

Recommended Practice for the Operation, Maintenance and Troubleshooting of Electric Submersible Pump Installations

API RECOMMENDED PRACTICE 11S
THIRD EDITION, NOVEMBER 1994

REAFFIRMED, OCTOBER 2013



AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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FOREWORD

This recommended practice (RP) is under the jurisdiction of the American Petroleum Institute (API) Committee on Standardization of Production Equipment.

This document presents recommended practices for the operation, maintenance, and troubleshooting of electric submersible pumps and auxiliary equipment. This recommended practice is provided to meet the need for guidelines, procedures, and recommendations covering electric submersible pumping equipment. These recommended practices are those generally considered necessary for successful submersible pump operation.

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

Recommended Practice for the Operation, Maintenance and Troubleshooting of Electric Submersible Pump Installations

1 Scope

This recommended practice covers all of the major components that comprise a standard electric submersible pumping system, their operation, maintenance, and troubleshooting.

It is specifically prepared for installations in oil and water producing wells where the equipment is installed on tubing.

It is not prepared for equipment selection or application.

2 Operation

2.1 CHECKS BEFORE START-UP

2.1.1 Make certain that the flowline hookup is completed, that all valves are of proper pressure ratings and are properly installed, including an adjustable tubing choke. All valves should be in their proper operating position (open or closed, as appropriate).

WARNING: A master or wing valve on the tubing could be exposed to the maximum discharge pressure of the pump when the fluid in the annulus is at the surface. Therefore, these valves must be able to withstand this pressure.

2.1.2 Check no-load voltage, potential, and current transformers for proper ratios, and adjust the underload and overload relays to proper setting for start-up according to the manufacturer's or user's specifications. Check to see that all the power fuses are sized properly for the downhole equipment.

2.1.3 Assure that other system relays and controls are in proper adjustment or position, and electrical connections are clean and tight. The system must be properly grounded and the junction box properly installed, including a cable vapor seal between the junction box and motor control panel.

2.1.4 Make certain that the proper scale ammeter chart paper is on the recorder, that the pen is operating properly and that the setting for the day and time are correct.

2.1.5 The control panel should contain a label or "Pull/Run Report" that gives "nameplate" information pertinent to the present equipment in the well. See Figure 1 for an example form that gives the data required.

2.1.6 Electrical checks, phase-to-ground, and phase-to-phase, should be made prior to start-up and readings recorded. Phase-to-phase readings must be balanced.

2.1.7 If scale or corrosion is a well problem, the preventative measures must be initiated before pump start-up. For further discussion of this matter, see 4.3.

2.2.1 If the well has been killed with heavy mud it should be displaced with a light fluid before pump start-up.

2.2.2 For larger horsepower units (above 250 HP) regardless of setting depth and low capacity units (less than 600 barrels/day) set deep (with static fluid level below 7,000 feet), it is recommended that the tubing be filled before start-up. This means these installations must be equipped with tubing check valves and drain valves. The tubing should be filled with light, clean fluid.

2.2.3 With all checks completed, start the equipment. For control of the pump discharge rate, the pump can be started against a restricted choke setting, but, should not be started against a closed choke or valve. For immediate control of the pump discharge rate, a tubing check valve and drain valve could be installed and the tubing filled prior to start-up.

2.2.4 Immediately after start-up, check the line current with a "clamp-on" ammeter and record. Using this information, calibrate the recording ammeter.

2.2.5 Check the load voltage and record. Exercise extreme caution when doing this.

2.2.6 Rotation should be verified as soon after start-up as possible by using either "pump up" time, wellhead tubing discharge pressure and flow, production test, or other appropriate method as recommended by the pump company or operating company procedures. If sand or debris is present in the well, it is recommended that the pump not be shut down for rotational check until solids have been displaced from the tubing.

2.2.7 If actual "pump up" time is exceeding calculated "pump up" time, it should be assumed that the pump is in reverse rotation and appropriate action taken.

