AFL IV with Dynamometer

Dynamometer Procedure & Sage DYN Software

Operator's Manual

Sage DYN software
Version 2.2.3.10

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Introduction to the AFL IV with Dynamometer

Read and understand all safety warnings and operation constraints in this operator's manual before proceeding with a dynamometer test.

The **AFL IV with Dynamometer** lets the operator use his own portable computer in combination with Sage DYN software to gather computerized dynamometer cards on pumping oil and gas wells. The Sage DYN software stores well data on the computer, and allows easy downloads or email of Adobe .pdf files. The software also allows easy measurement and calculation of surface and downhole cards, standing and traveling valve checks and counterbalance measurement.

All of the products offered by Sage Technologies are the result of years of field experience and technical innovation. In addition, our technical and training staff and our full repair shop stand behind each piece of equipment.

Included with your AFL IV with Dynamometer

AFL IV with Dynamometer box

- Sage DYN software CD
- Operator's field manual
- Wall-mount battery charger
- USB cable
- Load Cell
- String Transducer
- Current Transducer
- Load Cell cable and reel
- String Transducer cable and reel
- Current Transducer and reel

Other tools needed in the field

- Portable computer – with Windows 7 or Windows Vista or Windows XP operating system – with the Sage DYN software installed.

Sage DYN software

Installation instructions

A CD-ROM containing the Sage DYN software is included with purchase of the AFL IV with Dynamometer.

The Sage DYN is designed to work with any Windows 7, Windows XP or Windows Vista computer. This means that you can use your field portable computer to gather data and save it to a disk or USB memory stick, then use your office computer and printer to analyze the data and print a fluid level report.

To install the Sage DYN software, insert the CD into the CD-drive of your Windows computer. The CD will autorun. Please be patient during the installation, as several programs are being installed. One of these automatic installs, the CutePDF Writer, will allow you to save the fluid level report to an Adobe .pdf file, for email transmission.

The CD is not required in the field, once the software is installed on the field computer. Feel free to install the Sage DYN software on any other office or field computers. Then store the CD.

AFL IV with Dynamometer

Read and understand all safety warnings and operation constraints before proceeding.

Quick start instructions

- Connect the cables and transducers to the AFL IV with Dynamometer.
- Make a zero load cell reading. Connect the Current and String transducers to the Dynamometer. Install the Load and String Transducers. Install the Current Transducer.
- Turn on the pumping unit to minimize the reservoir pressure disturbance.
- Enter the appropriate rod taper information. If none is available, enter 0 for the number of rod tapers, to collect a surface card only.
- Gather a Load versus Position card.
- Gather a Current versus Position card.
- Gather the Standing and Traveling Valve Checks, along with a Counterbalance if possible.
- Save all your data.
- Remove the transducers form the pumping unit. You are done.
-

Before commencing a test, walk around the site, examining the equipment for proper maintenance. Make sure the throat bolts are installed on the pumping horsehead before separating the pumping unit. If there are no throat bolts, DO NOT proceed with a quantitative dynamometer.

Detail at the Wellsite – 40K Quantitative Load Cell

SAFETY FIRST! Work in pairs if possible.

1) Connect the transducers and cables to the **AFL IV with Dynamometer**. Turn on the power switch.
2) Check the **40K Quantitative Load Cell** zero while the Load Cell is lying on the ground.
3) If current measurements are being made, carefully install the amp clamp. **Be careful when walking or operating around an open electrical control box door. There is a risk of inadvertently being exposed to the electrical conductors. Safety First.**
4) Turn off the Pumping Unit.
5) Install the **Stuffing Box Protector** on the wellhead. Securely tighten the Rod Clamp around the Polished Rod.
6) Using the **Knock-off Stand,** throw slack between the upper rod clamp and the carrier bar to

7) allow installation of the Quantitative Load Cell. **Be extremely careful to keep fingers and hands clear** when the slack is thrown, as there is always a risk of the rod clamp slipping, causing the load to unexpectedly pick up.
8) When the **40K Quantitative Load Cell** is inserted, pick up the load.
9) Attach the **String Transducer** to monitor position. Place the String Transducer as near as possible to the vertical position.
10) Turn the pumping unit back on and you are ready to begin the test.

Detail at the Wellsite – Quick Clamp Load Cell

SAFETY FIRST! Work in pairs if possible.

1) Connect the transducers and cables to the **AFL IV with Dynamometer**. Turn on the power switch.
2) Check the **Quick Clamp Load Cell** zero while the Load Cell is opened and lying on the ground.
3) Turn off the pumping unit.
4) Attach the open **Quick Clamp Load Cell** to the rod below the carrier bar. Close the quick clamp.
5) Start the unit pumping.
6) Zero the moving clamped load cell, using the **Sage DYN** software.
7) You are now ready to start your test.

Detail at the Wellsite – Hydraulic Jack with Spool Spacer and 40 K Quantitative Load Cell

SAFETY FIRST! Work in pairs if possible.

1) Connect the transducers and cables to the **AFL IV with Dynamometer**. Turn on the power switch.
2) Check the **40K Quantitative Load Cell** zero while the Load Cell is lying on the ground.
3) If current measurements are being made, carefully install the amp clamp. **Be careful when walking or operating around an open electrical control box door. There is a risk of inadvertently being exposed to the electrical conductors. Safety First.**
4) Turn off the Pumping Unit.
5) Set the hydraulic jack and the 40 K load cell in the spool spacer.

6) Pressurize the hydraulic jack until the spacer plate can be inserted between the hydraulic jack and the load cell.
7) Depressurize the hydraulic jack to apply force to the spacer plate and the load cell.
8) You are now ready to begin the test.

AFL IV with Dynamometer - General Cautions

As in all oilfield situations, extreme caution and awareness must be exercised at all times when operating the AFL IV with Dynamometer.

Check the Pumping Unit and Site

Upon arrival at the site for testing, walk completely around the pumping unit examining all parts of the pump to determine if it is in good working order and properly maintained. If there is a question about safety of the unit, DO NOT PROCEED.

Work in Pairs

Always plan ahead of time how you will get off the well if necessary.

Check the Pumping Unit Brake

To perform a complete set of checks, the pumping unit must have a good working brake. Check before proceeding.

Check for Throat Bolts on Horsehead

Check for throat bolts on the horsehead of the pumping unit. Make sure they are installed before proceeding. If the unit does not have through bolts, only a quick clamp or hydraulic dynamometer should be considered.

Protective Gear Required

Always wear safety goggles when working at a running pumping unit to avoid damage to your eyes.

Wear a hard hat and gloves, especially when handling the wire on the string transducer.

During the dynamometer test, care must be taken to ensure free cable movement. Do not let the string transducer slip free during operation. The snapping cable can cause injury and may damage the string transducer.

Illustrated Procedure: Stacking Out the Well

For 40 K Quantitative Dynamometer

1) Install **stuffing box protector**

2) Install **rod clamp** with proper spacing below the carrier bar. Make sure the rod clamp below the carrier bar is tight.

3) Install **knock-off stand.** .

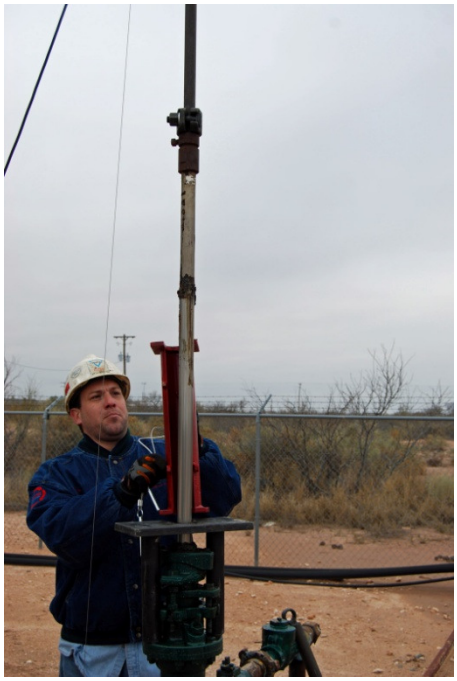
4) Bump **rod clamp** below **carrier bar** against **knock-off stand** to separate the unit.

5) Top **rod clamp** is now separated from the **carrier bar**.

6) Install **40K Quantitative Horseshoe Load Cell** .

7) Ease the top **rod clamp** back against the **40K Quantitative Load Cell**.

8) Remove the **knock-off stand** before beginning the test.



Work in Pairs

Always plan ahead of time how you will get off the well if necessary.

Illustrated Procedure: Installing a Quick Clamp Load Cell

This is an alternate procedure which uses the **Quick Clamp Load Cell**, instead of the 40K Quantitative Horseshoe Load Cell.

Before you begin, it is strongly recommended that you stop the pumping unit.

1) The **Quick Clamp Load Cell** is shown in open position at the well head, ready for install. Note that the cable is attached. The Quick Clamp load is zeroed before clamping on to the rod.

2) Attach the open **Quick Clamp Load Cell** to **carrier bar**. Close the quick clamp.
3) Start the unit pumping. Now zero the moving & clamped load cell using the **Sage DYN** software on the computer.

4) During the test, the **Quick Clamp Load Cell** and attached cable will travel with the **polished rod**.

At the end of the test, it is strongly recommended that you stop the pumping unit to remove the Quick Clamp Load Cell.

5) Use caution when removing the **Quick Clamp Load Cell** from the rod.

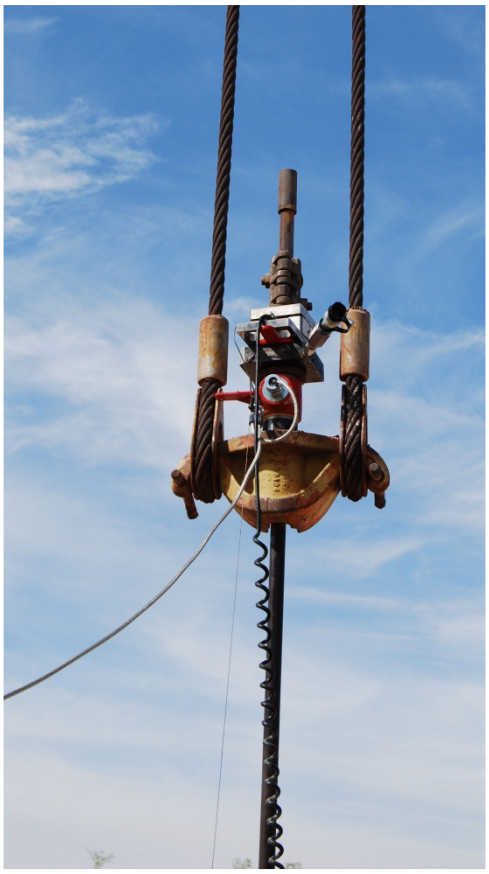
Illustrated Procedure: Using the Hydraulic Jack

For 40 K Load Cell and Spool Spacer

1) Below, see **Spool Spacer** ready to to accept hydraulic lift and load.

2) Set the **Hydraulic Jack** and **40K Load Cell** in the **Spool Spacer**.

3) Apply pressure to the **Hydraulic Jack,** shown below left.
4) Insert **spacer** and depressurize the system, which applies load directly to the **load cell,** as shown below right. Disconnect the **hydraulic cable**.



5) You are now ready to test.

6) To retrieve the **load cell**, pressurize the system. Remove the **spacer plate**. Depressurize the system. Remove the **hydraulic jack** and the **load cell**.

Sage DYN Software

Icon Operation of Software

In the upper area of the program window there are various icons which allow quick opening of various operations or files in the program. The same processes can also be achieved via the pull-down commands.

Starts a new Dynamometer test

Opens an existing Dynamometer file

Allows entry of program options, rod string and other items

Company name and Well name

Start a new Dynamometer session, and append data

Print Report

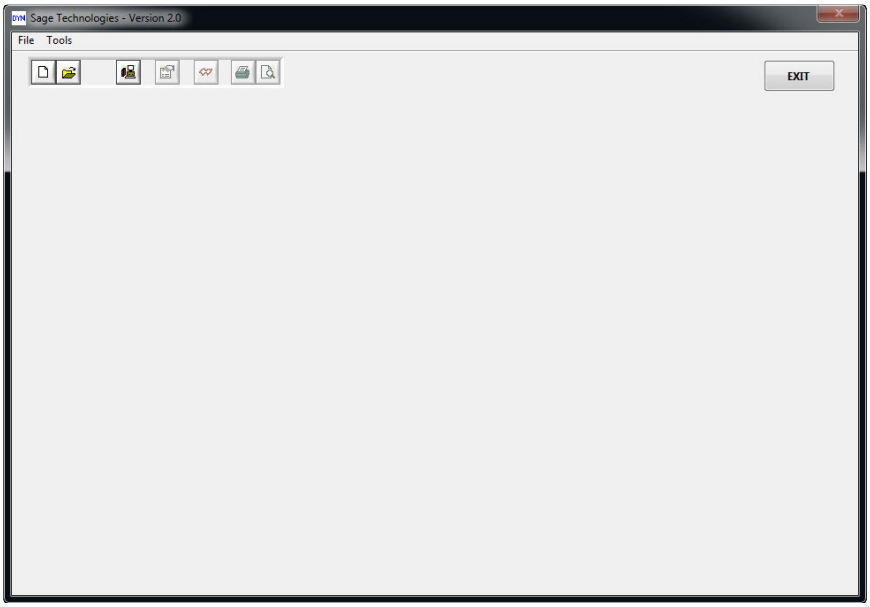
Print Preview

The main window shows the icon buttons at the top of the screen. Clicking the icon button brings up the screen associated with each icon.

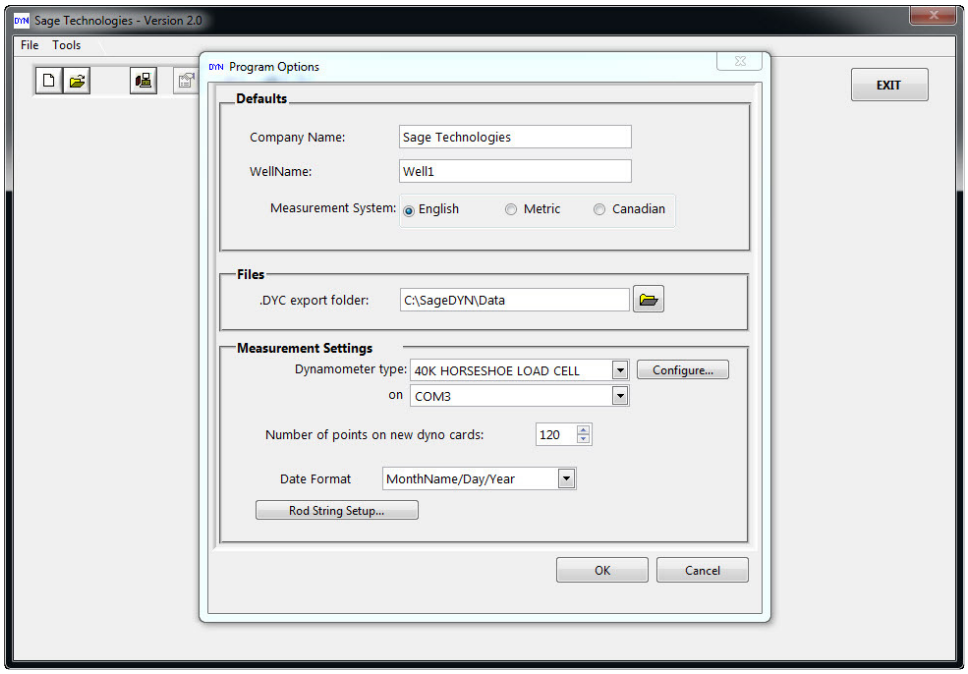
Sage DYN screen shots

Start-up Screen

Upon starting the Sage DYN program, this window appears.

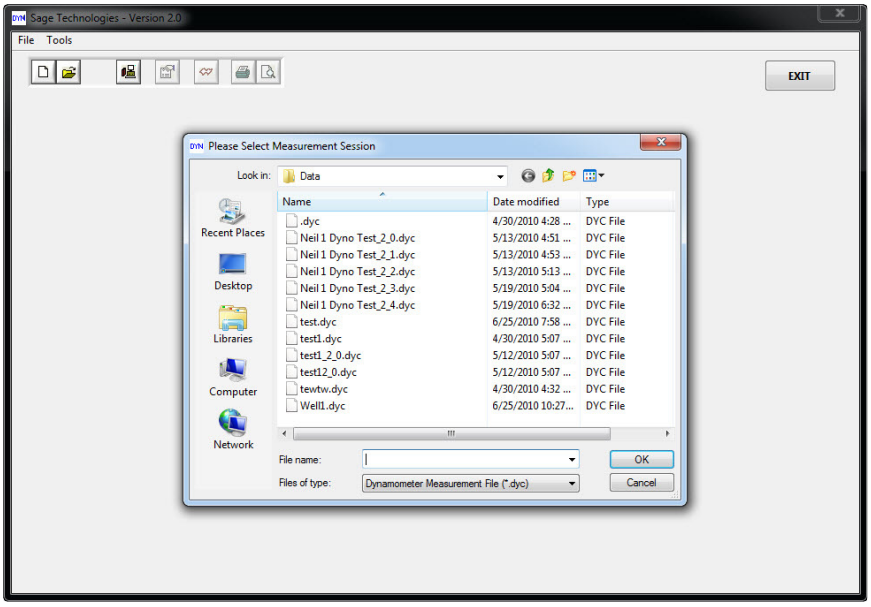


Select “Tools” then select “Options” and enter the rod string and other information. **These will become your future default settings for Dynamometer testing.** Click “OK” when finished.

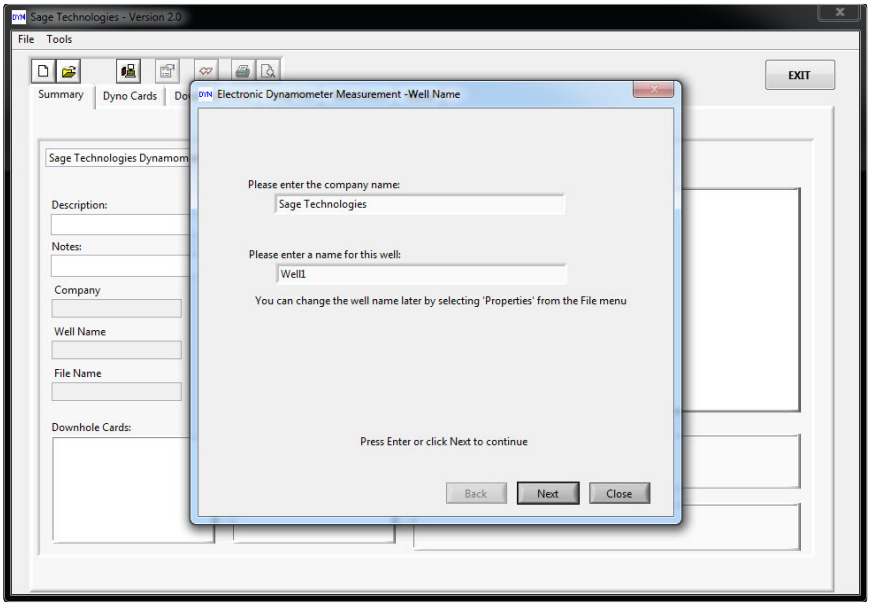


Starting a test: Existing file

If you are opening an existing file that has already been saved, click on the  icon and select the folder and file name desired. Click OK to open the file.

