(((ECHOMETER)))

Advanced Dynamometer, Torque, and Power

3 Day Seminar

WELCOME

PURPOSE:

1. *Apply Methodology Of Total Well Management*
2. *Learn To Fully Use The Well Analyzer's Capabilities.*
3. *Detailed Review Of Features And Functions Of TWM With Respect To Dynamometer Cards, Torque, And Power.*

WHY?

1. Proficient Use of TWM
2. Analyze Performance Of Wells
3. Improve Operations
4. Expend Less Time And Effort
5. Increase Oil And Gas Production
6. Reduce Operating Expense.

General Class Information

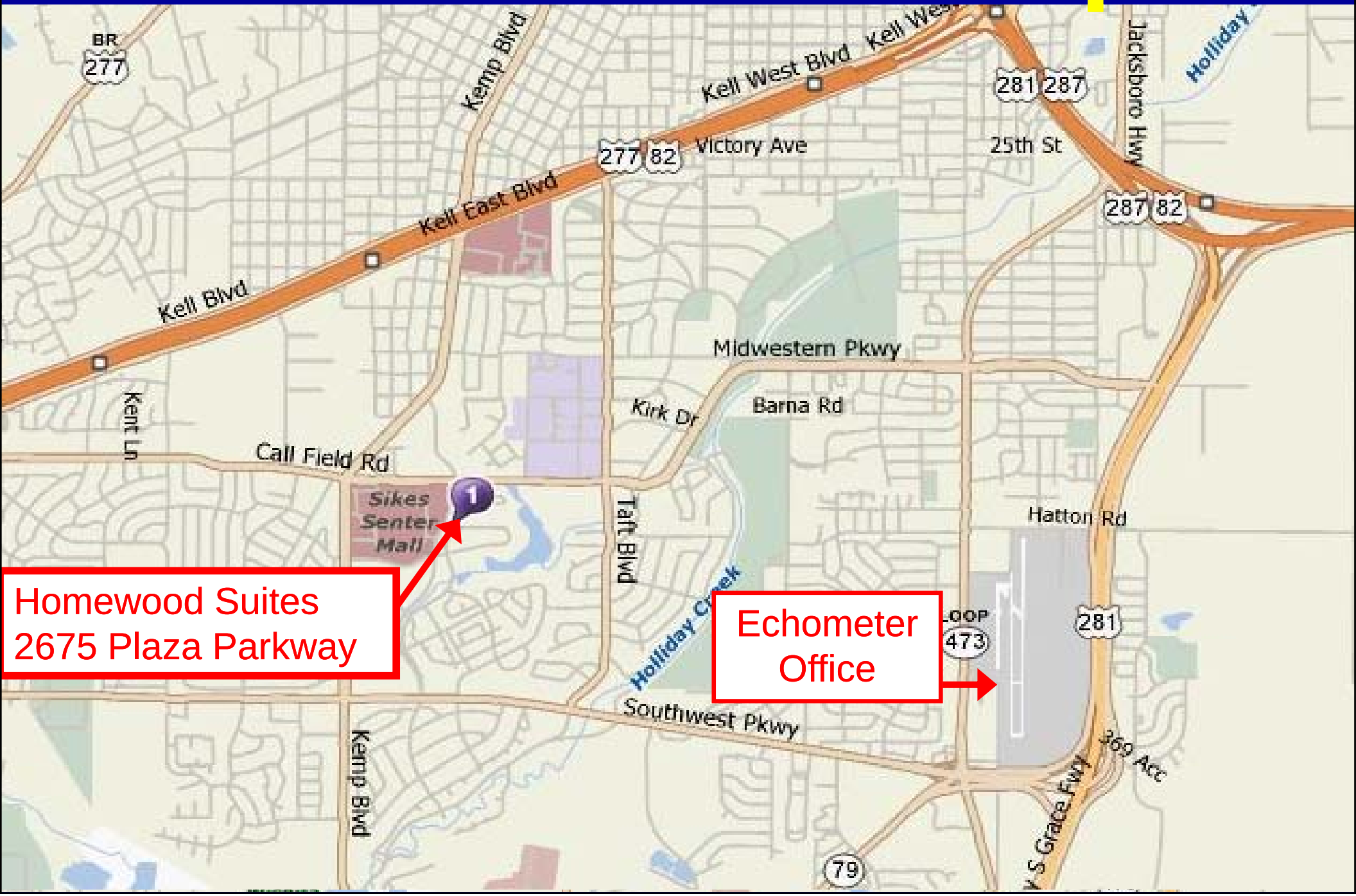
- TWM PROGRAM, used as the primary teaching tool
- Additional support will be available outside of normal class hours.
- Many of you have contributed to the development of this system.
- We appreciate your help.
- Ask Questions
- Make sure we take Breaks

Training Materials

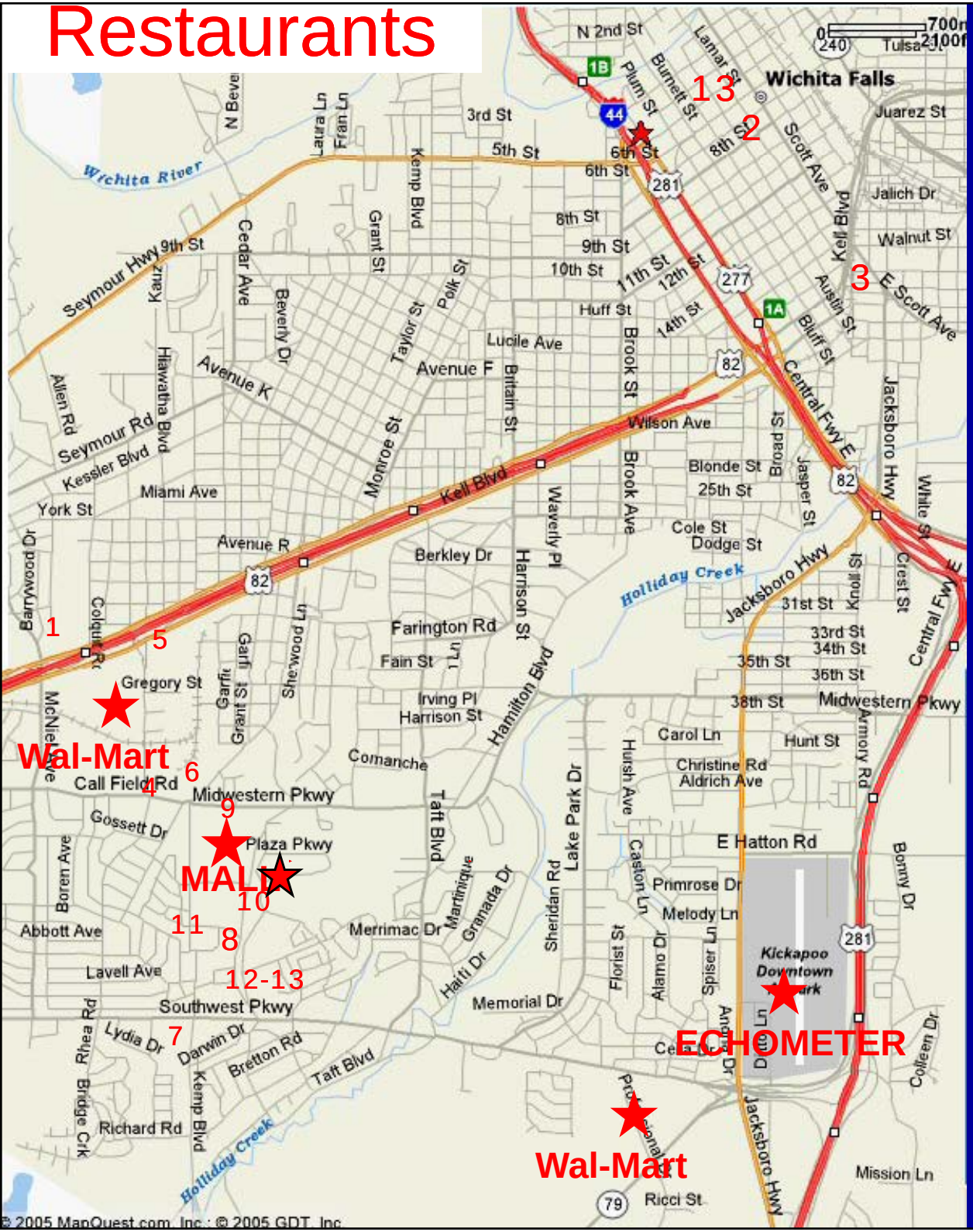
1. Copy of Presentation Slides
   - In Black Binder
   - In Color in PDF format on CD
2. TWM Manual (If you request one)
3. Echometer Help Center &TWM CD
4. Literature

Be sure to Write Name on Certificate for School

Wichita Falls Map



Restaurants



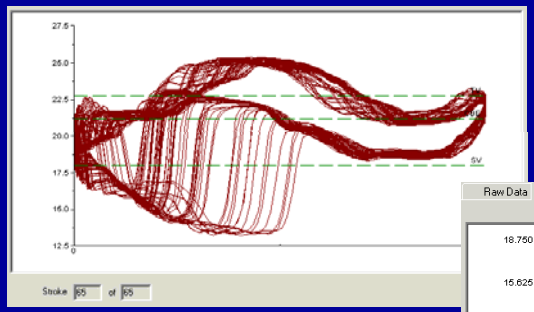
1. Cheddars Restaurant – 4214 Kell Blvd # 100 (1.54 miles)
2. Casa Manana - 609 8th St, (3.85 miles)
3. ***Branding Iron - 104 E Scott Avenue, (3.53 miles away) Lunch***
4. McAlister's - 3900 Call Field (0.81 miles)
5. Texas Roadhouse – 3130 Lawrence Rd, (1.03 miles)
6. Olive Garden - 3916 Kemp Blvd, (0.46 miles)
7. El Chico Café - 2803 Southwest Pkwy , (0.81 miles)
8. Hunan Chinese - 4516 Maplewood Ave, (0.48 miles)
9. Buffalo Wild Wings Grill & Bar – 3111 Midwestern Pkwy (0.3 miles)
10. Schlotzsky's Deli – 2611 Plaza Pkwy (0.0 Miles)
11. Buffet City – 4407 Kemp Blvd (0.52 miles)
12. Alfredo's Mexican Café – 4525 Maplewood Ave (0.58 miles)
13. Mc Bride's Land and Cattle Co – 501 Scott Ave (5.01 miles)

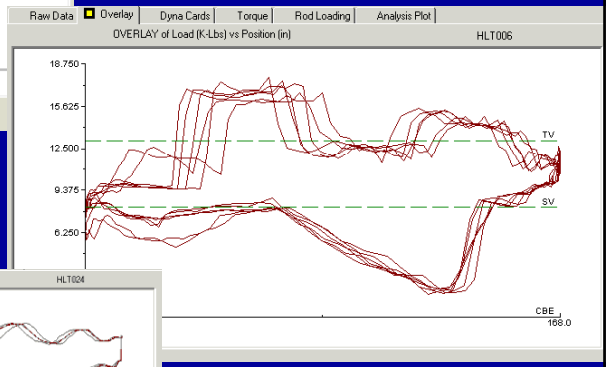
Role of Sucker Rod System Analyst

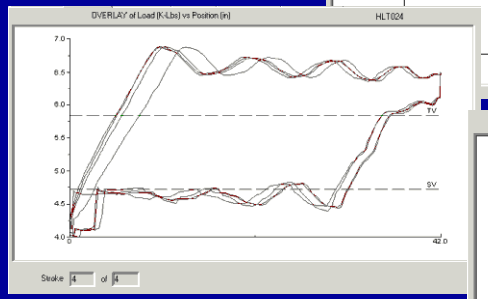
1. Time Requirement is about 45 minutes per well.
2. Analyze collected data at the well.
3. ID Problem and Make recommendations to fix problems
4. Record work necessary to fix problem as notes.
5. When recommended changes complete, new data should be collected once the well has stabilized
6. Notice if well performance changed as planned.
7. Follow-up on recommendations to learn from successes and failures.
8. Role changes from a data collector to a knowledgeable well analyst and problem solver.

