REMOTE ASSET MONITORING

RAM

RAM Features and Help Guide

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ECHOMETER

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Overview of the Echometer RAM (Remote Asset Monitoring) System

The RAM system is the newest addition to Echometer's existing suite of wellsite wireless monitoring tools that include TAM software and sensors designed for real time analysis of well performance. Application of these tools requires a person to be present during the acquisition and analysis at the well site. The existing TAM wireless system consists of:

(1) TAM - a windows-based control and analysis application and
(2) Wireless sensors system with a base communication device.
(3) A laptop computer

To perform extended monitoring requires one to have the entire TAM wireless system at the well site with supervision by an operator that manually acquires the records at appropriate time intervals. With the introduction of the RAM system, this is no longer the case.

The addition of the RAM system leverages the capabilities of the current system The RAM extends the reach of TAM allowing the user to remotely acquire and analyze data and to set up un-attended scheduled acquisitions of dynamometer, fluid levels, pressure and electrical power/current.

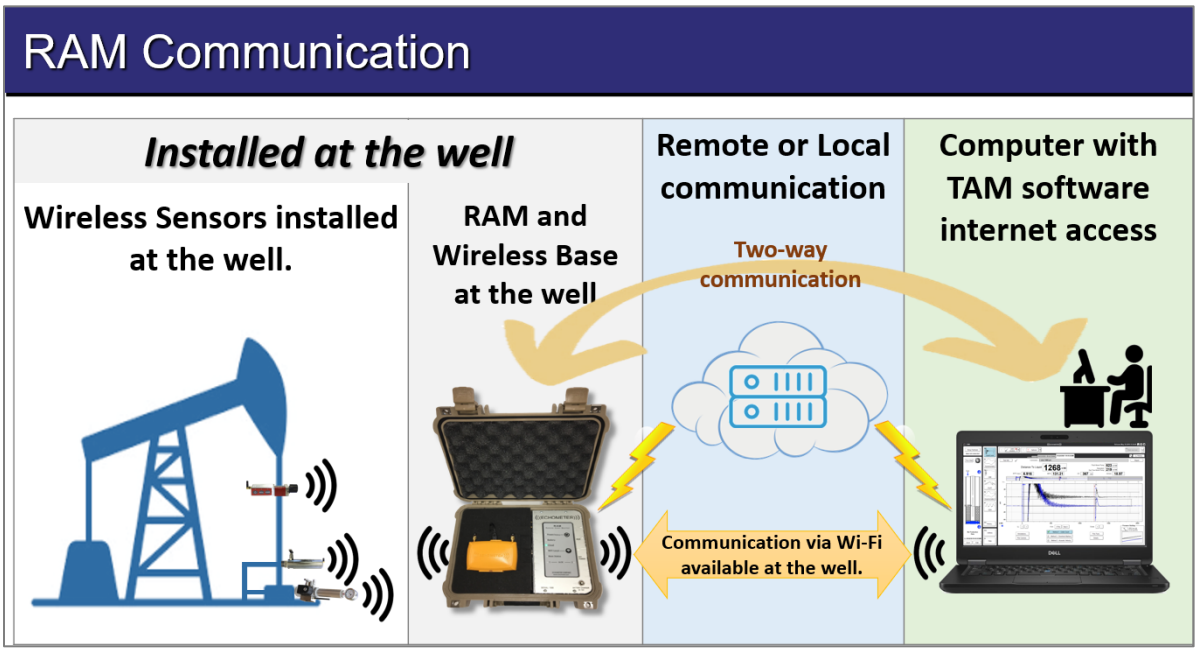
The RAM integrates with the current sensor system, providing a bridge from the TAM running on the laptop and the wireless sensor system. The RAM sits in the middle between TAM and the wireless sensor system. On one side the RAM interfaces with the wireless sensor system. On the other side the RAM interfaces with the Echometer Cloud or directly with a laptop. With this device-in- the-middle it is no longer a requirement to leave the entire system at the well for extended monitoring periods. Once the sensors and the RAM box are deployed at the well the user sets up schedules that enable RAM to collect data automatically over extended periods. The user is able to check in on the system remotely, via the cloud, and retrieve acquired data to be analyzed locally.

The RAM provides several services leveraging Echometer's current wireless product.

(1) The ability to acquire data through direct access of the wireless sensor system. The RAM bridges the gap making it seem the laptop were directly connected to the sensors. Once a RAM is deployed, with sensors installed on a well the user can remote-in at any time to directly acquire tests.

(2) The user can set up and modify scheduled acquisitions for dynamometer, liquid level and other tests. Schedule parameters configure the acquisition interval and duration.

(3) While a schedule is active on the RAM the user can log in remotely, via Internet, or locally through the RAM's hot spot, to retrieve acquired tests and/or modify the acquisition schedule. The remote option eliminates the need to drive to the well.



The RAM system, shown schematically in the previous figure, has several objectives for improved analysis and optimization of flowing and artificial lift wells:

- Automatically acquire data without user intervention
- Monitor individual well performance trends over extended periods of time
- Provide remote access to test equipment deployed in the field
- Monitor acquired data remotely and download it to user's computer
- Manual Data Acquisition override
- Increase productivity and safety of field personnel by reducing travel requirements

These objectives are satisfied by using a programmable system for stand-alone wireless data acquisition and communication via the Internet.

RAM Applications

Although the examples presented in this document refer primarily to application for rod pumped wells, the RAM system is applicable to all types of production operations as outlined in the following section.

Rod Pump Wells
- First Delivery Monitoring
- Well Pump Down Tracking
- POC/Timer Set-Up and Evaluation
- Power Analysis
- Pressure Transient Tests (Buildup/Drawdown)
- Fluid Level Depression Tests

Gas Lift Wells
- Start Up Sequence
- Intermittent Monitoring
- Pressure Transient Buildup Tests

ESP Wells
- First Delivery Monitoring
- Pump Down Tracking
- Fluid Level Trends
- Pressure Transient Tests

Gas Wells
- Liquid Loading Trends
- Monitor Batch Treatments
- Pressure Buildup Tests

Plunger Lift Wells
- Plunger Cycle Monitoring
- Liquid Level Monitoring
- Pressure Transient Tests

Flowing Wells
- Flowing Pressure Trends
- Pressure Transient Tests

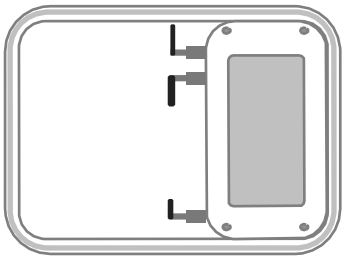
Injection Wells
- Injection Pressure Trend
- Injectivity Test
- Fall-Off Test

Hardware Requirements

The RAM system includes the electronic devices that are briefly listed here:

Laptop Computer

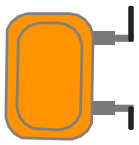
Running \Windows 10 Operating System
Runs the application TAM - Echometer's main acquisition and analysis software.
Network Connectivity (wireless and direct)
USB Connectivity



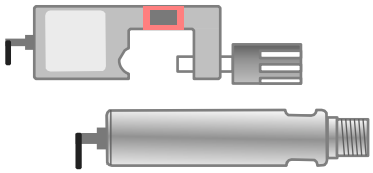
RAM box (data logger)

Single Board Computer system built to be deployed in the field (at the well). Contains just enough control software to acquire data unattended.
Communicates directly with TAM via laptop and indirectly with TAM via CLOUD.

Is able to autonomously acquire data using Echometer Wireless System. Provides remote access to data acquired at the well and to Wireless System.



Base Station
Hub / Controller base for Echometer Wireless System. (Replacement for wired Well Analyzer)
Plugs into computer using USB.

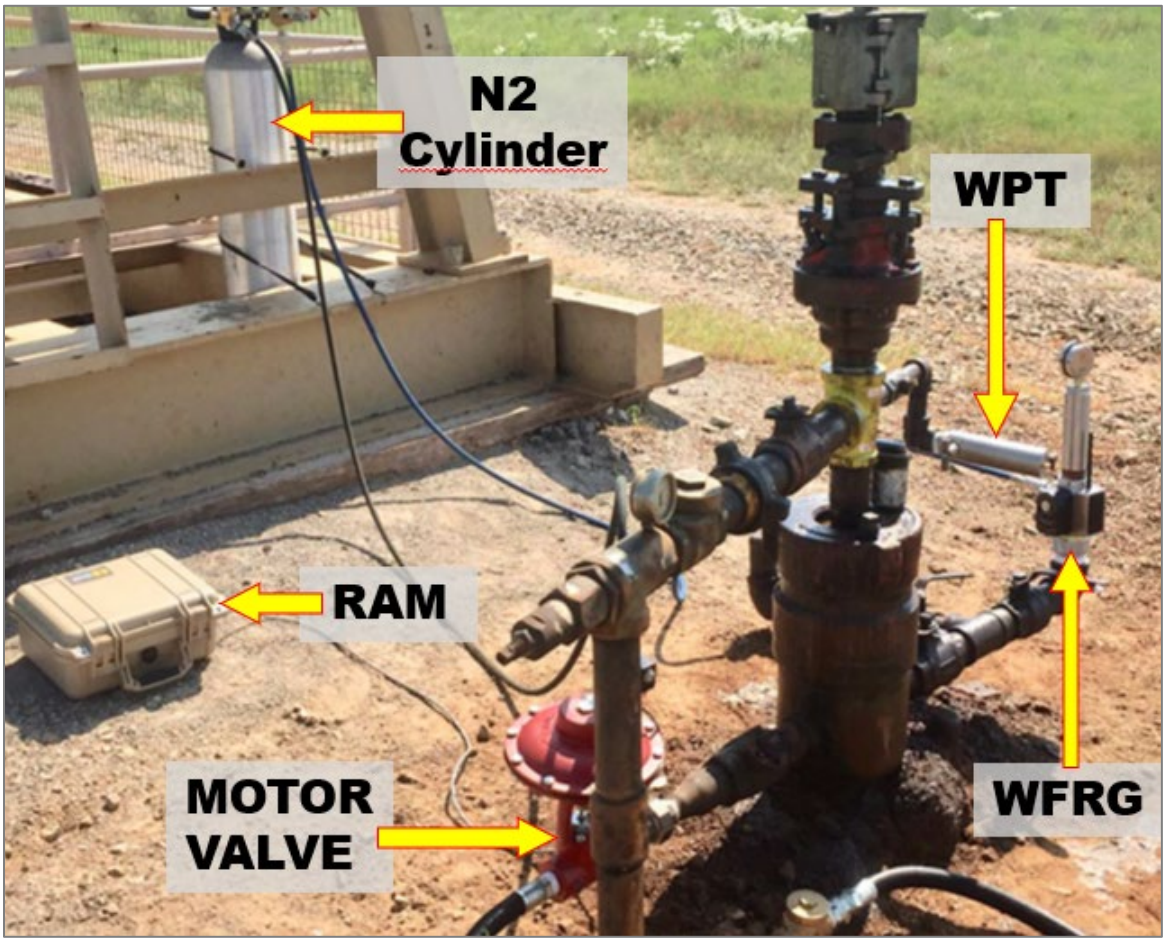


Sensors
Wireless sensors which communicate with Base Station using proprietary protocol.

CLOUD

Central cloud-based server application which provides the necessary node linking the RAM deployed in the field to TAM running on a laptop in office.

The following figure shows the equipment that is normally deployed in the field with the RAM for monitoring the performance of a rod pumped well and are briefly described in more detail in the following pages.



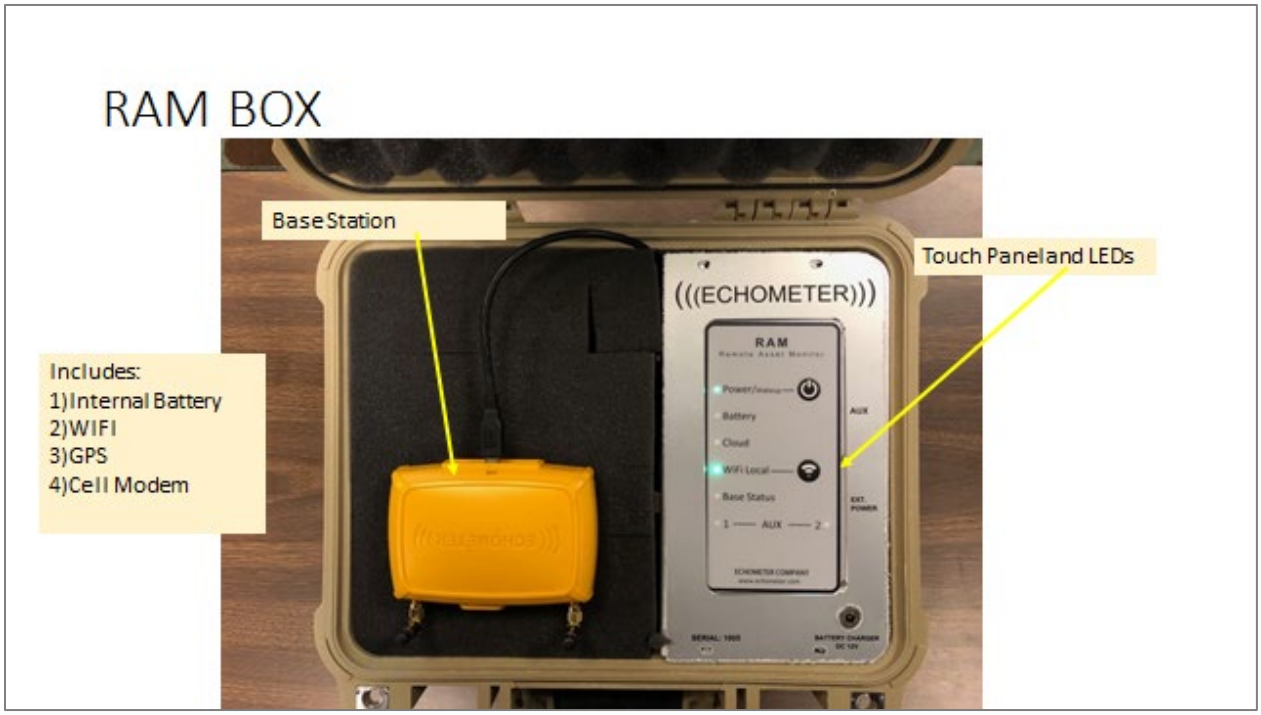
RAM Box Description

The RAM box includes a single board computer system built to be deployed in the field (at the well). The internal computer system contains just enough control firmware to acquire data unattended and communicate with external laptop or with the cloud via internet connection.

The RAM utilizes **existing wireless equipment** for data acquisition and has the ability to run two weeks without external power such as solar panels.

For acoustic fluid level acquisition has the ability to **control** an **external motor valve** during liquid level test to isolate the casing annulus from production flowline while the acoustic data is being recorded and the casing pressure is being monitored.

The RAM's electronics are housed in an enclosure that withstands environmental conditions of temperature, wind, rain, etc.



The RAM box is controlled via the touch panel buttons and LED indicators as described in more detail later in this document. Power management is one of the main considerations of the firmware that runs in the Single Board Computer and controls the status of the system, such as turning off the Wi-Fi after five minutes of inactivity, or putting the RAM in a low power mode when not communicating with the cloud.

Wi-Fi button is used to turn Wi-Fi back on when it has gone off to save power after 5 minutes of inactivity.

Sensors and Hardware Installed with RAM

All existing Echometer wireless sensors can be deployed with the RAM system. Unattended operation may require providing additional elements such as a motor valve, a nitrogen gas supply system and some type of external power source: batteries or solar panels for extended duration testing.

1) - Wireless Remote Fired Gun

The standard Echometer WRFG is used. Since multiple acoustic fluid level measurements will be acquired automatically without operator intervention it is necessary to provide Nitrogen gas at a regulated pressure via a permanent high pressure hose connection to the gas supply bottle as shown in the following figure.

Nitrogen and Pressure Regulators

The gun should be mounted vertically as shown in the picture. This prevents accumulation of moisture within the firing mechanism and the possibility of freezing under cold ambient temperature.

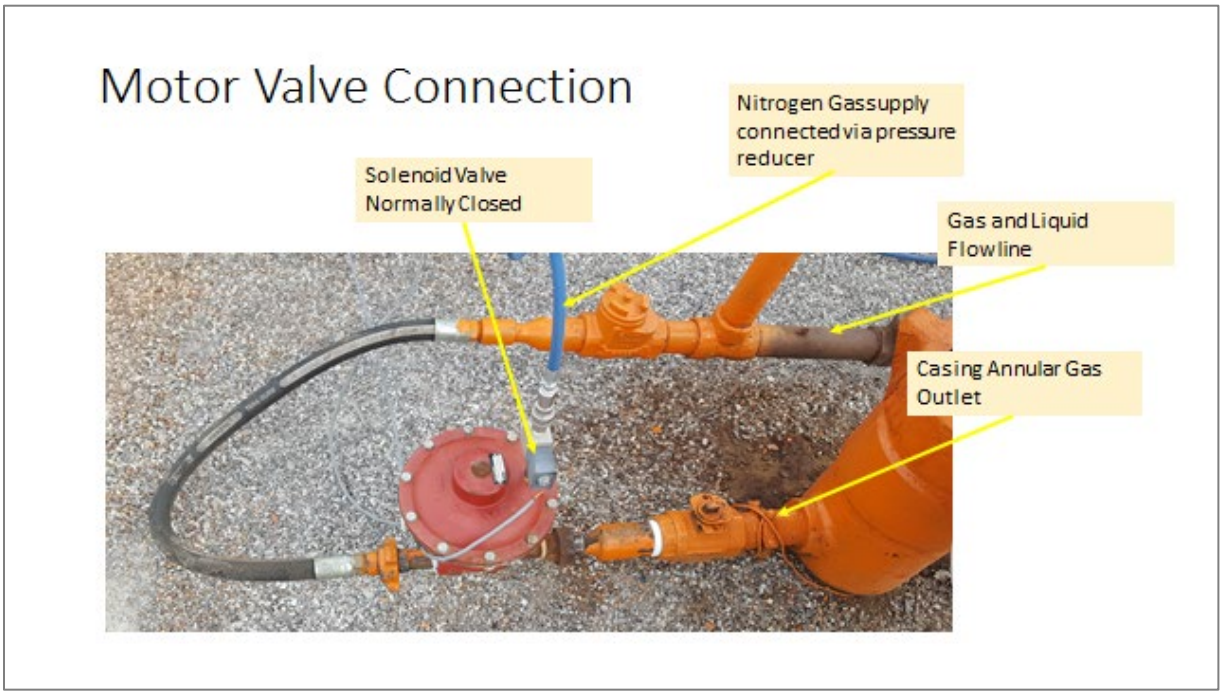
The user should verify a) there are no gas leaks at the filler connections and b) the chamber pressure stays constant once it is charged with gas. The gun's dart valve O-Rings should be in good condition and properly lubricated. (Please refer to the WRFG maintenance guide and video)

2) - Computer Operated Motor Valve

Acquisition of acoustic records in the annulus of pumping wells (rod pump or ESP) requires momentarily closing the flow of gas from the casing to the flowline. This action has several objectives:

- Reducing the acoustic background noise
- Preventing the reception of interfering echoes originated downstream in the flowline
- Maximizing the amplitude of the pressure pulse traveling downhole
- Stopping the gas flow out of the casing
- Monitoring the change in casing pressure when the casing is shut-in

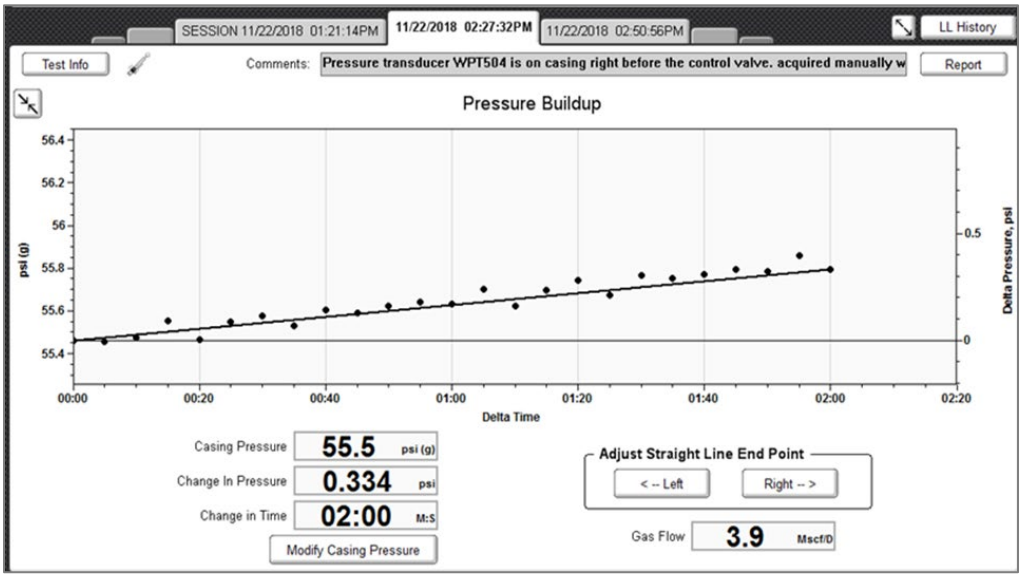
Several types of motor valves can be used.



The valve illustrated here is a normally-open valve with a pneumatic actuator. The operating gas pressure is provided from the Nitrogen tank via a pressure reducer set at the recommended pressure for proper valve operation. The gas pressure is applied to the valve dome via an electrical solenoid valve that is normally closed. When the computer issues the command to

"Close the Casing Valve" 1) the solenoid valve is opened, 2) the Nitrogen gas flows to the motor valve dome and 3) the motor valve closes. The completion of this action can be verified in TAM by monitoring the reduction in background acoustic noise, as discussed later in this document, and the fact that the casing pressure generally will increase as shown in the following figure.

The figure below shows a typical increase in casing pressure after closing the casing valve during acoustic fluid level measurement.



NOTE: If the casing pressure does not increase it could be an indication of :

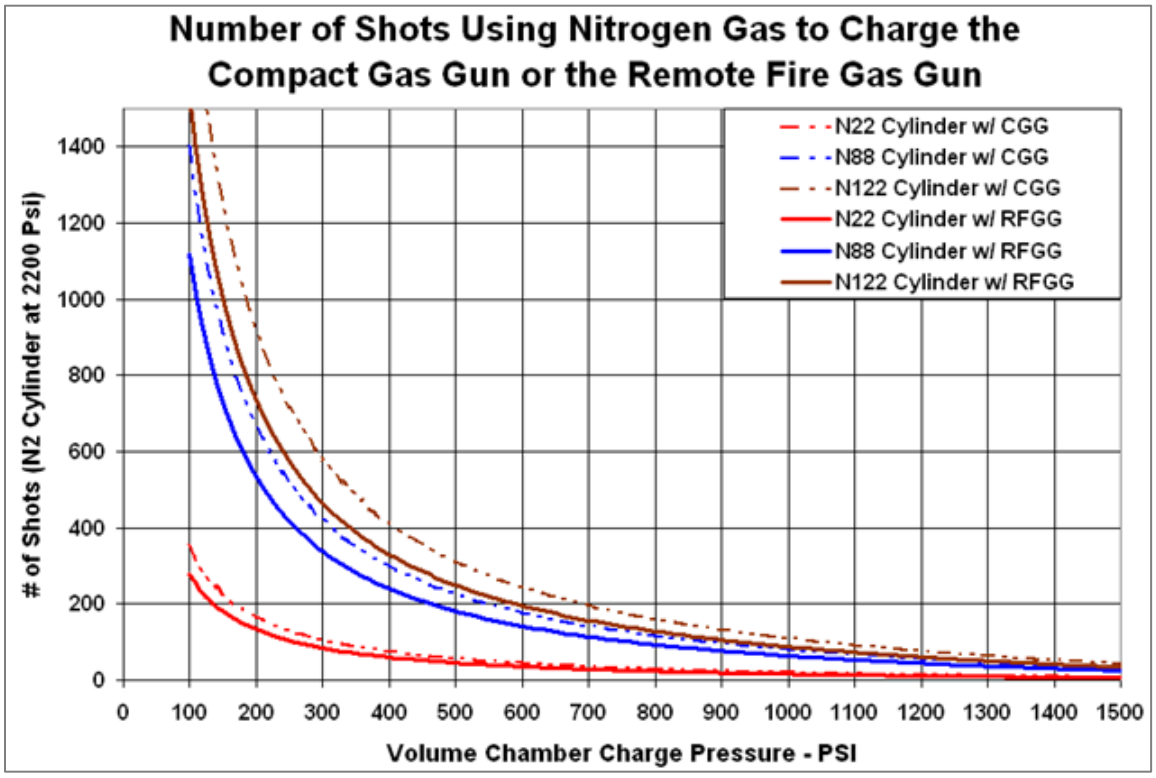
1. The casing valve did not close upon computer command due to valve malfunction, lack of Nitrogen gas, or other causes.
2. There was no flow of gas up the annulus and out to the flowline.

In some cases, it is possible for the pressure to decrease significantly. Usually, this is an indication that the fluid level is dropping when the pump flow rate exceeds the inflow of liquid from the formation.

3) - Nitrogen supply and Pressure Regulators

Nitrogen gas should be used to fill the chamber of the wireless remote fired gas gun and operate the flowline shut-off valve. (NOT CO_2 because it's pressure is dependent on the ambient temperature, it will freeze the flow restrictor in the automatic fill attachment and pressure regulators are unreliable)

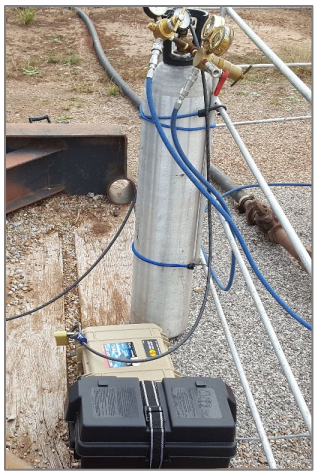
The size of the bottle should be sufficient to supply gas for the duration of the testing. The following graph can be used to estimate the number of fluid level acquisitions that can be performed with a given standard size nitrogen bottle and a given chamber pressure.



Two independent pressure reducer/regulator are required: one to supply the gas for the wireless remote fired gun and a second to supply gas to the motor valve operator.

To supply the gas to the gun chamber the user should initially set the regulator for 150 psi over normal operating casing pressure.

During the RAM setup procedure several acoustic records should be acquired manually to verify that the liquid level echo is clearly distinguishable from the background noise and other echoes that may be present. The chamber pressure should be adjusted (increased or decreased) to obtain a distinguishable echo from the liquid level and other wellbore cross sectional changes.



It is important to check for leaks at all connections using a soap solution in a spray bottle.

4) – Dynamometer Sensors

All Echometer wireless dynamometer sensors can be used in conjunction with the RAM. Due to their inherent stability and accuracy the horseshoe dynamometers (30K or 50K) are preferred for long term scheduled acquisition.