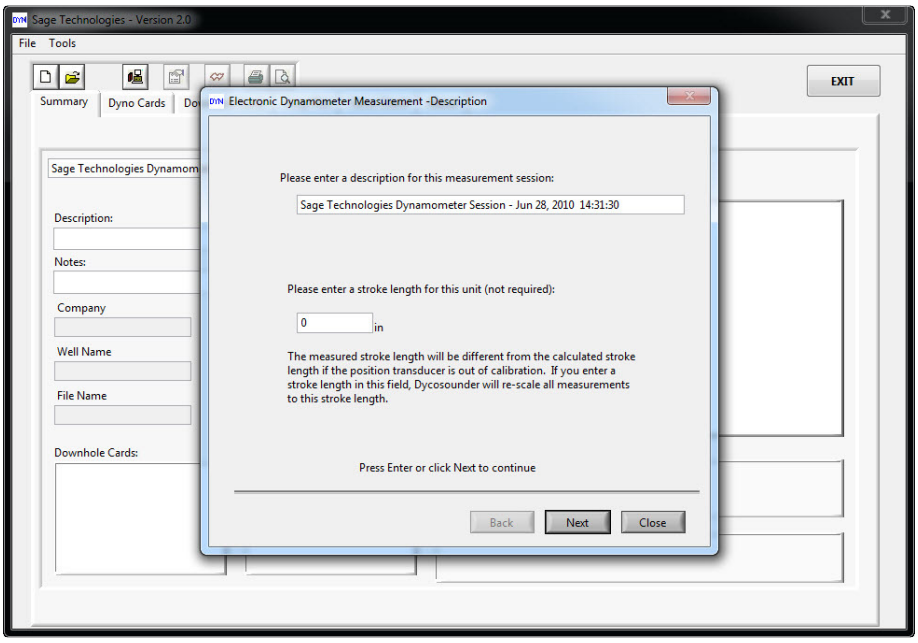


Starting a test: New file If you are starting a new test, click on the icon  , or select “File” then “New.” Enter the company and the well name on the new file. Click the “Next” button at the bottom of the screen to continue.



Enter a known stroke length or allow the measurement of stroke length. **Note: It is strongly recommended that you enter the stroke length, because the string transducer will always be at an angle from true vertical. By entering the stroke length, the slight offset from true vertical in the string transducer will automatically be removed by the software.**

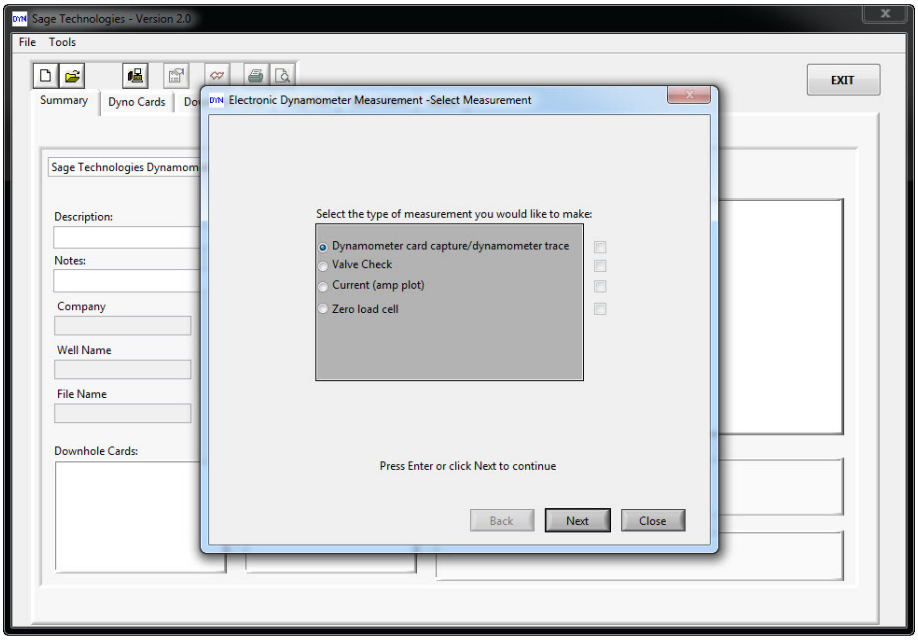
Click "Next" to continue.



Zero Load Cell

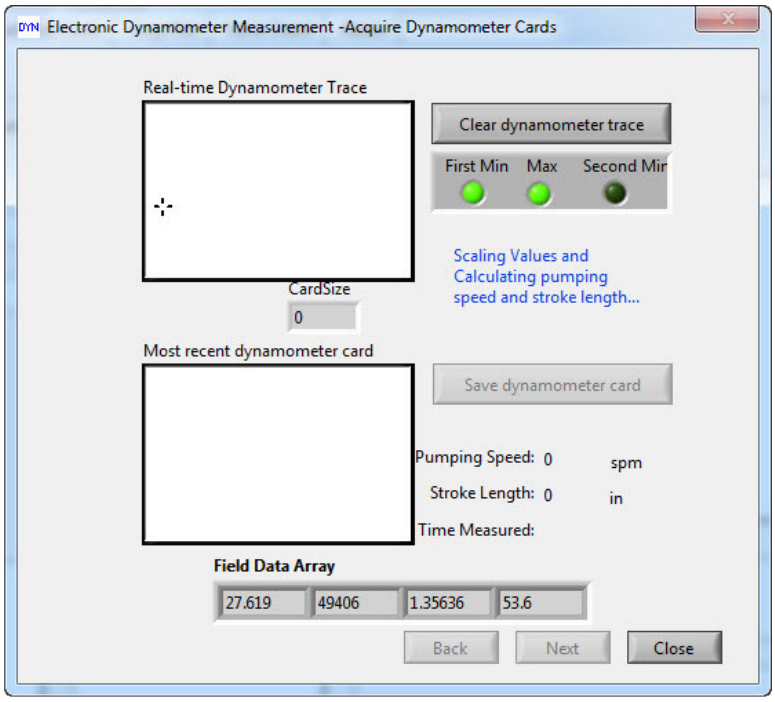
Zero the Load Cell before Installation on the well. To do this, click the Zero Load cell circle -- the bottom button on the screen below.

Click the button in front of the desired type of measurement to be made. Click "Next" to continue.



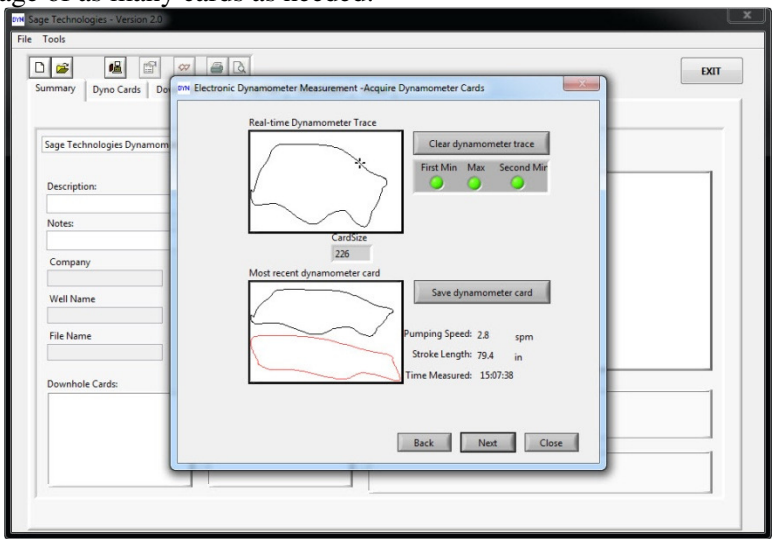
Dynamometer Cards

On the “Select Measurement” screen, click the radio button in front of “Dynamometer card capture/dynamometer trace: and then click “Next.” The “Acquire Dynamometer Cards” screen will open. Initially the dynamometer is sampling data and determining the proper card cycle. This will take several pump cycles to complete.



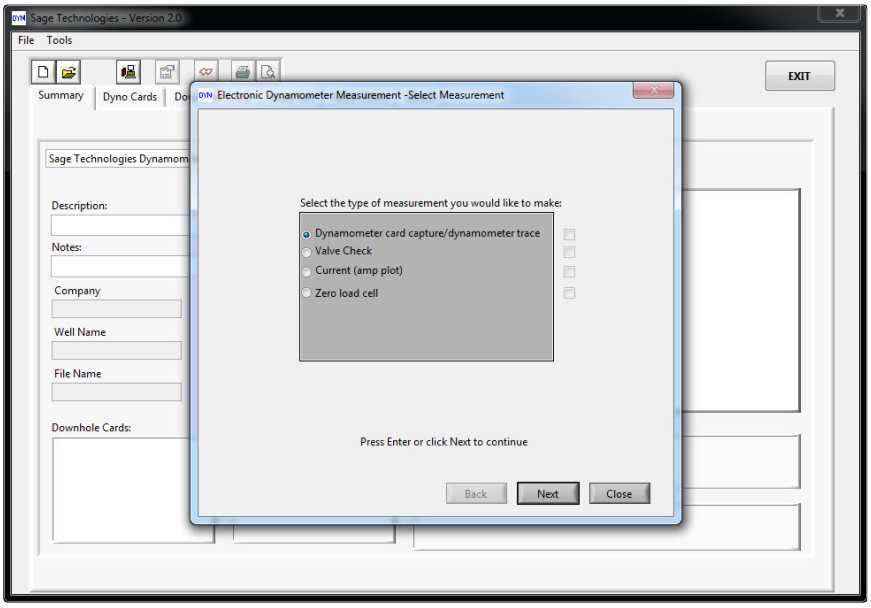
The top frame displays the Dynamometer trace continuously. The lower frame displays the most recent Dynamometer card being stored temporarily after each cycle. Note that the lower frame displays both the Surface Card and the Downhole Card. Additionally, the Pumping Speed, Stroke Length and time of the measurement are displayed on this screen.

To permanently save a card, click the “Save dynamometer card” button beside the lower frame. If it is not saved, the card will be replaced by the next card after completion of the next pump cycle. Sage DYN software allows storage of as many cards as needed.



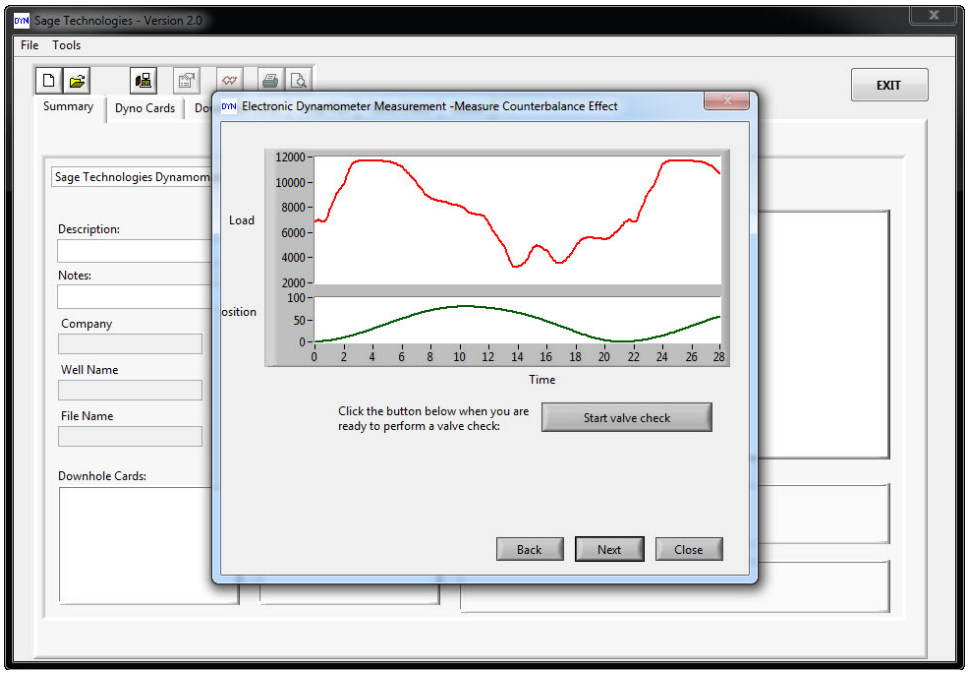
Click the **“Next”** button to end that Dynamometer measurement. Now the other measurements can be performed, one after the other.

The selection screen will reappear. A checked circle signals that a measurement has already been completed. Check a new circle to select another measurement.



Valve checks and counterbalance

Check the circle in front of Valve Check, then click "Next." The Perform Valve Check screen tab will appear, which shows two graphs: Position vs. Time and Load vs. Time.



During this test, the pumping unit will be stopped at the top third of the stroke (traveling valve), and then on the bottom third of the stroke (standing valve). To begin the valve check session, click "Start Valve Check."

Valve Check Tests:Method Explained

Valve Checks can only be accomplished with a good working pumping unit brake. Check that the pumping unit brake is in good working order before proceeding with a test.

Traveling Valve

In the upper third of the upstroke, a properly working Travelling Valve should be fully closed. If the pumping unit is stopped in this position, the load will remain constant, provided the valve is sealing correctly. **If the Travelling Valve is leaking, the load will decrease.**

Standing Valve

In the lower third of the downstroke, a properly working Standing Valve should be fully closed. If the pumping unit is stopped in this position, the load will remain constant, provided the Standing Valve is sealing correctly. **If the Standing Valve is leaking, the load will increase.**

Counterbalance

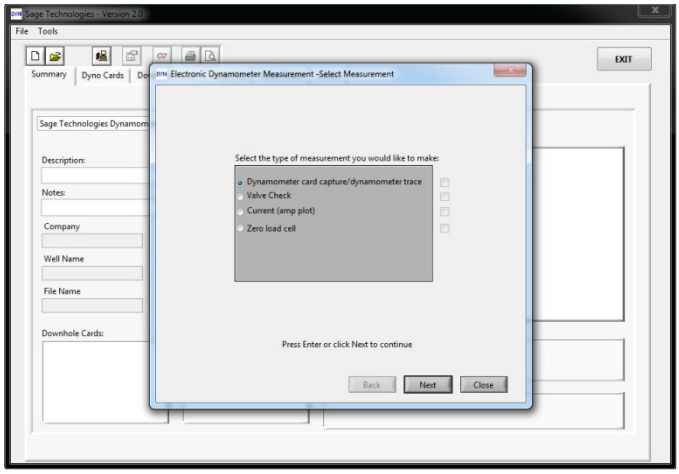
Counterbalance Method: No Chains or Clamps

For counterbalance measurement, first allow the unit to come to its resting position. Then turn the unit on, and let the unit roll to where the cranks are at 90 degrees from vertical. Now, try to find the point

where the unit will remain in balance on its own – with no brake. This should be the point where any movement in any direction will continue in that direction.

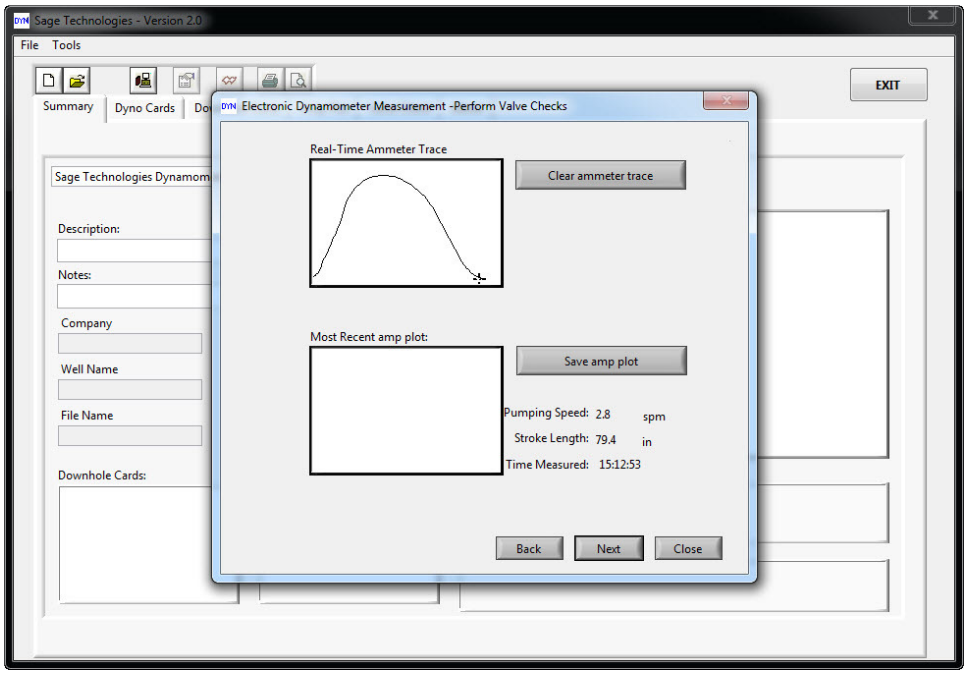
End Valve Check

To end the Valve Check and Counterbalance Section, click the “Stop Valve Check” button. Click the “Next” button to end this session and open the Select Measurement screen to again reveal optional measurements. Select the desired measurement and click “Next.”

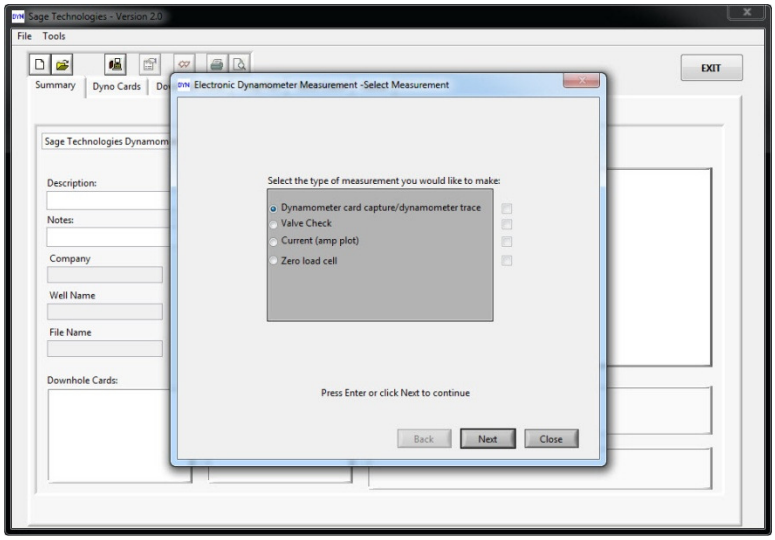


Measurement of Motor Current

This measurement records Motor Current versus Rod Position. The measurement is also sometimes called an Amp Plot.



Once the card appears, click on the Save button to save a representative current card. Clicking “Next” completes the session, and allows any additional measurements to be made.



