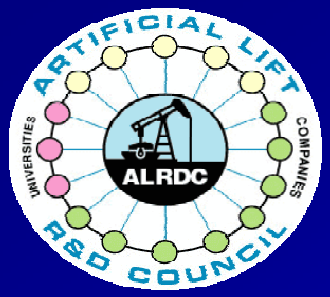




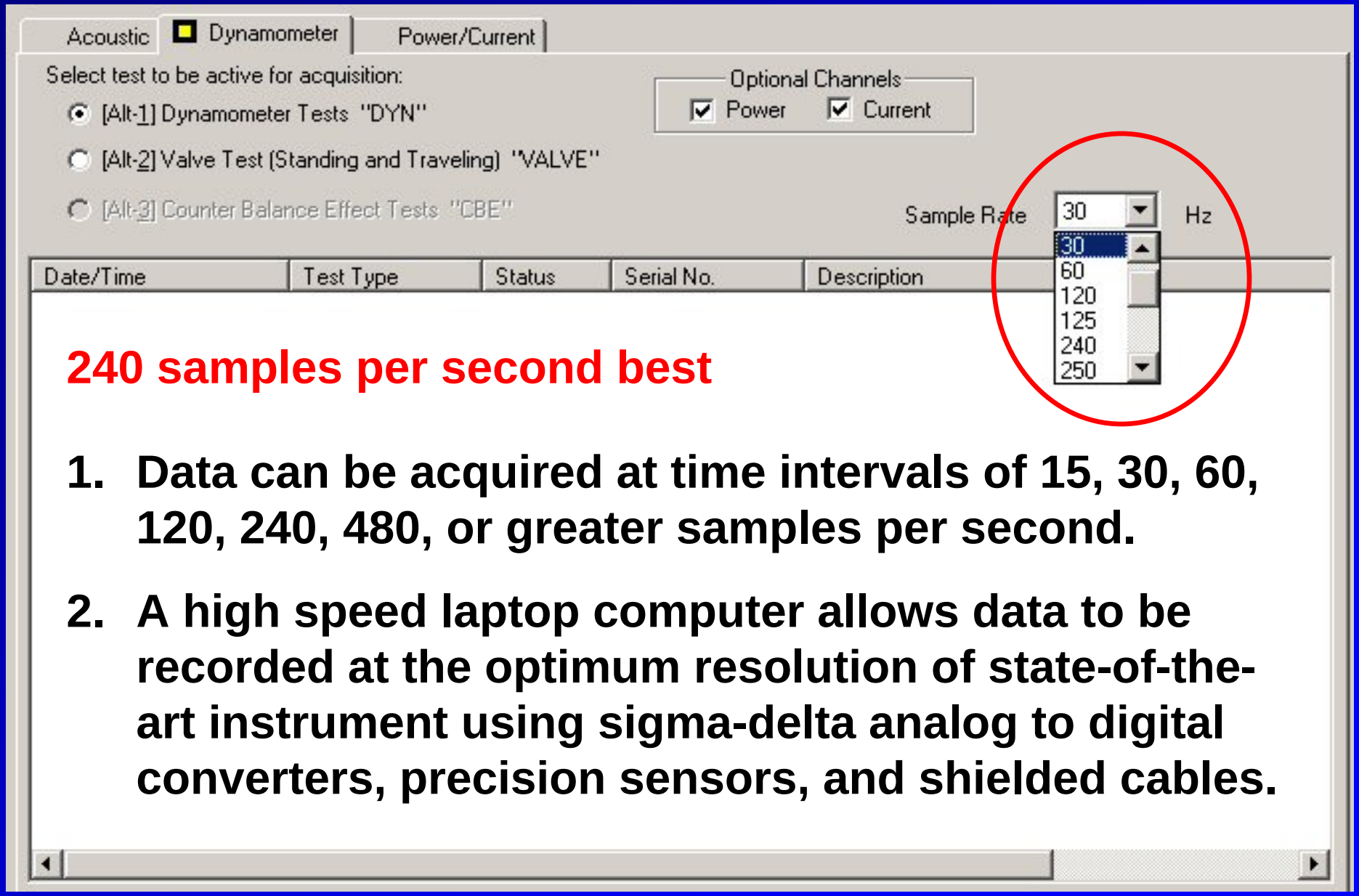
**Beam Pumping Workshop**

**Houston, Texas**

**October 4 - 7, 2005**

# Dynamometers Cards Benefits of High Speed and High Resolution Data Acquisition

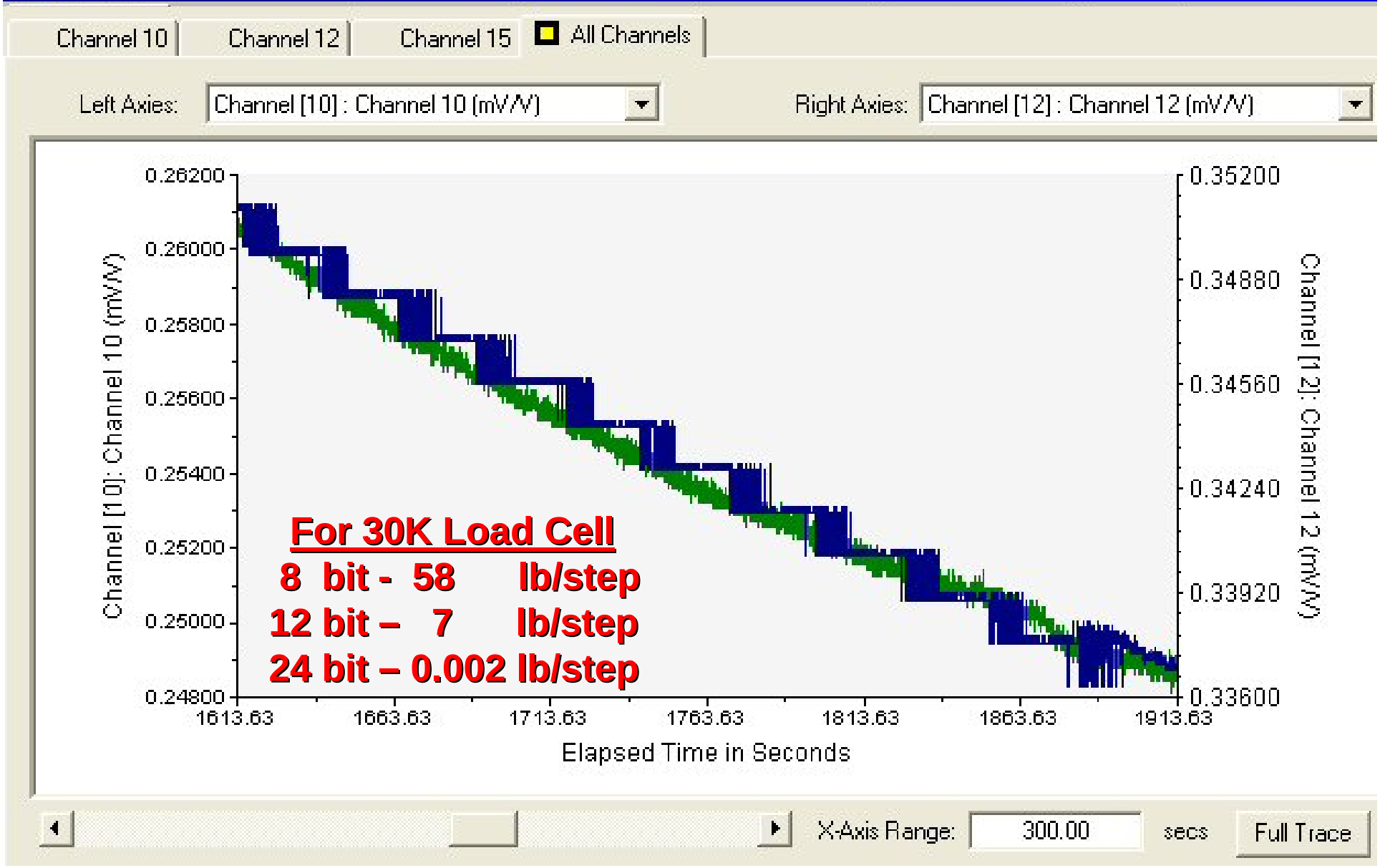
# High Speed Data Acquisition



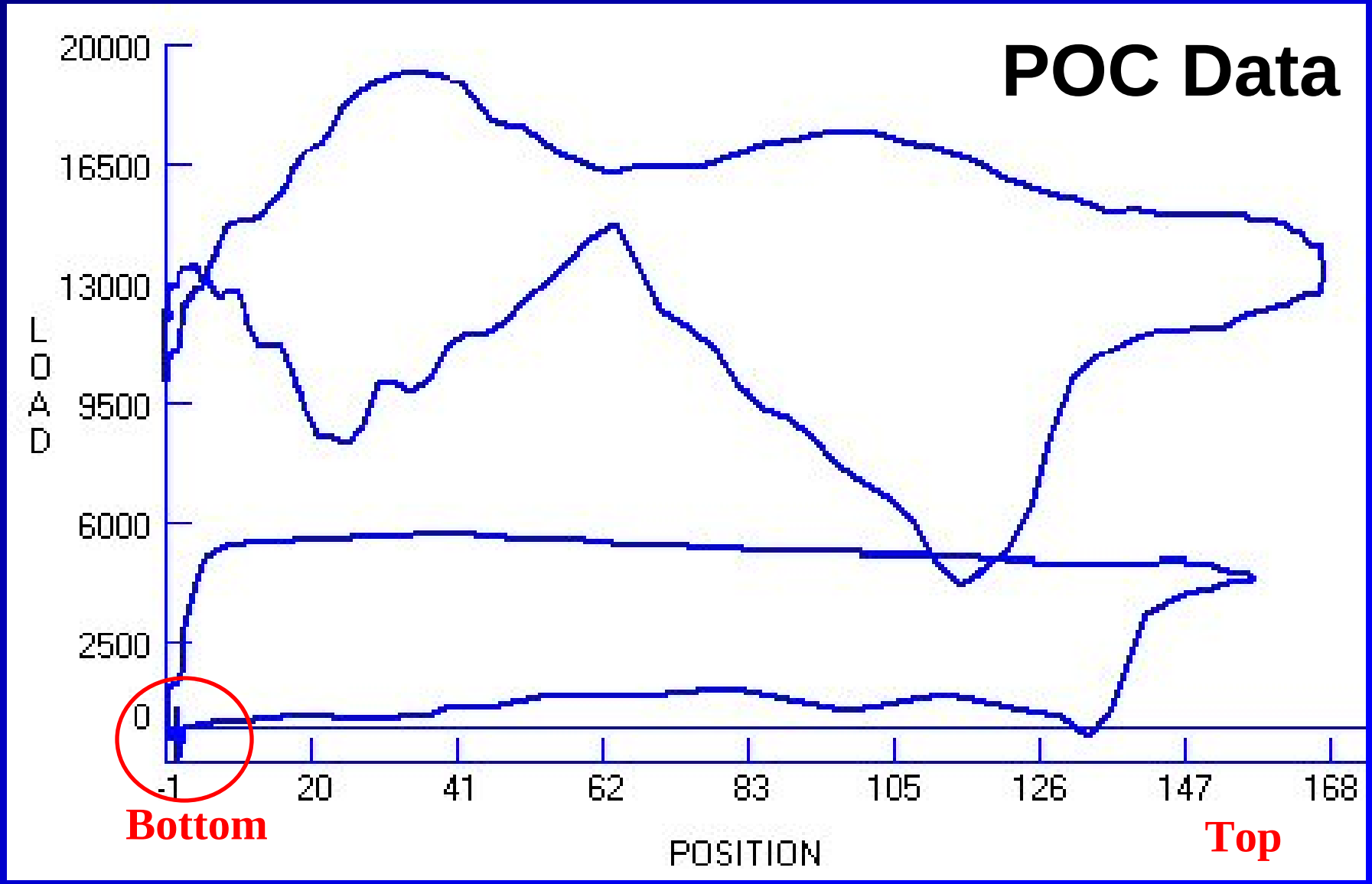

**240 samples per second best**

1. **Data can be acquired at time intervals of 15, 30, 60, 120, 240, 480, or greater samples per second.**
2. **A high speed laptop computer allows data to be recorded at the optimum resolution of state-of-the-art instrument using sigma-delta analog to digital converters, precision sensors, and shielded cables.**