Wireless 50 K Dynamometer

Wireless PRT

All of the wireless sensors are moisture resistant but should be protected from heavy rain using plastic enclosures. The wireless antenna should be oriented for line-of-sight communication with the RAM box. External batteries that are also moisture resistance should be connected to each sensor when long term measurements are to be performed.

5) Tubing Pressure Sensor

The Echometer wireless pressure sensor should be attached to the sampling valve at the pumping tee to measure the variation of tubing head pressure during every pump stroke.

The pressure record, in conjunction with the surface dynamometer card provides additional diagnostic information that can help troubleshooting problems in pump operation.

6) – Electrical Power/Current Sensor

Electrical power measurement provides invaluable data for optimization of beam pumping installations. The main objectives of the measurement generally performed in conjunction with dynamometer acquisition are to:

- Identify overloading and misbalancing of the gearbox
- Determine the power consumption and operating cost $/month and $/Bbl.
- Determine the overall efficiency of the pumping system

When measurements are performed with the RAM system, the wireless power sensor should be installed using the permanent external connector. Best wireless communication is achieved by locating the RAM box so there is direct line of sight with the antenna of the power sensor.

Wireless Power Sensor installation may be done safely, while the pumping unit is operating, using the external water-tight connector. The sensor is powered up then data acquisition and

transmission are initiated by depressing the “Acquire” button. Generally, power/current are acquired simultaneously with dynamometer data.

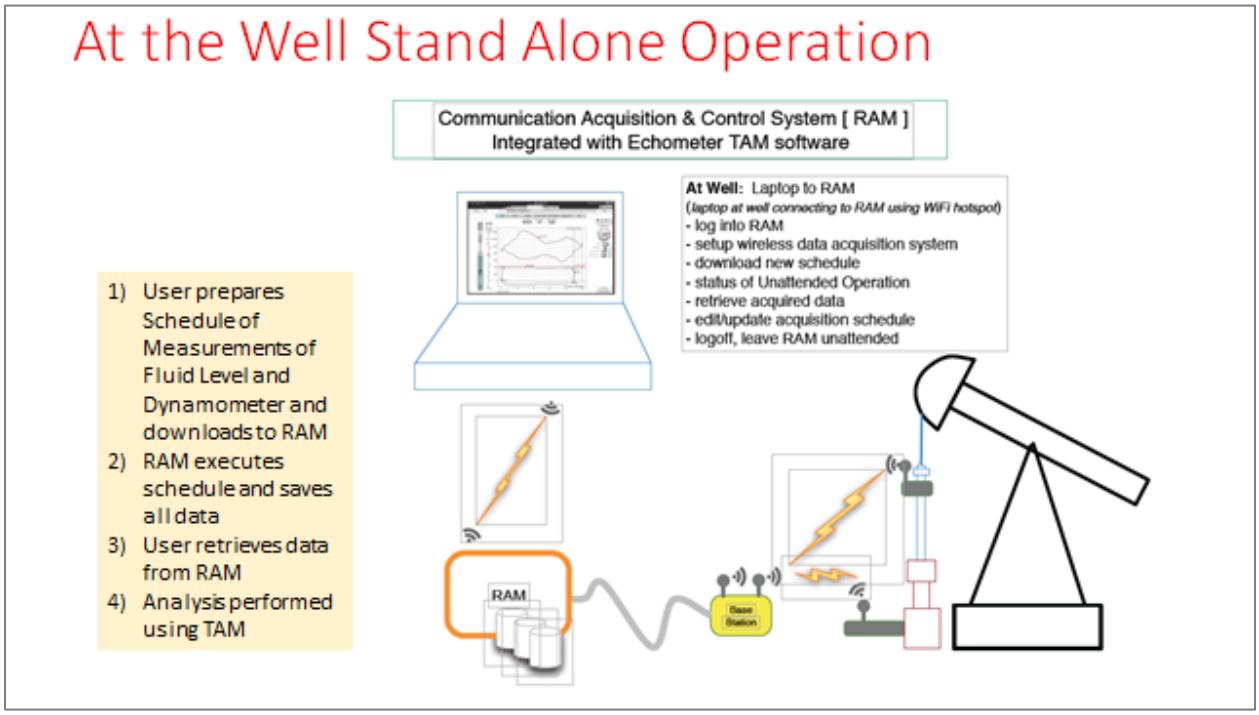
RAM System Deployed for a Typical Rod Pump Application

For a rod pump application, the RAM and sensors described in the previous section will be installed at the well and will be programmed for standalone acquisition of fluid level, dynamometer and power data.

The TAM program will connect the laptop directly to the RAM. Manual acquisition of fluid level and dynamometer data will verify that the system is operational and all sensors are communicating correctly with the RAM. Then a schedule of measurements to be performed automatically will be designed and set up in the RAM. After double checking that everything is properly set up, execution of the schedule is started so that the first records are acquired automatically.

The automatically acquired records are downloaded so the user can analyze the results to verify the accuracy and quality of scheduled data. If everything is satisfactory, the user logs out and the RAM box is left at the field to automatically continue acquisition in accordance with the schedule. Otherwise, adjustments are made to the sensors and the schedule is reset.

The following schematic illustrates direct connection from TAM to RAM via Wi-Fi and wireless communication of the RAM box with the sensors installed on the well.



Local Setup & Connection to RAM

All running and active schedules on the RAM should be removed before starting a RAM setup. For best results and reliable communication, the RAM box with the base and sensors should be placed in a location where there is cell coverage and a minimal level of wireless and radio traffic. The system provides the necessary tools to identify and select radio channels with minimal interference.

Step by Step Procedure for Local RAM Setup

1. Batteries for all sensors and the RAM should be fully charged.
2. Verify the Base is plugged into the RAM.
3. Power up the RAM (this can take up to 2 minutes).
4. Connect to RAM's local hotspot (if Wi-Fi button is not green, the user may need to press Wi-Fi button on RAM). User will have 5 mins to have TAM connect to RAM before it goes back into power saving mode.
5. User's laptop needs to connect to the RAM Wi-Fi connection.
6. Start TAM Application.
7. Select "Setup Hardware" button.
8. Select the "RAM" option from the dropdown list.
9. On the Login screen enter the password for the RAM.
10. Validate the hub address and the network configuration. Verify the latest version of the RAM Application is on the RAM.
11. Verify the Base is being detected by the RAM.
12. Select the Base icon.
13. Turn on sensors that will be used with the RAM test.
    a. If the Base is not connecting with a sensor, select "Pair" and the sensors should show up in left hand panel.
    b. Validate the sensors have a good battery charge and signal strength.
14. Perform zero offsets on the sensors used in scheduled acquisitions.
15. Attach the sensors to well.
16. Verify the RAM, Base and sensors have a good line of sight to each other.

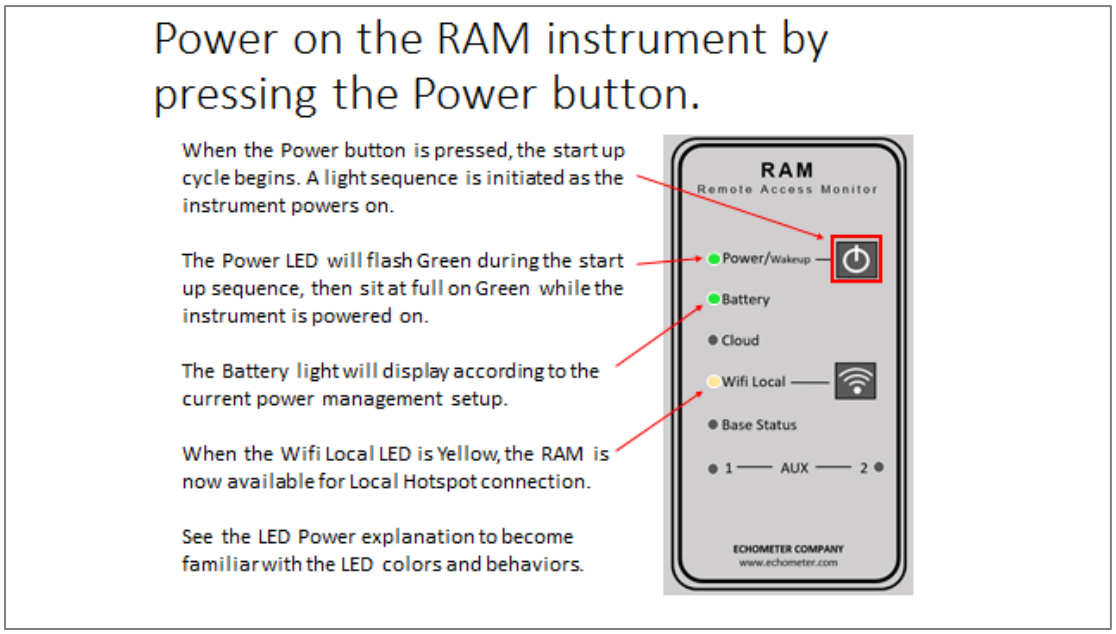
Power UP Sequence

1) When the Power button is pressed, the start up cycle begins. A light sequence is initiated as the instrument powers on.

2) The Power LED will flash Green during the start up sequence, then sit at full on Green while the instrument is powered on.

3) The Battery light will display according to the current power management setup.

4) When the Wifi Local LED is yellow, the RAM is now available for Local Hotspot connection.



See the LED Power explanation to become familiar with the LED colors and behaviors.

The table on the following page details the meaning of the various combinations of LED colors and flashing sequences that indicate whether the RAM is operating correctly or it needs to be reset by the user.

LED Flashing and Steady Codes

On System Startup, the MCU cycles all LEDs red, then green, then blue

Power/Wakeup	Color	Solid	Slow Flash	Medium Flash	Fast Flash
	Off	Powered Off (No Scheduled Wakeup)			
	Red	--	--	--	PowerOffPending
	Green	PoweredOn	ModemPoweringUp OR Sleeping	PowerOnPending	--
	Yellow	--	--	PowerBtnPressed	--
	Magenta	--	--	PowerOnNoTimeout (awaiting FW upload)	--

Battery	Color	Solid	Slow Flash
	Off	RAM Off, Running on Batteries	
	Red	Charging-VeryLow	RAM On, Running on Batteries, Charge VeryLow
	Orange	Charging-Low	RAM On, Running on Batteries, Charge Low
	Yellow	Charging-Medium	RAM On, Running on Batteries, Charge Medium
	Green	Charging-Hi	RAM On, Running on Batteries, Charge Hi

Cloud, RAM On	Color	Solid
	Off	Disconnected from Cloud OR RAM is off
	Yellow	RAM Trying to Establish Connection to Cloud
	Green	Connected to Cloud

Cloud, RAM Off	Color	Solid	Slow Flash	Medium Flash	Fast Flash
	Off	--			
	White	--	--	--	--
	Red	--	Power up	--	Poll Failed
	Green	--	--	--	--
	Blue	--	--	--	--
	Yellow	--	--	--	--
	Cyan	Server Contacted	Modem Sleeping	Init Complete	--
	Magenta	--	--	--	--
	Orange	--	--	--	--

WiFi Local	Color	Solid	Medium Flash
	Off	RAM is off OR WiFi Local is off	
	Green	Wifi Local on, one or more connections	--
	Yellow	Wifi Local on, no connections	Wifi Local button pressed

Base Status	Color	Solid
	Off	RAM is Off OR No Base Connected OR Base powered off OR Base not detected
	Green	Base is connected and powered on and has been detected by the software

AUX 2	Color	Solid
	Off	RAM is Off OR Valve Relay is off
	Green	Valve Relay is on

Users will not see RAM in this state (this is manufacturing)

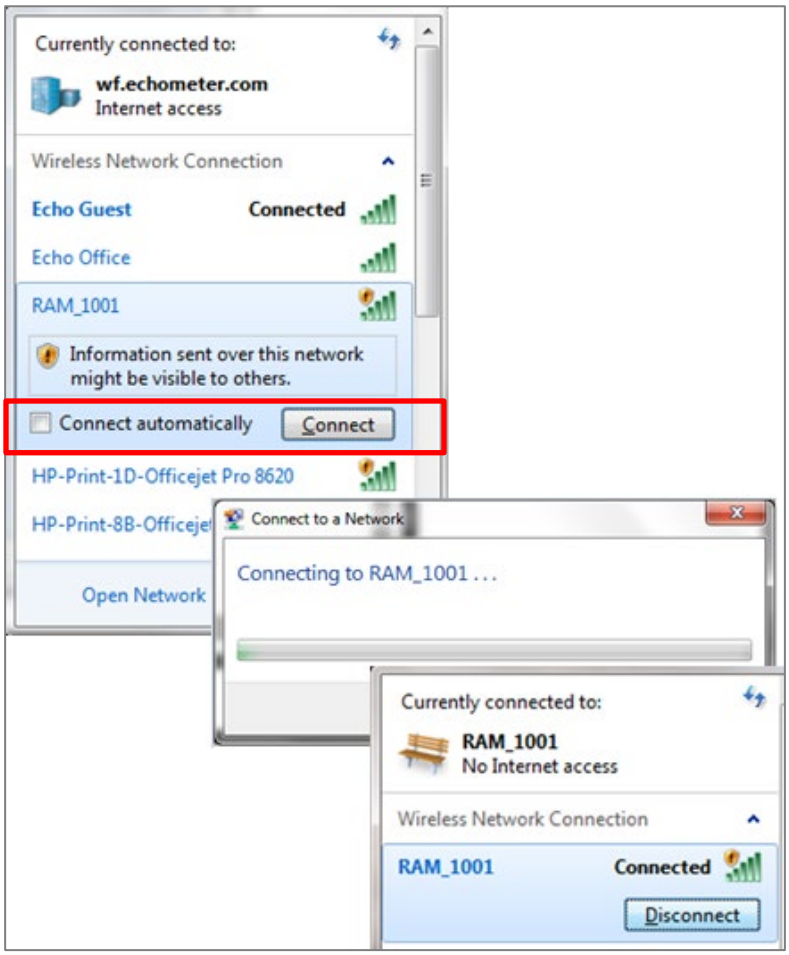
AUX 2	Color	Solid	Fast Flash
	Off	RAM is off OR No updates in progress	
	Red	RAM firmware update failure -- restart required	--
	Green	RAM firmware update successful -- restart required	RAM firmware update in progress
	Blue	--	MCU firmware update in progress

Aux 1

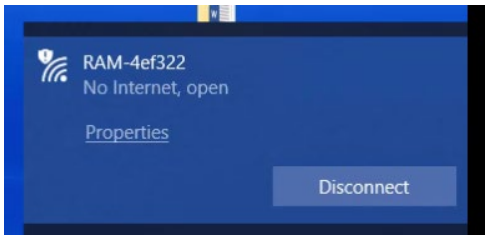
Example of Direct Connection of TAM to RAM

Connect the Laptop to the RAM Wi-Fi before starting up the TAM application to perform wireless acquisitions.

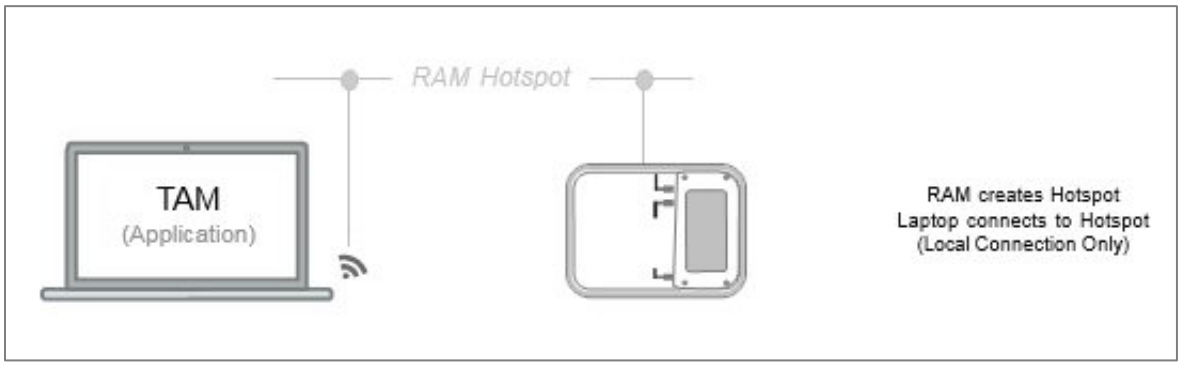
If the RAM Wi-Fi connection does not appear, it may be necessary to power cycle the RAM by pressing the Power button on the RAM instrument again.



RAM connection is now open:



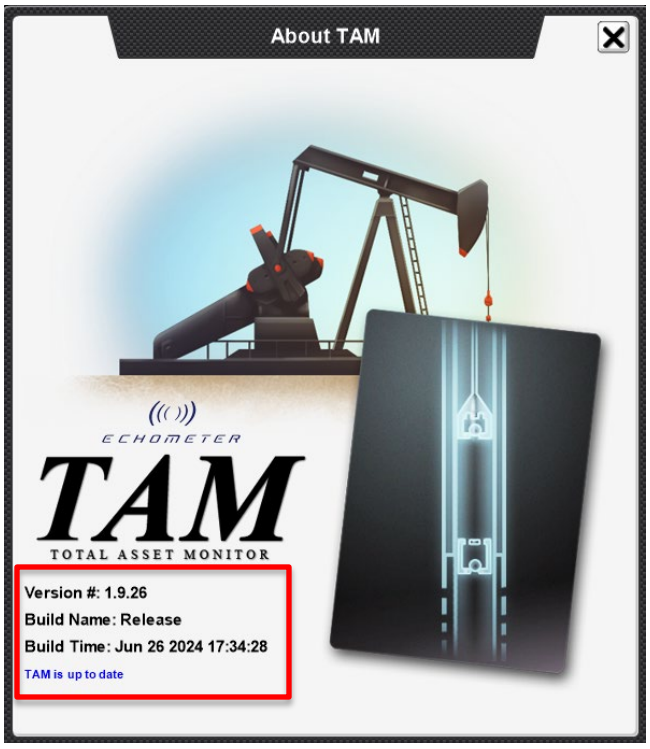
The Windows system Network menu reveals a Hot Spot created by RAM 1001 and creating a local WiFi network. It is possible to connect the laptop to this network.



Once the laptop is connected to the RAM hotspot, the user will have 5 minutes to open the TAM software and start setting up the RAM and necessary sensors for testing.

Start the TAM Application

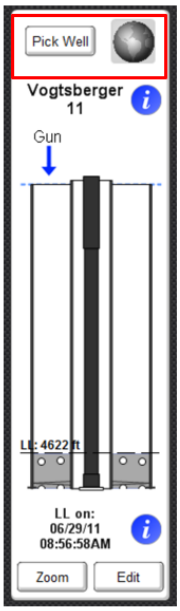
To communicate with the RAM the laptop must have installed TAM Version 1.8 or later



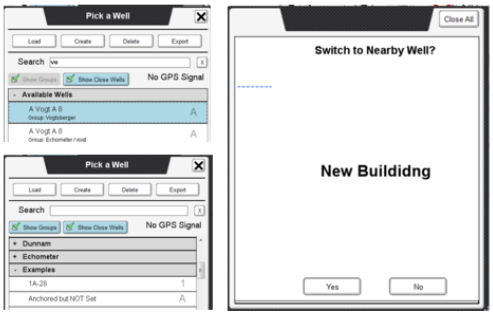
Select Well

The user will need to select en existing well or create the well they would like to perform the test on.

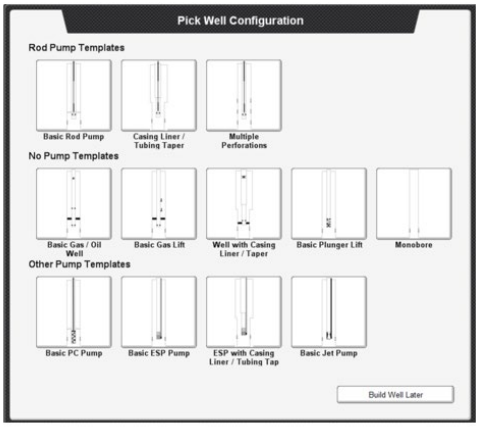
Methods to select an existing well:



- Search by typing
- Directory Tree
- GPS
  - Pop-Up
  - Search
  - Globe Icon

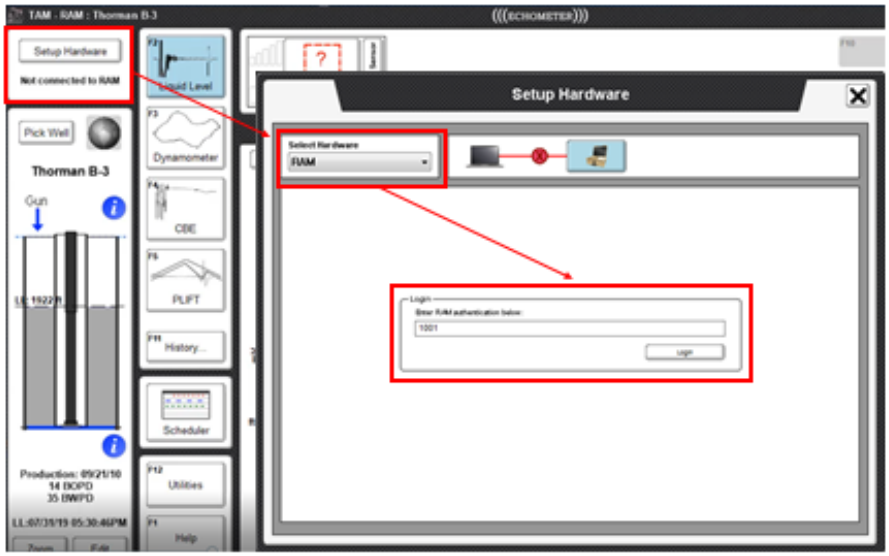


Or Create a New Well:



Login to RAM

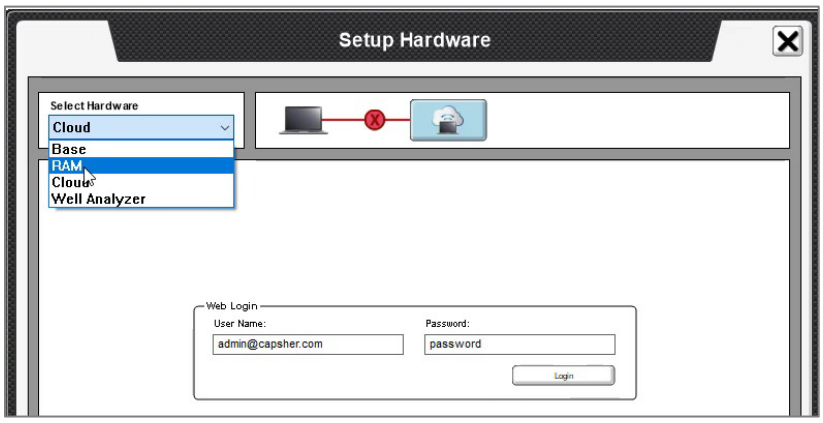
Click Setup Hardware. Select RAM from the Select Hardware dropdown menu.



Password

Enter the RAM Authentication password and click Login.

If TAM cannot connect, double check the computer is still connected to the RAM local Wi-fi. If the RAM has timed out and does not appear as a Wi-fi network option, it will be necessary to Power cycle the instrument again.



On the Select Hardware dropdown list select RAM.

Note: Cloud had been previously selected but not connected which is indicated by the graphic showing a red x between TAM and Cloud.

Upon entry of the password, selecting Login will start the login process to the RAM.

When TAM is connected, a green checkmark will appear between the Laptop and the RAM icons.

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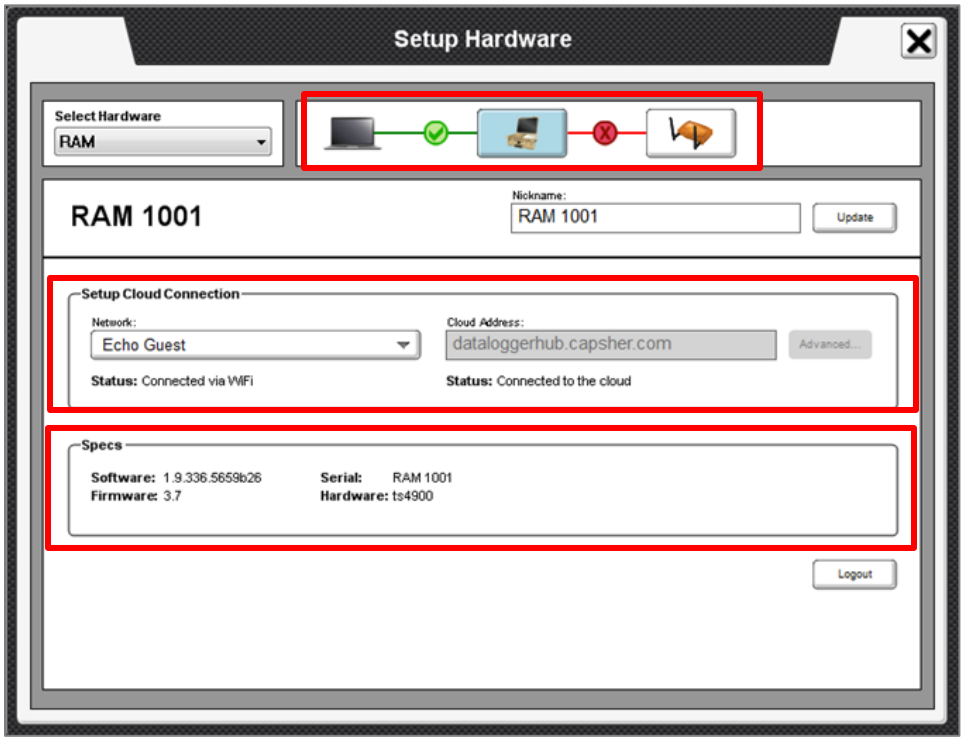


On successful login to RAM 1001 the screen changes to show RAM information. The are two panels of information.

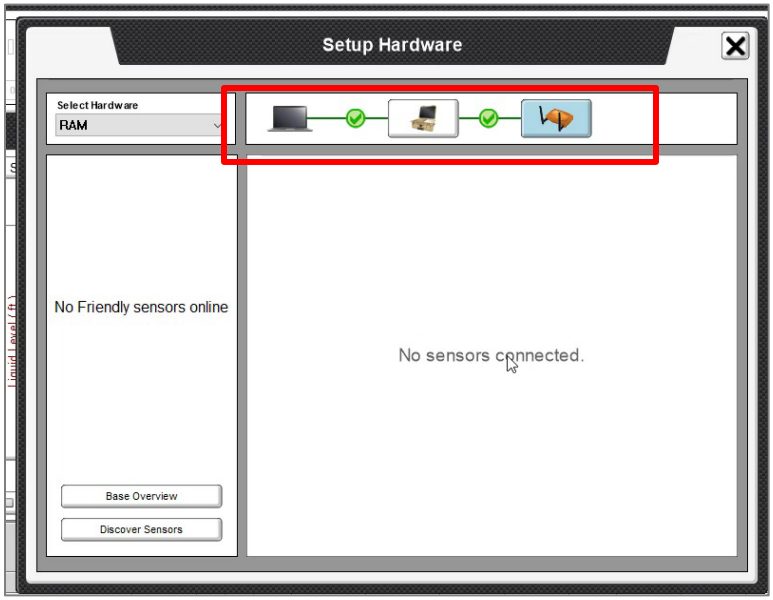
Setup Cloud Connection: Shows the current cloud connection configuration set within the RAM.

