and repaired or replaced as required.
j. All electrical motors, generators, controls, instrumentation, junction boxes, cabling, etc. shall be inspected for damage or deterioration and replaced or repaired in accordance with the requirements specified by the system manufacturer and applicable rules and regulations.
k. All hydraulic pumps, motors, power cylinders, piping, valves, and other system appurtenances shall be inspected, and repaired or replaced at certain intervals to minimize leakage and ensure reliable operation.
l. All pneumatic motors, piping, valves, and other pneumatic system appurtenances shall be inspected, and repaired or replaced as required.
m. All internal combustion engines and all auxiliary attachments shall be inspected and repaired at certain intervals as required
n. Flexible hose assemblies should be visually inspected at least annually and, as with all hoses, visual checks should be made prior to system operation for the following conditions. Hoses should be replaced in accordance with the guidelines specified in C.5.1 g) when such conditions are discovered at the earliest opportunity.

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- Damage or deterioration of the outer hose cover
- Kinking of the hose body
- Damage or deterioration of the hose end fittings

o. Replacement of flexible hose assemblies is recommended to be performed at 5 year intervals. This interval may vary depending on visual inspection service conditions.

p. Inspection of non-fired pressure vessels, including but not limited to air pressure vessels and air / liquid accumulators should be performed on an annual basis. Inspection may include visual inspection of the internal surfaces of such pressure vessels when suitable inspection covers allow this to be performed, or through the use of fiber-optic inspections via smaller openings. Such visual inspections should be conducted for the purpose of assessing the degree of corrosion that may have occurred to the internal surfaces of the pressure vessel (s) in question. In the event that corrosion is discovered, a means of determining the actual wall thickness in way of such corrosion should be determined via compression-wave ultrasonic (UT) inspection. In lieu of visual inspections, compression-wave (UT) inspections may be carried out to determine the minimum wall thickness in way of where corrosion would most likely occur. Such UT readings shall be compared to the minimum wall thickness allowed by the standards by which the pressure vessel was manufactured, based on the maximum allowable working pressure designated by the pressure vessel manufacturer.

C.4.4 Maintenance activities shall, at a minimum, consist of lubrication, function testing, adjustments, and replacement of expendable parts or components (as defined in Section 3) to ensure equipment serviceability.

C.4.5 In lieu of unnecessary intrusive maintenance specified by Category II, III, and IV activities conducted at specific calendar intervals, the user may devise and implement a reliability-based maintenance system whereby certain measurable criteria is established within acceptable ranges to monitor and assess equipment component and/or system performance. Such criteria shall be used to trigger the implementation of maintenance activities as opposed to calendar-based intervals. Such a system shall be based on identifying single-point failures and their mechanisms, coupled with a criticality rating based on the consequences of failure.

C.5 Determination of design load and design safety factors non-purpose-built systems

For non-purpose-built BOP handling systems devised by field personnel, regardless of whether they are intended to be installed on a temporary or permanent basis, the user shall determine the design load of the system prior to installation to ensure that it is fit for purpose. This shall be accomplished by identifying all components intended to be used in the primary load path (s), and determining the working load limit of each component. The design load of such a system shall be no greater than the working load limit of the weakest component in the load path. Once this has been determined, clauses 9.13.3, 9.13.4, and 9.13.5 of API Spec 7K shall be used as guidelines by a licensed professional engineer or a person who by education, training, and experience can demonstrate the knowledge and skills required to determine the design load and design safety factors in the following manner:

C.5.1 Subsystem design requirements in clause 9.13.3 of API Spec 7K are considered self-explanatory and shall be adhered to as closely as possible. In consideration of field personnel not possessing the same degree of engineering / design competence of a professional design engineer, the following guidelines are offered so that the intent of the requirements in the above-mentioned clause is achieved:

a. The documented working pressure of all valves shall meet or exceed the working pressure of the system in which they are intended to be installed. Relief valves or regulating valves shall be installed and set at the working pressure of the system in which they are installed. Exhaust pressure from relief valves shall be piped to a location to prevent emissions from striking personnel or polluting the environment.

b. Compressed rig air piping shall be fabricated with galvanized or non-galvanized schedule 40 (minimum) seamless steel pipe (ASTM A106, Grade B or equivalent), with either threaded or welded fittings with a rated working pressure that meets or exceeds the working pressure of the piping

c. Hydraulic piping up to and including 2 in. in diameter with a working pressure equal to or less than 3,000 psi shall be fabricated with non-galvanized schedule 80 (minimum) seamless steel pipe (ASTM A106, Grade B or equivalent) with socket-welded fittings with a rated working pressure that meets or exceeds the working pressure of the piping.

d. Flexible hoses used in piping systems shall comply with the guidelines provided in C.5.1 g).

e. Where pad-eyes are required, they shall be designed such that the allowable stress in the pad-eyes, pad-eye welds, and pad-eye supporting structure shall be no greater than 40% of the yield strength of the materials used at the designated design load of the system. The documented tensile strength of the pad-eye weld filler material shall not be less than the ultimate tensile strength of the material it is welded to. Holes in all pad-eyes shall be machined and not flame-cut.

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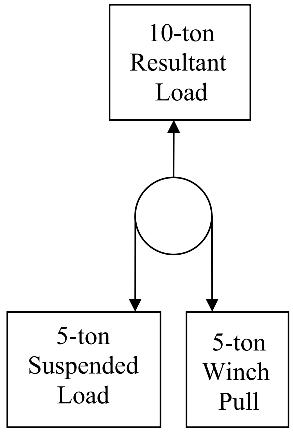

Figure C.1—Illustration of the Resultant Load on a Single Sheave Block

f. Prime movers intended to be used, such as the equipment specified in C.2.7, hydraulic, electric, or pneumatic motors, internal combustion engines, winches, and hoists which provide the power to lift and suspend the BOPs or BOP stacks shall not be capable of inducing forces that exceed 110% of the design load of the system unless the load monitoring devices and operating procedures are developed and implemented by the user as outlined below. Load limiting devices may also be incorporated to limit such forces, such as circuit breakers, engine governors, pressure relief valves, pressure regulating valves, etc. Friction-type clutches do not qualify as a load limiting device.