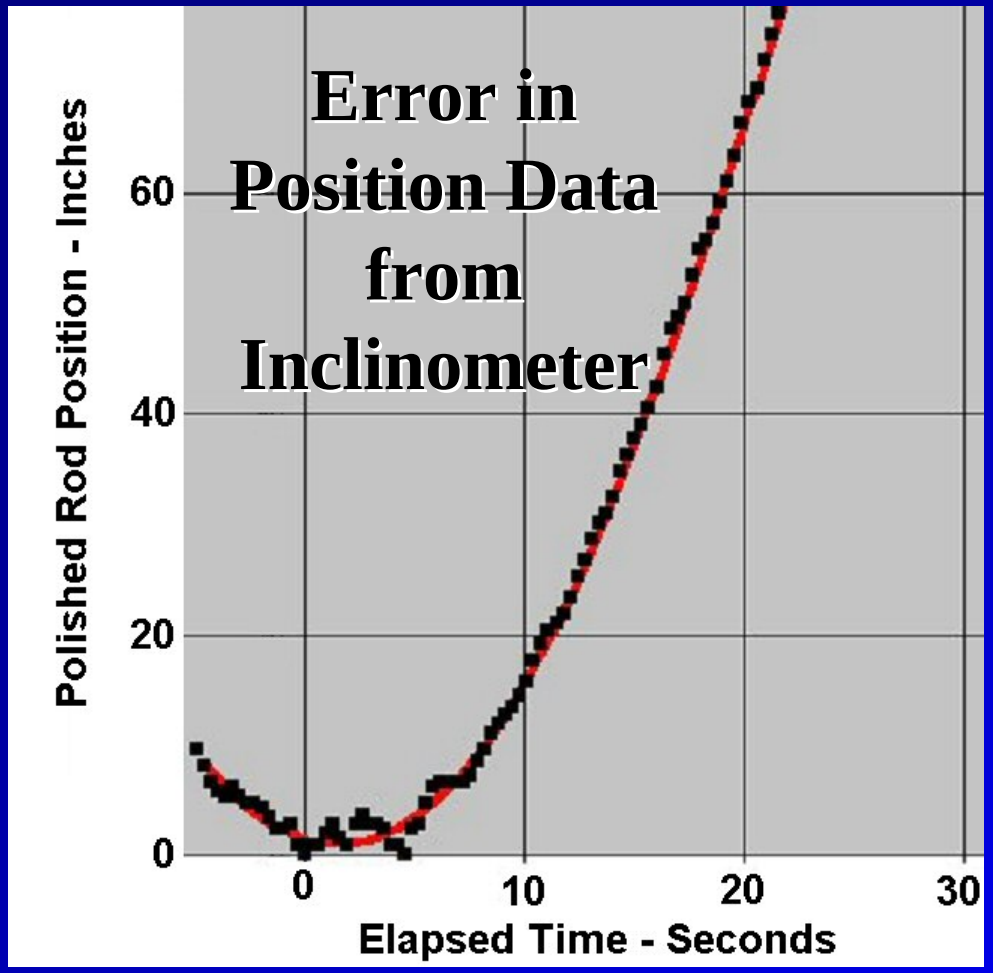
# Older Style Analog to Digital Converters DO NOT Have Sensitivity for Small Signals



# Downward Spike on Pump Card Near Bottom, Appears to be Improperly Spaced



# String Boxes and Inclinometers

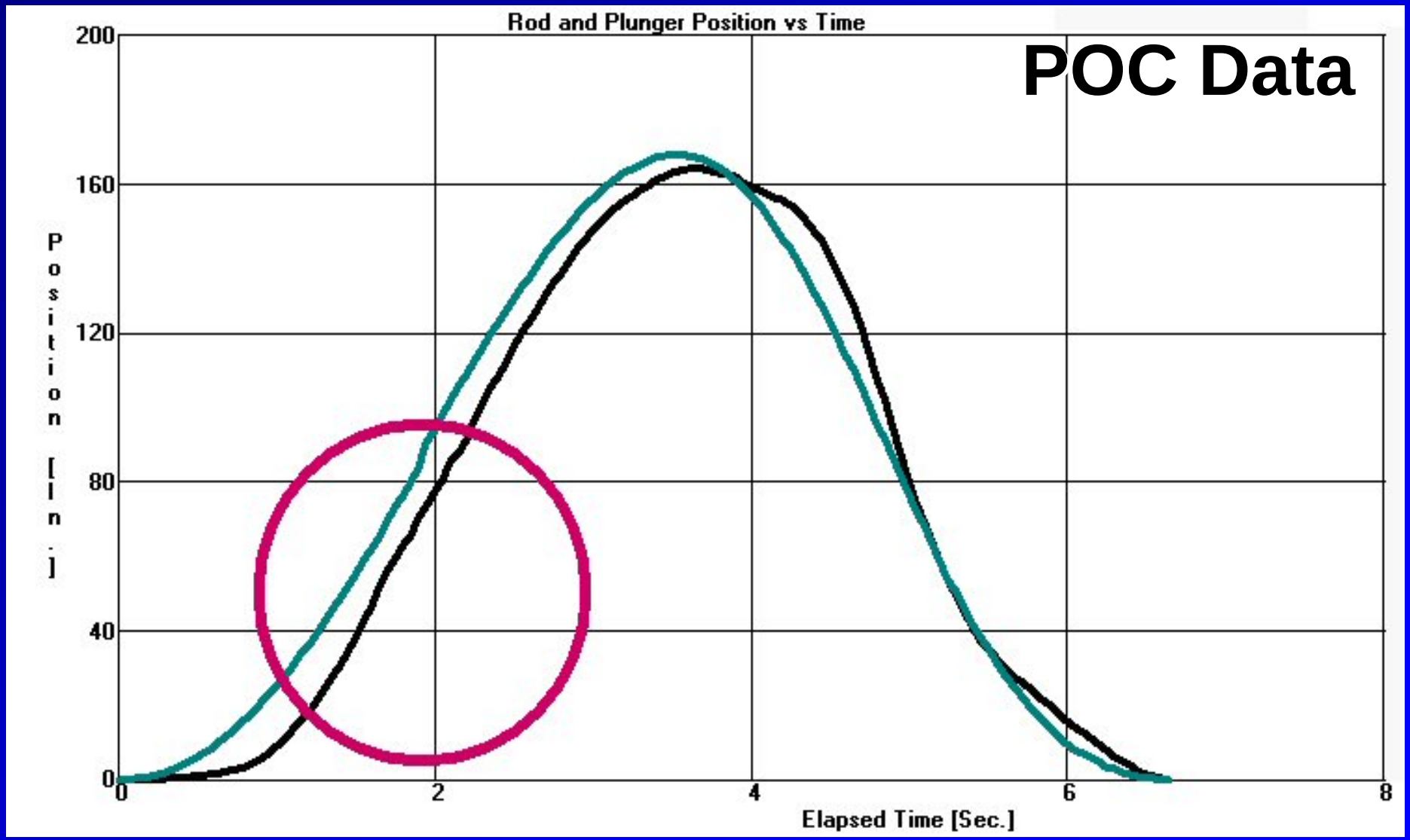



1. Tends to have poor resolution at top and bottom of stroke
2. Smoothing of the Position data required to prevent load spikes

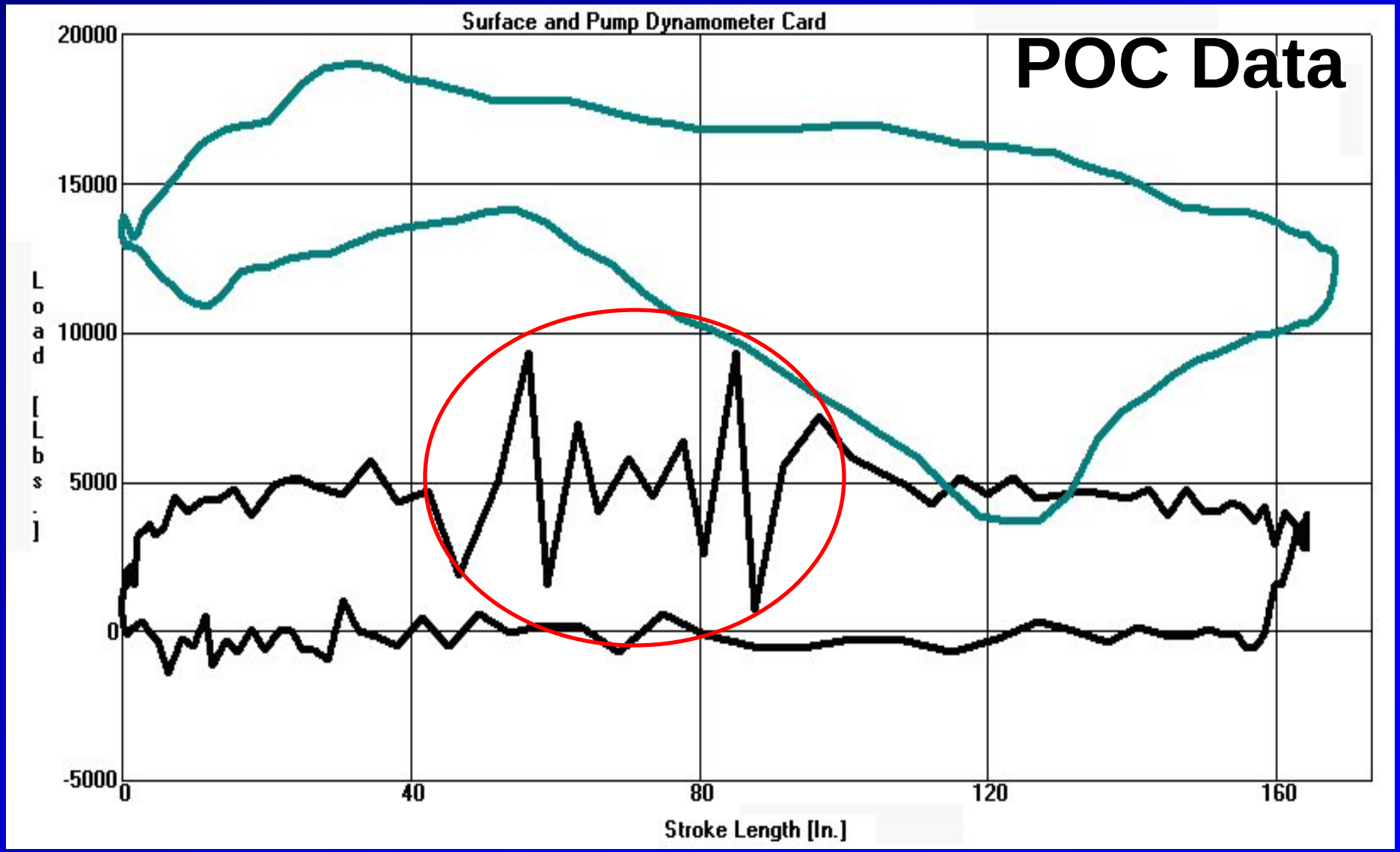
# Problems with using Motor RPM to Determine Polished Rod Position