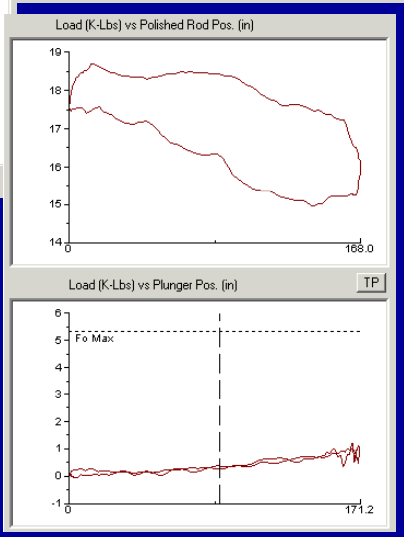
Well Analysis Identifies the Problem

- Inflow Performance
- Pump Performance
- Mechanical Loading
- Prime Mover
- System Efficiency Analysis
- Root Cause of Failure
- Data Trends Over Time
  - Has Well's Production Changed?
  - Has the Fluid Level Changed?
- Dynamometer









Goal is to answer the WELL PERFORMANCE QUESTIONS

What Well Information Should be Known in Order to Analyze a Well?

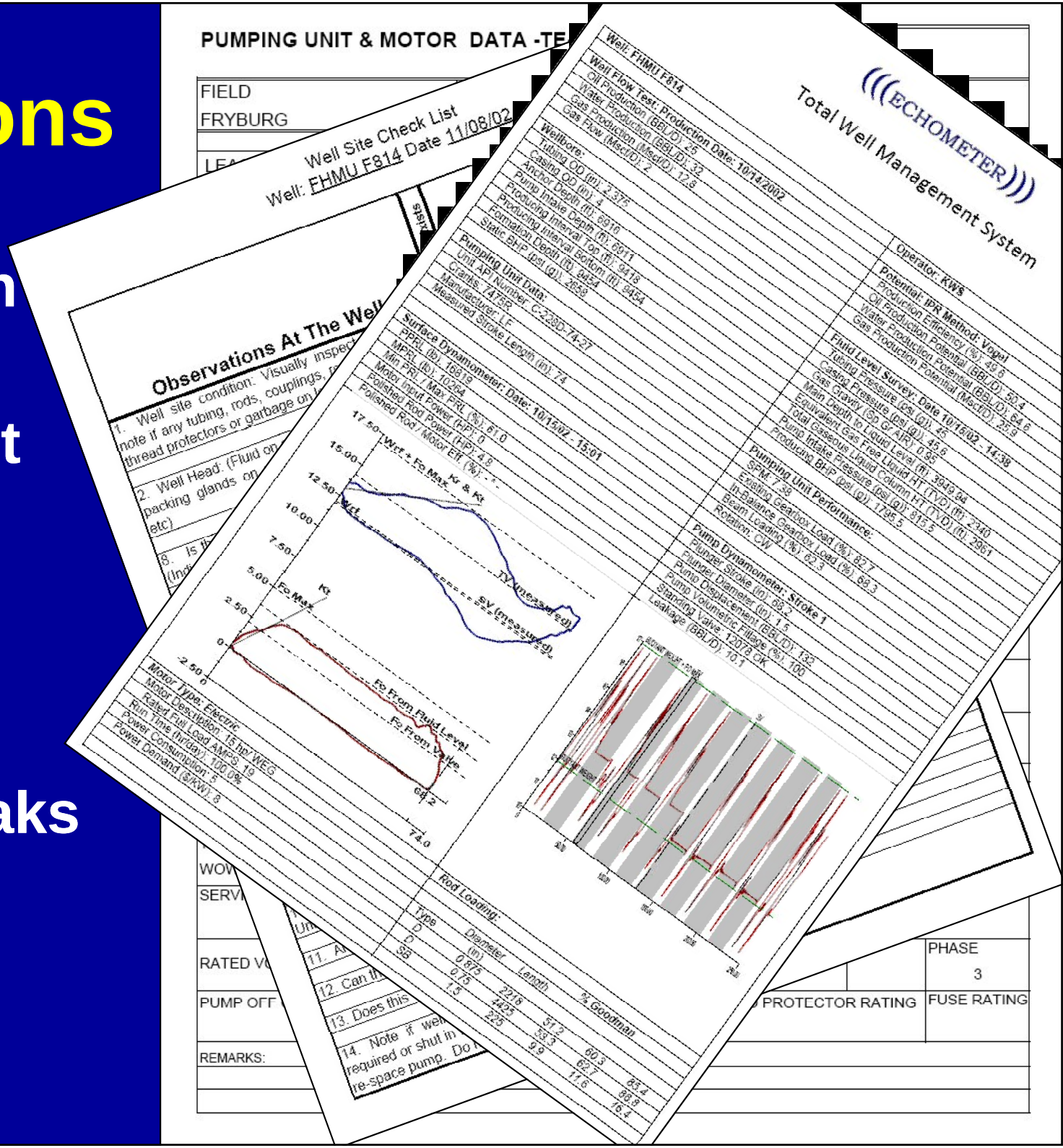
- Wellbore description
- Artificial Lift System Design
- Recent and/or Representative Well Test
- Pump Capacity (or, Pump Card)
- Producing BHP & Static BHP
- Current Production Equipment Setup
- Energy Efficiency
- Fluid Properties
- Past History

Input into TWM before going to the Well

Record Observations at the Well

- Consistency in Approach
- Use Check List
- Motor Info
- PU Info
- Site Condition
- Noticeable Leaks
- Is Fluid going into the tank

CheckList_TE2.XLS

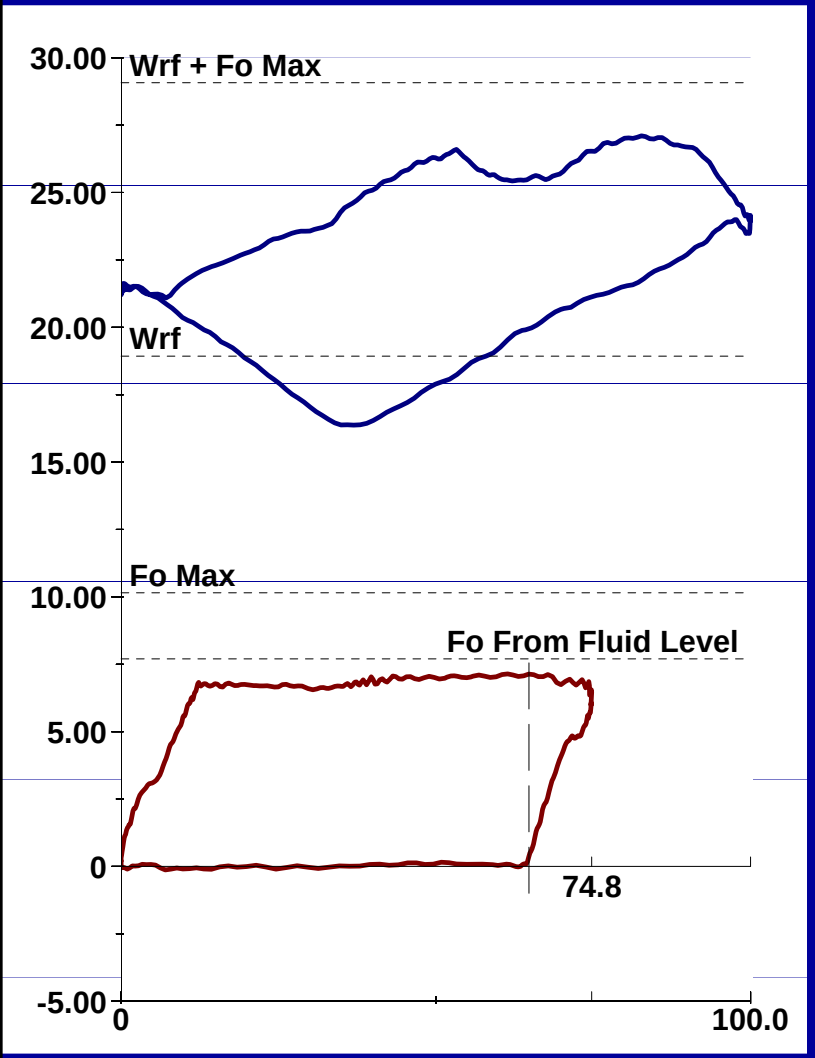


Key Observations at the Well

- Tubing and Casing Pressure Readings
- Is Produced Fluid Warming the Flow Line
- Is Polished Rod Hot to the Touch
- Hear any Unusual Noises at the Well
- Are Belts, Polished Rod, or Pumping Unit Shaking or Vibrating
- Are Downhole Impact Loads Shaking the Ground
- Can the Pump Pressure up the Tubing
- Does this Tubing Pressure Leak Off

