Recommended Practice for Electrical Submersible Pump Installations

RECOMMENDED PRACTICE 11S3
SECOND EDITION, MARCH 1999

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 American Petroleum Institute (API) Subcommittee on Field Operating Equipment.

This document presents recommended practices for the storage, transportation, handling, installation, start-up and pulling of electrical submersible pumps and auxiliary equipment.

This document includes usage of the verbs shall and should, whichever is the more applicable to the function. For the purpose of this document:

Shall indicates the recommended practice is considered a minimum requirement that has universal applicability to the specific activity.

Should indicates a recommended practice: (a) for which alternative practices may be equally safe and/or effective; or, (b) which may be impractical under some circumstances or applications.

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

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Electrical Submersible Pump Installations

1 Scope

1.1 This recommended practice covers the installation and replacement of all major components that comprise a typical, electrical submersible pumping system. (See Figure 1.) Specifically, it covers installations in oil and gas production operations where the equipment is installed on tubing. It does not cover equipment selection or application.

1.2 Any of several installation procedures may be acceptable for good operations. All installations, however, require good engineering practice, sound judgment, and proper maintenance.

2 References

This recommended practice includes, by reference, either in total or in part, other standards and recommended practices listed below. The latest edition of these standards and recommended practices should be used unless otherwise noted:

API

RP 11S	*The Operation, Maintenance and Troubleshooting of Electrical Submersible Pump Installations*
RP 11S1	*Electric Submersible Pump Teardown Report*
RP 11S2	*Electric Submersible Pump Testing*
RP 11S4	*Sizing and Selection of Electric Submersible Pump Installations*
RP 11S6	*Testing of Electric Submersible Pump Cable Systems*
RP 11S7	*Electric Submersible Pump Seal Chamber Section*
RP 11S8	*Application and Testing of Electric Submersible Pump System Vibrations*
RP 500	*Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*
RP 505	*Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone O, Zone 1 and Zone 2*

ASTM [1]

D-877	*Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disc Electrodes*

IEEE [2]

1017	*Recommended Practice for Field Testing of Electric Submersible Pump Cable*

3 Transportation, Handling and Storage of Equipment

3.1 CABLES

3.1.1 Downhole Pump Cables

The recommended method to lift a reel of cable is to insert an adequately sized piece of pipe through the center of the reel to serve as an axle. The reel should be lifted with a power spooler or with a spreader bar and a wire rope or chain sling attached to this axle. A reel of cable should never be lifted using a sling without a spreader bar as the cable or the cable reel could be damaged. The following are also recommended:

a. Necessary precautions should be taken to protect the cable and reel from damage during storage, transportation or installation of equipment.
b. The reel of cable should never be allowed to roll against objects that might crush or otherwise damage the cable or reel.
c. A minimum 4-in. clearance should be allowed between the outermost layer of the cable and the flange of the cable reel to protect the cable from damage. (See Figure 2.)
d. The reel should be transported and handled with the reel axle horizontal to the ground.
e. The reel rims—when transported by conventional means—should be chocked (blocked) on both sides of the reel, and that the reel should be properly secured by "boom chains" passing through the center section of the reel.
f. Chains should never pass over the top of the reel or touch the cable.
g. When forklifts are used to handle cable reels:

1. Forks shall be long enough to support both reel rims;
2. Forks shall be of adequate width to safely lift the reel;
3. Forks shall be locked in position;
4. Lifts shall be made on the reel rims only (when approaching the reel from its end);
5. Only one cable reel shall be lifted at a time.

3.1.2 Motor Lead Extension (Flat) Cables

3.1.2.1 To ensure physical protection, a motor lead extension cable that is shipped separately should be boxed, crated, reeled or secured to a pallet.

[1] American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959.

