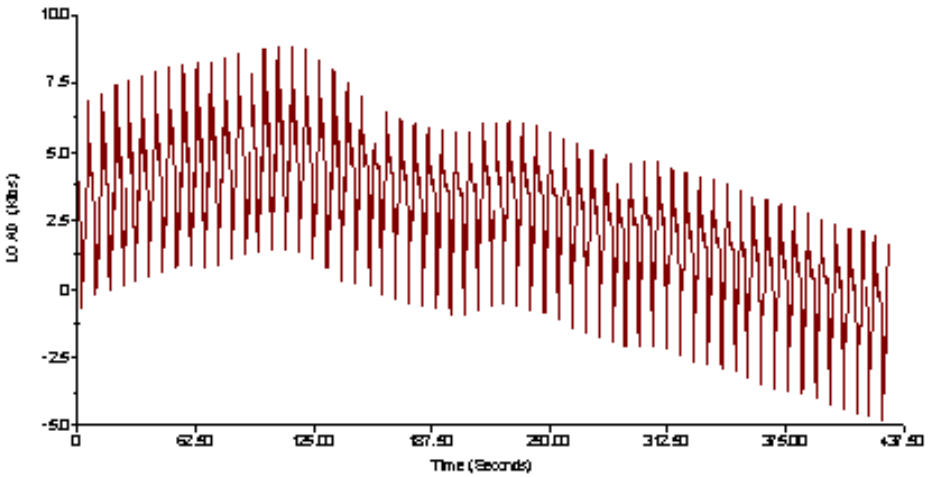
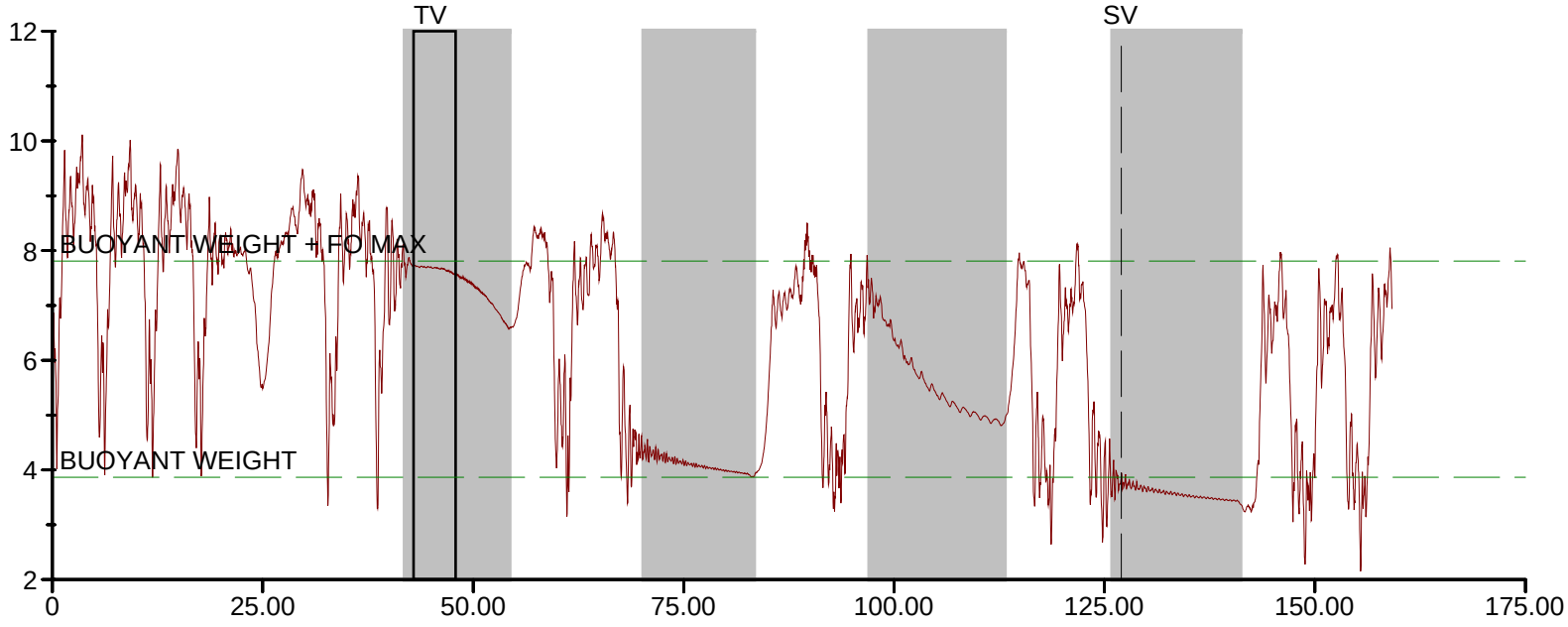
Acquiring Dynamometer Data Using the Polished Rod Transducer when the Polished Rod is Bending or Misaligned

Text added to TWM Manual Jan 2006

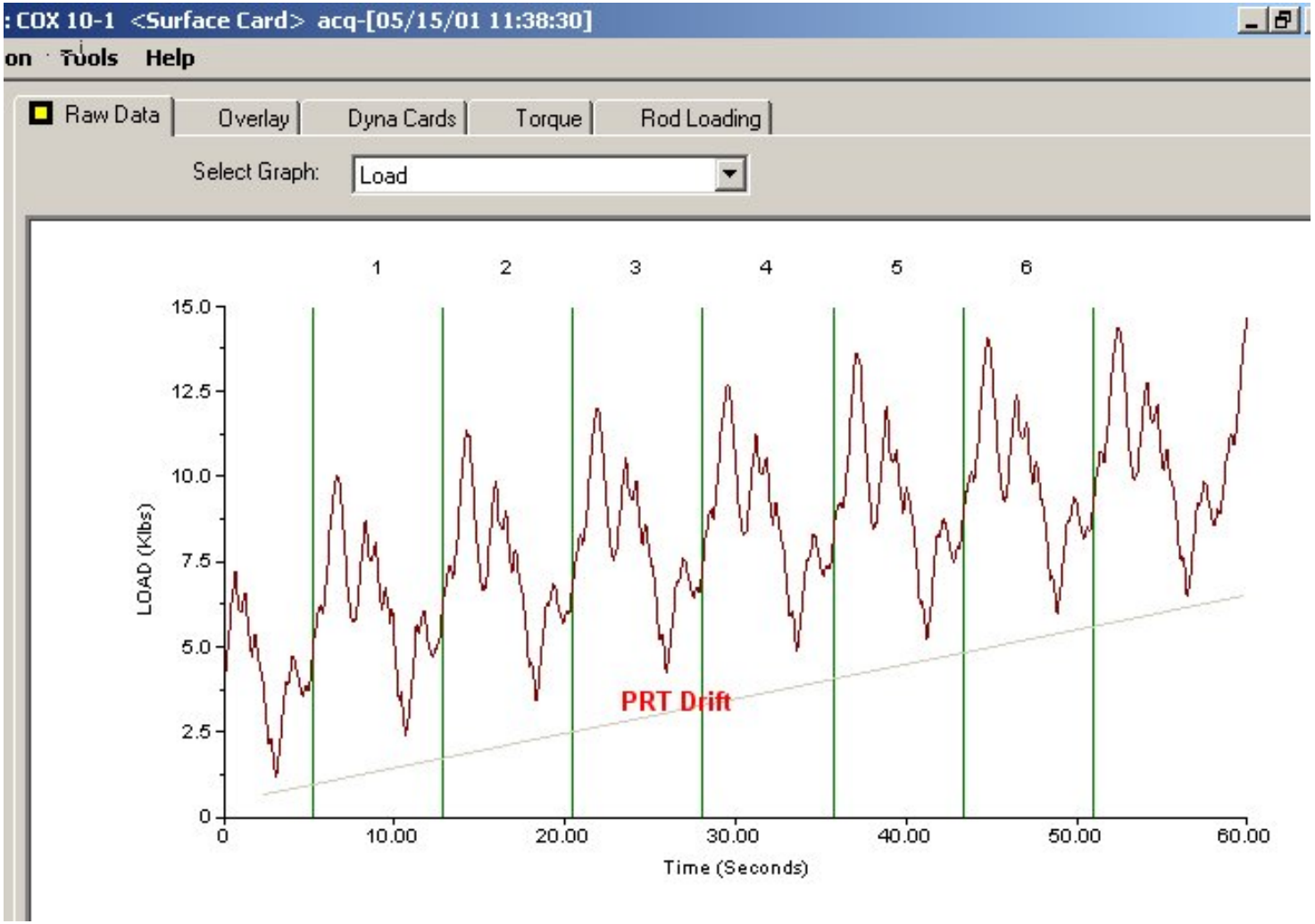
Drift of the load during data acquisition is minimized by waiting for the PRT temperature to equalize with that of the polished rod, thus it is most efficient to attach the PRT onto the polished rod (with minimum tightening) at the earliest time after the operator arrives at the well. Stop the unit just long enough to attach the PRT and the coiled cable then restart the motor so that pumping continues with minimum interruption.



Correcting for drift would help most the analysis of Valve test data



Proper ***tightness*** reduces load drift.



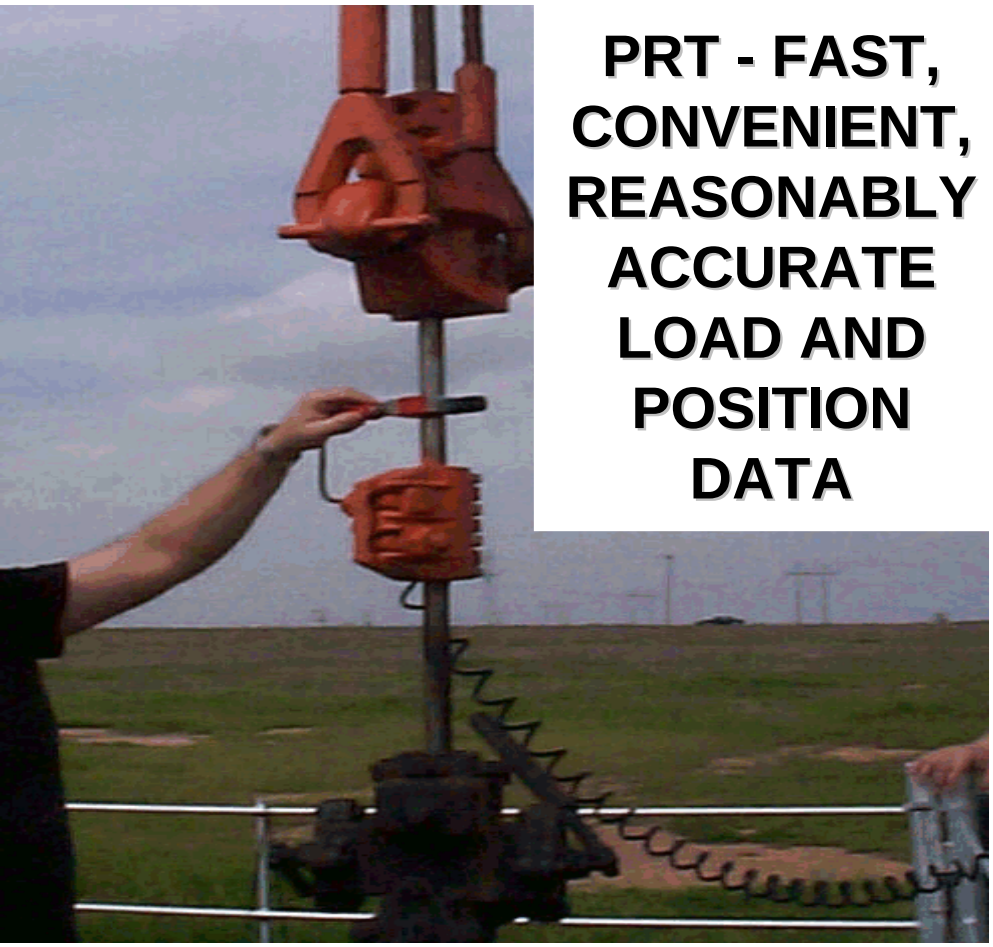
Any change in temperature of the transducer or polished rod will be the primary cause of load drift.

Try to maintain the PRT at the same environment temperature as the polished rod OR let the temperature stabilize after the PRT is placed on the polished rod.