1. Calculated position uses API dimensions for a pumping unit entered either by hand or selected from a database.
2. Wrong pumping unit is select
3. Pumping unit not in the database
4. Field assembly of the pumping unit results in dimensions not matching database
5. Wrong radius/stroke length
6. Direction of rotation

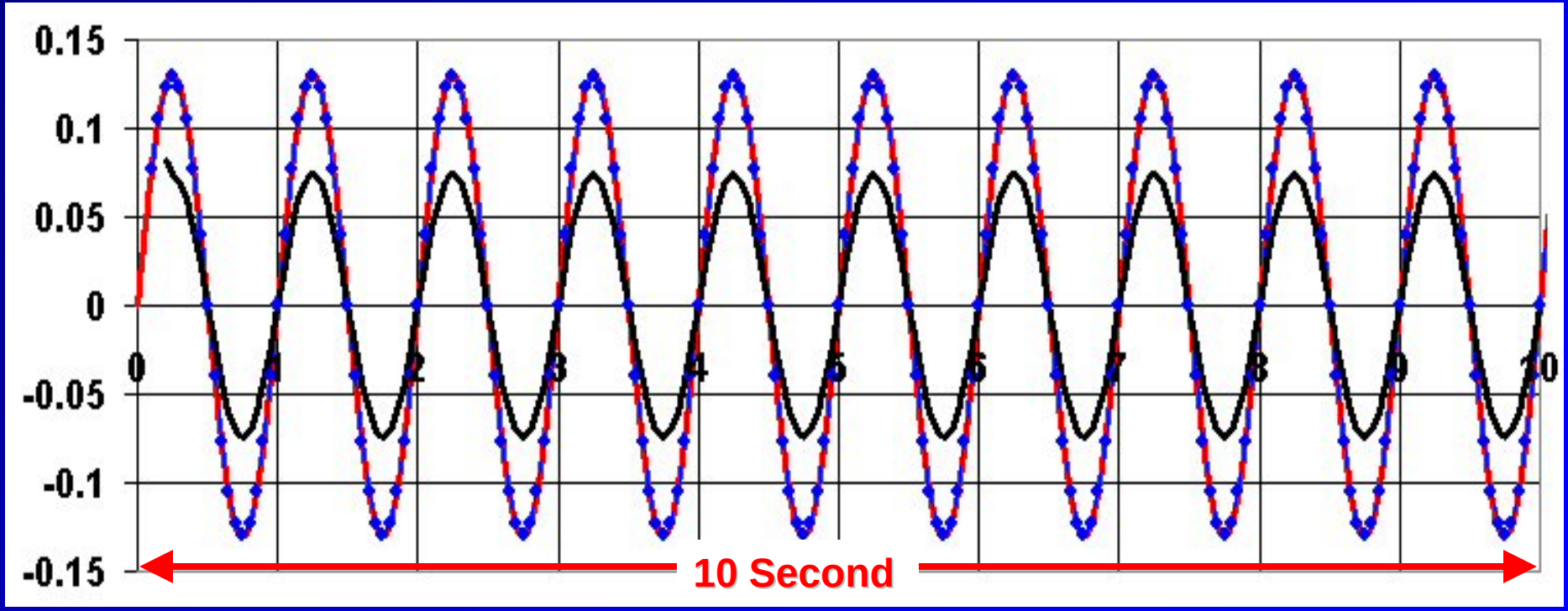
# Noise in Position Data Requires Filtering of Acquired Signal



# Spikes on Pump Card Near Center Caused by Noise in Position Data

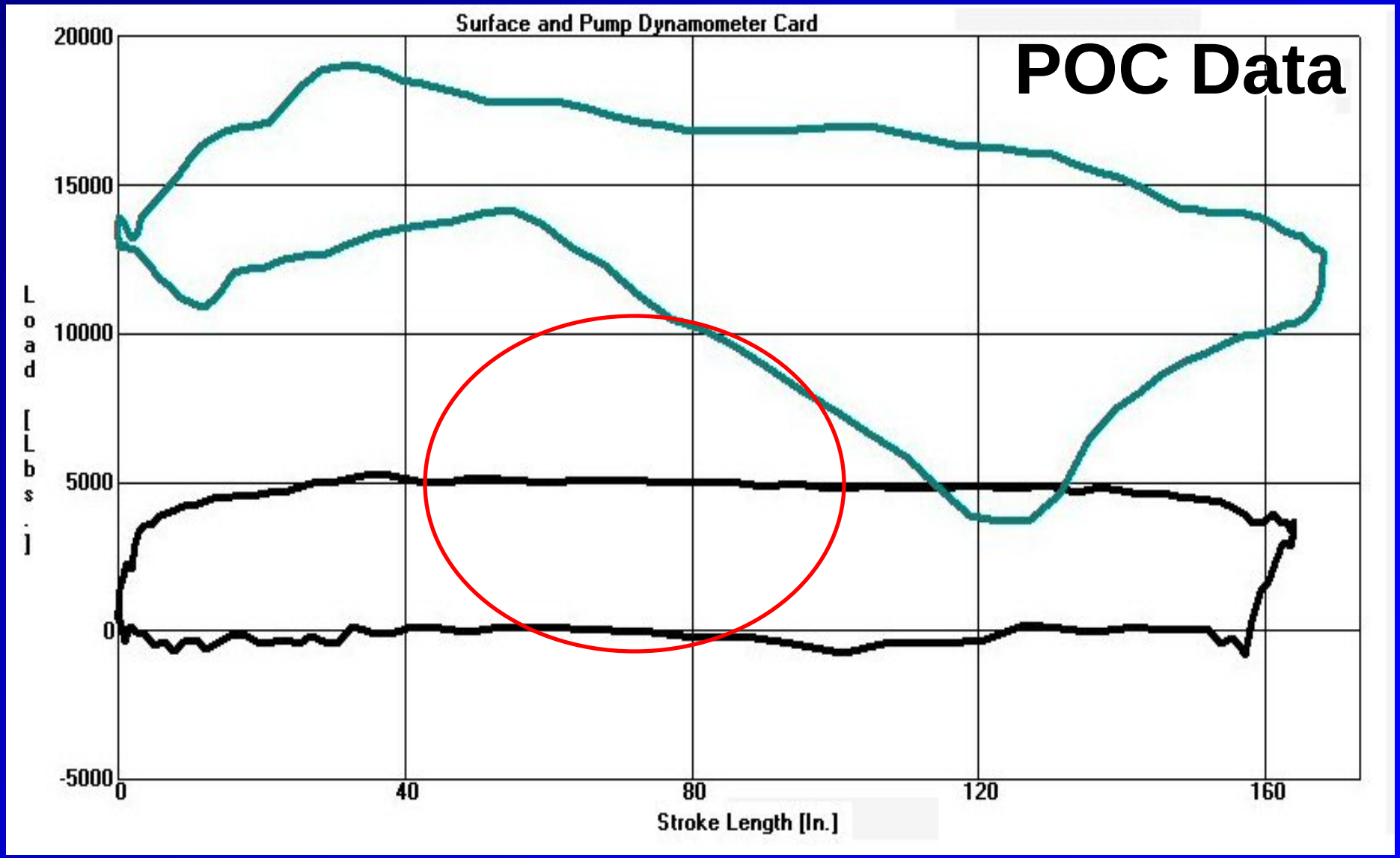


# Averaging Important for Longer Duration Event



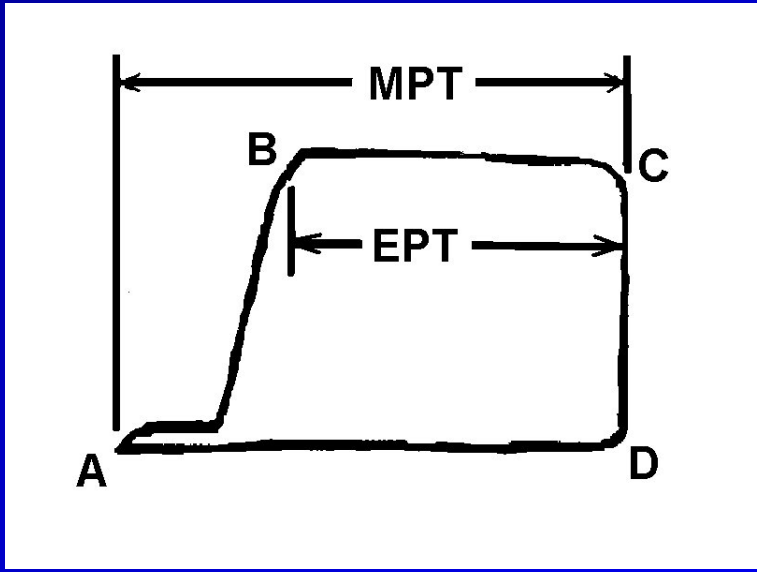

1. Blue - 20 Samples per Second results in 20 data values acquired during event.
2. Black – Median Filter without Regression
3. Averaging Smoothes out Peaks and Flattens Curve