- A load monitoring device shall be fitted and confirmed to be calibrated and in serviceable condition prior to BOP stack handling operations.
- The operator of the equipment shall ensure that the applied load indicated by the load monitoring device shall not exceed a value that will result in exceeding the safe working load of the BOP handling system as defined in C.6.

g. The resultant load on a single sheave block as illustrated in Figure C.1, and its attachment to supporting structure shall not exceed the documented working load limit of the sheave block as specified by the manufacturer.

h. Flexible hoses shall be selected, fabricated, tested, cleaned, and installed in accordance with the following guidelines:

- The use of flexible hoses shall be kept to an absolute minimum required to compensate for vibration, thermal expansion and contraction, misalignment, or relative movement required between the hose end terminations.
- Flexible hoses shall have a working pressure equal to or exceeding the piping system into which they are installed. The minimum burst pressure of flexible hoses shall be a minimum of 4 times the working pressure of the hose as specified by the hose manufacturer.
- Only hydraulically-crimped type hose end fittings shall be used. Swivel-type end fittings that are widely available are recommended to be installed at each end of the hose to prevent hose twisting during installation and removal. No galvanized end fittings shall be used, and no Teflon tape shall be applied to any pressure sealing threaded connections, such as NPT (National Pipe Thread) threads.
- Raw hose body material used to fabricate hose assemblies shall not be older than 5 years from the date of manufacture, and shall be suitable for and compatible with the type of media being conveyed.
- Paint should not be applied to the outside of hose assemblies at any time
- All hose assemblies shall be internally cleaned to the extent necessary after pressure testing to ensure that any contamination inside the hose assembly will not adversely affect system operation. Hose assemblies shall be capped and sealed after testing and cleaning.
- When installing hose assemblies, they shall be routed and secured in such a manner that will avoid kinking or bends in the hose body that are less than the published minimum bending radius. Additional protection for the hose outer cover shall be provided in way of contact with surfaces subject to vibration.
- Each hose assembly shall be pressure tested to a minimum of 1.5 times the working pressure of the hose body prior to cleaning. Water should be used as the pressure testing media.
- When hose assemblies are fabricated by a qualified third party, the user shall request that the above requirements shall apply, and that a certificate be issued for each hose assembly to verify that such hose assemblies comply with the above requirements with the test pressure specified on the certificate. Each certificate should have a unique certificate number.

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- A list of all hose assemblies utilized in a system is recommended to be maintained by the user to allow prefabrication of hose assemblies for replacement. Such a list should specify as a minimum, the hose manufacturer and part number, type and part number of the end fittings, overall length, and the working pressure of the hose assembly. If any hose assemblies are fabricated by a third party, the certificate number for each hose assembly should be included on this list.

i. For temporary or permanent BOP stack storage structures fabricated by the user, the design shall comply with the applicable requirements of API Spec 7K to determine the design load and applicable design safety factors. The design of these structures shall be based on either one or both of the following conditions in addition to the design criteria specified in API Spec 7K as applicable. In the event of any conflict between the conditions specified below, the most severe condition shall be utilized to develop the design.

- Survival conditions specified in the Operating Manual for the MODU on which the storage structure is to be installed.
- For fixed installations, the same maximum wind velocity used for the design of the derrick shall be taken into account.

C.5.2 The following design factors shall be applied by a licensed engineer or a person who by education, training, and experience can demonstrate the knowledge and skills required:

C.5.2.1 The applicable default dynamic factors specified in Table 1 of clause 9.13.4.2 of API Spec 7K shall be applied.

C.5.2.2 An additional factor of 1.3 shall be applied to account for a combination of the following forces:

a. Maximum anticipated wind velocity;
b. Any potential side loading;
c. Additional dynamic forces induced by stopping and starting the lifting, lowering, or transverse movements;
d. Potential damage or deterioration of components in the primary load path if the system is intended to be permanently installed.

C.5.2.3 A safety factor of 2.5 shall be applied after applying the above factors. Exceptions are as follows:

a. For systems incorporating multiple load paths, if any one primary load path should fail while the system is in operation at the rated load, the stress in the weakest component in any of the remaining primary load paths shall not exceed 80% of the yield strength of the material;

b. For structural components, the minimum design safety factor specified above shall be derived by applying a scaling factor of 1.5 to the design loads and designing to the allowable stresses specified in American Institute of Steel Construction (AISC) *Spec for Structural Steel Buildings Allowable Stress Design and Plastic Design* (current edition).

C.5.3 The ratio of the sheave diameter or winch drum pitch diameter and the rope diameter shall be a minimum of 18 to 1 in order to maximize the fatigue life of the wire rope. Exceptions to this requirement may be taken when space constraints or other circumstances dictate smaller ratios. In these cases, sheaves and/or drums should be provided that have the largest ratio that can be installed, operated, and maintained in the space provided. For temporarily installed non-purpose-built systems utilizing single or multiple sheave blocks, smaller ratios may be utilized, but it is recommended that the lowest ratio not be less than 10 to 1. For permanent installations where wire rope is utilized with sheaves and winch drums yielding smaller ratios than 18 to 1 (regardless of whether they are purpose-built systems or not), the user shall assess and appropriately modify the frequency of visual inspection and replacement of the wire rope to account for the reduction of wire rope fatigue life.