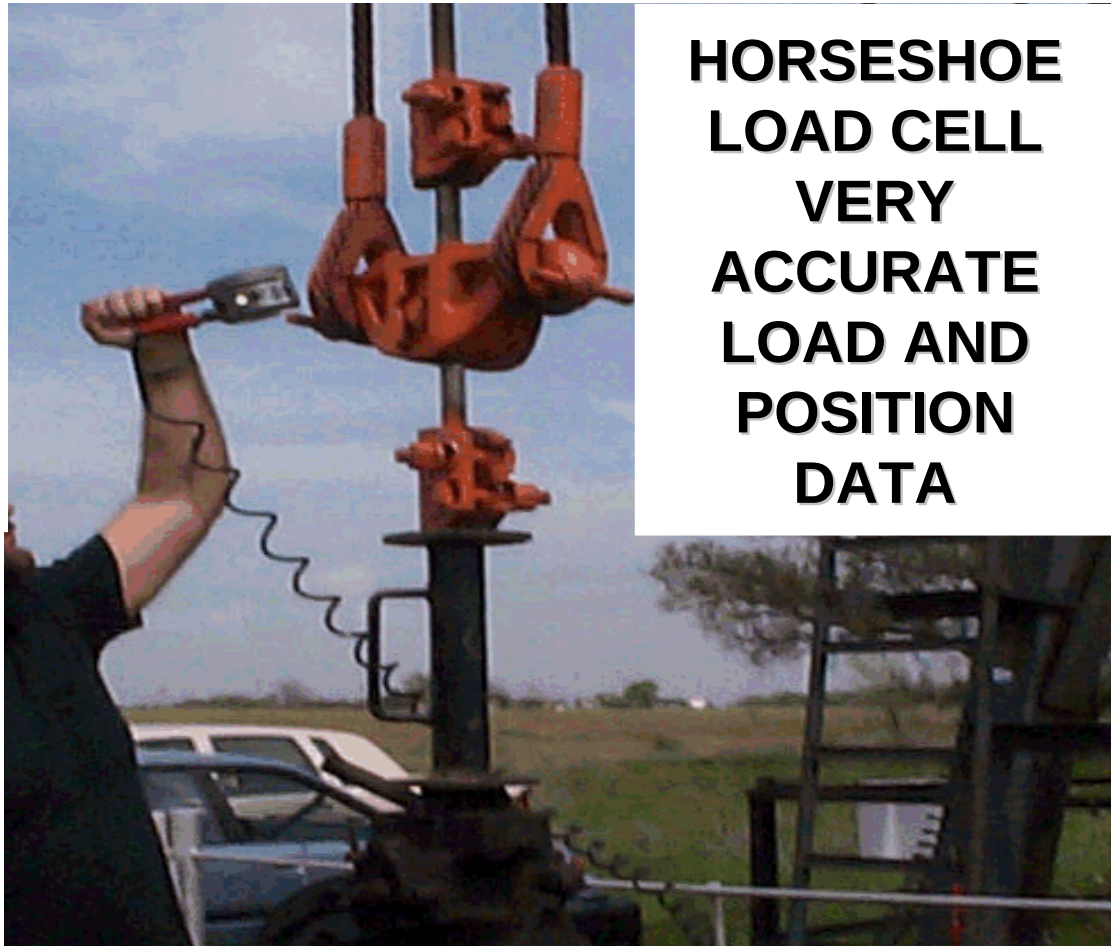
Comments concerning load drift When the Dyno load data slopes, it is “usually” because of one of the following reasons:

- Center the PRT on the polished rod by using the half moon cut. DO NOT push the PRT too far forward on the polished rod, OR load drift can occur.
- PRT should be attached to the polished rod at least 6 inches from any load bearing clamp. Stress lines are not uniform if the PRT is too close to the clamp.
- Do NOT attach PRT onto a rusty polished rod. If the steel surface is not bonded to the polished rod prior to attaching the PRT, then use emery cloth on the polished rod to clean and smooth the polished rod surface.
- Try to maintain the PRT at the same environment temperature as the polished rod OR let the temperature stabilize after the PRT is placed on the polished rod.
- Loop the coiled cable around the adjusting screw to prevent the cable connector from pulling out of the transducer connector. Dynamometer’s coiled cable can vibrate loose from the polished rod transducer connector as the polished rod travels up and down. Side load caused by the coiled cable pulling on the polished rod transducer can affect the transducer's output.

Common Types of Portable Dynamometers



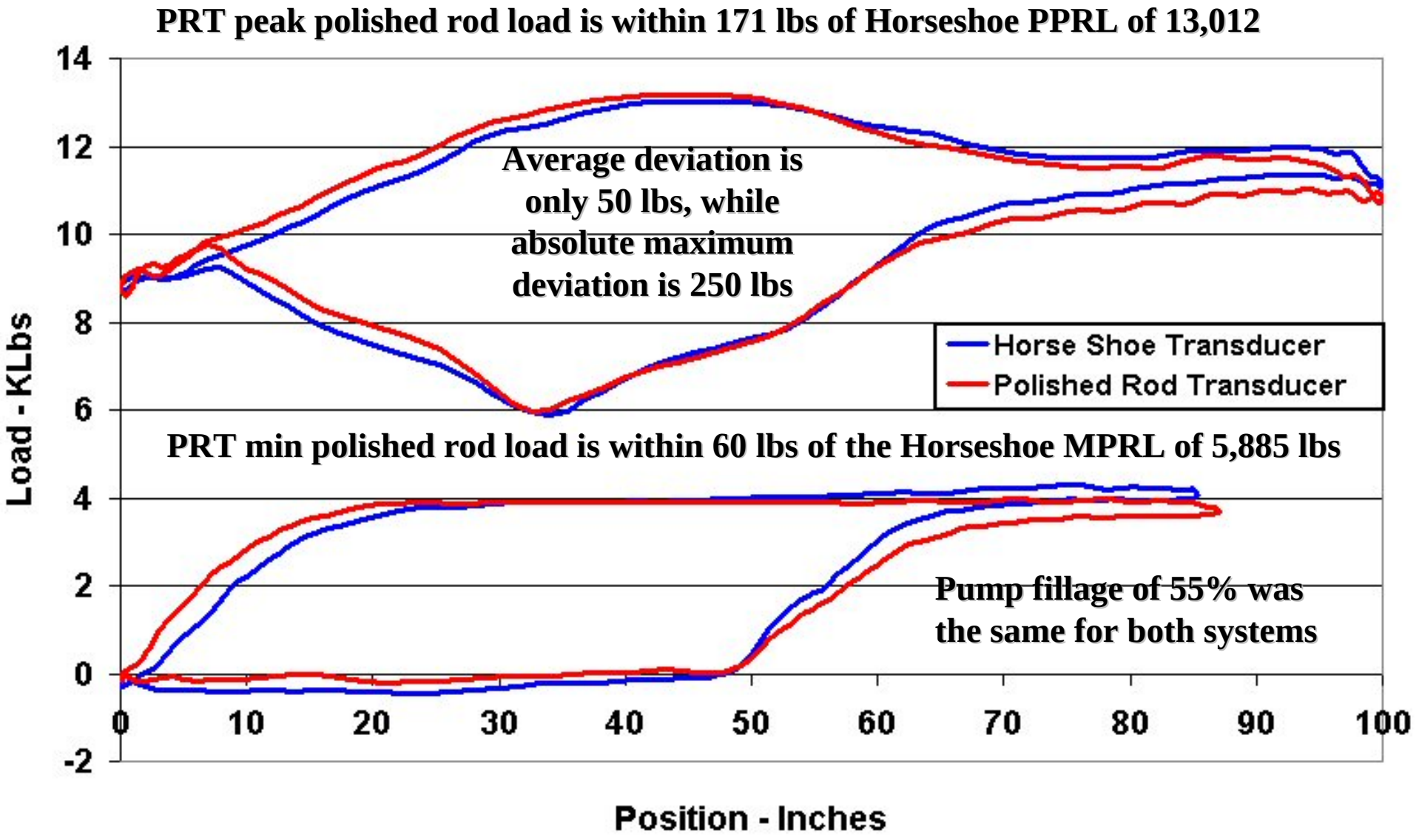
PRT - FAST, CONVENIENT, REASONABLY ACCURATE LOAD AND POSITION DATA



HORSESHOE LOAD CELL VERY ACCURATE LOAD AND POSITION DATA

1. **To acquire Dynamometer Data most operators primarily uses the PRT, but occasionally must use the horseshoe load cell.**
2. **Why is *BAD* appearing data acquired using the PRT *GOOD***
3. **Appearance of dyno data may indicate a misaligned polished rod**

Compare PRT and Horseshoe Acquired Loads



1. Shapes of the dynamometer cards are the same.
2. Difference in load acquired using the PRT when compared to the load acquired with a horse load cell is small

Polished Rod Transducer Determines Vertical Load using Hooke's Law

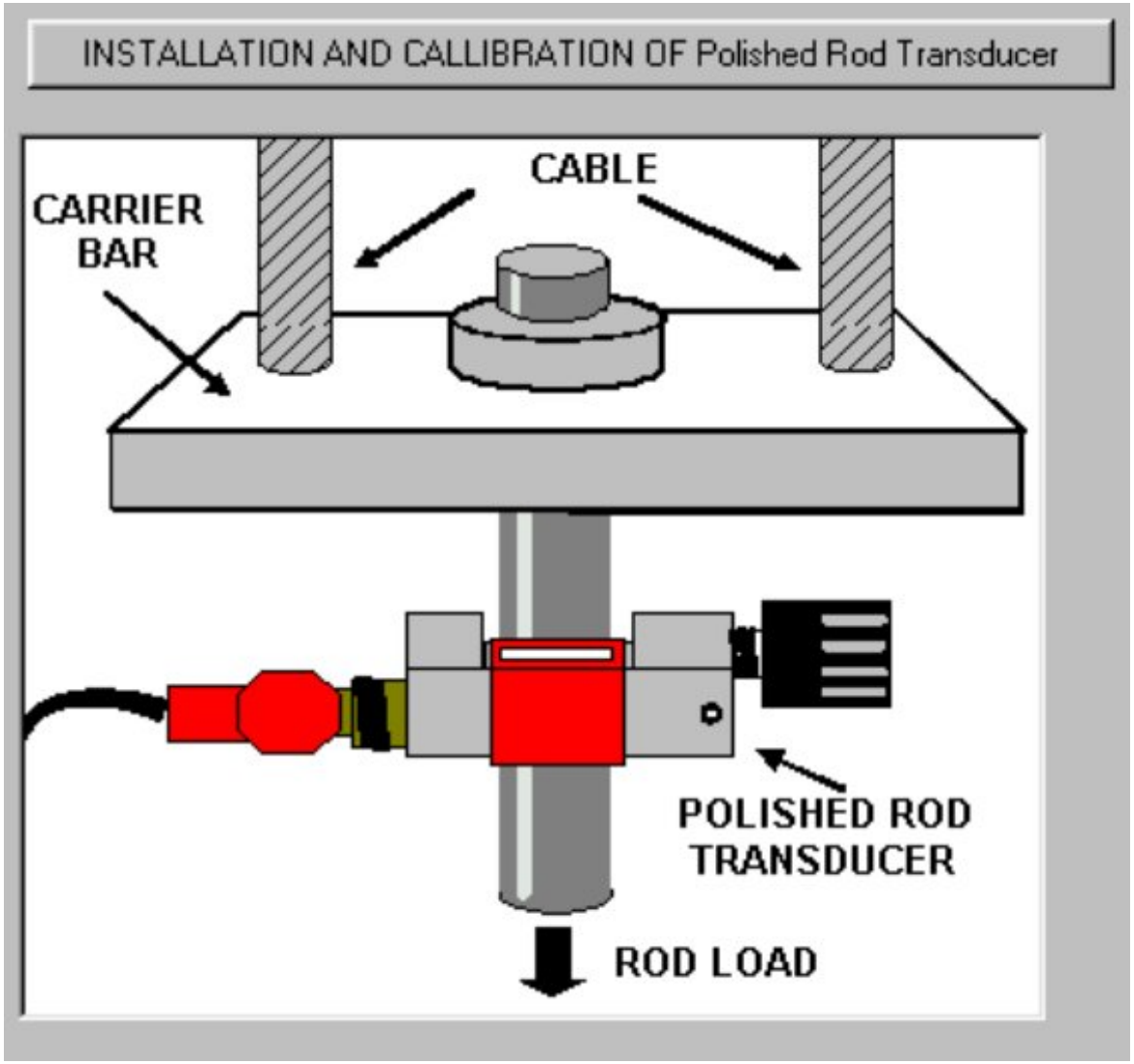
1. Attaches to the polished rod.