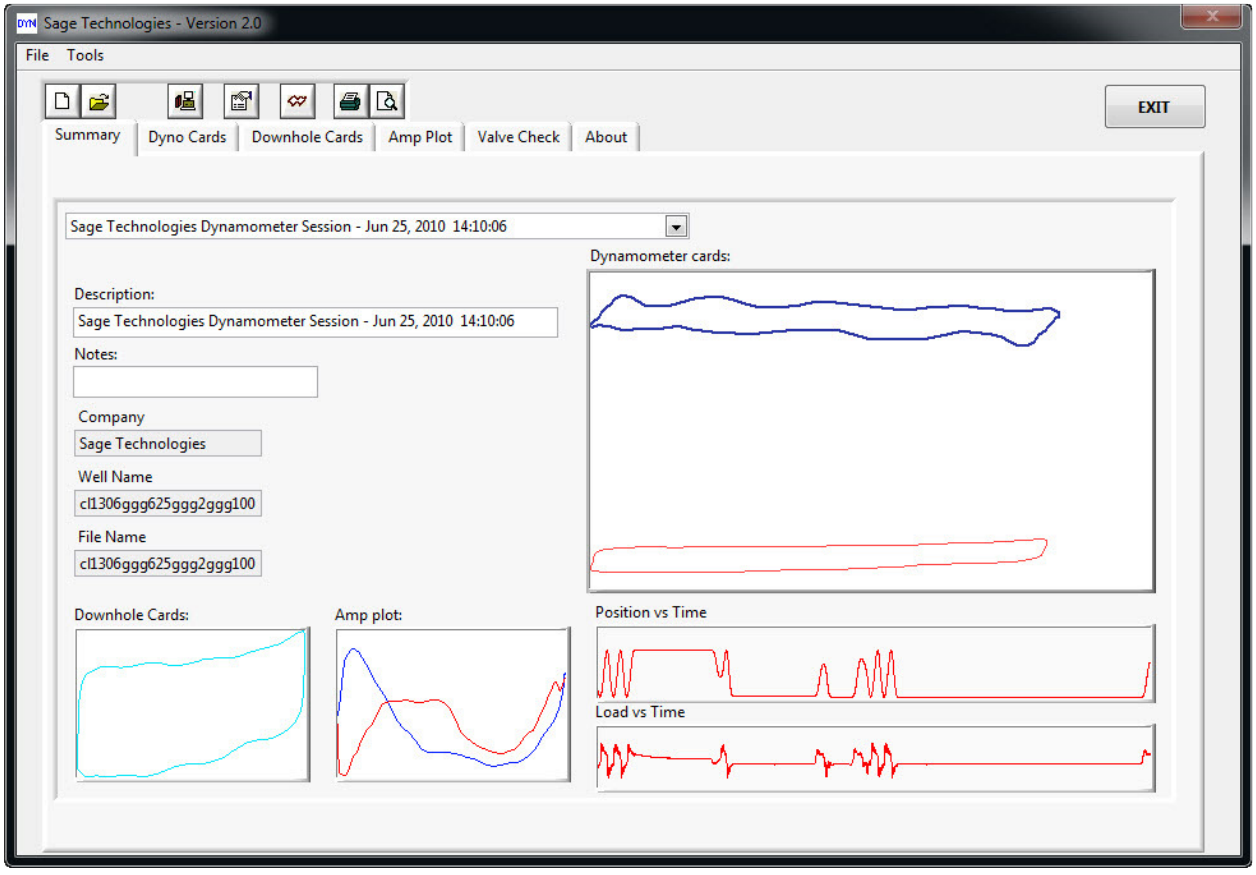
Once all the desired data is gathered, clicking “Close” closes this screen, and reveals the Summary Screen tab with all of the gathered data displayed.

Display Measurement Results

Summary Tab

Once measurement is complete, results of all measurements are displayed on the Summary Tab.

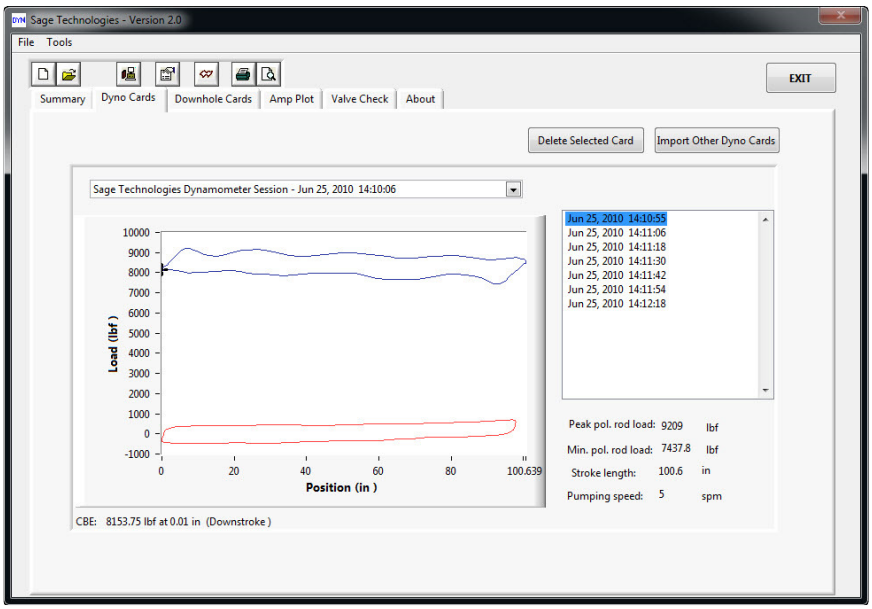
Remarks can be entered in the field “Notes” in the middle of the screen. Remarks are limited to 40 characters. The text will be saved when the file is saved, and will be included in the testing report.



Dyno Cards Tab

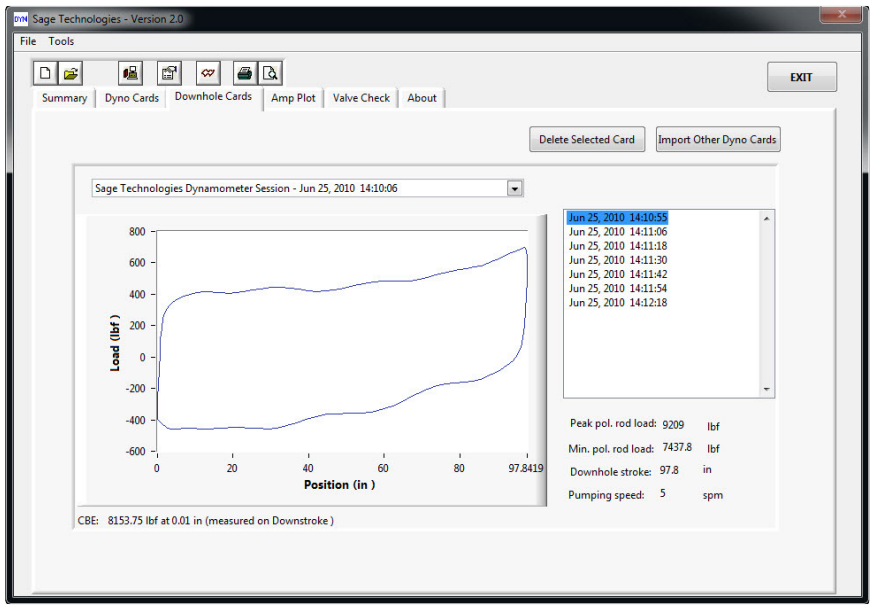
Clicking on the Dyno Cards Tab opens the screen with the saved Dynamometer cards. The different cards can be opened by clicking on the date/time in the right window.

Holding “shift” and picking more than card allows you to see different dynamometer cards overlaid on each other.



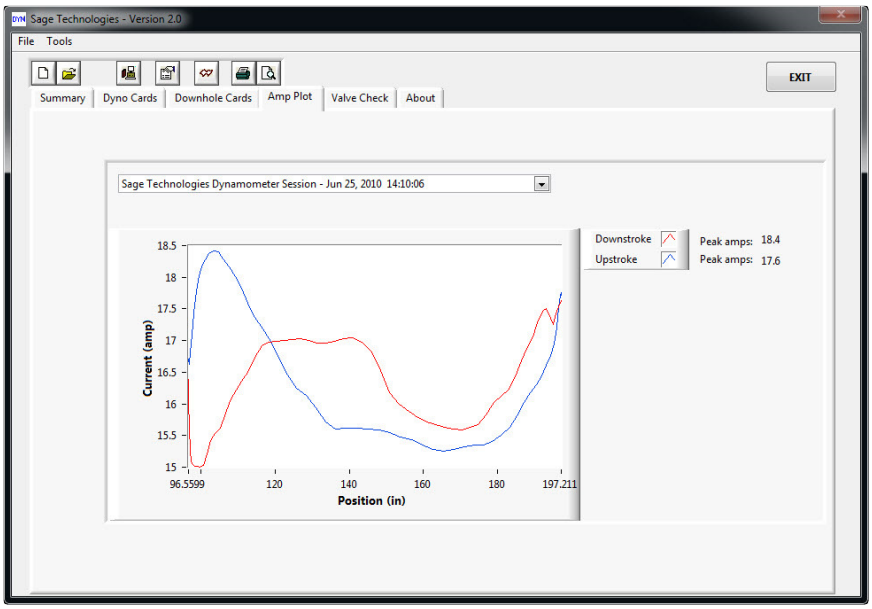
Downhole Cards Tab

Clicking the Dyno Trace Tab allows display of the downhole cards by themselves. Remember to enter the appropriate rod string data to get accurate downhole cards.



Amp Plot Tab

The current versus position graph of the measurement of motor current is displayed on the Amp Plot Tab. The current curve for the upstroke is blue, while the current curve for the downstroke is red.

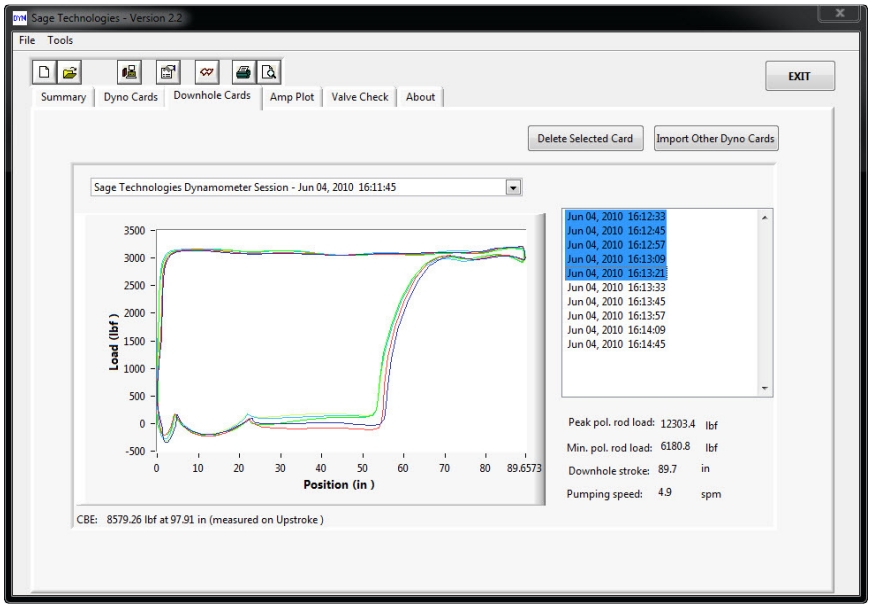


Card Overlay Feature

Surface and Downhole dynamometer cards recorded and saved over time can be overlaid to give a graphic illustration of the history of the well pumping through multiple cycles.

You can also import previous tests on the Downhole Card tab, by clicking on the Import Other Dyno Cards tab to see a list of other cards that you can select to overlay.

In this downhole pump card, the five highlighted cards are shown overlaying each other. Different colors are assigned to different cards.



Sequence of colors for downhole pump card overlays
1. Blue
2. Red
3. Green
4. Teal
5. Yellow
6. Purple
7. Orange

Clicking on a day and time in the right-hand box lets you pull up a downhole pump card with a blue outline.

Clicking a second day and time overlays a downhole pump card with a red outline, and selecting a third date overlays a green outline.

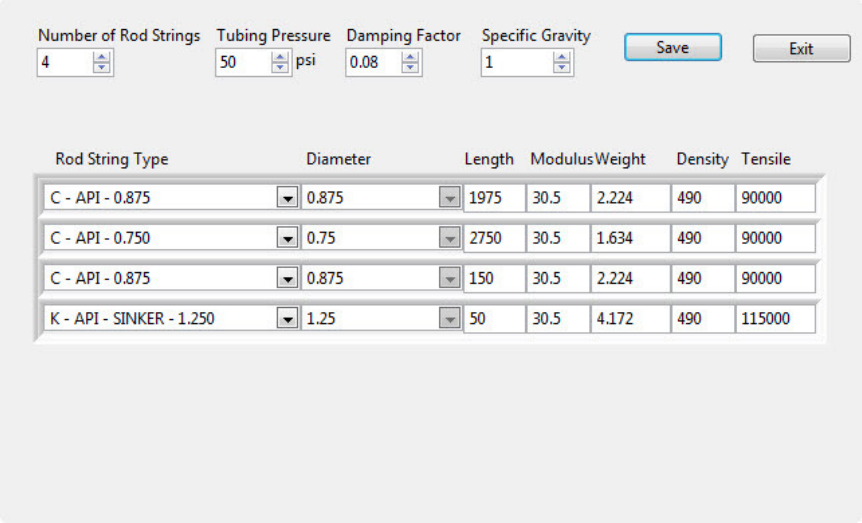
Seven different colors for seven different overlays are possible, and colors will appear in the order shown at left, according to the sequence in which they are selected. For example, clicking the bottom date in the box above would bring up a blue pump card outline. Following that with a click in the middle of the list will overlay a red pump card.

Note: More than seven pump cards can be overlaid, but colors will repeat the same seven-color sequence.

Entering Rod String Data

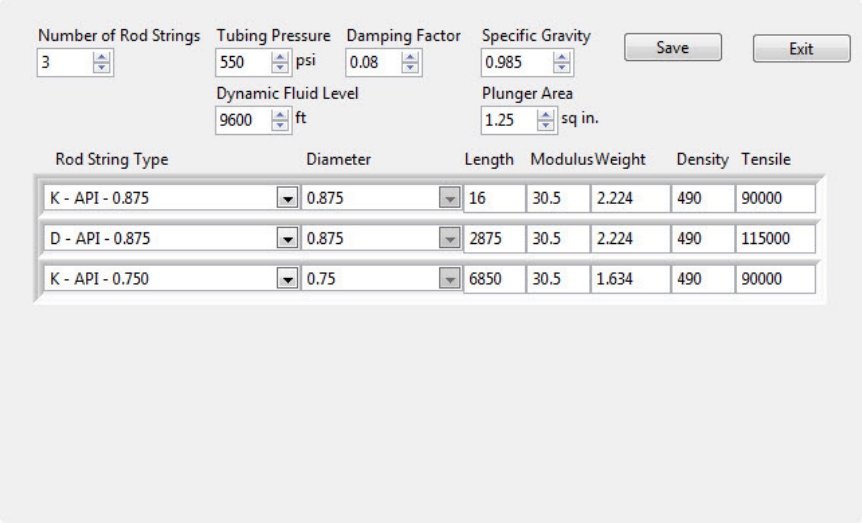
Rod String data may be entered when dynamometer testing with either a Quantitative Load Cell or a Quick Clamp Load Cell. Data is entered on the tab.

Entering Rod String Data – 40K Quantitative Load Cell

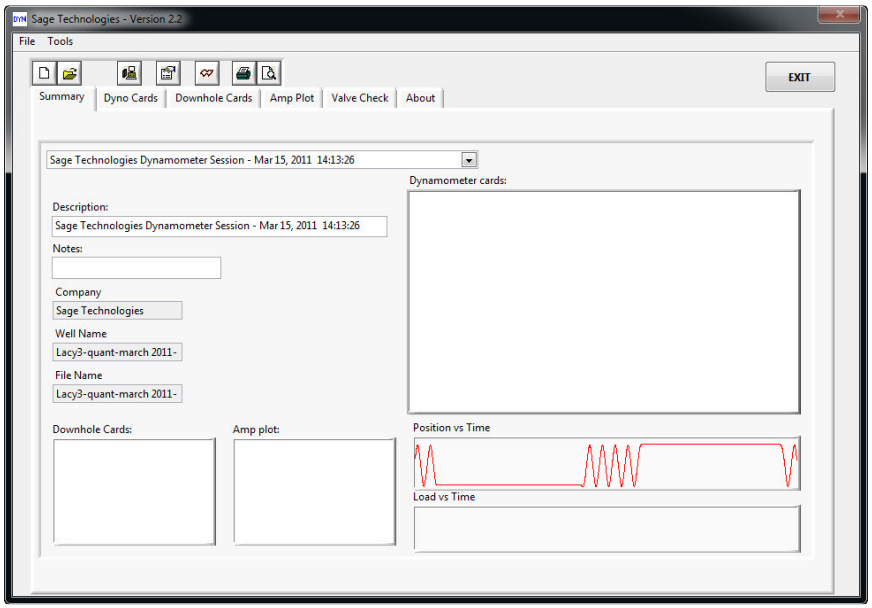


Entering Rod String Data – Quick Clamp Load Cell

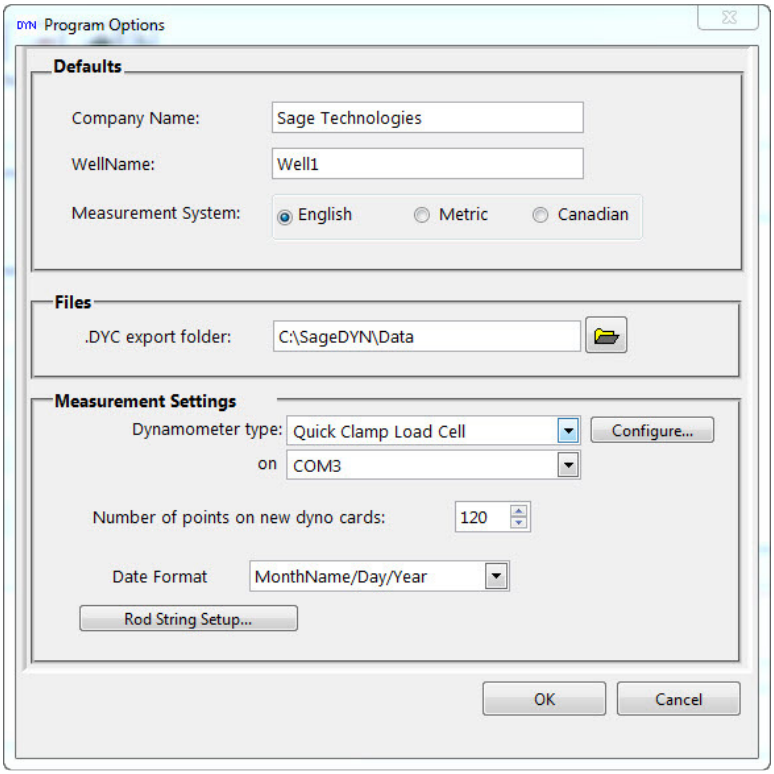
The Quick Clamp Load Cell requires the additional entries of the fluid level and plunger area so that a predictive surface card can be constructed.