[2] Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

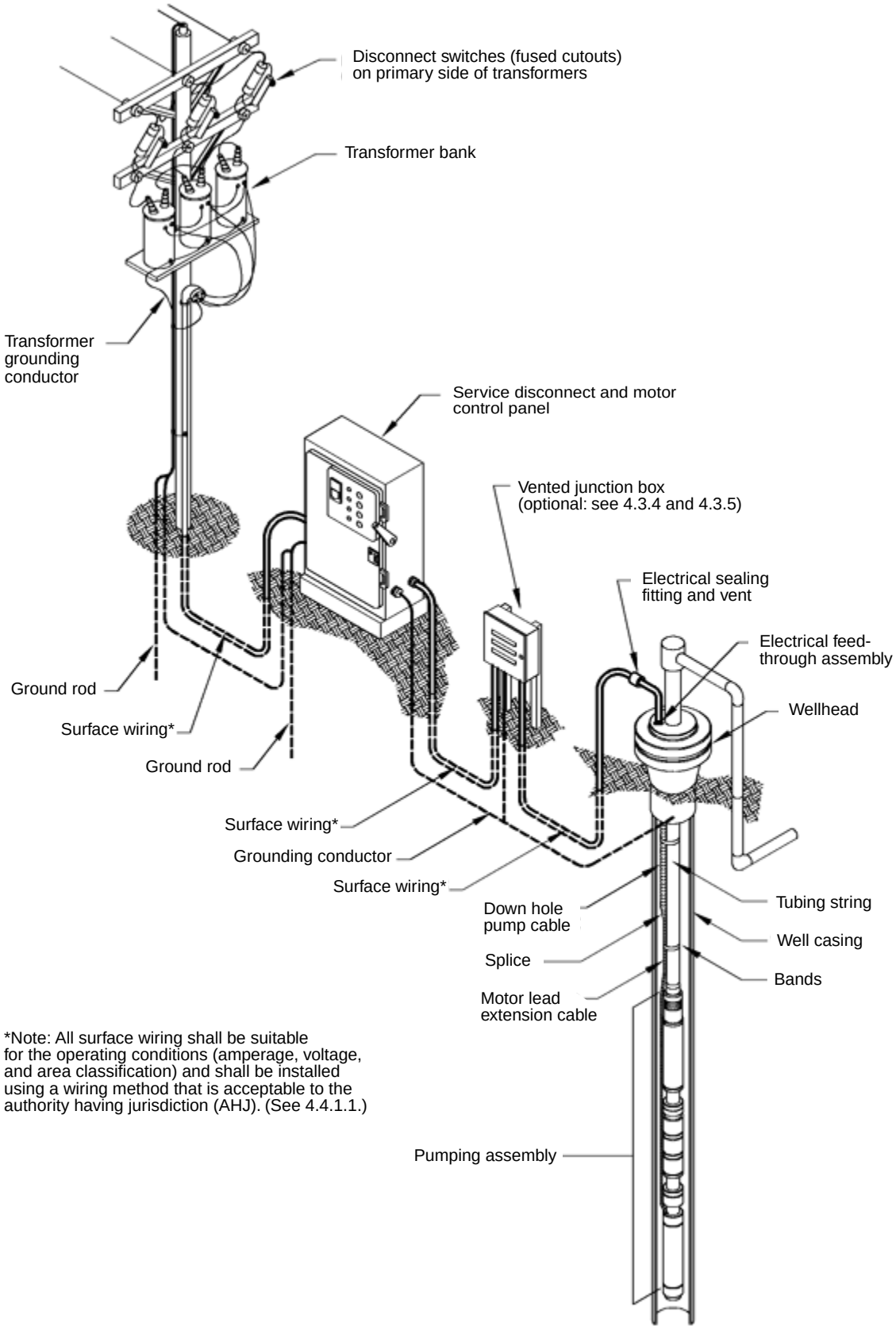

Figure 1—Components of an Electrical Submersible Pumping System

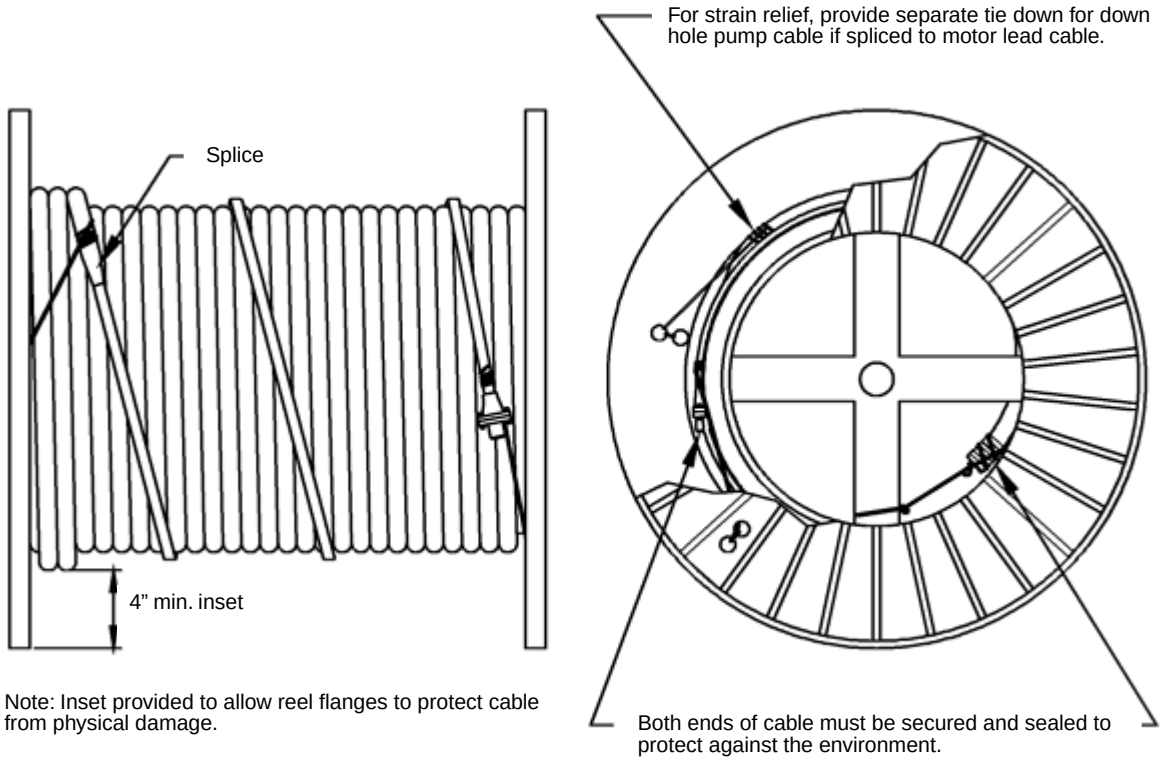

Figure 2—Preparation of Cable for Transportation and Handling of Spools

3.1.2.2 To protect the cable from the elements, each end of the lead extension cable should be sealed.

3.2 PUMPS, MOTORS, SEALING SECTIONS, AND GAS SEPARATORS

3.2.1 These components normally are shipped and handled in metal shipping boxes provided by the manufacturer.

3.2.2 These components should be properly supported at points one-fourth the distance from each end inside the shipping box and should have proper shipping caps installed in accordance with the manufacturer's specifications.

3.2.3 The length of the truck or trailer bed used to transport the equipment should adequately support the total length of the equipment shipping box with no more than a 3-ft overhang.

3.2.4 Equipment shipping boxes should be in a horizontal position when transported.

3.2.5 Support blocks under shipping boxes should be properly spaced for the equipment load, and boom chains securing the boxes should be located only over these support blocks.

3.2.6 All equipment shipping boxes should be marked by the manufacturer to show which end should be placed toward the wellhead. When off-loading the equipment at the well location, that end of the box should be placed as close to the wellhead as practical.

3.2.7 Shipping boxes should be lifted with a two-point lift and maintained in a horizontal position.

3.2.8 Boxes should not be dragged, bounced or dropped when handled.

3.3 SURFACE AND MISCELLANEOUS EQUIPMENT

3.3.1 Transformers

3.3.1.1 Transformers should be provided with lifting eyes for loading, unloading, and handling.

3.3.1.2 Transformers should be lifted either with cables or a lifting beam. Covers should be bolted in place when cables are used, and a spreader bar should be used to maintain the transformer in a vertical position.

3.3.1.3 Where a crane or hoist is unavailable, transformers should be skidded or jacked-up for movement on rollers. Care shall be taken to avoid tipping transformers. Jacks should be used only under the jack lugs or bosses provided—never under drain valves and the like.

3.3.2 Motor Control Panels

3.3.2.1 When transporting motor controllers, they should be secured to the truck bed (or other surface, as applicable) to prevent movement, tipping or excessive vibration.

3.3.2.2 Nothing should be placed on top of the motor controller. Pry bars should be used rather than hammers for uncrating control panels.

3.3.2.3 The interior of motor control panels (controllers) should be kept clean and dry. All internal components should be examined for shipping damage.

3.3.3 Accessory Equipment

