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**Standard**

## **PCP Failure Nomenclature**

**Version 3.0**

**PCP Run-Life Improvement JIP**

**Prepared by**

**C-FER Technologies**

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## FORWARD

The objective of this Standard on Progressing Cavity Pump (PCP) Failure Nomenclature is to provide a common terminology for classifying, recording and storing failure information regarding wells pumped with PCPs, and therefore, consistency in failure analysis performed with data gathered by different operating and service companies.

An effort was made to conform, as much as possible, to: (1) the International Standard ISO 14224: *Petroleum and Natural Gas Industries – Collection and Exchange of Reliability and Maintenance Data for Equipment* (1996 and 1999); (2) ISO 15136: *Downhole Equipment for Petroleum and Natural Gas Industries – Progressing Cavity Pump Systems for Artificial Lift* (2001 and 2003); and (3) *ESP Failure Nomenclature Standard, Version 4.2*, C-FER Technologies ESP-RIFTS JIP (2007). In general, broad definitions and failure attribute classifications were borrowed from ISO 14224 and the ESP Failure Nomenclature Standard, while the nomenclature for components and parts was developed in line with ISO 15136.

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## 1. SCOPE

Each production system failure can be characterized by a number of attributes, with each attribute describing one piece of information. The various categories of attributes that together constitute a unique failure record generally include:

- The well identifier;
- Installation, start, failure and pull dates;
- Well geometry and completion information;
- Production and operational data in the period prior to failure (oil, water, and gas flow rates; wellhead and bottomhole temperature and pressure; RPM; etc.);
- Information on the equipment in the well or at surface, including but not limited to the pump (manufacturer, model, serial number, etc.), the rods (size, grade, etc.) and the tubing (size, grade, weight, etc.); and
- Any other relevant information regarding the failure.

This PCP Failure Nomenclature Standard provides a terminology for classifying, recording and storing information specific to PCP and tubing system failures, for use within the PCP Reliability Information and Failure Tracking System (PCP-RIFTS).

While only failure information is covered by this Standard, the importance of tracking all the information listed above cannot be overstressed.

A PCP failure tracking system should include records not only on failed systems but also on systems currently operating. This is considered good practice and allows for “censored” data<sup>1</sup> analysis. A tracking system should also include records of PCP equipment stopped for reasons other than a PCP system failure, such as a tubing leak, change of artificial lift method, etc.

This Standard covers PCP and tubing system equipment related to both surface drive and downhole drive applications. Other downhole, surface power supply and surface drive equipment are excluded. This is summarized in Figure 1. It is recommended that information on relevant surface and other downhole equipment also be part of any PCP failure tracking system.

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<sup>1</sup> “Censored” data includes systems that did not fail. This includes systems pulled for reasons other than a PCP System or Tubing System failure, as well as systems that are still running. This data contains valuable runtime data that must be included in any analysis.

## Scope

For the purposes of this Standard, the PCP System and the Tubing System are considered to be separate systems within the overall Production System, but are collectively referred to as the Artificial Lift System, as shown in Figure 1. Boundary diagrams of the PCP System for surface drive and downhole drive applications are shown in Figures 2 and 3, respectively. The boundary of the Tubing System is shown in Figure 4.

## 2. DEFINITIONS

For the purpose of this Standard, the following definitions of ISO 14224, with slight modifications apply:

<b>Failure:</b>	The termination of the ability of an item or system to perform a required function.
<b>Failure Descriptor:</b>	The apparent, observed Mechanism of Failure (of a Failed Item).
<b>Failure Cause:</b>	The circumstances during design, manufacture, or use which have led directly to a Failure.
<b>Item:</b>	Any part, component, device, subsystem, functional unit, equipment or system that can be individually considered.
<b>Required Function:</b>	A function or a combination of functions of an item, which is considered necessary to provide a given service.

The following additional definitions also apply:

<b>Artificial Lift System:</b>	The combined PCP System and Tubing System.
<b>Contributing Cause:</b>	The circumstances during design, manufacture, or use which have contributed to a Failure, but which would not have led to the failure independently.
<b>Failed Item:</b>	Any Item that has failed.
<b>Mechanism (of Failure):</b>	The physical or chemical process that led directly to the item failure.
<b>PCP System:</b>	The assembly of components necessary to transmit energy provided in the form of torque and speed at the polish rod (or voltage and current at the ES-PCP cable) to a downhole PCP (or ES-PCP) which then converts this energy to supply pressure and flow rate to the produced fluids. (Specifically, this includes those components that lie within the system boundary shown in either Figure 2 or 3).
<b>Production Period:</b>	The time between when an Artificial Lift System is installed in a well and when it is pulled from the well.
<b>Primary Failed Item:</b>	The Failed Item responsible for initiating the Failure of the PCP System or Tubing System.
<b>Reason for Pull:</b>	The motive for the Artificial Lift System pull.
<b>Reliability:</b>	The probability of an item to perform its required functions, under given conditions, for a given time interval.
<b>Tubing System:</b>	The assembly of components necessary to deliver a flow rate through a sealed conduit from the discharge of a downhole pump to surface. (Specifically, this includes those components that lie within the system boundary shown in Figure 4).

## Definitions

More detailed comments on the above definitions are included in Sections 3 to 6 of this Standard.

### 3. FAILURE DATA STRUCTURE

In PCP-RIFTS, information specific to failures shall be classified according to the following attributes:

- Reason for Pull
- PCP System Failed? / Tubing System Failed?
- Primary Failed System
- Primary Failed Item
- Failure Descriptors
  - Components' Pull Descriptors
- Components' Pull Condition
- Failure Cause
  - Contributing Causes

#### 3.1 Reason for Pull

As per the definition in Section 2, the Reason for Pull is the motive for the Artificial Lift System pull. A Reason for Pull shall be defined once the operator has determined that the PCP System and/or Tubing System must be removed from the well because of a suspected PCP or Tubing System failure or because of other circumstances.

In the case of a suspected failure of the Artificial Lift System, the Artificial System is generally pulled from the well to be inspected and if required, repaired or replaced. In this case, the Reason for Pull is the primary symptom pointing towards a downhole equipment failure. It is usually related to an abnormal operating condition as detected by the operator or installation monitoring system, or by inadequate performance on a well test.

The Artificial Lift System can be pulled when no failure is suspected in the system. In this case the Reason for Pull should describe why the system is being pulled. This can include failures or suspected failures of other components or systems (i.e. downhole components or systems which do not fall within the boundaries of the PCP System or Tubing System).

Table 1 contains possible Reasons for Pull of the Artificial Lift System.

## Failure Data Structure

Reason For Pull: General	Reason For Pull: Specific	Description
Abnormal Operating Condition	No Flow to Surface Low Flow to Surface High Torque/High Current Low Torque/Low Current Short Circuit or Low Impedance in Downhole ES-PCP Component Other Abnormal Operating Condition Detected	Symptom/evidence of possible failure, as detected by abnormal operating conditions.
Maintenance/Repair of non-Artificial Lift System Component	Casing Repair Sand Control Repair Well Clean-Out Other Downhole Equipment Repair	Suspected failures or maintenance requirements of downhole components outside the Artificial Lift System.
Well Optimization or Recompletion	Change Artificial Lift System Method/Resize Artificial Lift System Convert Well Change/Modify Producing Zone Stimulate Well Other	System pulled to optimize the Artificial Lift System or recomplete the well.
Suspension of Production	Permanent Abandonment Temporary Abandonment Shut-In	System pulled to suspend the well.
Other	Economics Log Well Well Test Other	
Unknown	Unknown	

**Table 1 Possible Reasons for Pull**

### 3.2 System Failed?

The attribute “PCP System Failed?” indicates whether or not the PCP System failed. Likewise, the attribute “Tubing System Failed?” indicates whether or not the Tubing System failed. Valid values for these attributes are “Yes”, “No” and “Unknown”. It is possible for either, both, or neither of the PCP or Tubing Systems to have failed.

As defined in Section 2, a Failure occurs when an item has lost its ability to perform any of its Required Functions. Implicit in this definition is the recognition that the Required Functions have been clearly established, which involves identifying the desired level of performance for each function. The desired level of performance defines the boundary between satisfactory and unsatisfactory operating conditions and will generally be different among different applications, and even within the same application as conditions change with time.

## Failure Data Structure

It is important that all of the Required Functions (and desired levels of performance) be clearly defined and understood in advance to allow operational personnel to identify Failures consistently.

In some cases, the value of “PCP System Failed?” and/or “Tubing System Failed?” may be determined before the systems have been pulled, though making this determination in advance is not recommended. In most cases, the value should only be determined after the system has been pulled.