2. Strain in the radial direction resulting from a stress in the axial direction is converted into changes in axial load on the polished rod

3. Hooke's law, $\varepsilon_z = \sigma_z / E$,for homogeneous isotropic materials $\varepsilon_r = \mu\varepsilon_z$

4. PRT is approximately 3 times more sensitive than horse shoe load cell gauge that measures axial strain.

Placement on Polished Rod



Do NOT attach onto a rusty polished rod.

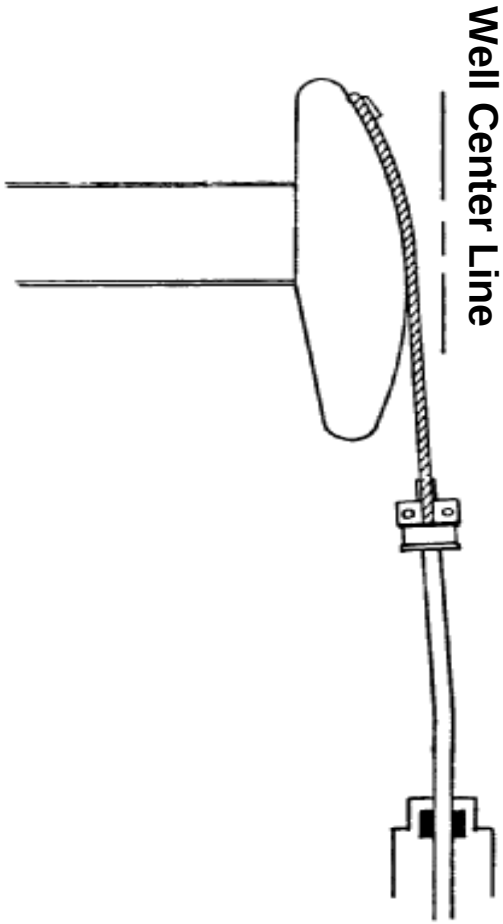
If the steel surface is not bonded to the polished rod prior to attaching the transducer, then use emery cloth on the polished rod to clean and smooth the polished rod surface.

Should be attached to the polished rod at least 6 inches from any load bearing clamp.

Dynamometer Transducer

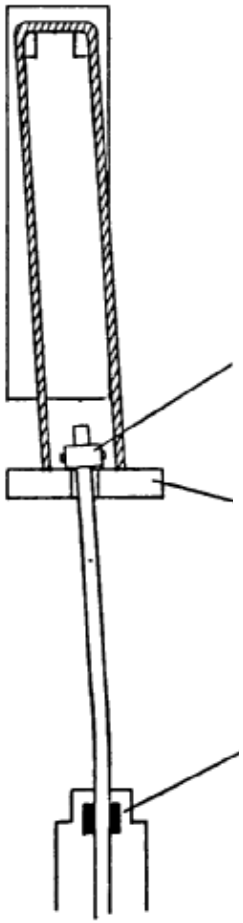
1. **Polished Rod Transducer is quick and easy to use**
2. **Transducer Temperature should be Equalized with Environment Prior to Data Acquisition**
3. **Does not measure the vertical load, but measures the diameter change of the polished rod.**
4. **Weight of rods in fluid plus setting pump card on zero load line used to convert change in load into surface load.**
5. **If the rod string is vertical, not parted, no excessive friction, and correct lengths entered into the software, then the calculated surface loads can be very accurate.**
6. **If loads appear to be in error, then operator should consider acquiring loads using the Horseshoe load cell.**

Pumping Unit Misalignment



10 SPM =

5,256,000 Strokes in One Year Bending the Polished Rod like a piece of wire until it BREAKS

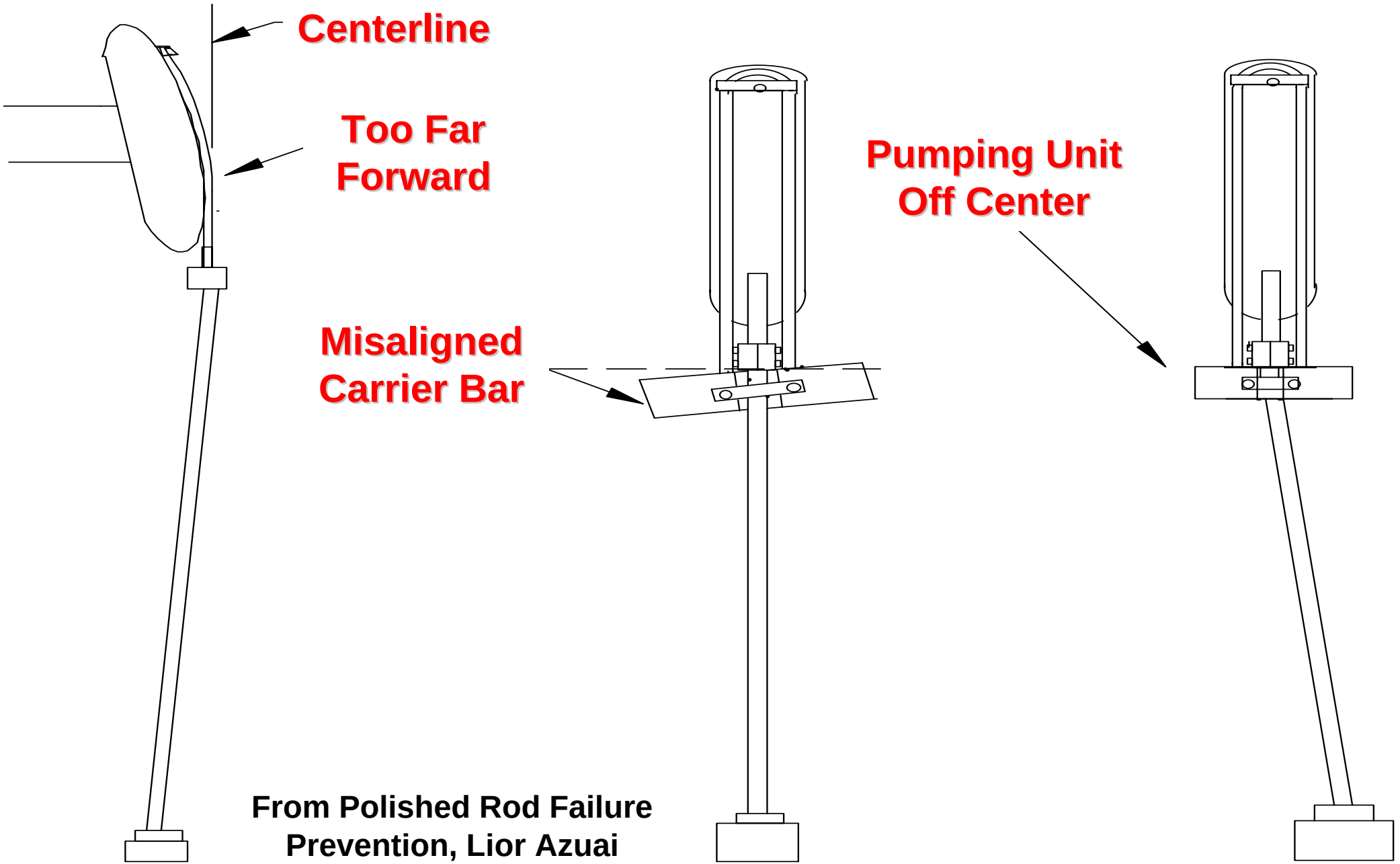


Pumping Unit is Too Far Back

Pumping Unit is Right or Left of the Wellhead

Visual Inspection

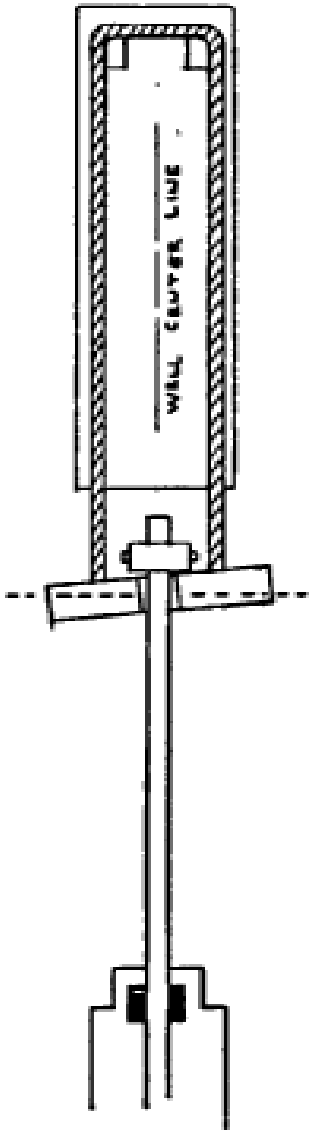
From different angles look how the polish rod moves with the horse head.



From Polished Rod Failure Prevention, Lior Azuai

Carrier Bar Not Level

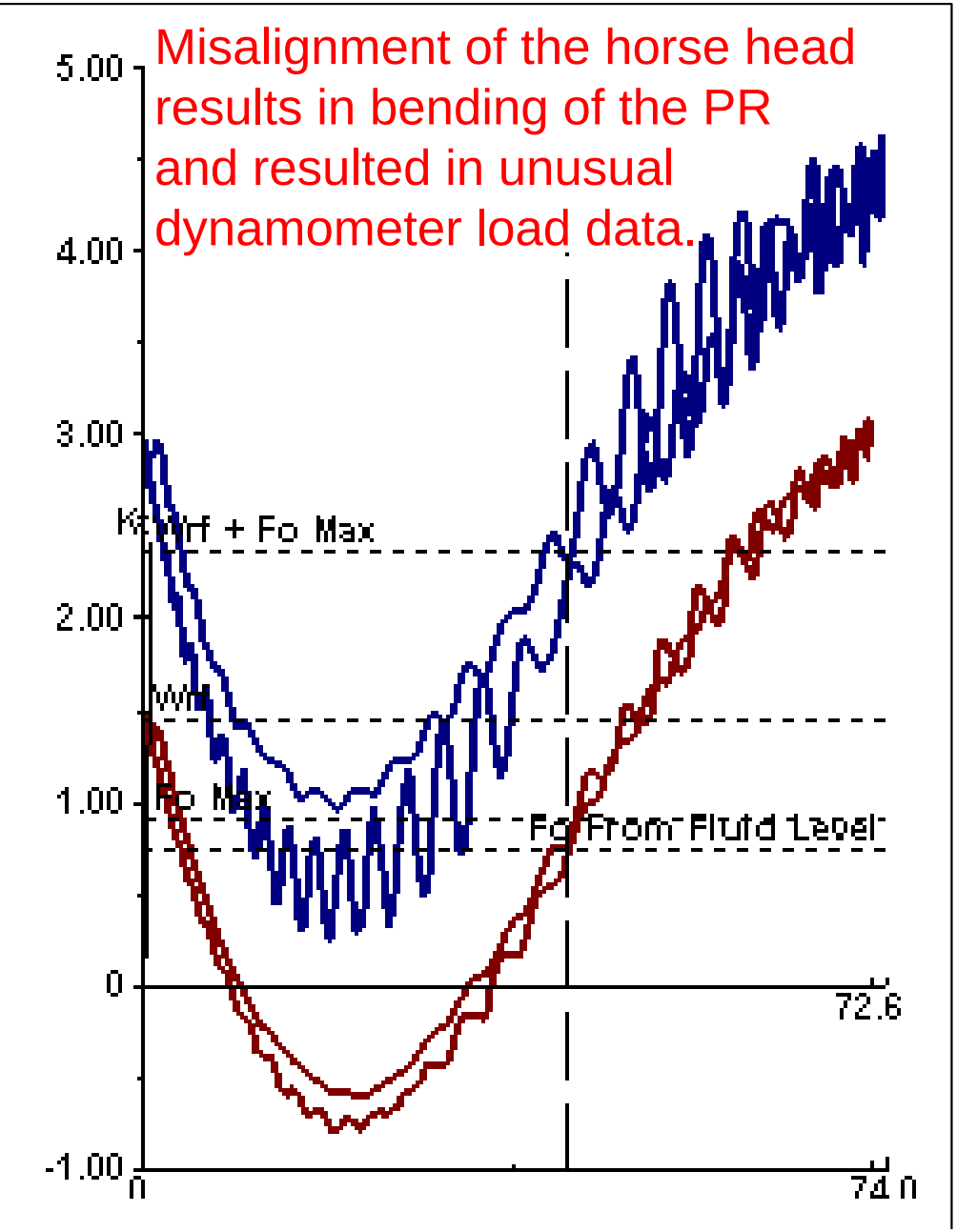
- **Check the carrier bar OR Polished Rod with a level; look for uneven bridle length**
- **Check between the clamp and the carrier bar with a feeler gauge, will it slide under one side or the other?**
- **With the clamp off, look for a worn or dished out area on the carrier bar where the clamp sits.**
- **If load Cell on Carrier Bar, then use a leveling plate or helical washer to spread the load across the carrier bar.**
- **Examine the Pumping Unit base and the tie downs of the pumping unit for any signs of movement**