C.5.4 BOP attachment points for lifting BOPs and / or BOP stacks should be specified by the original BOP or BOP stack manufacturer including any limitations. In the event that such information is not made available for whatever reason, alternative lifting methods which do not incorporate specific attachment points on the BOP or BOP stack may be utilized, such as wrapping it with a sling if designed in accordance with specifications and instructions provided by licensed engineer or a person who by education, training, and experience can demonstrate the knowledge and skills required.

C.6 Determination of safe working load

The user is responsible for determining the *safe working load* (SWL) of BOP handling systems in accordance with API Spec 7K.

a. The SWL as defined in clause 3.0 of ISO 14693 is the *design load* reduced by the *dynamic load*.

b. The SWL shall not exceed the *design load* of the BOP handling system as defined in clause C.5 above.

c. If for whatever reason it is impossible to estimate with any accuracy or certainty what the *dynamic load* is, a dynamic factor of 1.33 shall be utilized for onshore or fixed offshore installations, and a dynamic factor of 1.5 shall be utilized for offshore floating

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installations. These factors shall be taken into account in addition to considering the effects of prevailing wind velocity, potential side loading, and the condition of the primary load path (s) as determined by visual means prior to system operation.

d. When procuring BOP handling systems that are designed and manufactured in accordance with API Spec 7K, and in connection with the above, the user shall specify in the purchase agreement, the maximum dynamic forces and/or accelerations that the system would reasonably be subjected to, including but not limited to maximum wind velocity, accelerations imposed during transportation (if the system is portable) for installations on land rigs and fixed platforms. In the case of installations intended for floating MODUs, the user shall specify the maximum wind velocity and vessel motion criteria that the system would be subjected to for drilling operations as well as survival mode as documented in the MODU's Operating Manual.

C.7 User-provided loose gear and wire rope utilized in the primary load path of purpose-built BOP handling systems

C.7.1 For loose gear provided by the user as specified in C.2.2.g that are intended to be used in the primary load path of purpose-built systems designed and manufactured to API Spec 7K, the published *working load limit* of each loose gear component in the primary load path shall be no less than the *design load* of the BOP handling system as documented by the BOP handling system manufacturer.

Note: The design factor of loose gear is the ratio between the ultimate breaking strength and the working load limit as documented by the loose gear manufacturer. In some cases, the design factor of such loose gear may vary between 4 to 1 and 5 to 1. Under no circumstances shall the design factor of loose gear utilized to handle BOPs or BOP stacks be less than 4 to 1.

C.7.2 Wire rope provided by the user shall equal or exceed the specifications of the wire rope originally provided with the BOP handling system based on the system manufacturer's wire rope specifications.

C.8 Load monitoring / indicating systems

C.8.1 For purpose-built systems the manufacturer is required to provide load monitoring / indicating devices when specified in the purchase agreement. As such, the user is responsible for specifying the desired capabilities of such devices. These capabilities may include but not be limited to real-time display of the load being handled, audio/visual alarms when the applied load reaches certain values, data loggers to record system operating and loading data, and automatic fail-safe shut-downs that will activate when the load indicated by such devices reaches a specified percentage of the documented rated load of the system.

C.8.2 For non-purpose-built systems, a calibrated load cell shall be utilized in the primary load path between the BOP stack and the handling system, and a means of monitoring the load cell display shall be provided so that the actual weight of the BOP stack can be determined during the initial phase of handling.

C.9 System installation requirements

The following shall be regarded as minimum requirements for the installation of both purpose-built and non-purpose-built BOP handling systems:

a. All welding shall be performed in accordance with a qualified welding procedure, and all welders shall be qualified to the welding procedure that they are assigned to perform. Such procedures and qualifications shall be documented.

b. Selection, fabrication, cleaning, testing, and installation of flexible hose assemblies shall comply with the guidelines provided in C.5.1 g).

c. Traceable documentation shall be available to verify that all pressure vessels, including air / liquid pressure accumulators utilized in the system meet the following minimum requirements:

- The maximum allowable working pressure of the pressure vessel shall meet or exceed the working pressure of the piping systems into which they are intended to be installed;
- All pressure vessels shall meet or exceed all applicable design and manufacturing codes and standards;
- Pressure-relieving devices shall either be installed on the pressure vessel or in the piping system in a manner such that they cannot be isolated from the pressure vessel in order to prevent pressurization above the designated maximum allowable working pressure;
- Inspection openings shall be provided on the pressure vessel to allow visual inspection of the internal surfaces;

d. Documentation shall be available for the following components and materials used to support or suspend the primary load only:

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- Vendor certificates for wire rope, slings, and loose gear (Note: Slings and loose gear are defined in clause 3.0 of API Spec 7K). Such certificates shall, at a minimum, provide a serial number to identify the specific wire rope, sling, or piece of loose gear, and specify the breaking strength and / or working load limit (as applicable);
- Mill certificates for all steel plates or shapes;
- Documentation for welding consumables used for welding;
- Documentation of the welding procedures and welder's qualification to such procedures;

e. Documented instructions and procedures for any system assembly, testing, and commissioning that is required to be performed at the installation site shall be available prior to commencing installation, which shall include, but not be limited to the following:

- A list of required lubricants and special tools;
- Adjustment procedures required after assembly of the system or sub-systems;
- Wiring diagrams and system electrical connection drawings;
- Specifications for the connection of rig-supplied utilities to the system, including but not limited to electrical power, instrumentation and control system wiring, and piping connections for compressed air, hydraulic power, and water;
- System commissioning procedures including but not limited to function and load testing procedures;

f. An inventory of spare parts, raw materials, lubricants, and all equipment and expendable materials required to support the installation shall be procured and delivered to the site prior to commencing installation.

g. Arrangements for the supply and erection of scaffolding and work platforms shall be made for access to areas of the rig required for system installation.

h. Documented work planning and safety procedures shall be made available, including but not limited to the following:

- Electrical power circuit and piping system pressure isolation and lock-out / tag out procedures;
- Fire prevention and control measures;
- Job planning and risk assessment procedures;
- Personal protective equipment and fall protection;
- Personnel assigned to conduct safety audits;

i. Environmental protection procedures shall be available and communicated to the work force.

j. Arrangements shall be made for third party witnessing and / or verification as required.