“Unknown” should only be selected for either system if insufficient data was recorded and it is not possible to find out whether the system failed. In circumstances like this, selecting Unknown is preferable to leaving the field blank.

It is possible for a system which has not failed to have one or more components or parts which are later determined not to be reusable. Likewise, a system which has failed may have one or more components or parts which are later determined to be reusable.

For the purposes of the PCP Run-Life Improvement project (PCP RLI) and PCP-RIFTS, a successful flushby is not considered a failure of either the PCP System or the Tubing System. If the well is brought back on production, and neither the rotor nor the stator is actually pulled from the well, it is not considered a workover or the end of a production period. A successful flushby is merely an interruption in production, which can be reflected in the “Actual Runtime” variable (in the General Data Set).

### 3.2.1 Primary Failed System

In the event that both the PCP System and the Tubing System have been determined to have failed, the value of the “Primary Failed System” indicates in which system the sequence of events that led to the failure was initiated. This failure of the Primary Failed System may (or may not) have been the cause of the failure of the other system. If only one system has failed, this parameter should indicate that system, and if neither system has failed, it should be left blank. If both systems have failed, and it is not possible to determine which failed first, then “Unknown” should be entered. Note that when entering data into the database, a value for this variable need only to be filled in if both the PCP and Tubing Systems have failed. In data processing, the appropriate system will be entered if one system has failed and the other has not or if neither system has failed.

### 3.3 Primary Failed Item

As per the definition in Section 2, a Failed Item is any part, component, device, subsystem, functional unit, equipment or system that can be individually considered and which has failed.

## Failure Data Structure

Primary Failed Items are recorded separately for the PCP System and Tubing System in the event that both systems are determined to have failed. The Primary Failed Item in the PCP or Tubing System is the Failed Item within the respective system responsible for initiating the sequence of events that lead to the system failure. Possible Primary Failed Items are listed in Section 4 for the PCP System and in Section 5 for the Tubing System.

If the failure initiates at a part outside a system but progresses to within the system, the Primary Failed Item for the system is the item in the system in which the system failure initiated. Therefore, when both the PCP and Tubing Systems have failed, each will have a separate Primary Failed Item, even when the failure of an item in one system led to the failure of both systems.

The Primary Failed Item is not necessarily the item considered most severely damaged, nor the item whose Failure generated the evidence (i.e. Reason for Pull) of the downhole equipment failure. Tracing back this sequence of events from the system failure and identifying the Primary Failed Item normally requires some in-depth investigation.

Note that if the attribute PCP System Failed? or Tubing System Failed? = “No”, then the Primary Failed Item for the PCP System or Tubing System should be <blank>. Note that for any record, either system (PCP System and Tubing System), both systems, or neither system may have failed. If both systems have failed, then a Primary Failed Item should be established for each system.

### 3.4 Failure Descriptors

As per the definition in Section 2, a Failure Descriptor is an apparent, observed mode or mechanism of failure (of the Failed Items). These observations are probably made during the downhole equipment pull or shop inspection. They are the main perceptible signs of damage to the PCP System or Tubing System components or their parts, that may have resulted in the system failure.

Table 2 lists possible Failure Descriptors for the components and associated parts. Note that some Failure Descriptors may not be applicable to some parts.

Table 3 lists possible Supplementary Failure Descriptors. Supplementary Failure Descriptors provide more specific information about the failure. They apply only to certain Failure Descriptors, as shown in the table.

Many other descriptors are often recorded in the field or at the shop. Tables A.1 and A.2 in Appendix A show how other descriptors are likely to be mapped onto the descriptors in Table 2.

In PCP-RIFTS, two Failure Descriptors are recorded for the Primary Failed Item: the Primary Failure Descriptor and the Secondary Failure Descriptor. The Primary Failure Descriptor

## Failure Data Structure

represents the most prominent observation related to the mode or mechanism of failure while the Secondary Failure Descriptor represents the second most prominent observation. A Supplementary Failure Descriptor may apply to either the Primary or Secondary Failure Descriptor.

## Failure Data Structure

Failure Descriptors		Comments
<ul style="list-style-type: none"> <li>• Failed Hypot Test</li> <li>• Faulty Power</li> <li>• High Impedance/Resistance</li> <li>• Low Impedance/Resistance</li> </ul>	<ul style="list-style-type: none"> <li>• Open Circuit</li> <li>• Short Circuit</li> <li>• Phase Unbalance</li> </ul>	Electrical failures: related to the supply and transmission of electrical power. (Generally only used for ES-PCP systems.)
<ul style="list-style-type: none"> <li>• Coated-external</li> <li>• Coated-internal</li> <li>• Contaminated/Foreign Material</li> </ul>	<ul style="list-style-type: none"> <li>• Plugged</li> </ul>	Failures related to substances (e.g. paraffin, asphaltene, scale, sand, iron sulfide) depositing and/or accumulating in certain parts.
<ul style="list-style-type: none"> <li>• Blistered</li> <li>• Brittle</li> <li>• Burnt (Electrical)</li> <li>• Corroded</li> <li>• De-bonded</li> <li>• Discoloured</li> <li>• Eroded/Pressure Washed</li> </ul>	<ul style="list-style-type: none"> <li>• Hardened</li> <li>• Heat Cracked</li> <li>• Melted</li> <li>• Overheated</li> <li>• Swollen</li> <li>• Worn</li> </ul>	Material failures: usually related to the physical characteristics of the material such as colour, hardness, finish, etc.
<ul style="list-style-type: none"> <li>• Bent</li> <li>• Broken/Fractured</li> <li>• Buckled</li> <li>• Burst/Ruptured</li> <li>• Collapsed</li> <li>• Damaged</li> <li>• Dented</li> <li>• Disconnected</li> <li>• Failed Pressure Test</li> <li>• Failed Vibration Test</li> <li>• Faulty Clearance or Alignment</li> <li>• Leaking</li> </ul>	<ul style="list-style-type: none"> <li>• Loose/Spinning</li> <li>• Low Efficiency</li> <li>• Pitted</li> <li>• Punctured</li> <li>• Scratched/Grooved</li> <li>• Squashed/Flattened</li> <li>• Stuck</li> <li>• Torn</li> <li>• Twisted</li> <li>• Vibration/Rub marks</li> <li>• Vibration/Unbalanced</li> </ul>	Mechanical failures: usually the result of force, pressure, or torque.
<ul style="list-style-type: none"> <li>• Maintenance Discard</li> <li>• Missing</li> </ul>	<ul style="list-style-type: none"> <li>• Other</li> </ul>	
<ul style="list-style-type: none"> <li>• Unknown</li> </ul>		

**Table 2 Possible Failure Descriptors**

## Failure Data Structure

Failure Descriptor	Supplementary Failure Descriptor
Contaminated/Foreign Material	• Produced Sand
	• Frac Sand
	• Asphaltene
	• Paraffin
	• Workover Debris
Plugged	• Produced Sand
	• Frac Sand
	• Asphaltene
	• Paraffin
	• Workover Debris
Corroded	• CO <sub>2</sub>
	• H <sub>2</sub> S
Coated-external	• Asphaltene • Paraffin
Coated-internal	

**Table 3 Possible Supplementary Failure Descriptors**

### 3.4.1 Pull Descriptors

Observations regarding the conditions of all PCP and Tubing System components and their associated parts (e.g. from pull and teardown reports) should be maintained in the tracking system. These observations are recorded as Pull Descriptors and are selected from the list of descriptors in Tables 2 and 3.

Note that for the Primary Failed Item, the Pull Descriptors should be the same as the Primary and Secondary Failure Descriptors.

### 3.5 Pull Condition

In PCP-RIFTS, a “service life perspective” is used to describe the condition of components and parts. Thus, a component or part is considered Not Reusable if the condition of the item is considered inadequate for reuse in any reasonable application.

Therefore, items to be considered Not Reusable include:

- Items that have failed while in operation (i.e. have lost their ability to perform a required function) and which cannot easily be returned to an acceptable state for reuse;
- Items that have been submitted to shop tests or teardown inspections and have failed to meet the required specifications;

## Failure Data Structure

- Items that require substantial repair (see Section 3.8) or are discarded and thus deemed unsuitable for reuse in their current state; and
- Items that have not failed while in operation, but are deemed not reusable, regardless of the result of any inspections (if performed). Such items may be simply discarded because they are considered as having achieved a “reasonable” run-life or believed to have reduced Reliability for some other reason.

