

Recommended Practice for Installation, Maintenance, and Lubrication of Pumping Units

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Recommended Practice for Installation, Maintenance, and Lubrication of Pumping Units

1 Scope

This recommended practice provides guidance related to the proper installation, care, and maintenance of surface mounted beam pumping units, varieties of which are described in API 11E. Information provided in this document is of a general nature and is not intended to replace specific instruction provided by the pumping unit manufacturer. This document further establishes certain minimum requirements intended to promote the safe installation, operation, and servicing of pumping unit equipment.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Specification 11E-2013, *Specification for Pumping Units*

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1

base

The basic frame or skid to which a pumping unit is assembled. Typically is the structural element that interfaces with or is clamped to the foundation.

3.2

brake

Component of a pumping unit that is often composed of a disk or drum mounted on the reducer input shaft combined with a mechanism to impart a restraining friction torque and restrain the motion of all rotary joints.

3.3

carrier bar

Part of the pumping unit that supports the load of the sucker rod string through the polished rod clamp.

3.4

center bearing

Structural bearing assembly supporting the walking beam of a class 1 lever design pumping unit.

3.5

certified installation print

Drawing reviewed and approved (stamped) by a licensed professional engineer competent in the areas of site preparation, foundations, and proper mounting requirements of heavy industrial equipment.

3.6

cranks

Driving link in the four-bar linkage of a beam pumping unit that is located between the output shaft of the gear reducer and the pitman link.

3.7**cross-beam clamp**

Device used to constrain the pumping unit to its supporting foundation. Often a beam-like member placed on top and spanning the base rails with anchor bolts joining it to the foundation anchorage.

3.8**equalizer**

Connects the pitman links to the rear of the walking beam.

3.9**foundation**

Structural element designed to support the pumping unit base and transmit loads into the earth via distributed contact with soil or piles.

3.10**horsehead**

Component of a beam pumping unit designed to transmit force and motion from the walking beam to the flexible wireline.

3.11**pitman**

Connecting link in the pumping unit mechanism between the cranks and the equalizer.

3.12**prime mover**

Primary driving mechanism imparting rotary motion on the pumping unit system. Typically connected to the speed reducer via a belt drive. Common variants are electric motors and internal combustion engines.

3.13**pumping unit**

Machine for translating rotary motion from a crankshaft to linear reciprocating motion for the purpose of transferring mechanical power to a downhole pump.

3.14**rod clamp**

Clamping device that is affixed to the polished rod of the well for the purpose of either transmitting axial loads to other components such as the carrier bar or constraining motion.

3.15**samson post**

Support member of the walking beam that has a bearing mounted to a fixed location atop which is attached to and provides the fulcrum location for the walking beam.

3.16**sheave**

Rotating component of a V-belt drive designed to transmit power from the belts to the rotating shaft on which it is affixed or vice versa.

3.17**skidding**

Horizontal movement as a result of dynamic forces from rotating cranks, counterweights, and other bodies.

3.18**tie-down clamp**

Clamping device used to affix the pumping unit base to the foundation.

3.19**V-belt**

Common method of transferring power from one rotary element to another. Typically connects the output sheave of the prime mover to the input sheave of the speed reducer.

3.203.20**wireline**

Flexible element connecting the well's polished rod to the horsehead of the pumping unit.

4 Foundation and Site Preparation**4.1 General**

The following discusses the typical role and requirements associated with the pumping unit foundation. It describes a general process of preparing a location to support a pumping unit installation.

Pumping units, by their nature, transmit very large forces to the supporting earth. Foundations provide a means of distributing these forces over a broad area allowing the soil and underlayment to generate sufficient strength and stiffness to withstand them while yielding only very small deflections. The stability and rigidity provided by the foundation and the site preparations necessary to constrain movement are essential in maintaining proper alignment and providing the pumping unit with long operational life. Many times, structural failures involving pumping units can be traced back to an insufficient foundation or poor site preparation practices.

The means by which pumping unit foundations transmit their loads into the earth take several forms ranging from simple surface contact with the underlying soil to driven or helical piles sunk deeply into the earth. In each case, the foundation must possess sufficient strength and stiffness to allow localized forces applied by the pumping unit to be adequately distributed over an area of soil contact or to a series of piers (piles) so that the local load bearing capacities of these elements are not exceeded. It is also often necessary for the foundation to possess sufficient mass to constrain dynamic up-lifting forces produced by some pumping unit models and prevent degradation of the soil contact interface under the foundation. The mass of the foundation also helps to stabilize the unit against skidding.

One area of particular importance is rigidity under load. The top surface of the foundation should remain as flat (planar) as possible under all operational loading conditions. The pumping unit base structure is typically clamped to the top surface of the foundation and excessive deflection can result in damage to the structural components or the pumping unit mechanism. The allowable deflection under load varies somewhat by pumping unit model but in general, the vertical deflections measured at the top surface of the foundation should not exceed 0.035 in. (0.9 mm) throughout the operating cycle. This measurement can be easily made using a dial indicator anchored on the ground while measuring at a point on the foundation surface.

4.2 Foundations Mounted on Grade**4.2.1 General**

Foundations of this type typically derive their support through a distributed area of contact with the earth. This includes poured in place reinforced concrete slabs, precast concrete slabs, board mats, and certain other integrated portable pumping unit base structures that are specifically designed for similar distributed load bearing capability. These foundations often do not require any other form of anchorage to fix their location relative to the earth. They are, however, highly reliant on proper site preparation to provide the necessary stability and strength to resist pumping unit forces over time.