# A 5 Order Best Fit Regression Filter Smoothed Out Noise in Pump Card



# Upstroke Fluid Pound

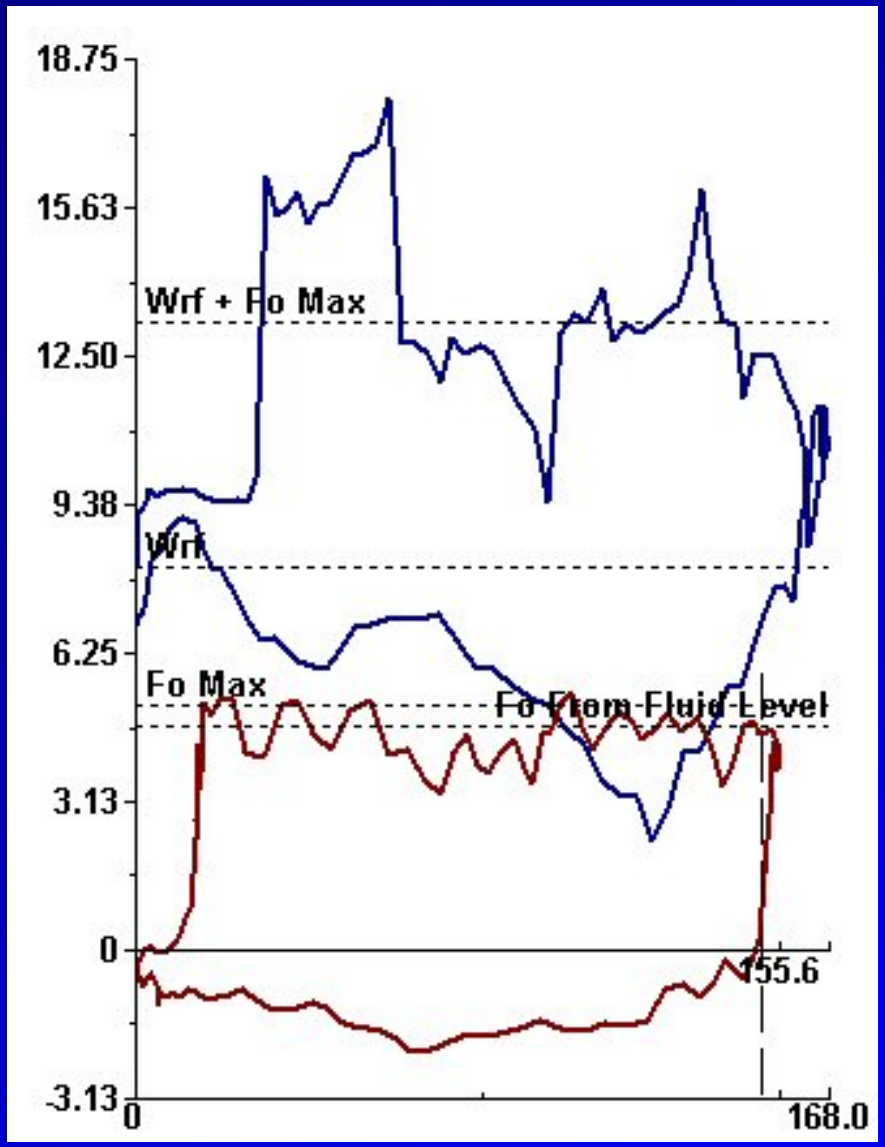
**Tubing anchored or unanchored**



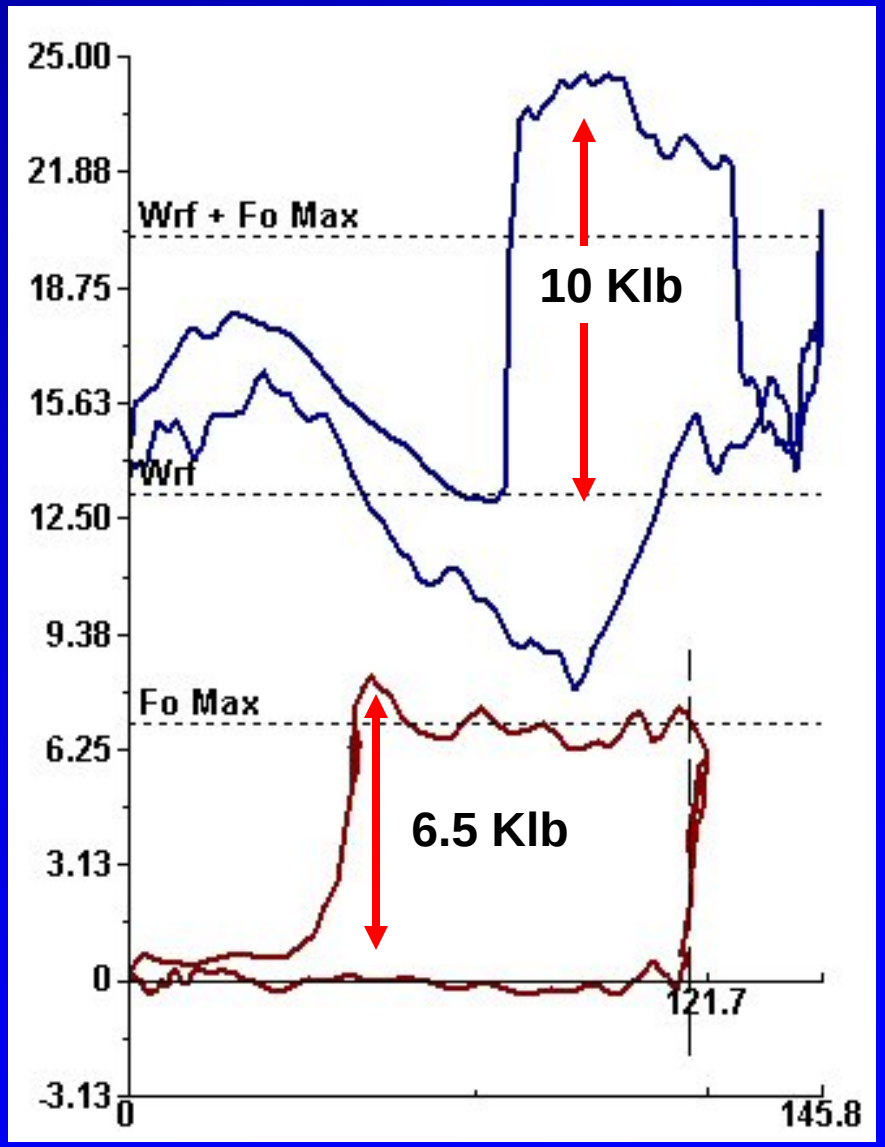

**Traveling Valve Ball/Seat not closing properly at beginning of upstroke: Flow restricted by very viscous fluid in pump OR TV ball prevented from going on seat OR flow area smaller than plunger above pump to small OR damaged/pitted TV ball.**

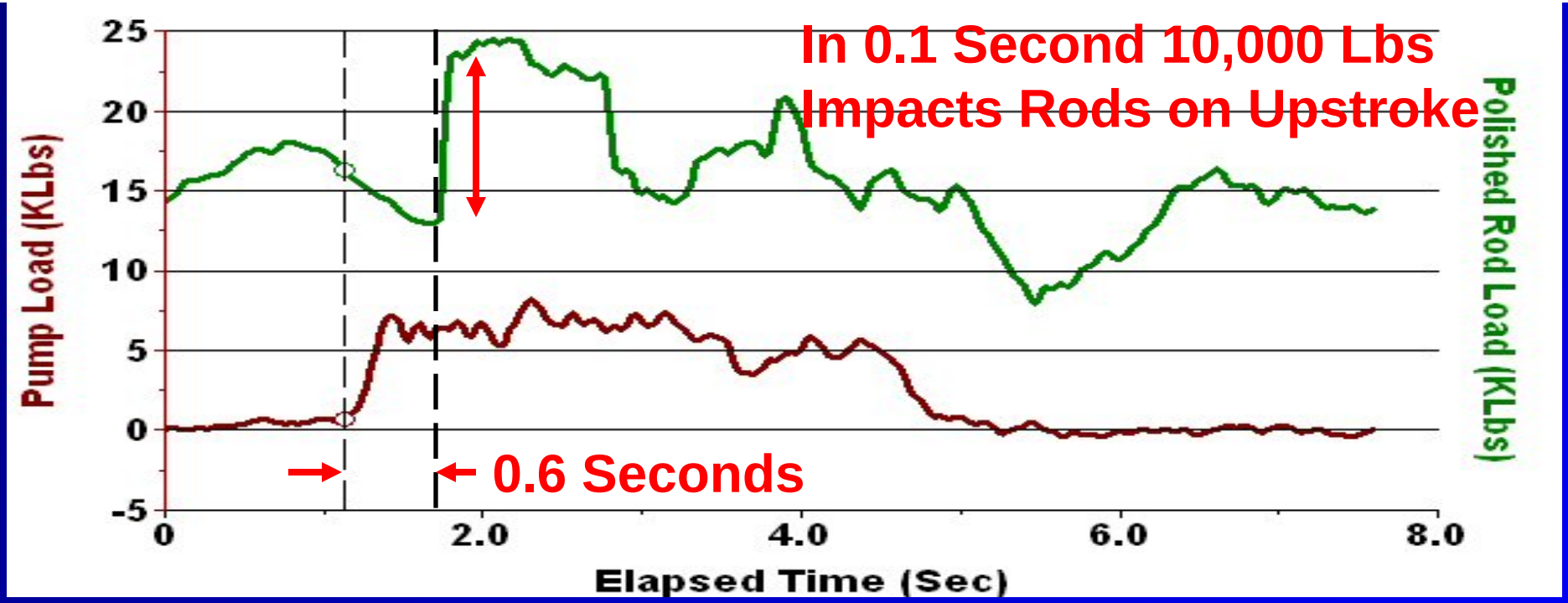
# Shock Loads Increased Rod Failures:

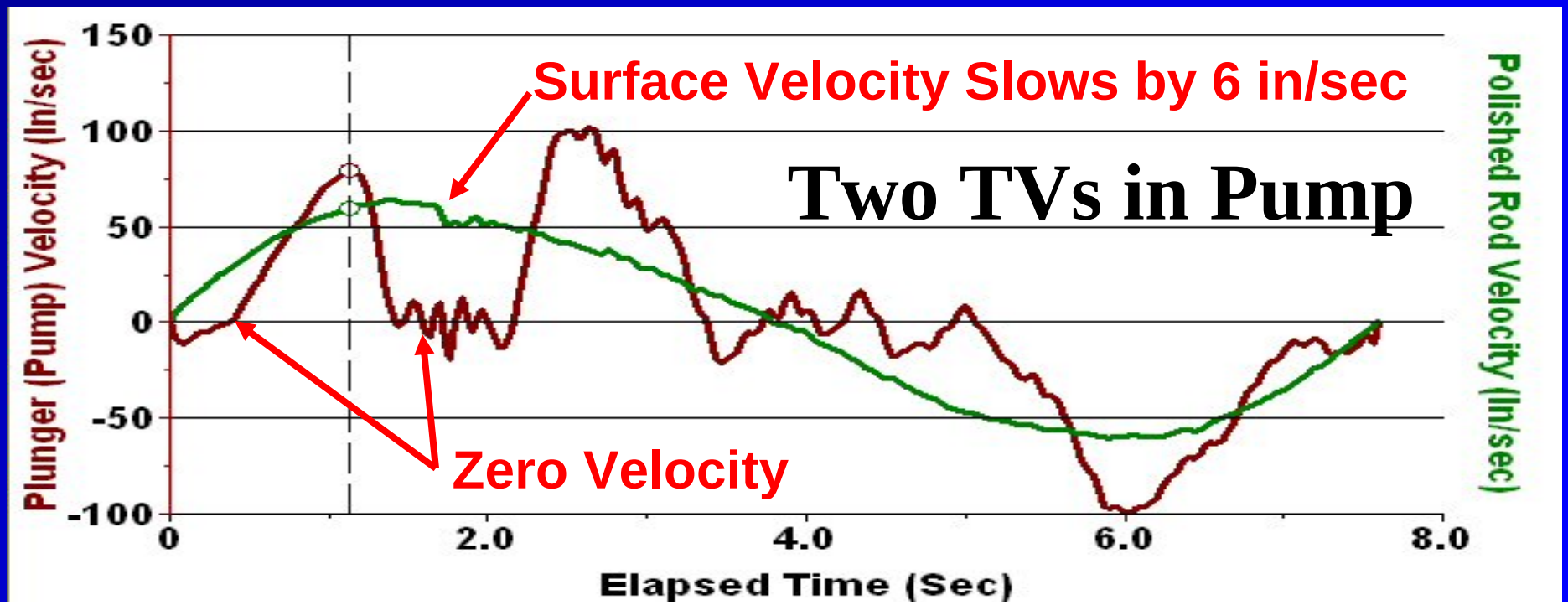
## Gunk in Pump



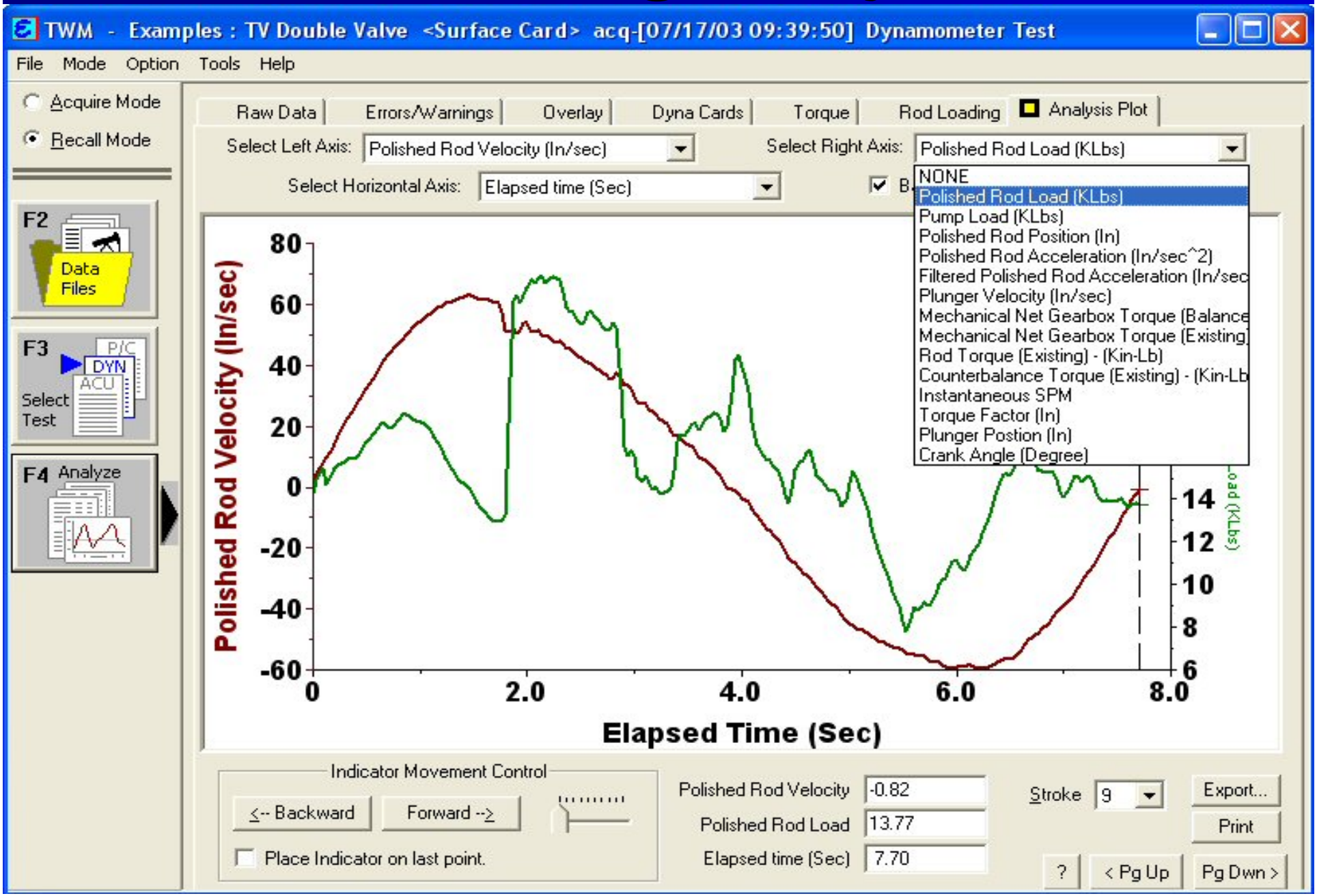

## Two TVs in Pump



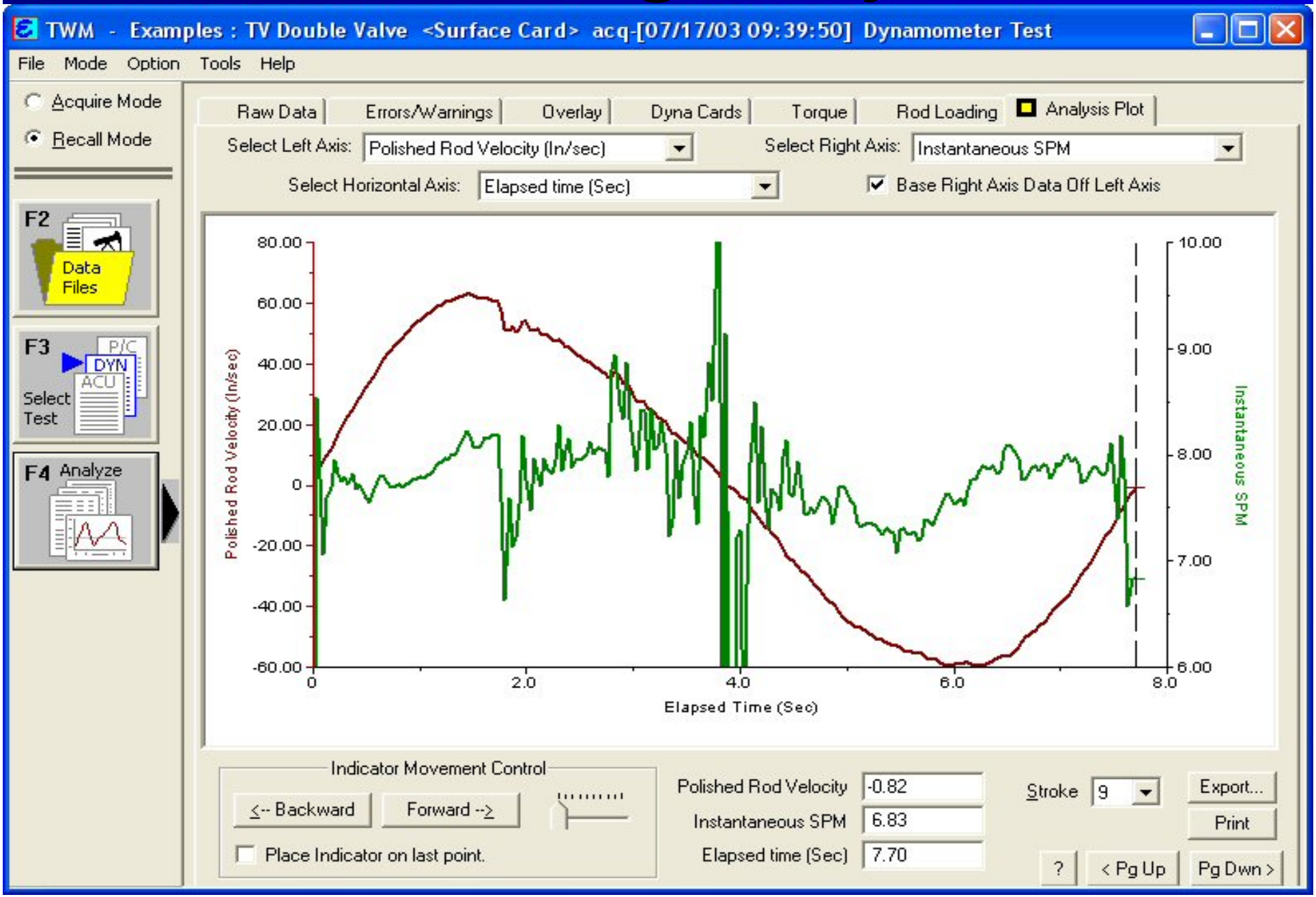

In 0.1 Second 10,000 Lbs
Impacts Rods on Upstroke
0.6 Seconds
Pump Load (KLbs)
Polished Rod Load (KLbs)
Elapsed Time (Sec)
25
20
15
10
5
0
-5
0
2.0
4.0
6.0
8.0


Surface Velocity Slows by 6 in/sec
Two TVs in Pump
Zero Velocity
Plunger (Pump) Velocity (In/sec)
Polished Rod Velocity (In/sec)
Elapsed Time (Sec)
150
100
50
0
-50
-100
0
2.0
4.0
6.0
8.0