Components or parts that are submitted to shop tests, pass the required specifications, and are deemed to be in appropriate state for reuse are to be considered Reusable. This should include components and parts that only require minor regular servicing prior to reuse (e.g. cleaning).

It is possible under these definitions for a part which is deemed Not Reusable to be repaired and placed back in service. For example, a worn rotor may be considered Not Reusable, but can be rechromed and used again. The rechroming is considered a substantial repair.

A part which cannot be reused in the same application, but is kept for possible use in a different application is to be considered Reusable.

A part needing substantial repair is to be considered Not Reusable. A repair is considered “substantial” if it cannot be done quickly and easily with basic tools. For example cleaning sand out of a pump would normally not be considered a substantial repair. Chasing the threads on a rotor with a die would not be considered substantial if it can be done at the rig, or in conjunction with cleaning. Rechroming a rotor is considered a substantial repair.

It is important to emphasize that whether an Item has or has not failed does not have any bearing on whether or not that Item is to be considered Reusable. An Item has failed if it ceased to perform any of its required functions. An Item is Not Reusable if it cannot be returned to service following minor repair or cleaning. The following examples show how these two can be unrelated to each other:

- A pump is stuck due to sand. (Either a flushby was not attempted, or it was unsuccessful.) This pump is considered to have failed, as it is no longer performing its required function. It is brought to surface, and the sand is cleaned out. The pump tests okay and can be returned to operation, so it is considered Reusable.
- A Tubing System fails due to rod/tubing wear in a deviated well. The PCP System and the pump itself have not failed. Due to the age of the pump, however, the operator decides that it is not worth rerunning and it is discarded. This pump is considered Not Reusable, even though it did not fail.

## Failure Data Structure

### 3.6 Failure Causes

As per the definition in Section 2, the Failure Cause is associated with the circumstances during design, manufacture or use, which have led to a failure. The Failure Cause is generally related to the answer to the question: What could have been done differently to prevent this failure from occurring?

As noted in ISO 14224, identification of the Failure Cause normally requires some in-depth investigation to uncover the underlying human or organizational factors as well as the technical cause. Table 4 contains possible Failure Causes (General and Specific) of a PCP System or Tubing System.

Note that if the attribute PCP System Failed? or Tubing System Failed? have a value of “No”, then the respective Failure Cause should be <blank>.

## Failure Data Structure

<b>Failure Cause: General</b>	<b>Failure Cause: Specific</b>		<b>Comments</b>
<ul style="list-style-type: none"> <li>System Design / Selection</li> </ul>	<ul style="list-style-type: none"> <li>Equipment selection</li> <li>Equipment selection – materials</li> <li>Improper data used in design/selection</li> </ul>	<ul style="list-style-type: none"> <li>Equipment selection – pressure capacity</li> <li>Equipment selection – volumetric capacity</li> <li>System configuration</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Improper system design / selection, including use of improper data or errors in calculations</li> <li>Inadequate pump flow or head capacity, motor power capacity, etc.</li> <li>Improper equipment selection</li> <li>Improper material selection</li> </ul>
<ul style="list-style-type: none"> <li>Manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>Fabrication problem</li> </ul>	<ul style="list-style-type: none"> <li>Materials selection</li> <li>Quality control</li> <li>Mechanical design</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Improper mechanical design or selection of parts or components</li> <li>Improper fabrication or assembly of parts or components</li> <li>Improper quality control</li> </ul>
<ul style="list-style-type: none"> <li>Storage and Transportation</li> </ul>	<ul style="list-style-type: none"> <li>Packaging or restraints</li> <li>Storage</li> </ul>	<ul style="list-style-type: none"> <li>Transportation</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Improper or inadequate equipment handling during storage or transportation</li> </ul>
<ul style="list-style-type: none"> <li>Installation</li> </ul>	<ul style="list-style-type: none"> <li>System assembly</li> <li>Well cleanout</li> <li>Installation – field service (vendor)</li> </ul>	<ul style="list-style-type: none"> <li>Installation – field service (rig)</li> <li>Reran damaged equipment</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Improper procedures during installation or well preparation</li> <li>Improper system assembly and installation, including space-out procedures</li> </ul>
<ul style="list-style-type: none"> <li>Surface Equipment</li> </ul>	<ul style="list-style-type: none"> <li>Surface drive equipment failure (e.g., drivehead or power transmission equipment)</li> <li>Electrical equipment failure (e.g. VSD or switchboard)</li> </ul>	<ul style="list-style-type: none"> <li>Surface flow equipment failure (e.g. plugged flowline)</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>System failure resulting from the failure of equipment at surface (outside the PCP or Tubing System boundaries)</li> </ul>
<ul style="list-style-type: none"> <li>Operation</li> </ul>	<ul style="list-style-type: none"> <li>Enhanced recovery method or production strategy</li> <li>Inadequate monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Operating procedure</li> <li>Operation of other wells in field</li> <li>Well treatment</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Improper operating procedures or inadequate monitoring</li> <li>Field management practices</li> </ul>
<ul style="list-style-type: none"> <li>Reservoir or Fluids</li> </ul>	<ul style="list-style-type: none"> <li>Asphaltene</li> <li>Bottomhole temperature</li> <li>Free gas</li> <li>Sand</li> <li>Reservoir Failure</li> <li>Corrosive Fluids</li> </ul>	<ul style="list-style-type: none"> <li>Scale</li> <li>Paraffin</li> <li>Water cut</li> <li>High inflow</li> <li>Low inflow</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Unexpected reservoir conditions, leading to (1) plugging by scale, paraffin asphaltene, sand, etc. or (2) lower/higher productivity, higher GOR or water cut</li> <li>Reservoir fracturing, subsidence, etc</li> </ul>
<ul style="list-style-type: none"> <li>Completion</li> </ul>	<ul style="list-style-type: none"> <li>Failure of perforations / liner / openhole</li> <li>Failure or improper sand control system</li> </ul>	<ul style="list-style-type: none"> <li>Wellbore completion failure</li> <li>Non-PCP or tubing downhole failure (other)</li> </ul>	<ul style="list-style-type: none"> <li>Failure of the wellbore completion (e.g. casing, tubing, packer, safety valve, liner)</li> </ul>
<ul style="list-style-type: none"> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Weather / Oceanographic</li> <li>Natural disaster</li> <li>Power Disruption / Lightning</li> </ul>	<ul style="list-style-type: none"> <li>Poor power quality</li> <li>Other</li> </ul>	<ul style="list-style-type: none"> <li>Weather, war, terrorist attack, etc.</li> <li>Power supply issues</li> <li>Failure of instrumentation or control</li> </ul>
<ul style="list-style-type: none"> <li>Unknown</li> </ul>	<ul style="list-style-type: none"> <li>Unknown</li> </ul>		<ul style="list-style-type: none"> <li>Failure cause unknown</li> </ul>
<ul style="list-style-type: none"> <li>Normal or expected wear and tear</li> </ul>	<ul style="list-style-type: none"> <li>Normal or expected wear and tear</li> </ul>		<ul style="list-style-type: none"> <li>Equipment run-life met or exceeded expectations</li> </ul>

**Table 4 Possible Failure Causes**

## Failure Data Structure

### 3.6.1 Contributing Causes

As per the definition in Section 2, a Contributing Cause is associated with the circumstances during design, manufacture or use, which have contributed to a failure. For any failure, there may be several factors that contribute to the failure. While the main or root cause is tracked as the Failure Cause, any additional factors can be tracked as Contributing Causes. Any factor or circumstance that by itself would not have caused the failure should be tracked as a Contributing Cause.

Table 4 contains possible Contributing Causes of a PCP System or Tubing System.

### 3.7 Sacrificial Components

A PCP System or Tubing System may contain parts which are intended to “fail”, that is to come apart or open, under certain circumstances. Examples include tubing drains and sucker rod shear couplings. When one of these items fails in use, whether or not it should be recorded as a system failure depends on the conditions under which it failed.

Example: A tubing drain is designed to open when the pressure in the tubing exceeds a predetermined value. This is useful in PCP systems in the event that the pump gets stuck, and the rotor cannot be removed from the stator. The tubing drain can then be blown open, thereby allowing the workover rig crew to pull tubing which is not filled with fluid. Clearly, if the Artificial Lift System is being pulled for some reason unrelated to the tubing drain, and the tubing drain is blown open just prior to being pulled, this should not be considered a failure of the part. Consider a different situation, however. PCPs can produce a “deadhead” pressure of up to three times their rated pressure. If a pump’s deadhead pressure exceeds the burst pressure of the tubing drain, then the drain could open if the flowline valve at surface is blocked for any reason. This is to be considered a Tubing System failure, despite the fact that the tubing drain performed as it was designed. The main Required Function of the Tubing System is to deliver fluid from the pump to surface, and when the drain is blown, the tubing system can no longer perform this function. Furthermore, the tubing drain should be considered the Primary Failed Item in this case.