Specs: The **Specs** section of the Setup Hardware screen lists the Software, Firmware, and Hardware versions.

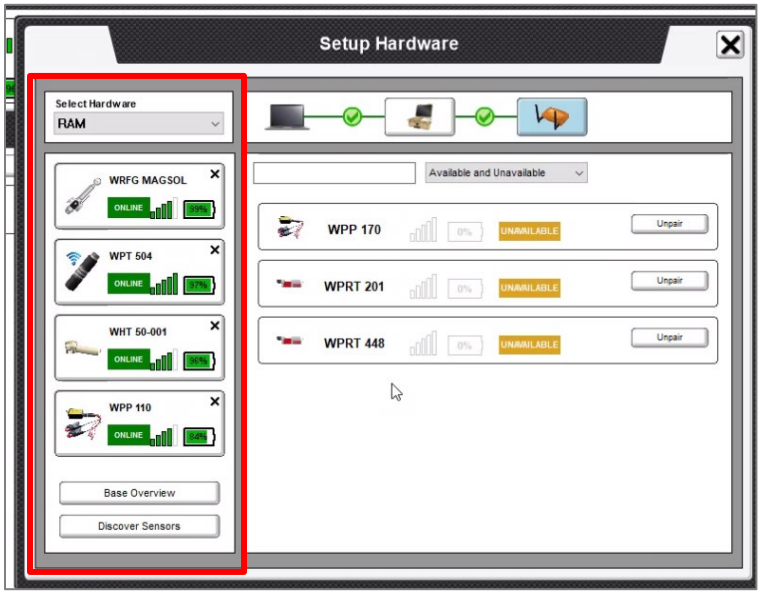
Note: the connection between the RAM and the Base Station shows a red X indicating not active connection.

Follow the steps on the next page to verify current versions are up to date.

Select Sensors and Test Validation



The sensors to be used for testing should be installed, powered up and in communication with the RAM box.



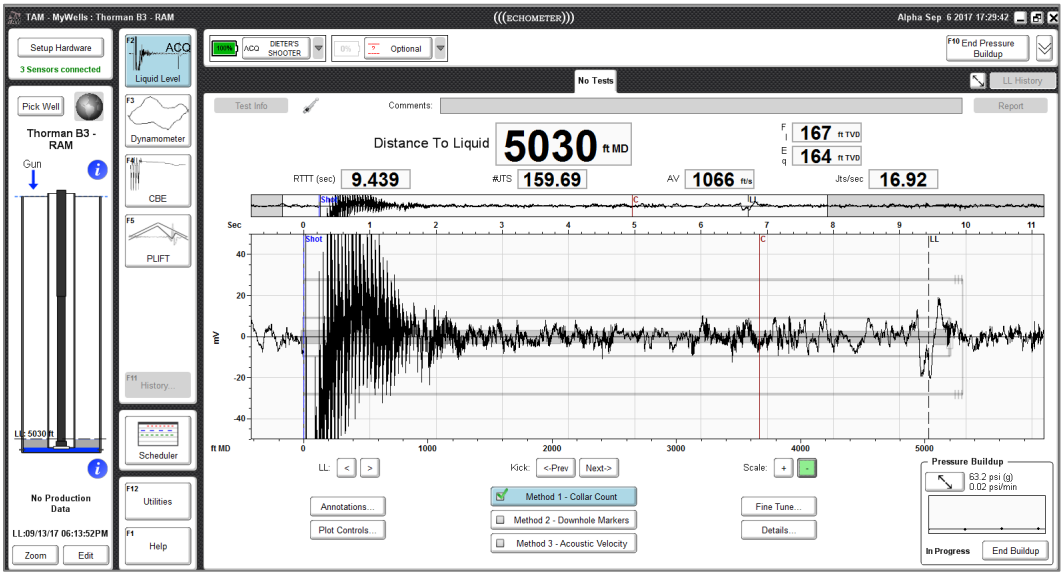
Sensors that are active are displayed at the left. Sensors that have been used previously but are not being used at the present time are listed to the right.

Each sensor's parameters and calibration coefficients are displayed when a sensor button is clicked on the left panel. Make sure that the sensor is unloaded (atmospheric pressure or zero load) before the zero offset is acquired and saved.

Manual Liquid Level test

To perform a LL Test using the RAM:

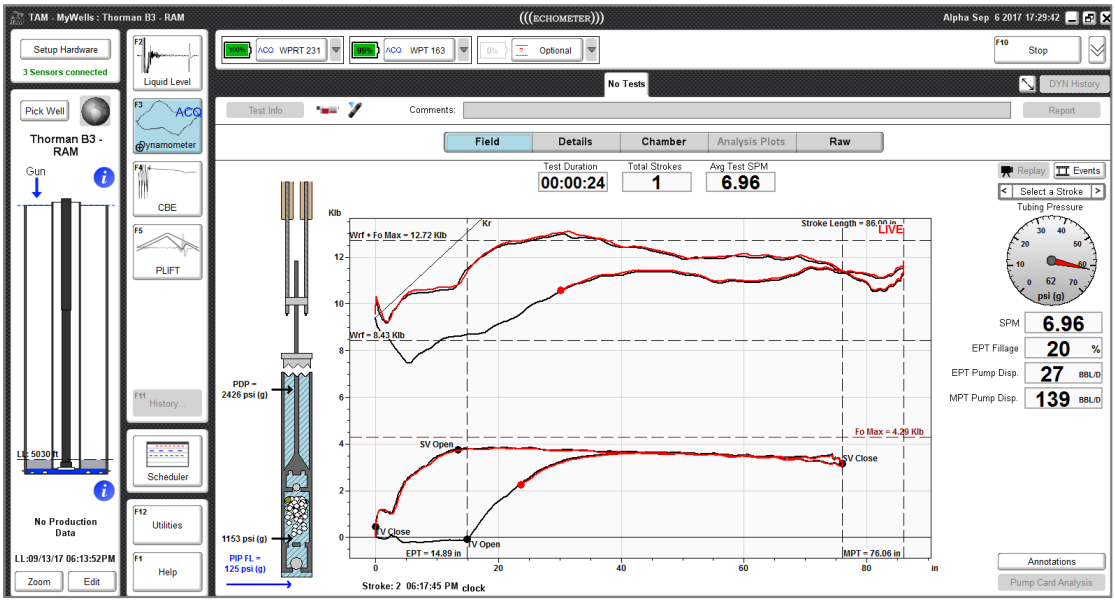
1. Select the LL module for the well.
2. Select the wireless gun you would like to use for schedule acquisition.
3. Perform a LL test to verify everything is setup correctly.



Manual Dynamometer Test

To perform a DYN Test using the RAM:

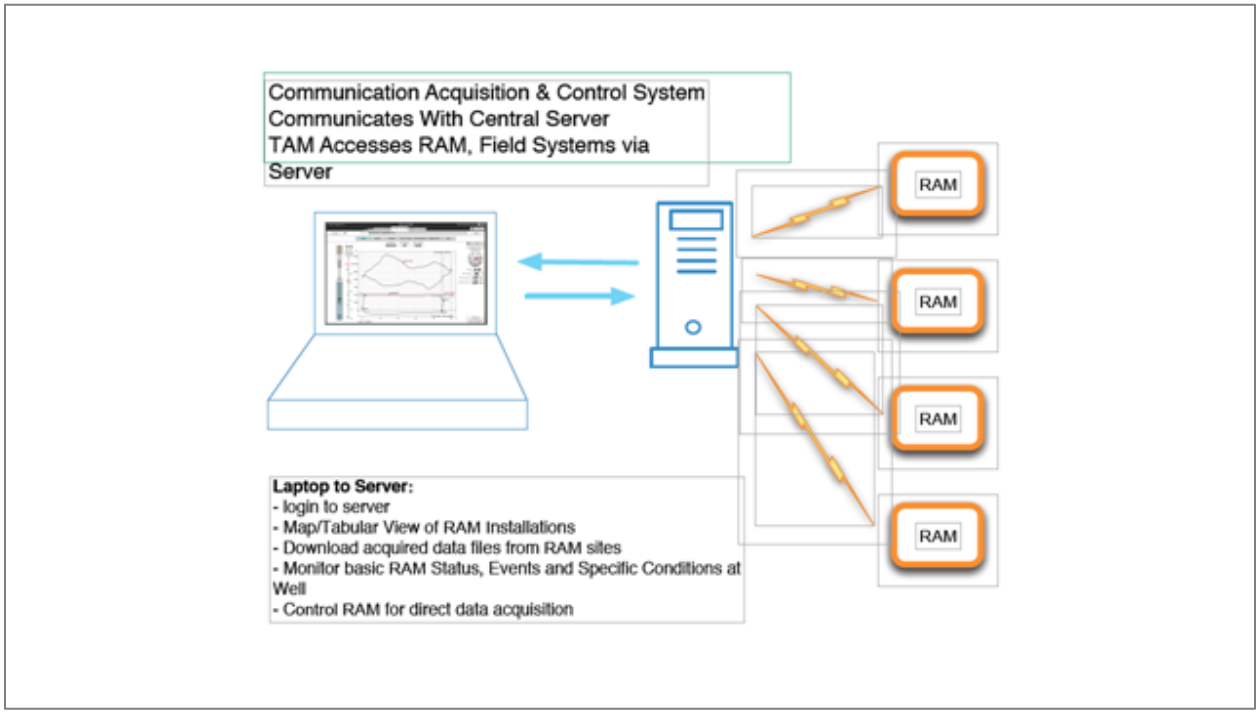
a. Select the DYN module for the well.
b. Select wireless load cell and optional sensors.
c. Perform a DYN test to verify everything is setup correctly.



Having completed the manual acquisitions, the user can continue to set up a schedule of future measurements or perform additional tests as required.

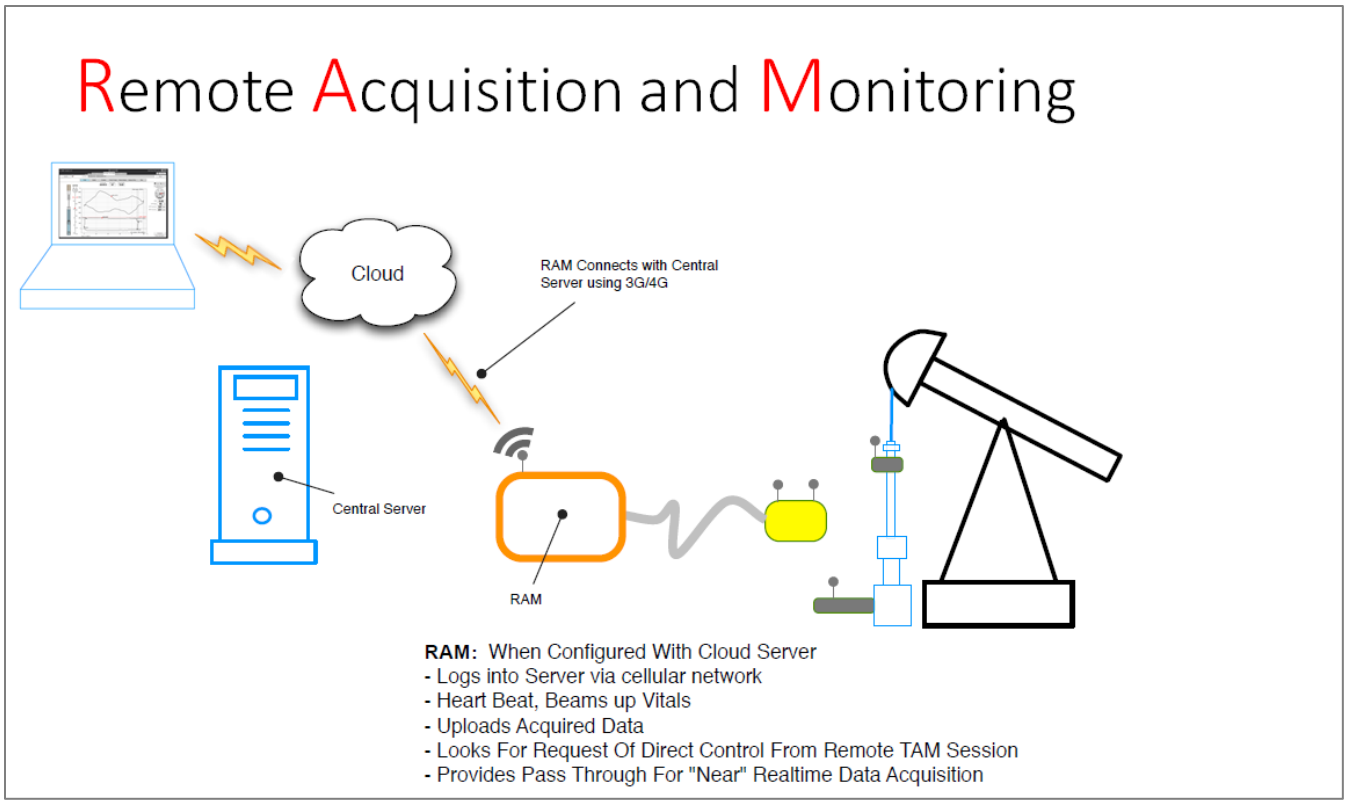
Example of Connection via Cloud from TAM to RAM

An Internet connection and the TAM Program Version 1.8 or later is required.



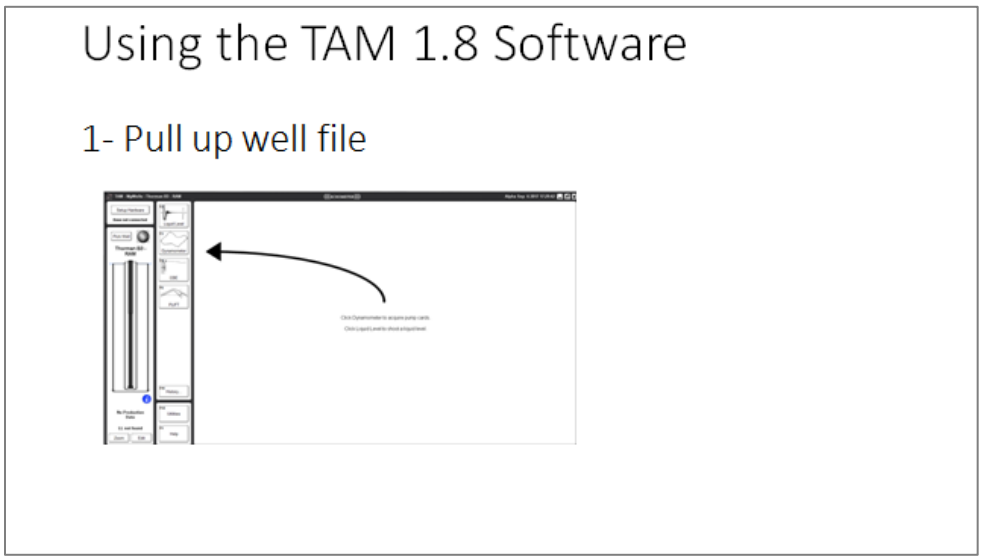
Connecting to RAM Remotely

- The RAM has been installed at the well and is connected to the cloud.
- Wireless Sensors were installed on the well and are active.
- The RAM may have been programmed for standalone acquisition of fluid level, dynamometer and power data according to a schedule.
- The RAM may be dormant or may be online depending on the time of day and the power saving settings.
- The RAM may be executing the schedule and be in data acquisition mode or may be awaiting commands from the user.
- RAM is connected to Cloud via Cellular network.
- User connects to RAM via Cloud.
- User manually acquires fluid level and dynamometer data remotely.
- User sets up fluid level and dynamometer measurement schedules in the RAM.
- Schedules are activated and automatic measurements begin.
- User logs out.
- At a later time, user logs-in retrieves data and/or modifies schedules.
- User logs out.



Since RAM has already been installed at the well the user should load the well file for the same well.

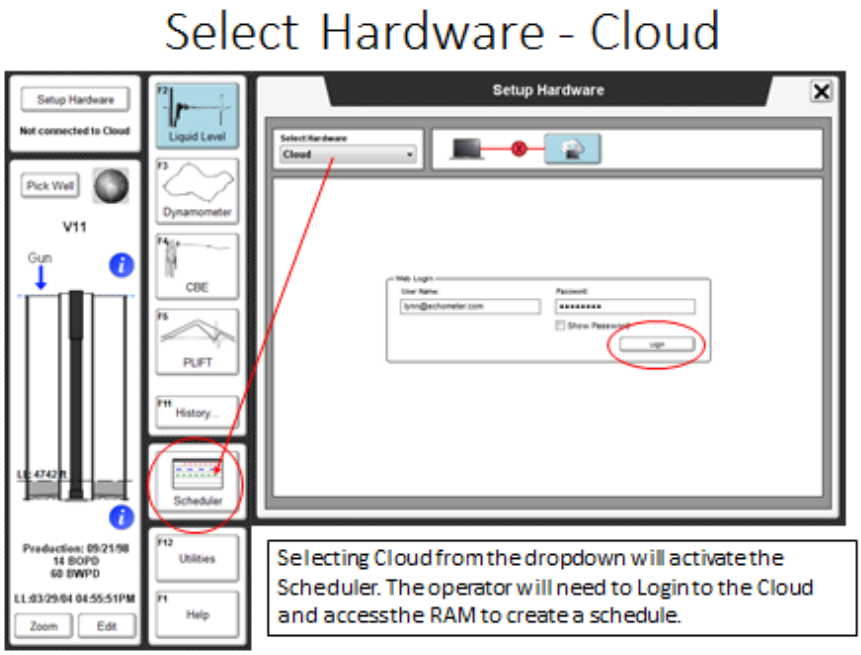
Using TAM Version 1.8 or later, pull up the well file for the well where the RAM is installed.



Upon connection the RAM will verify that the well selected in the laptop corresponds to the well where the RAM has been installed.

If NOT, then the program will alert the user of the mismatch and display a warning message as discussed later in this document.

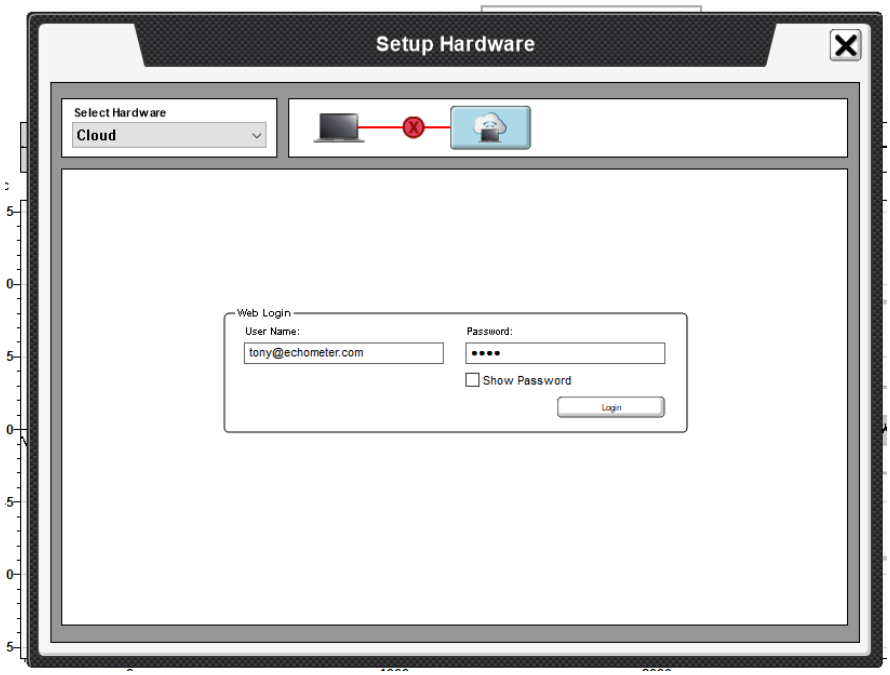
Connect to Cloud



Note: No current connection between TAM and Cloud as indicated by red X on link icon.

1. Establish an internet connection on the laptop with TAM Application installed.

2. Select Cloud from the Select Hardware dropdown box.



The operator will need to Login to the Cloud and access the RAM to create a schedule for unattended acquisition of fluid level and dynamometer records.

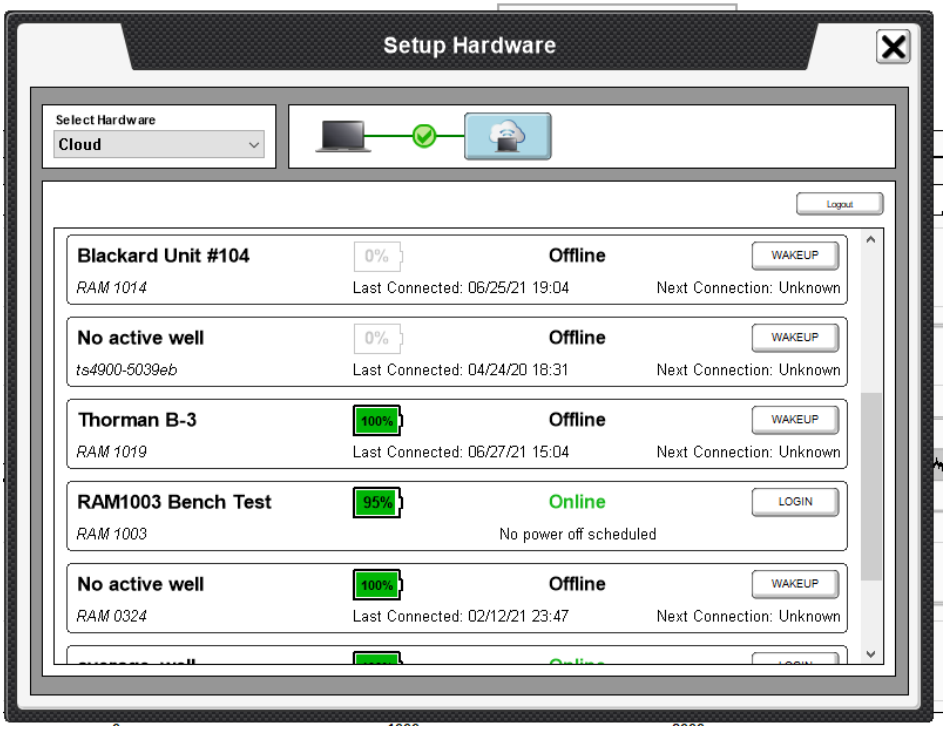
3. Enter User Name and Password and click “Login”

Password

Connection requires entering the user’s access code for security.

Echometer and user can set the password to the RAM via ram.echometer.com. Users will need to have the appropriate credentials to login. Users will only be able to see the RAMs that Echometer has granted them access to.

Logging into the Cloud will connect to the Server/Hub that serves as a secure pass-through to the RAM. Each RAM has an internal computer that listens for the Wakeup command that will come from the Server/Hub. Once the Wakeup command is received, the RAM computer will boot up and connection to the RAM will begin.



Cloud connection is now complete. The Setup Hardware screen shows the users RAMs and their states. If a RAM is currently in Low Power Mode this is indicated by the label “Offline” with an active “Wakeup” button.

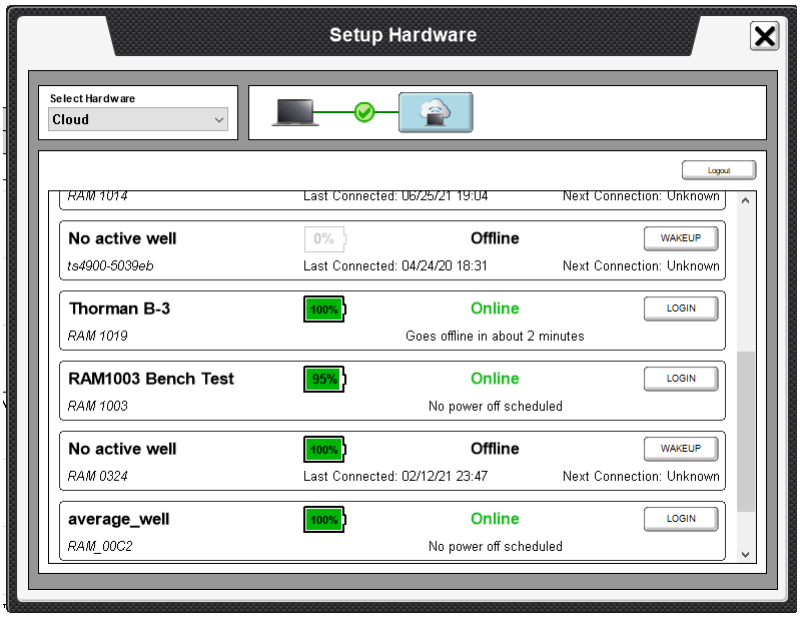
The screen displays only the RAMs that are accessible by the user and are currently active:

1. A list of RAMs the operator has access to is displayed.
2. Each RAM displays an Activity Status and the option to WAKEUP or LOGIN.
    - No Active Well – The RAM is not being used for acquisition.
    - Well Name displayed – The RAM is installed on a well and being used for acquisition.
    - Internal RAM Battery % displayed.
    - Offline – The RAM is not connected to a user and is in Low Power mode.
    - Online – The RAM is active and the user can connect by logging in.

In order to connect and login to the RAM it needs to be in Operational Mode. Selecting the WAKEUP button will request the RAM to transition from Low Power Mode to Operational Mode. If a RAM is currently in Low Power Mode this is indicated by the label “Offline” with an active “Wakeup” button.

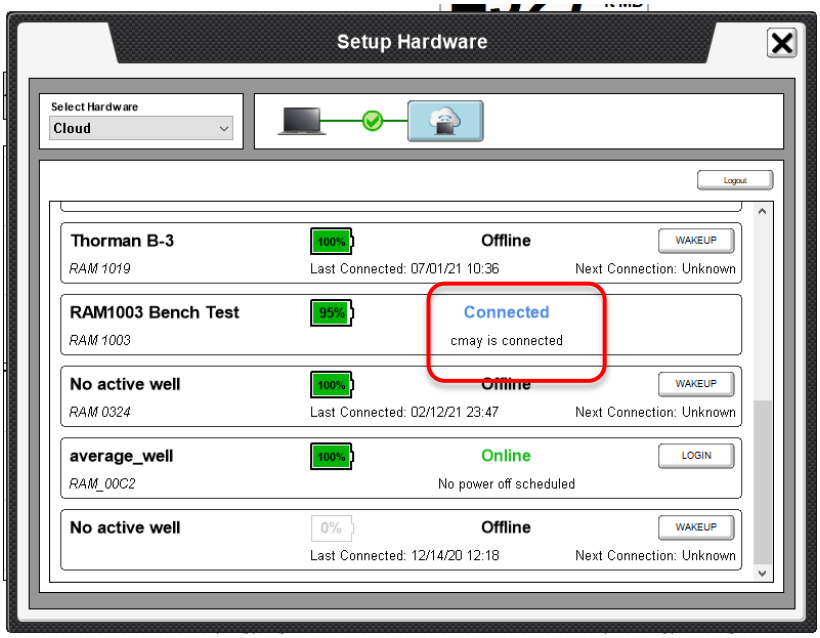
Login to a RAM that is Online

When the specific RAM that the user wants to control is already **Online** then connection can be made by clicking on the “LOGIN” button.