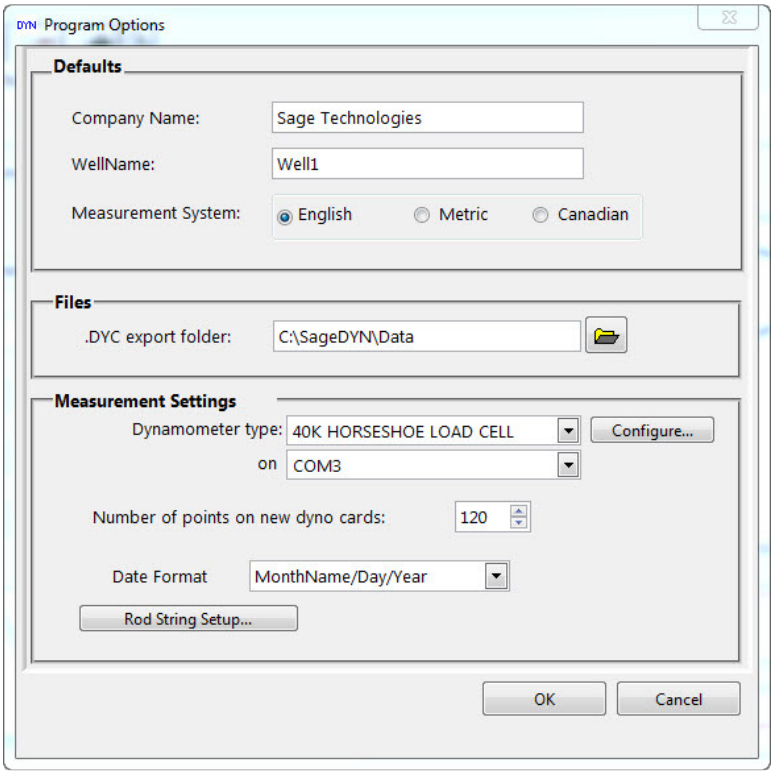
Note: On the **Summary** screen tab, you see how to open a 40K Quantitative dynamometer card with the Quick Clamp option enabled. Notice that no data is displayed.



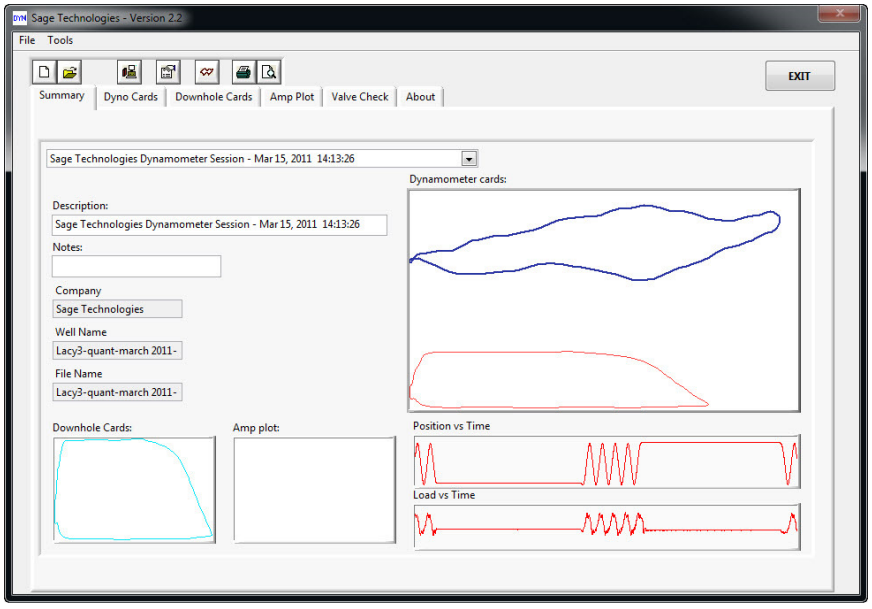
You can see the data by selecting the correct load cell. In **Measurement Settings: Dynamometer type:** select the down arrow by the entry to select the 40K Quantitative Load Cell.



Now the option screen looks as follows. **Measurement Settings: Dynamometer type:** 40K Horseshoe Load Cell.

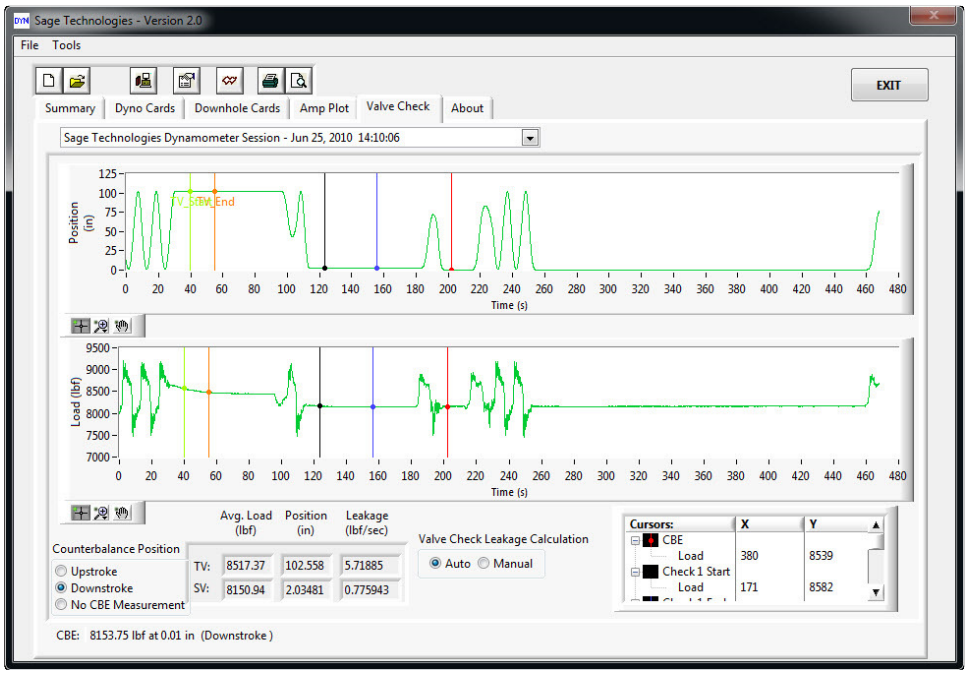


And data now appears on the dynamometer card by changing to the proper load cell.



Valve Check and Counterbalance Calculations

Clicking the Valve Check Tab will open the screen with the Valve Check and Counterbalance calculations.



On this tab, you can move the valve check lines to make calculations as to the integrity of the valves. Click the cursors with the left mouse button and keep the mouse button pressed to move the cursors on the graph.

The following lines can be moved in the Auto Mode:

- TV-Start: Traveling Valve start
- TV-End: Traveling Valve end
- SV-Start: Standing Valve start
- SV-End: Standing Valve end
- CBM: Counterbalance measurement

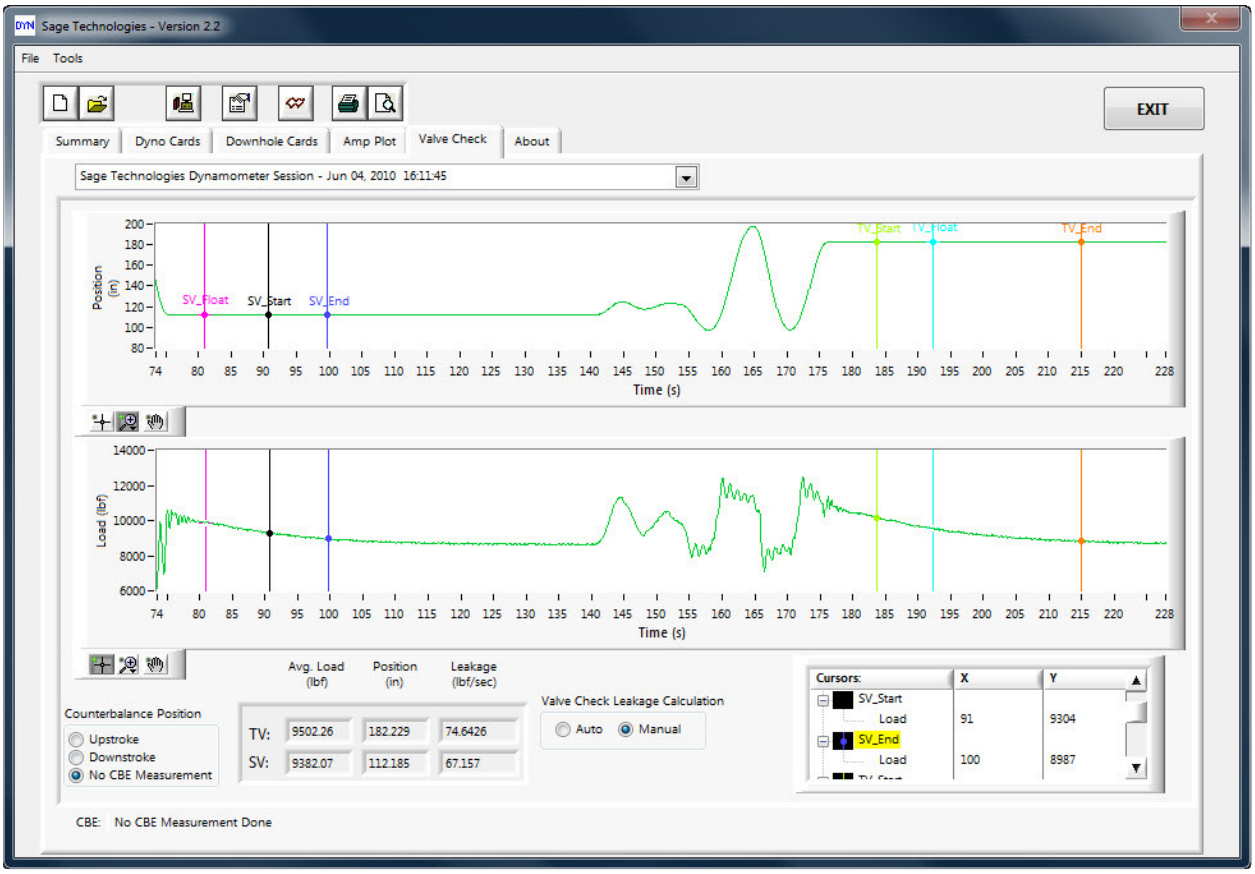
In the Auto Mode, a linear fit is performed between TV-Start and TV-end for the leakage calculation. And, a linear fit is performed between SV-Start and SV-End for the leakage calculation. Also, the sursors have a defined order in that TV-Start must come before SV-End in time.

The following lines can be moved in the Manual Mode:

- TV-Start: Traveling Valve start
- TV-End: Traveling Valve end
- TV-Float: Traveling Valve float
- SV-Start: Standing Valve start
- SV-End: Standing Valve end
- SV-Float: Standing Valve float
- CBM: Counterbalance measurement

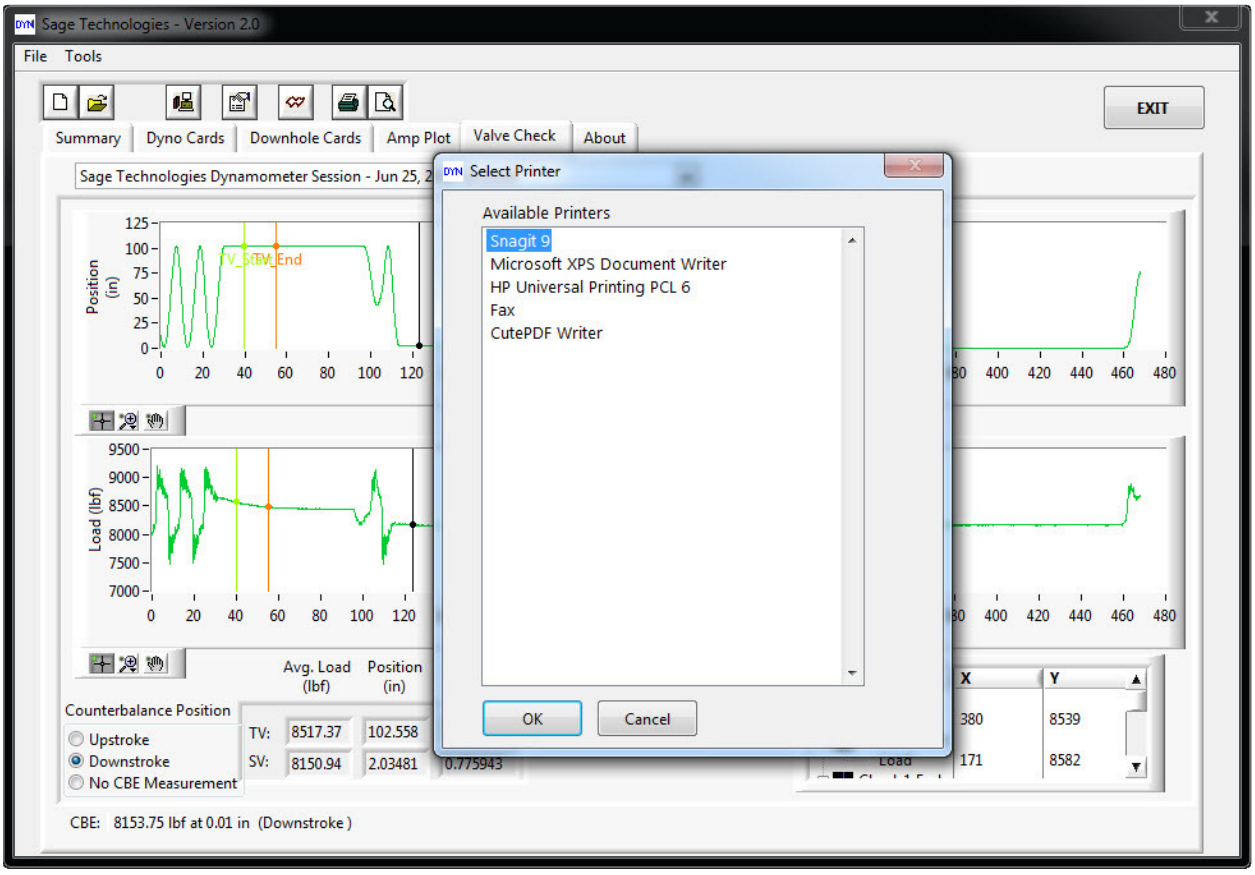
In the Manual Mode, a second order polynomial fit is performed between the three matched cursors (TV-State, TV-End, TV-Float) and (SV-Start, SV-End, SV-Float). Also, the cursors in the manual mode have no predetermined order in time. So, the polynomial fit is performed on the three cursors as a whole. Also,

the two special cursors TV-Float and SV-Float have unique characteristics in that they no longer snap to the load line that has been measured. In the case of these two cursors, you may move the sight point above or below the measured load line to account for unique pump attributes (gas compression, etc.). This allows for a more accurate value for pump leakage.



Report

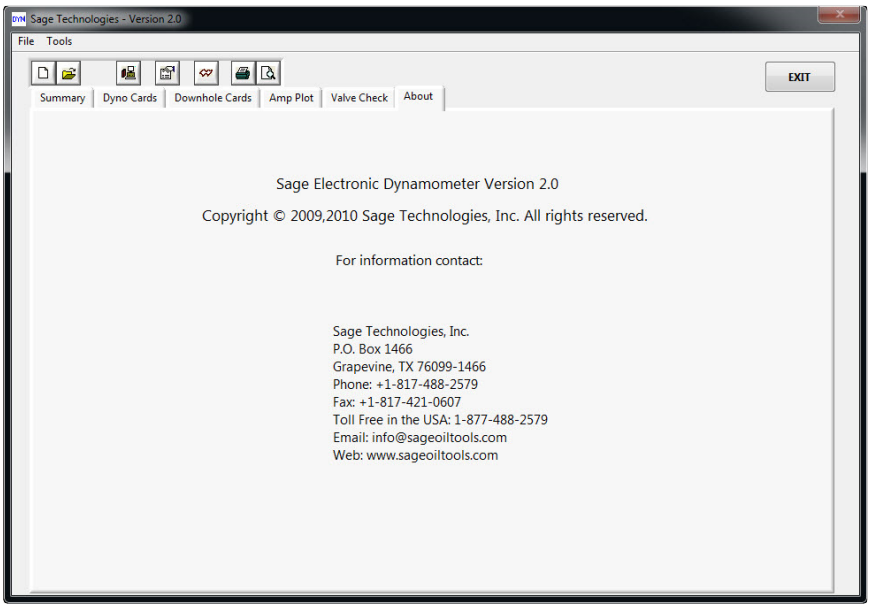
Click the  icon to open and print the data Measurement Report. Click the desired output printer and click OK to print. Use the CutePDF Writer to make Adobe Acrobat files.



Close the Sage DYN program by clicking the “Exit” button at the top right of the screen.

About

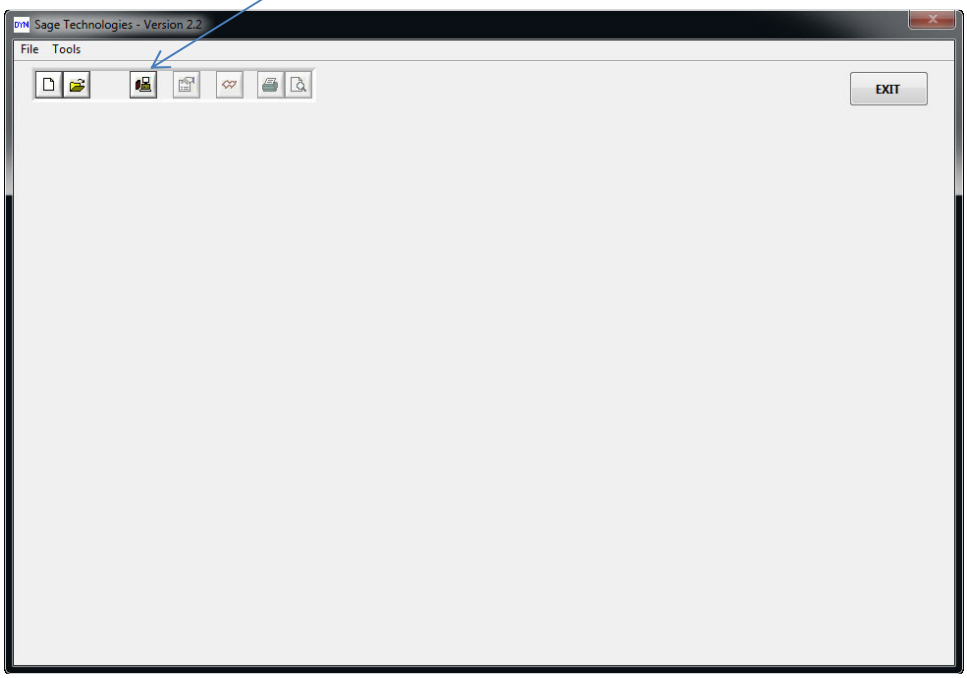
The **About Tab** displays the address, phone numbers, website and email of Sage Technologies, Inc., designer, manufacturer and seller of the AFL IV with Dynamometer and the Sage DYN software.