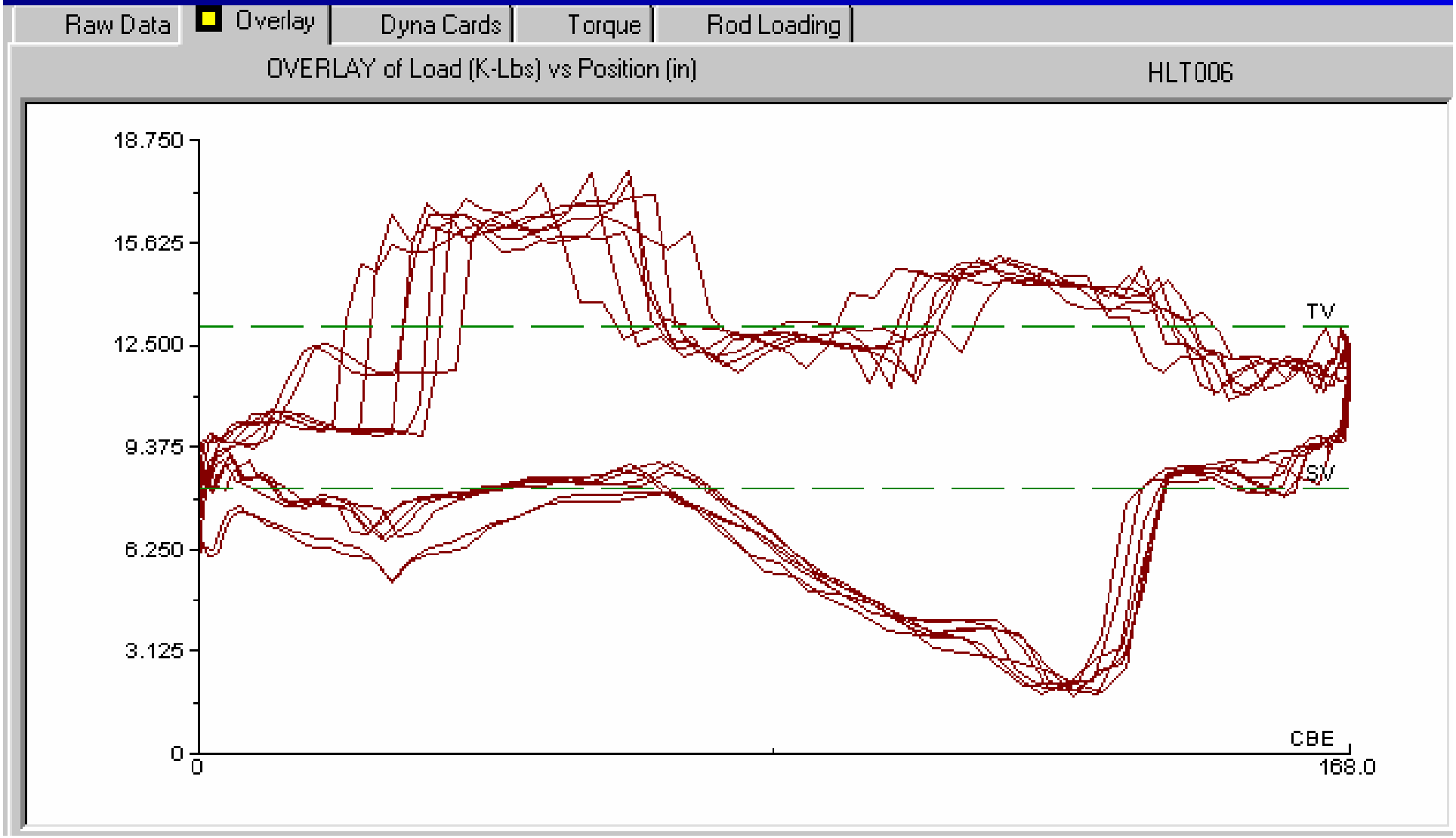
# Visualize Using Analysis Plots



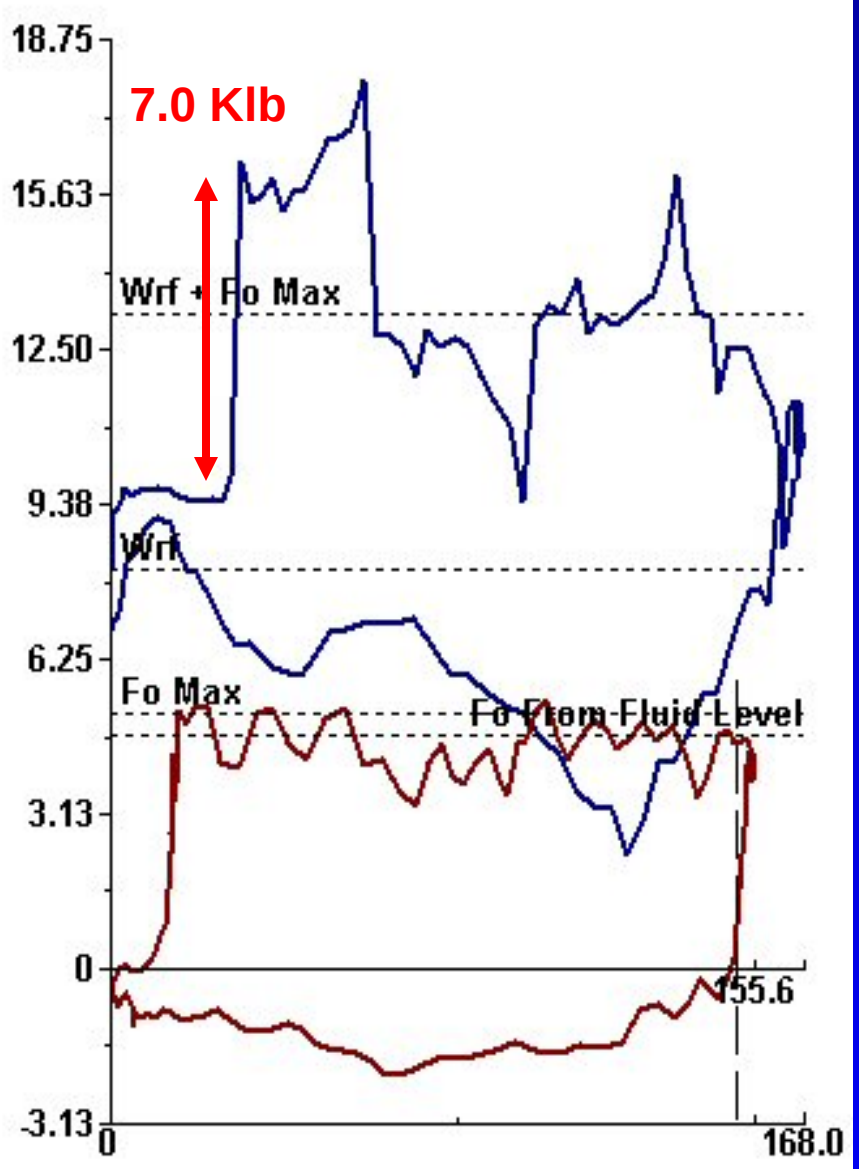
# Visualize Using Analysis Plots

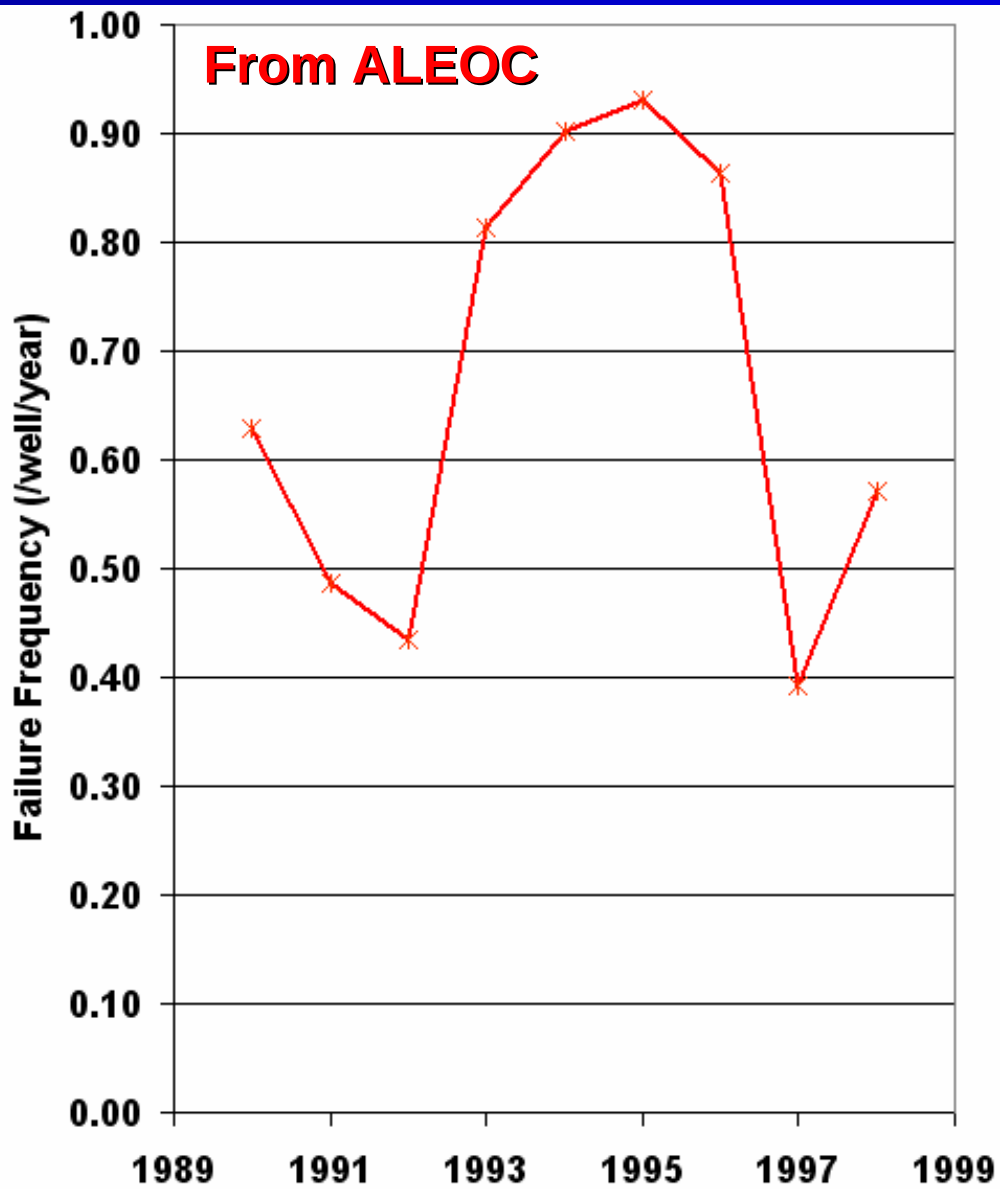


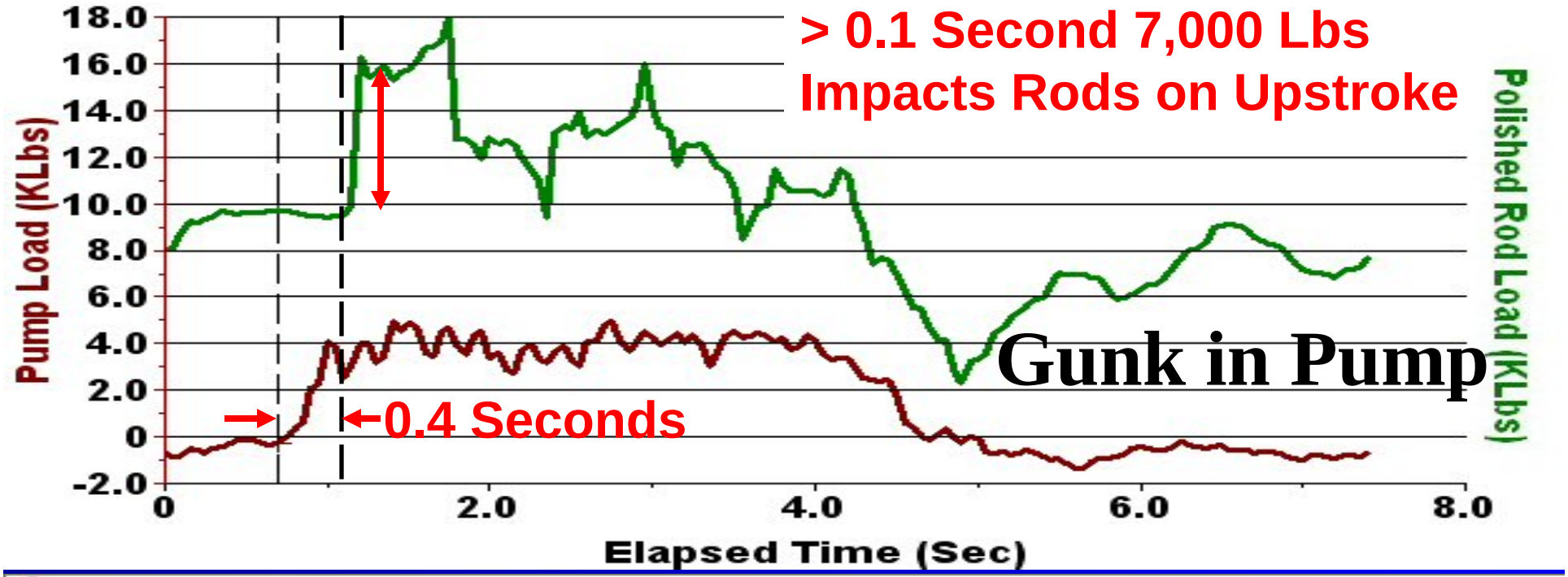
# Erratic Behavior Due to Delay in TV Ball Going on Seat