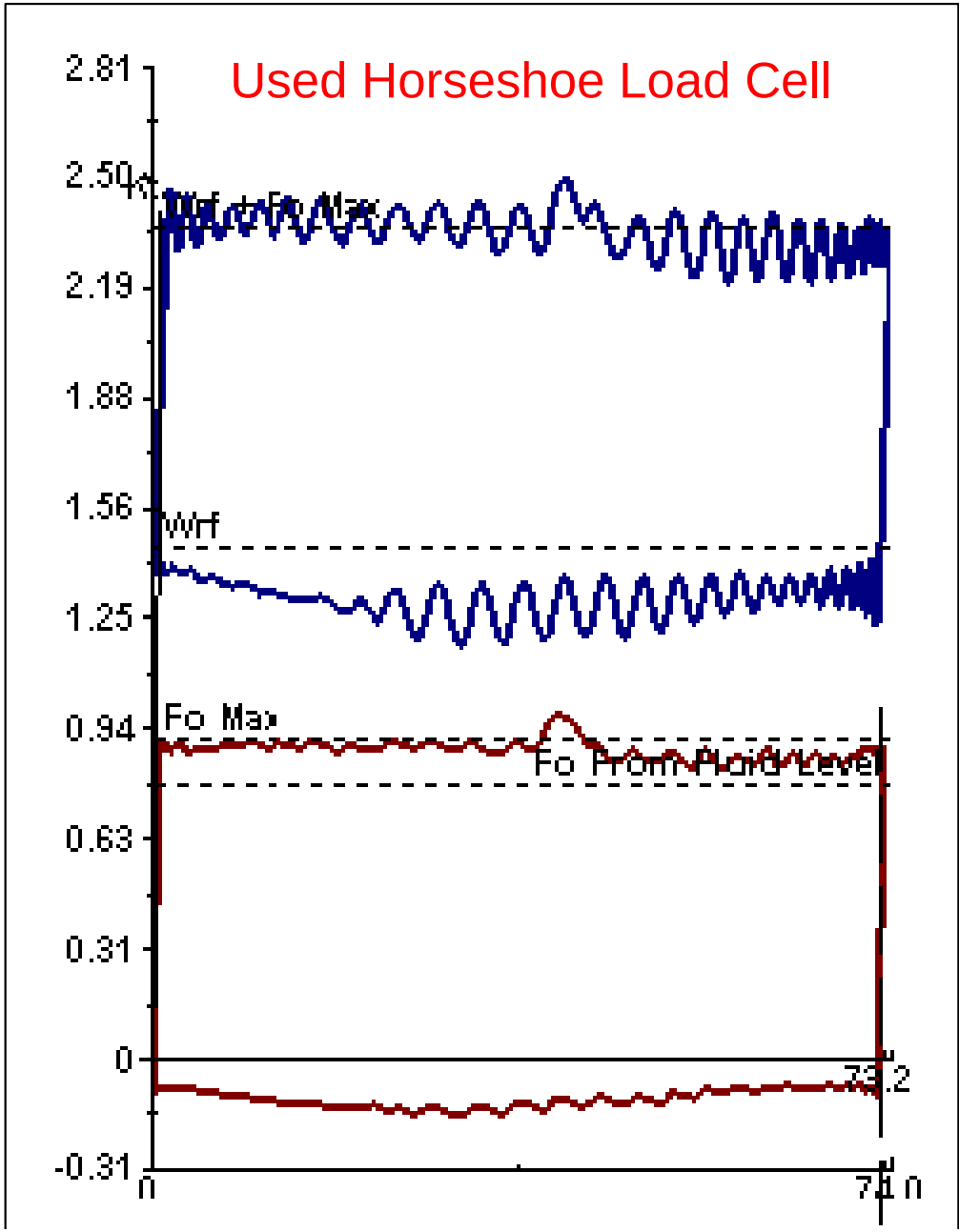


From Polished Rod Failure Prevention, Lior Azuai

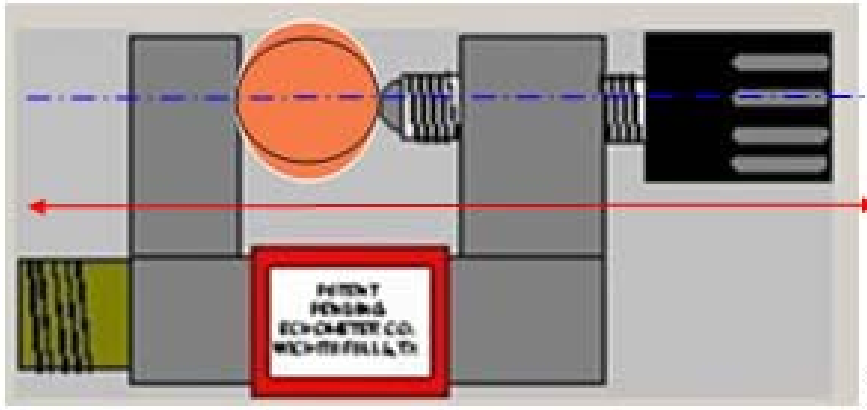
INDECO Pumping Unit without a Horse Head

Carrier bar directly connected to the walking beam by rods. Polished rod deflection due to walking beam moving on a radius and not vertically aligned over well head.

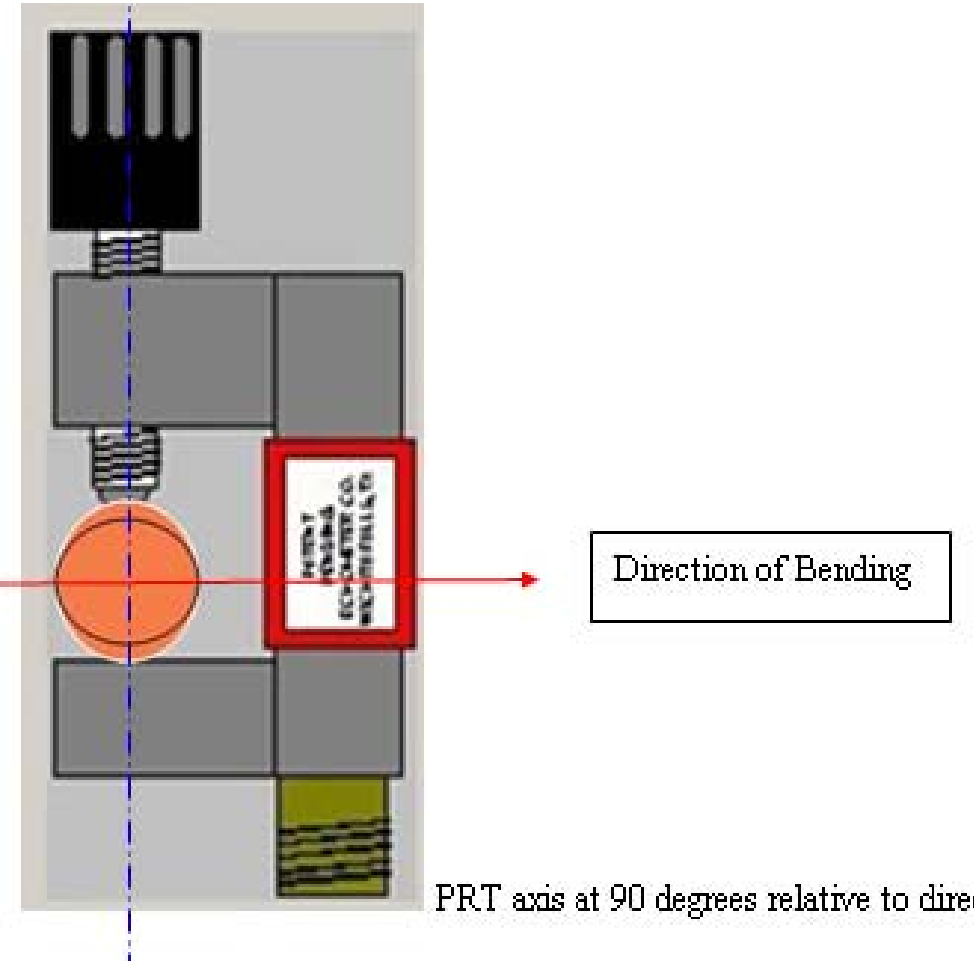




Bending Polished Rod



PRT axis at 0 degrees



PRT axis at 90 degrees relative to direction of bending

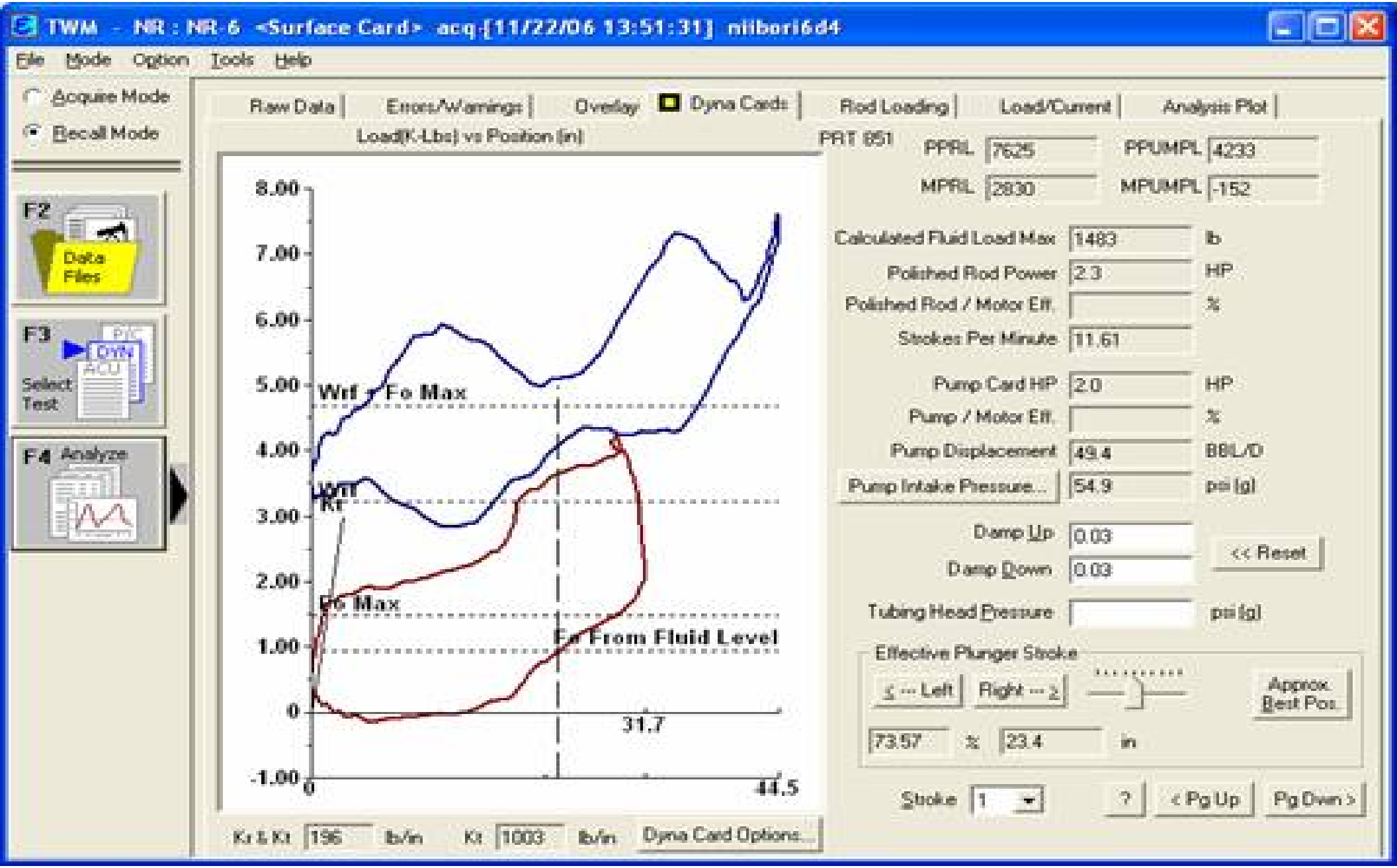
Misshaped Dynamometer Card from this type of transducer can be an indication that the center of the carrier bar is not aligned with the stuffing box.