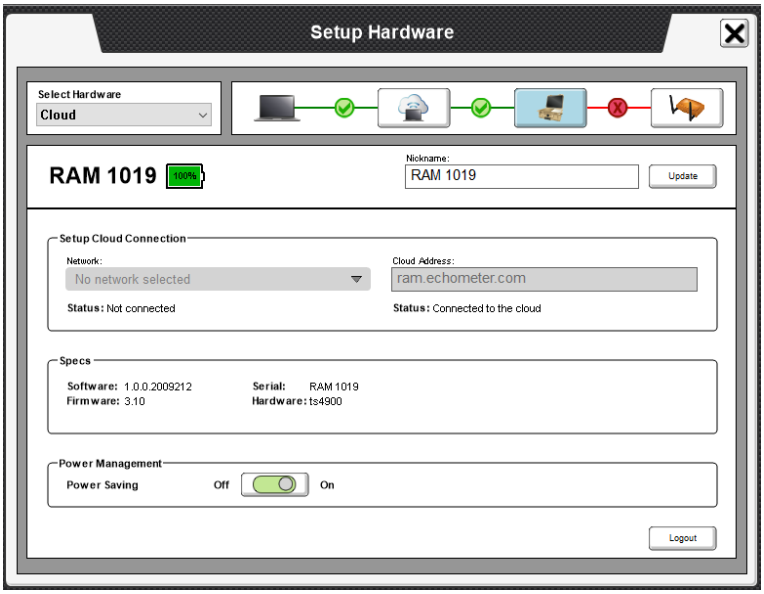
Access to the selected RAM requires clicking on the LOGIN icon and entering the user's access code for security.

NOTE: When using a computer with the TAM program that had been used previously to login to the same RAM the password used previously is remembered and is automatically used to complete the login.

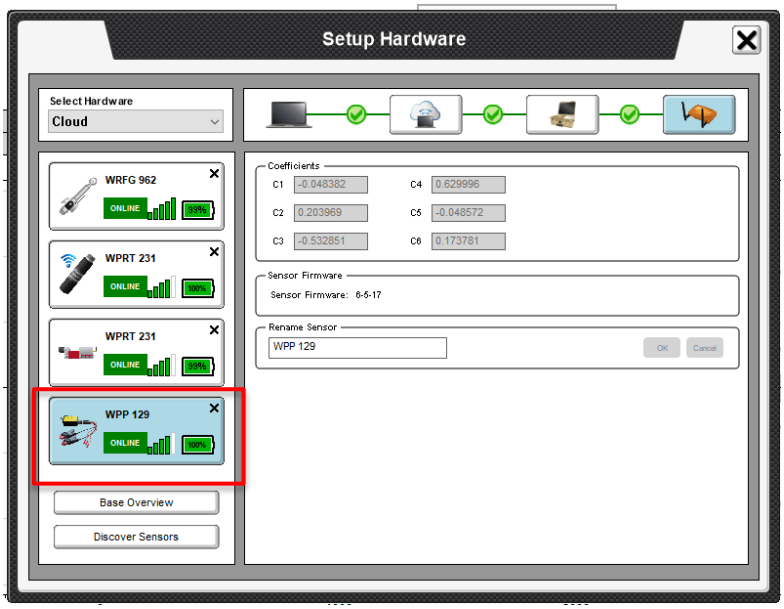


When a user is connected to a RAM the user's computer Name is displayed.

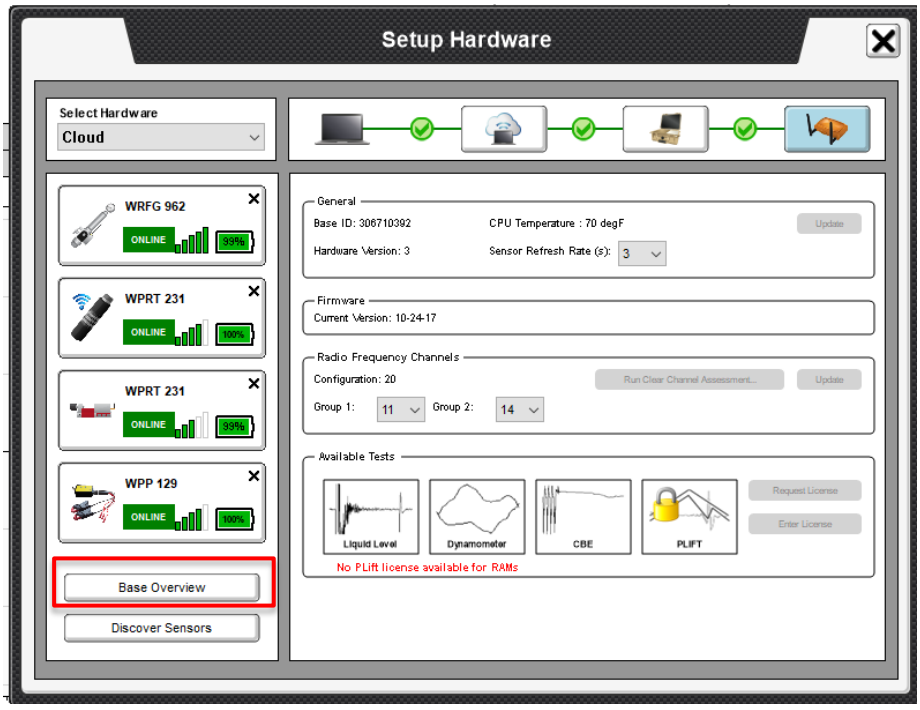
After clicking Login on RAM 1019 the following screen is displayed momentarily until the RAM connects to the Base station. Note that at this point a red X appears between the RAM and the base station. TAM is connected to the RAM via the cloud but a connection with the base station has not yet been established. Most of the time the connection is established almost immediately and this screen may not be displayed.



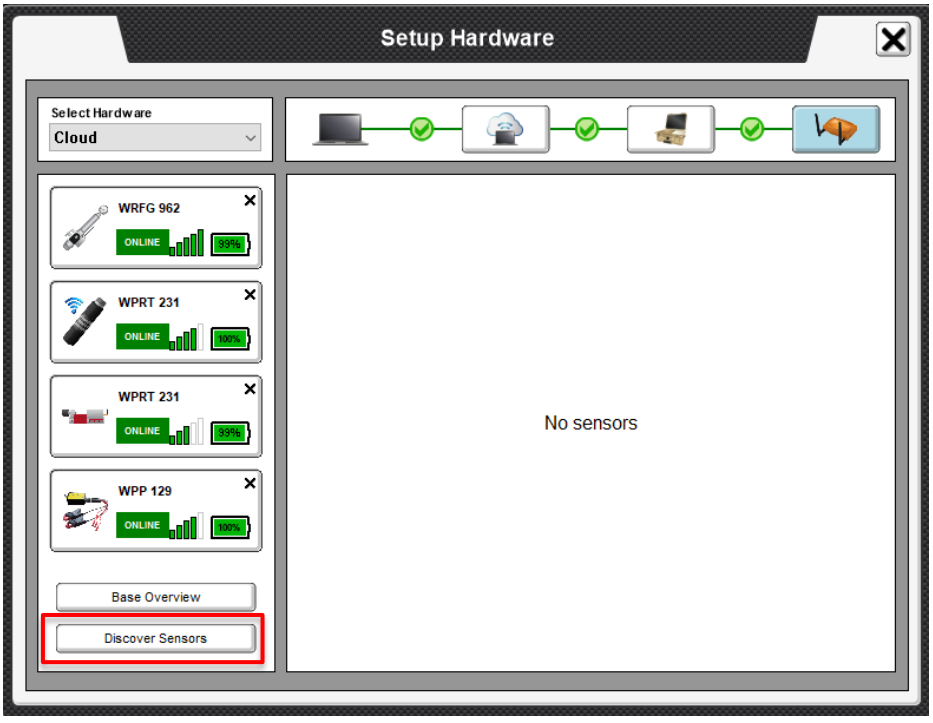
After connecting to the base station all sensors that are currently online are displayed on the left side of the screen as shown below:



The user can click on the button of a specific sensor to display its details in the rightmost pane.



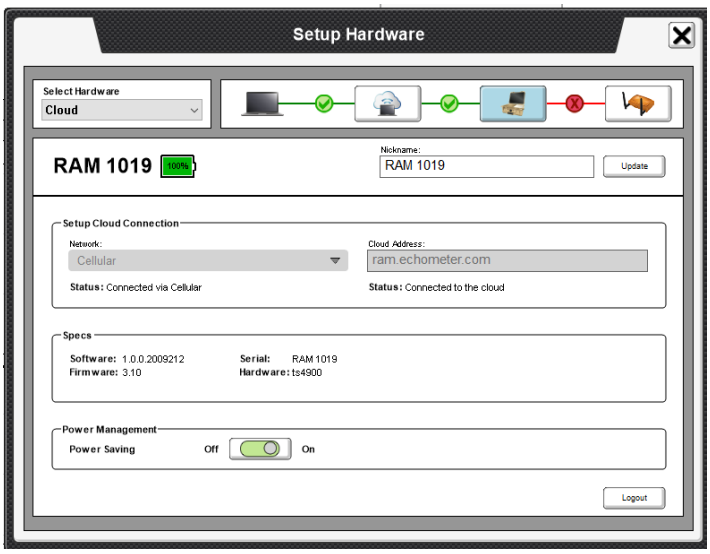
Clicking on “Base Overview” displays information about the Base Station and the firmware.



Clicking on “Discover Sensors” will display other sensors that may be online but are not currently paired with the base station.

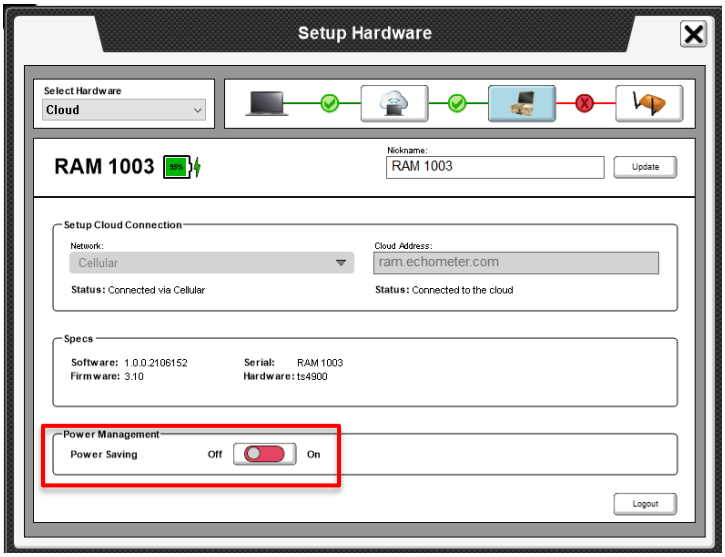
Examples of other RAM Connection Conditions

1) Connected to RAM showing information about cloud connection, firmware date, and power management setting.



Note that the Base Station is not connected. This may be a momentary condition due to delay in communications or it may indicate a problem with connections to wireless sensors.

2) Connection to a RAM that is continuously Online



The Power Saving switch is set to OFF so the RAM will be continuously connected to the cloud.

Login to a RAM that is OFF line

The first step is to send a “WAKEUP” request to the RAM by clicking the corresponding button.

Selecting the WAKEUP button will request RAM 1011 to transition from Low Power Mode to Operational Mode.

The RAM 1011 has received the request to transition from Low Power to Operational mode. This is being reflected by the graphic showing “**Waking Up ….**” Label.

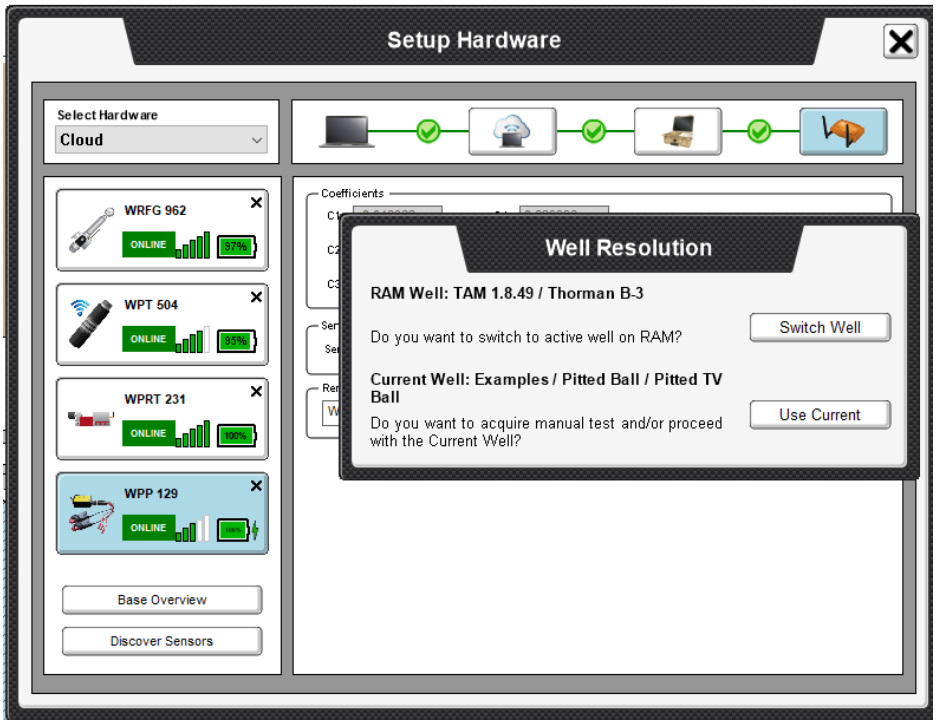
The Waking Up process may last several minutes depending on the speed of communications between the RAM and the Cloud. After some time if connection has not been completed the message “Wakeup Failed” is displayed and the button label changes to “Try Again”. It is a good practice to try multiple times since often the connection may be made on the second try.

When waking up is completed normally, the label will change to “**Online**”.

The RAM is now “Online” This is reflected by the Wakeup Button label changing to “LOGIN”. It is now possible to login the RAM’s services.

Well Conflict Resolution

The well selected by the user in his computer's TAM application should match the well where the RAM is installed. When connection is attempted with a different well file, the user is alerted of the conflict and given the option to use the RAM's well file or use the well file that is currently open on his computer.



Most of the time the user should switch to the RAM's well file.

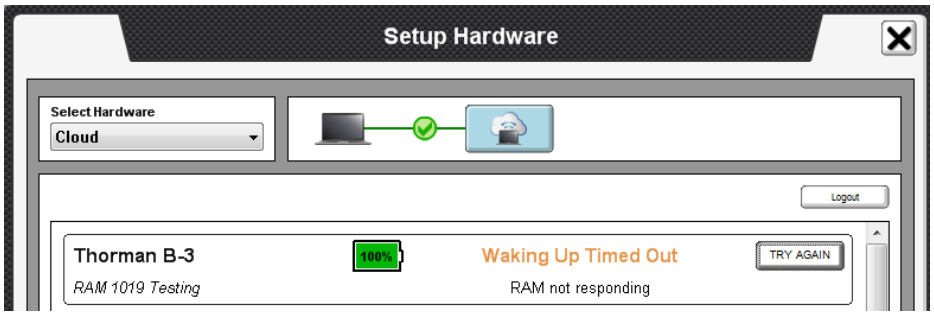
If the RAM's well file is not currently one of the wells that are in the user's TAM laptop, it will be created in a group identical to the group where the original well file was stored in the computer that was used to create the RAM connection and schedule.

In this example the RAM's well file was originally in a group labeled TAM 1.8.49 with a well name of Thorman B-3.

Failure to Wakeup RAM

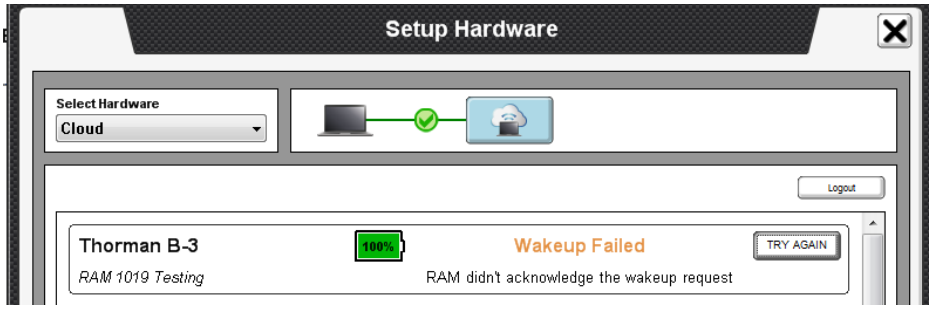
The following messages are displayed when there are problems connecting to the remote RAM via the cloud when the RAM is not On Line.

1) The wakeup call was acknowledged but the RAM took too long to respond and the process timed out.



In this case it is convenient to click the button “Try Again” and generally this results in obtaining the connection and setting the RAM to the “Online” mode.

2) The wakeup request was not acknowledged.

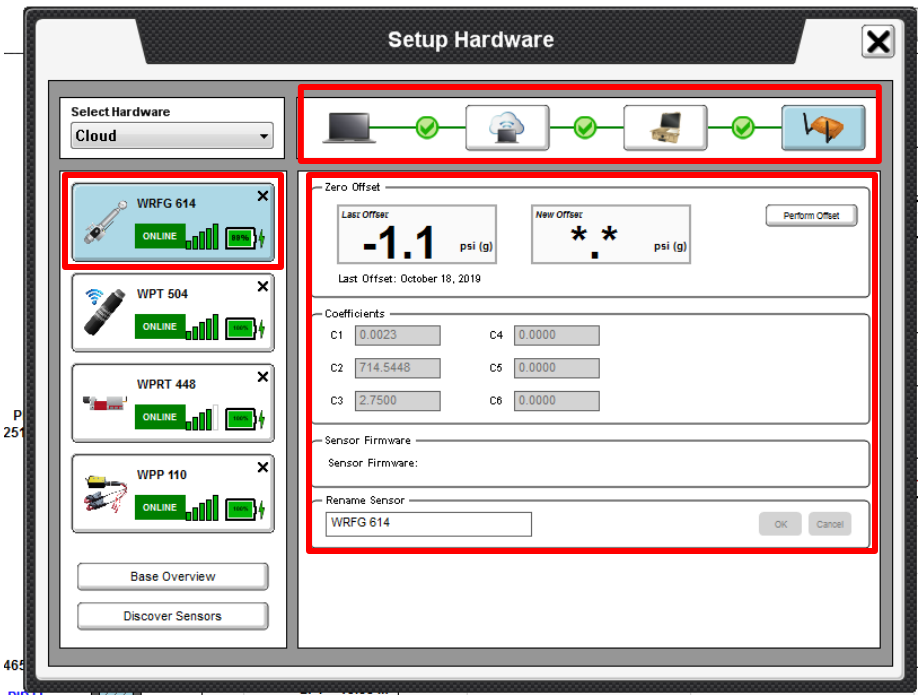


In this case the click on the “Wakeup” button was not received and acknowledged by the RAM.

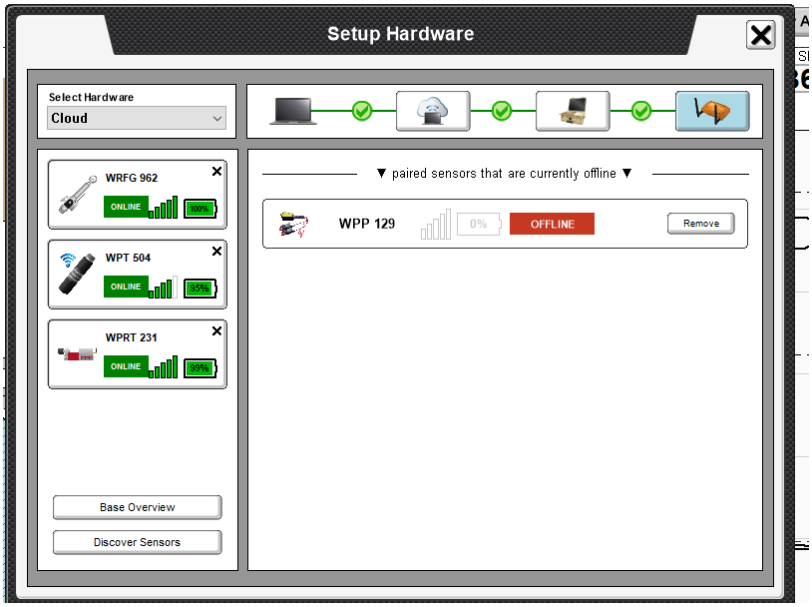
Viewing Sensors that are Active

After a connection with the RAM has been established the next step is to Login to the RAM after entering the required key or password. NOTE: When using a computer with the TAM program that had been used previously to login to the same RAM, the password used previously is remembered and is automatically used to complete the login.

Upon connection to the RAM and Base Station the screen displays all the sensors that are active and communicating with the Base and the RAM.



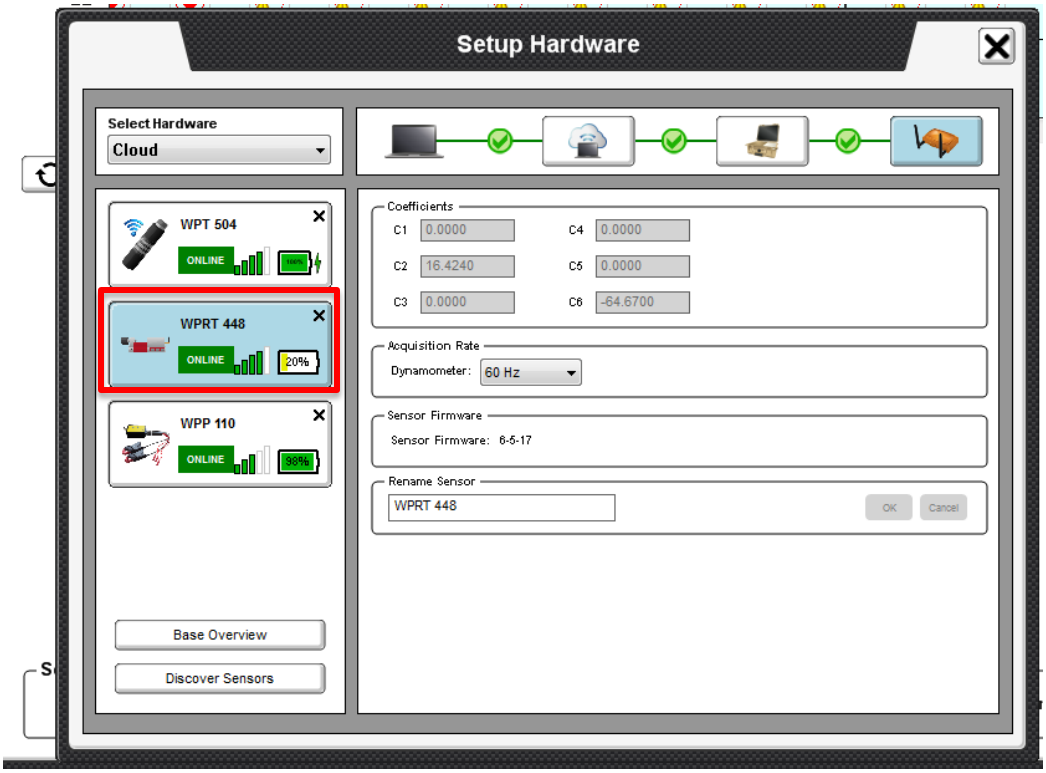
As shown by the icons with green check marks, TAM is now logged into the RAM via the Cloud. It has an active Base Station and the available wireless sensors associated with the Base Station are shown at the left. The wireless gun WRFG 614 is selected and its parameters are displayed on the right panel.



The figure above shows an instance where one of the sensors is offline now due to a drained battery but it had been used earlier with this RAM.

Battery Status

The charge level of all sensors is indicated in each sensor's button:



For the wireless WPRT the screen shows that only 20% battery charge is remaining. However, the sensor is still operating correctly and can be used for manual or scheduled acquisition.

Example of Manual Remote Acquisition of Fluid Level, Dynamometer and Tubing Pressure

Remote manual acquisition of data can be initiated once connection to the RAM has been completed.

The standard TAM acquisition procedure is followed:

1-Select well data and verify the well description is up to date
2-Select test module
3-Start acquisition

The user can either start by acquiring fluid level first or initiate dynamometer acquisition first then proceed to liquid level.

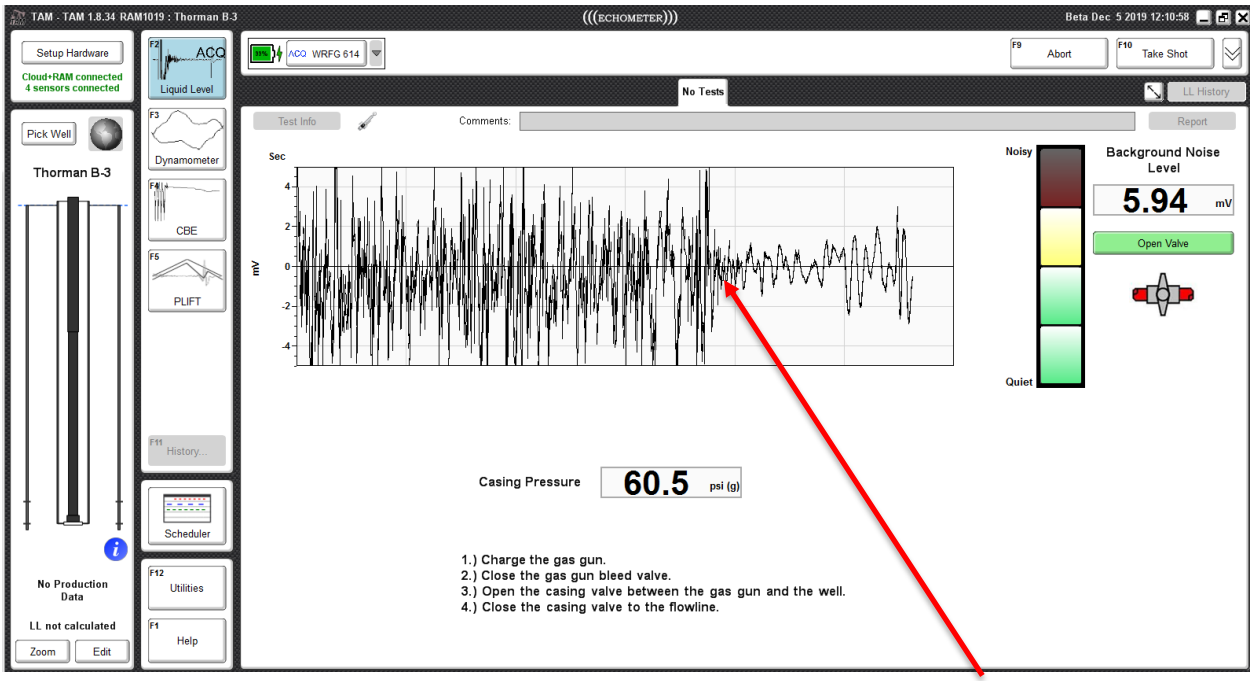
NOTE: the following screens pertain to remote acquisition at a rod-pumped well using a wireless WPRT, a wireless remote fired gas gun WRFG and a wireless pressure sensor WPT connected to the pumping tee.