3.3.3.1 All accessory equipment should be boxed or otherwise properly protected and identified when shipped.

3.3.3.2 When transported or handled, this equipment should be provided the same protection and handling care outlined for other system components.

3.4 STORAGE

3.4.1 For extended storage of equipment, the equipment manufacturers should be contacted for specific recommendations. The use of desiccant or corrosion inhibitors, or both, may be desirable.

4 General Surface Installation

4.1 GENERAL

All equipment shall be properly installed for the application and for the location. The installation of all components shall comply with the requirements of authorities having jurisdiction (AHJs).

Note: Users of this recommended practice should note that 4.2.1.1, 4.3.3, and 4.3.6 recommend minimum distances between electrical equipment and the wellhead that exceed API RP 500 area classification boundaries for wells equipped with electrical submersible pumps. The greater minimum distances are based on current manufacturers' recommendations, which consider both the area classification of facilities and also the need to assure adequate physical clearance for running and pulling operations. Shorter distances, where required or preferred for local condition—particularly for urban or offshore installations—should be acceptable if they are based on good engineering practice and comply with API RP 500 or RP505 area classification guidelines.

4.2 PRIMARY SERVICE TRANSFORMERS

4.2.1 Users should refer to the submersible pump manufacturer's recommendations for additional information regarding the installation, sizing, and mounting of transformers. General recommendations are given below:

4.2.1.1 Transformers should be located far enough from the wellhead and other lease production facilities to meet applicable codes and safety requirements and should provide adequate physical clearance for well maintenance operations. For onshore installations, it is recommended that a distance of 30 m (100 ft) be maintained between transformers and wellheads.

4.2.1.2 It is recommended that transformers not be located directly over motor control panels to facilitate transformer servicing.

4.2.1.3 Disconnect switches (fused cutouts) should be located on the primary sides of the transformers.

4.2.1.4 Lightning arrestors should be installed on transformer primaries. Lightning arrestors and surge protection should be considered for transformer secondaries and motor control panels.

4.3 MOTOR CONTROL PANELS, VENTS, AND JUNCTION BOXES

4.3.1 Access to live parts (particularly medium voltage) shall be limited to qualified personnel. Adequate marking should be provided.

4.3.2 Motor control panel components shall be suitable for the operating conditions (e.g., voltage, current, ambient temperature, and area classification).