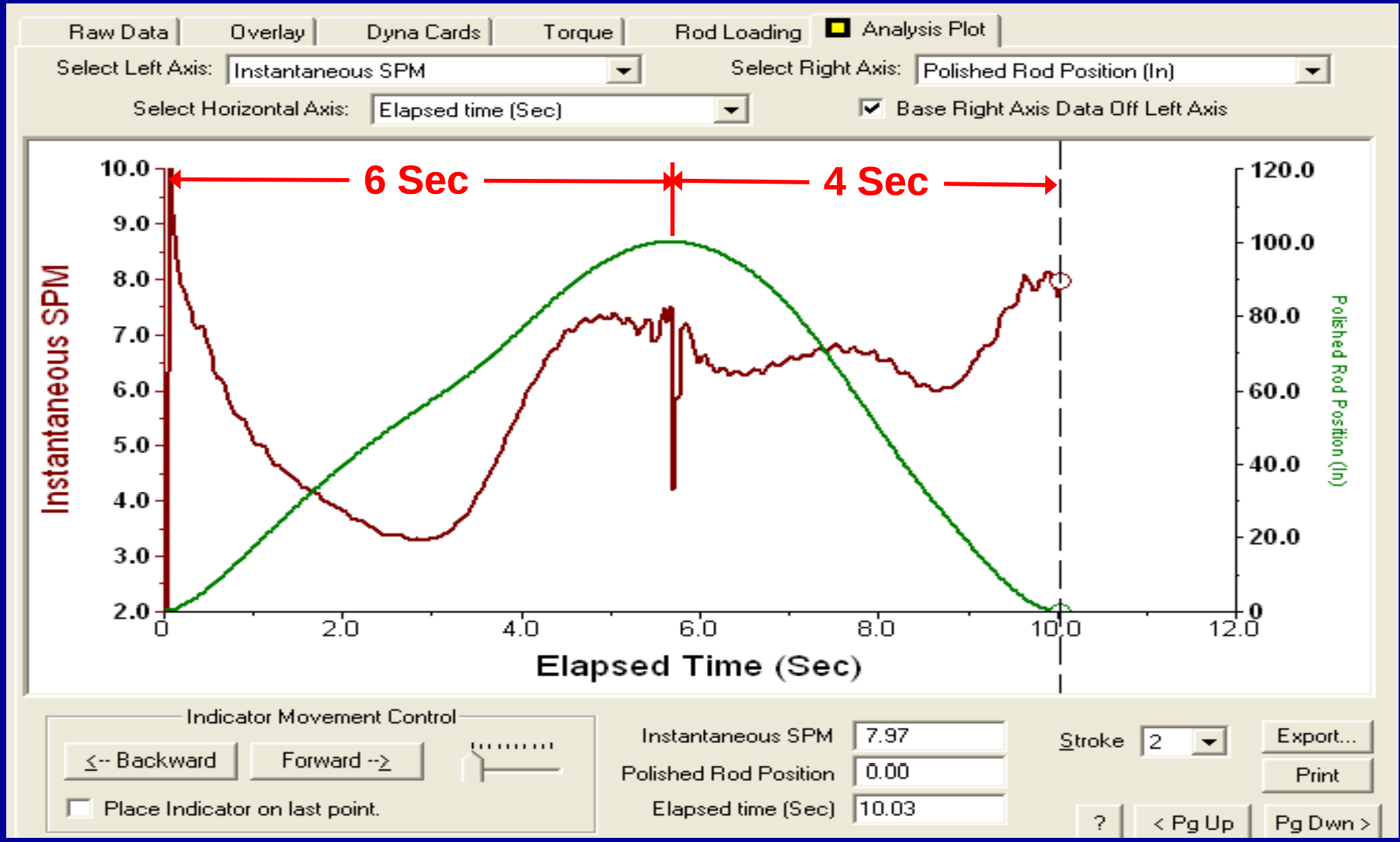
Problem Shown w/ Digital Camera

Dynamometer Cards Appear to be OK



Thanks to James Harris for Video

Normal 7 SPM Slows to 3 SPM Due to Rod Heavy Imbalance



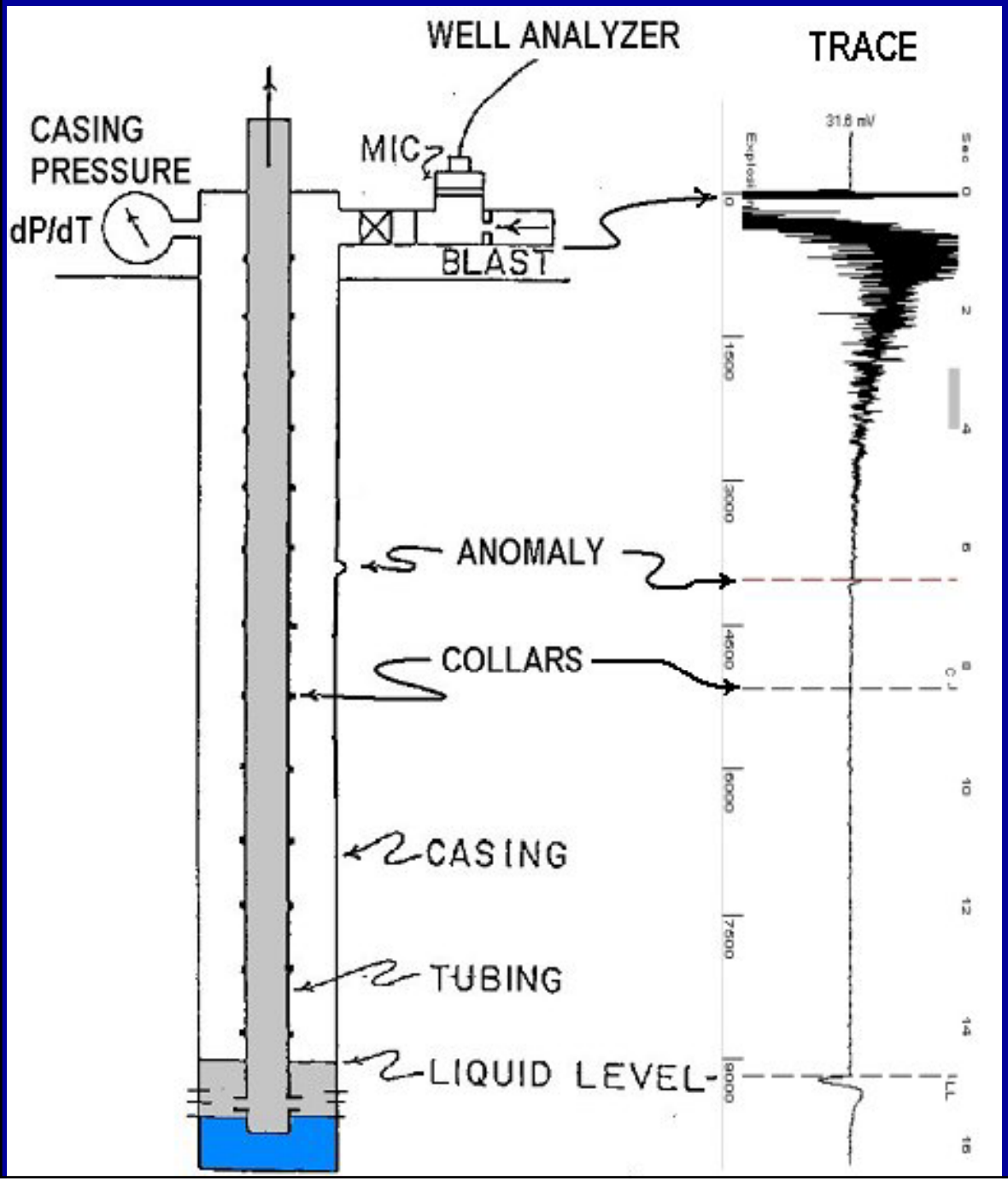
Common Practices that Result in Operational Problems

- Need to tag in-order to pump.
- Disabled POC Controller - set on hand and running 24 hrs/day.
- Increase SPM in Order to Maintain Production.
- Increase SPM because Fluid Level is above the pump.
- Pull the Well, because no Fluid in the Tank.
- Wells Produce into Common Tank, no good test data.

ACOUSTIC SURVEYS ANSWER FOLLOWING QUESTIONS IN ORDER TO ANALYZE A WELL:

1. What is the depth to the top of the liquid?
2. Does liquid exist above the pump?
3. What is the percentage of liquid in the annular fluid column?
4. Does the liquid in the casing annulus restrict production?
5. What is the casing-head pressure? Does it restrict production?
6. Is gas flowing up the annulus? At what rate?
7. What's maximum production rate available from well?

Wellbore Reflections shown in Fluid Level



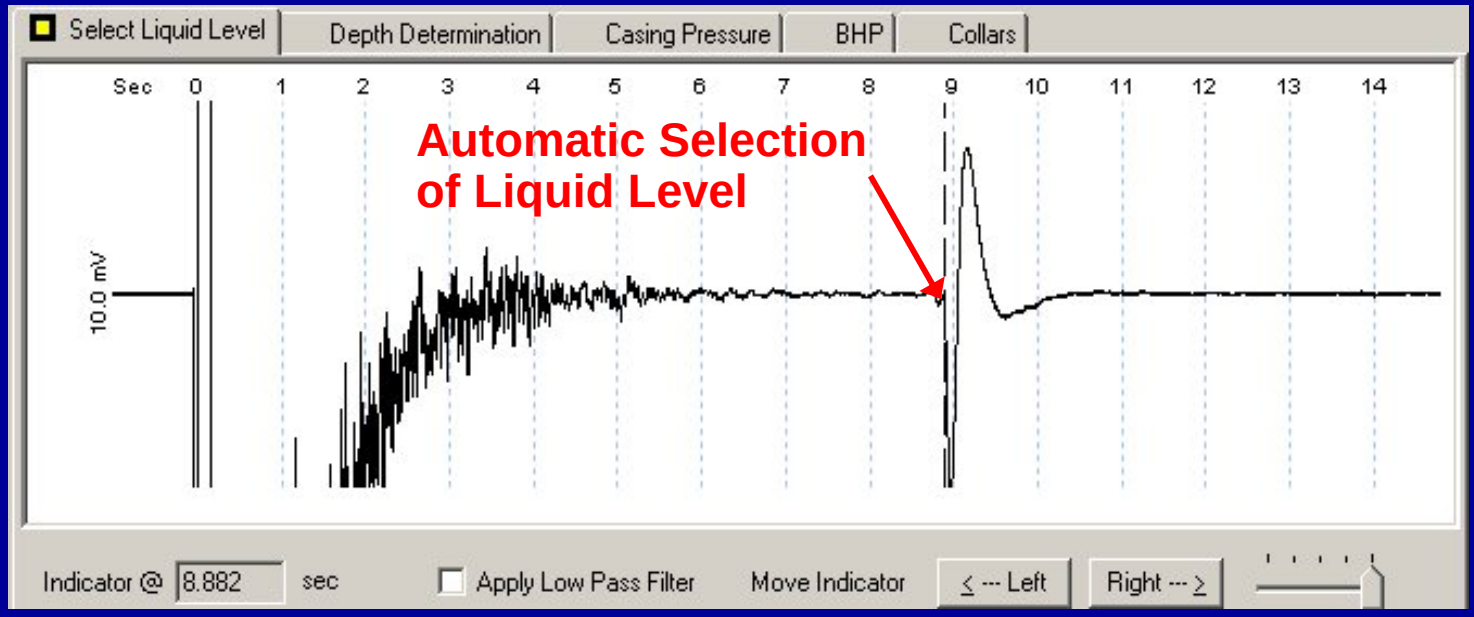
1. Acoustic Fluid Level and Pressure Build-up are used to answer Questions

2. The Depth from the gun to an anomaly in the casing annulus reflect back to the microphone at the surface.

3. Microphone housed in the gas gun detects the blast from the shot and reflected sound from collars, liners, perforations, liquid level, plus other obstructions in the annulus.