PR Misalignment induces unusual stresses in the steel polished rod due to bending of the polished rod during the stroke.

Using Dynamometer Transducer that converts Diameter Change into Polished Rod Load

1. Sometimes an unusual slope/shape of the dynamometer data is acquired.
2. Slope/shape may be due to placement of transducer on the polished rod.
3. Polished rod could be bending due to misalignment of the polished rod from the horse head to the wellhead.
4. Try to rotate the transducer around the polished rod
   - Notice if the surface dynamometer card changes shape as axis of bending changes with respect to transducer.
5. Dynamometer data may appear normal if axis of bending does not impact diameter change of the polished rod measured by transducer.
6. Surface stroke length is usually not affected

Is my pump working?



PU setting


Vertical line
Followed line with polish rod
NR-6


Vertical line
Followed line with polish rod
NR-6

Dynamometer Card acquired when polish rod was stroked vertically using crane.

TWM - NR : NR-6 <Surface Card> acq-[12/19/06 04:49:09]

File Mode Option Tools Help

Acquire Mode
Recall Mode

F2 Data Files

F3 P/C DYN ACU Select Test

F4 Analyze

Raw Data | Overlay | Dyna Cards | Rod Loading | Analysis Plot

Load (K-Lbs) vs Polished Rod Pos. (in)

6.250
5.625
5.000
4.375
3.750
3.125
2.500
0
44.5

Load (K-Lbs) vs Plunger Pos. (in)

5
4
3
2
1
0
Fo Max
0
44.8

PRT 851

PPRL	3667	PPUMPL	401
MPRL	2977	MPUMPL	0

Calculated Fluid Load	1705	lb
Polished Rod Power	0.1	HP
Polished Rod / Motor Eff.		%
Strokes Per Minute	5.31	
Pump Card HP	0.1	HP
Pump / Motor Eff.		%
Pump Displacement	33.5	BBL/D
Pump Intake Pressure	1221.5	psi (g)
Damp Up	0.01	
Damp Down	0.01	
Tubing Pressure		psi (g)

<< Reset

Pump Fillage Adjustment

<--- Left | Right ---> | Fillage 77.33 % | Approx Best Pos.

Stroke 1 | ? | < Pg Up | Pg Dwn >

Use Level to Check Polished Rod Alignment

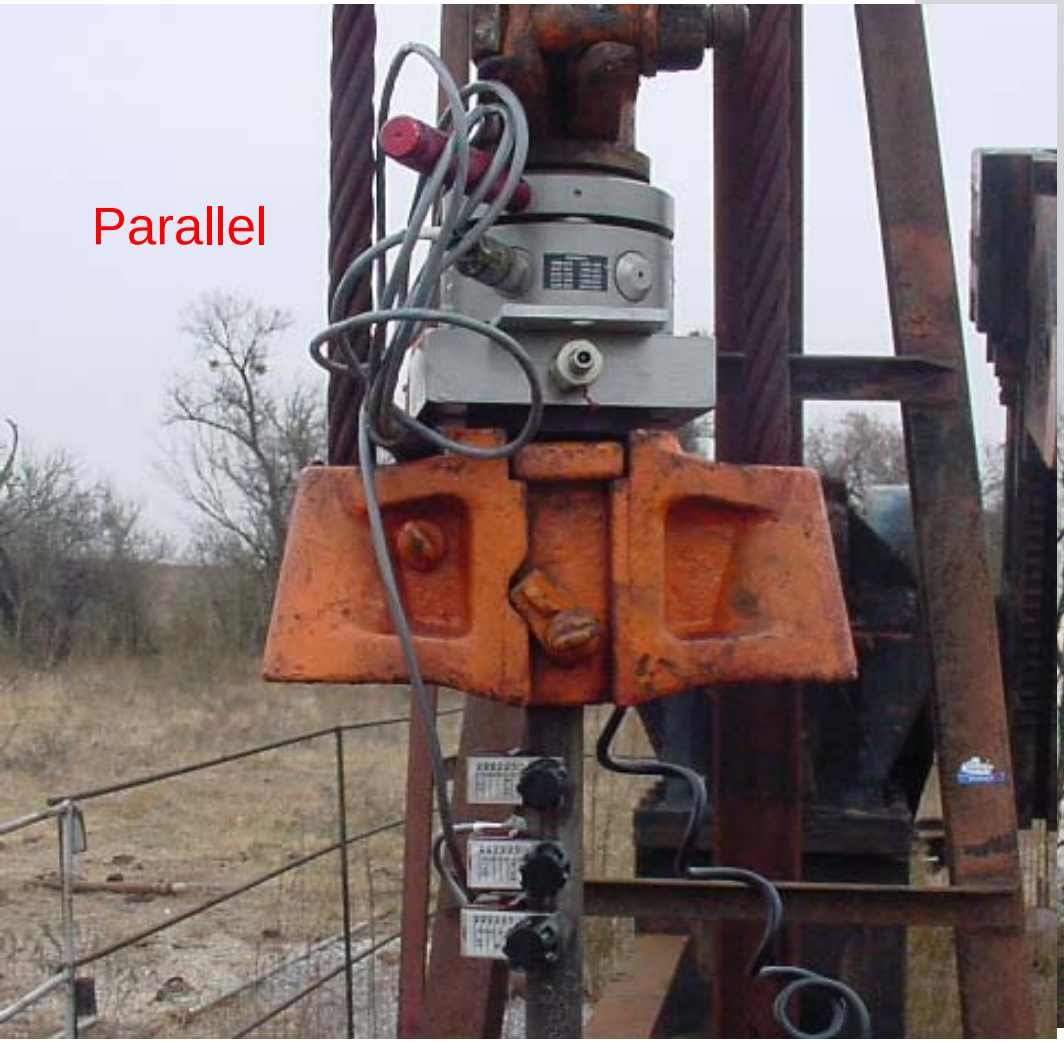
Misalignment approximately 0.5 inch per 4 foot in height

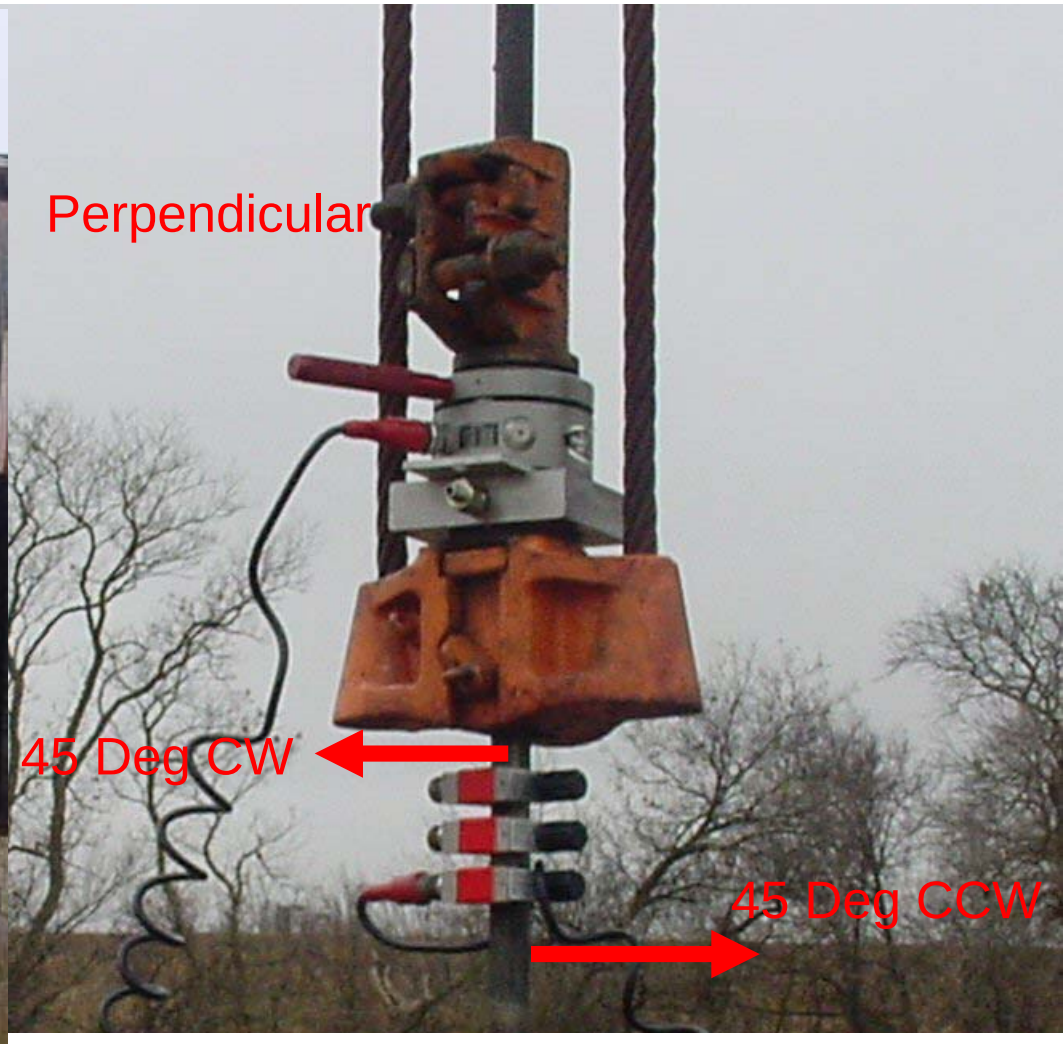
Use a carpenters level and **inspect** the polish rod at the top of the stroke and near the bottom of the stroke.

Testing of Bending Polished Rod:

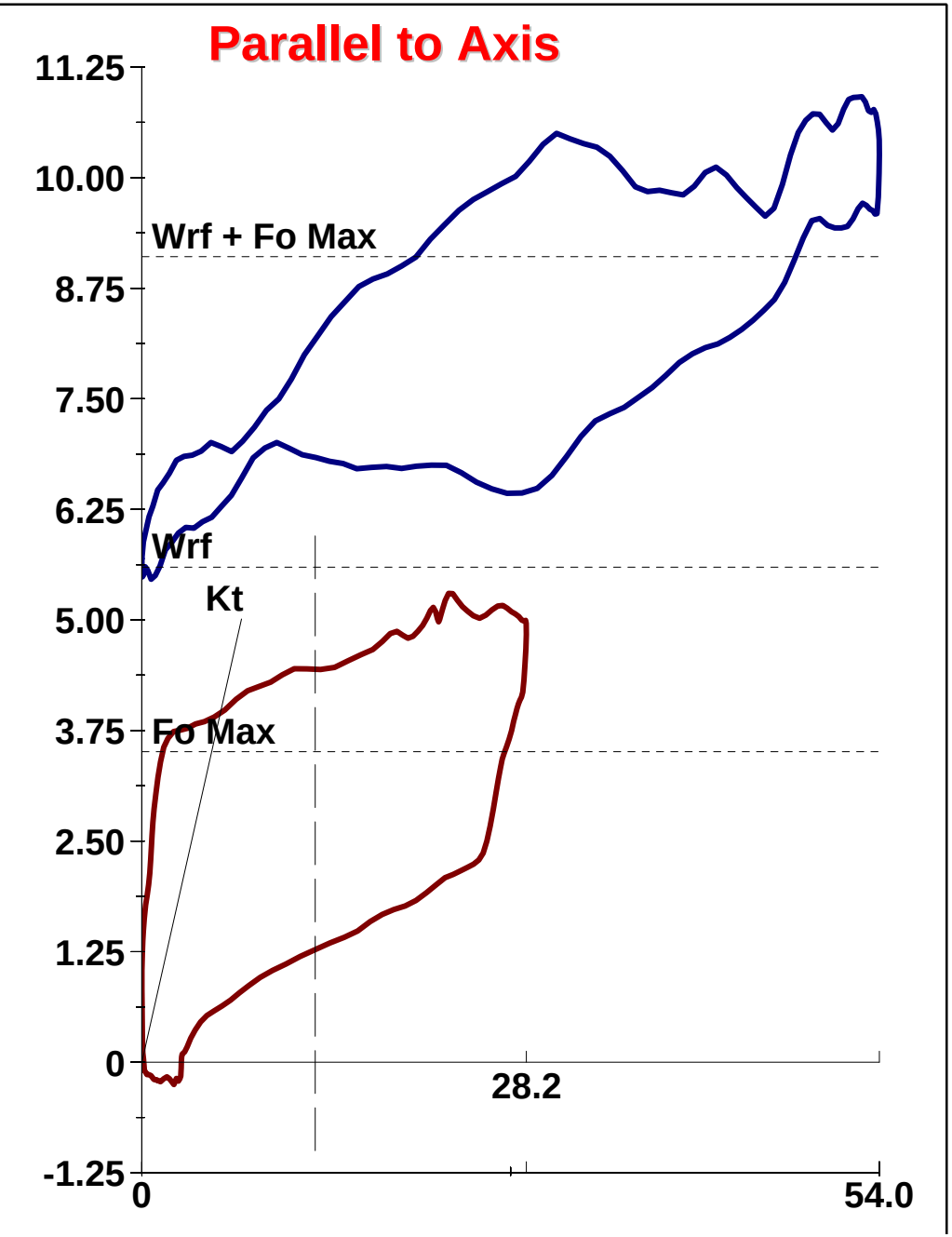
1) **Data acquired at same time using both types of load cell Transducers**