4.3.3 It is recommended that a vent be installed between the wellhead and the motor control panel. This vent should limit the pressure on the sealing fitting between the vent and the motor control panel to 6 in. of water column. (See Figure 1.)

4.3.3.1 A properly designed vented junction box is one method of achieving the recommendation of 4.3.3. (See Figures 1 and 3.)

4.3.3.2 If a vented junction box is installed, it should be located more than 5 m (15 ft) from the wellhead or other provisions should be made to allow access for well servicing units.

4.3.4 Junction boxes installed between the wellhead and the motor control panel should be adequately ventilated to prevent the accumulation of ignitable concentrations of flammable gases or vapors inside the junction box. Reference API RP 500 or RP 505, as applicable, for additional information on ventilation. (See Figure 1.)

4.3.5 Conduit or cable interconnecting junction boxes and control panels shall be sealed with an approved electrical sealing device between the junction box and the control panel. An additional sealing fitting is recommended on the conduit or cable entering the junction box from the wellhead unless provisions are made to prevent pressure in excess of 6 in. of water column from being placed on the junction box. Sealing fittings are required at area classification boundaries both for conduit and for cables that do not have a gas/vapor-tight continuous sheath. (See Figure 1.)

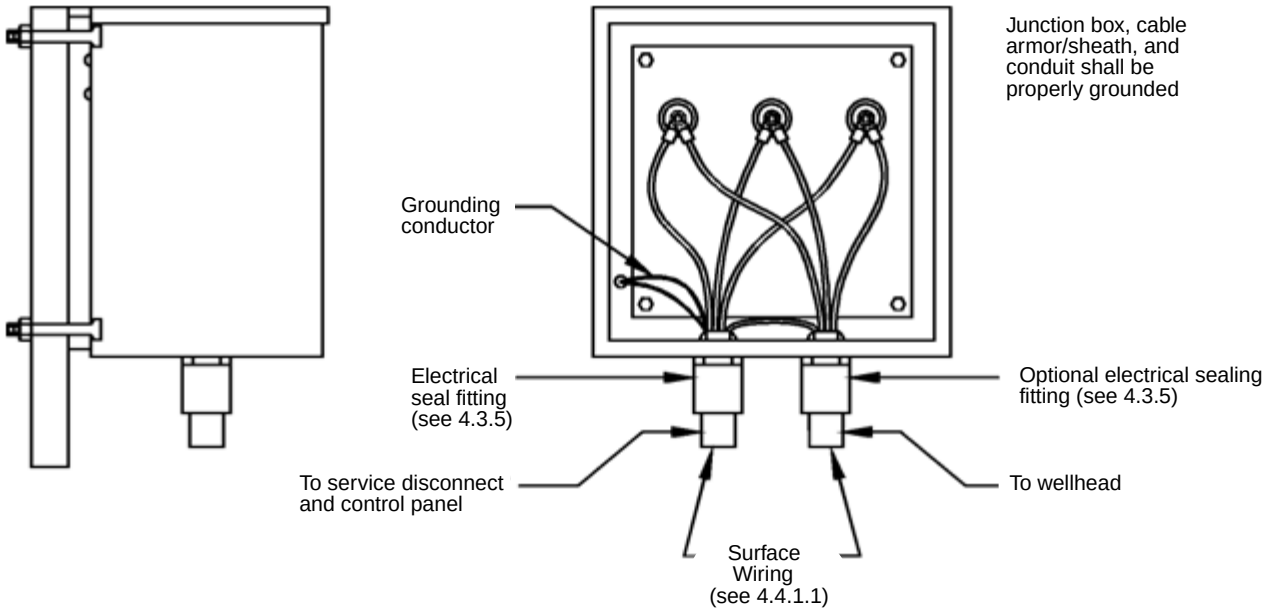

Figure 3—Vented Junction Box

4.3.6 Motor control panels should be located more than 15 m (50 ft) from wellheads.

4.4 SURFACE WIRING

4.4.1 Users should refer to manufacturer's recommendations as well as the following:

a. All surface wiring shall be suitable for the operating conditions (amperage, voltage and area classification) and shall be installed using a wiring method that is acceptable to the AHJ. (See Figure 1.)
b. All conductive cable supports, junction boxes, and motor control panels shall be adequately grounded. (See Figure 1.)
c. All wiring methods shall provide an electrically-continuous, low-impedance-effective grounding path with the capacity to safely conduct any fault current likely to be imposed on it.

4.5 WELLHEADS

Installations should follow manufacturer's recommendations. The wellhead area should be physically protected in a suitable manner to comply with local codes and user requirements.

5 Installation and Pulling Equipment

5.1 WELL SERVICING RIGS

5.1.1 Well servicing rigs shall be of adequate capacity, in good operating condition and have sufficient mast height to effectively and efficiently service the installation.

5.1.2 Rig floors should be kept as clean as possible. Rig safety railings should be in place as applicable.

5.1.3 Well-service rig personnel should be made aware that electrical submersible pump equipment can be easily damaged. Personnel should be properly instructed in applicable handling procedures. Adequate supervision should be provided to ensure these procedures are followed.