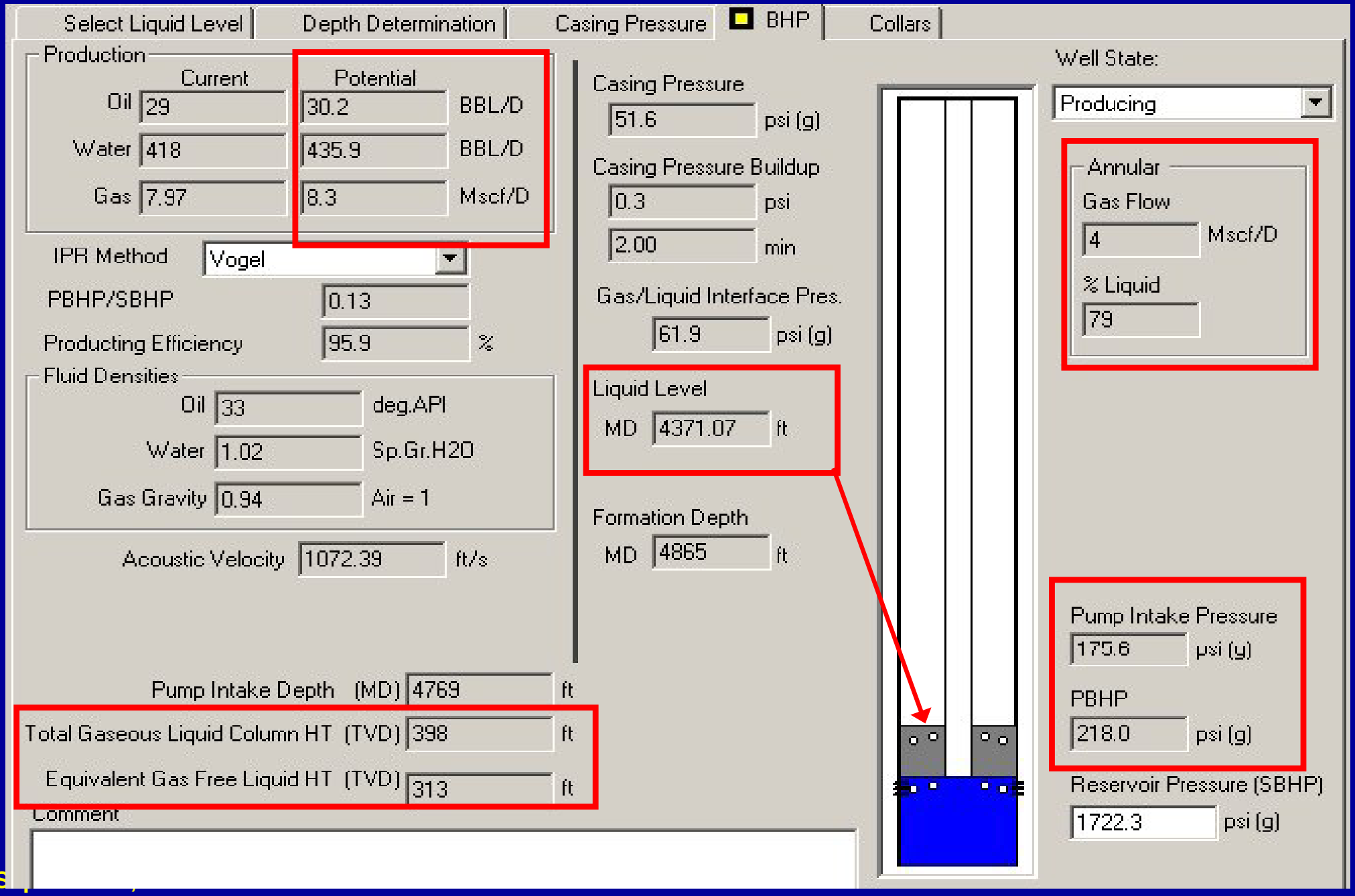
Measured Time to Liquid Level During POC Controlled Pumping Cycle

Well Shut-in Just Prior to Beginning of Pumping Cycle



Well Pumped OFF Just Prior to POC Turning Motor Off

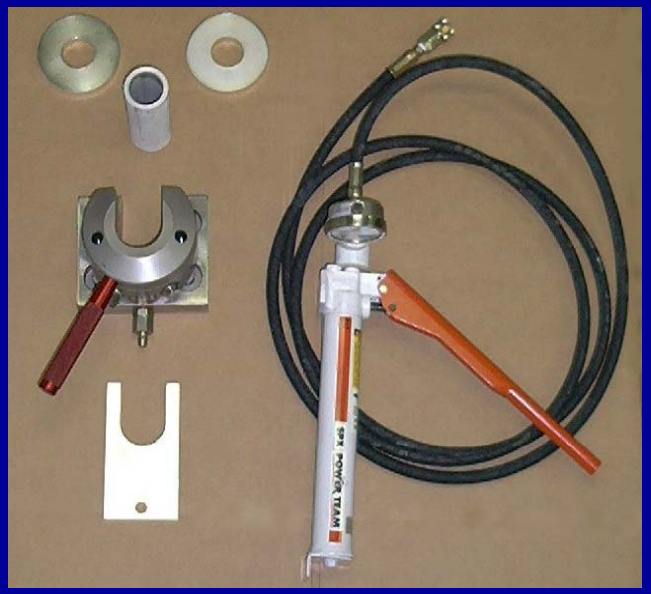
Acoustic Liquid Level Test Analysis

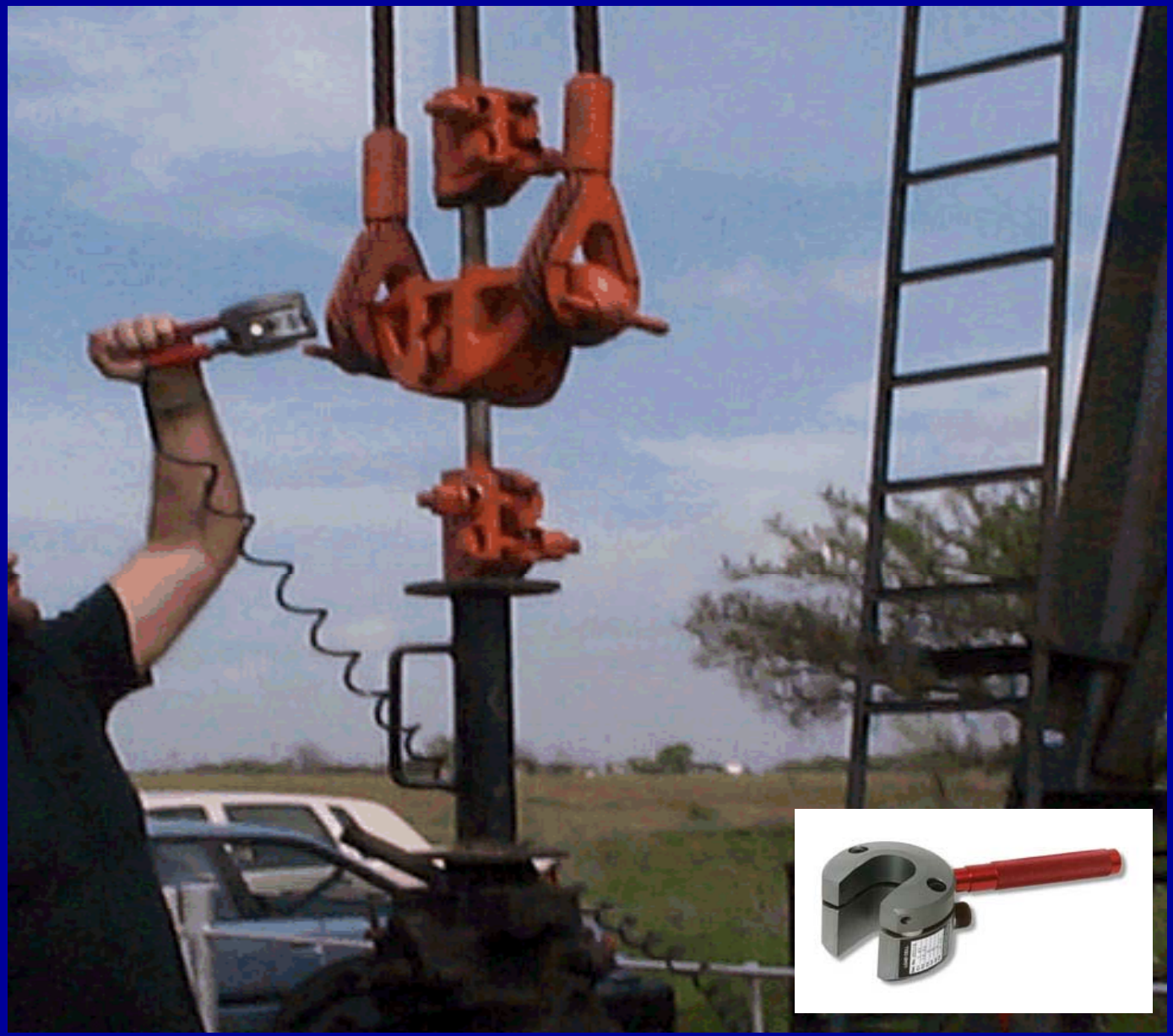


DYNAMOMETER SURVEY ANSWER FOLLOWING QUESTIONS IN ORDER TO ANALYZE A WELL:

1. Is the well pumped off?
2. What is the pump intake pressure?
3. What is the pump fillage? And pump displacement?
4. What is the current pumping speed?
5. Are the traveling and/or standing valves leaking?
6. Are the maximum and minimum rod loads within limits?
7. What is the polished rod and pump horsepower?
8. Gearbox overloaded? Is the unit properly balanced?
9. Required counterweight movement to balance the unit?
10. Is the downhole gas separator effective?