C.10 System commissioning requirements after initial installation

C.10.1 For purpose-built BOP handling systems installed on any rig, it shall be function tested, followed by a proof load test prior to commissioning the system for the first time. The proof load test value shall be at an amount specified by the system manufacturer. For proof load test values exceeding the static weight of the BOP stack and all of its attachments, a means shall be provided to safely add the weight required to achieve the specified load. Alternatively, the system manufacturer may conduct a proof load test of the primary load paths of the system either independently, or at one time as a system at a separate facility. For attachments between the system and the rig that are designed to transmit the load to the rig structure, these may be independently tested at the same load and the same force vector direction that would be exerted on them if the system was installed and subjected to the specified proof load value.

C.10.2 Non-purpose-built systems shall be function tested, followed by a proof load test after initial installation to at least 1.25 times the static weight of the BOP stack and all of its attachments. When a means of creating the weight necessary to conduct this load test is not available or could create safety hazards to rig personnel, the load test shall be conducted under close scrutiny at the static weight of the BOP stack and all of its attachments. Such scrutiny shall be focused on all components in the primary load path to detect any initial deformation or cracking. A means shall be established to quickly and safely abort this load test without losing control of the movement of the BOP stack in the event of detecting initial failure of any primary load path component so that safety hazards to rig personnel are avoided. Alternatively, independent load testing of all primary load path components may be conducted as long as such testing satisfies all intents and purposes of the independent testing of the system and its attachments points on the rig as described in C.10.1.

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C.11 Periodic load testing requirements after initial installation and commissioning

C.11.1 Purpose-built systems, whether they are permanently installed or not may require load testing to a load value specified by the system manufacturer after initial installation and commissioning. Factors to be considered by the user to determine if and when load testing is required include but are not limited to the following:

a. When primary load carrying components have been remanufactured (as defined in Section 3), and such components or their attachments to the load path have not been warranted by the system manufacturer to be fit for service, and cannot be independently load tested prior to installation.
b. When measurable wear and / or corrosion limits to all primary load carrying components are not provided by the system manufacturer, and such components have been found to be visibly worn or corroded, and cannot otherwise be independently load tested, and it is desired by the user to continue operation of the system with such components installed.
c. When a means to measure the fatigue life-cycle limit of all primary load carrying components or the system itself are not provided by the system manufacturer, the user should implement load testing at certain load values and intervals, based on system manufacturer's recommendations.
d. When the limits specified in b) and c) above are specified by the system manufacturer, and the user does not replace, remanufacture, or repair such components in a manner such that the systems or components are warranted by the system manufacturer that they are fit for service when such limits are reached or exceeded

C.11.2 No load testing of purpose-built systems shall be required, based on the following:

a. If the user replaces primary load carrying components prior to or when the limits specified in C.10.1 b) and c) are reached, and they have either been independently load tested or warranted by the system manufacturer to be fit for purpose prior to installation.
b. When damaged or deteriorated components are replaced with new components, re-qualified components (used components determined to be in serviceable condition by the system manufacturer), or remanufactured components that have been warranted by the system manufacturer to be fit for service.

C.11.3 Non-purpose-built systems shall be load tested to 1.15 times the static weight of the BOP stack and all of its attachments prior to each system operation for as long as they are installed. When a means of creating the weight necessary to conduct this load test is not available or could create safety hazards to rig personnel, the load test shall be conducted under close scrutiny at the static weight of the BOP stack and all of its attachments. Such scrutiny shall be focused on all components in the primary load path to detect any initial deformation or cracking. A means shall be established to quickly and safely abort this load test without losing control of the movement of the BOP stack in the event of detecting initial failure of any primary load path component so that safety hazards to rig personnel are avoided.

C.12 BOP handling systems supported by the ground

For any system used for a land rig operation that is supported by the ground and is not installed on the rig, and where the rig structure is not used to support or suspend the load, the primary load carrying components that transfer the load to the ground shall be visually examined by personnel familiar with the design of such systems for damage or deterioration prior to operation. In addition, the user or personnel familiar with such systems shall also ensure that the ground in way of supporting the load is suitable for supporting the load at the rated load of the system. Ground preparation, such as the laying of sand or gravel, and/or the use of mats placed between the system contact points and the ground shall be performed to ensure the load will be evenly and adequately distributed into the ground at each contact point without undue penetration.

C.13 BOP stack or rig modifications resulting in load increases on purpose-built BOP handling systems

C.13.1 Modifications to BOP stacks are highly probable over the life-cycle of any given rig. Whenever it is intended to modify a BOP stack to the extent that the static weight of the BOP stack and all of its attachments may increase, the user shall request the system manufacturer to conduct an analysis to determine whether modifications to the handling system, and / or revisions to the dynamic conditions within which the handling system can be operated are required. The user shall ensure that recommendations issued by the manufacturer are carried out and complied with.

C.13.2 Whenever rig modifications may impact the criteria upon which a purpose-built BOP handling system was designed to meet, the user shall request the system manufacturer to conduct an analysis of the proposed rig modifications to determine whether modifications to the handling system, and / or revisions to the dynamic conditions within which the handling system can

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be operated are required. The user shall ensure that recommendations issued by the manufacturer are carried out and complied with.