5.1.4 It is very important that the work plan for the installation or pulling of equipment provide adequate time for personnel to perform each task.

5.1.5 The well-service rig placement should be as close as conditions permit over the center of the well. This placement should be checked periodically during the installation and the rig realigned as required.

5.1.6 Blow-Out-Preventer (BOP) equipment should have either pipe rams slotted for the electrical submersible pump cable or annular preventers to prevent damage while cable equipment is being installed. If annular preventers are used, the sealing element hydraulic pressure should be adjusted to prevent crushing the cable while maintaining control of the well.

5.2 TUBING SPIDERS

5.2.1 Slips shall be the correct size for the tubing being handled.

5.2.2 Only sharp and clean slips should be used.

5.2.3 The tubing spider doors should be of the slotted or "cutout" type to permit passage of the power cable.

5.2.4 Slips should be secured from spinning.

5.3 BACK-UP TONGS

5.3.1 Back-up tongs of the correct size should be used to prevent tubing rotation during make-up or break-out.

5.3.2 During running or pulling operations, the back-up tongs should be inspected regularly for buildup of material that would allow slippage and resulting damage to the cable.

5.4 CABLE SPOOLERS OR REELS

5.4.1 Power cable spoolers of adequate size should be used and should be maintained in good condition.

5.4.2 It is recognized that power cable spoolers may not always be available and that cable reels and conventional stands may be used instead. In this case, at least one person should be available to handle the reel.

5.4.3 Reels of cable should be placed 25 to 30 m (75 to 100 ft) from the wellhead and should be in the rig operator's direct line of sight.

5.4.4 Reels of cable shall be located so that the cable does not pass over the rig operator's head.

5.4.5 Reel supports and spoolers should be in a position so that the reel axle is at right angles to the wellhead. Spool operators shall stay clear of reel rims during running or pulling operations.

5.4.6 When the ambient temperature requires heating the cable for running, a suitable shelter with heaters should be utilized.

5.5 DOWNHOLE PUMP CABLE PROTECTION

It may be necessary, because of local ground conditions, to provide some protection for the cable where it contacts the ground when passing from the cable reel to the cable sheave. In such a case, protective material should be placed on the ground under the cable to prevent cable damage.

5.6 CABLE SHEAVE

5.6.1 A cable sheave shall be used when running or pulling downhole electrical submersible pump cable.

5.6.2 Sheaves should be a minimum of 1.4 m (54 in.) in diameter, and be of such construction to prevent cables from "jumping off" the sheave wheel during operation.

5.6.3 During equipment installation, cable sheaves should be supported above the ground when preparing to feed the cable through the sheave.

5.6.4 After the cable has passed through the sheave and has been securely banded to the tubing, the sheave should be raised to a "running position"; approximately 8 to 14 m (25 to 45 ft) above the slips. The sheave should then be secured such that the cable is as close as possible in line with the movement of the traveling blocks

5.6.5 The cable should not be used to reposition the sheave.

5.6.6 In securing a sheave to the service rig, the sheave should be hung by a primary hanging device. A secondary safety hanging device shall be provided—and connected to a separate support on the sheave and on the rig. The safety device shall not have any load on it during normal running or pulling operations.

5.6.7 When flat, downhole pump cable is being run, a flat rimmed sheave should be used.

5.6.8 The sheave axle, support frame, wheel rim and rim-to-frame clearance should be inspected prior to each use.

6 Running Equipment into the Well

CAUTION: Electrical submersible pump equipment should not be assembled at the well location under adverse or inclement weather conditions because of possible contamination of the equipment, unless adequate protection from the environment is provided.

6.1 EQUIPMENT CHECK

6.1.1 Before any installation work is begun, all equipment delivered to the lease should be checked for the following:

a. All required well equipment is on the well site.

b. The proper size and type of equipment was delivered as ordered.

c. c. All equipment serial numbers are recorded.

d. A tally and caliper record of all the subsurface equipment assembly is made.

6.2 CASING CHECK

6.2.1 A full gauge tool [in which the outer diameter (OD) of the tool is slightly larger than the OD of the equipment] should be run to a depth of 18 m (60 ft) below the motor setting depth, or as deep as well conditions permit, prior to the installation of equipment. This should occur prior to the installation (a) in a new well, (b) when larger diameter equipment is run, (c) if evidence of damage is found on the cable, or unit upon removal from a well, or (d) if the unit is to be run to a lower setting depth.

6.2.2 Although some burrs, tight spots, partially collapsed casing, or other problems may be present, gauging the casing as recommended in 6.2.1 will ensure adequate clearance for the installation. It is allowed alternatively, however, to run a full bore casing scraper to assure there are no burrs that might

damage the cable or to run a stiff string assembly to check for dog legs that may damage the equipment.

6.2.3 If gauging the casing indicates any tight spots, appropriate action should be taken to eliminate the problem prior to installing equipment. If tight spots cannot be eliminated, smaller diameter equipment should be used.