Step by Step Procedure for Remote Data Acquisition

1. Start TAM Application
2. Select “Setup Hardware” button
3. Cloud Connection
    a. Select the “Cloud” option from the dropdown list
    b. On login screen enter password for the Cloud
    c. List of RAMs user has access to will show
    d. Wakeup RAM that you would like to connect to (this could take up to 3 mins)
    e. Once RAM is online then log into the RAM
    f. Verify Base and sensors come online (this could take up to 1.5 mins)
4. Select Test (Liquid Level or Dynamometer)
5. Verify that a Scheduled Test isn’t in the process of being performed
6. For LL Test using the RAM
    a. Select the LL module for the well
    b. Select wireless gun you would like to use for schedule acquisition
    c. Perform a LL test to verify everything is setup correctly
7. For DYN Test using the RAM
    a. Select the DYN module for the well
    b. Select wireless load cell and optional sensors
    c. Perform a DYN test to verify everything is setup correctly

Perform a Manual Fluid Level Acquisition using RAM

After clicking on the acoustic button and selecting “New Test” the acquisition screen is displayed. After closing the flowline valve, by clicking on the “Close Valve” button, the user should monitor the background noise level and notice the decrease in amplitude that gives an indication of the actual closing of the valve. Note: In wells with little or no flow of annular gas the change may not be noticeable.

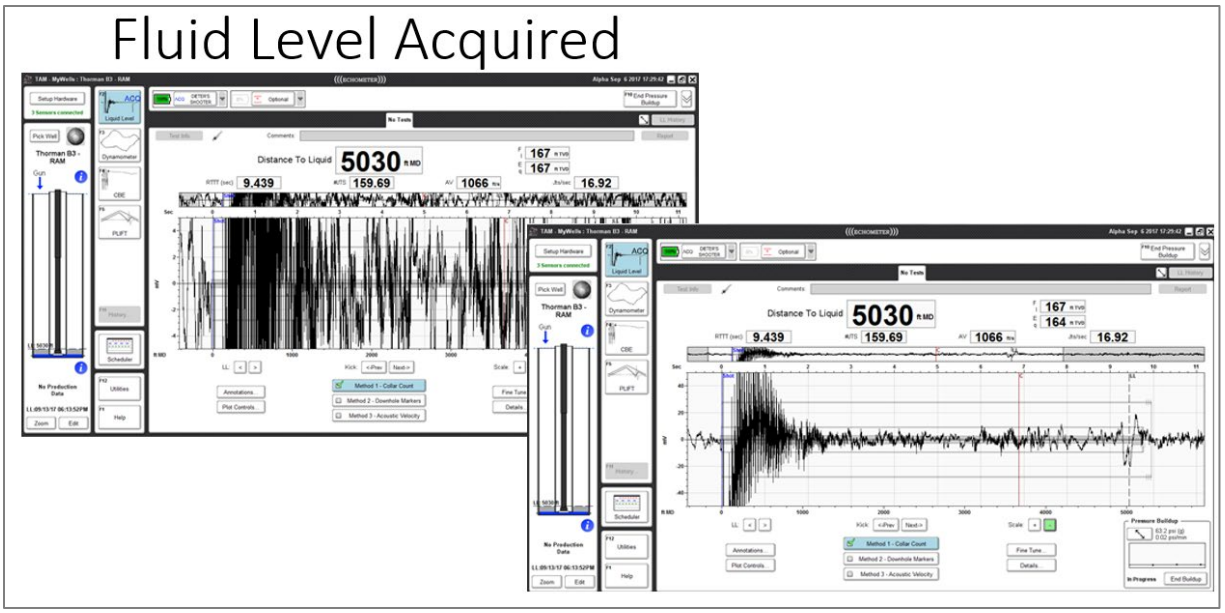


Background noise is displayed in conjunction with casing pressure. Casing valve is closed.

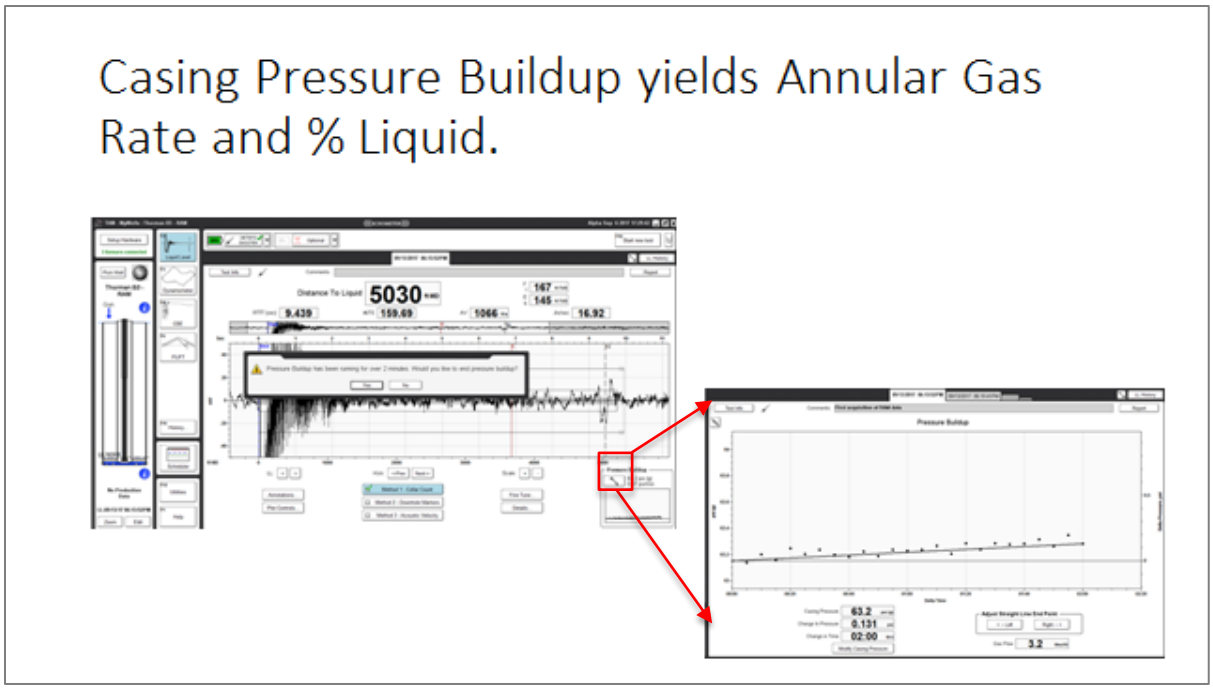
Monitor pressure and Well noise then start a new fluid level test by firing a pressure pulse by clicking the “Take Shot” button.

NOTE: Once acquisition of the fluid level record and the pressure buildup test is completed the casing valve is automatically opened.

Upon expiration of the preset acquisition time (generally dependent on the well depth) the acoustic signal and fluid level analysis are displayed.



The vertical scale of the graph may require adjustment depending on the noise level and magnitude of the fired pulse. In this example the vertical scale range has been increased by clicking on the (-) button) to clearly visualize the echoes of interest.

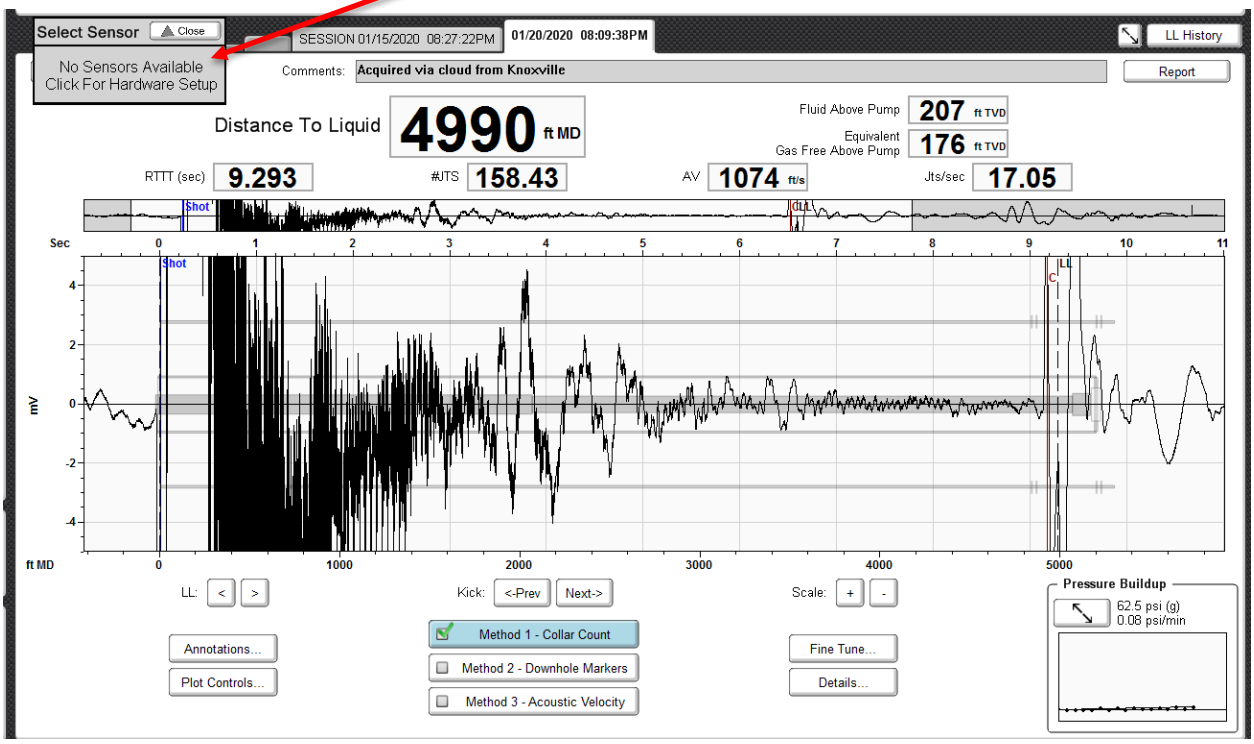


Wellbore pressure is monitored as a function of time to compute the rate of gas flow within the wellbore at the depth of the gas/liquid interface.

Casing pressure is acquired at 5 seconds intervals for a recommended minimum time of two minutes. Casing pressure trend is monitored in detail by expanding pressure vs. time graph using expand button highlighted in the previous figure.

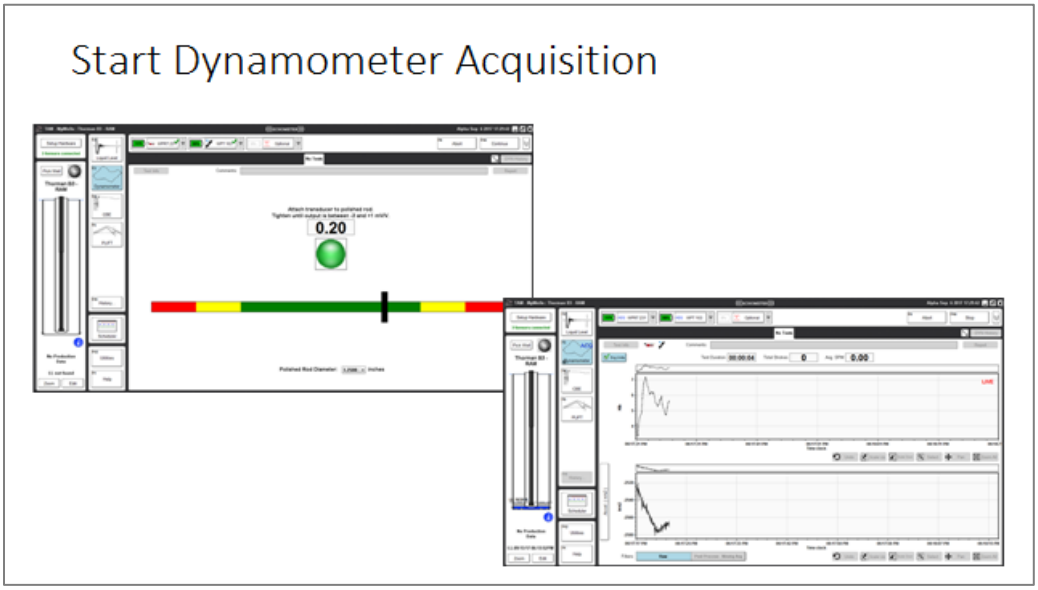
Warning When a Wireless Sensor is not connected

If the user attempts to acquire a fluid level record and the WRFG is not online, the following message is displayed in the acoustic tab:



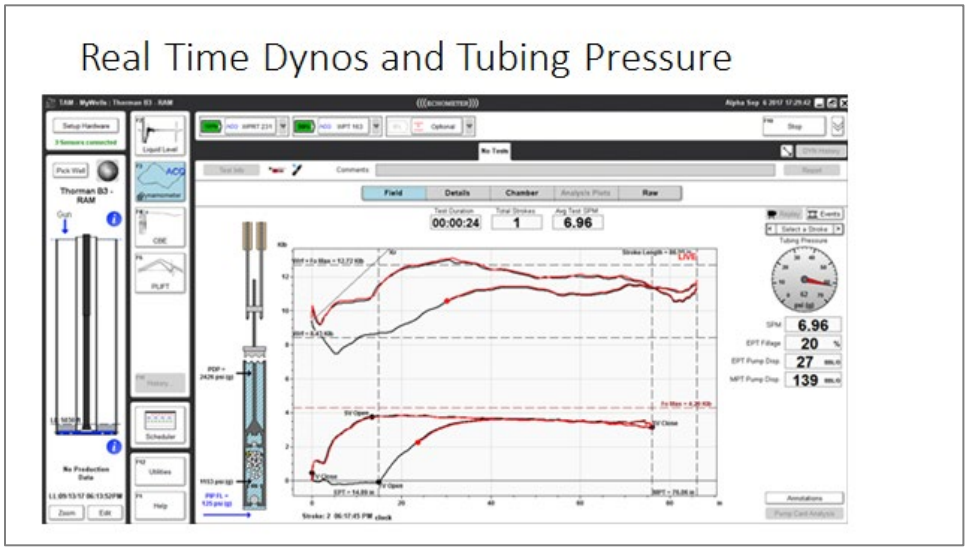
Perform Manual Dynamometer Test using RAM

After clicking on the Dynamometer button and selecting “New Test” the acquisition screen is displayed.



Since the WPRT is already installed on the polished rod this screen is used only to verify that data is being transmitted and is within proper range.

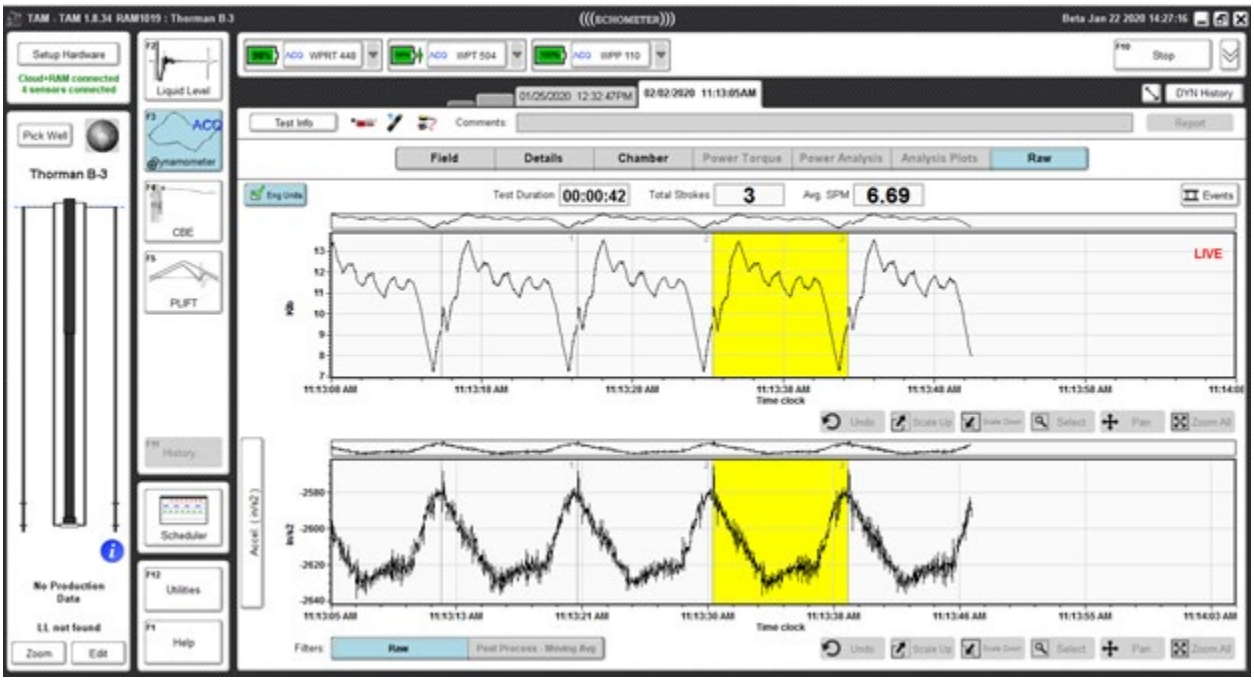
Clicking “Continue” starts recording of dynamometer data, displayed as load and acceleration vs. time for the first few strokes and then for subsequent strokes the record is displayed as dynamometer cards in real time.



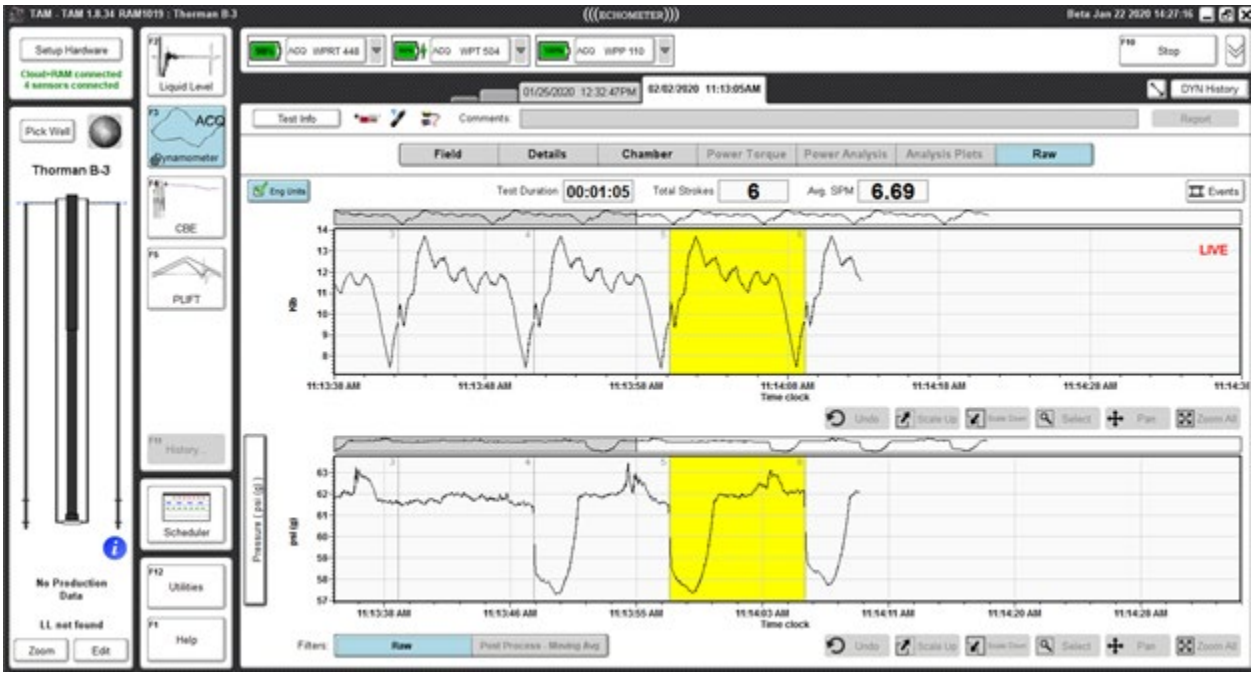
NOTE: The smoothness of the real-time tracing of the dynamometer display depends greatly on the speed of the internet connection and the traffic being handled by the cloud.

Display of Raw Data

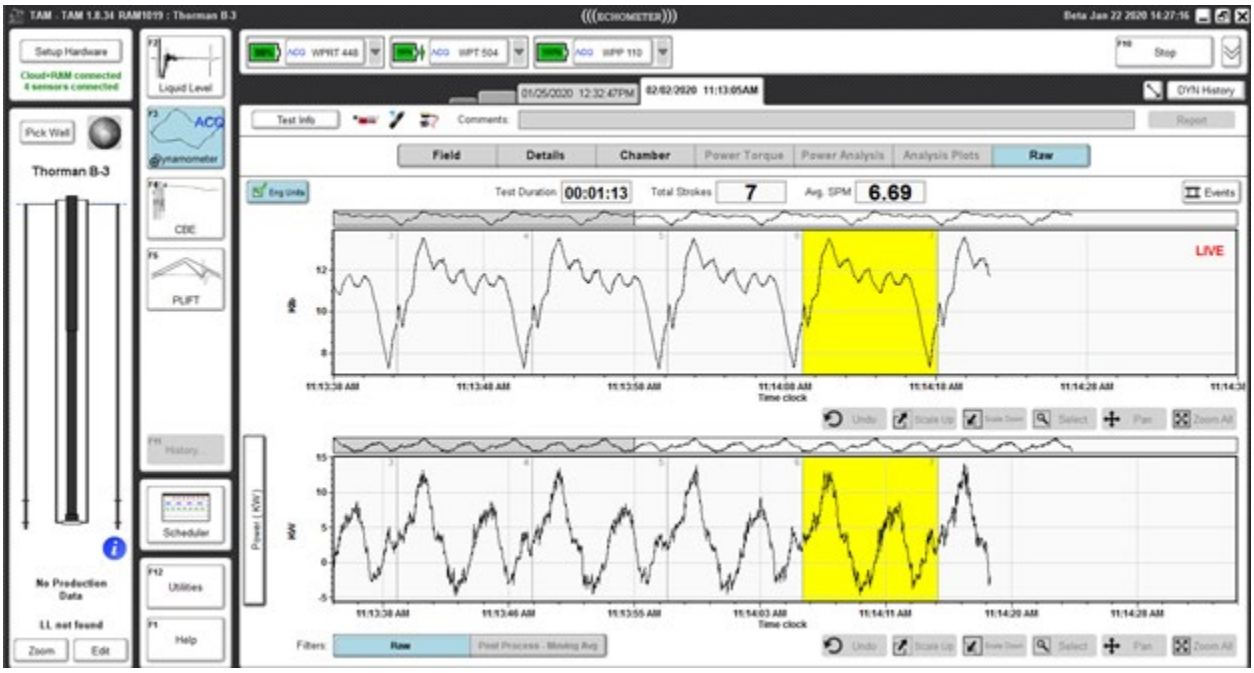
During remote dynamometer acquisition the raw data display is active and the user can select which variables are monitored in addition to the polished rod load vs. time as shown in the following figures:



Default polished rod load and acceleration. NOTE the LIVE label in the load display.



Polished rod load and pumping tee pressure.

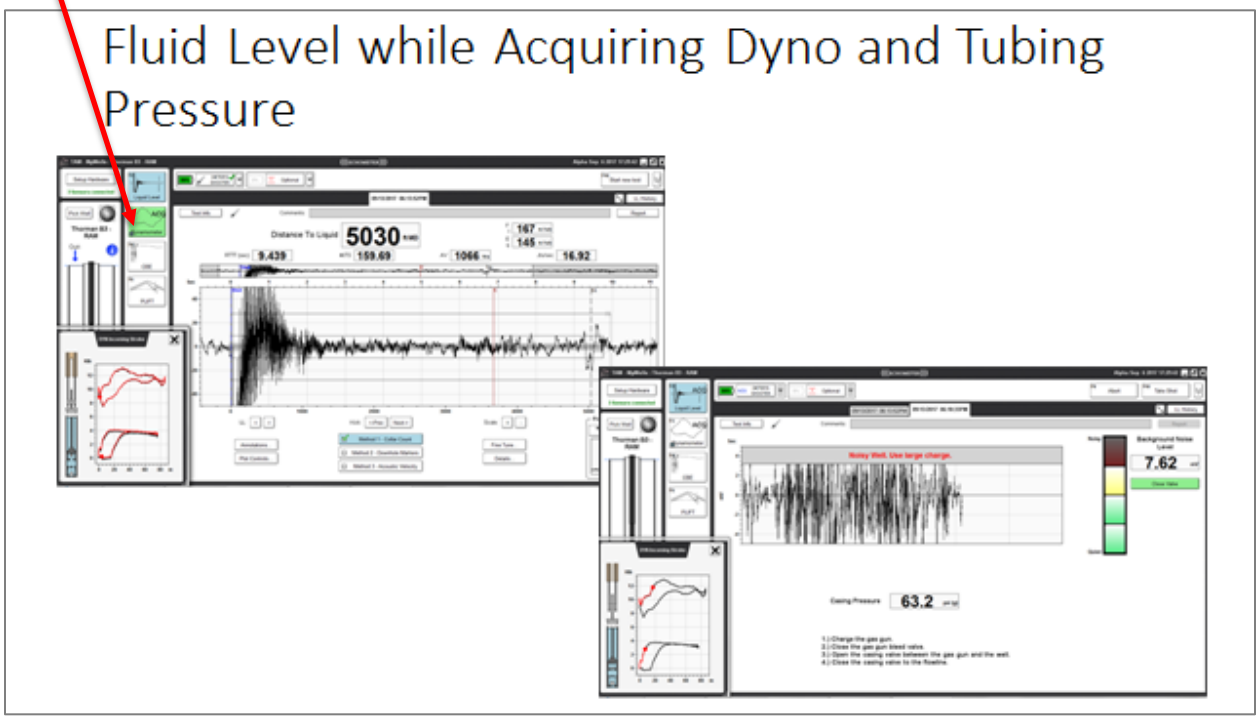


Polished rod load and motor power.

Polished rod load and motor voltage.