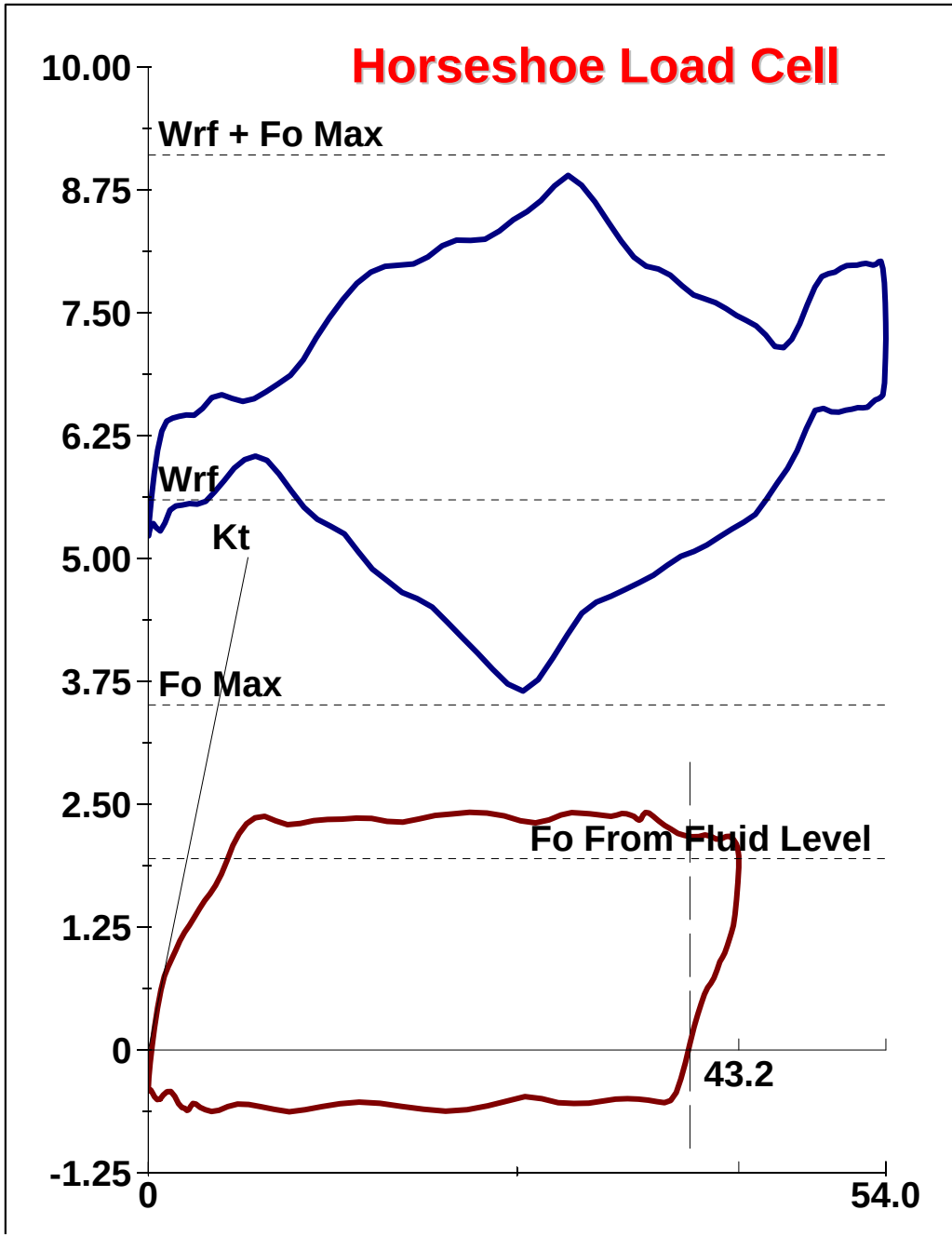
2) **Collected Dynamometer Data @ 45 Deg CCW, Perpendicular, 45 Deg CW, & Parallel to axis of Pumping Unit**