C.14 Third party verification of purpose-built systems

Generally, if the purchase agreement requires third party certification of a purpose-built system, the manufacturer is responsible for making arrangements with such third parties, and the user is not involved, other than to ensure that copies of any certificates are maintained on file. However, the installation of purpose-built systems may require third party oversight to some degree, depending on applicable rig classification rules and / or regulatory requirements. Such oversight may include but not be limited to the verifying:

a. The system is certified to meet API Spec 7K and any other applicable requirements specified in the purchase agreement;
b. The installation and any subsequent testing and commissioning activities meet all applicable rig class rules and / or regulatory requirements.

In this case, the user is responsible for making the arrangements for such third party oversight.

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Addendum 2
April 2006

Procedures for Inspection, Maintenance, Repair and Remanufacture of Drilling Equipment

API RECOMMENDED PRACTICE 7L
FIRST EDITION, DECEMBER 1995

American Petroleum Institute

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Procedures for Inspection, Maintenance, Repair and Remanufacture of Drilling Equipment

Replace Appendix A with the following:

APPENDIX A—RECOMMENDED PRACTICE FOR OPERATING LIMITS, INSPECTION, CARE, AND USE OF CEMENT HOSE, DRILLING MUD VIBRATOR AND JUMPER HOSE, AND ROTARY HOSE

This standard covers all types of hoses specified in clause 9.10 of API Spec 7K. The definitions of terms contained in clauses 3.0 and 9.10.1 of API Spec 7K shall apply.

A.1 Hose length

A.1.1 ROTARY HOSE LENGTH

In order to avoid kinking rotary hose, the length of hose and height of standpipe should be such that while raising or lowering the traveling equipment, the bending radius of the hose will not be less than the value of the Minimum Bending Radius (MBR) provided in Table 7 and C.1 of API Spec 7K at the swivel when the traveling equipment is in its lowest drilling position and at the standpipe when the traveling equipment is in its highest drilling position. The recommended length of rotary hose is derived by the following equation (see Figure A.1).

$$L_H = L_T/2 + \pi R + 2C + S \qquad \text{(A.1)}$$

where

L_H = length of hose, m (ft)

L_T = length of hose travel, m (ft)

R = minimum radius of bending of hose (see API Spec 7K, Table 7 and C.1 for MBR value). Note: The MBR for certain hoses may be less than the value provided in this table, m (ft)

C = coupling length, m (ft)

S = 0.3 m (1ft) allowance for hose length tolerance and contraction when internal pressure is applied (see API Spec 7K, clause 9.10.5)

Whenever it is necessary to operate with hoses that do not meet the optimum length requirements derived from the formula above, the user should select a hose that is longer than the optimum length. In these cases, the user should determine whether a longer hose could cause safety hazards by interfering with personnel on the drill floor. If such is the case, the user should make adjustments to either or both the height of the standpipe gooseneck and the hose termination on the traveling equipment, and repeat the calculations with the formula provided until the optimum hose length to be utilized is determined.

A.1.2 CHANGES TO HOSE LENGTH AS A RESULT OF PRESSURIZATION

The overall length of hoses at atmospheric pressure will probably change as pressure is applied (see clause 9.10.4 and 9.10.5 of API Spec 7K). The user shall ensure that sufficient hose length is provided between connection points to avoid overstressing the hose when it is under pressure.

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A.2 Mud standpipe height

The recommended standpipe height is derived by calculation using the following equation (see Figure A.1).

$$H_s = L_T/2 + Z \tag{A-2}$$

where

H_s = vertical height of standpipe, m (ft)

L_T = length of hose travel, m (ft)

Z = height, m (ft), from the top of the derrick floor to the end of hose at the swivel when the swivel is in its lowest drilling position

Note: When the actual length of hose is greater than the length calculated in A.2, the standpipe height should be increased by one-half the difference between the actual length and the calculated length.

A.3 Hose end connections

Clause 9.10.6.2 of API Spec 7K specifies that hose end connections may be affixed to hose couplings with line pipe threads per API Spec 5B for hose assemblies with a working pressure rating of 34.5 MPa (5,000 psi) or less. For rotary hose assemblies with a working pressure greater than 34,5MPa (5000 psi) no threads of any kind may be utilized to affix the end connections to the hose coupling. The user should be aware that in certain applications where there is considerably more hose movement during operation, such as on floating offshore rigs, cyclic bending stresses have caused fatigue failures at the last engaged thread between the end connection and the hose coupling when such threads are of the pressure-sealing type, such as line pipe threads specified by API Spec 5B. Therefore, the user should consider alternatives to the use of line pipe threads to join the end connection to the hose coupling for these applications. As such, it is recommended that the user specify the end connection to be affixed to the hose coupling by butt-welding in the purchase agreement for any hose with a working pressure specified in Table 7 and C.1 of API Spec 7K. Alternatively, if the manufacturer can provide it, an "integral" hose coupling/end connection may be specified by the user in the purchase agreement. Such "integral" hose coupling/end connections are manufactured from a single piece of material. Hose assemblies installed onto the swivel gooseneck and onto the standpipe should be as nearly tangential as possible. The use of a standard connection on the swivel gooseneck (see Clause 5 of API Spec 8A, clause 7.2.1, Figure 2, or API Spec 8C, clause 9.9.4.1, Figure 5) will ensure this relationship. The angle of the end of the standpipe gooseneck should be 15 degrees from the vertical, and oriented toward the vertical line of travel of the hose connection point on the swivel.