Simultaneous Fluid Level and Dynamometer

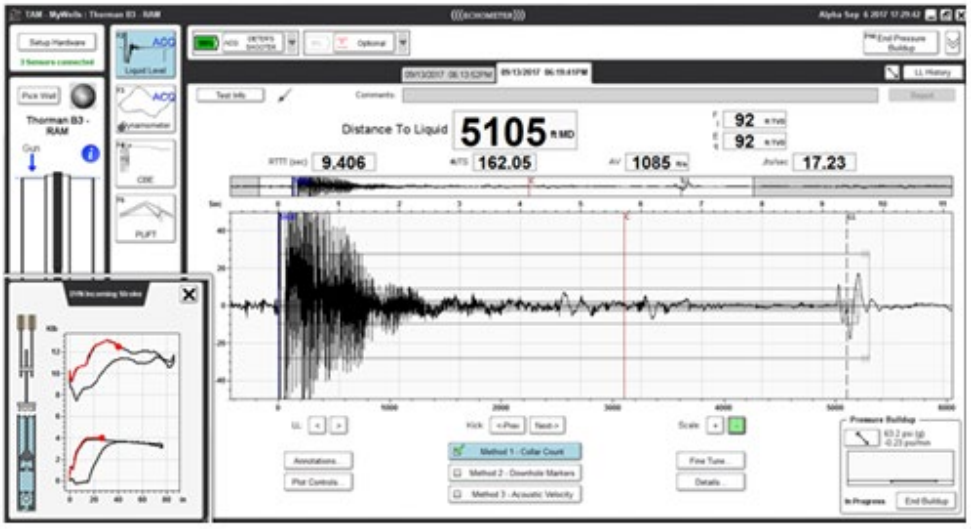
Concurrent acquisition of dynamometer and fluid level is implemented by opening the inset dyno display at the bottom left of the screen. This display is obtained by clicking on the (+) icon at the bottom left of the Dynamometer button.



The user then can undertake a fluid level acquisition while dynamometer data continues to be recorded.

All analysis tools provided by TAM are active during remote acquisition via Cloud and RAM system as shown in the following figures.

Fluid Level Acquired and Displayed

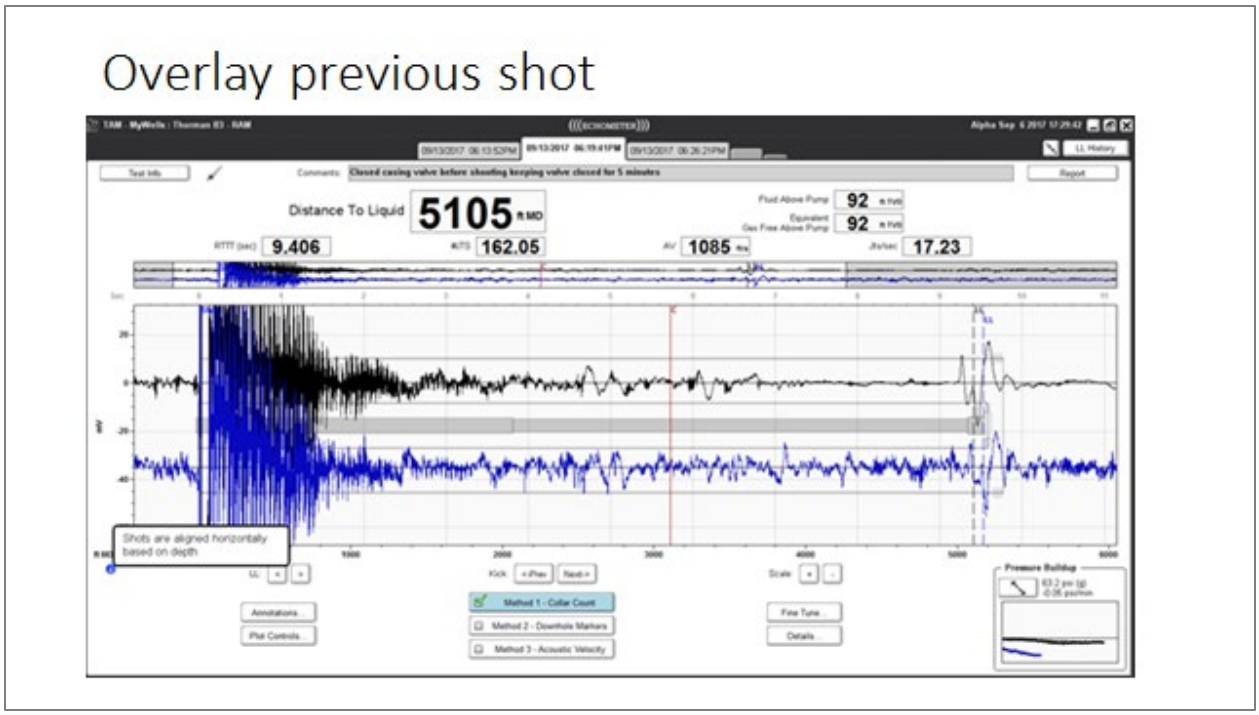


Fluid level analyzed while dynamometer records are being acquired.

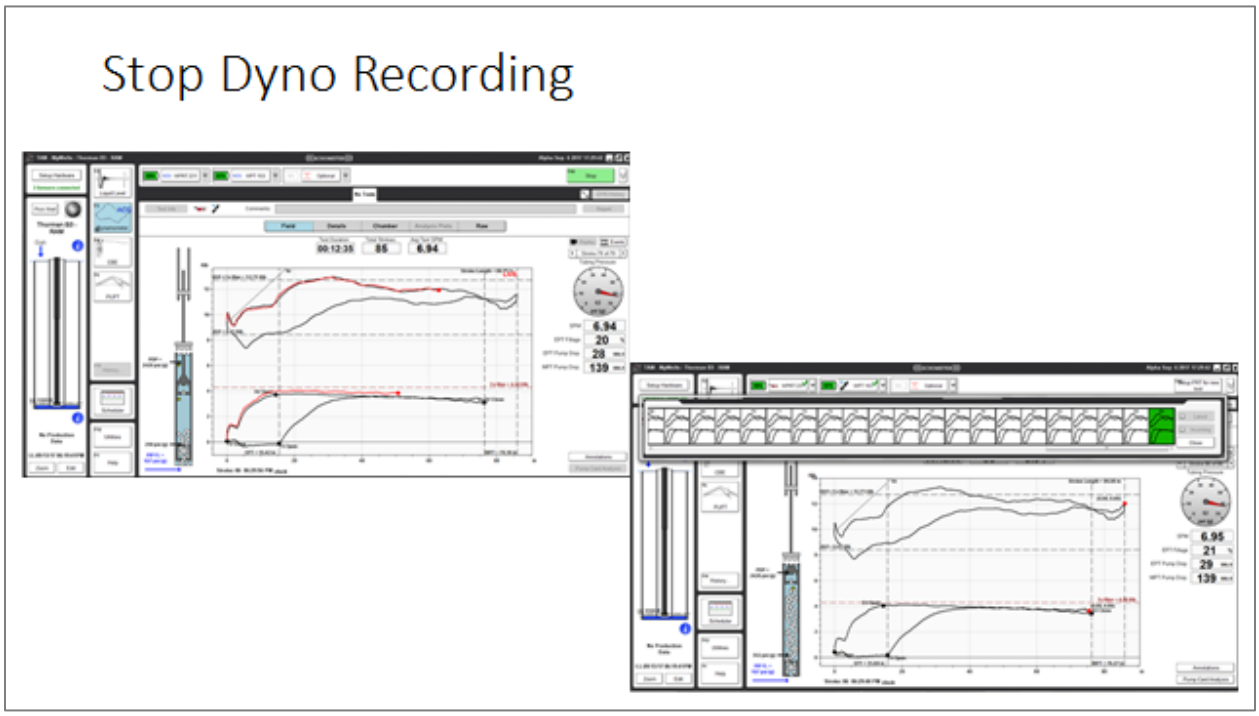
Detail of LL Echo

Using the "Details" button and opening the "Kick Selection" screen the position of the LL marker can be verified or adjusted.

Fine selection of liquid level echo indicated just below up-kick caused by perforated interval.



Overlay of previously acquired fluid level records help verify selection of the liquid level echo.

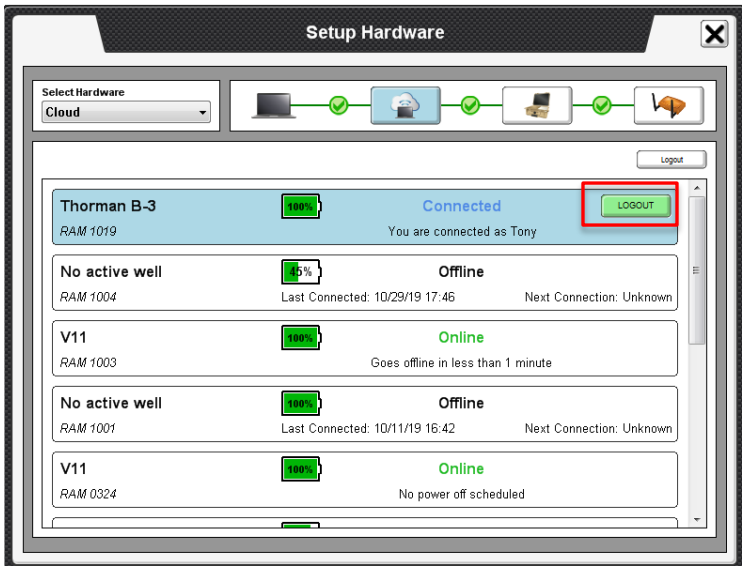


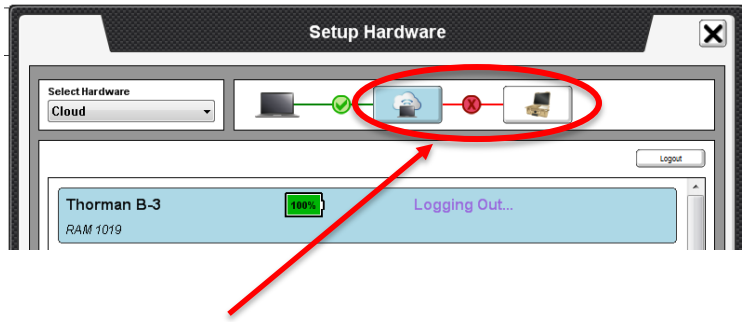
After stopping dynamometer acquisition, all recorded strokes are viewed and/or reprocessed with the usual TAM tools.

Completion of Remote Acquisition Session

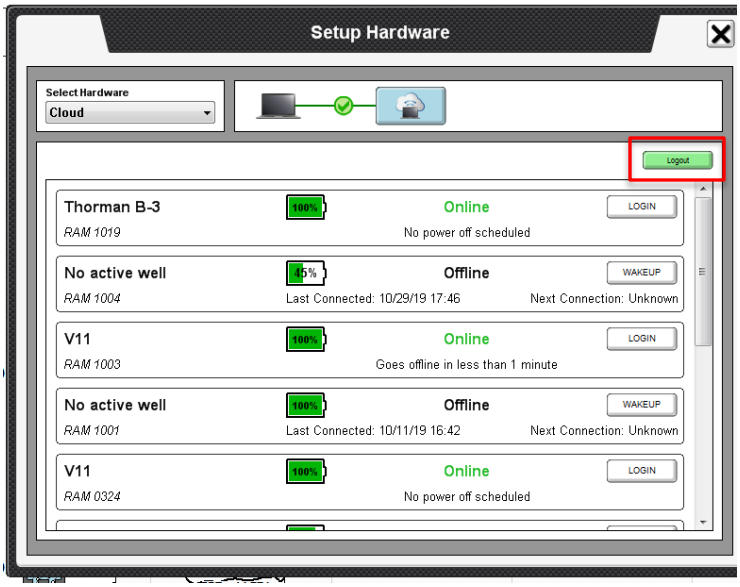
Upon completion of the remote data acquisition session, the connection to the RAM is closed by logging out. This is a two-step procedure:

1) Logout from the RAM by clicking the Logout button.

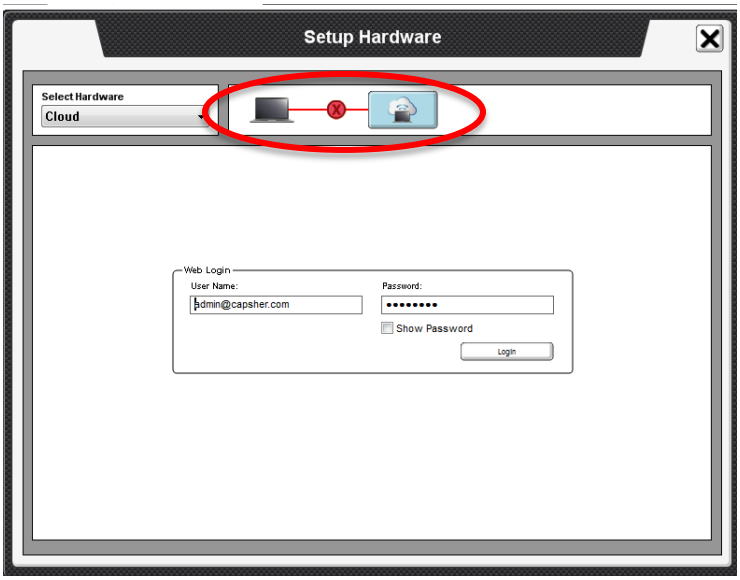




In the Setup Hardware tab, the red X indicates connection with RAM is closed. The user has the option to login in again or if he has the necessary credentials, wakeup or login to other RAMs.

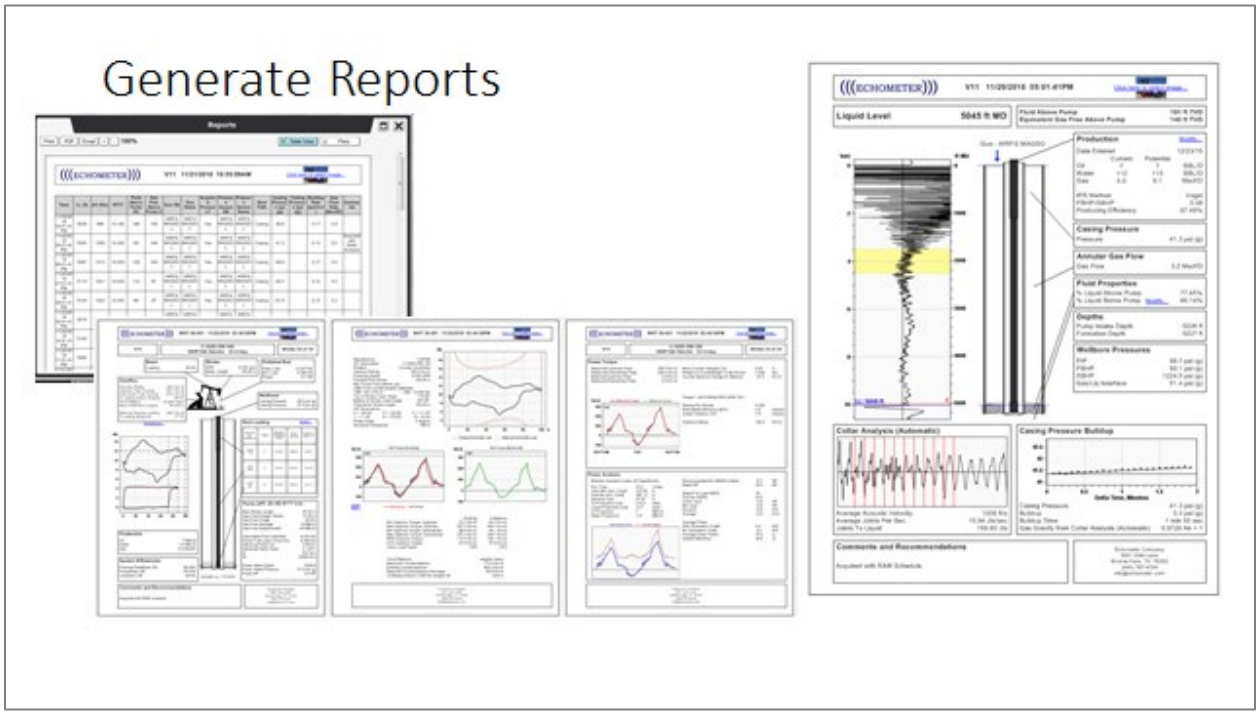


2) Click the Logout button to disconnect from the Cloud. The following screen is displayed in the event the user wants to reconnect to the Cloud server.



Report Generation

All data acquired manually via the cloud is resident in the user's laptop so the user can proceed to analyze the records in detail and generate the corresponding TAM reports.



Alternately, before disconnecting from the RAM, the user can set-up a schedule to continue acquiring data according to a programmed schedule as shown in the following section.

Defining and Starting a Schedule

The RAM can be programmed to acquire records according to a specified time sequence without user intervention.

Objectives:

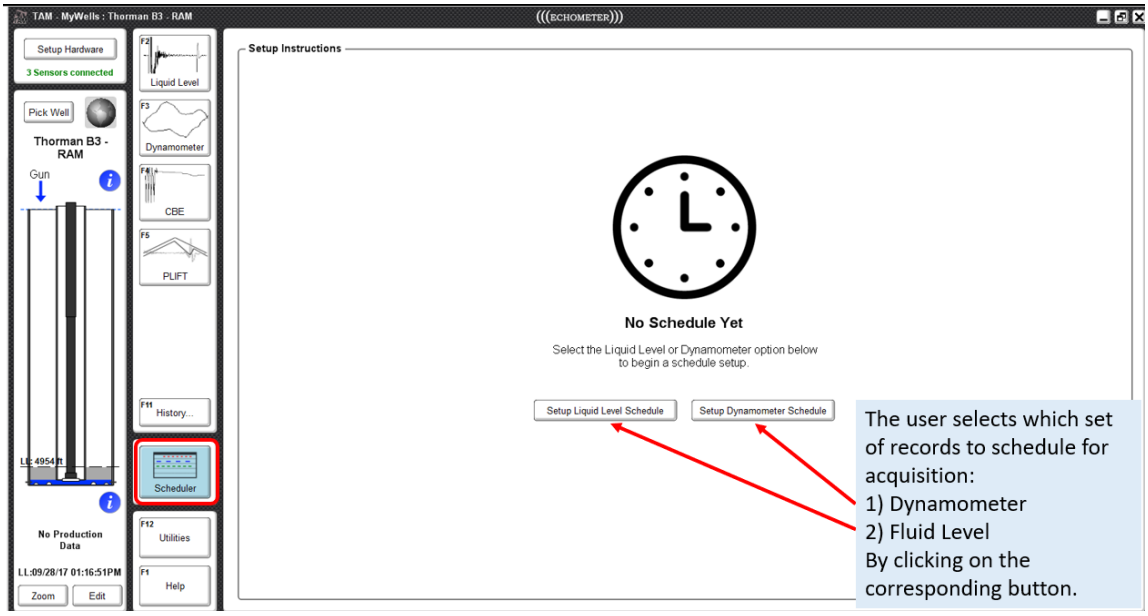
- Unattended data acquisition according to a preset schedule
- Remote monitoring of schedule progress
- Remote updating of acquisition schedule
- Downloading acquired data remotely
- Terminating scheduled acquisition

NOTE: If the Base or the Well Analyzer are selected in Setup Hardware, the Scheduler module will not appear in the Features column of TAM. Selecting either RAM or Cloud in the Setup Hardware menu will activate the Scheduler module.

Recommended Procedure to Setup LL Schedule on RAM

1. Select Schedule Module
2. To setup LL Schedule
    a. Select “Setup Liquid Level Schedule”
    b. Verify Sensors are selected
    c. Enter Parameters of Schedule
        i. Start of Test
            1. Start of Schedule - Once schedule is kicked off the first test will be performed.
            2. On - Lets user set the date and time when the first LL test will be performed.
        ii. End Test
            1. Never - Test will be performed until the user stops the schedule.
            2. After - After a set number of tests are performed no more tests will be scheduled.
            3. On - Lets user set the date and time when the last LL test will be performed.
        iii. Acquisition Length
            1. ACU - User defines how long to acquire acoustic data.
            2. PRESS - User defines how long to acquire pressure data.
        iv. Motor Valve Controls
            1. Shut for Acquisition - If selected, a signal is sent to MCU to shut motor valve.
            2. The time area allows the user to define the number of secs to shut the valve before acquisition starts.
        v. Repeat
            1. Defines how often test should be performed.
    d. After Parameters have been set then select “Add to Schedule”

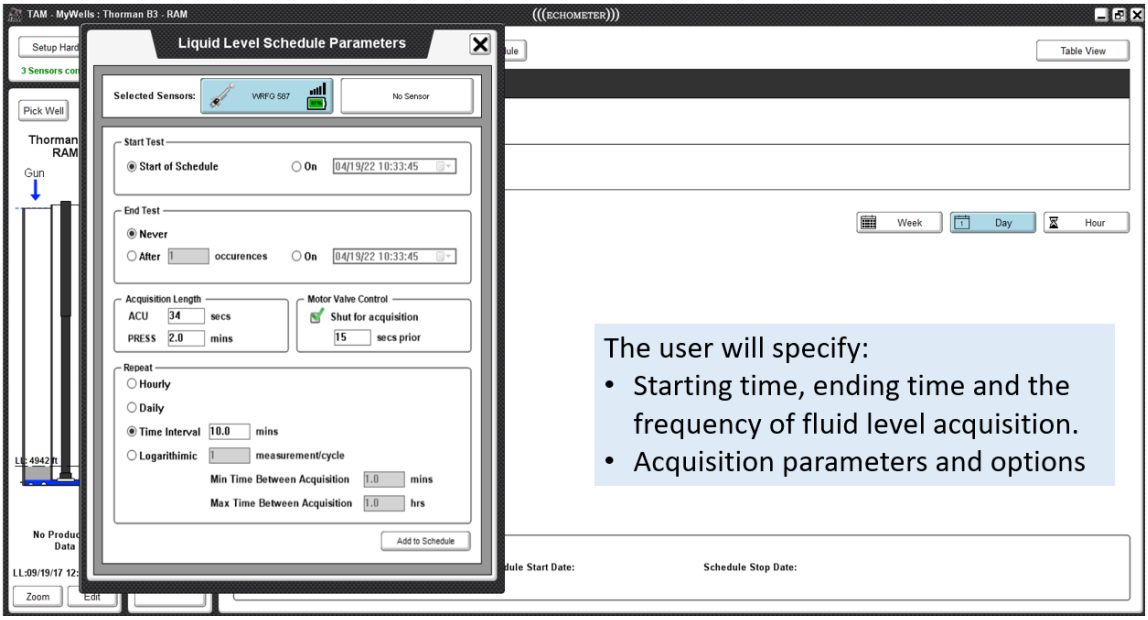
Open the ‘Schedule” function by clicking on the mode button to display this screen that allows setting up the scheduling for liquid level and dynamometer acquisition.

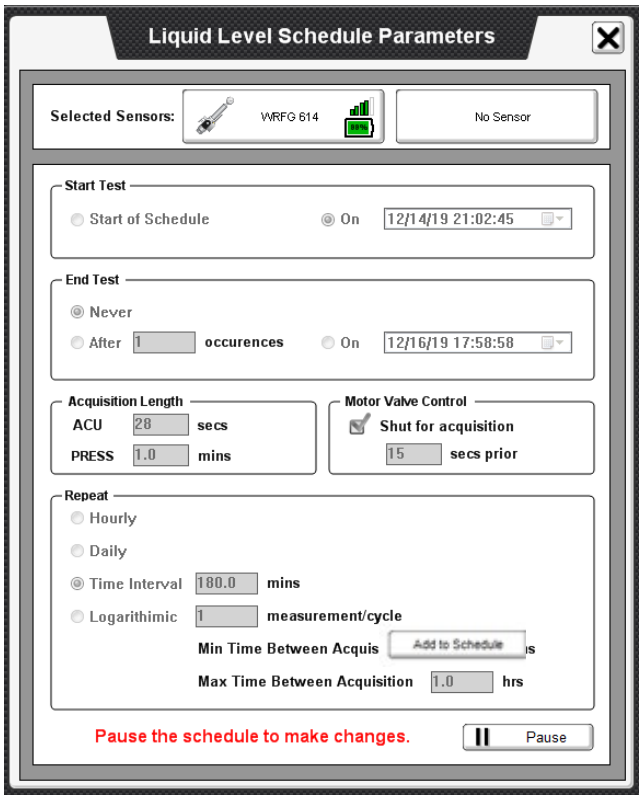


The user then selects which set of records to schedule for acquisition by clicking on the corresponding button: 1) Setup Liquid Level Schedule 2) Setup Dynamometer Schedule

<u>Specifying LL Schedule Parameters</u>

- Starting time and ending time and the frequency of fluid level acquisition.
- Acquisition parameters and options





Start of schedule execution

End of of schedule execution

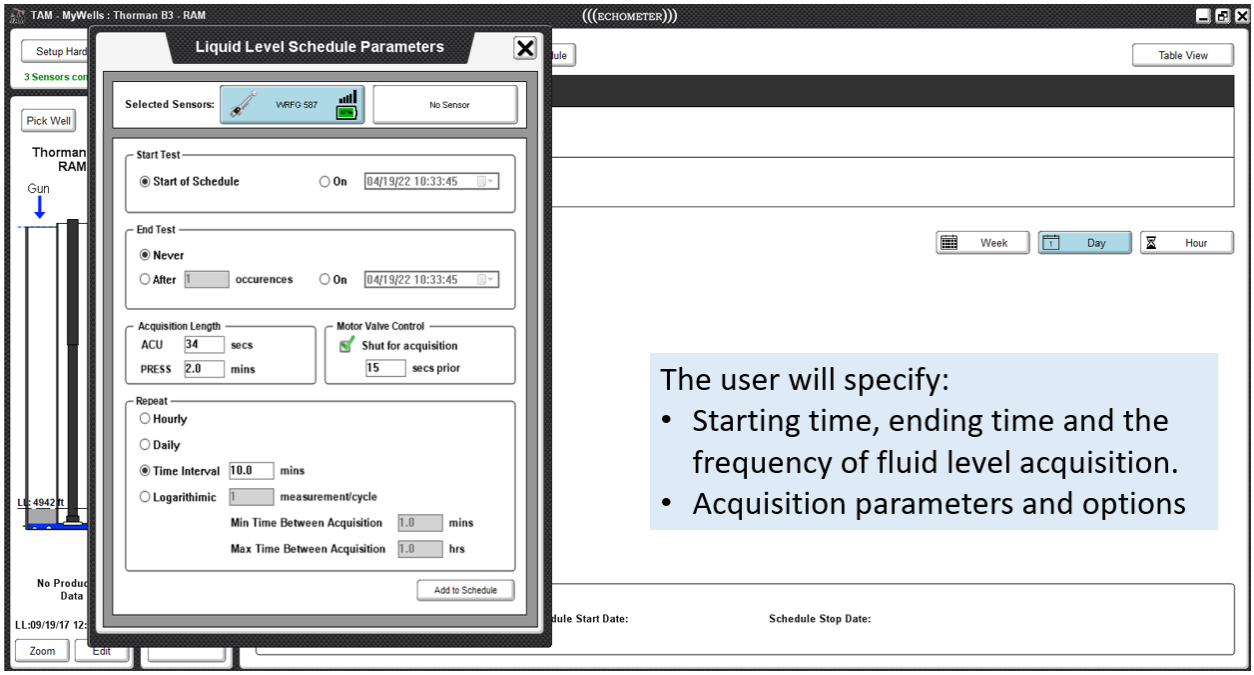
Control Acoustic Record Acquisition

Set Frequency of Fluid Level Shots

After test parameters have been defined, click “Add to Schedule” from the Scheduler View.