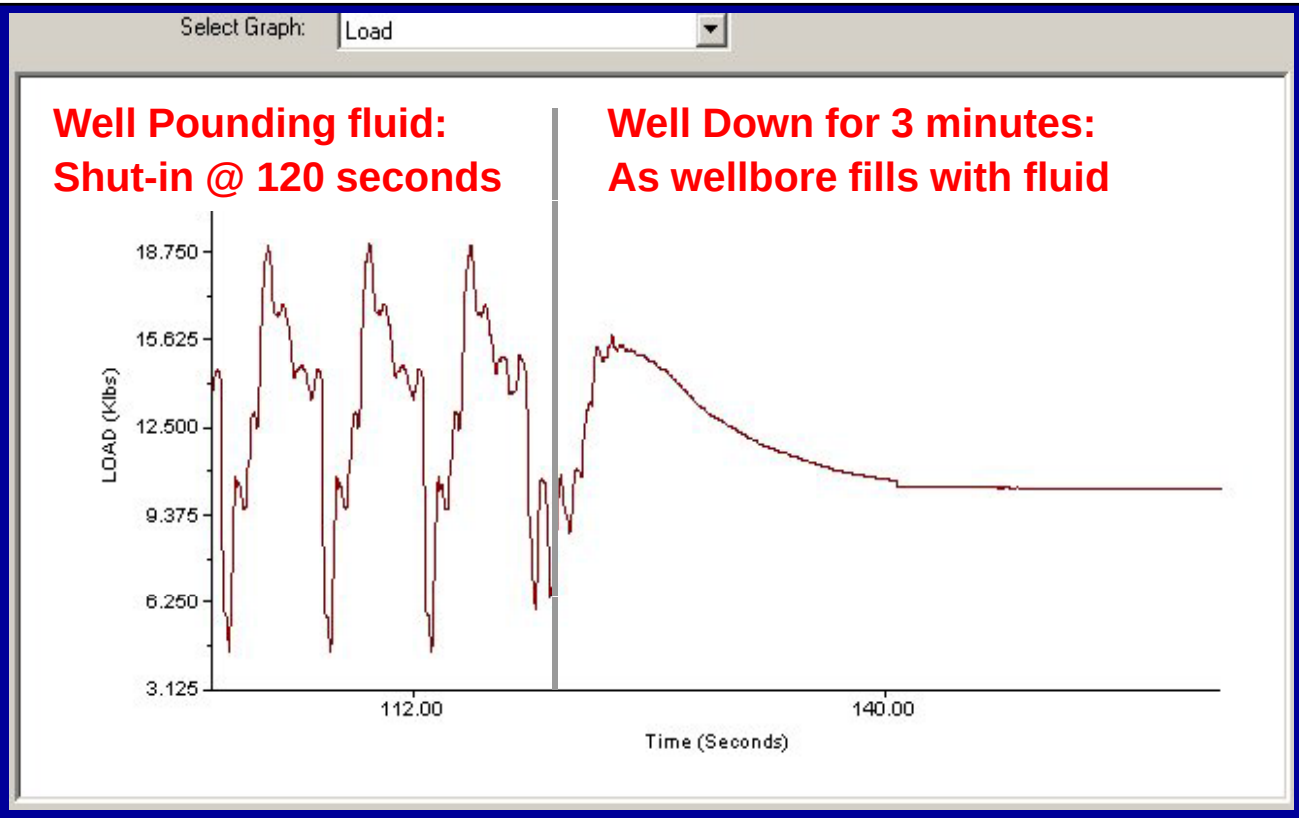
Use Any of these Transducers to Perform a Dynamometer Survey

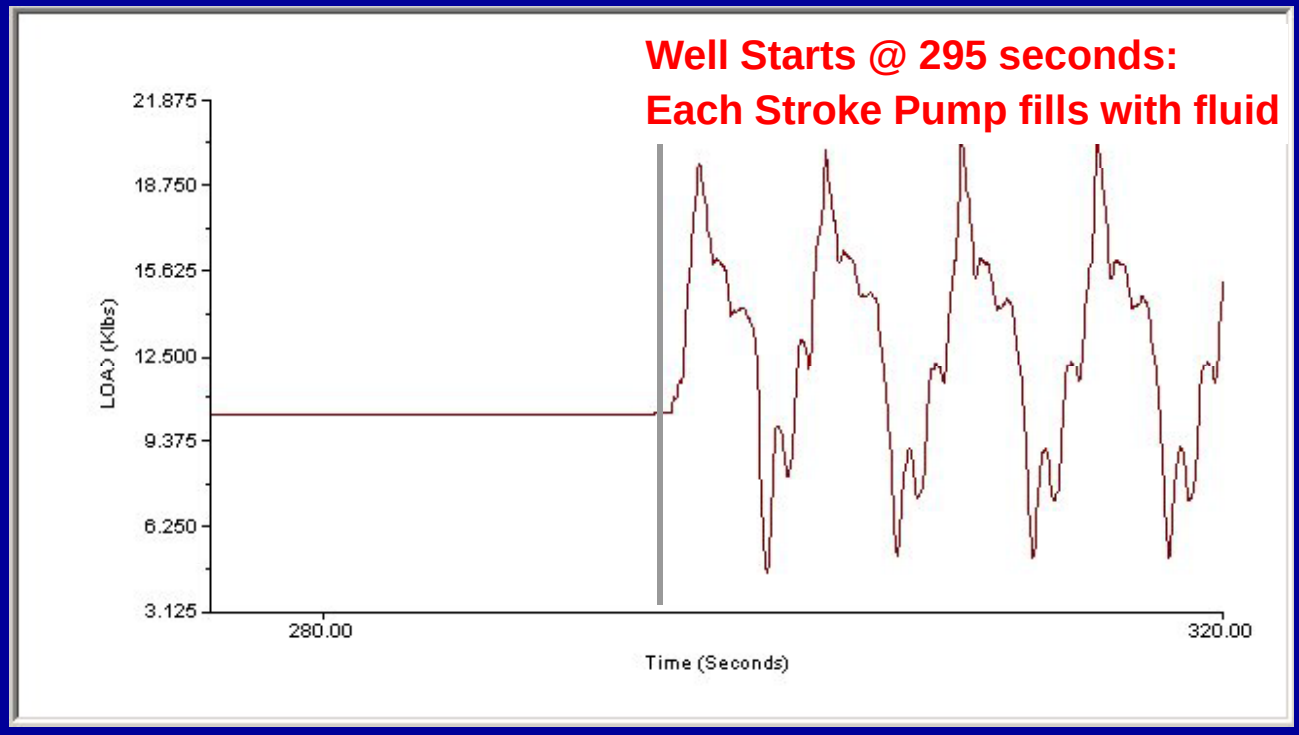




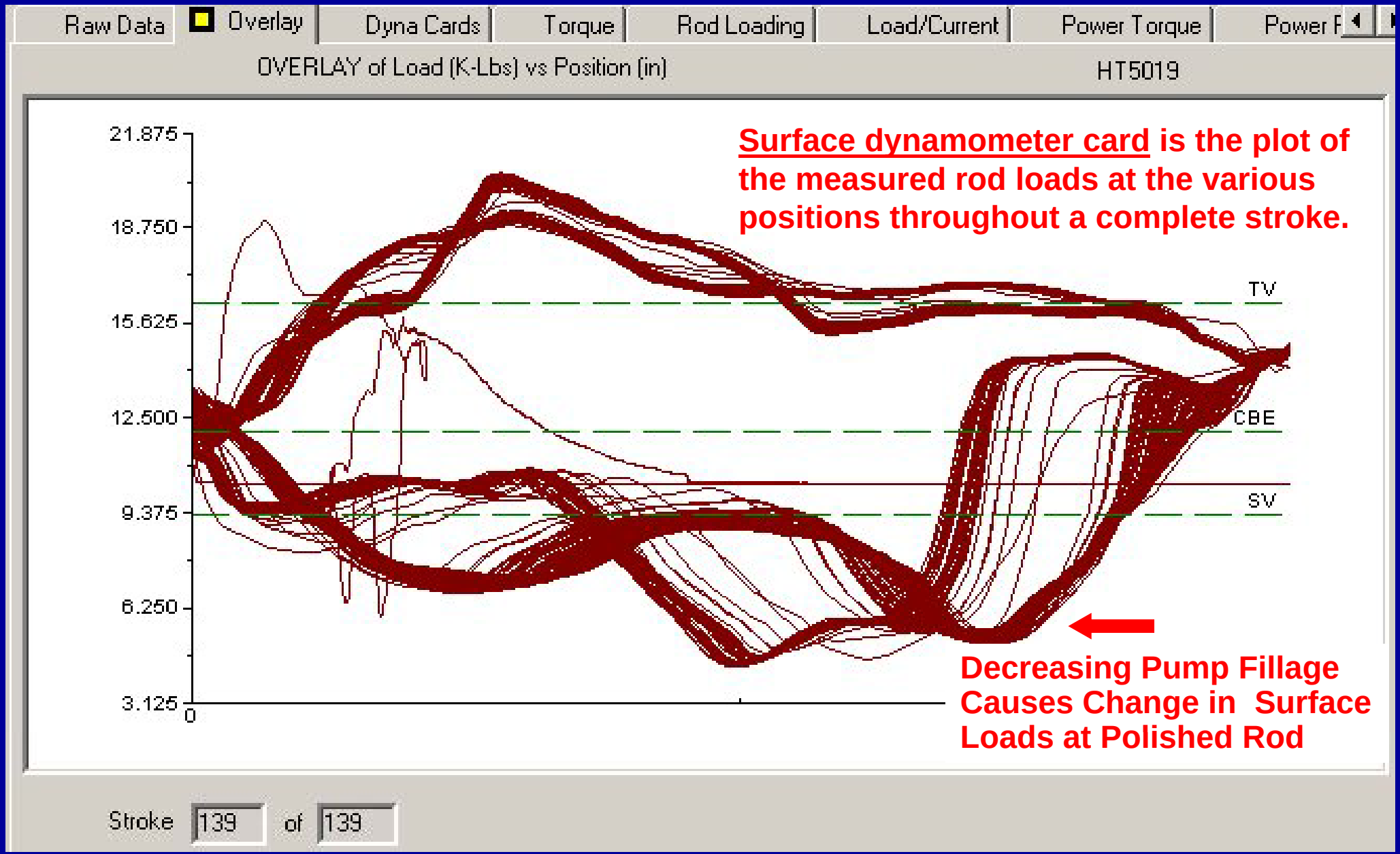
Measure Load Applied to the Polished Rod