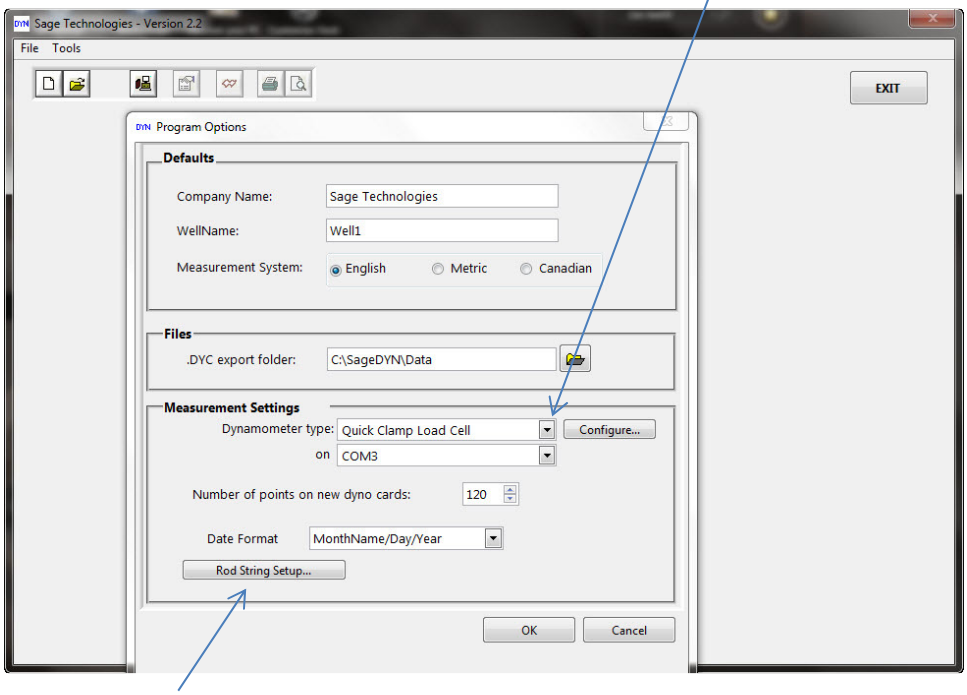
Sage DYN Software Examples

Example using Quick Clamp Transducer

From the opening screen, select the **Program Options** icon (looks like a tiny computer).



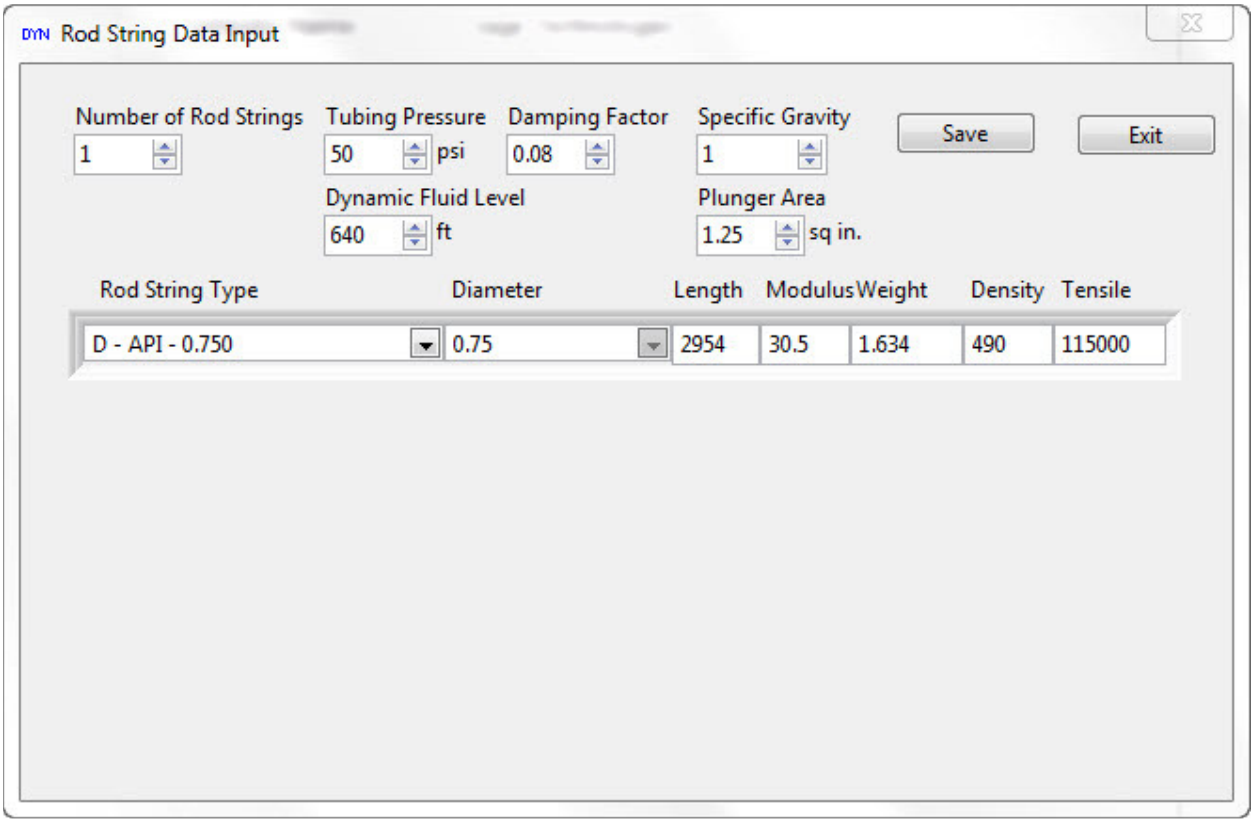
This will bring up the **Program Options** screen. Select the **Quick Clamp Load Cell** option.



Next, select the **Rod String Setup**, which will bring up the Rod String Data Input screen.

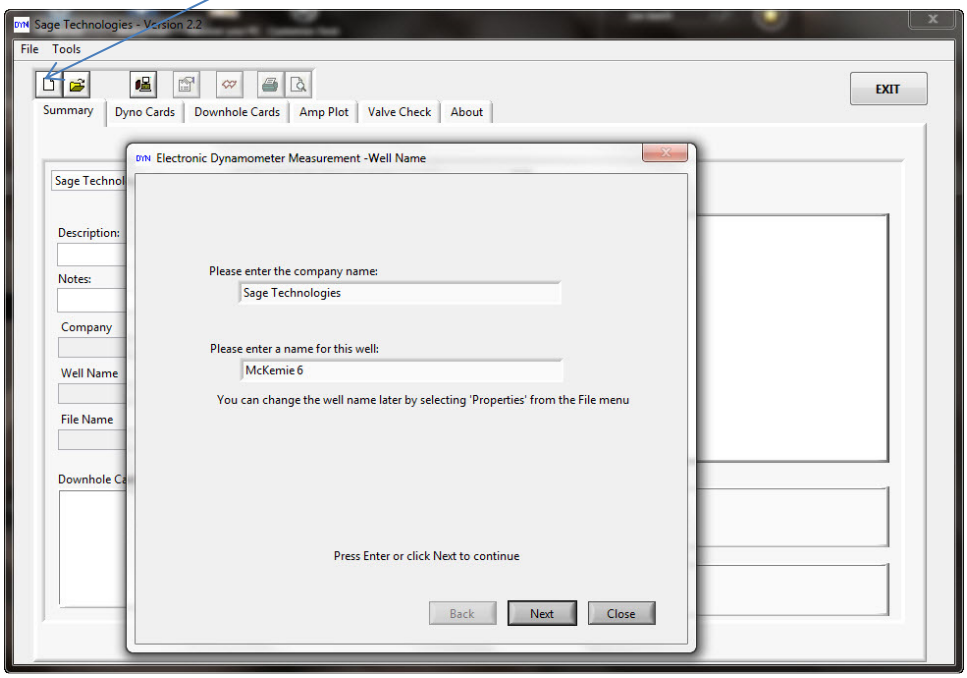
Rod String Data Input Boxes – Detail

Enter the **Rod String Data** in the input boxes.



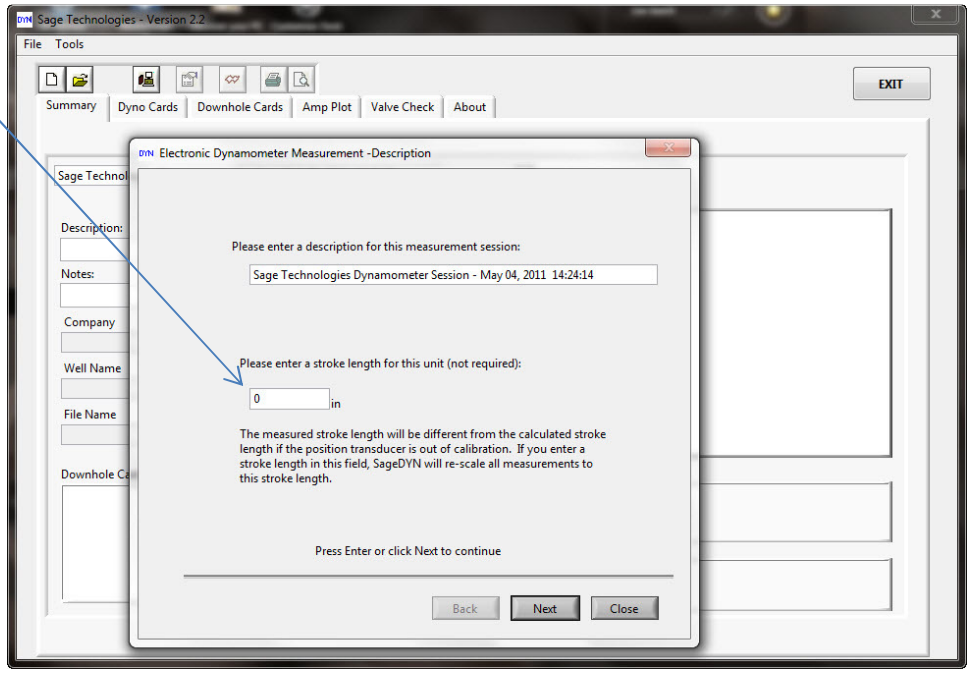
☐ ***Number of Rod Strings***	Select up to 10 total variations in your rod string
☐ ***Tubing Pressure***	Enter your exit pump pressure
☐ ***Damping Factor***	Enter rod damping factor default = 0.08
☐ ***Specific Gravity***	Enter the specific gravity of the produced fluid
☐ ***Dynamic Fluid Level***	Enter the pumping fluid level – found using your gas gun
☐ ***Plunger Area***	Enter the plunger diameter
☐ ***Rod String Type***	Select via pulldown the rod string type and diameter
☐ ***Length***	Enter the length of this section of rod string

Select the **New Test** icon (looks like a blank page), which will bring up the **Dynamometer Measurement – Well Name** screen.

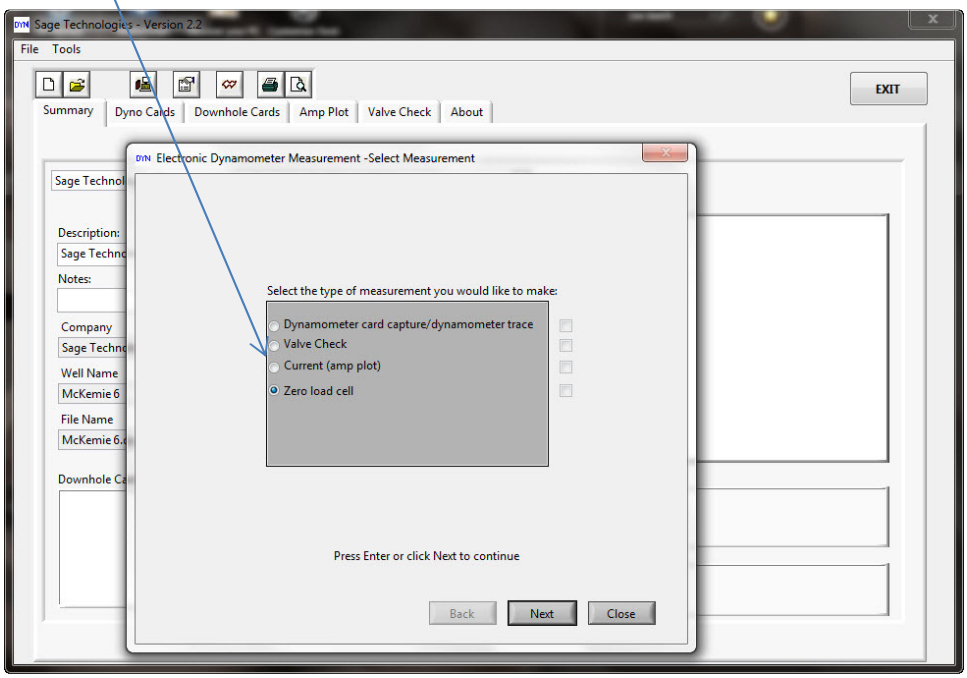


Enter the **Company Name**, if desired. Enter the **Well Name** and click **Next**.

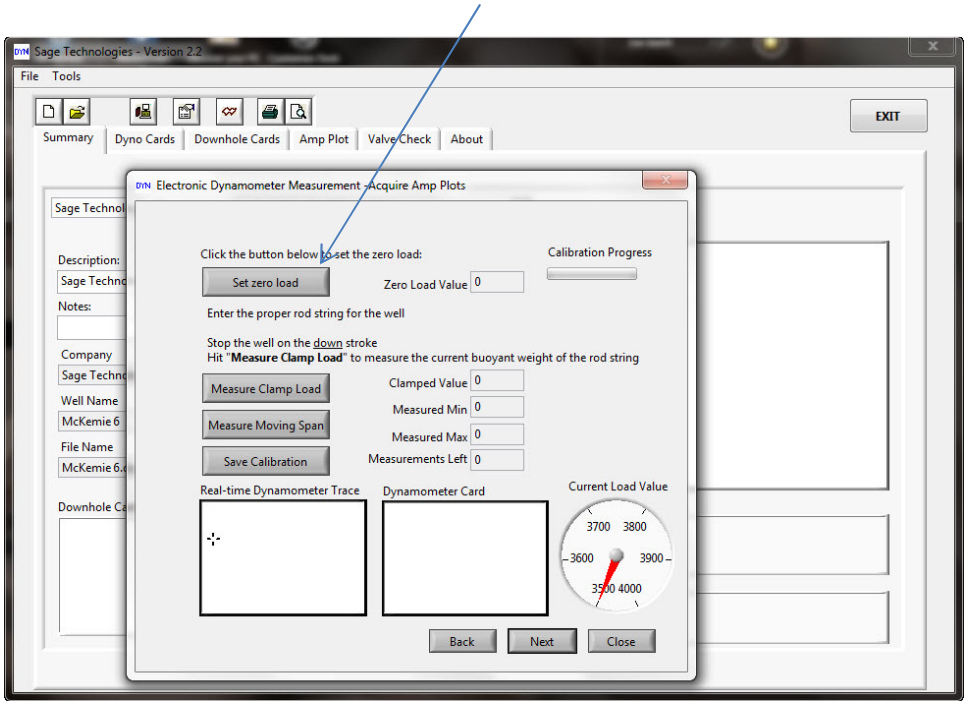
On the Electronic Dynamometer Measurement – Description page, you may enter the stroke length, if you know it, or you may let the dynamometer measure the stroke length for you by leaving the input box blank.



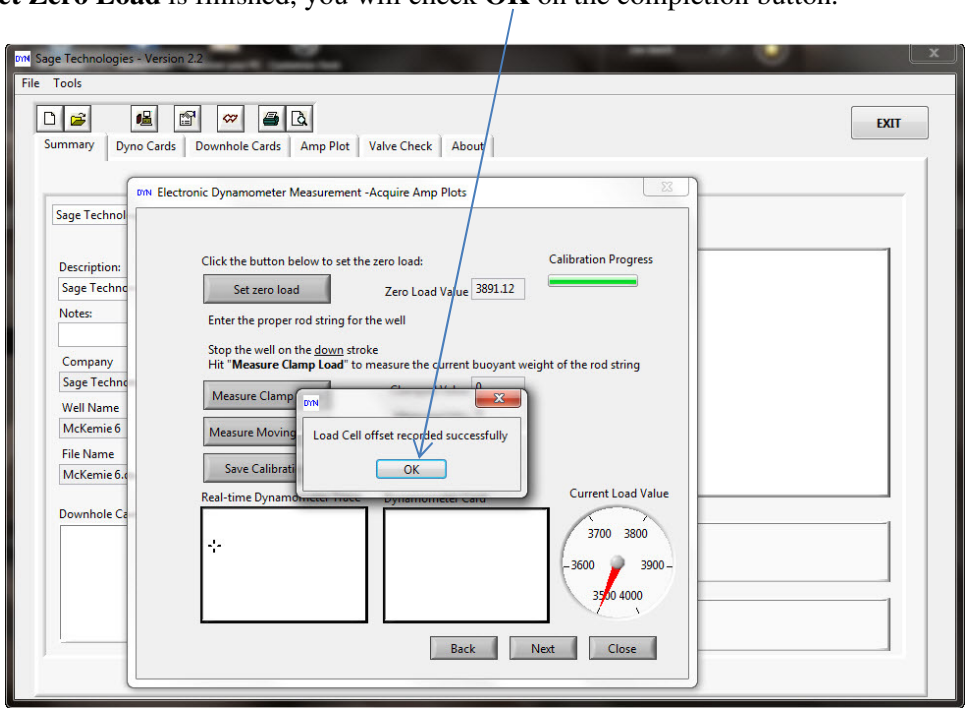
Be sure the **Zero Load Cell** option is selected, and click **Next**, to begin calibrating the Quick Clamp Load Cell.



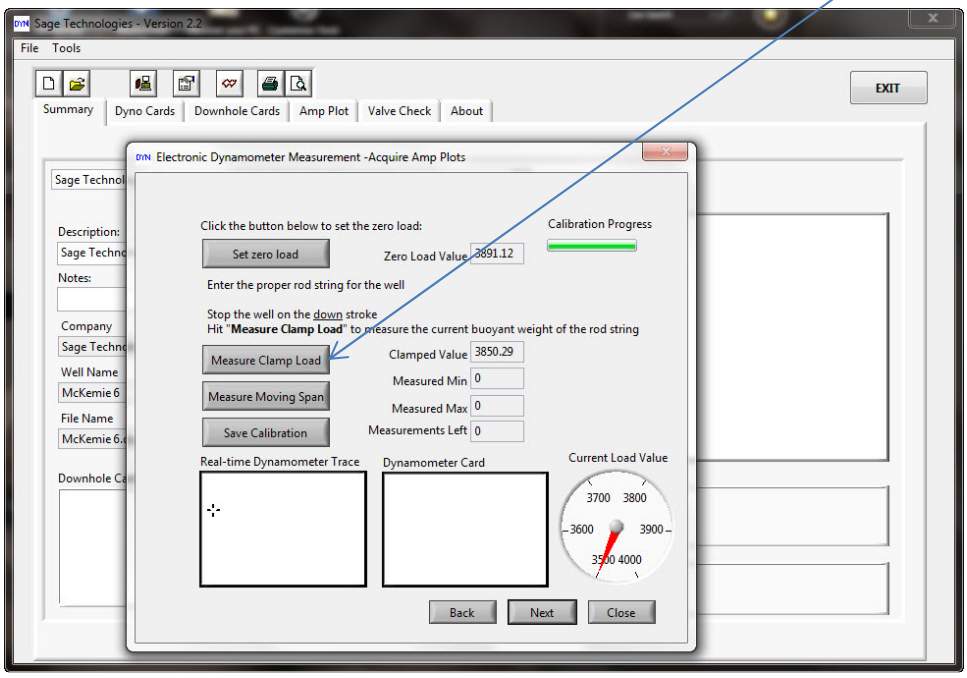
Start the calibration process by selecting the **Set Zero Load** button.



When the **Set Zero Load** is finished, you will check **OK** on the completion button.