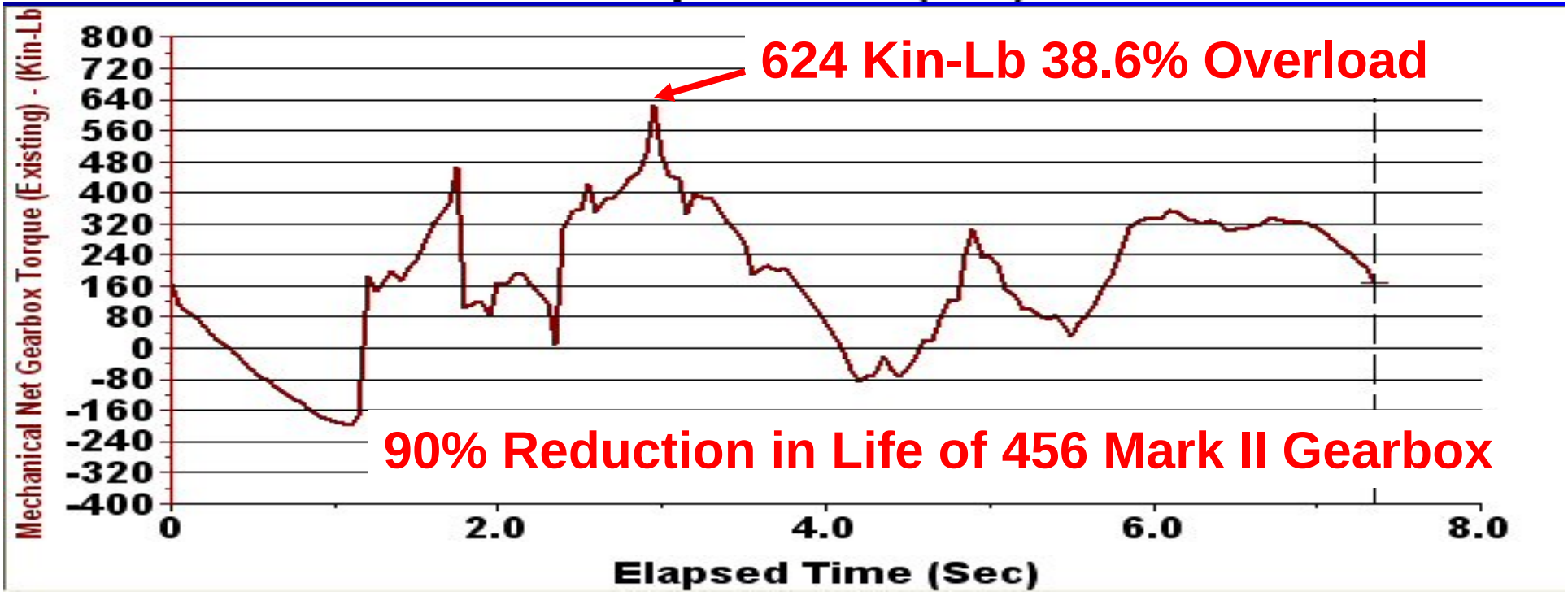


# Shock Loads Increased Rod Failures:
## Gunk in Pump

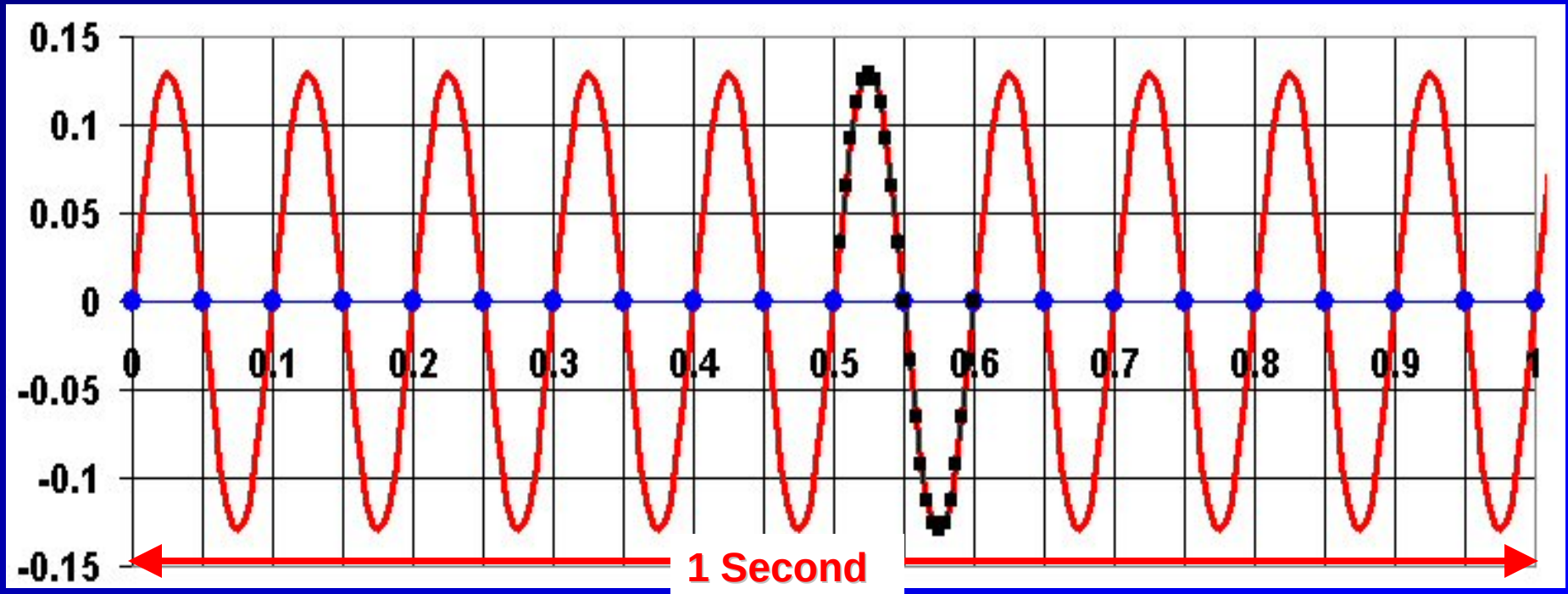



> 0.1 Second 7,000 Lbs
Impacts Rods on Upstroke
Gunk in Pump
0.4 Seconds
Pump Load (KLbs)
Polished Rod Load (KLbs)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0
-2.0
0
2.0
4.0
6.0
8.0
Elapsed Time (Sec)

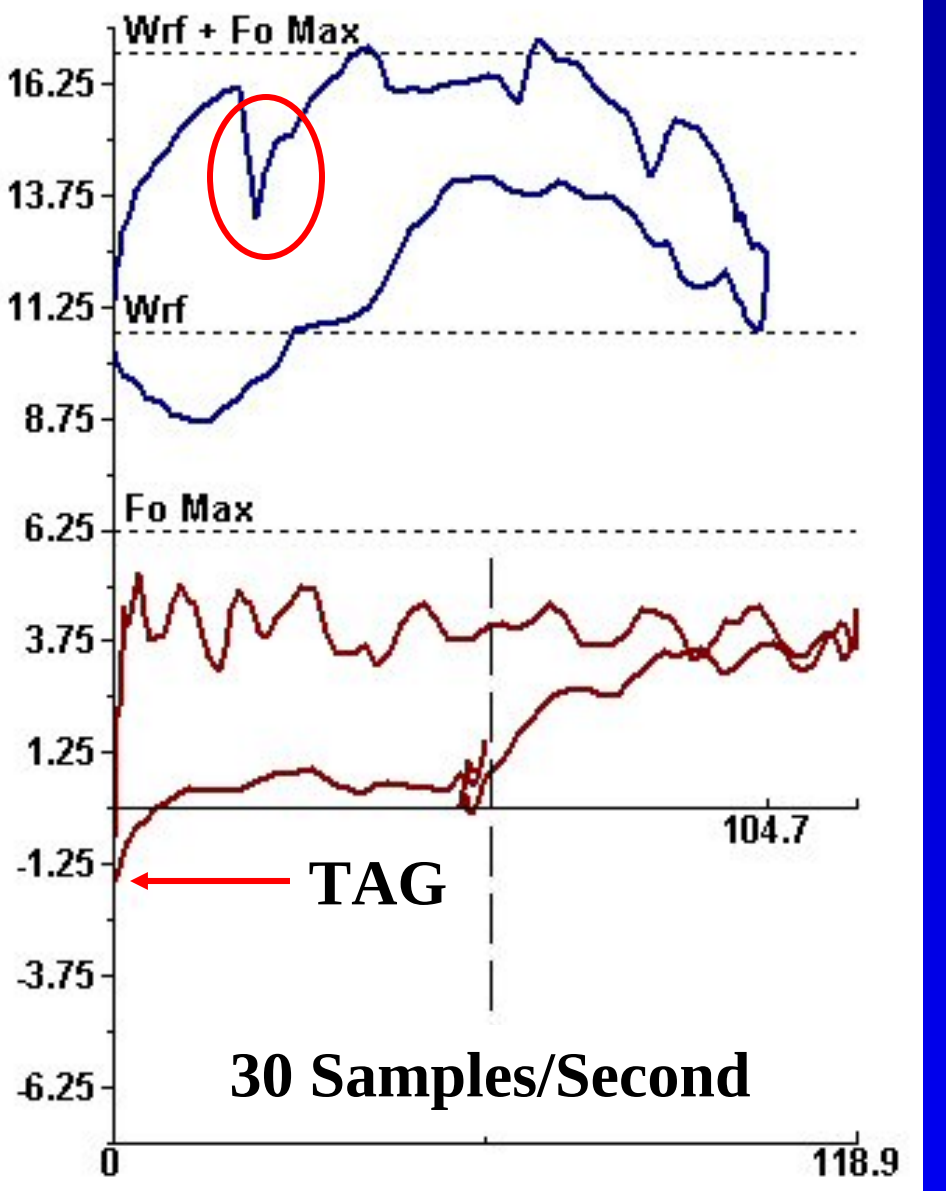

624 Kin-Lb 38.6% Overload
90% Reduction in Life of 456 Mark II Gearbox
Mechanical Net Gearbox Torque (Existing) - (Kin-Lb
800
720
640
560
480
400
320
240
160
80
0
-80
-160
-240
-320
-400
0
2.0
4.0
6.0
8.0
Elapsed Time (Sec)

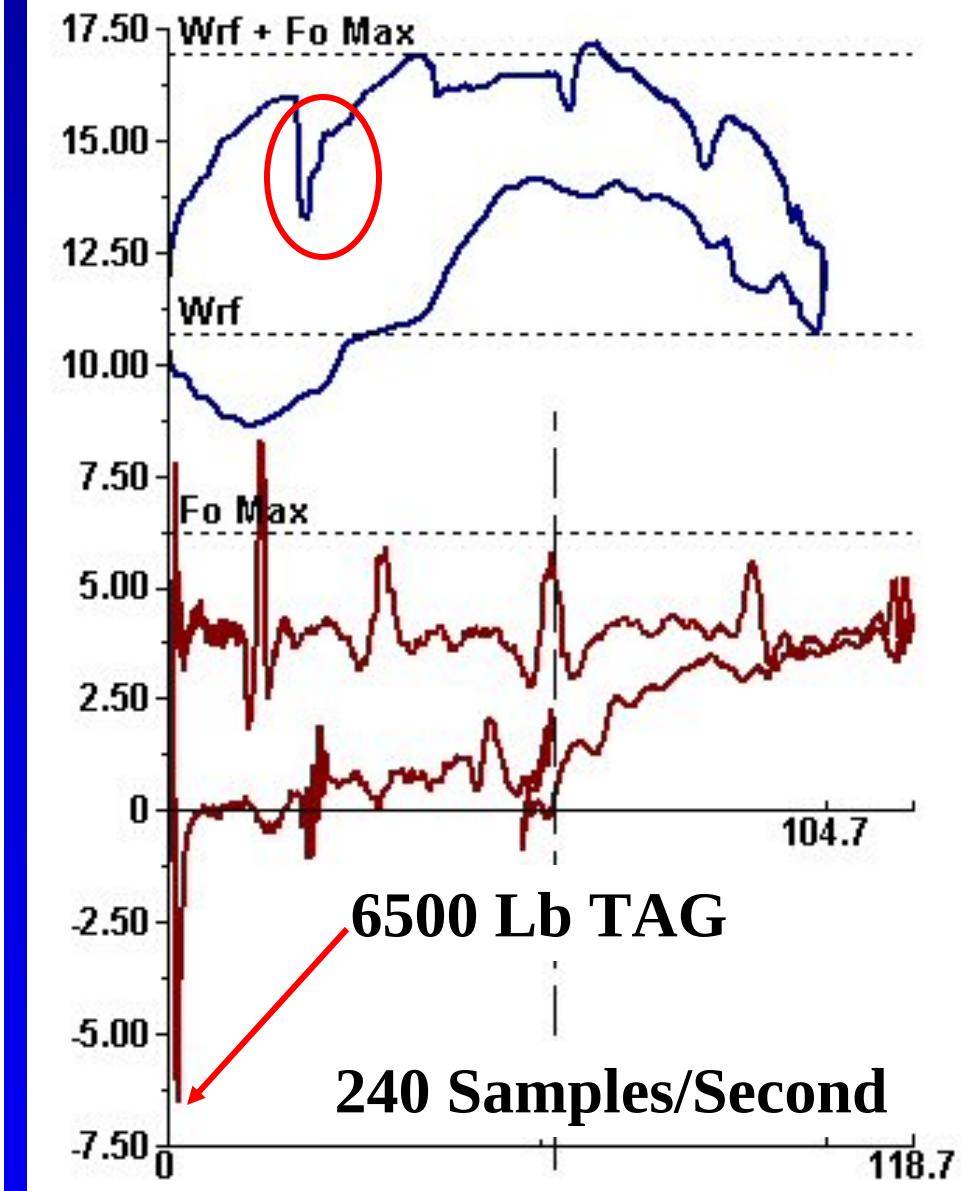
# Sampling Rate Important for 1/10 Sec Duration High Speed Event