1. POC Operates with Down Time = 24 Minutes/Cycle for an Average Run Time = 17 hrs/day = 70.84%
2. Test Rate/Pump Displacement = 387/574 = 67% OR 16.18 hours/day
3. Pump Off Stroke #118 = 76.98 % Fillage
4. Well Down @ 120 sec Pumping @ 295 Seconds Pump Off @ 894 Seconds = (894-295)/(894-120) =77.4% Fillage

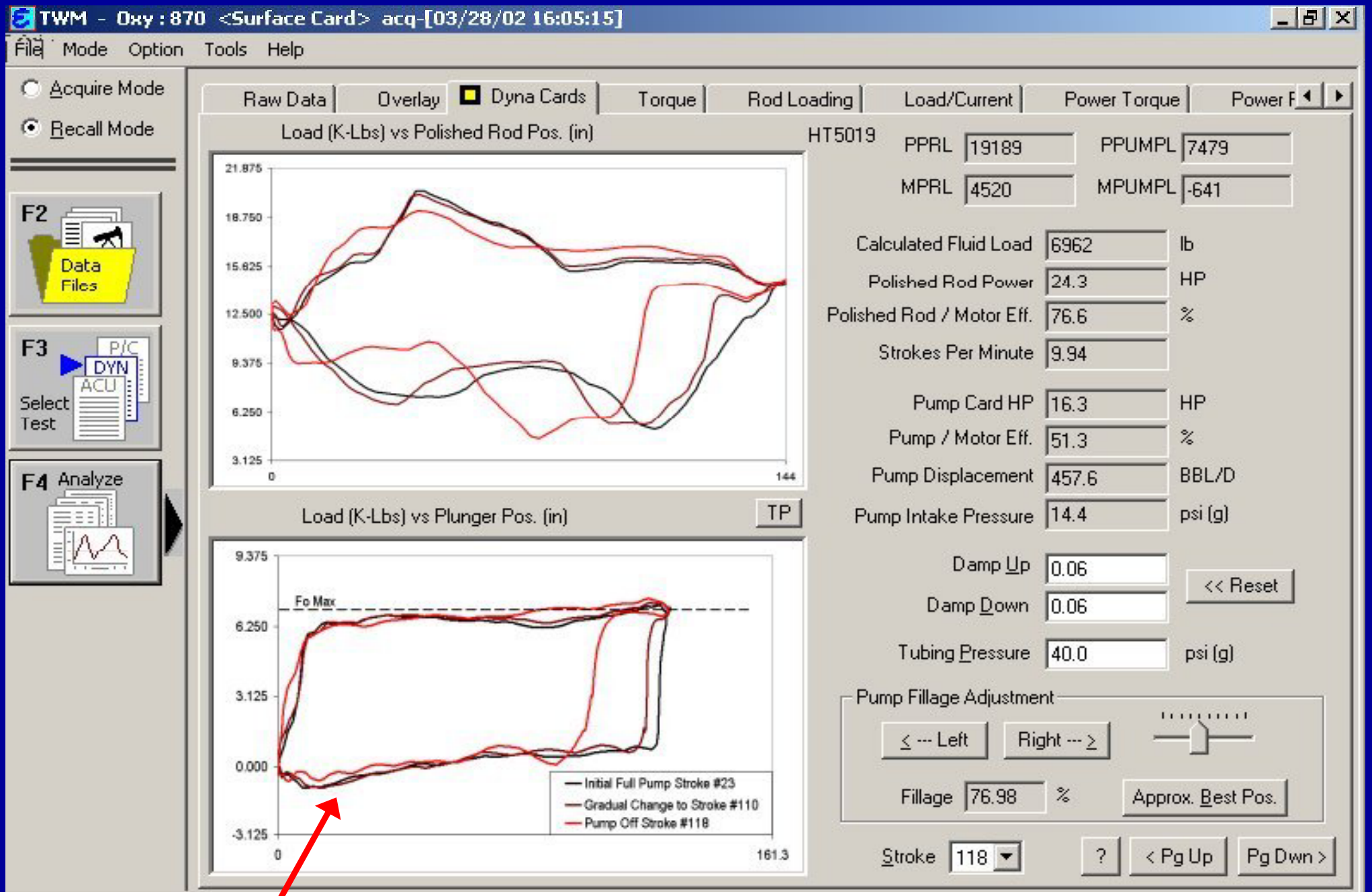




Overlay 139 Surface Dynamometer Card Shows Load Change During POC Cycle

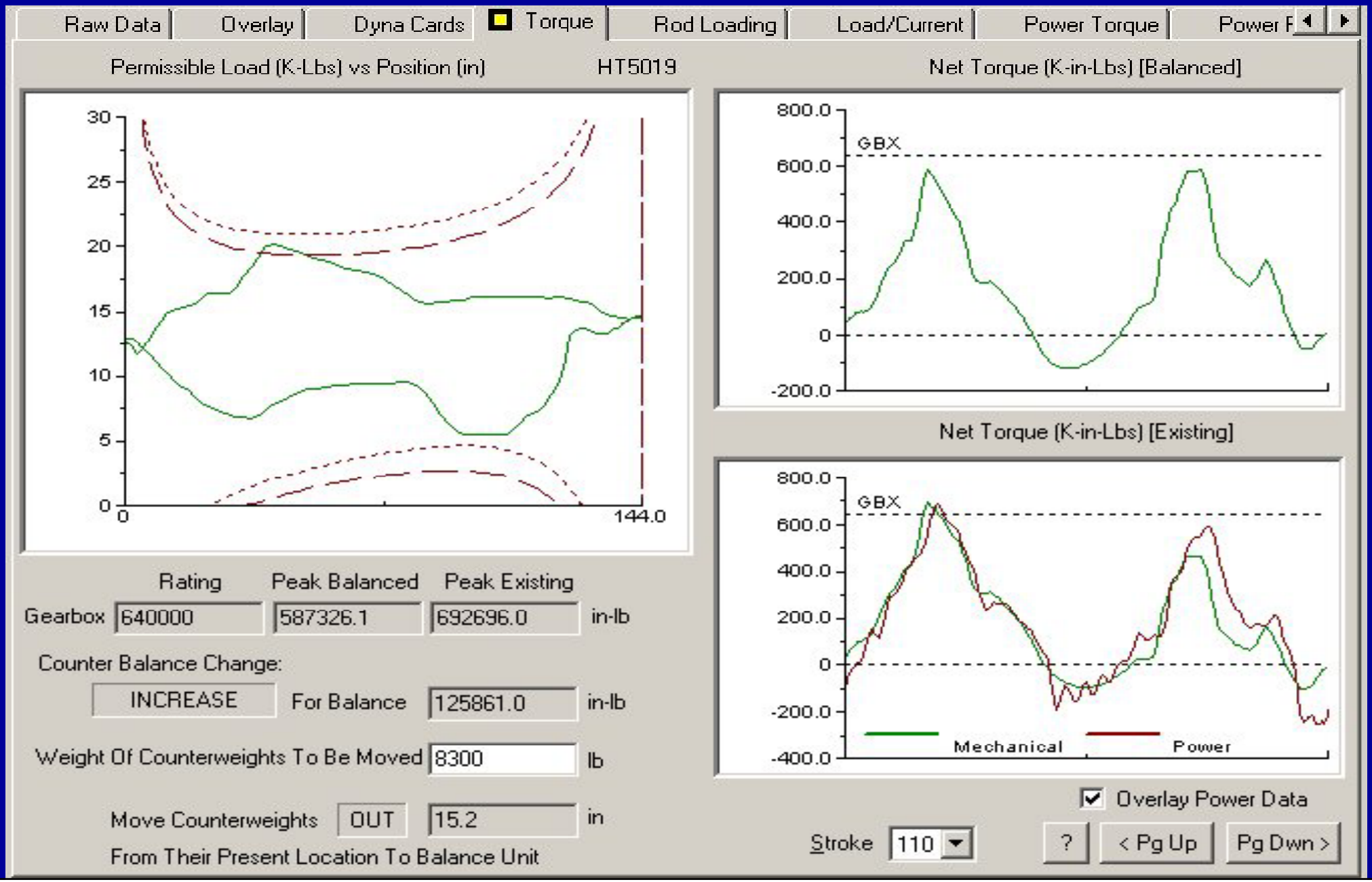


Surface and Pump Dynamometer Card



Pump dynamometer card - calculated load the pump applies to the bottom of the rod string.

Peak Polished Rod Load Exceeds Permissible Load on Gearbox

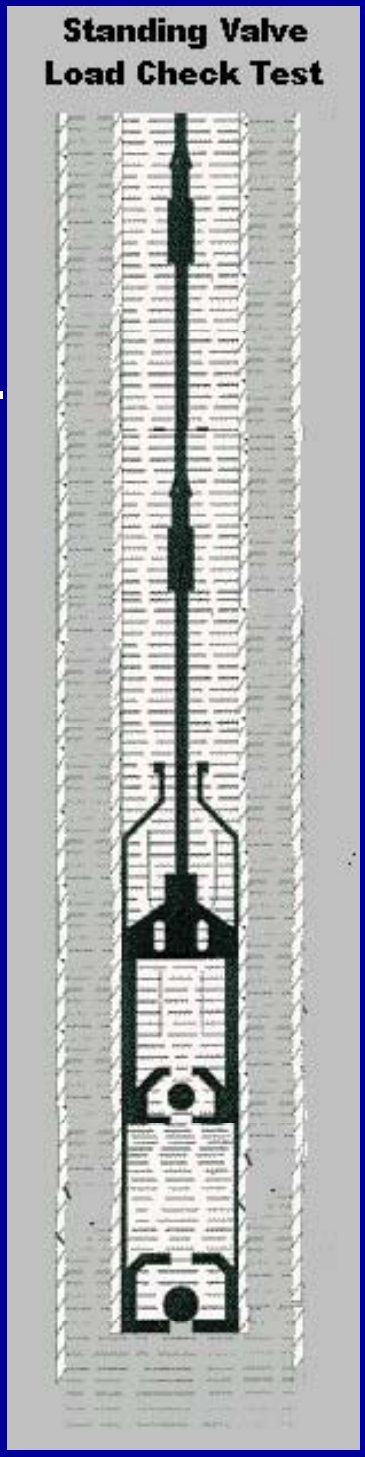


Valve Check Load Tests Answer Following Questions in Order to Analyze a Well:

1. What rate does the Traveling Valve Leak?
2. What is the condition of the traveling valve, the pump barrel and plunger and the tubing string?
3. Is the fluid being held in the tubing?
4. Does the Standing Valve Leak?
5. Are the rod string lengths correct?