4.2.2 Site Preparation Recommendations for Foundations Mounted on Grade

4.2.2.1 General

The following requirements are performed for the initial site preparation.

- Contact a local geotechnical engineer to conduct an evaluation of the soil and installation site and provide a plan for preparations.
- Remove loose materials (scoria, etc.) surface vegetation, roots, and other organic materials from the soil that will underlie the pumping unit foundation.
- Excavate, back-fill, compact, and amend the soil with materials in accordance with the geotechnical engineering plan.

4.2.2.2 Site Drainage

The foundation site should be elevated slightly relative to the surrounding area such that water will tend to drain away from the foundation. Do not allow water to pool adjacent to or drain across the site.

4.2.2.3 Soil Load Bearing Capacity

The soil bearing strength should normally exceed 1500 lb/ft² (7323 kg/m²). Select foundation design with sufficient soil contact area to distribute pumping unit loads appropriately. If necessary, amend the soil with materials designed to increase the bearing capacity beneath the foundation as recommended by the geotechnical engineer. Soil pressure should not exceed that of the bearing strength in any location.

4.2.2.4 Soil Stiffness

The required soil stiffness depends on the magnitude of the applied loads from the pumping unit, the ground contact area of the foundation, and the allowable vertical deflection of the foundation under load (see above). Pumping unit base loading information is typically available from the pumping unit manufacturer to use in selecting an appropriate foundation design.

4.2.2.5 Cold Climates

In cold climates, the soil often freezes to substantial depth in winter resulting in a condition known as frost heaving. Water entrained within the soil expands in volume and in more severe cases can affect pumping unit alignment. Subsequent thawing often results in extremely wet conditions near the surface that may affect the load bearing capacity of some soils. The geotechnical engineer may suggest lining the excavated pit with a geotextile barrier fabric to prevent migration of select fill and soil amendments away from the load bearing area. In severe frost heaving conditions, there may be advantages to mounting the foundation on piles.

4.3 Foundations Mounted on Piles

Foundations of this type derive their support from discreet piles (piers) that have been sunk into the earth to sufficient depth to achieve the required load bearing capacity. The piles are typically spaced at intervals beneath the foundation so as to concentrate their numbers in areas where the highest applied loads are predicted to occur. This form of foundation support has become popular in cold climate locations with substantial frost heaving or in locations where normal surface preparations may be impractical (marshes, etc). Pile supported foundations are often elevated above grade such that they rest completely on the piles and make no direct contact with the soil. This is common in cold climates where frost heaving might otherwise lift the foundation off the piles. Foundations used in this type of mounting are typically precast concrete pads, with embedded steel pads or plates to fix them to the top of the piles or steel fabricated mats. The design of the foundation must be sufficient to distribute the local pumping unit loads over a

series of piles with the cumulative capacity to withstand them. The foundation stiffness should be sufficient to perform this function while limiting deflections to within the allowable limits for the pumping unit structure. Lateral support for the foundation is typically provided via diagonal bracing of the exposed piles or by supplemental attachment of the foundation to piles driven at an angle relative to vertical.

5 Installation of Pumping Units Using Foundation Bolts and Grouting Between the Block and the Pumping Unit Base

The following describes a basic process to properly mount the pumping unit on a concrete foundation in which final unit leveling is accomplished with wedges and then grouting under the base flanges. The base is then fastened to the foundation via embedded foundation bolts (anchors).

- Pour concrete foundation block to the certified (approved/stamped) drawing provided by the pumping unit manufacturer or operator. Locate foundation bolts accurately, using grouting tubes. Finish top of foundation, level and flat.
- After the foundation has hardened, strike a centerline from the center of the well tubing across to the top of the foundation using a chalk line as located by the certified installation drawing.

The pumping unit manufacturer shall provide the base with punched or scribed centerline marking on cross members at the front and rear of the base. On units with bolted-on extension bases, the centerline marking will be on the main base.

- Where practical, the pumping unit manufacturer should provide lifting points on major components to aid in installation or reconfiguration of the unit. The intended use and safe working load capacity of lift points should be described in the operator instructions or physically marked on the pumping unit structure.
- Set the base on the foundation, using wedges to support the base about 1 in. above the foundation. Line up center marks on the base with the chalk line on the foundation.
- Move the base to or from the well according to value shown on the foundation print for dimension from the base member to the centerline of well. Also, align the pumping unit base laterally with the centerline of the wellhead.
- Use wedges to level top of the base. Check level both lengthwise and crosswise of base at several points along its length.
- The manufacturer should provide a means for attaching plumb line on a longitudinal centerline of samson post top.
- After mounting the samson post on the base, drop a plumb line from the center of the samson post top to a centerline drawn on top of the foundation. If the plumb bob does not fall on centerline, readjust wedges or make other corrections.

The pumping unit manufacturer shall provide a longitudinal adjustment of the walking beam on the center bearing, or of the center bearing on the samson post, as a means of accurately adjusting the beam's alignment with respect to centerline of the well.

- After mounting the walking beam on samson post and connecting the pitmans to the cranks, drop a plumb line at the center of the horsehead (out from the arc plate of the horsehead a distance equal to one half of the diameter of the wire line) down to the center of the well tubing. Adjust the walking beam longitudinally or laterally so that the plumb bob will be within $\frac{1}{16}$ in. of the center of the well tubing. Check for proper tracking of wire line on horsehead.
- Apply grout material under the base completely filling the void between the concrete and the lower base flange and allow to harden before removing wedges. The cured grout material should be of sufficient compressive strength to support the combined pumping unit weight and well load.