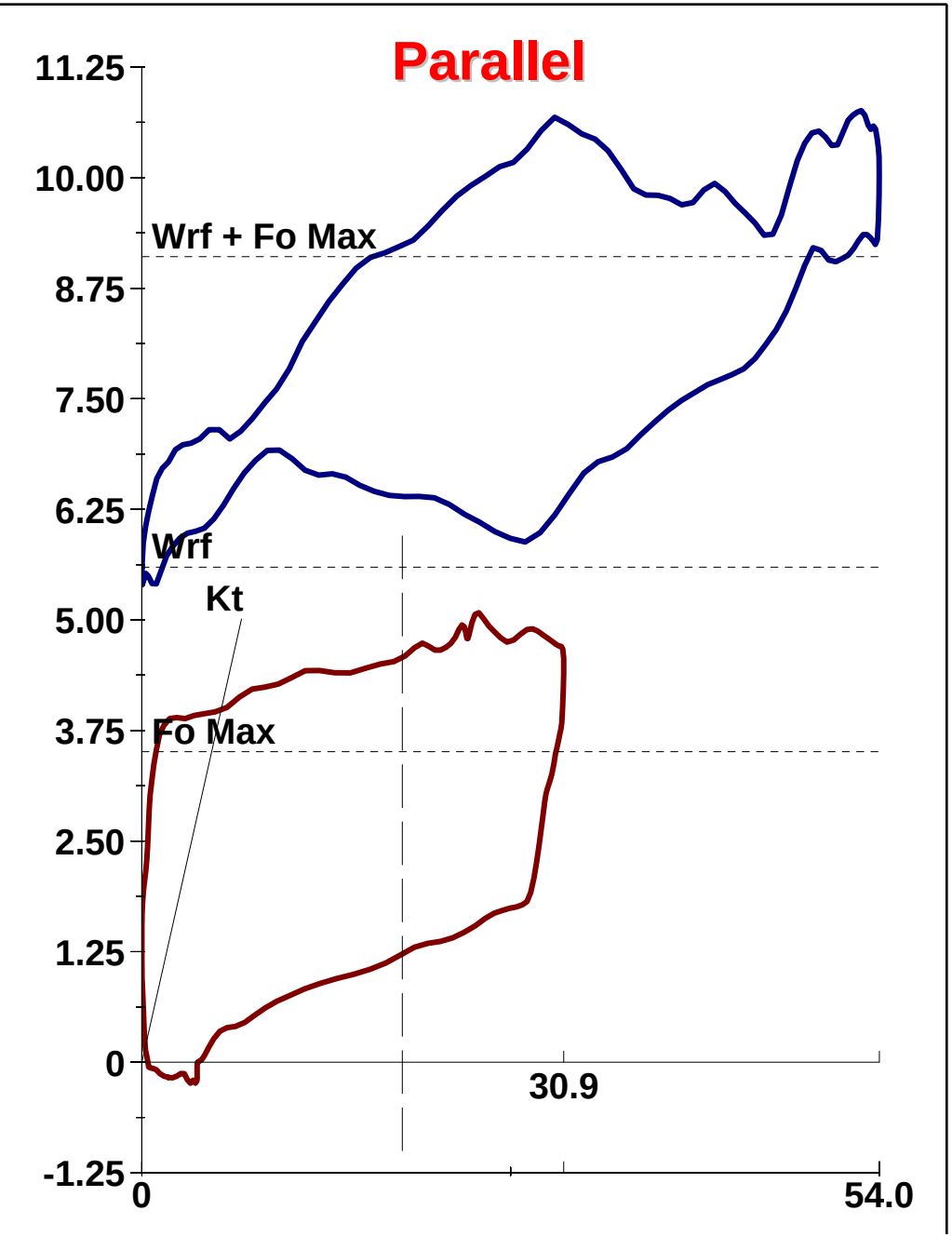


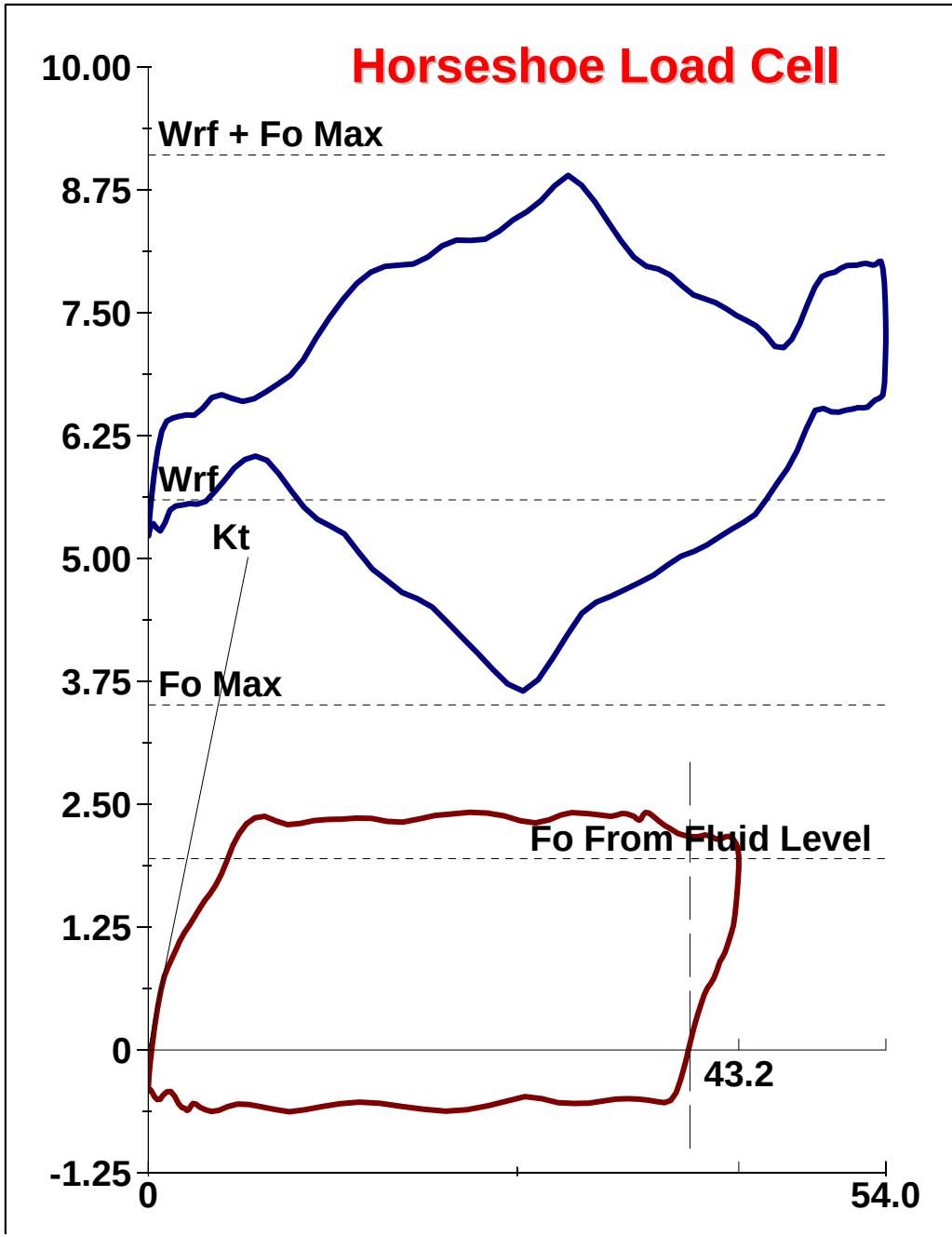
Top Transducer



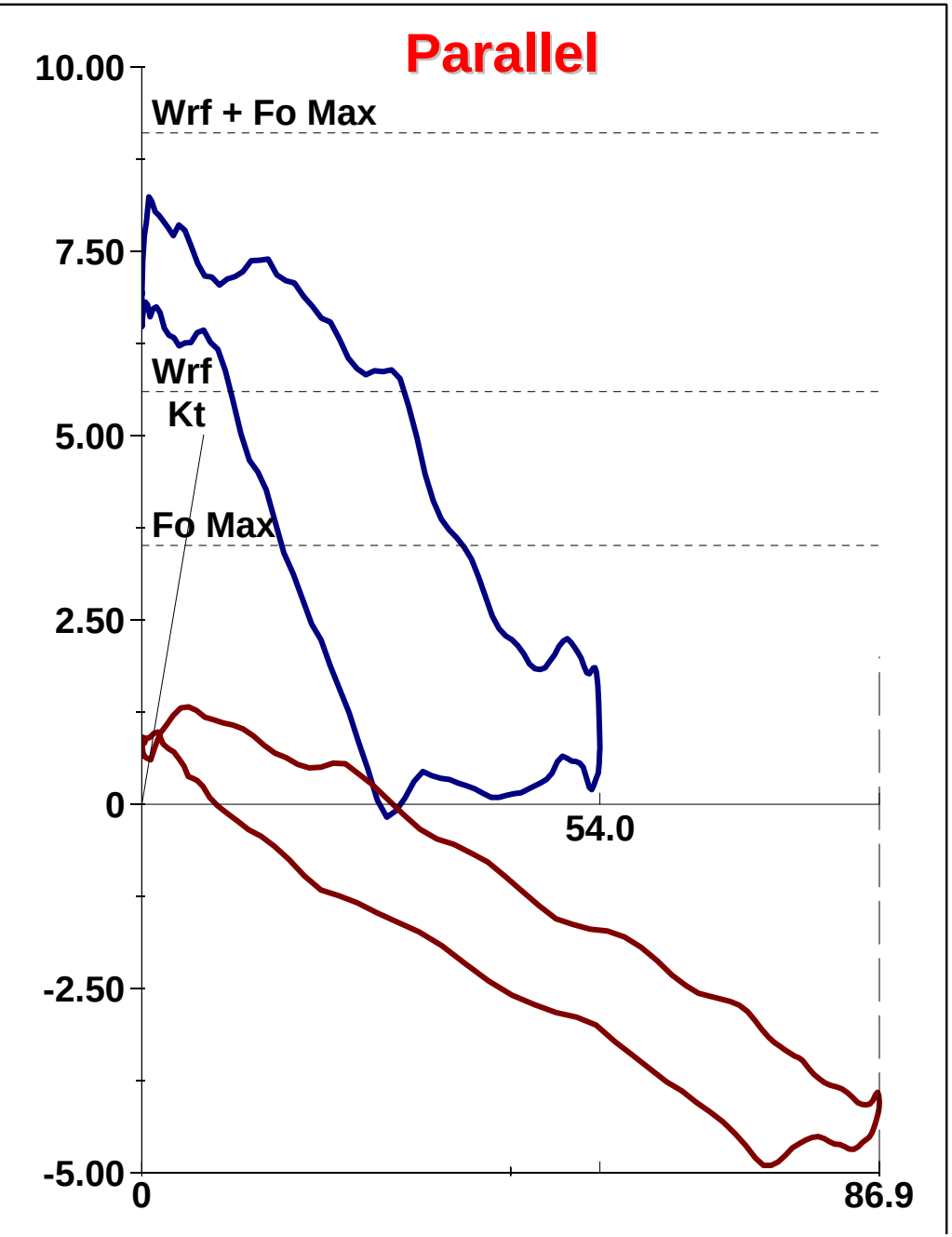


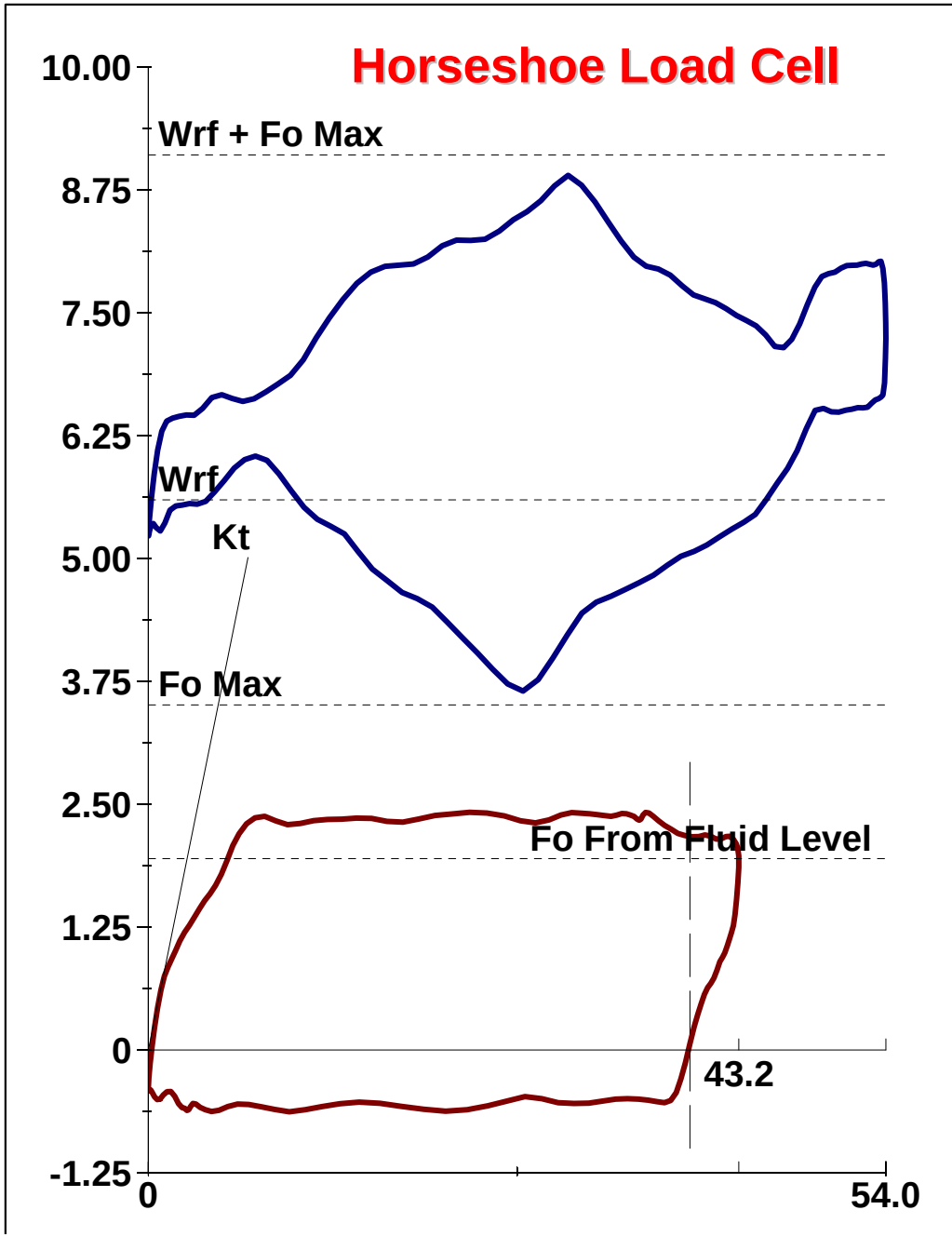
Middle Transducer

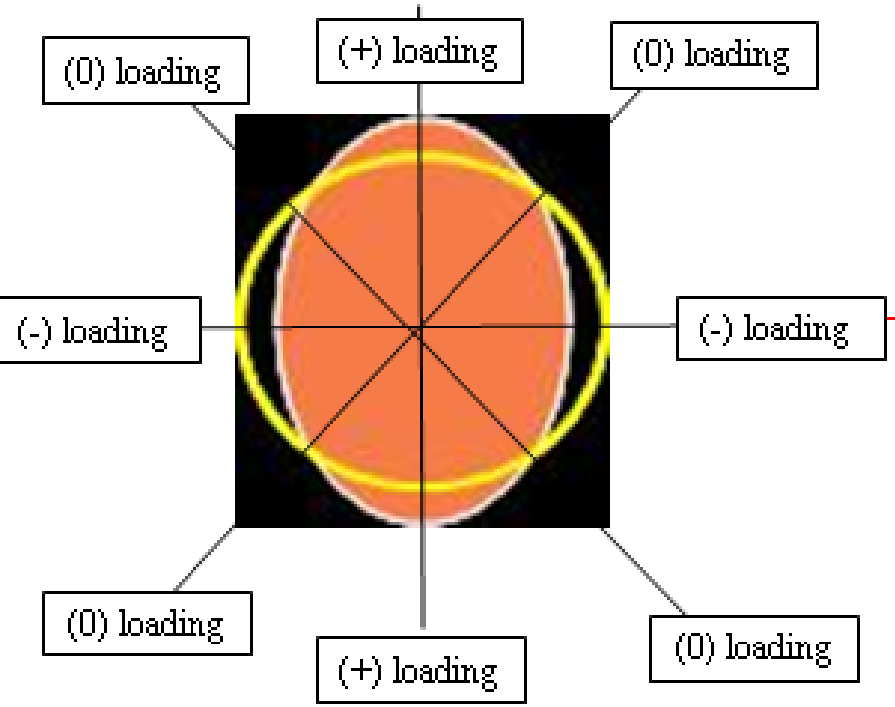


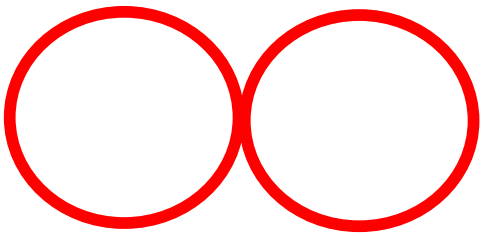


Bottom – Distance from Carrier Bar Impacts Loads









Direction of Bending

Possible to move centerline of PR in Circular path or figure 8

Figure above shows that the additional "loading" could be cyclical with a period that is twice the period of rotation of the polished rod.

If polished rod does not rotate, then it may be best to install the transducer at (+/-) 45 degrees angle from the axis of bending.