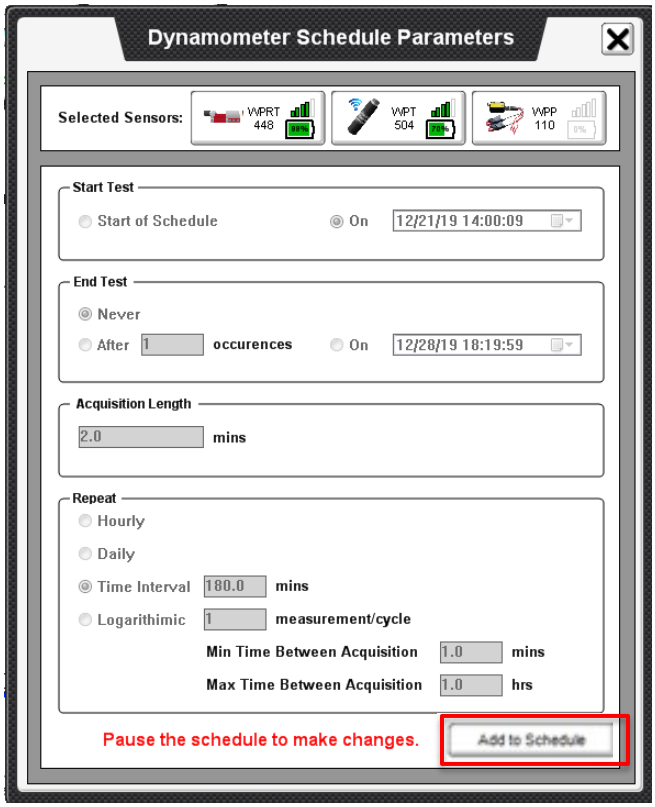
Recommended Procedure to Setup DYN Schedule on RAM

1. Select “Setup Dynamometer Schedule” or “View Dynamometer Schedule”
2. Verify Sensor are selected
3. Enter Parameters of Schedule
    a. Start of Test
        i. Start of Schedule - Once schedule is kicked off then first test will be performed.
        ii. On - Let user set the date and time when the first DYN test will be performed.
    b. End Test
        i. Never - Test will be performed until the user stops the schedule.
        ii. After - After so n test are performed then no more test will be performed.
        iii. On - Let user set the date and time when the last DYN test will be performed.
    c. Acquisition Length
        i. User defines how long to acquire a dynamometer test.
    d. Repeat
        i. Defines how often test should be performed.
    e. After Parameters have been set, click “Add to Schedule”.



Specifying DYN Schedule Parameters

- Starting time and ending time of dynamometer acquisition.
- Duration of dynamometer record.
- Select Sensors.



Start of schedule execution

End of schedule execution

Set Duration of Dynamometer Record Acquisition

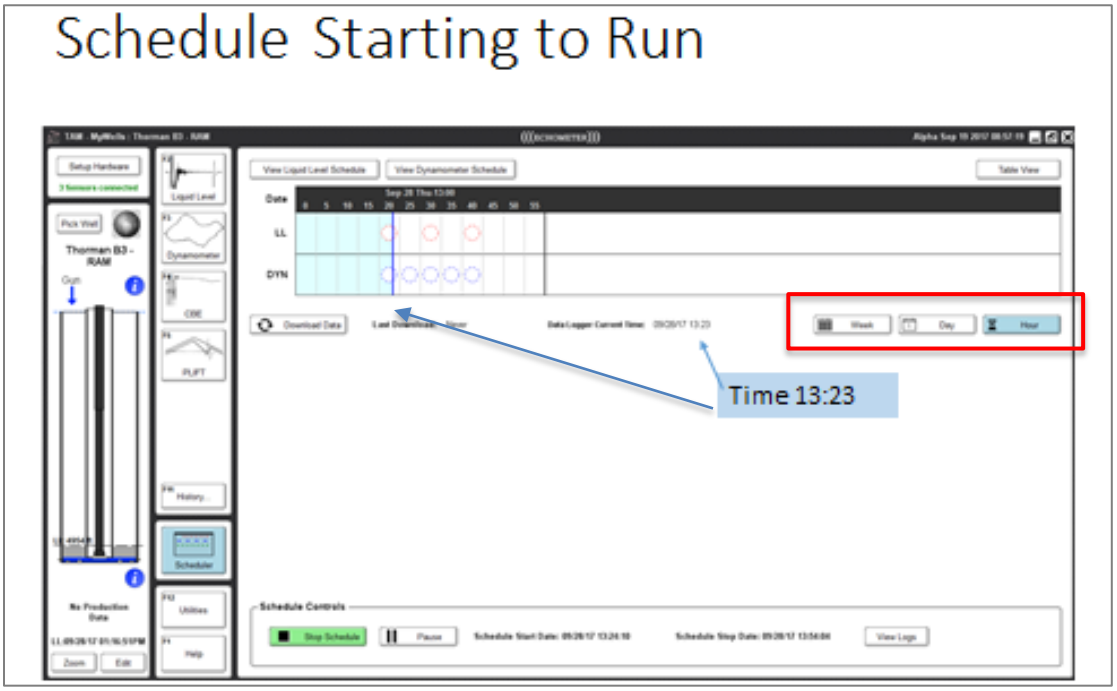
Set Frequency of Dynamometer Acquisition

After test parameters have been defined, click “Add to Schedule”.

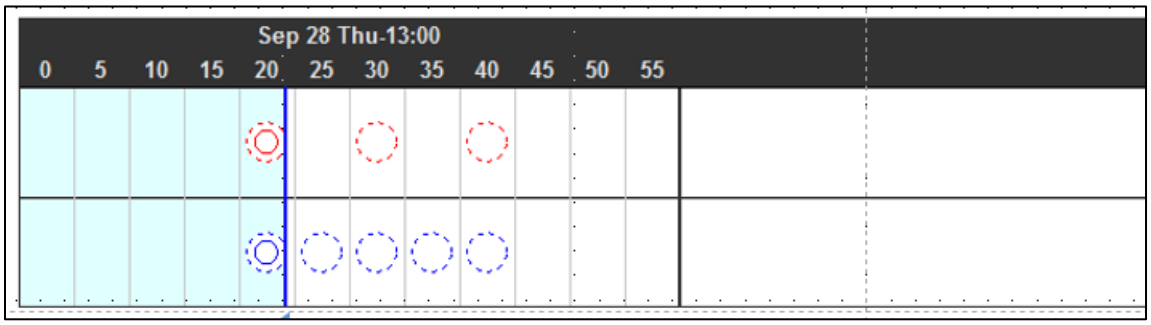
Example of Scheduled Acquisition

The following figures illustrate the sequence of screens that correspond to the progress of the execution of the schedule that was previously setup.

By default, the schedule is displayed as a time-line graph with selectable time periods of hours, days or weeks. The display is in real time which is shown on the screen as the current time of the RAM clock. The vertical blue bar is located at the current time of 13:23 corresponding to the hourly time scale displayed at the top of the strip.

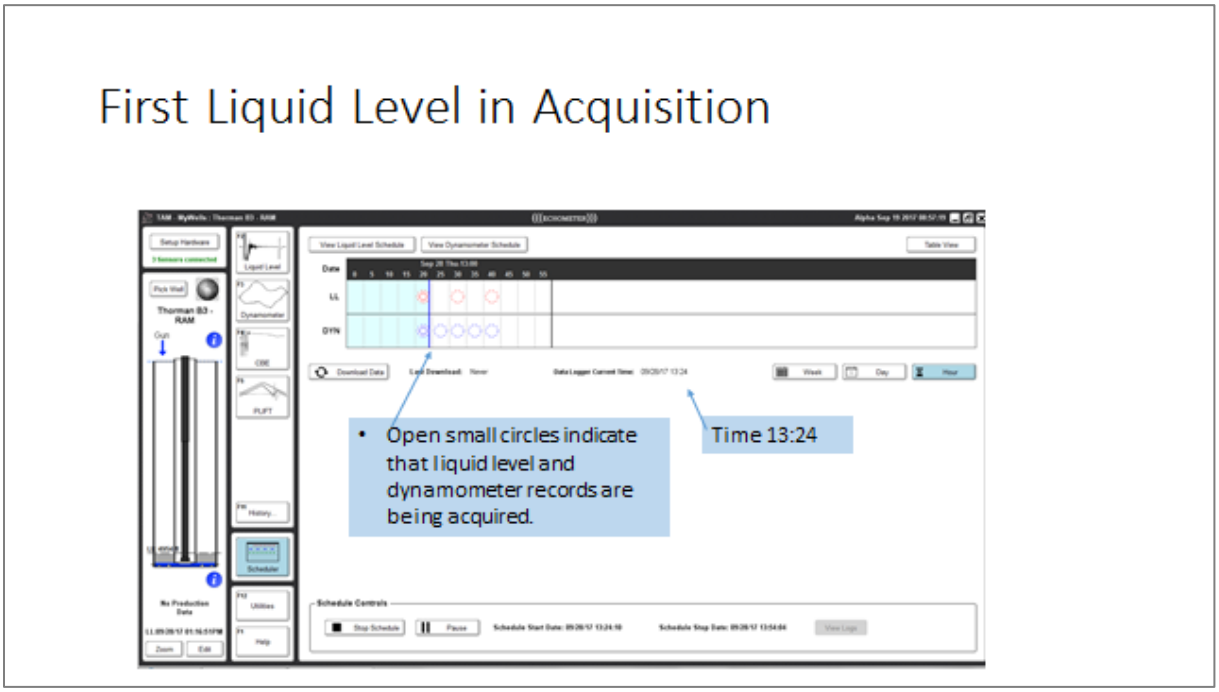


In the following figure, the timeline is shown in more detail to display graphically the current status of the schedule on Thursday September 28 at the 13:00 hour interval divided in 5 minute slots.

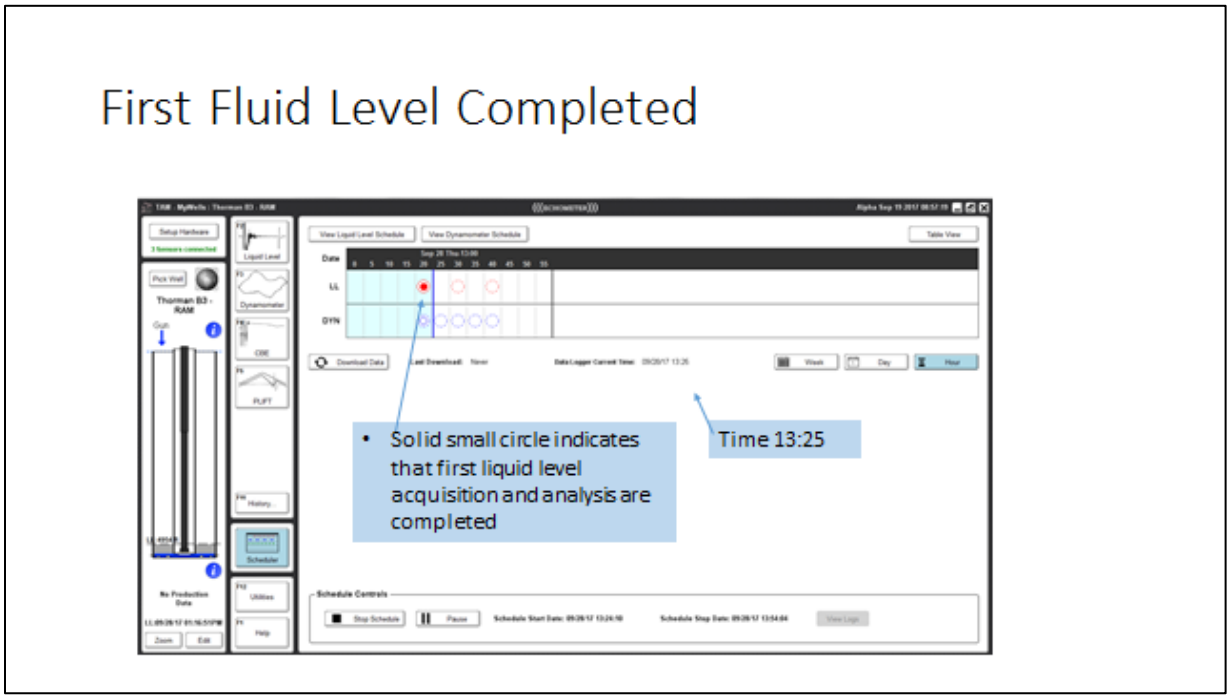


Large circles with dashed perimeter indicate scheduled acquisitions to be performed at the indicated time slots.

Open small circles, inside the large circles, indicate that liquid level and dynamometer records are in the process of being acquired but acquisition has not been completed.

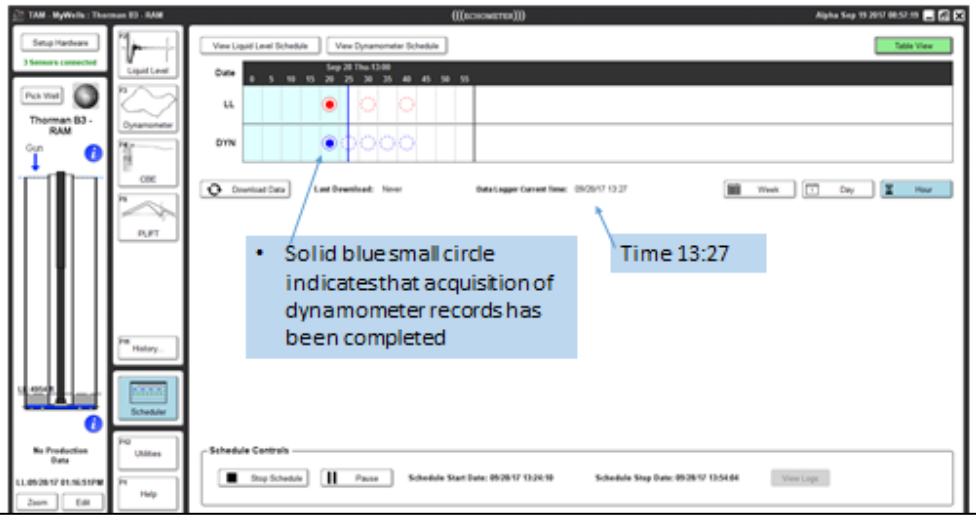


Once the records have been acquired the small circles are filled with their corresponding color.



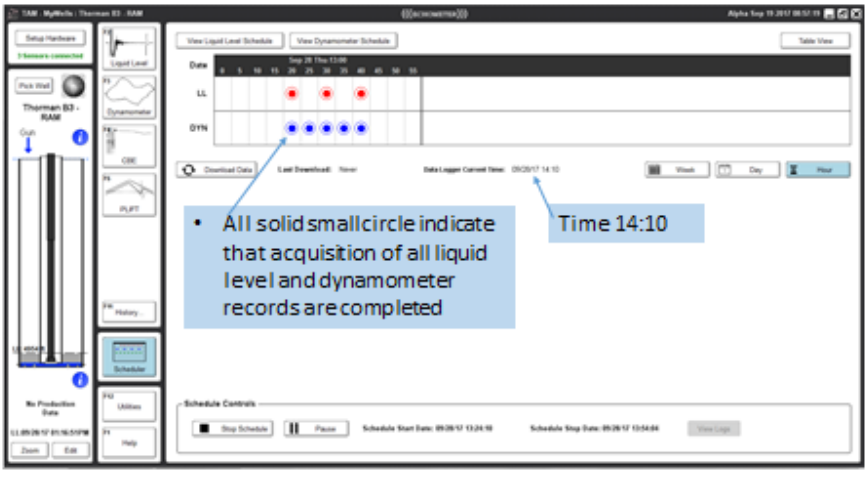
A solid small red circle indicates the first liquid level acquisition and analysis is complete.

First Dynamometer Record Completed



A solid blue circle indicates acquisition of scheduled dynamometer records has been completed

All Fluid Levels and Dynamometers Completed

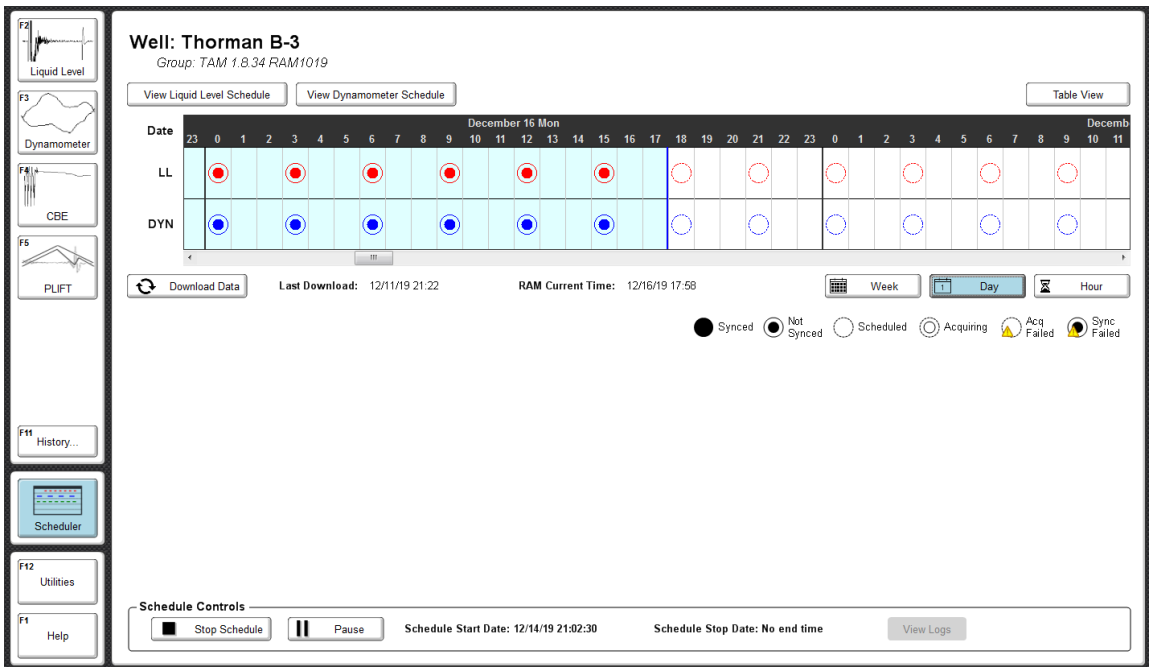


In the figure above, there are no more dashed circles and the blue timeline is not present. This indicates the schedule has been STOPPED.

View and Retrieve Scheduled Tests

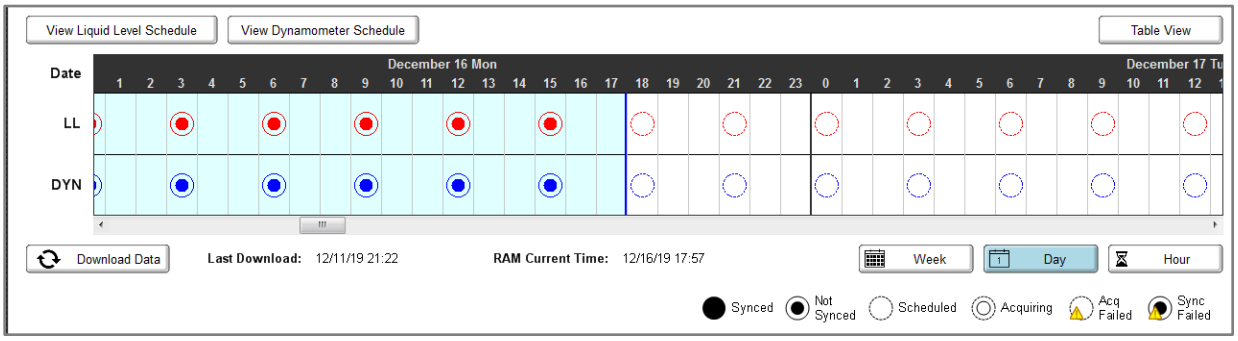
At any time during the execution of scheduled acquisition the user can review the status of the acquisition, verify which tests have been completed, and determine which and when records will be acquired in the future.

At the bottom of the schedule timeline, the slider allows scrolling through the time scale to the region of interest.



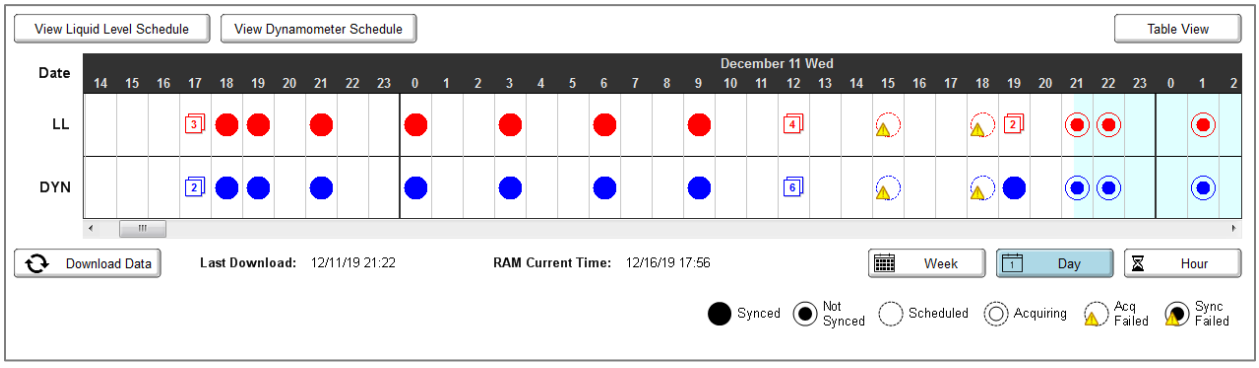
Schedule Calendar View Time Line

By default, the scheduled acquisitions are displayed graphically as a function of time on a scale selectable as weekly, daily or hourly. Each record to be acquired is represented in the form of small dotted circles that are not filled. Circles are located approximately at the times specified by the user when the time scale is appropriate. Records that have been acquired are represented by small circles filled in red (fluid level) or blue (dynamometer).



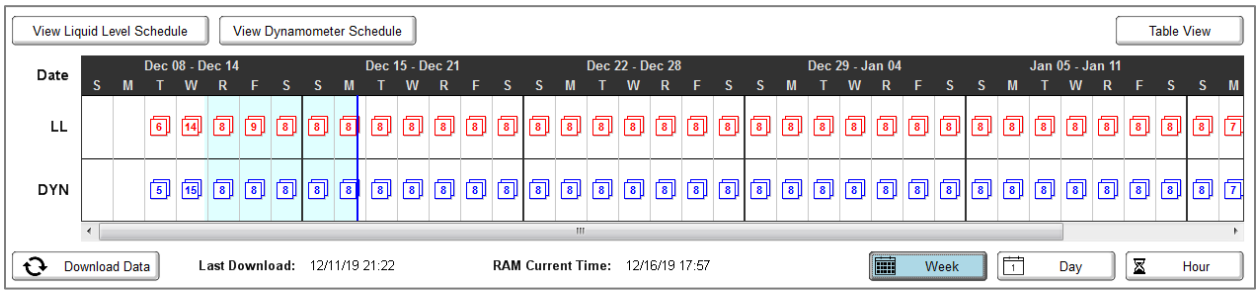
This figure shows the “Day” view at the end of the first day (Dec 16) and start of new day at a current time of 17:57 or 5:57 PM. Acquisition of liquid level and dynamometer data are scheduled to occur every 3 hours at about the same time. Previous acquisitions are shown with small filled circles inside the dotted circles. Last acquisitions were at about 15:00 and next scheduled acquisition will be at about 18:00 hours.

Some data was downloaded on 12/11 at 21:22 hours. Scrolling back to that date the following figure shows large filled circles that indicate the records that have been downloaded or synced up to 9:22 PM. (21:22)



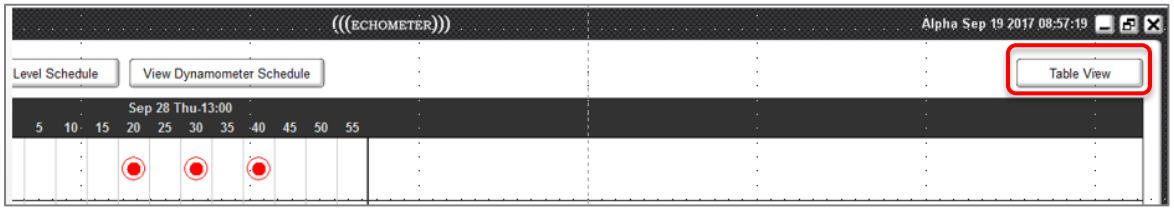
The time line also shows that scheduled acquisition failed on Dec 11 at 15:00 and 18:00 hours indicated by the yellow triangles and multiple (4) records were acquired around 12:00.

The following figures shows the “Week” view. With one entry per day. When multiple acquisitions are within the same time period the circles are replaced by squares with the corresponding number of data records per day as shown below:

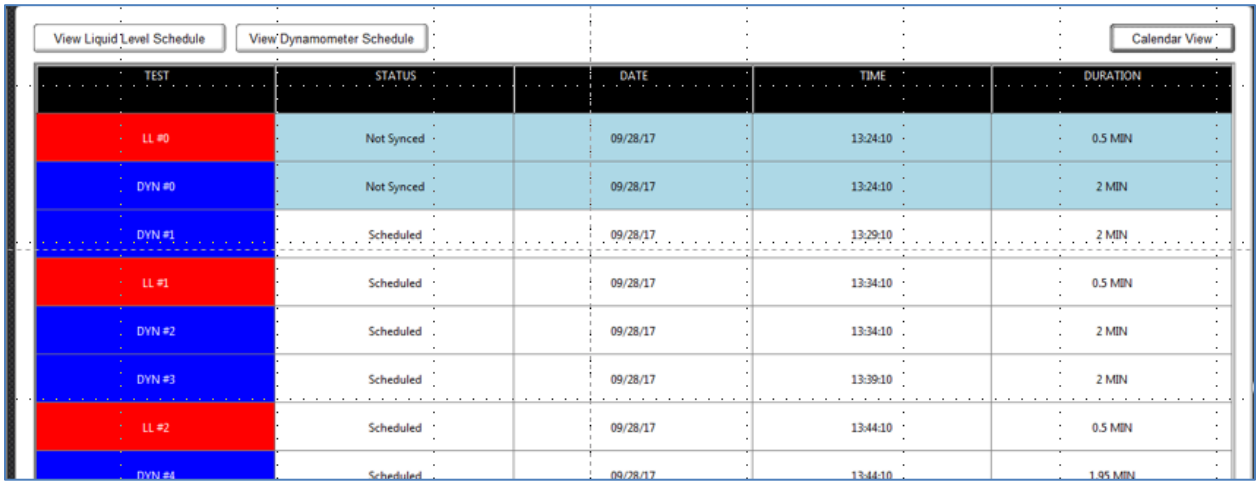


Schedule Status Table View

The user has the option of viewing the schedule as a table instead of a time line calendar. This option is selected by clicking on the “Table View” button at the upper right corner of the schedule window.