The same arguments can be made for a shear coupling, which is installed (particularly on continuous rod strings) to facilitate pulling the rods when the rotor is stuck within the pump. The shear coupling is designed to part under an axial load greater than any which would be expected in operation. This load would be applied by a workover crew attempting to pull the rods. If the coupling shears during operation (i.e. not during a workover) then it is to be considered failed. The PCP System can no longer perform its functions (which include transmitting energy to the pump through the rod string) and therefore must be considered failed. Furthermore, the shear coupling should be considered the primary failed item in this case.

## Failure Data Structure

The next question is whether a sacrificial part should be considered to be failed when it does not come apart during a workover under the load it was designed for. In general, for tubing drains and shear couplings, a decision to pull the system has already been made when the rig crew applies the force or pressure to try to actuate the sacrificial component. This, the fact that the sacrificial component did not come apart during the workover had no effect on the ability (or lack thereof) of the system to perform its required functions. The part did not fail during system operation and should not be considered as “failed”. However, if a drain was intentionally sized to protect the pump from a closed flowline valve, and it did not open when the valve was inadvertently closed, resulting in a pump failure, then it may be considered as failed. The Tubing System may be considered to be the Primary Failed System in this case, as the failure of the tubing drain to open is what led to the failure of the PCP system. The tubing drain would be the primary failed item of the Tubing System and the PCP or the PCP Stator would be the Primary Failed Item of the PCP System.

### 3.8 Flushbys

As described in Section 3.2, a successful flushby is not considered the end of a Production Period, and therefore does not need not to be tracked for the purposes of the PCP Run-Life Improvement project.

## 4. PCP SYSTEM

The attributes described in Section 3 are used to track information specific to PCP System failures. The boundary of the PCP System is shown in Figure 2 for surface driven systems and Figure 3 for downhole driven systems (ES-PCP systems). Note that a shroud, if used in an ES-PCP system, is part of the PCP System (in the same way that tail joints are part of the surface-driven PCP system).

### 4.1 PCP System Failed?

Whether or not the PCP System has failed is determined in the manner described in Section 3.2. The required functions of the PCP System include transmitting torque from surface to the pump, and producing pressure and flow at the pump discharge. Other functions may also be considered “required” depending on the system configuration and application.

### 4.2 Primary Failed Item

Table 5 lists possible Primary Failed Items for the PCP System. The PCP System is divided into Subsystems. The reason for this is that there are times when it may not be possible to determine which of the rotor or stator is the Primary Failed Item (for example, if a pump is stuck due to sand). In such cases, the subsystem (PC Pump) can be selected. Also, there may be times when both items have failed, but it is not possible to determine which is the Primary Failed Item. For example, if the pump has suffered severe wear, both the rotor and stator may be affected.

PCP System

System	Subsystem	Component	Subcomponent		
PCP System	PC Pump	PCP Rotor	<ul style="list-style-type: none"> <li>• Base Metal</li> <li>• Drive String Coupling</li> </ul>	<ul style="list-style-type: none"> <li>• Coating</li> <li>• Weld</li> </ul>	
		PCP Stator	<ul style="list-style-type: none"> <li>• Housing</li> <li>• Elastomer</li> </ul>	<ul style="list-style-type: none"> <li>• Rotor Stop/Tag Bar</li> <li>• Bond</li> </ul>	<ul style="list-style-type: none"> <li>• Coupling</li> </ul>
	Rods	Rods	<ul style="list-style-type: none"> <li>• Rod Body</li> <li>• Shear Coupling</li> <li>• Welds</li> </ul>	<ul style="list-style-type: none"> <li>• Connections</li> <li>• Centralizers</li> </ul>	<ul style="list-style-type: none"> <li>• Polished Rod</li> <li>• Guides</li> </ul>
	Pump Intake	Pump Intake	<ul style="list-style-type: none"> <li>• Intake Ports/Screen</li> <li>• Discharge Ports/Screen</li> <li>• Coupling</li> </ul>	<ul style="list-style-type: none"> <li>• Tail Pipe Joints</li> <li>• Housing</li> <li>• Sand Separation Apparatus</li> </ul>	<ul style="list-style-type: none"> <li>• Gas Separation Apparatus</li> </ul>
	ES-PCP Drive	ES-PCP Seal	<ul style="list-style-type: none"> <li>• Shaft</li> <li>• Coupling</li> <li>• Thrust Bearing</li> <li>• Bag Chamber</li> </ul>	<ul style="list-style-type: none"> <li>• Labyrinth Chamber</li> <li>• Mechanical Seals</li> <li>• Relief Valves</li> <li>• O-rings</li> </ul>	<ul style="list-style-type: none"> <li>• Head</li> <li>• Base</li> <li>• Housing</li> <li>• Oil</li> </ul>
		ES-PCP Motor	<ul style="list-style-type: none"> <li>• Shaft</li> <li>• Coupling</li> <li>• Thrust Bearing</li> <li>• Stator</li> </ul>	<ul style="list-style-type: none"> <li>• Rotors</li> <li>• Rotor Bearing</li> <li>• Filter</li> <li>• O-rings</li> </ul>	<ul style="list-style-type: none"> <li>• Head</li> <li>• Base</li> <li>• Housing</li> <li>• Oil</li> </ul>
		ES-PCP Cable	<ul style="list-style-type: none"> <li>• Main Power Cable</li> <li>• Pigtail</li> <li>• Splices</li> </ul>	<ul style="list-style-type: none"> <li>• Packer Penetrator</li> <li>• Motor Lead Extension</li> <li>• Wellhead Penetrator</li> </ul>	<ul style="list-style-type: none"> <li>• Pothead Connector</li> </ul>
		ES-PCP Gear Box	<ul style="list-style-type: none"> <li>• Gears</li> </ul>	<ul style="list-style-type: none"> <li>• Shaft</li> </ul>	<ul style="list-style-type: none"> <li>• Housing</li> </ul>
		ES-PCP Flexshaft	<ul style="list-style-type: none"> <li>• Flex Shaft</li> <li>• Bearings</li> </ul>	<ul style="list-style-type: none"> <li>• Housing</li> <li>• Coupling</li> </ul>	
	Other	Other PCP System Components	<ul style="list-style-type: none"> <li>• Shroud</li> <li>• Packer (on insertable pump assembly)</li> </ul>		

**Table 5 Possible Primary Failed Items: PCP System<sup>2</sup>**

Notice that in the cases where both the PCP System and the Tubing System failed, there will be a Primary Failed Item for each system. In these cases, the user will be required to indicate which one of the two systems failed first using the attribute Primary Failed System.

<sup>2</sup> PC Pump Subsystem should be selected as the Primary Failed Item if a distinction cannot be made between the rotor and stator (e.g. the rotor and stator are stuck together).

## 5. TUBING SYSTEM

The attributes described in Section 3 are also used to track information specific to Tubing System failures. Information related specifically to the Tubing System is described below. The boundary of the Tubing System is shown in Figure 4.

### 5.1 Tubing System Failed?

Whether or not the Tubing System has failed is determined in the manner described in Section 3.2. The required functions of the tubing system include forming a sealed conduit through which fluid is delivered from the pump discharge to surface. Other functions may also be considered “required” depending on the system configuration and application.

### 5.2 Primary Failed Item

The Primary Failed Item for the Tubing System may be any component or part listed in Table 6.

System	Subsystem	Component	Subcomponent
Tubing System	Tubing	Tubing	<ul style="list-style-type: none"> <li>• Connections</li> <li>• Body</li> </ul>
		Tubing Rotator	
		Torque Anchor	
		Tubing Centralizer	
		Tubing Drain	<ul style="list-style-type: none"> <li>• Shear Pin</li> </ul>
		Check Valve	
		Tubing Swivel	
		Subsurface Safety Valve	
		Other Tubing System Component	

**Table 6 Possible Primary Failed Items: Tubing System**

Notice that in the cases where both the PCP System and the Tubing System failed, there will be a Primary Failed Item for each system. In these cases, the user will be required to indicate which one of the two systems failed first using the attribute Primary Failed System.