Pilot Out of Rod Rotator

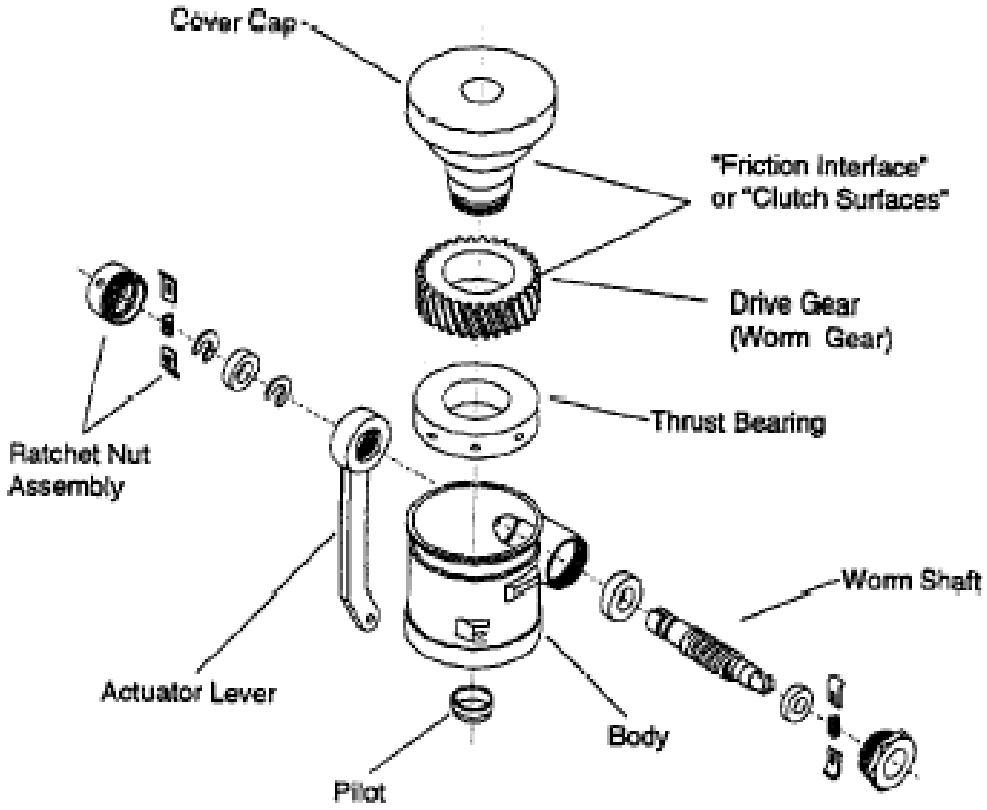
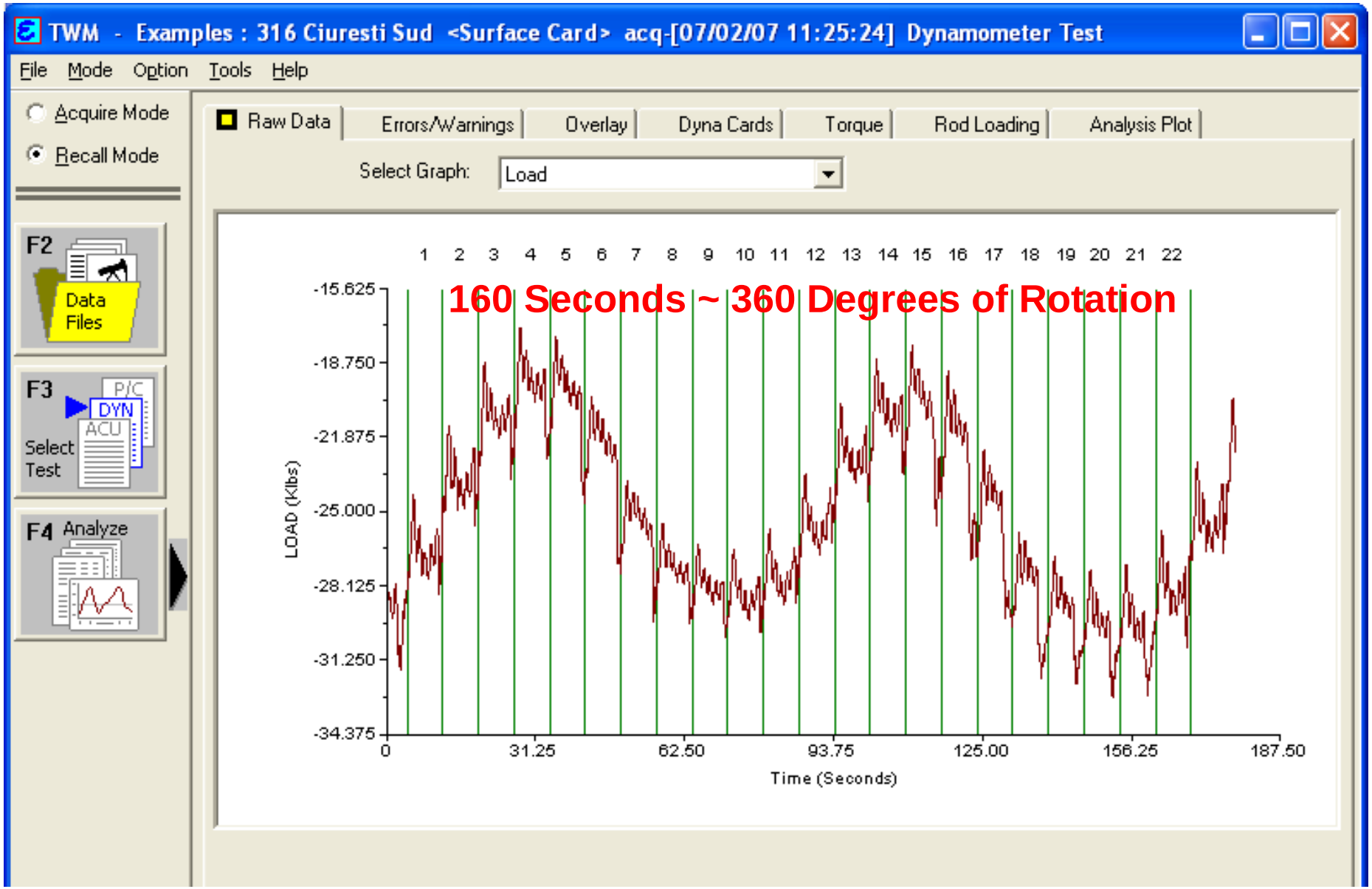


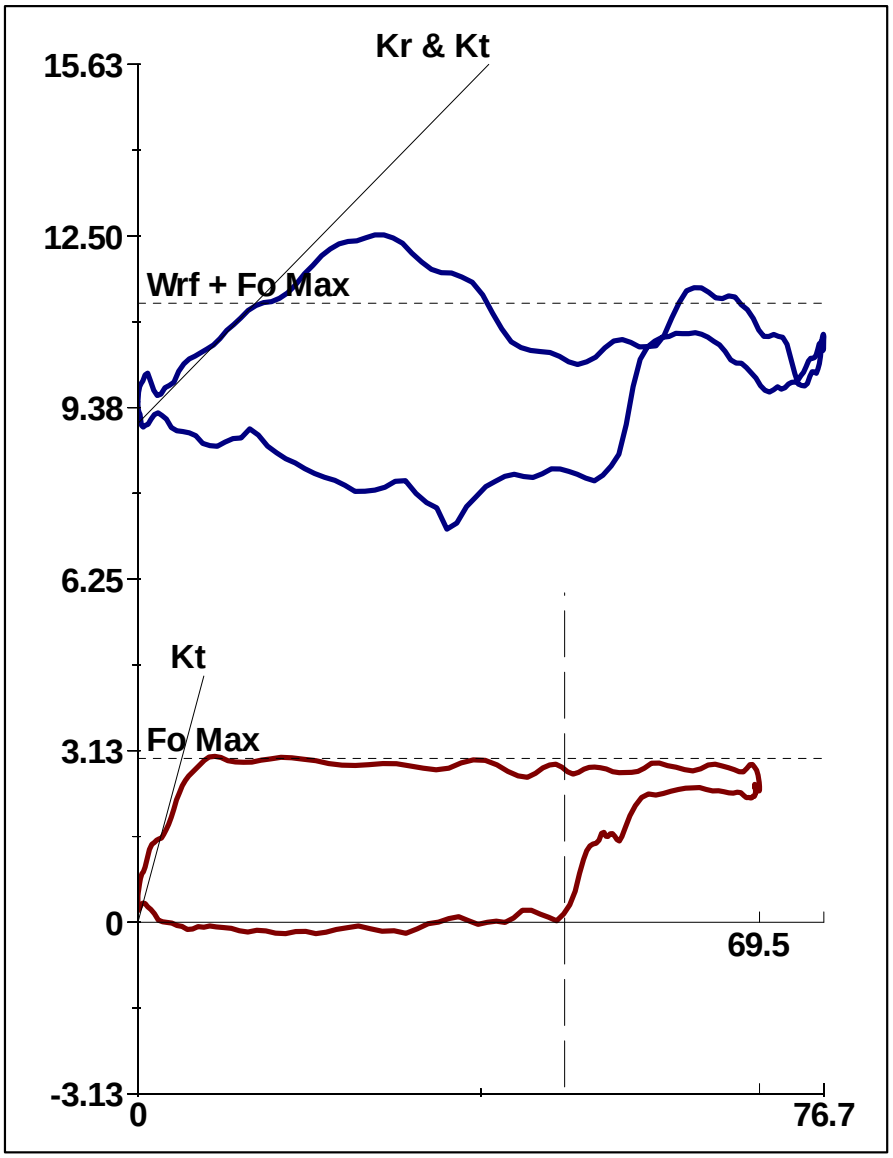
Figure 1 - T-302 Rod Rotator

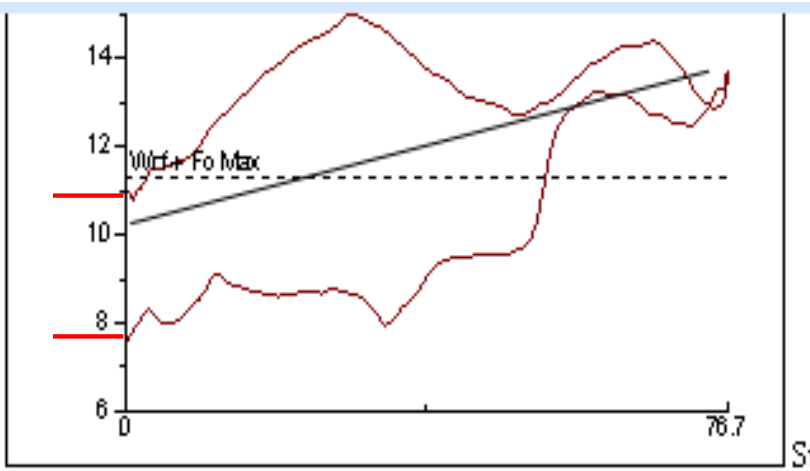
Rod Rotator Can Misalign the Polished Rod



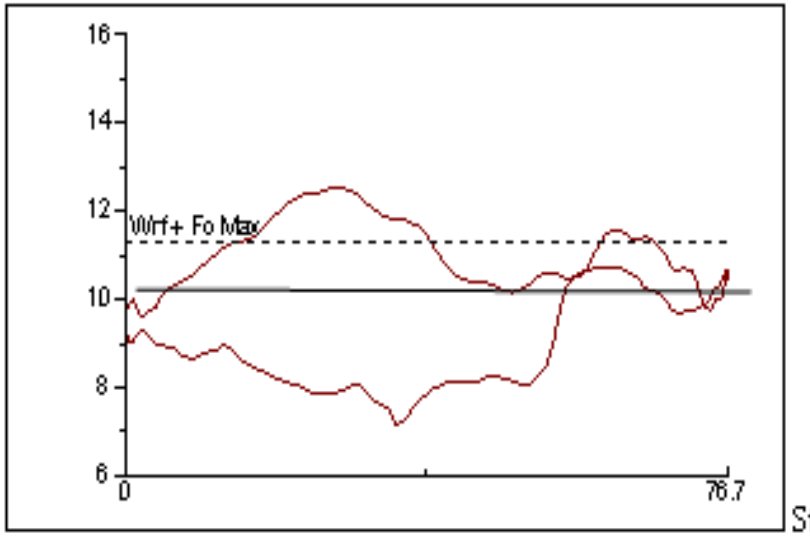
As the polished rod rotates, the transducer rotates so that the direction of bending relative to the axis of the transducer changes for each stroke

Cards show polished rod bending is causing the surface card to be tilted, by rotating the transducer to a position at angle different from the direction of bending.

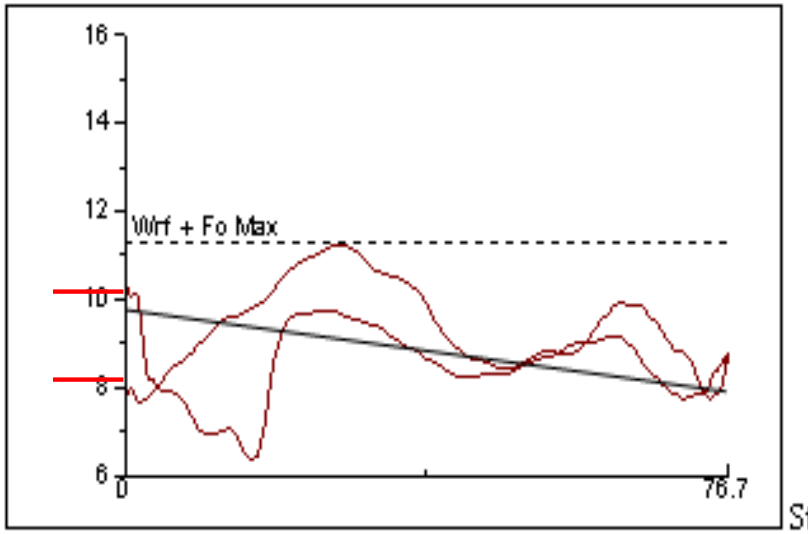




Stroke 17



Stroke 19



Stroke 22

Observations

1. **An abnormal shaped Polished Rod Transducer's surface dynamometer card can be used to identify:**
   - **Polished rod is misaligned**
   - **Rod rotator is defective**
   - **Pumping unit is without a horse head**
   - **Carrier bar is not level.**
2. **Align Polished Rod To Prevent Catastrophic Polished Rod Failure**
3. **Operator may improve the dynamometer data by just rotating the transducer by some angle**

Recommendations

1. For Temperature Drift the operator can place PRT on Polished Rod some length of time prior to acquiring data to allow Temperature of PRT to equalize with environment
2. Operator should use the Polished Rod Transducer for ease of use and speed.
3. Operator should use the Horseshoe load cell for the best loads from the standpoint of accuracy
4. For some analysis operator must either use the horseshoe load cell or you move the pumping unit and align the horse head and wellhead, then re-acquire load using the PRT.