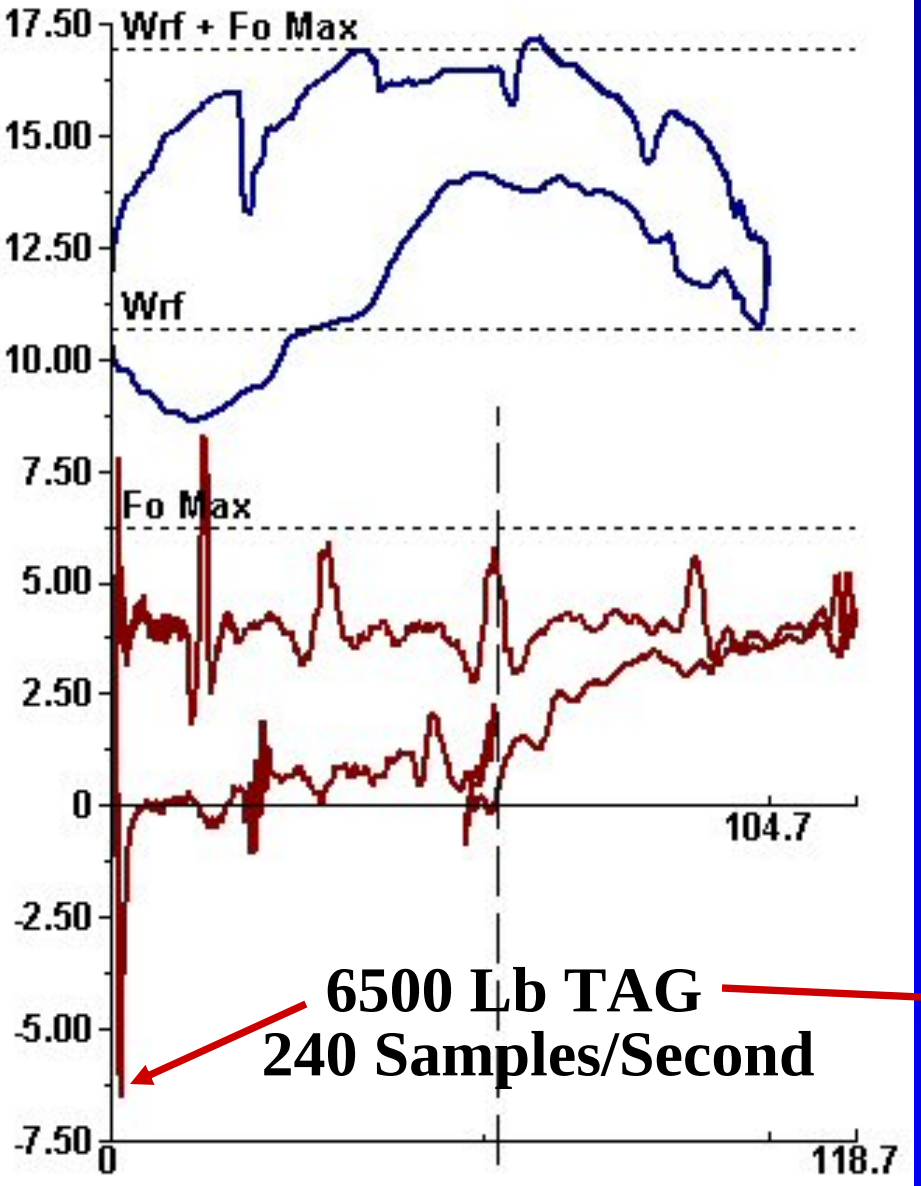

1. Blue - 20 Samples per Second results in 2 data values acquired during event.
2. Black - 240 Samples per Second results in 24 data values acquired during event
3. Sampling to slow can completely miss occurrence an Event

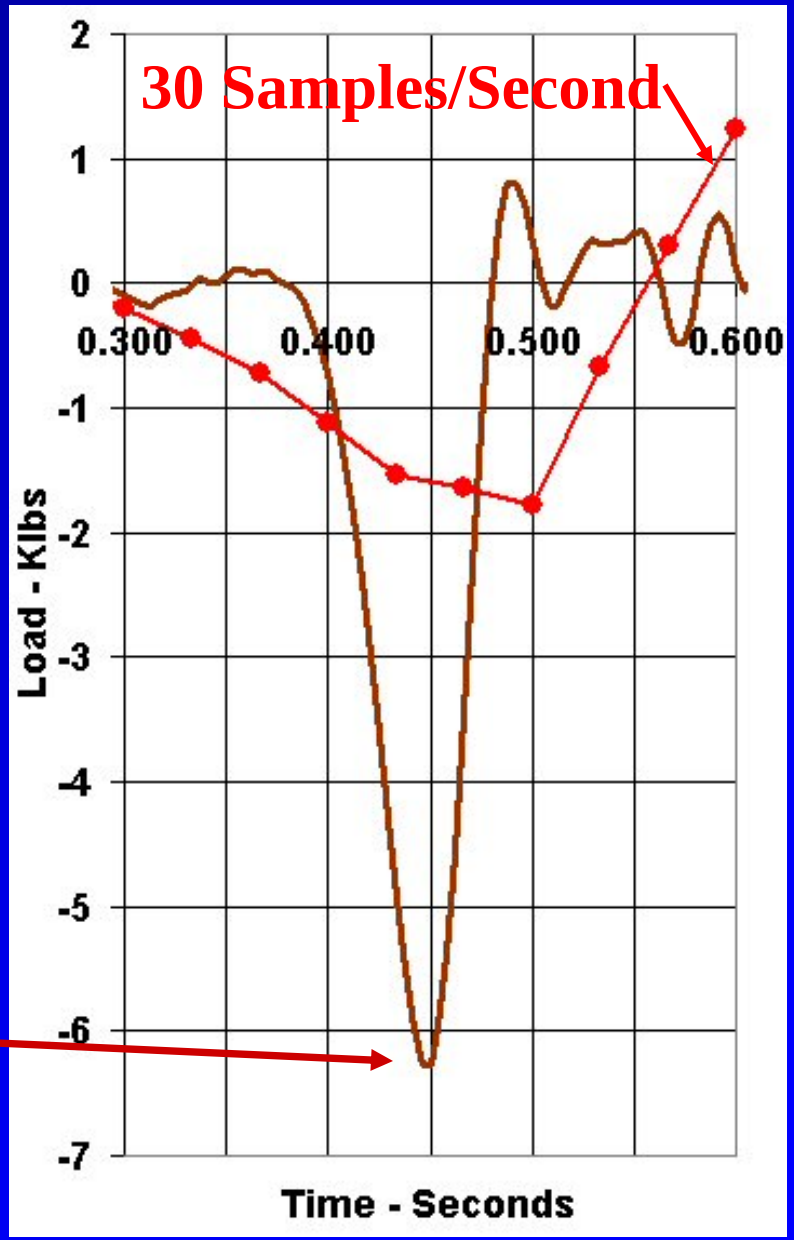
# High Speed Sampling Shows Correct Tag Force



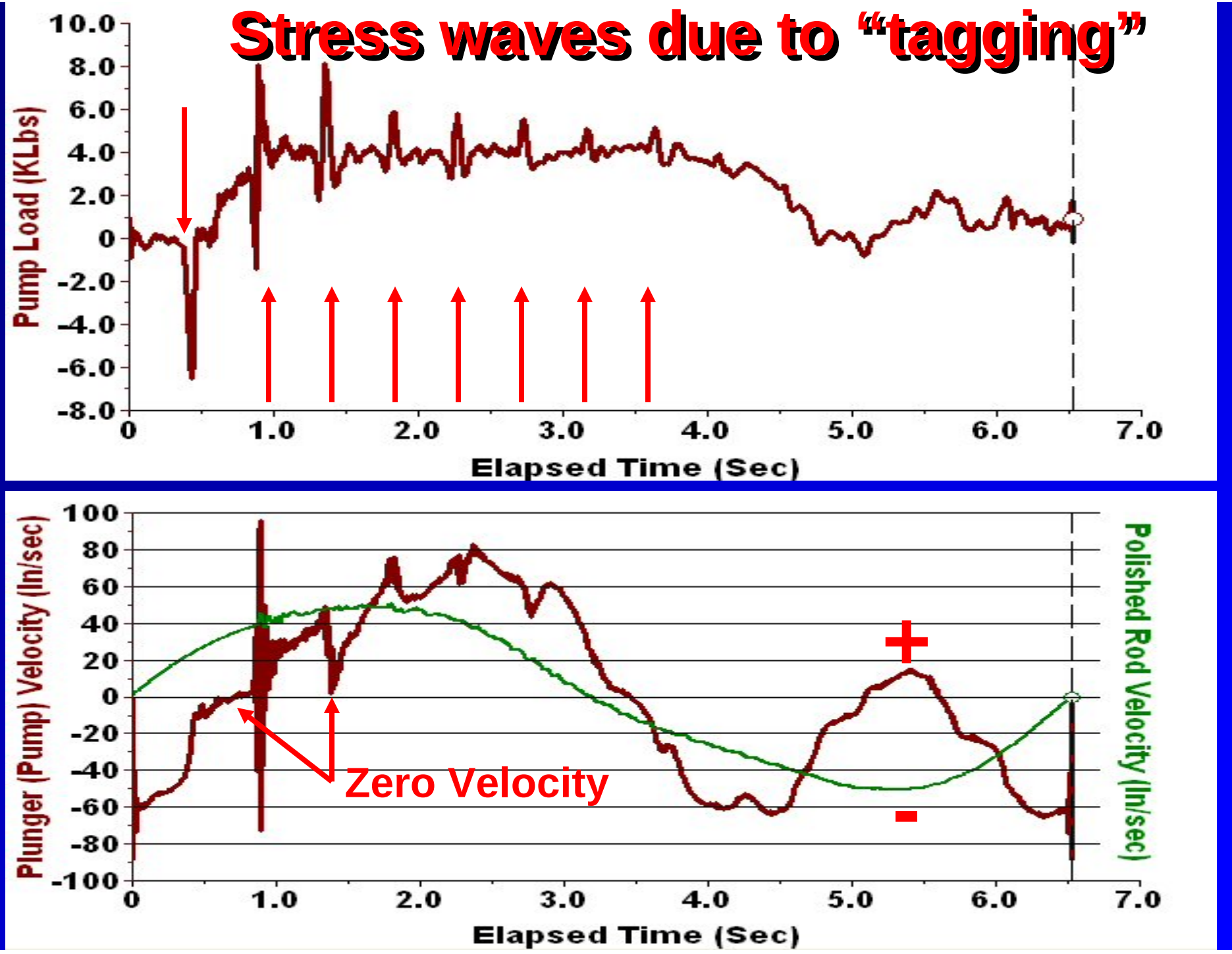



# Compare Tag Force of 30 & 240 Hz



# Stress waves due to "tagging"



# High Speed and High Resolution Data Acquisition

1. Noisy or poor quality data requires special processing/smoothing to prevent false load spikes.
2. High speed/high resolution data required to see character of sudden impact loads.
3. High speed/high resolution data is used to clearly analyze the severity of sudden impact loads.

# Questions ?