## **6. OTHER SYSTEMS**

### **6.1 Other System Failures**

Failures of systems in the well other than the PCP System and the Tubing System may be tracked in one of two ways. If the other system failure caused the PCP System or the Tubing System to fail, then the other system failure can be tracked as a Failure Cause (as described in Section 3.5). If neither the PCP System nor the Tubing System failed, then the other system failure may be tracked as a Reason for Pull (Maintenance/Repair of non Artificial Lift System Component).

## 7. REFERENCES

- ESP Failure Nomenclature Standard. Version 4.2, C-FER Technologies, ESP-RIFTS JIP, November 2007.
- International Standards Organization (ISO) 14224: Petroleum and Natural Gas Industries – Collection and Exchange of Reliability and Maintenance Data For Equipment. 1999.
- International Standards Organization (ISO) 15136.1: Petroleum and Natural Gas Industries - Downhole Equipment - Progressing Cavity Pump Systems for Artificial Lift – Part 1: Pumps. 2001
- International Standards Organization (ISO) 15136.2: Petroleum and Natural Gas Industries - Downhole Equipment - Progressing Cavity Pump Systems for Artificial Lift – Part 2: Surface Drive Systems. 2003.

Figures

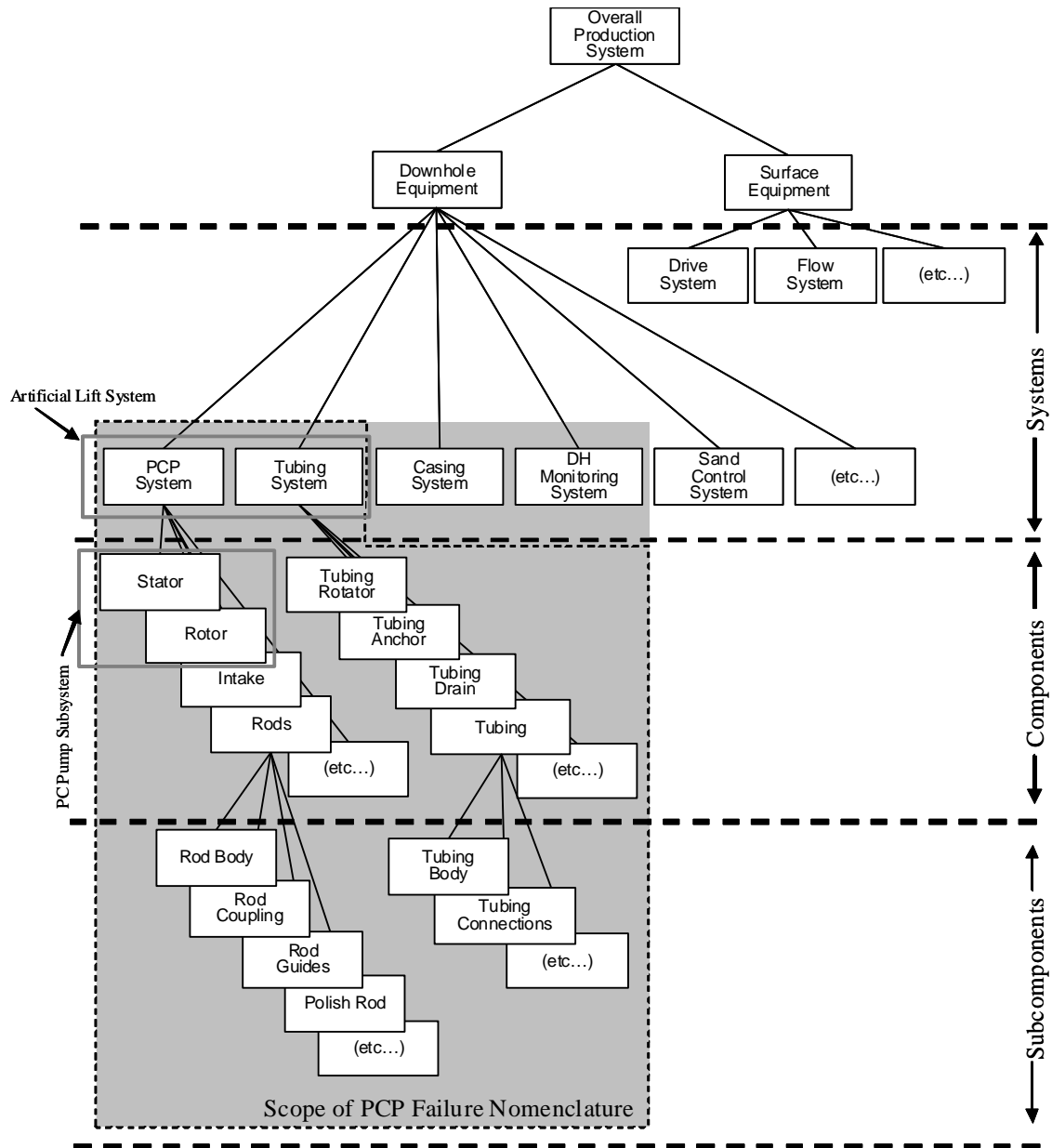


Figure 1 Equipment Hierarchy

Figures

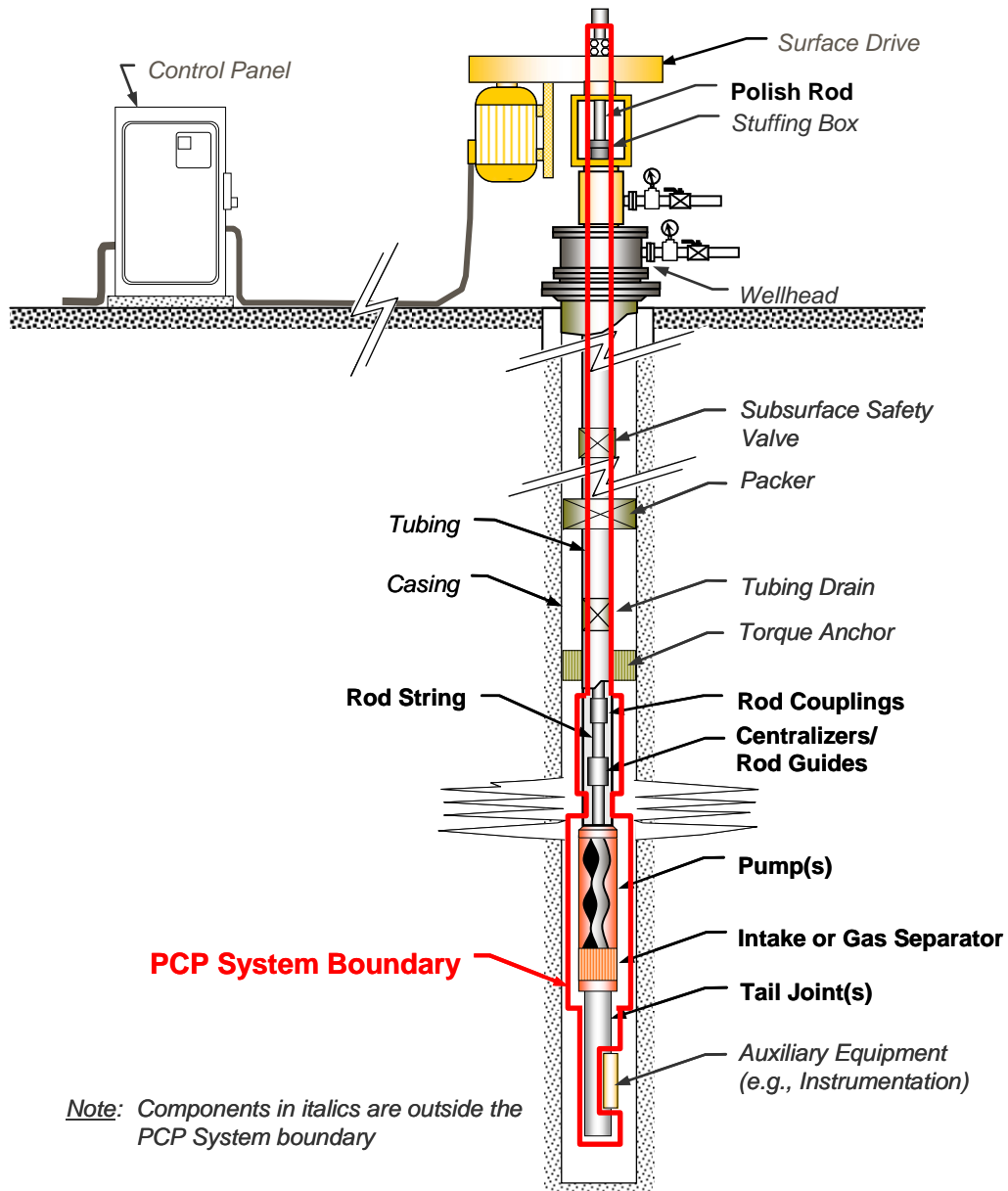


Figure 2 PCP System Boundary: Surface Drive

Figures

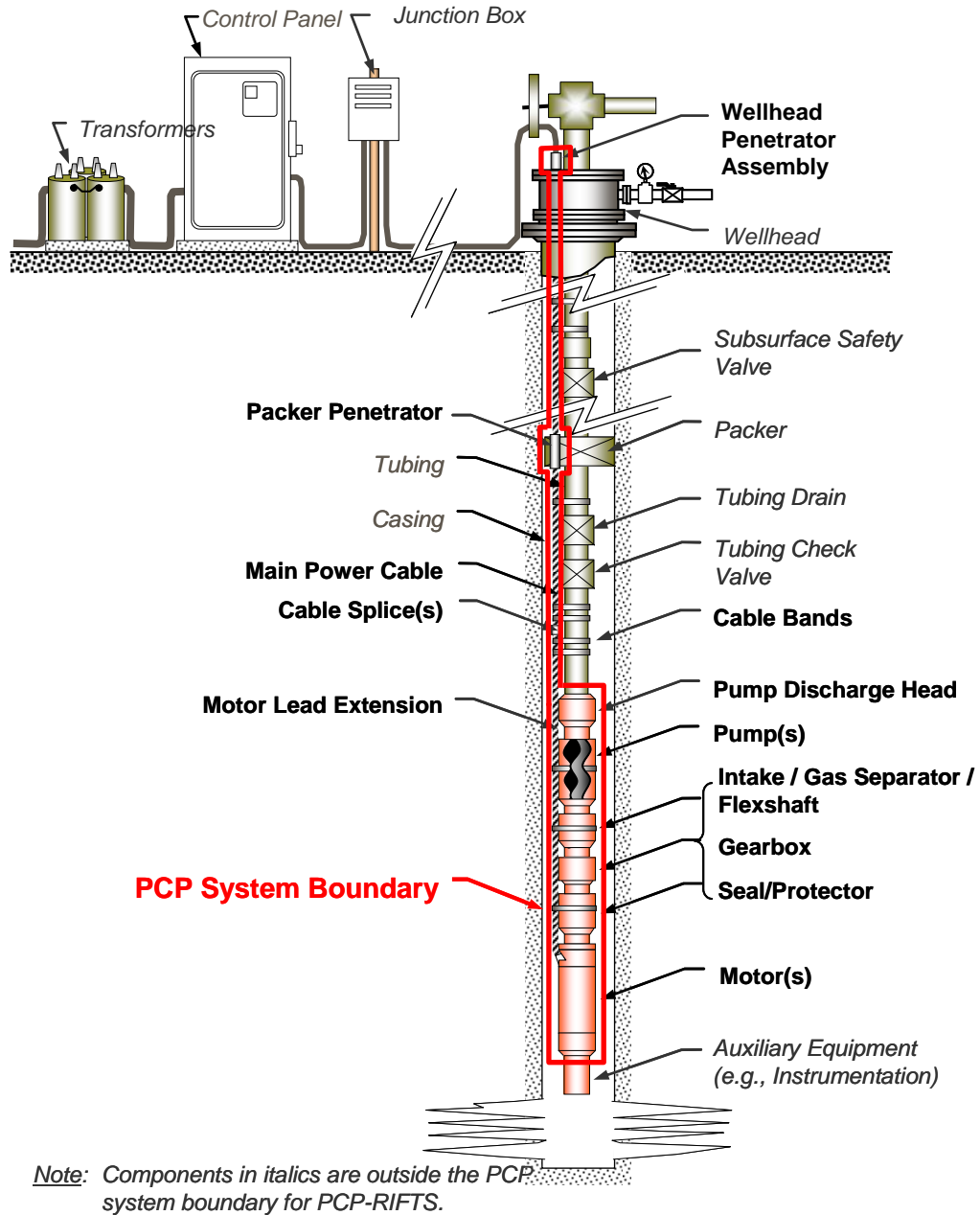


Figure 3 PCP System Boundary: Downhole Drive

Figures

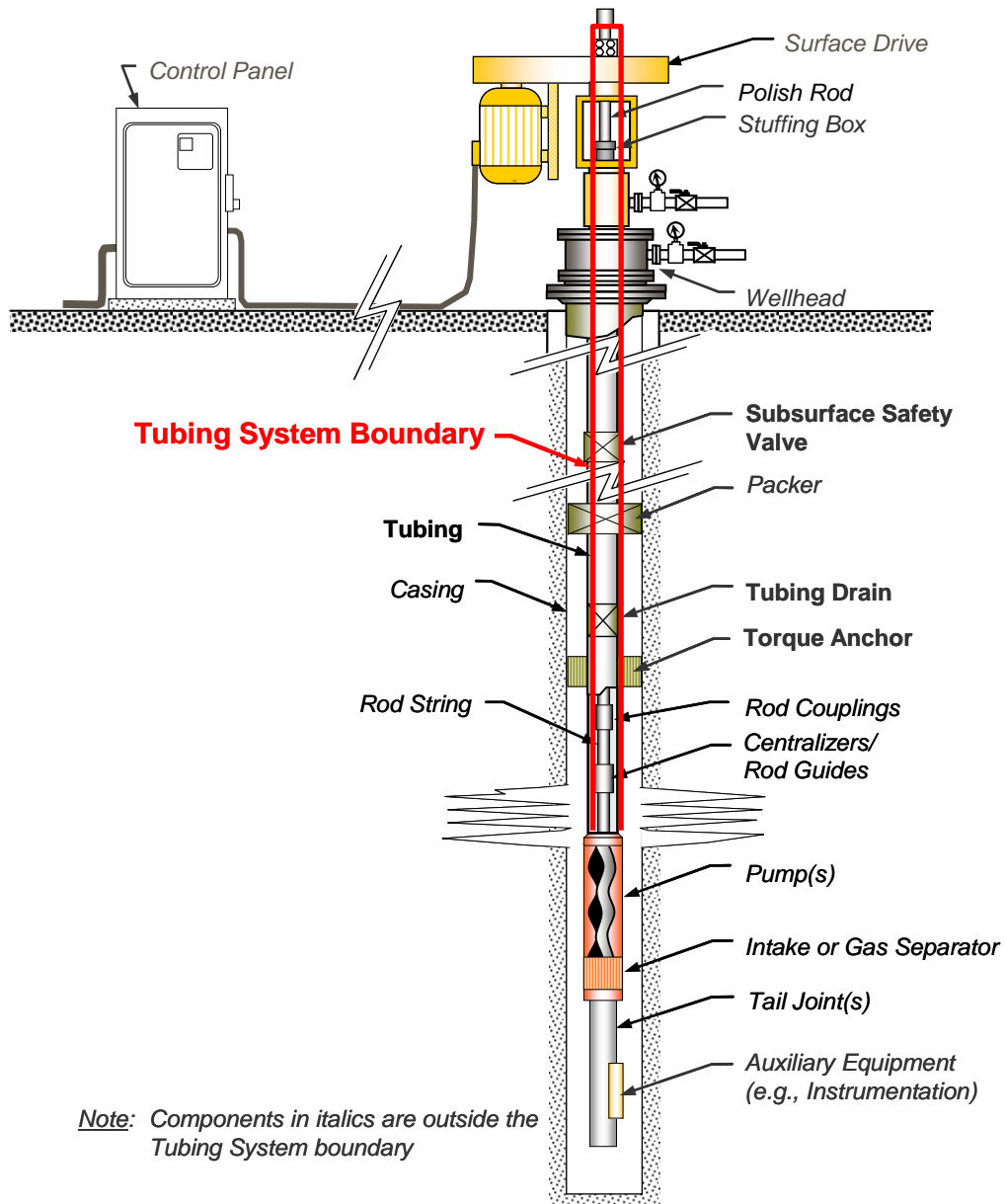


Figure 4 Tubing System Boundary

## Appendix A – Failure Descriptor Mapping

The list of failure descriptors in Table 2 is not a complete list of every descriptor which might be seen on a PCP failure report from a vendor or other source in the field. If other descriptors are given in the field, they should be mapped to one of the terms in the table. Tables A.1 and A.2 show how some common rotor and stator descriptors can be mapped into the format described in this Standard.