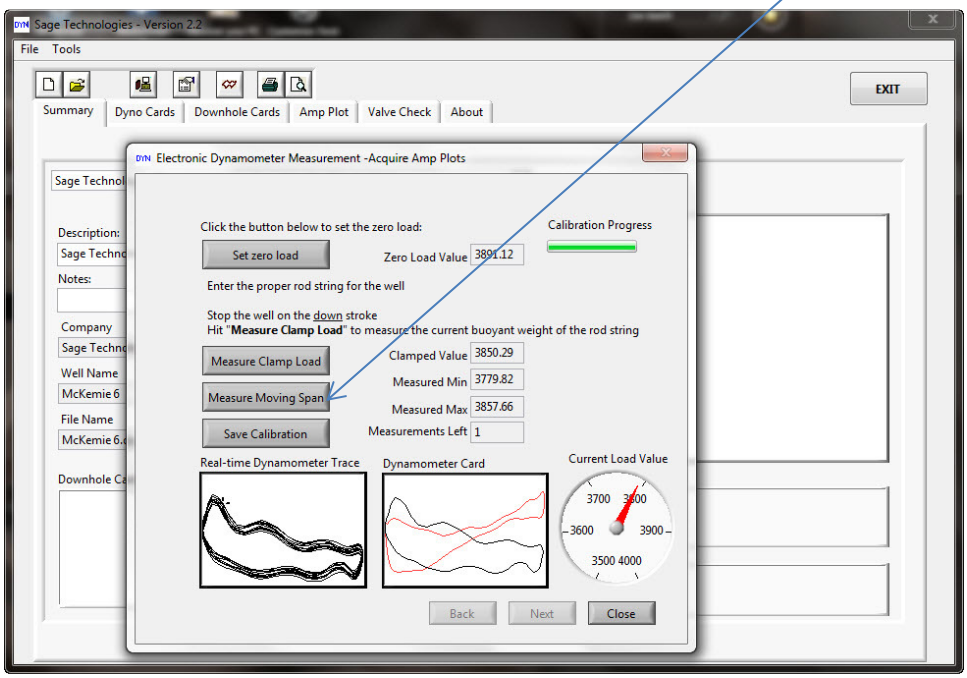


Now, stop the Pumping Unit on the downstroke, and clamp the **Quick Clamp Load Cell** onto the Rod String, below the Carrier Bar. Then, click the software button that reads **Measure Clamp Load**.

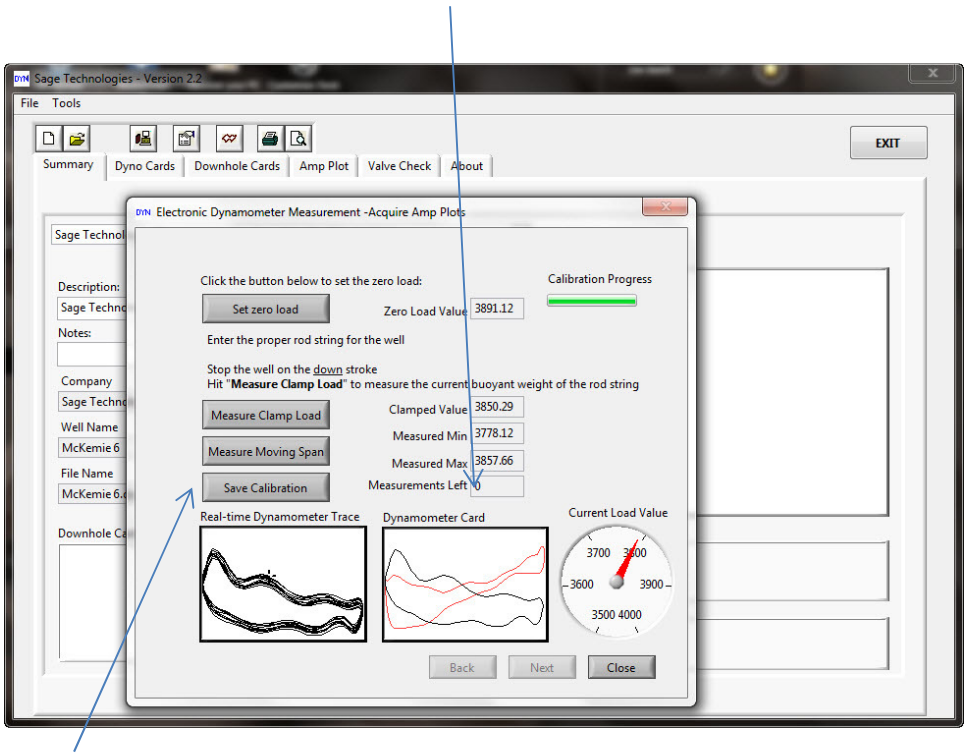


Click **Next** when finished.

Restart the pumping unit. Once the unit is running again, click the **Measure Moving Span** button. This will gather data over 10 complete pump cycles to complete the calibration.

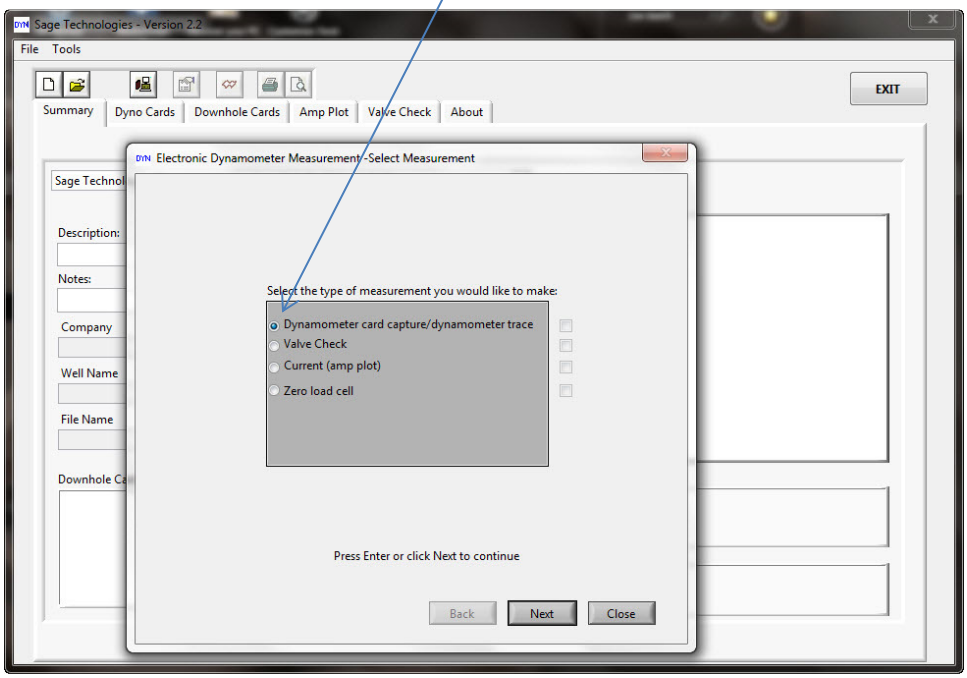


When the calibration is finished, the **Measurements Left** box will have counted down to zero.

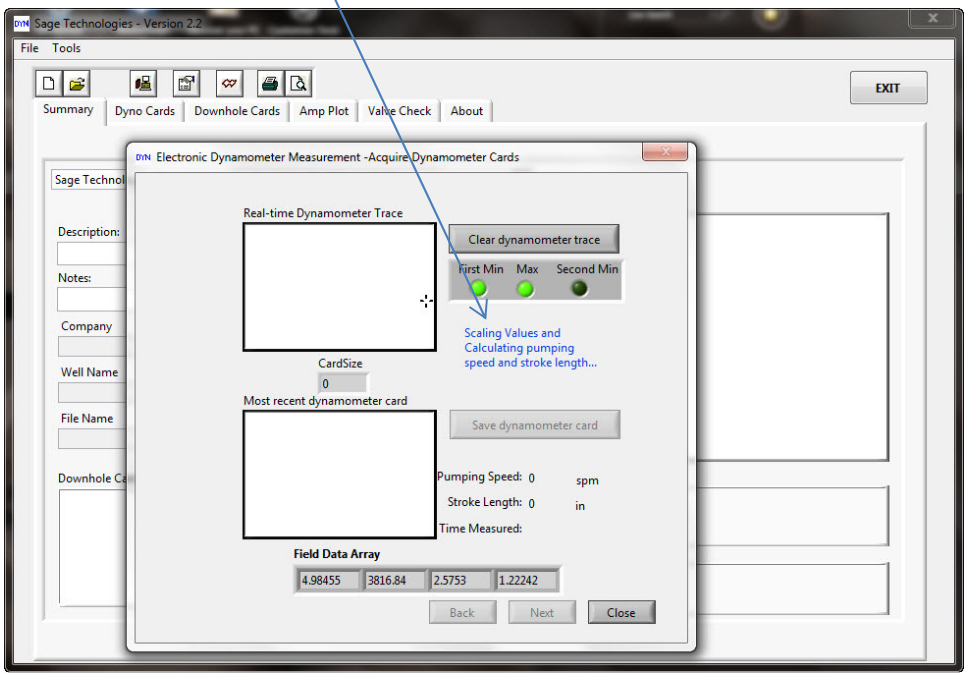


Click the **Save Calibration** button followed by **Next** to continue with the dynamometer job.

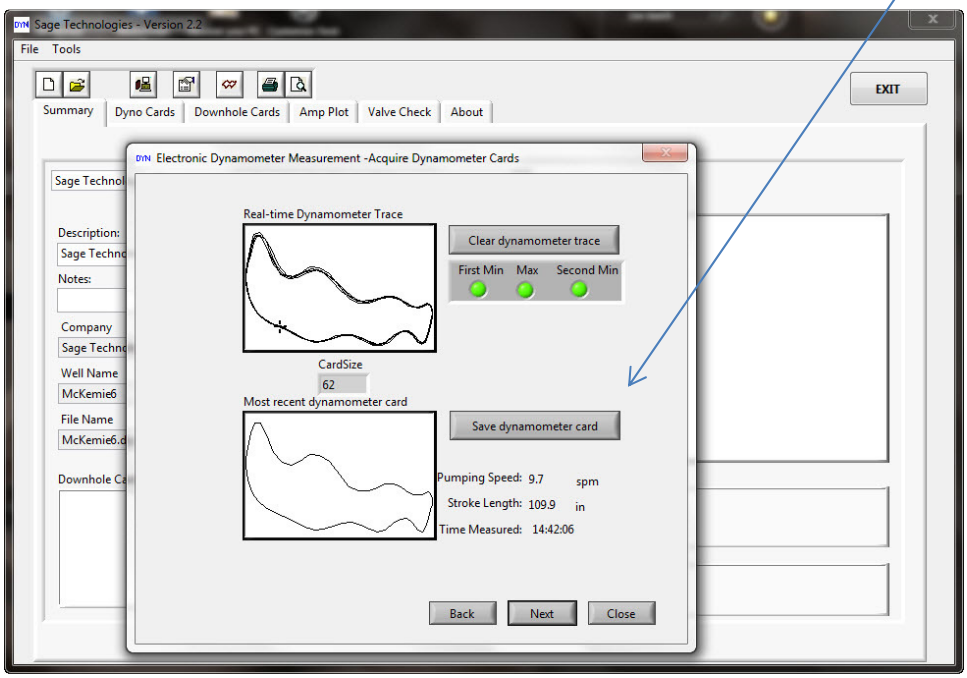
Now check the **Dynamometer card capture/dynamometer trace** button, followed by **Next**, to start gathering Dynamometer cards.



Initially, the screen will display a message as it begins to gather data.

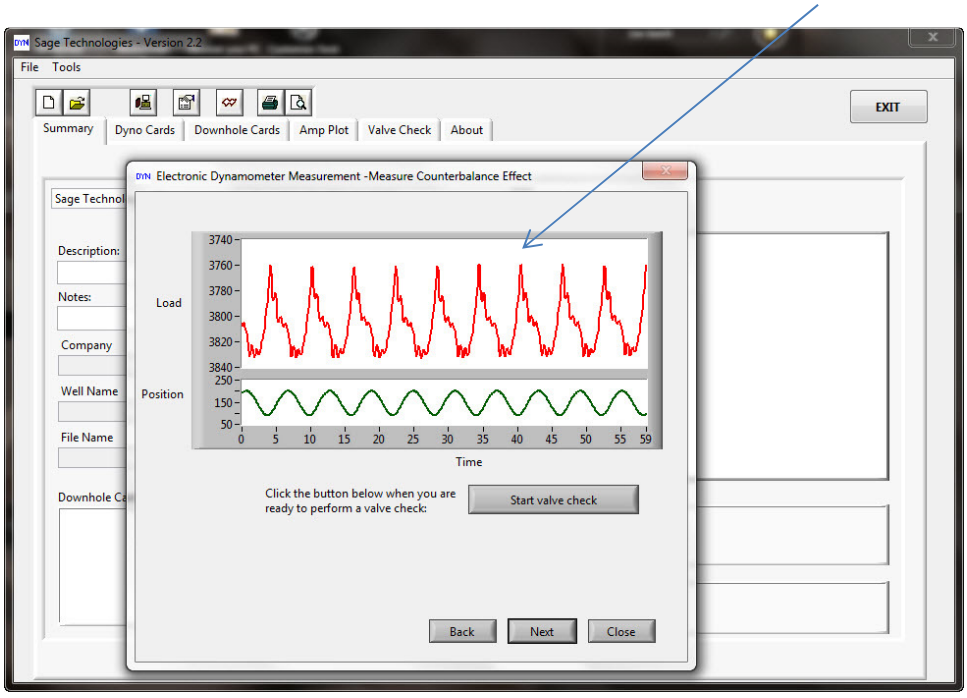


Once the data begins to display, you save individual dynamometer cards by clicking the **Save Dynamometer Card** button.



Once you have collected enough dynamometer cards, click **Next** to move on to **Valve Checks**.

Note: When doing valve checks using the **Quick Clamp Load Cell**, the load initially will be displayed as an A-D reading, rather than as an actual load. Do not let this bother you; when the test is complete, all readings are converted to actual load using the rod string data. Also, if you need to change the rod string data later, because of a data entry mistake, the values will automatically recalculate.



Example: Data Storage

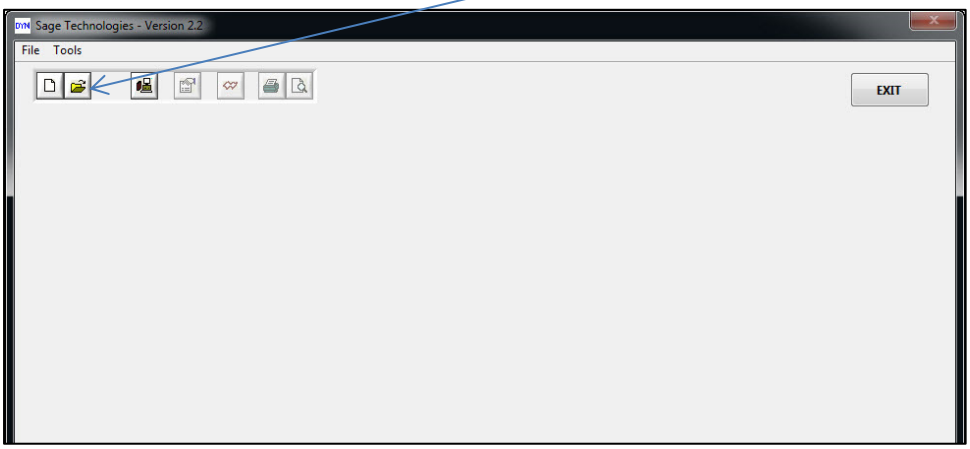
Organizing well data files

Some users like to keep all of their well files in the same directory and then scroll through the directory looking for the data they want to find. Other users prefer to put the data from each well in its own directory. Below is an introduction to the individual directory method. Use whichever method that works for you.

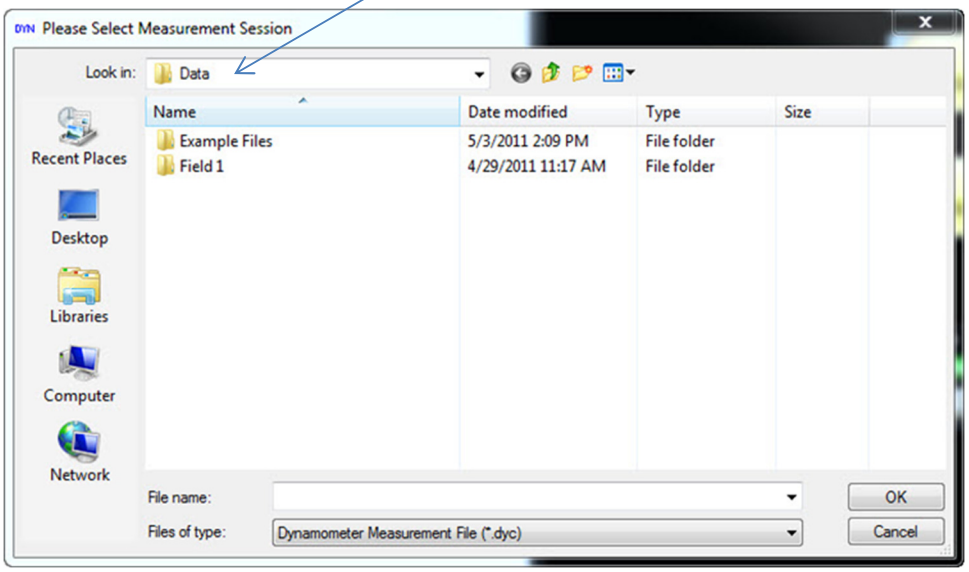
Building up your well file database

To start organizing your work so that you can easily find well files, start by opening the **Sage DYN** program. In this example, you will navigate to the **Data** directory under SageDyn banner at the top of the screen. You will notice in this example that there are already a couple of folders that have been created for data storage.

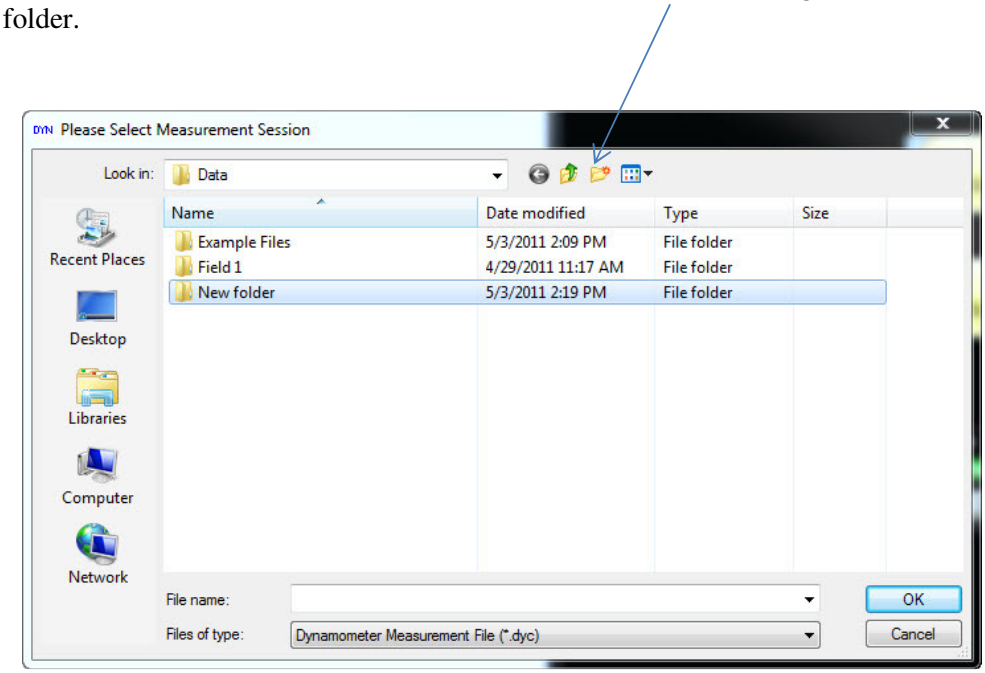
- On the Sage DYN software screen, start by clicking on the **File** icon, which looks like a half-opened file folder.