6.3 PREPARATION OF WELLHEAD FOR RUNNING EQUIPMENT

6.3.1 Prior to installing submersible electrical pump equipment:

a. The casing flange, the wellhead, or both should be inspected for burrs or extended square corners that could damage the pump or motor or cause cable bands to hang up.

b. All burrs should be removed and sharp corners tapered to eliminate potential installation problems.

c. If blowout preventer equipment is used, it should be checked for proper clearance and design as indicated in 5.1.6.

6.4 LIFTING EQUIPMENT INTO RUNNING POSITION

CAUTION: Prior to lifting any equipment, the lift unit (crane, A-frame, etc.), slings, chains, and lift bails shall be inspected to ensure they are satisfactory.

6.4.1 Prior to removing the motor from the shipping box, the motor head should be raised to allow installation of the motor clamp, using a sling of nylon or other suitable material of adequate length and capacity.

6.4.2 The bottom end of the equipment should be supported so it does not swing into the wellhead, BOP, or the rig floor.

6.4.3 The submersible pump equipment should be lifted with the rig elevators, using the proper size and type of clamp for each piece of equipment being lifted.

CAUTION: Ensure that the clamp is of proper size and properly installed prior to placing it in the elevator so no load is transmitted to the elevator latch.

6.4.4 Shipping caps should not be removed until the equipment is in a vertical position over the wellbore and ready to be coupled to another piece of the equipment assembly.

6.4.5 The following tests and checks should occur in compliance with the appropriate manufacturers' and users' specifications during assembly and prior to installing the equipment in the well.

a. Check for free rotation of all components.

b. Make appropriate electrical checks of the motor, including an insulation resistance test.

Note: Because all three conductors are connected through the motor windings, performing an insulation resistance test on one conductor effectively tests the insulation of all three conductors.

CAUTION: High voltage insulation resistance tests can damage interconnected instrumentation unless precautions are taken.

c. Perform appropriate electrical tests of the cable and motor assembly after the motor lead extension is attached to the motor.

d. Ensure that equipment is filled with the proper grade and quantity of oil.

e. Check that all fill, vent, and drain plugs are properly installed and tightened.

f. Perform appropriate pressure tests.

6.4.6 A lifting or handling sub should be used to lift the assembled unit.

6.4.7 Assembled or partially assembled equipment should not be allowed to stand in the derrick because of possible damage to equipment alignment. Equipment should be suspended by lifting clamps in the derrick or wellbore or should be laid down.

6.5 CABLE SPLICING

Several types of cable-splicing techniques are practical depending on wellbore conditions and cable material. The cable manufacturer should be consulted for suitable techniques. The motor lead extension cable should be spliced to the power cable before the cable is shipped to the location.

6.6 CABLE BANDING

6.6.1 Banding tools should be in good condition and adjusted correctly. Personnel using these tools should be trained and supervised to ensure proper banding.

6.6.2 On armored cable, bands should be tightened until the armor is slightly distorted, but not crushed.

6.6.3 Bands should not be installed on cable splices. Banding immediately above and below a splice is recommended to prevent any cable load from being transmitted to the splice.

6.6.4 The minimum banding recommendation is two bands per tubing joint, with one band in the middle of the joint and the other band 2 to 3 ft above the collar.

6.6.5 When running through a dogleg or other tight spot in the well, consideration should be given to installing more bands per joint.

6.6.6 Cable band saddles should be used on unarmored cable. Saddles may be used on armored cable, if desired.

6.6.7 On unarmored power cables using saddles, bands should be tight enough to prevent slippage of the cable or the saddle.

6.6.8 An acceptable alternative to banding is the use of cable clamps.

6.7 CHECK VALVES AND BLEEDER OR DRAIN VALVES

6.7.1 If a check valve is installed, it should be located six to eight joints above the pump to allow gas to be purged from the pump on start-up.

6.7.2 If a check valve is installed, a bleeder or drain valve also should be installed. It should be located one or two joints above the check valve.

6.8 RUNNING PRACTICES

6.8.1 The majority of cable damage occurs because of mishandling or improper installation practices. Attention to installation practices is imperative to ensure proper installations.

6.8.2 It is extremely important that running and pulling of tubing is slow and smooth. Rapid acceleration or deceleration can cause cable damage.

6.8.3 One member of the rig crew should be made responsible for ensuring that the cable stays aligned with the slot or "cutout" in the tubing spider doors (see 5.2.3).

6.8.4 It is not good practice to allow cables to drag on the ground (see 5.5). Slack should be maintained on the cable between the cable reel and the cable sheave. The cable should reel on or off the top of the reel.

6.8.5 Electrical continuity and insulation resistance checks of the cable and motor should be made periodically at:

a. A minimum of once every 2,000 ft.
b. Pump setting depth.
c. When terminations or splices are made.

6.8.6 Cables should be installed only within the cable manufacturer's recommended ambient temperature range.

6.9 PUMP SETTING DEPTH

6.9.1 Submersible pumps normally are set with the motor above the well perforations.

6.9.2 To obtain proper motor cooling when the motor is set below the perforations, some means should be provided (motor shroud, for example) to ensure adequate fluid flow past the motor.