MOTOR DATA:		INSTALLED: _____	
_____ H.P.	_____ VOLTAGE	_____ N.P.	_____ AMPS
PUMP DATA:		INSTALLED: _____	
_____ TYPE	_____ STAGES	_____ TYPE	_____ INTAKE
PUMP DESIGN CAPACITY _____		B/D	
CABLE DATA:			
_____ TYPE	_____ LENGTH	_____ SIZE	
TRANSFORMER DATA:			
_____ TAP SETTINGS	SECONDARY VOLTAGE RANGE _____		
VOLTAGE DATA:			
_____ VOLTAGE NO LOAD		_____ LOAD VOLTAGE	
COMMENTS: _____			

2.2 SYSTEM START-UP

Figure 1—Well Equipment Documents

2.3 ADJUSTMENTS AFTER WELL STABILIZATION

2.3.1 After motor current stabilizes, the overload, underload and the restart timer should be reset for proper “normal running” condition as specified by manufacturer’s or user’s specifications.

2.3.2 Overload setting is normally set at 120 percent of motor nameplate amperage.

2.3.3 Underload setting is generally set at 80 percent of normal motor operating amperage. Gassy wells may require even a lower underload setting, but caution should be exercised to insure underload protection for pump off or gas lock conditions.

2.3.4 The restart timer is normally set at 10 minutes per 1000 feet of operating fluid level depth, however, not less than 30 minutes.

Note: Never restart pump by hand before recommended time lapse.

2.3.5 If an adjustable underload time delay control relay is provided in the motor control panel, it is normally set at 20 seconds. Local well operating conditions may require a different setting.

2.4 OPERATING DATA GATHERING

2.4.1 Accurate operating data:

- a. Is required to monitor the system under normal operating conditions.
- b. Will provide information that will be useful in troubleshooting the well under abnormal operating conditions.
- c. Will be useful in accurate resizing of the equipment, if required.
- d. Should be filed individually by well, and should always include:
 1. Start-up ammeter chart
 2. Well test data sheets with corresponding ammeter chart attached
 3. Current regular ammeter chart
 4. Any other pertinent system and well operating data.

2.4.2 Frequency of data gathering:

- a. When well is initially put on production, data should be collected daily for first week, weekly for first month, and at least monthly thereafter.

2.4.3 Production well test data that should be taken and entered on a Production Test Data Sheet similar to Figure 2 includes:

- a. Date, time and duration of test
- b. Oil, water and gas (both tubing and casing gas)
- c. Tubing pressure and choke size
- d. Fluid level, flowline pressure, casing pressure, and choke size.

- e. Operating bottomhole pressure (BHP)
- f. Ammeter chart (24-hour) properly marked with date and time of test
- g. Other data as shown on Production Test Data Sheet (Figure 2).

2.5 ANALYZING OPERATING DATA

2.5.1 Analysis of operating data must consider both permanent well installation data (i.e., tubing size and length, casing size, perforation depth, fluid characteristics, etc.) as well as production test data.

2.5.2 Once the pump is in the well and operating, it should be analyzed to determine if it is functioning properly. (The importance of collecting operating data was covered in Section 2.4.) This data should be analyzed as follows:

- a. Date, Time and Duration of Test
 1. Recording the date, time, and duration of the testing period, along with any other events occurring in the field, allows correlation of the events with the test ammeter chart. Examples of field events that may be important to data analysis are: nearby injection or producing wells down, large electrical equipment coming on-line, etc.
- b. Oil, Water and Gas (both tubing and casing gas)
 1. The fluid volumes being produced through the tubing should be used to determine if the pumping is properly sized and operating at maximum efficiency.
 2. The water-oil ratio should also be analyzed to determine if any changes are occurring.
- c. Tubing Pressure and Choke Size
 1. This data is used to check pump sizing and efficiency.
- d. Fluid Level, Casing Pressure and Choke Size
 1. This data should be used to determine pump efficiency and well inflow performance (IPR or PI).
- e. Operating Bottomhole Pressure
 1. Used to verify PI of well and in conjunction with the fluid level it can be used to determine average annulus fluid density.
- f. Ammeter Chart (24-hour, properly marked)
 1. The ammeter chart is an extremely important data source for monitoring well operation and for troubleshooting. The ammeter chart should be observed daily to insure proper operation.
 2. Use a 24-hour chart during production testing or during periods of troubleshooting and use 7-day charts during normal weekly operation.
- g. Other Data as Shown on Production Test Data Sheet (Figure 2).

3 Troubleshooting

3.1 Historical Operating Information for the Producing Area



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