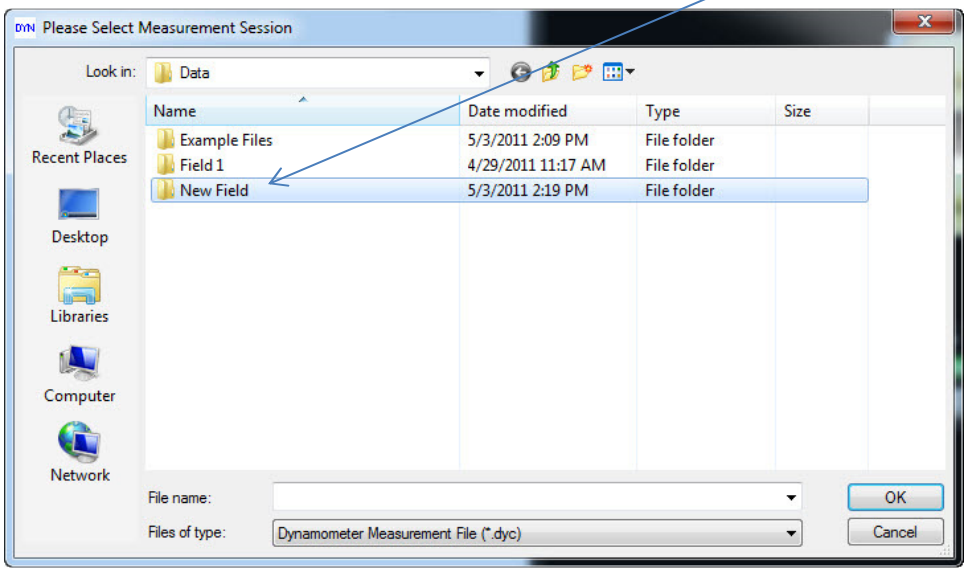
- Clicking on the **File** folder lets you navigate to the **Data** directory. *(Note: This is an example. Organize files as you wish on your own computer.)*



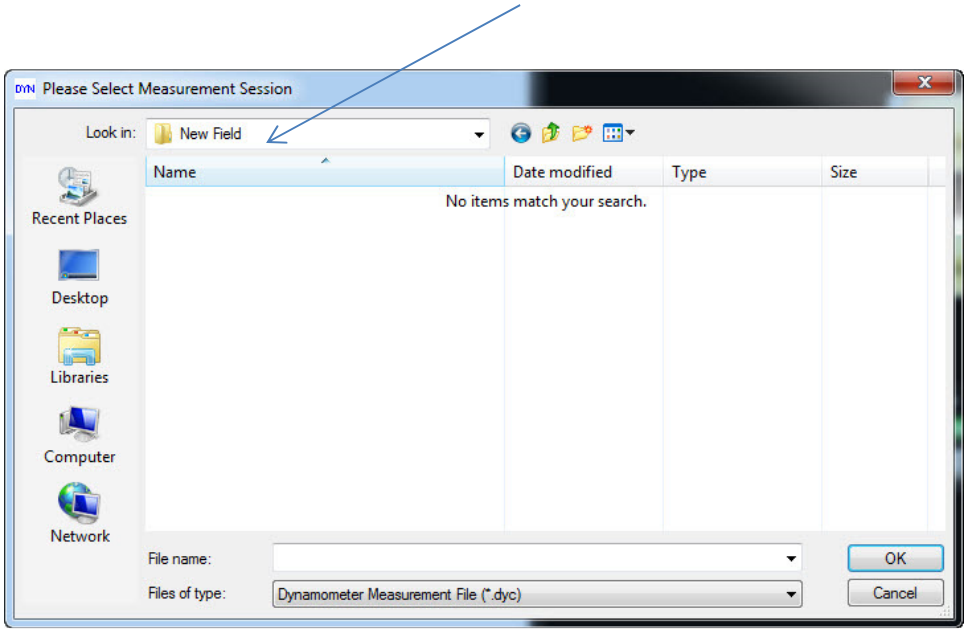
- Click on the **Create New Folder** icon (which looks like a folder with orange star) to create and name a new folder.



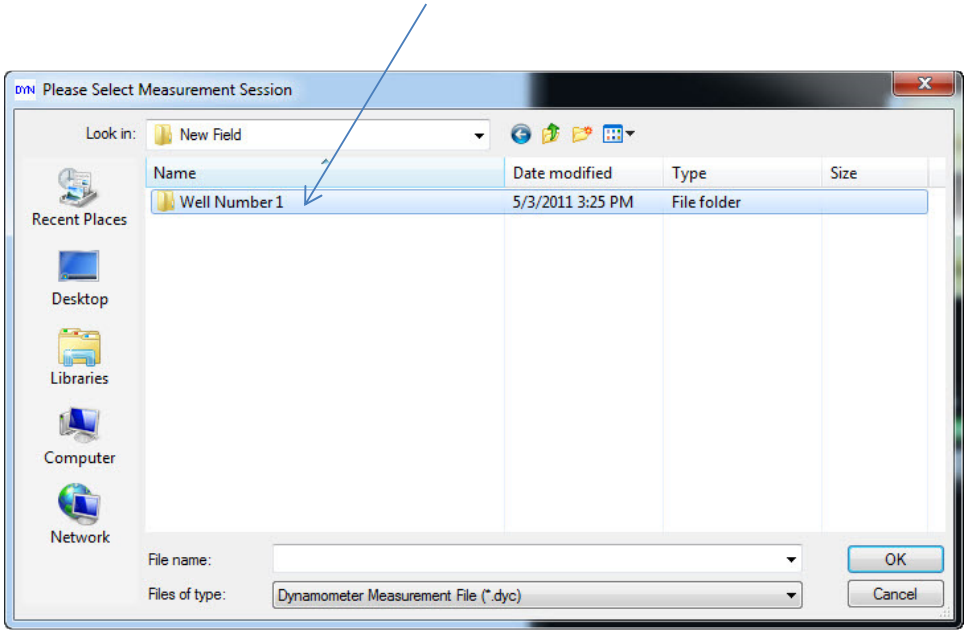
- Right click the mouse on the **New Folder** name and rename it by typing **New Field**. *(Note: This is for example only. You may name the file whatever you choose.)*



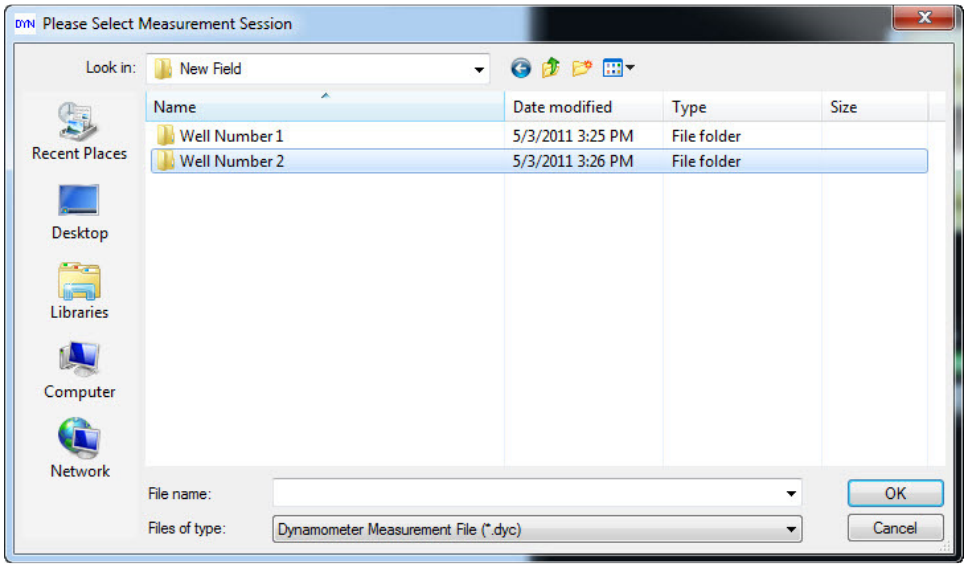
- Using the left mouse button, double click on the **New Field** folder to open that folder.



- Left click on the **Create New Folder** icon (open folder with orange star) to again make a new folder and right click the resulting file to rename it **Well Number 1**. *(Note: Or name as desired.)*

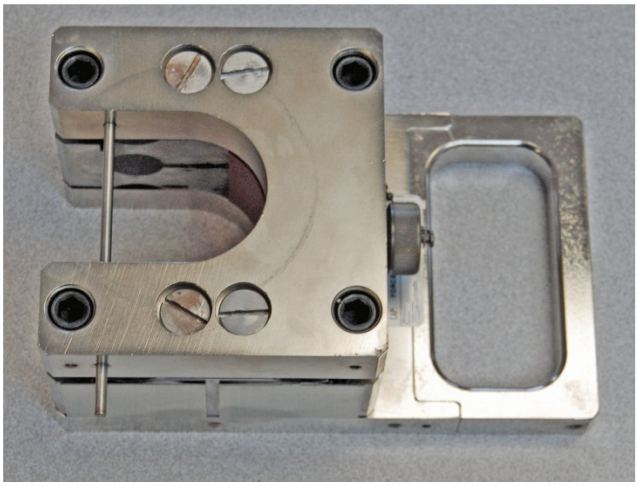


- Repeat the above file creation and file naming process to make individual folders for all of your wells.
- Then, when you are testing and ready to store a file, navigate to the proper Field Folder, then to the proper Well Number folder, and then name and save your Current Test file with an easily identified name. The Sage DYN software automatically puts a time and date stamp on the data for easy chronological organization. For easy reference, all recorded tests for each well can be easily found and saved within the same folder in the future.



Transducer Options

40K Quantitative (Horseshoe) Load Cell Transducer



The **40K Quantitative Load Cell,** also known as the Horseshoe Load Cell, is used to accurately measure polished rod load. The Horseshoe Load Cell has a vertical install height of 3.5 inches. This load cell can be installed either of two ways.

Note: Before installing the Horseshoe Load Cell with either of these two methods, BE SURE ***the motor has been shut off and the pumping unit brake has been set.***

Horseshoe Load Cell Installation

Method One: Horseshoe Load Cell Installation

1. The first install method is to place the **Horseshoe Load Cell** between the **carrier bar** and the **rod clamp**. To install the Horseshoe Load Cell using this method, a **stuffing box protector** is used to extend slightly above the stuffing box. A temporary **knock-off stand** is positioned on the stuffing box protector. A **fine thread rod clamp** is temporarily installed on the polish rod above the knock-off stand, such that on the downstroke, the temporary polish rod clamp will come in contract with the knock-off stand. This produces separation between the carrier bar and the top rod clamp. *At this point,* the Horseshoe Load Cell is inserted between the carrier bar and the permanent rod clamp. The brake on the pumping unit is slowly released causing the slack to pick up between the carrier bar and the permanent rod clamp. This applies the load to the Horseshoe Load Cell. The knock-off stand may now be removed and the well motor started for the dynamometer test.

Method Two: Horseshoe Load Cell Installation

2. The second install method for the **Horseshoe Load Cell** allows the elimination of any errors that might be caused by raising the pump in the barrel as happens when you insert the **Horseshoe Load Cell** between the carrier bar and the permanent champ clamp. It requires that an inexpensive **spool**

spacer be permanently installed between the **carrier bar** and the **permanent rod clamp**. The spool spacer has dimension that allows the Horseshoe Load Cell and a special **hydraulic lift mechanism** to be inserted in the spool spacer. The hydraulic lift occurs with the help of a hand pump and hydraulic hose. As the unit lifts up, a small **shim spacer** is inserted between the lift and the Horseshoe Load Cell. Then as the hydraulic pressure is released, the load is applied through the shim spacer directly onto the horseshoe load cell. The hydraulic hose is removed, the pumping unit started, and you are ready for the dynamometer test.

Method Two, the hydraulic lift method, allows for the most accurate use of the Horseshoe Load Cell, without the corresponding thickness offset of 3½ inches caused by inserting the load cell as in Method One.

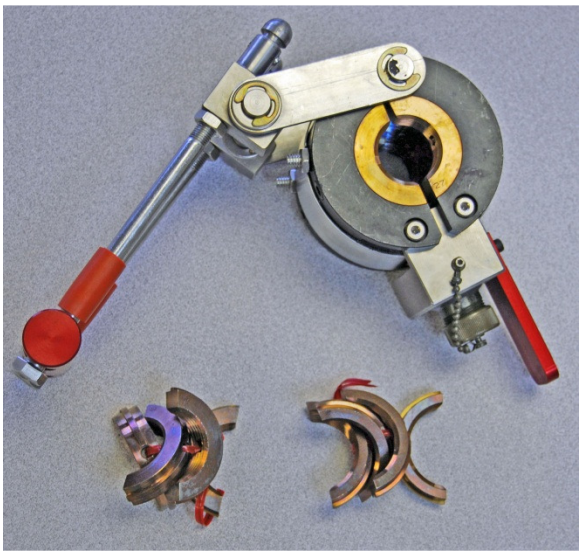
Whereas in Method One, the entire rod string is lifted by the 3½- inch vertical height of the Horseshoe Load Cell, which causes the pump plunger to be further separated from the standing valve and to operate in a different (higher) part of the pump barrel. And sometimes this will cause pump performance during the test to be different from actual pump performance. The different pump spacing will cause a slightly different compression ratio, and will change the look of gas interference and other effects. By using Method Two, the hydraulic lift method, the pump spacing is changed only slightly, which causes a minimal change to the pumping string.

The 3 ½-inch Horseshoe Load Cell is a very versatile and accurate way to measure polish rod load. One Horseshoe Load Cell allows you to deal with both common methods of load cell insertion without the need for varying load cells.

The readings from the Horseshoe Load Cell are gathered using the **Sage DYN software**, to obtain a surface card. A downhole pump card is calculated using the rod string detail. Both a standing and a traveling valve test can be performed. The software calculates pump leakage, standing valve leakage, traveling valve leakage and other items. A counterbalance may also be performed.

The Horseshoe Load Cell has an in-the-field zero transducer function. The in-the-field calibration allows for greater absolute accuracy and compensation for transducer drift over time. Sage Technologies also offers a complete recalibration service if needed, on all load cells.

Quick Clamp Load Cell Transducer



The **Quick Clamp Load Cell** is easy to use for a quick qualitative look at pump performance. The Quick Clamp Load Cell is a precision polished-rod load cell that uses the latest sensor technology to accurately measure smaller changes in rod loads than other similar devices.

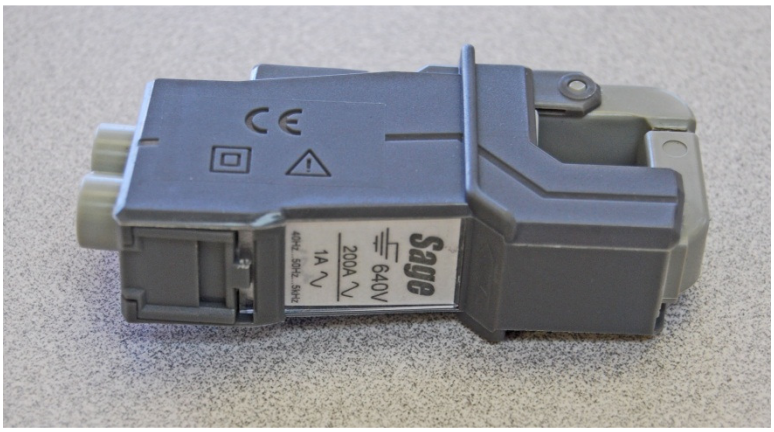
The cost-effective transducer **can fit all rod sizes**, eliminating the need for separate transducers for each rod size. Users can quickly fine-tune the device to variations in rod diameter by adjusting the **ball seat** on the clamp. It allows for fast hand-operated clamping action, enabling an easy tool-free installation, which reduces set-up time. The **universal adapter kit** included with the Quick Clamp Load Cell allows the transducer to fit all rod sizes by changing out the jaws inside the load cell.

The transducer's high sensitivity to changes in the load weight provides a more detailed dynamometer card which allows for accurate rod pump analysis. Precision stainless steel moving parts provide for a reliable field operation. And, the on-board thermal correction provides excellent stability in harsh oilfield conditions.

The Quick Clamp Load Cell transducer clamps to the polished rod below the carrier bar in a quick set-up motion. The Quick Clamp Load Cell does not change the relationship between the pump and the barrel, making it ideal for a quick dynamometer analysis. With the Sage DYN software, the Quick Clamp Load Cell allows easy gathering of surface pump cards, calculation of downhole pump cards, standing valve check and traveling valve checks. This allows complete pumping unit diagnostics.

The Quick Clamp Load Cell is approximately 3 ¾" diameter x 10 ¾" handle length. The Sage DYN software has a special selection for the Quick Clamp Load Cell that allows for easy calibration and data collection.

Current Clamp Transducer

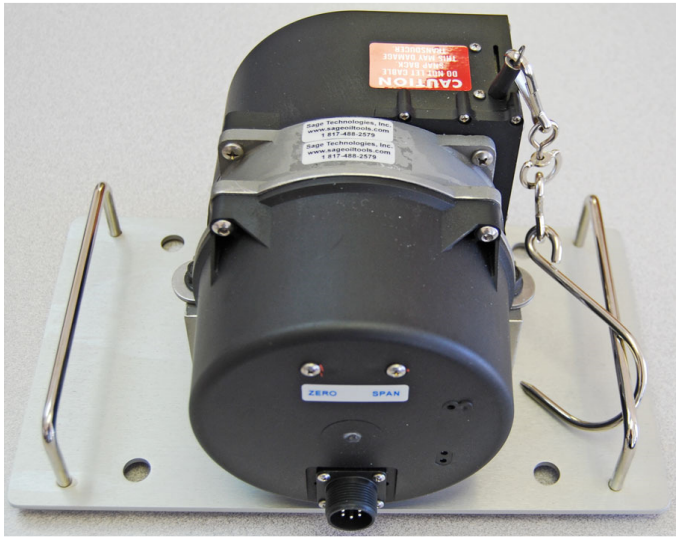


The **Current Clamp Transducer** allows easy measurement of the **motor current**. Motor Current is measured throughout the pumping cycle on both the upstroke and the downstroke. This allows easy viewing and analysis for quick pumping unit balance.

The current transducer is a small handheld device with an opening jaw that is easily clamped around the power wires in the control panel. To use the current transducer, you do not need to make any changes to the control panel as some other devices require.

The **Sage DYN** software displays a motor current plot for quick visual analysis.

String Transducer



The String Transducer monitors the position of the rod string during dynamometer testing. Proper position data is recorded across the entire range of pumping comfiguration.

The String Transducer installs in seconds, functions properly without perfect alignment, and the string retracts into the housing for trouble-free operation.