6.10 WELLHEAD COMPLETION

6.10.1 The tubing should be landed and the wellhead made-up according to proper procedures for the specific type of wellhead being installed.

6.10.2 To ensure safe operations, piping and valves of adequate pressure ratings should be installed to connect the wellhead to the flowline. Consideration should be given to pump discharge pressure, wellbore pressure, maximum shut-in pressure, and other applicable parameters.

7 Start-Up Procedure

7.1 PRE-START-UP PROCEDURE

Note: All electrical safety procedures (e.g., lock-out tag-out procedures) should be followed when working on electrical equipment.

7.1.1 Ensure that all junction boxes, motor control panels, and transformers are properly grounded.

7.1.2 Measure the voltage and check the phase rotation at the incoming side of the control panel. If necessary, de-energize the transformer and change the tap settings to obtain the correct supply voltage.

7.1.3 After the correct supply voltage is obtained, make any required adjustments to the motor control panel to obtain the correct control-circuit voltage. Check current transformers for correct ratios. Adjust overcurrent (overload) and undercurrent (underload) protection settings if, necessary, and ensure that all other control panel relays and controls are in proper adjustment and position.

7.1.4 Energize the control panel with the downhole equipment disconnected, and ensure that all systems are functioning properly. Then de-energize the control panel.

7.1.5 Perform insulation resistance tests of phase-to-ground resistance of the cable and motor. Make phase-to-phase continuity readings to check the resistive balance of the electrical system.

7.1.6 The use of phase rotation equipment is recommended to attain proper directional rotation at start-up prior to connecting the cable leads to the junction box.

7.1.7 Ensure that the flowline hook-up is completed and that all valves are properly installed and in their proper operating position.

7.2 EQUIPMENT START-UP

7.2.1 Ensure that all pre-start-up procedures are completed (See. 7.1).

7.2.2 Follow appropriate safety standards for starting electrical equipment. For example, some procedures may recommend standing to the side of the panel when operating the start button.

7.2.3 The following operational checks and measurements should be performed and recorded to ensure that the equipment is operating properly:

a. The running voltage and amperage on each leg.
b. The pump-up time.
c. The flow rate (should be compared to the pump operation design).
d. Leaks in the valves and production tubing.

7.2.4 After the well stabilizes, reset overloads, underloads and restart timers for running conditions specified by the user or manufacturer.

7.2.5 The equipment should be closely monitored for several days. Periodic tests and equipment analyses are recommended. Reference API RP 11S.

8 Pulling Equipment Out of Wells

8.1 HISTORICAL DATA

Note: Reference API RP 11S.

8.1.1 Listed below are factors and observations to be considered when making decisions as to whether or not used equipment may be reinstalled or repaired:

a. Physical condition and run time of each component of the electrical submersible pump equipment.
b. Complete cable history.
c. Operating environment.
d. Equipment operating history (including ammeter chart analyses).
e. Equipment sizing relative to present requirements.

CAUTION: Ensure that the well is under control and that all flowline and wellhead valves are in the proper position.

8.2 PULLING EQUIPMENT

8.2.1 Pulling practices involve basically the same procedures required when installing equipment. (See 6.8.) Although the equipment being pulled may be used, it requires the same careful handling as new equipment.

8.2.2 Consistent with local well control requirements, the bleeder or tubing drain valve should be opened either before the tubing is pulled or after the fluid level in the tubing has been reached. The time and method of shearing the valve depend on the specific installation and the type drain valve being used.

8.3 BAND REMOVAL

8.3.1 As equipment is being pulled, a record of the number of missing bands should be maintained. A decision should be made as to whether the number of missing bands is detrimental and whether they should be retrieved or pushed to the bottom.

8.3.2 Bands should be cut off with a proper cutting tool but never broken off by prying. Excessive force used to break the bands can damage the cable. Eye protection should be worn when bands are being removed.

8.3.3 The condition of the bands being removed should be noted. If corrosion is evident, a change in band metallurgy may be appropriate.

8.4 SPOOLING CABLE

8.4.1 Cable should not be coiled on the ground. This could result in cable damage during handling.

8.4.2 When respooling cable onto a reel, a hard rubber hammer should be used to assist in keeping the cable in line. Metal instruments should not be used.

8.4.3 It is a good practice to "flag" damaged spots on the cable while coming out of the well. This will assist in the repair of the cable should it be decided that such action is practical.

8.5 SHIPPING EQUIPMENT

8.5.1 Equipment to be shipped should be placed in appropriate equipment shipping crates.

8.5.2 Ensure that a proper number of supports are included in the shipping crate and that they are positioned correctly to support the equipment. (See 3.2.2.)

8.5.3 Ensure that proper shipping caps are installed in accordance with the appropriate manufacturer's specifications.

8.5.4 Water should be drained from the pump. Undrained water can cause serious equipment damage under freezing conditions. When draining pumps, check for sand, gravel, and the like. Note the occurrence of such on the pulling report. Samples of solids should be collected for analysis, if desired.

8.5.5 Equipment should be returned for inspection and testing as soon as possible so the cause of equipment failure can be determined and any necessary design or operating changes can be made.