A.4 Handling

In order to minimize the possibility of kinking the hose during crating or uncrating, the crate should be rotated as the hose is uncoiled out of or coiled back into the crate. When handling the hose on and off the drill floor, it should be kept as straight as possible, and should not be handled with a sling hitched to the middle of the hose. The end connections of the hose should always be protected from damage due to sliding, abrading, or striking against objects. Special carriers may be devised to lift the hose from its mid-body to ensure that any bends induced in the hose while lifting and transporting are not less then the Minimum Bending Radius (MBR) specified in API Spec 7K, Table 7 and C.1. Whenever a hose has been removed from service and set aside for any reason, it should be protected from damage.

A.5 Twisting

All hoses covered by this standard should not be intentionally twisted during installation, because each layer of reinforcement is fitted in an alternating right-hand and left-hand helical path around the hose for its entire length. Therefore, if the hose is twisted in one direction, one layer of reinforcement contracts while the other expands. Thereafter, a hose that is twisted and subsequently subjected to pressure and/or bending, permanent damage to the hose will result that will affect its pressure integrity and shorten its useful life. Twisting rotary hose is sometimes employed to force the hose away from the traveling equipment or other interferences in the derrick to avoid contact, snagging, or abrasion. This practice should always be avoided. If the hose interferes with the derrick or mast structure or other objects, the standpipe should be repositioned to avoid these interferences (Note: moving the standpipe may require a hose of a different length to be used per the formula in clause A.2). Alternatively, the objects that the hose is coming into contact with should be repositioned. In cases where a flanged hose end connection is provided that requires the hose to be twisted to align the bolt holes, the other end of the hose should be fitted with an end connection that does not

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require a fixed or specific radial orientation in order to be mated, such as a hammer union. Alternatively, a swivel fitting can be installed in one or both hose attachments. To assist the user, each length of hose has a longitudinal lay line of a different color than the hose cover. By line of sight down the length of the hose, this lay line should remain in view without forming a helical path after the hose is installed. This should be used as a guide in making certain the hose is installed without twisting.

A.6 Damage to the outer cover of the hose

Rotary hoses should be installed to provide adequate clearance between potential interferences. In some cases, due to high winds or offshore rig motion, hoses may come in contact with interferences in the derrick. When this occurs, hoses should be inspected as soon as practicable for any damage to the outer cover. If the cover is damaged to the extent that the reinforcement materials of the hose are exposed to the elements, repairs should be carried out to the damaged area(s) to protect the reinforcing materials as soon as possible. This can be performed with epoxy or polyurethane resins, or other materials specified and approved by the hose manufacturer. If this is not done, moisture will enter into the reinforcement materials, and there are no existing means available to remove it. As a result, corrosion will occur to the reinforcement materials, which over time, will progress to the point where the strength of the reinforcing materials will be reduced, and the pressure integrity and useful life of the hose will be compromised.

A.7 Safety clamps

The hose manufacturer is required to ensure that safety clamps specifically designed for the hose are available for purchase by the user, and to mark the hose body where such clamps are to be fitted in accordance with the requirements in API Spec 7K. Safety clamps shall be designed to provide one or more attachment points that will allow the user to secure a length of chain or a wire rope sling to the safety clamp. Such attachment points shall incorporate a 28 mm (approximately 1-$^{1}/_{8}$ in.) minimum diameter hole for attaching a safety chain or wire rope sling and will be so designed as to allow adequate clearance from the hose. The chain or wire rope sling, and the attachment hardware, such as a shackle or connecting link shall have a minimum breaking strength of 72640 N (16,000 lbs), or a working load limit of 3,000 lbs (9600 N) with a 5 to 1 safety factor for hoses up to 4 in. internal diameter. For hoses with 5 in. and 6 in. internal diameter the minimum breaking strength shall be 145280 N (32,000 lbs), or a working load limit of 27240 N (6,000 lbs) with a 5 to 1 safety factor. The chain or wire rope sling shall be used to handle the ends of the hose, and provide a means of restraining the end of the hose if the end fitting becomes disconnected. The free end of the chain or wire rope sling shall be attached to a secure structure or object that is capable of withstanding the breaking force of the chain or wire rope sling, and shall be of a sufficient length without restricting the movement of the hose. The user shall specify the proper safety clamps as specified above to be provided in the purchase agreement for the hose that is being supplied. The hose manufacturer shall include shipment of the proper safety clamp with each hose supplied, and any pertinent installation instructions. Safety clamps provided by the hose manufacturer shall be installed by the user on all rotary, vibrator, and jumper hoses at the locations marked on the hose body. The user shall verify that the safety clamp provided is of the proper size, and is installed in accordance with the hose manufacturer's instructions as provided.

A.8 Vibration and pulsation

Continuous pressure pulsations and vibration may shorten the useful life of rotary, vibrator, and jumper hoses used in high pressure mud piping systems. Surge chambers or pulsation dampeners of the proper size should be installed in each mud pump discharge line to minimize pulsations and vibration in the high pressure mud piping system and hoses. The precharge pressure for pulsation dampeners should be set at 10% of the maximum pump pressure. The suction piping to the pump should be pressure-charged or operated with a flooded suction to minimize cavitation of the drilling mud in the fluid end of the mud pump that can cause pressure pulsations. Pulsation dampeners designed for the pump suction piping should also be installed to minimize pulsation and cavitation. If the corrective measures specified above have been installed but are ineffective in controlling the pressure pulsations to an acceptable level, the user should consider replacing the hose with one that has a higher Flexible Spec Level (FSL) as specified in clause 9.10.3.2 in API Spec 7K. Generally, unacceptable pressure pulsations are those that exceed 10% of the designated standpipe pressure. The user should also consider the installation of digital (versus analog) pressure monitoring instrumentation, coupled with standpipe pressure data logging instrumentation to allow more accurate detection and recording of unacceptable pressure pulsation in the affected hose assemblies covered by this standard during drilling operations. The user is also cautioned that unacceptable pressure pulsations, combined with high operating pressures and / or temperatures (see clause A.9), and / or high flow rates (see clause A.10) and / or certain types of oil based drilling mud (see clause A.13 below) will most likely have a severe impact on the useful life of the hoses affected. High operating pressures in this regard are considered to be those which exceed 80% of the working pressure of the hose.