Sage Pressure Transducer

The **Sage Pressure Transducer** is a high quality stainless steel media isolated pressure sensor, intended for the use of measurement of liquids and gases. Utilizing **Krystal Bond ™ technology**, the Sage Pressure Transducer offers a one-piece stainless steel sensing element free of welds, internal o-rings or oil fill. This translates into rugged construction, high cycle life and a wide range of media compatibility.

For fluid level testing with the AFL IV with Dynamometer, the Sage Pressure Transducer can be easily attached to the **Pressure Pulse Gas Gun** via its **Swagelok** quick-connect. The fitting allows easy hand installation. All connections are watertight and the electrical output is via 4-20ma current loop for outstanding noise immunity.

The Sage Pressure Transducer is available in the ranges of 1,500 psi and 3,000 psi. All pressure transducers are supported in the **Sage AFL software** for easy data gathering.

Note: See the Acoustic Fluid Logger IV Manual (downloadable at www.sageoiltools.com or available through Sage Technologies, Inc.) for more on *fluid level testing* with the AFL IV with Dynamometer.

Maintenance: AFL IV with Dynamometer

Charging the battery

The AFL IV with Dynamometer battery should be charged regularly after each day's use, using the wall-mount charger that accompanies the unit. Insert the round, yellow end of the charger cable over the charger port on the AFL IV with Dynamometer front panel, and tighten the black thumb ring. Then plug the other end of the charger into a wall outlet.

The charger has been designed to work automatically with 110-volt or 220-volt (50hz or 60 hz) voltage. Usually an overnight charge will be sufficient.

Note: Keep the power switch in the off position during charging.

Occasionally, a damaged battery will need to be replaced. (See the following pages on battery replacement in this manual.) Prior to replacing the battery, however, efforts should be made to charge the unit with the accompanying battery charger for at least 24 hours.

When storing the AFL IV with Dynamometer, always make sure the power switch is turned off, to avoid running down the battery.

Wallmount charger connection

Battery Replacement

Supplies needed for changing the battery on the AFL IV with Dynamometer:

- One medium Phillips screwdriver and one ¼" nut driver or ¼" wrench
- New AFL IV with Dynamometer battery from Sage Technologies

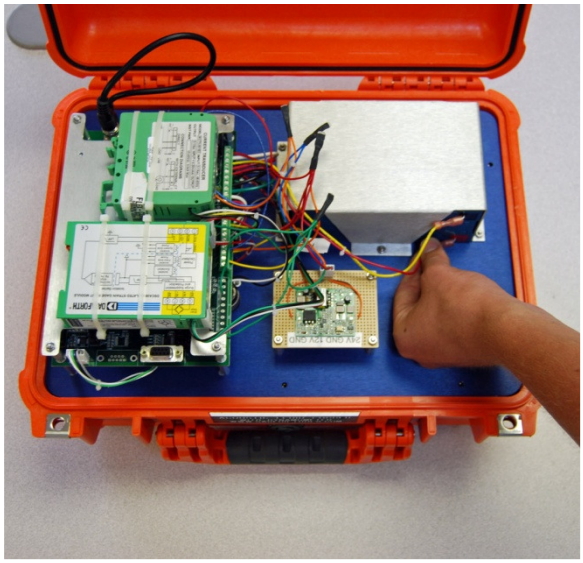
Note: It is absolutely necessary to use caution to avoid damage to the internal circuit boards or internal wiring cables while changing a battery.

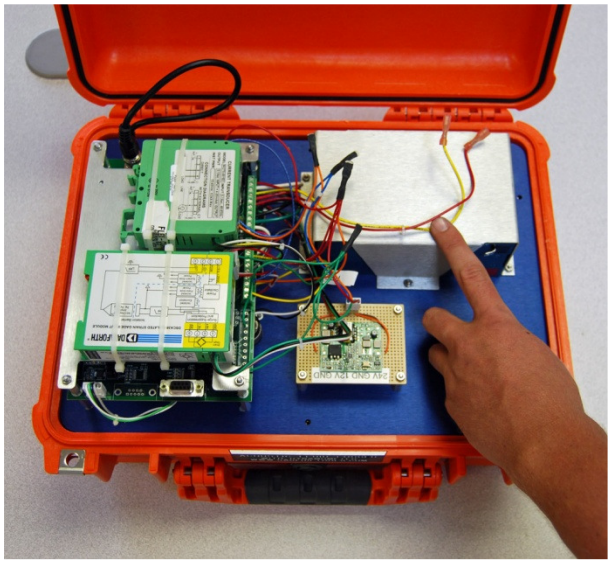
First, using the medium Phillips screwdriver, remove the ten **outermost** screws on the AFL IV with Dynamometer front panel – two on each side and three each at the top and bottom of the panel. These screws attach the front panel to the box. Note: The inner set of screws holds other components to the front panel – do not remove these.

Remove ten outermost screws.

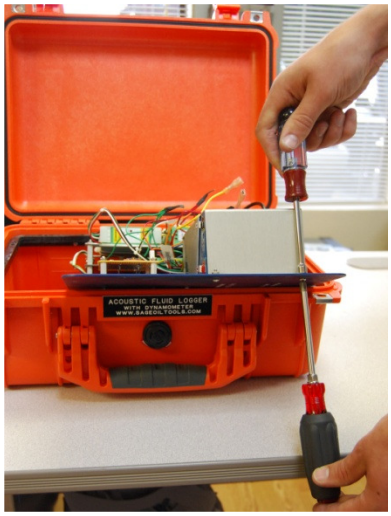
Remove and save the ten outermost screws from front panel.
Note: Inner sets of screws hold circuit boards and battery to the top panel – Do not remove the inner screws.

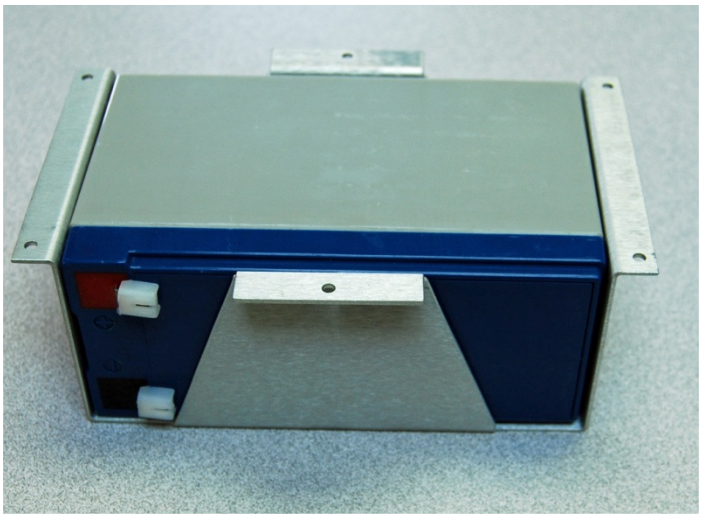
Lift and remove the front panel. The front panel holds the battery box and battery, as well as the printer, internal circuit boards and wiring. Be careful not to disturb the internal wiring. Flip over the panel and set it upside down on the orange AFL IV box. Disconnect the red and yellow battery wire connections from the battery. **Warning: DO NOT work on the unit while the battery is connected.**



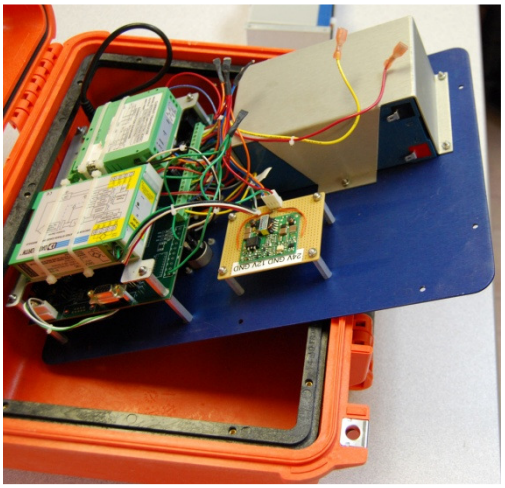


Use one medium Phillips screwdriver and one ¼" nut driver or ¼" wrench, remove and save the six screws that hold the battery box to the back of the AFL DYN front panel. Remove the old battery and replace it with a new AFL DYN battery from Sage Technologies (which is also a standard 12-volt motorcycle battery). Place the battery face-down (red connector up) in the battery box, as shown below right; be sure that when the battery box replaced onto the metal plate, the battery connections face toward the middle of the front panel and are stacked near the outside edge of the panel. (See below left photo.)





Replace the six screws that hold the battery box to the front panel, as above left. Tighten screws completely. (Screws are #6-32, 3/8" if replacement of lost screws is necessary.)



Reconnect the battery; be SURE to **connect the red battery connection wire to the red battery pole, and the yellow connection wire to the black battery pole.**

At this point, lift the front panel and clean out any dirt or debris that has fallen inside the orange box. Any stray screws, metal parts, paper clips or excessive dirt may harm the circuit board.

To complete battery replacement, replace the front panel in the box, being careful not to cut any cables or wires. Then reinstall the ten #6-32 3/8" front panel screws.

Replacement Parts and Supplies

AFL IV with Dynamometer box

Wall-mount Charger

AFL 12-volt battery

USB cable

Dynamometer accessories

Load Cell – Quantitative 40 K - Horseshoe Load Cell Transducer
Load Cell – Quick Clamp Load Cell Transducer
String Transducer – 250 inches
String Transducer – 500 inches
Motor Current Probe
Cable with reel – for Load Cell Transducers
Cable with reel – for Motor Current Probe
Cable with reel – for String Transducers
Stuffing Box Protector
Knock-off Stand
Rod Clamp Wrench
Fine Thread Rod Clamps:

1.5 inch (1 ½") polished rod clamp

1.25 inch (1 ¼") polished rod clamp

1.125(1 ⅛") polished rod clamp

Acoustic Fluid Logger IV accessories

Pressure Pulse Gas Gun – 1,500 psi

Pressure Pulse Gas Gun – 3,000 psi

Pressure Transducer – 1,500 psi – with 25-ft. cable

Pressure Transducer -- 3,000 psi – with 25-ft. cable

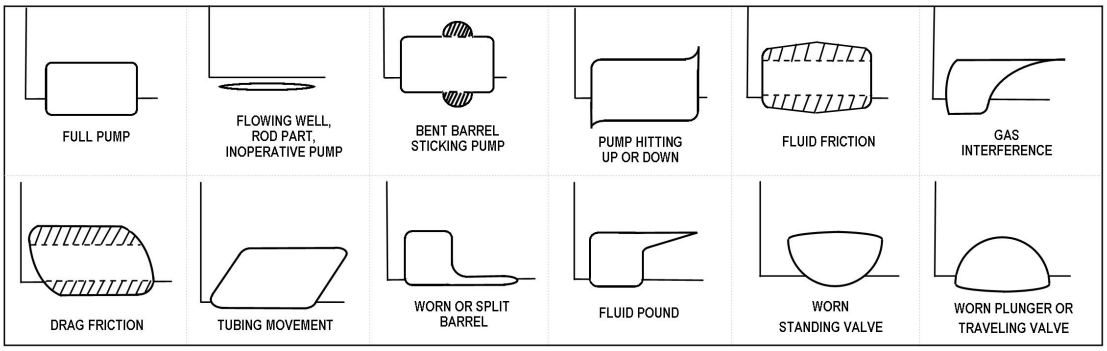
Other optional accessories

Carrying case – sized to fit your custom Sage Dynamometer set-up

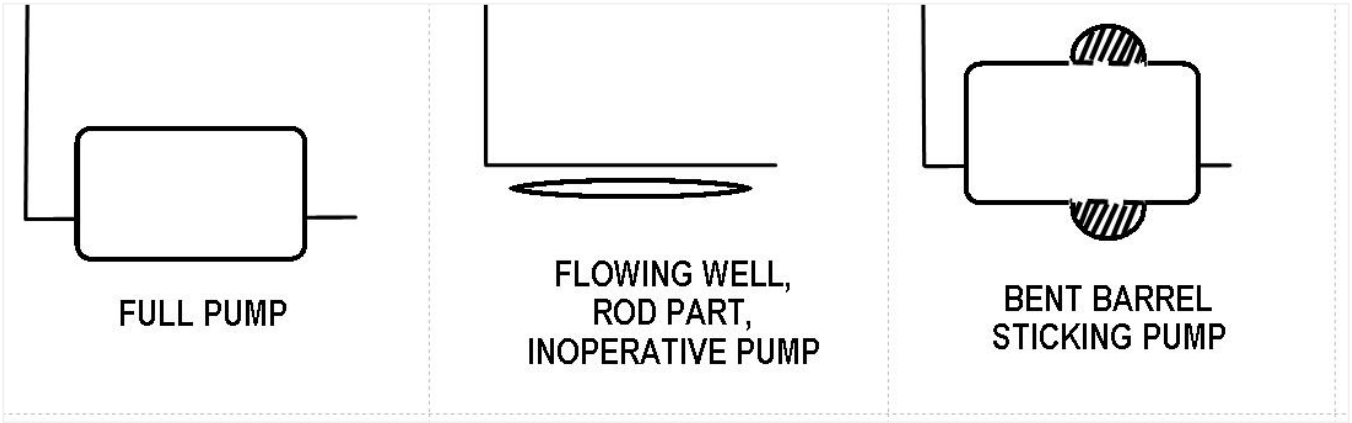
Appendix A: Dyno Card Shapes

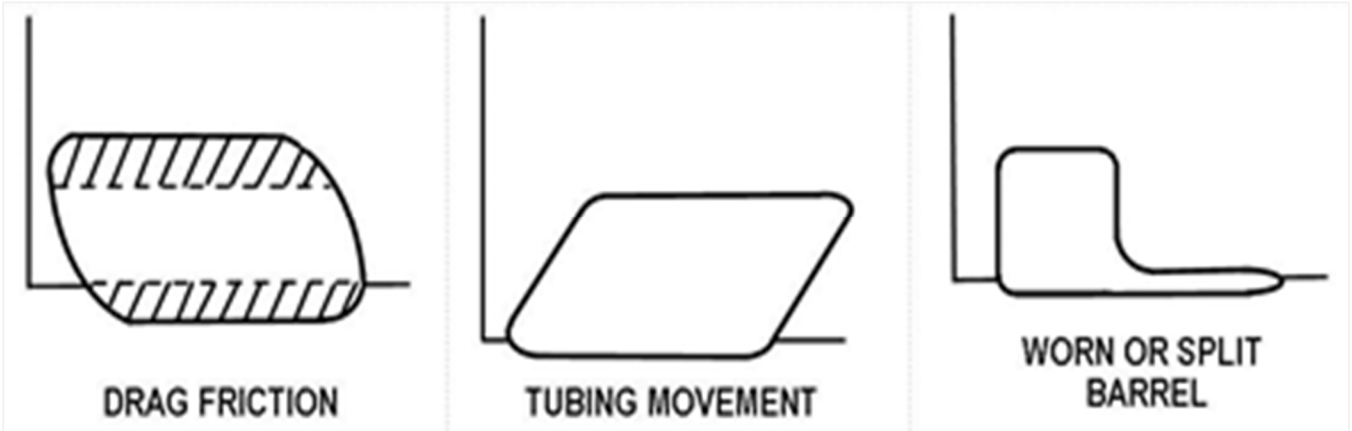
Onscreen dynamometer surface and downhole cards give you the ability to make a quick well diagnosis. Basic dyno card shapes and associated identifiable problems are shown here. A copy of this page may be affixed to the inner lid of the AFL IV with Dynamometer to aid in downhole dyno card identification.

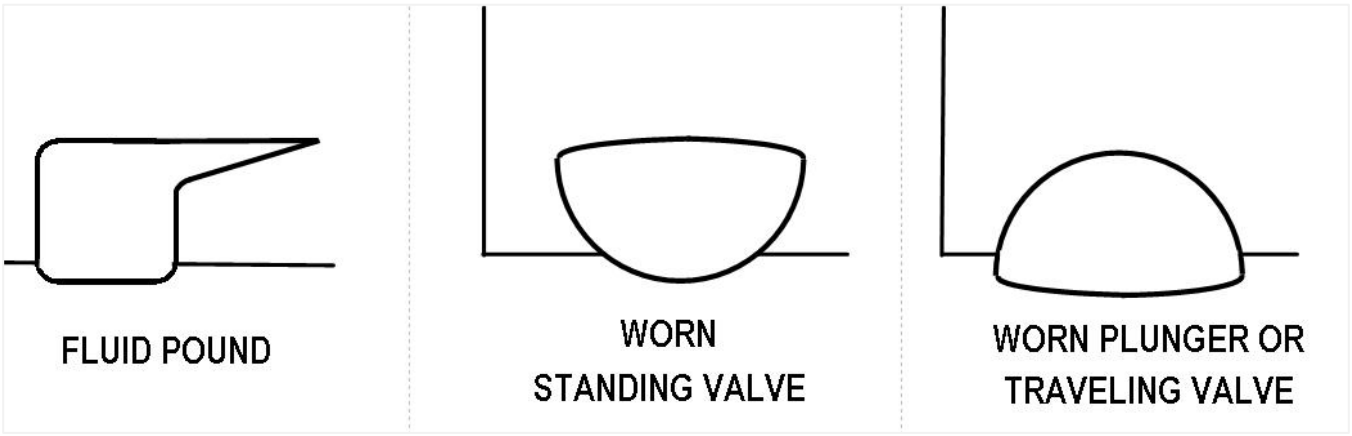
Downhole Dynamometer Card Shapes

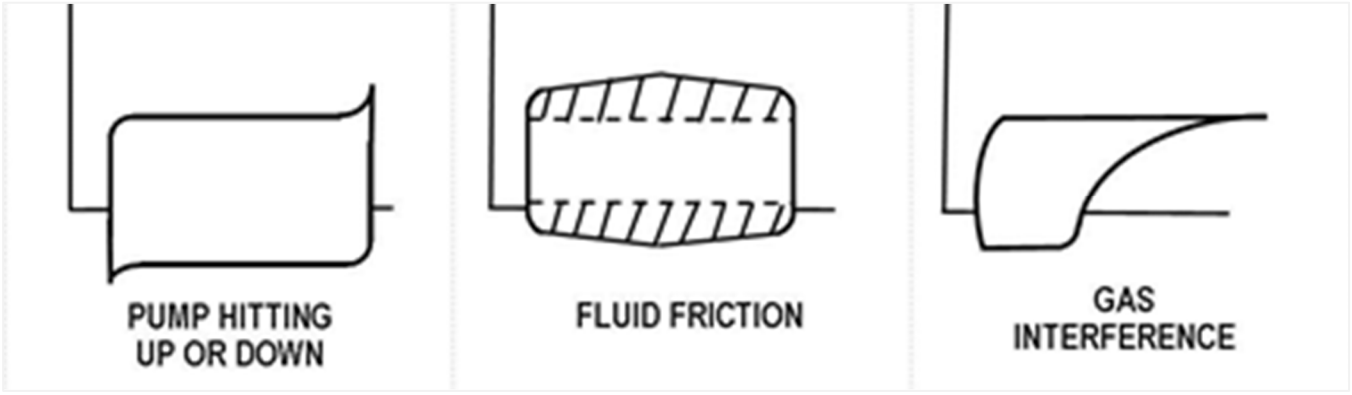


Downhole Dyno Cards – Detail






FLUID POUND
WORN
STANDING VALVE
WORN PLUNGER OR
TRAVELING VALVE


PUMP HITTING
UP OR DOWN
FLUID FRICTION
GAS
INTERFERENCE

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Grapevine, TX 76099-1466
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