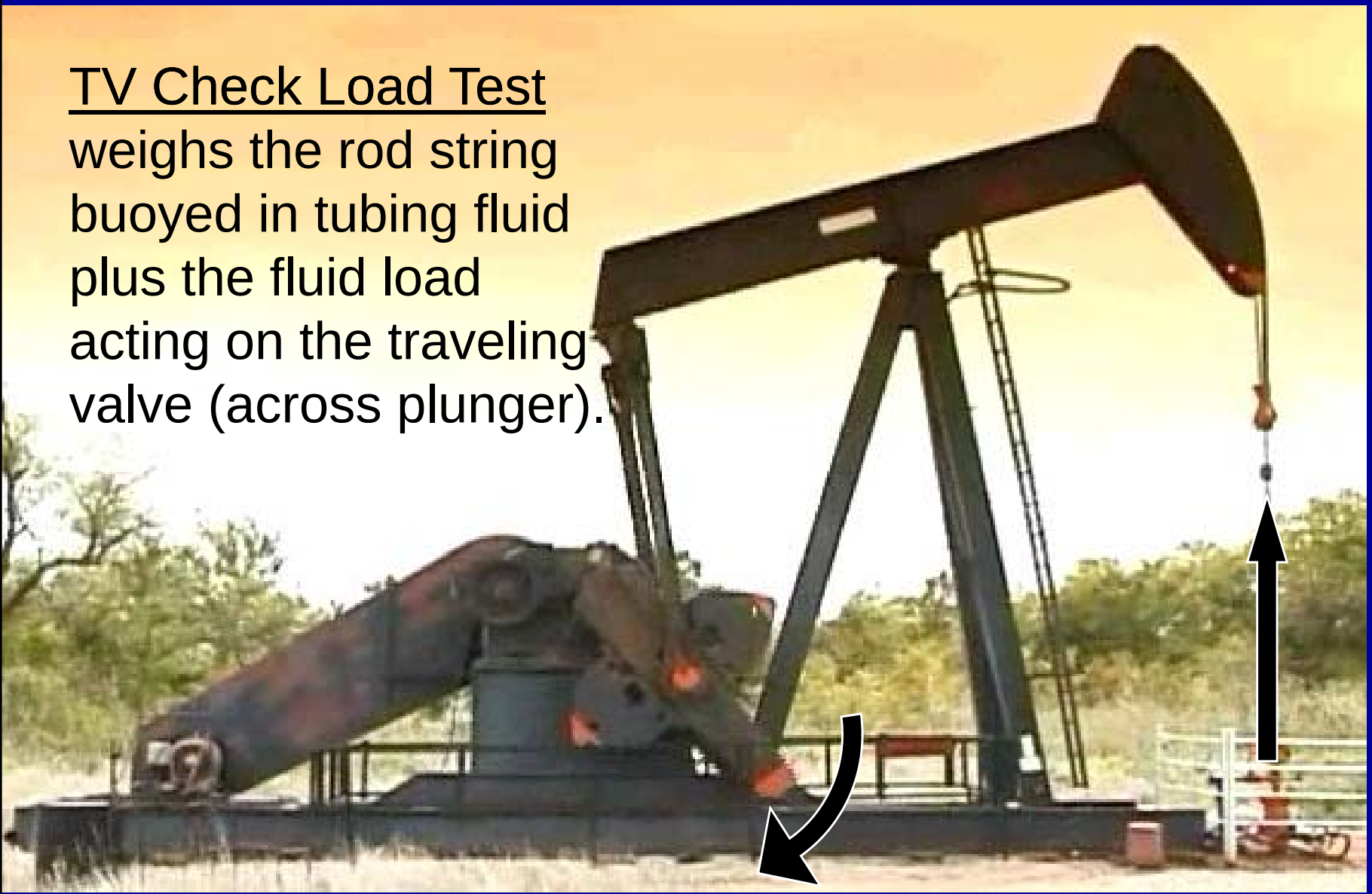
Stop on the Down Stroke to Monitor for Leakage from the Pump into the Casing

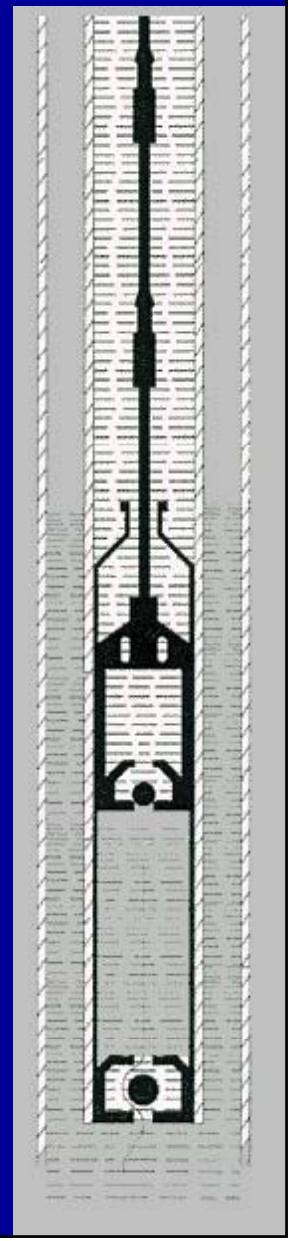
Standing valve test taken during the down stroke by gently stopping about ¼ from the bottom of the stroke.



Stop on the Upstroke to Monitor for Leakage from the Tubing into the Pump

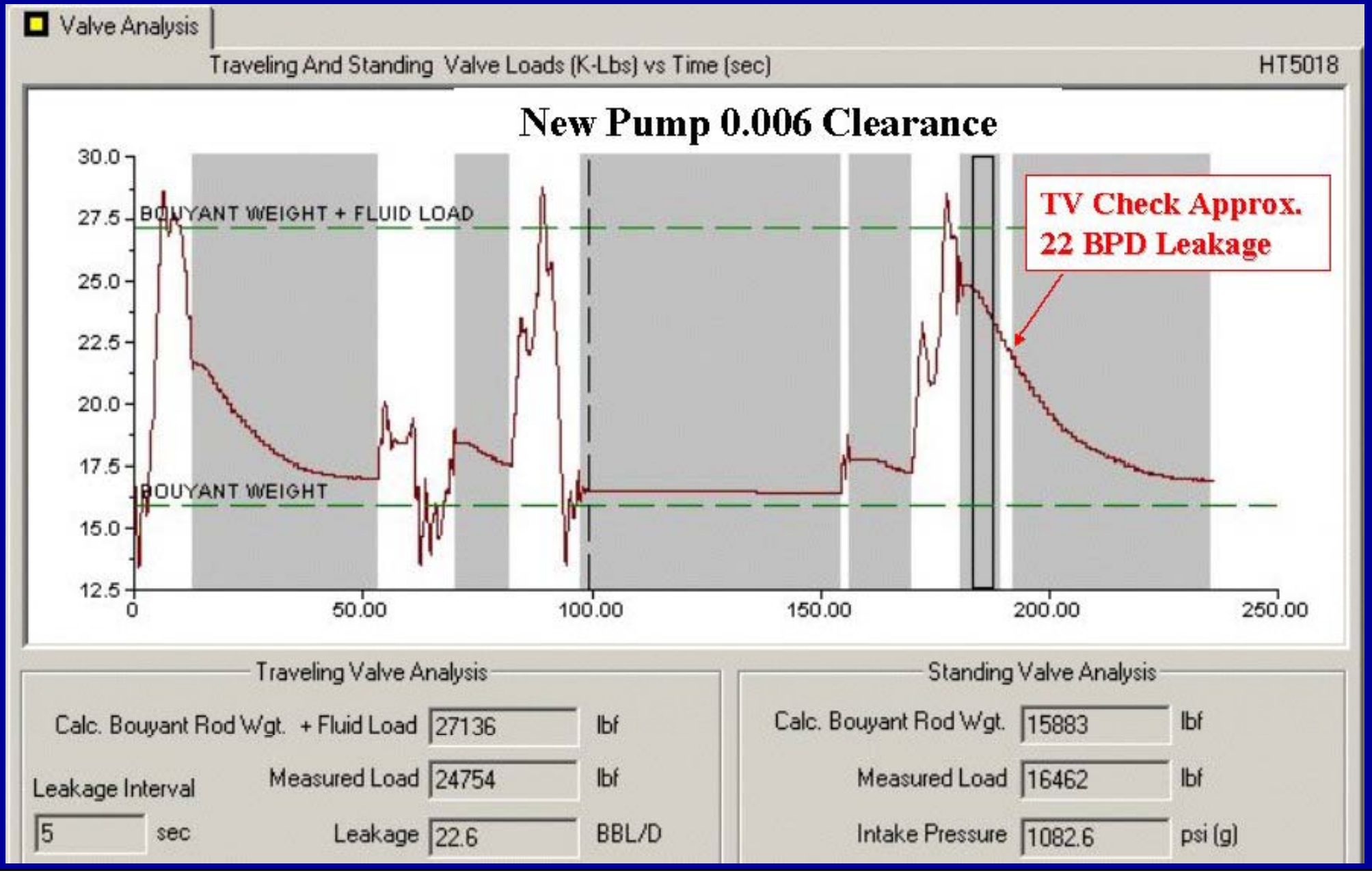
<u>TV Check Load Test</u>
weighs the rod string buoyed in tubing fluid plus the fluid load acting on the traveling valve (across plunger).