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A.9 Operating temperature

Hose assembly operating temperatures should not be outside the designated temperature range specified by clause 9.10.3.1 of API Spec 7K. Operating a hose outside its designated temperature range will shorten its useful life. The user shall specify the operating temperature range of the hose in the purchase agreement in accordance with the temperature range selections specified in clause 9.10.3.1 of API Spec 7K when purchasing new hoses. If the anticipated operating temperature is above and/or below any of the temperature ranges specified in clause 9.10.3.1 of API Spec 7K, the user shall consult with the hose manufacturer and reach an agreement on the operating temperature range of the hose to be specified in the purchase agreement.

A.10 Flow rates and abrasive media

Flow rates through the hose assembly should not exceed the maximum flow rate specified by the hose manufacturer. Flow rates exceeding maximum values will shorten the useful life of hoses covered by this standard. In addition, abrasive conditions caused by sand or other solids in the mud can cause the useful life of hoses covered by this standard to be shortened. The maximum flow rate for hoses may vary between different manufacturers for the same size and pressure rating. Because standpipe flow rates are increasing due to more demanding drilling conditions, additional mud pumps are being used to provide these higher flow rates. Therefore, it is important for the user to determine whether larger diameter hoses are required to prevent exceeding maximum flow rates. In addition, the user should require the hose manufacturer to provide the maximum flow rate for each hose delivered under a purchase agreement.

A.11 Exposure to pressurized gases

When a rotary hose is exposed to gases under pressure for a prolonged period of time, gases will permeate through the liner. When this occurs, pressurized gas is trapped outside the liner and is not vented unless the hose is manufactured to meet API Spec 17B. If for any reason the hose is subsequently depressurized, the gas will not permeate back through the liner material at a sufficient rate to prevent collapse of the liner. As such, the following guidelines are provided to the user for certain drilling, completion, and workover operations that will or may expose a rotary hose to pressurized gases.

A.11.1 AIR AND GAS DRILLING AND WORKOVER OR COMPLETION OPERATIONS

Rotary, vibrator, and jumper hoses covered by this recommended practice shall not be used in air or gas drilling operations. In addition, whenever it is intended or likely that the hose will be exposed to well bore effluents during workover or well completion operations the user should consider using hoses made in accordance with API Spec 17B instead of hoses made to meet API Spec 7K.

A.11.2 UNDER-BALANCE OPERATIONS

Under-balance operations (UBO) are defined as performing drilling operations with returns to surface using an equivalent mud weight that is maintained below the open-hole pore pressure. UBO shall not be construed to mean the same thing as air or gas drilling, or workover or well completion operations. Most UBO are designed such that there are safeguards and redundancies provided to prevent the rotary hose from being exposed to well bore influx and/or nitrogen injection operations for a prolonged period of time that could damage the hose. When UBO are designed in this manner, and procedures are carefully followed to prevent prolonged exposure of the hose to pressurized gases, hoses made to API Spec 7K may be used without incident. However, some UBO are designed to allow exposure to either well bore influx and/or nitrogen gas, and the user is cautioned to assess the risks of such exposure based on UBO design and arrangement, and to use hoses made to comply with API Spec 17B when such exposure is intended or likely to occur.

A.11.3 INSPECTION OF ROTARY HOSES EXPOSED TO PRESSURIZED GASES

Rotary hoses that have been exposed to pressurized gases should be inspected to determine whether the integrity of the liner has been breeched or has collapsed. This can be accomplished with the use of a fiber-optic borescope to visually examine the inner surface of the hose liner over the full length of the hose. The detection of bulges, blisters, punctures, or any other breach of the liner material shall be cause for rejection of the hose from further service, and should be replaced and disposed of.

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A.12 Working pressure

The working pressure for rotary, vibrator, and jumper mud hoses and cement hoses is published by the hose manufacturer and is specified in API Spec 7K, Table 7 and C.1. The user is responsible to ensure that the working pressure of the hose is not exceeded while in service, including pressure surges and pulsations that occur in the system (See A.8, Vibration and Pulsation).

A.13 Oil base mud

The use of oil base mud having an excessively high aromatic content will cause the hose inner liner to swell and shorten the useful life of the hose. It is recommended that oil base mud be held to a minimum aniline point of 66°C (150°F).

A.14 Barge-attended offshore rigs

For mud jumper hoses used between barges and offshore drilling rigs, care must be used so that alignment is maintained between both end connections. It is recommended that swivel joints be used at both ends. Operations in rough weather and high seas that induce bends in the hose that could violate the Minimum Bending Radius of the hose (see Table 7 and C.1 of API Spec 7K), and/ or high axial forces on the hose will shorten the useful life of jumper hoses in this application, which may cause a failure while in service.

A.15 Rotary hose field pressure testing

Field pressure testing of rotary hose, when required for establishing periodic safety levels of continued operation, should be conducted in accordance with the following guidelines:

A.15.1 Visual inspection should include examination of any external damage to the body, end structure, and couplings. Safety clamps should be checked for proper attachment to the hose, and safety clamp fasteners should be checked for damage, deterioration, and tightness. Safety chain or wire rope slings should be checked for damage or deterioration and that they are properly attached to structure capable of supporting the breaking strength of the safety chain or wire rope sling.