Vendor Descriptor	PCP-RIFTS Descriptor	Description
Base Metal Wear	Worn	Rotor chrome worn through to base metal and/or surface is severely worn (e.g., flat spots)
Flat Spots		
Fluid Wash	Eroded / Pressure Washed	Rotor chrome fluid washed to base metal
Base Metal Washing		
Snapped	Broken / Fractured	Rotor broken or parted
Broken		
Grooved	Scratched / Grooved	Rotor surface grooved and/or scored
Scored		
Heat Checking	Heat Cracked	Rotor chrome surface heat cracked
Pumped Off		
Surface Cracking		
Heat Cracks		
Checking		
Heat Cracked		
Acid Attack	<NONE IN DATA>	Dull grey chrome due to acid
Dull Grey (Acid)		
Other	Other	Other damage
Broken Pin		
Pitting	Pitted	Rotor surface pitted
Pits		
Pitted		
Worn	Worn	Rotor chrome is worn
Sand Wear		
Abrasion		
General Wear		
Sand Wear		
Needs Chrome		
Bent	Bent	Rotor is bent
Unknown	Unknown	Rotor description unknown

**Table A.1 Mapping for PCP Rotors**

Appendix A

Vendor Descriptor	PCP-RIFTS Descriptor	Description		
Bent	Bent	Pump housing is bent		
Dry	Hardened	Stator elastomer is hard and/or cracked, burnt, or shows signs that the pump was run dry		
Burnt				
High Operating Temp				
Pumped Off				
Starved				
Hot Spots				
Hardened				
Hard/Cracked				
Rubber Hard & Brittle				
Gas Hardening				
Missing Rubber			Torn	Stator elastomer is torn and/or missing
Torn Rubber				
Elastomer Torn				
Elastomer Missing				
Excessive Pressure				
Cut				
Chunked				
Rips				
Over Pressure				
Chemical Attack	<NONE IN DATA>			
High Pressure Wash	Eroded / Pressure Washed			
Fluid Wash				
Hole	Punctured	Stator is punctured.		
Hole in stator				
Foreign Material	Contaminated / Foreign Material	Some type of foreign material is in the pump stator		
Sand Embedded				
Chert Embedded				
Stones Embedded				
Gas Blisters	Blistered			
Blistered				
Gas Bubble				
Grooved	Scratched / Grooved	Surface of stator elastomer is grooved		
Grooves				
Other	Other	Other damage		
Corrosion				
Elastomer Shrunk				
Slippage				
Swollen	Swollen	Stator elastomer is swollen		
High Torque				
Torque				
Worn	Worn	Stator elastomer is worn or exhibits abrasive wear		
Abrasion				
General Wear				
Sand Abrasion				
Flat Spots				
Unknown	Unknown	Stator description unknown		

Table A.2 Mapping for PCP Stators

## Appendix B – Examples

Several examples are included below, to illustrate the use of this Standard.

### Example 1

<b>Production Report:</b>	The system ran for six months, after which the drive unit shut down on high torque. A flushby unit was called. A flushby was performed successfully and the well was put back on production.	
<b>Pull Report:</b>	Just the rotor was pulled from the stator and only during the flushby; rods were not pulled from the well.	
<b>Teardown/Inspection Report:</b>	None	
<b>Failure Investigation:</b>	The pump presumably was sanded prior to the flushby.	
<b>General</b>		
	<b>Period Status:</b>	Still on Production
	<b>Reason for Pull General:</b>	
	<b>Reason for Pull Specific:</b>	
	<b>Primary Failed System:</b>	
<b>PCP System</b>		
	<b>PCP System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Tubing System</b>		
	<b>Tubing System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Components</b>		
	<b>Rotor Pull Condition:</b>	
	<b>Stator Pull Condition:</b>	
<b>Comments:</b>	A successful flushby does not result in the end of a Production Period, as the pump is not pulled from the well.	

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**Example 2**

<b>Production Report:</b>	A pump ran for 8 months, during which time three flushbys were performed due to sanding. After a field power failure, the system would not restart, shutting down on high torque when a restart was attempted. A flushby unit was unable to pull the rotor from the stator, so a workover was required.	
<b>Pull Report:</b>	Three joints of tubing above the pump were filled with sand. All components appear to be okay and were sent to the shop for testing and inspection.	
<b>Teardown/Inspection Report:</b>	Minor wear was detected on both the rotor and stator. The pump tested okay (with a slightly lower efficiency than in-test, but within acceptable limits). The pump was sent back to the field for re-use.	
<b>Failure Investigation:</b>	A pump stoppage due to power failure allowed a large amount of sand to settle above the pump, making it impossible to restart. The power failure was caused by lightning. Power failures in this field are not common.	
<b>General</b>	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	High Torque/High Current
	<b>Primary Failed System:</b>	PCP System
<b>PCP System</b>	<b>PCP System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	PC Pump
	<b>Primary Failure Descriptor:</b>	Plugged
	<b>Primary Failure Descriptor, Supplementary:</b>	Produced Sand
	<b>Failure Cause General:</b>	Other
	<b>Failure Cause Specific:</b>	Power Disruption/Lightning
<b>Tubing System</b>	<b>Tubing System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Components</b>	<b>Rotor Pull Condition:</b>	Reusable
	<b>Stator Pull Condition:</b>	Reusable
<b>Comments:</b>	If power failures were common in the field, the Failure Cause may be related to design or operation instead, as it should be expected that power failures in a sandy field will cause situations of this type, so contingency plans to prevent this type of failure should have been in place.	

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**Example 3**

<b>Production Report:</b>	A well was on production for 3 months. The system was shut down to perform minor scheduled maintenance on the drivehead. Following the work, the system would not restart due to high torque.	
<b>Pull Report:</b>	Stator elastomer appeared swollen. Rotor was fine.	
<b>Teardown/Inspection Report:</b>	Elastomer was swollen. Boroscope revealed severe blisters inside pump. Some "chunking" was also observed--this was believed to be a secondary effect of the blistering. The intake sub and tag bar were trashed with the stator.	
<b>Failure Investigation:</b>	Decompression at shutdown likely caused CO <sub>2</sub> which had diffused into the elastomer to expand, beyond the capability of the elastomer to withstand, leading to blisters. The elastomer used in this pump was not appropriate for fluids containing significant CO <sub>2</sub> --the person making the selection had neglected to consider this.	
<b>General</b>		
	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	High Torque/High Current
	<b>Primary Failed System:</b>	PCP System
<b>PCP System</b>		
	<b>PCP System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	PCP Stator - Elastomer
	<b>Primary Failure Descriptor:</b>	Blistered
	<b>Secondary Failure Descriptor:</b>	Torn
	<b>Failure Cause General:</b>	System Design/Selection
	<b>Failure Cause Specific:</b>	Equipment Selection - Materials
<b>Tubing System</b>		
	<b>Tubing System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Components</b>		
	<b>Rotor Pull Condition:</b>	Reusable
	<b>Stator Pull Condition:</b>	Not Reusable
	<b>Pump Intake Pull Condition:</b>	Not Reusable
	<b>Tag Bar Pull Condition:</b>	Not Reusable
<b>Comments:</b>	<p>If the person making the elastomer selection was not aware of the CO<sub>2</sub> in the well, the specific failure cause may be "Improper data used in design" instead. If the possibility of explosive decompression of the elastomer had been known, the failure cause may reflect the operational practice of shutting down the well for routine drive maintenance.</p> <p>Even though no comment is made on the condition of the intake sub and tag bar, the fact that a decision was made at the time of inspection to trash them means their conditions are recorded as "Not Reusable".</p>	