Measured and Computed Valve Loads

TV Load Loss function of Pump-Barrel Clearances



On site Power Survey Answer Following Questions In Order to Analyze a Well :

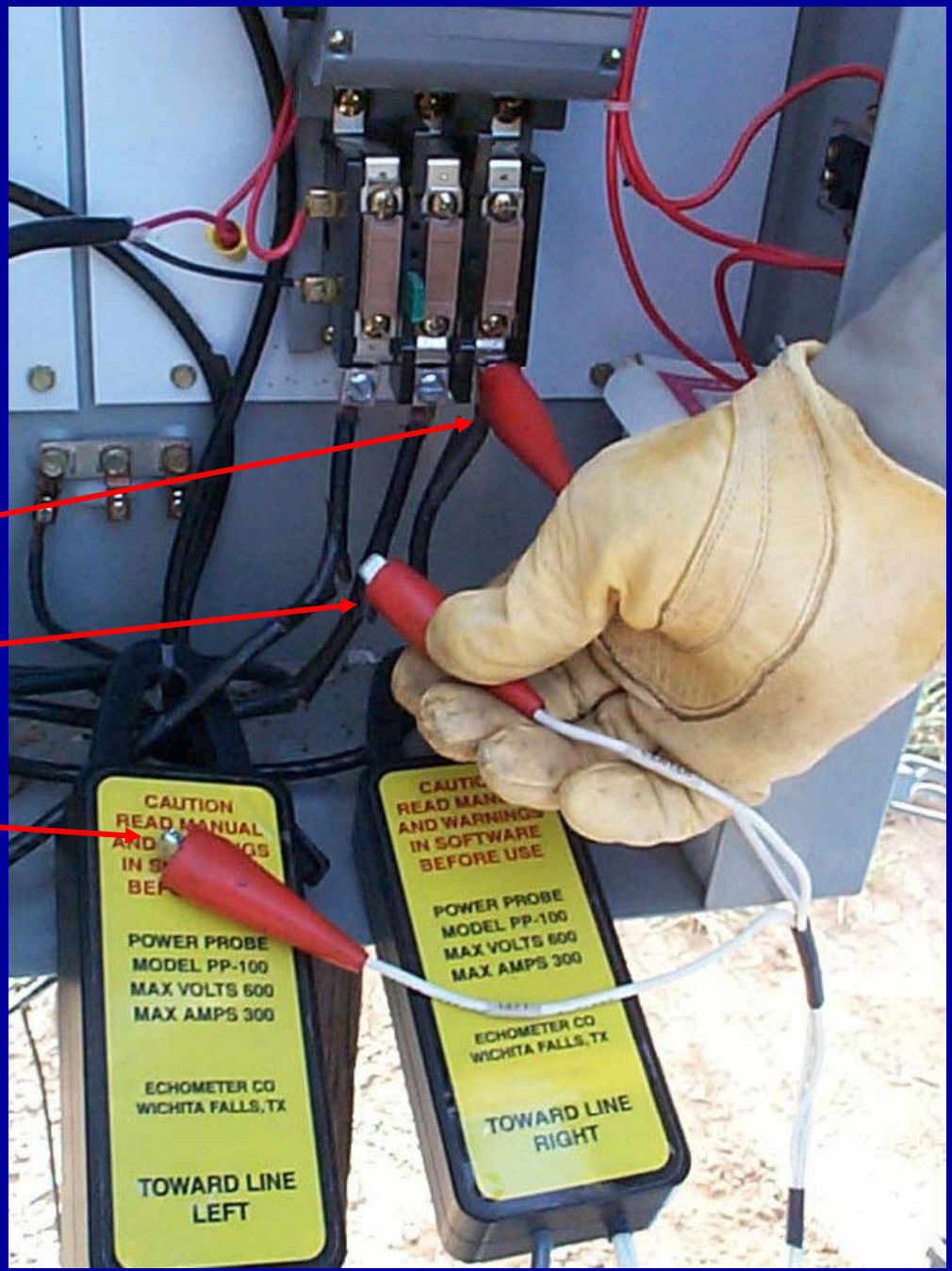
1. What is the apparent motor current?
2. What is the real motor current?
3. What is the power use during a pump stroke?
4. What is the exact power consumption , KWH/day, $/month, $/Bbl, etc?
5. Is the motor over/under sized for the load?
6. What is the power factor?
7. Is the Unit electrically balanced?
8. Does the motor performance require more detailed analysis?
9. What is the Torque loading?
10. What movement of the weights is required to electrically balance the unit?
11. What is total system efficiency?

Power Measurement Equipment

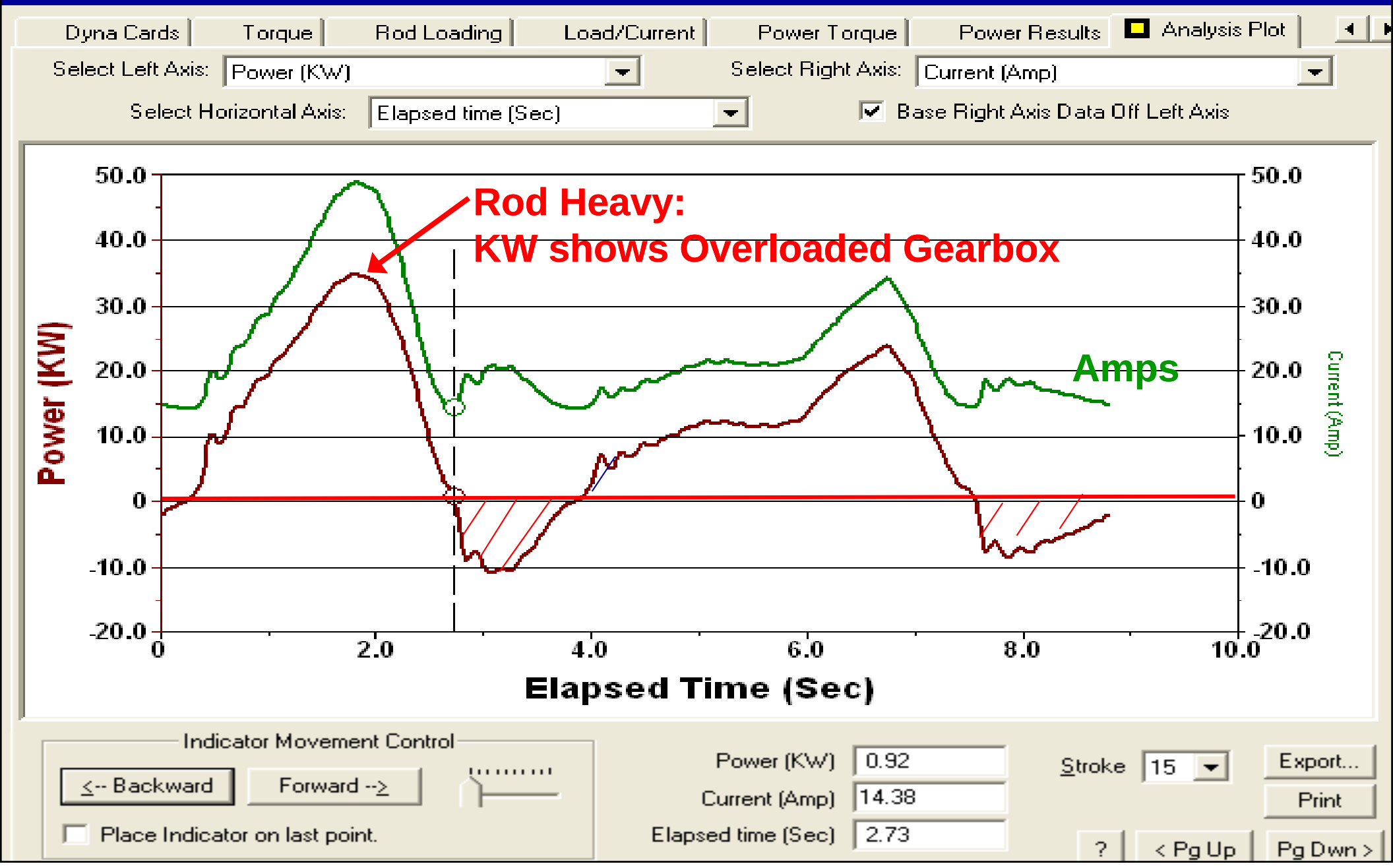
1. Acquire:
   - RMS (thermal) motor current
   - Average (real) motor current
   - kW during a pump stroke cycle.

2. Three voltage sensing leads
   RIGHT
   CENTER
   LEFT

3. Two current sensors.



Electric Power (kW) and Current (Amps) Input to the Motor over the time of One Pump Stroke



Motor Power and Electrical Cost Analysis
Low System Efficiency from 600 Psi Back Pressure

Overlay | Dyna Cards | Torque | Rod Loading | Load/Current | Power Torque | Power Results | Ana

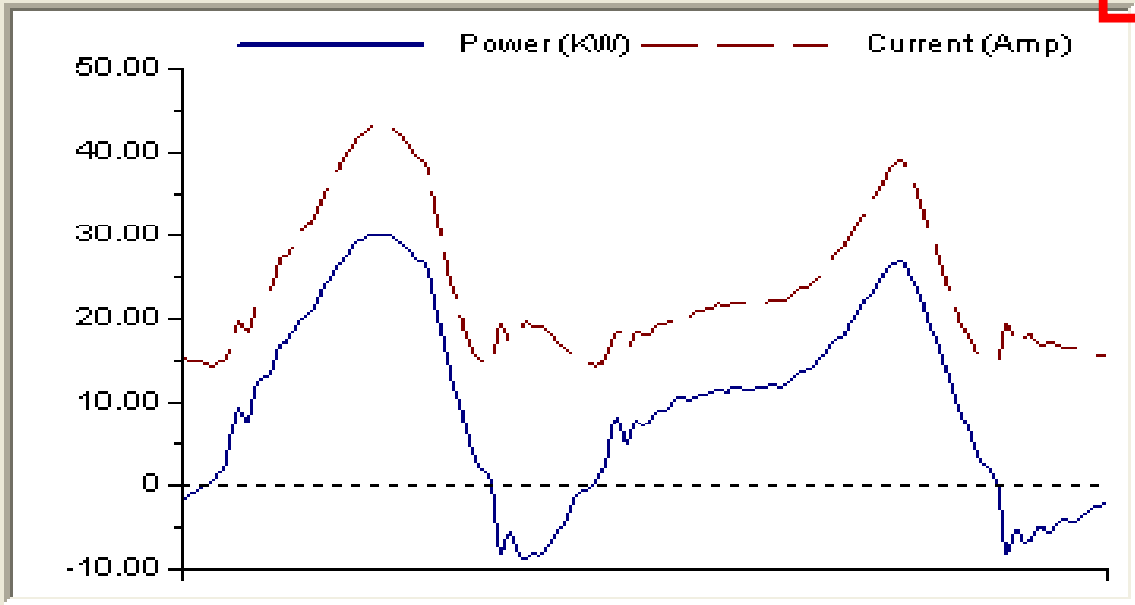
Monthly Operation Costs (30 Days per Month):

Run Time	24	hr/day
Cost With Gen. Credit	353.34	$
Cost No Gen. Credit	396.56	$
Demand Cost	97.73	$
Oil Prod. Cost	126.7	¢/bbl
Liquid Prod. Cost	22.6	¢/bbl
Oil Production	13	BBL/D
Water Production	60	BBL/D

Cost $

Recommended Minimum NEMA D Motor	20.3	HP
Rated HP	30	HP
Rated Full Load AMPS	39	
Thermal AMPS	25.2	
Gross Input	14.8	HP
Net Input	13.2	HP
Demand	12.2	KW
Average	10.9	KVA

Power



Average Power

With Generation Credit	9.8	KW
No Generation Credit	11.0	KW
Avg. Power Factor	69.0	%
System Efficiency	27.9	%

System Efficiency

Stroke 12 | ? | < Pg Up | Pg Dwn >

To be a Successful Troubleshooter

- **Must Use Data to Determine the Solution to Well Problem's.....**
- **Needs to look** 10,000 feet **down a** 3 inch **diameter black hole and** "SEE" **what is happening .....**
- **People often think you are a Wizard**