A.15.2 Hoses should be arranged as straight as possible, and twisting (see clause A.5) shall be avoided.

A.15.3 Prior to conducting pressure testing, the hose should be suspended in normal unstressed position from standpipe to swivel.

A.15.4 Rate of pressure rise should not be less than 6.9 MPa (1,000 lb per in.^{2}) or greater than 68.9 MPa (10,000 lb per in.^{2}) per minute.

A.15.5 All air in the hose shall be bled off prior to applying test pressure. When possible, water should be used as the test media.

A.15.6 The duration for holding the maximum test pressure in the hose should not exceed 10 minutes.

A.15.7 Field test pressure shall not exceed 1.25 times the maximum working pressure of the hose regardless of the test pressure that is specified by the hose manufacturer. Test pressures may also be limited to the maximum working pressure of the valves installed in the mud system that are used to isolate the hose for pressure testing based on the maximum pressure that can be exerted on the valve gates or seats as specified by the valve manufacturer.

A.15.8 The area adjacent to the hose to be tested shall be cleared of unnecessary personnel. Personnel assigned to conduct testing operations should wear appropriate personnel protective equipment, such as gloves, eye shields or goggles, and be positioned out of harm's way in case there is an uncontrolled release of pressure.

A.15.9 A means shall be provided to release the pressure contained in the hose under controlled conditions after pressure testing is completed.

A.15.10 Hoses that are found to be leaking during the course of pressure testing should be removed from service and either repaired or destroyed and disposed of immediately after testing.

A.16 Hose modifications in the field

Attaching new couplings to used hose body materials is not recommended. Users considering the installation of new hose couplings onto a used hose body for the purpose of continuing to use it in high pressure mud or cement service as defined in API Spec 7K shall be aware that the pressure integrity of such a hose assembly may be compromised. In addition, the user shall be aware

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that, regardless of what markings may remain on the hose after re-coupling that would indicate its original compliance with API Spec 7K, its fitness for purpose as originally certified will also most likely be compromised. It is recommended that if used hose is re-coupled by other than the original manufacturer, the original manufacturer's markings should be removed. This includes, but is not necessarily limited to the practice of cutting a rotary hose into shorter lengths for the purpose of fabricating one or more vibrator or jumper hoses.

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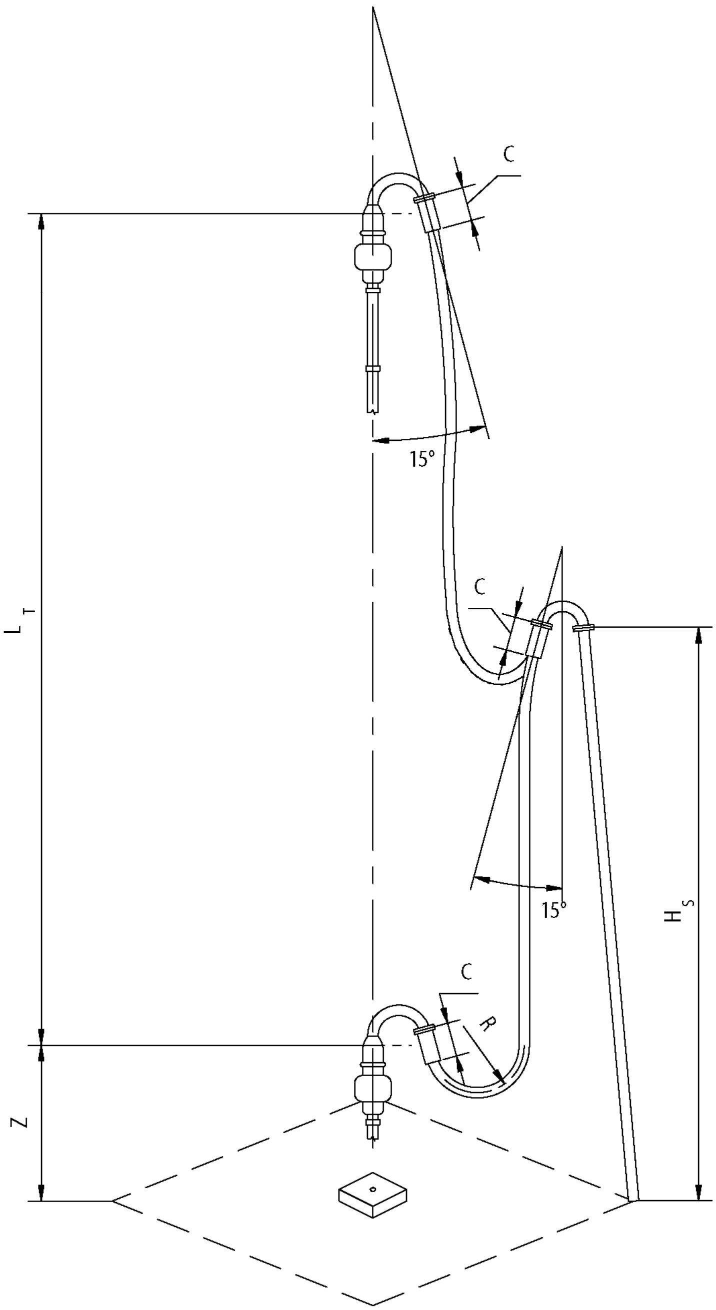

Key

C = coupling length, m (ft)

Hs = vertical height of standpipe m (ft)

R = minimum radius of bending of hose, m (ft)

L_T = length of hose travel, m (ft)

Z = height, m (ft), from the top of the derrick floor to the end of hose at the swivel when the swivel is in its lowest drilling position

Figure A.1—Layout for Rotary Hose

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