9 Field Evaluation of Used Equipment

9.1 ON-SITE OBSERVATIONS AND INSPECTIONS

It is good practice to document the results of on-site observations and inspections. Factors that can determine the suitability of the reuse of equipment on location include the following:

9.1.1 Downhole Pump Cables

9.1.1.1 Used downhole pump cables should be spooled and inspected for physical damage and corrosion. It should be checked for the following:

a. Damaged, deteriorated armor.
b. Swollen insulation.
c. Exposed conductors.

d. Deteriorated or an excessive number of splices.
e. Corrosion.

9.1.1.2 Field electrical integrity tests should be performed in accordance with API RP 11S6.

9.1.2 Pumps

9.1.2.1 The condition of the pump intake should be noted. It should be checked for solids buildup, sand, and wear. Samples of solids should be collected for possible analysis.

9.1.2.2 Check for smooth shaft rotation.

9.1.2.3 The pump should be examined for corrosion.

9.1.3 Motors

9.1.3.1 Motor electrical checks should be performed.

9.1.3.2 Check for smooth shaft rotation.

9.1.3.3 The motor oil condition should be checked for the following:

a. The presence of water in the motor.
b. The presence of metal cuttings in the oil.
c. Unusual color.
d. Unusual odor.

9.1.3.4 The motor should be checked for corrosion at the following sites:

a. At the O-ring seat in the motor head.
b. On the body and other seal areas.

9.1.4 Seal Chambers

9.1.4.1 Seal chambers normally are not recommended for reuse.

9.1.4.2 If reuse is intended, the seal chamber must always be handled in a vertical position and the following checks should be performed:

a. Check for smooth shaft rotation and evidence of endplay.
b. Pull the vent plugs and check for the presence of water and metal debris.
c. Examine for excessive corrosion.

9.1.5 Motor Lead Extensions

9.1.5.1 Motor lead extensions normally are not recommended for reuse unless adequately checked and found to be acceptable for reuse.

9.1.5.2 If the reuse of motor lead extensions is intended, any mechanical damage should be noted and the motor lead extension should be sent to a shop to be tested in accordance with API RP 11S6.

9.1.6 Electrical feed through assemblies.

9.1.6.1 Clean and inspect electrical connections and mechanical interfaces.

9.1.6.2 Check for evidence of electrical arcing.

9.1.6.3 Perform high voltage insulation resistance tests on the conductors of all components of the assembly. The minimum acceptable resistance between conductors and conductors to ground should be in accordance with the manufacturer's recommendations.

10 Assessment of Used Equipment

Once equipment is sent in for inspection or repair, or both, the following procedures are considered to be minimum prior to reuse.

Note: Reference API RP 11S1, which contains forms to document the tear-down results.

10.1 DOWNHOLE PUMP CABLES

10.1.1 All cables should be electrically tested both before and after repairs are made. To maintain armor integrity, any corrosion, scrapes, and other physical damage must be repaired prior to reuse.

Note: Insulation resistance testing (obtaining megohm readings) alone does not provide sufficient information to evaluate the condition of a downhole pump cable. Reference API RP 11S6.

10.1.2 It is a good practice to allow the cable to de-gas (i.e., "breathe") for several days prior to testing unless it can be verified that the cable is not gas-charged.

10.2 PUMPS

10.2.1 Ensure smooth rotation.

10.2.2 Check shaft play and extension.

10.2.3 Perform water or acid flush, as applicable. If plugging is suspected, it is recommended that the pump be torn down prior to flushing.

10.2.4 Perform pump performance tests per API RP 11S2.

10.2.5 For (optional) vibration tests, refer to API RP 11S8.

10.3 MOTORS

10.3.1 Perform applicable electrical tests on the motor.

10.3.2 Check the motor oil condition using a dielectric test in accordance with ASTM D-887.

10.4 SEAL CHAMBERS

10.4.1 Refer to API RP11S7.

10.5 MOTOR LEAD EXTENSIONS/POTHEADS

10.5.1 Perform the mechanical and electrical tests in accordance with API RP 11S6.

10.5.2 Never attempt to repair damaged portions of motor lead extensions and never reuse O-rings.

10.6 ELECTRICAL FEED THROUGH ASSEMBLIES

10.6.1 Follow the manufacturer's recommended testing procedures.

Note: Insulation resistance tests (usually denoted by megohm readings) alone do not provide sufficient information to evaluate the condition of feed through assemblies.

10.6.2 Perform appropriate electrical and mechanical tests in accordance with API RP 11S6.

10.7 REUSING EQUIPMENT

After equipment has been properly evaluated and found suitable for reuse, API recommended practices and the manufacturers installation procedures should be followed for installation.

10.7.1 It is recommended that a data base of historical performance and inspection results of ESP components be maintained. API RP 11S2 provides a format for recording data.

10.7.2 Previous operating performance can be reviewed to determine if design improvements can be made to increase the operating time between failures.

10.7.3 In some cases, equipment that may be marginal for reuse in its original environment may be suitable for operation in a less harsh environment. For example, cable used previously in a deviated well, or other harsh conditions, could be used in a well with less severe conditions.x

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