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**Example 4**

<b>Production Report:</b>	A PCP system is installed in a deviated well. An operator noticed the tank level had not changed in 2 days, although the drive was running. A workover was performed.	
<b>Pull Report:</b>	A hole was found in the in tubing, five joints above the pump.	
<b>Teardown/Inspection Report:</b>	The pump elastomer was found to have hardened, presumably due to high temperature. The stator was scrapped. The rotor had heat checking, and was sent for rechroming. The intake sub and tag bar were kept for reuse after minor cleaning.	
<b>Failure Investigation:</b>	Recirculating fluid through a hole in tubing led to increase in temperature of fluid, which caused the pump to be burnt. This was a low rate well with no fluid rate measurement (other than daily tank level readings), so there was no automated process for detecting the low flow rate. The torque was low, but there was enough friction torque that the low torque limit did not trigger a shutdown. The tubing failure was considered to be an expected failure--in this field, continuous rods are not used for economic and operational reasons, and tubing failures are expected after a reasonable time, which this well had reached.	
<b>General</b>	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	No Flow to Surface
	<b>Primary Failed System:</b>	Tubing System
<b>PCP System</b>	<b>PCP System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	PCP Stator - Elastomer
	<b>Primary Failure Descriptor:</b>	Hardened
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	Operation
	<b>Failure Cause Specific:</b>	Inadequate Monitoring
<b>Tubing System</b>	<b>Tubing System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	Tubing Body
	<b>Primary Failure Descriptor:</b>	Worn
	<b>Secondary Failure Descriptor:</b>	Burst/Ruptured
	<b>Failure Cause General:</b>	Normal or Expected Wear-and-Tear
	<b>Failure Cause Specific:</b>	
<b>Components</b>	<b>Rotor Pull Condition:</b>	Not Reusable
	<b>Stator Pull Condition:</b>	Not Reusable
	<b>Pump Intake Pull Condition:</b>	Reusable
	<b>Tag Bar Pull Condition:</b>	Reusable
<b>Comments:</b>	The tubing failure was expected after some time due to the rods running through a deviation. An informed decision has been made that it is more economic to deal with these periodic failures than to install continuous rod, so the failure cause is normal wear-and-tear. In other circumstances, this could be considered an Equipment Selection failure (e.g. if the person selecting the equipment had the option of using various wear mitigating measures and decided not to without a good reason). The failure descriptor was "Burst/Ruptured". In some cases "Leaking" may have been an option as well, depending on the size of the hole in the tubing. The pump failure was caused by the tubing failure, but could have been prevented if there had been better monitoring in place--either a flow switch to indicate that there was no flow, or a better setting on the low-torque shutdown could have allowed this pump to be reused after the Tubing System failure.	

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**Example 5**

<b>Production Report:</b>	After a workover, the operator neglected to open the flowline valve before starting the pump. The high pressure generated by the pump working against a closed flowline valve caused the tubing drain valve to blow. The operator realized within minutes that the valve was closed and on opening it detected that there was no flow to surface.	
<b>Pull Report:</b>	The tubing drain was blown. The pump looked okay on a visual inspection.	
<b>Teardown/Inspection Report:</b>	The pump tested fine at the shop, and no damage was observed on a boroscope inspection.	
<b>Failure Investigation:</b>	The burst pressure on the tubing drain was less than the pump's deadhead pressure, so it burst when pumping against the closed valve. Note that the tubing drain was installed only to prevent the need to pull a wet tubing string--it was not intended to protect the pump from an overpressure situation.	
<b>General</b>		
	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	No Flow to Surface
	<b>Primary Failed System:</b>	Tubing System
<b>PCP System</b>		
	<b>PCP System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Tubing System</b>		
	<b>Tubing System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	Tubing Drain
	<b>Primary Failure Descriptor:</b>	Burst/Ruptured
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	Operation
	<b>Failure Cause Specific:</b>	Operating Procedure
<b>Components</b>		
	<b>Rotor Pull Condition:</b>	Reusable
	<b>Stator Pull Condition:</b>	Reusable
	<b>Pump Intake Pull Condition:</b>	Reusable
	<b>Tag Bar Pull Condition:</b>	Reusable
<b>Comments:</b>	The tubing drain worked as expected, opening under high pressure, but this is still considered a tubing failure, because the Tubing System as a whole is no longer able to perform its primary required function.	

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**Example 6**

<b>Production Report:</b>	One month after installation, a well suddenly stopped producing flow to surface. The drive was still running at low torque. Parted rods were suspected, so the system was pulled.	
<b>Pull Report:</b>	A rod was broken (rod body failure). The rotor was found to be sanded in the pump and was freed by the workover rig.	
<b>Teardown/Inspection Report:</b>	There was no manufacturing defect in the rod string. After cleaning, the pump tested okay and was returned to the field.	
<b>Failure Investigation:</b>	A slug of sand caused a spike of high torque, which led to the rod failure. The high-torque shutdown setting for the drive unit was set too high. When the pump sanded up, it increased the torque to the point where the rods failed (before a high torque shutdown would be triggered). There was no sand control in this well (being in a CHOPS field). Slugs like this are known to spontaneously occur in this field.	
<b>General</b>		
	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	No Flow to Surface
	<b>Primary Failed System:</b>	PCP System
<b>PCP System</b>		
	<b>PCP System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	Rod Body
	<b>Primary Failure Descriptor:</b>	Broken/Fractured
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Tubing System</b>		
	<b>Tubing System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	Operation
	<b>Failure Cause Specific:</b>	Inadequate monitoring
<b>Components</b>		
	<b>Rotor Pull Condition:</b>	Reusable
	<b>Stator Pull Condition:</b>	Reusable
	<b>Pump Intake Pull Condition:</b>	Reusable
	<b>Tag Bar Pull Condition:</b>	Reusable
<b>Comments:</b>	Care should always be used in selecting "Reservoir or Fluids" as a failure cause. If the reservoir and fluid conditions are known, they can usually be considered in the design, and then would not be a failure cause (it would be a design problem instead). In this case, it is known that the slugs occur, and sand control is not used for a valid reason. The sand should not then be listed as a failure cause. The main cause was that the high-torque shutdown was set improperly. Had it been set correctly, the system would have shut down, and a flushby could have been attempted.	

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**Example 7**

<b>Production Report:</b>	In a new CHOPS well, a used pump was selected to produce the initial fluid with very high sand cut. After 3 months, the flow rate to surface had declined to an unacceptably low rate, so the system was pulled. Since the sand cut was substantially lower at this point, a new pump was installed.	
<b>Pull Report:</b>	The pump showed severe wear due to sand.	
<b>Teardown/Inspection Report:</b>	The pump tested at very low efficiency. A visual inspection showed severe wear both on the rotor and stator. The pump (including the intake and tag bar) was trashed.	
<b>Failure Investigation:</b>	Wear was as expected; the very high sand cut produced in the early life of such wells was the reason a "trash" pump was selected.	
<b>General</b>		
	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	Low Flow to Surface
	<b>Primary Failed System:</b>	PCP System
<b>PCP System</b>		
	<b>PCP System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	PC Pump
	<b>Primary Failure Descriptor:</b>	Worn
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	Normal or Expected Wear-and-Tear
	<b>Failure Cause Specific:</b>	
<b>Tubing System</b>		
	<b>Tubing System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Components</b>		
	<b>Rotor Pull Condition:</b>	Not Reusable
	<b>Stator Pull Condition:</b>	Not Reusable
	<b>Pump Intake Pull Condition:</b>	Not Reusable
	<b>Tag Bar Pull Condition:</b>	Not Reusable
<b>Comments:</b>	Even though this failure was expected, even planned, it is still a system failure.	

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**Example 8**

<b>Production Report:</b>	A well has a high water cut with some sand production. After some time, the efficiency of the pump gradually dropped. When it dropped below an acceptable level, the pump was pulled.	
<b>Pull Report:</b>	The pump showed significant wear.	
<b>Teardown/Inspection Report:</b>	The pump tested at low efficiency. A visual inspection showed wear on the stator; the rotor looked reasonably fine. It was determined that the pump could be used in a heavy oil well with low water cut, and was sent to an appropriate field for reuse.	
<b>Failure Investigation:</b>	Wear was as expected in an application with sand.	
<b>General</b>		
	<b>Period Status:</b>	Period Completed
	<b>Reason for Pull General:</b>	Abnormal Operating Condition
	<b>Reason for Pull Specific:</b>	Low Flow to Surface
	<b>Primary Failed System:</b>	PCP System
<b>PCP System</b>		
	<b>PCP System Failed?:</b>	Yes
	<b>Primary Failed Item:</b>	PCP Stator
	<b>Primary Failure Descriptor:</b>	Worn
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	Normal or Expected Wear-and-Tear
	<b>Failure Cause Specific:</b>	
<b>Tubing System</b>		
	<b>Tubing System Failed?:</b>	No
	<b>Primary Failed Item:</b>	
	<b>Primary Failure Descriptor:</b>	
	<b>Secondary Failure Descriptor:</b>	
	<b>Failure Cause General:</b>	
	<b>Failure Cause Specific:</b>	
<b>Components</b>		
	<b>Rotor Pull Condition:</b>	Reusable
	<b>Stator Pull Condition:</b>	Reusable
	<b>Pump Intake Pull Condition:</b>	Reusable
	<b>Tag Bar Pull Condition:</b>	Reusable
<b>Comments:</b>	A pump which can be reused in a different application is considered "Reusable" as per Section 3.5 of this Standard. In this case, even though the pump's efficiency was low in a high water cut application, it would be fine for use in a heavy oil application (assuming the elastomer is appropriate for that oil).	