The following figure shows a schedule in table view mode.



Each row represents either a fluid level or a dynamometer record. The first column identifies and numbers the Tests, highlighted in red for liquid level and blue for dynamometer.

The status of the test is indicated in the second column followed by the date of the test, the time the record was acquired, and its duration in the following three columns. If acquisition of the respective records has been completed the row is highlighted in light blue otherwise it is not highlighted.

- Synced status means that the record has been downloaded
- Scheduled status means the record will be acquired at the indicated date and time

Pause and Modify Schedule

At any time during the execution of scheduled tests the timing and parameters of the schedule can be modified by pausing and then entering the new parameters.

Recommended Procedure to Modify Schedule

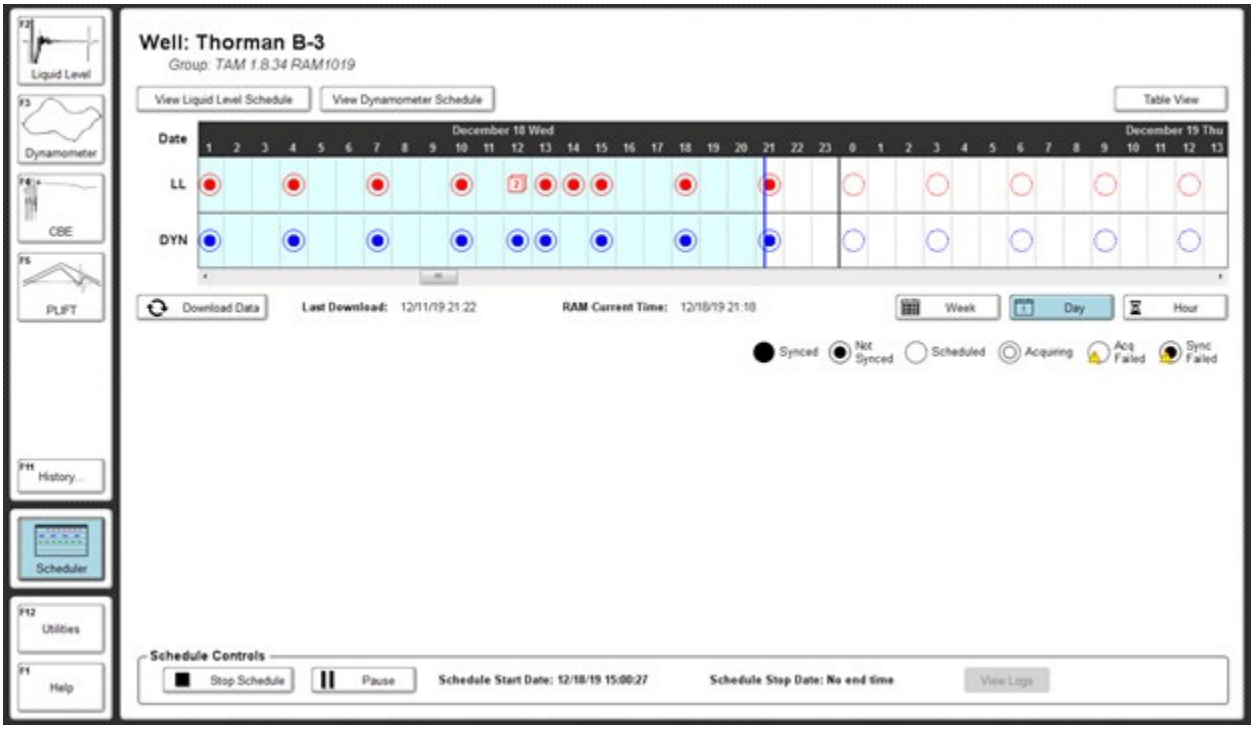
Reconnect to the RAM if not already connected.

1. Start TAM Application.
2. Select “Setup Hardware” button.
    a. Local Connection
        1. Select the “RAM” option from the dropdown list.
        2. On the login screen, enter the password for the RAM.
        3. Validate the hub address and the network configuration. Verify the latest version of the RAM Application is on the RAM.
        4. Verify the Base is being detected by the RAM
    b. Cloud Connection
        1. Select the “Cloud” option from the dropdown list.
        2. On the login screen enter password for the Cloud.
        3. List of RAMs the user has access to will display.
        4. If the RAM you would like to connect to is not already Online, wakeup the RAM (this could take up to 3 mins).
        5. Once RAM is online then log into the RAM.
        6. Verify the Base and sensors come online (this could take up to 1.5 mins).
3. Select “Scheduler.”
4. View Status of tests.
5. Select Pause Schedule.
6. Make changes to LL by selecting the “View Liquid Level Schedule.”
7. Make changes to DYN by selecting the “View Dynamometer Schedule.”
8. Select “Resume Schedule” on the Scheduler View

Example of Schedule Modification

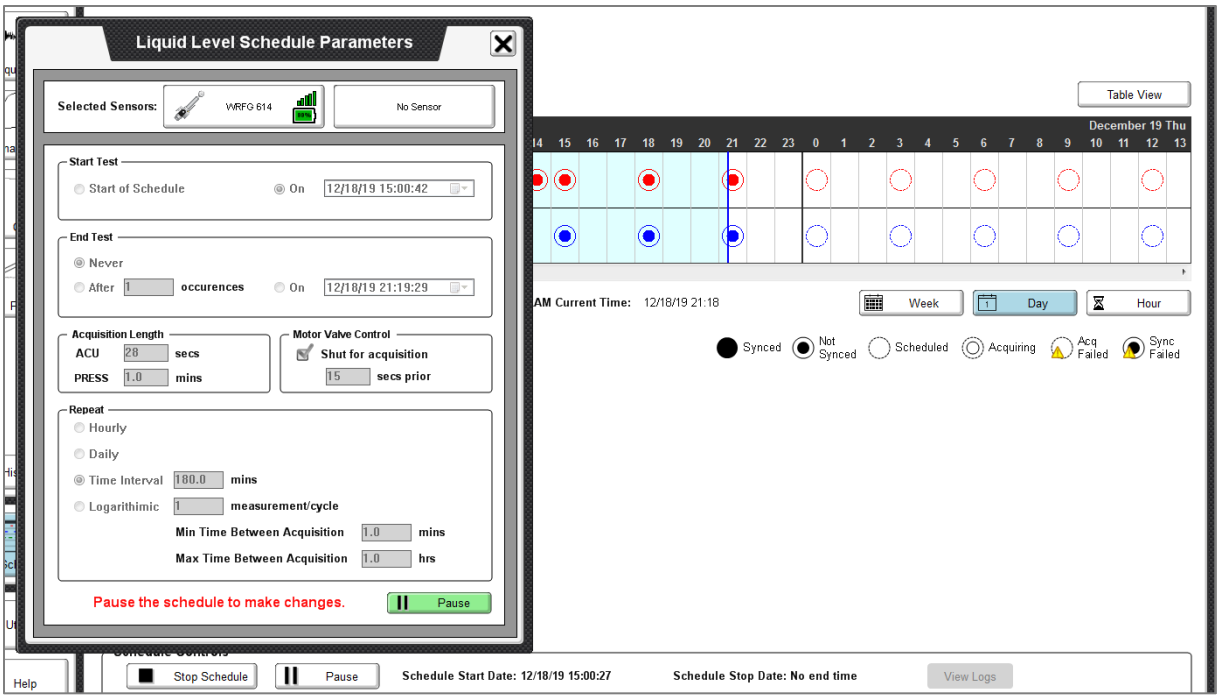
The following screens illustrate the procedure for modifying the schedule starting at step 3) Select “Scheduler” of the list in the previous page.

Once the schedule calendar is displayed the user should verify the existing schedule is running and a test is not currently being acquired by scrolling to the current date and time as shown below.

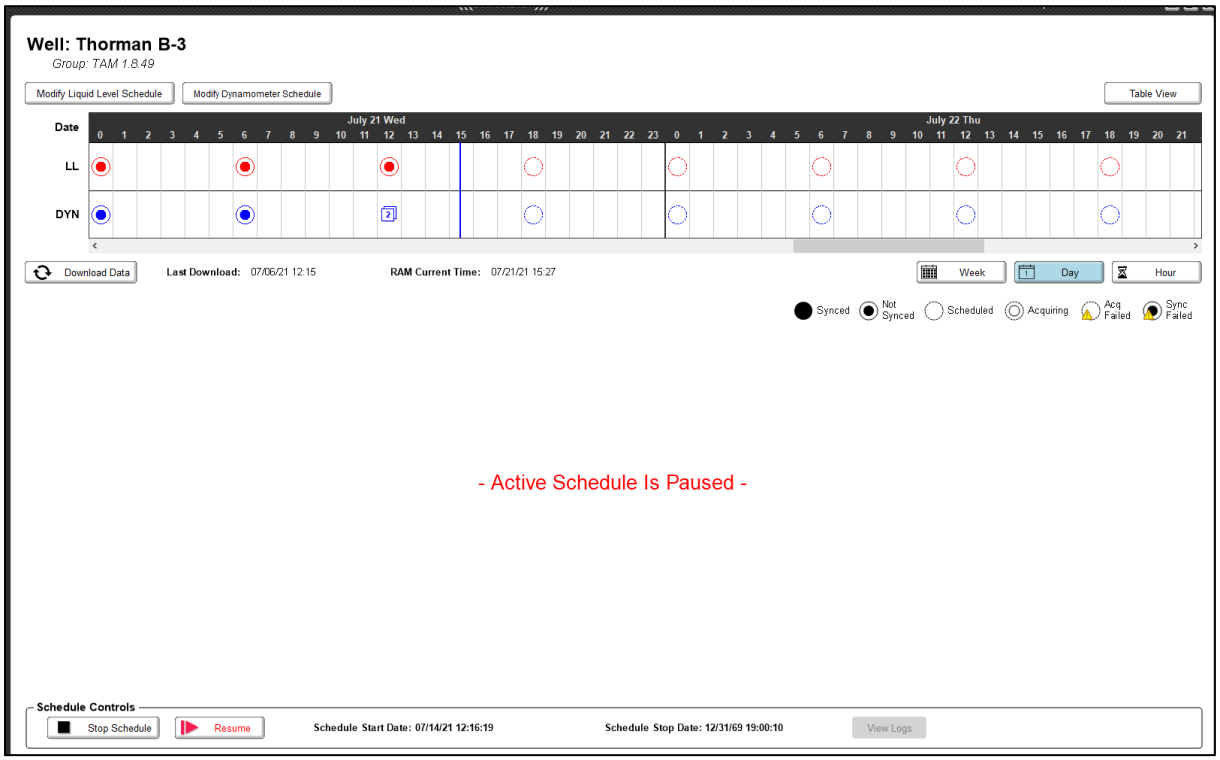


Current RAM time is 21:18 and the records at 21:00 hours have been acquired and the next scheduled tests will be acquired after midnight.

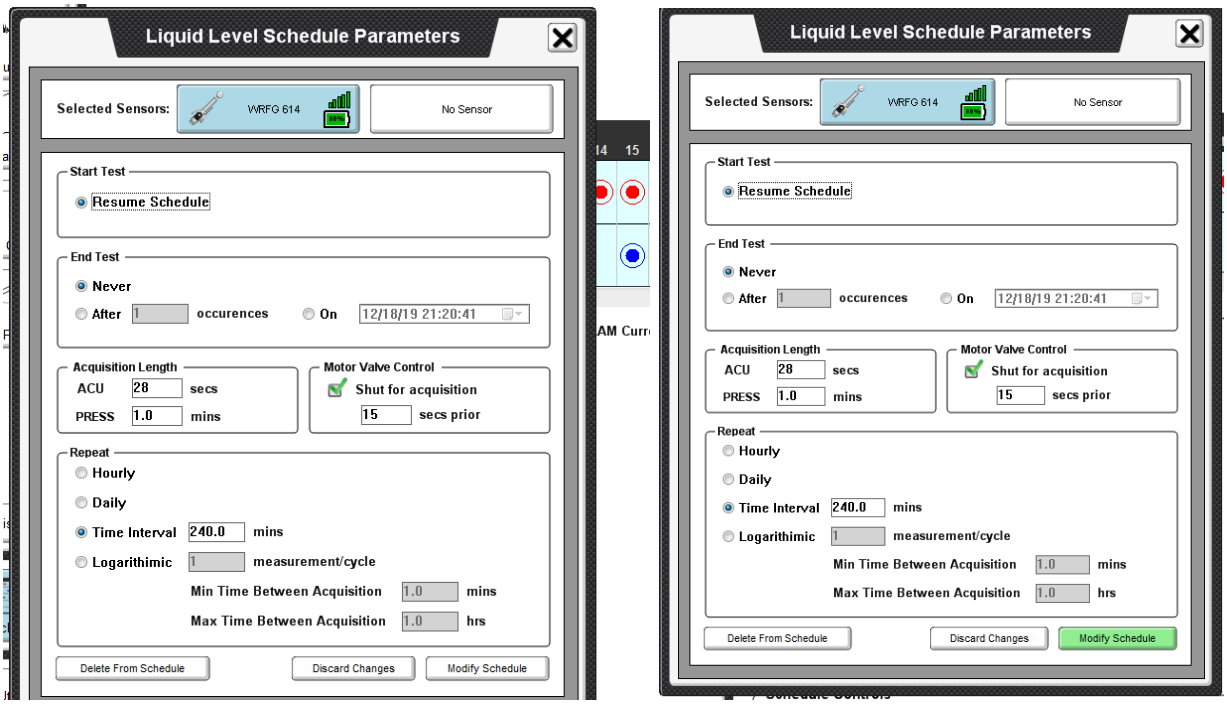
It is OK to Pause the schedule and review the current settings for fluid level and dynamometer acquisition.



The existing Fluid Level schedule is set for acquiring one record every 3 hours near the top of the hour.



Click the Pause Schedule button to make a change to the frequency of acquisition to once in 4 hours.

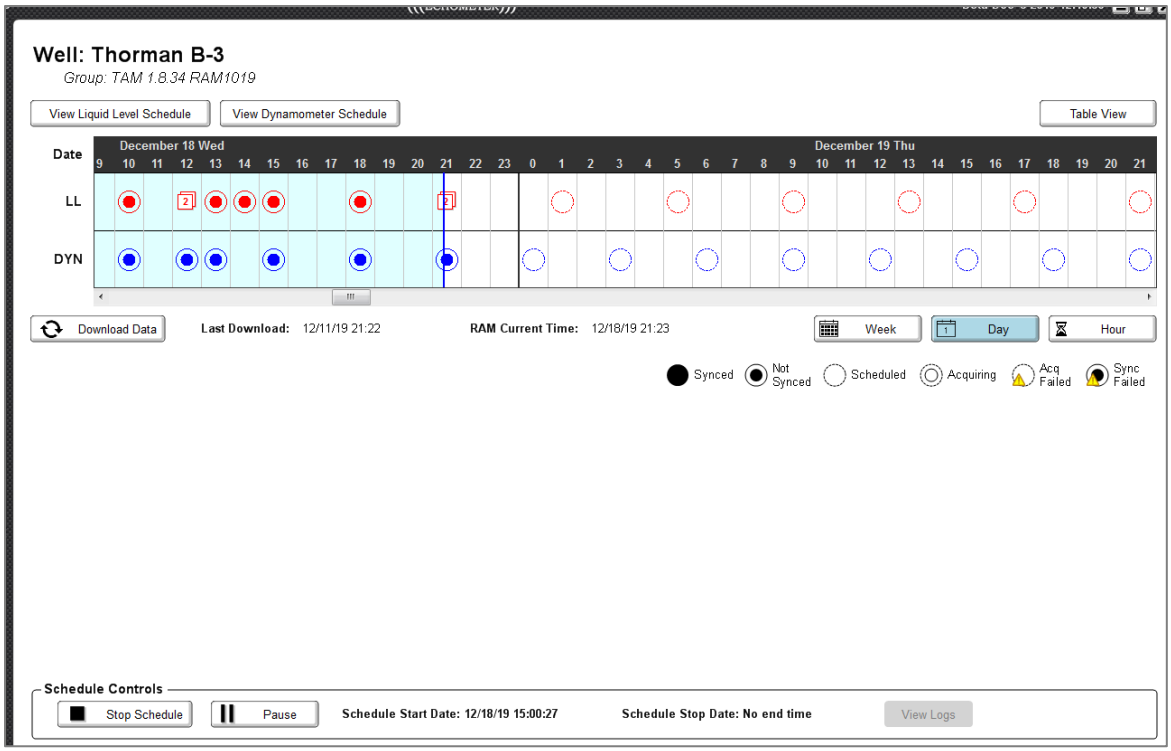


Change frequency to once every 4 hours (240 minutes) then click “Modify Schedule”

At this point the user could also modify the dynamometer acquisition schedule but, in this example, it was left at the original frequency of one record every 3 hours.

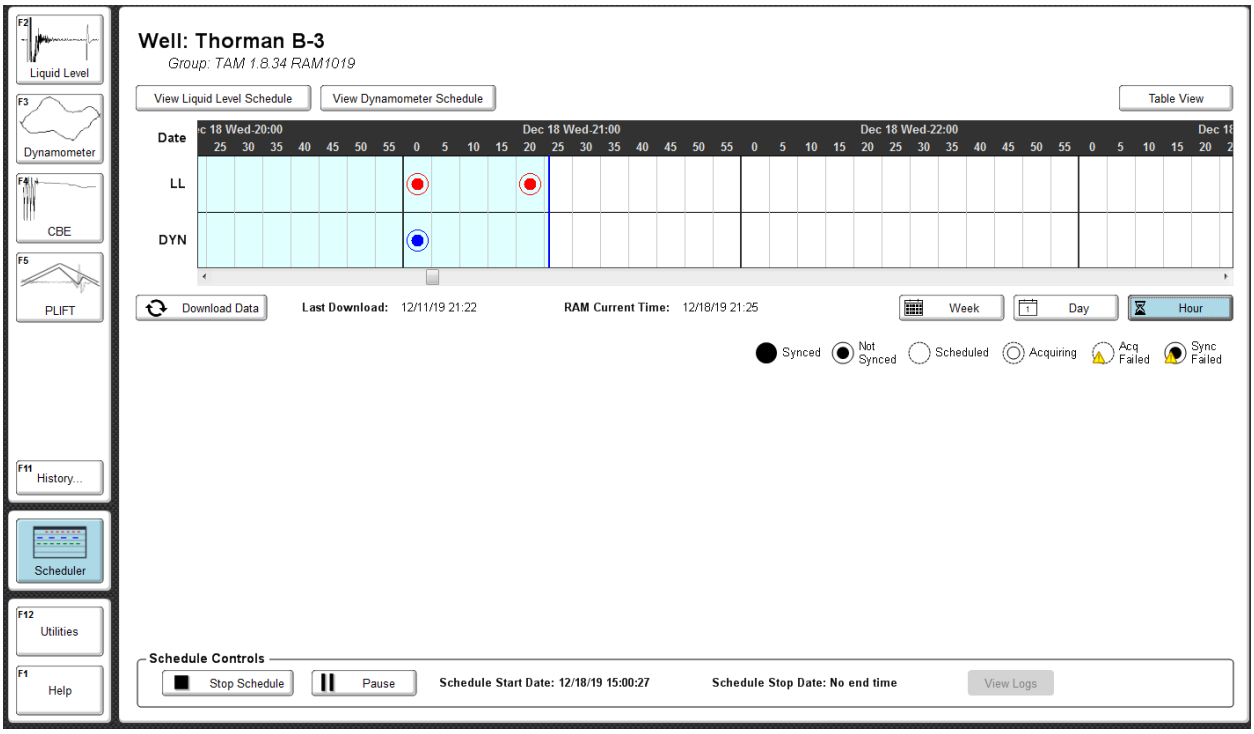
To activate the modified schedule, it is necessary to click the “Resume” button.

After clicking Resume the new schedule time line is displayed.

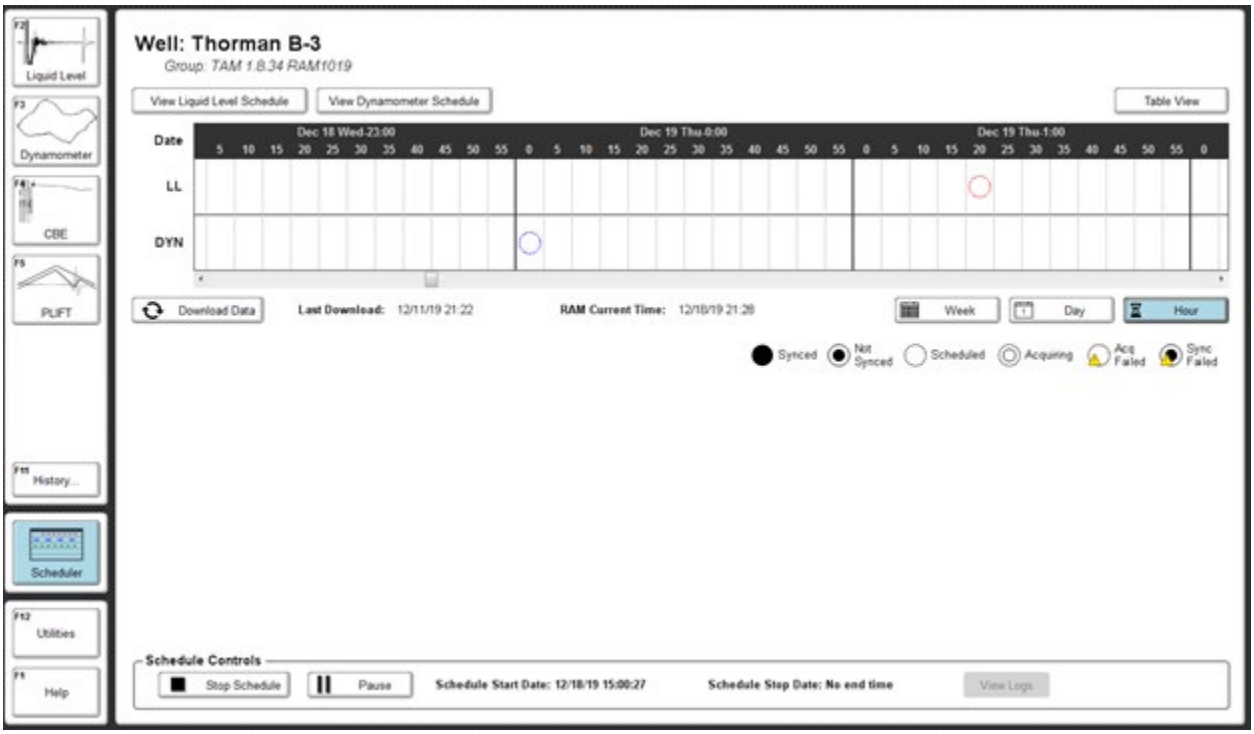


NOTES:
1) At 21 hours now indicates 2 records have been acquired.
2) The future acoustic records are shown to be acquired every 4 hours.
3) The acoustic records are now shifted in time relative to the dynamometer future records, since the dynamometer schedule was not modified. The measurements are not in phase.

As soon as the Resume button is clicked the first acoustic record corresponding to the modified schedule is acquired. To view this fact, it is necessary to change the time scale from “Day” to “Hour” as shown in the following figure.



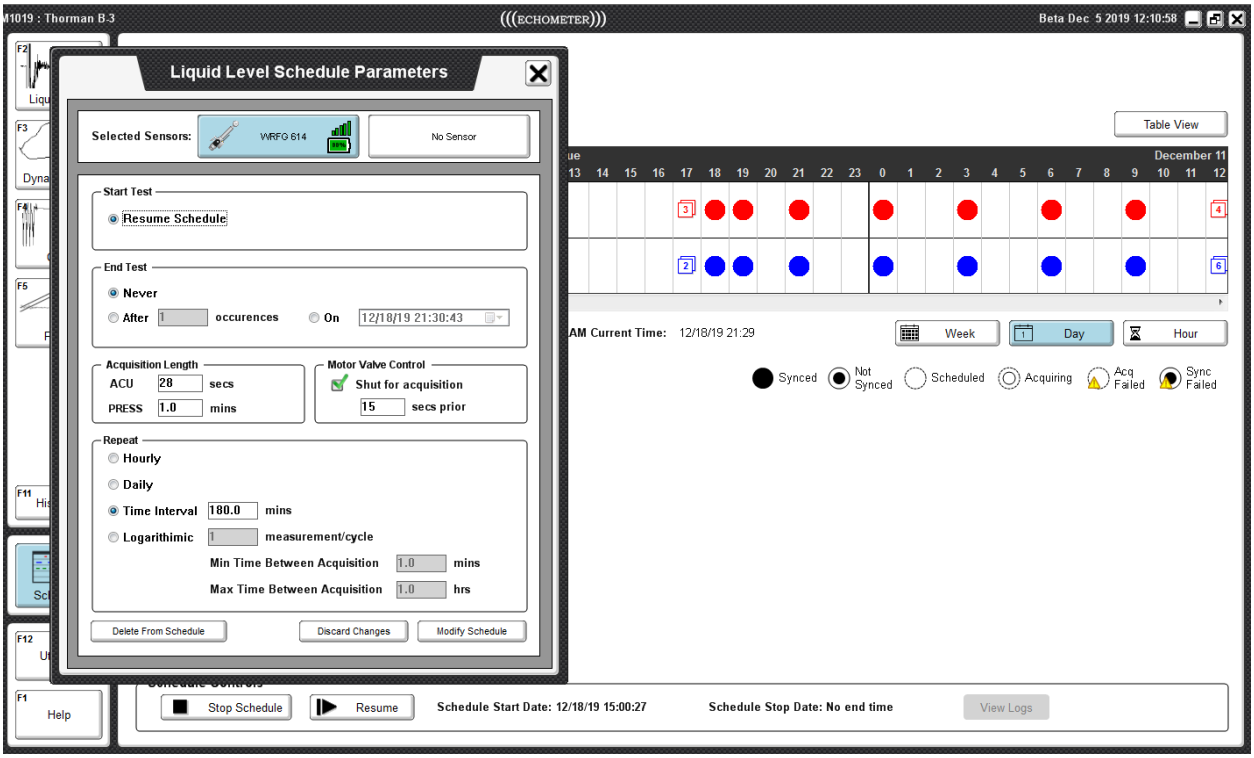
Changing the time line to “Hour View” shows the completed acoustic record at 21:20 on Dec 18 that was acquired according to the new schedule.



Still in “Hour view” shows next acoustic record to be acquired on Dec 19 at 01:20 so now the fluid level measurements would be out of phase relative to the dynamometer measurements since the dynamometer schedule was not modified.

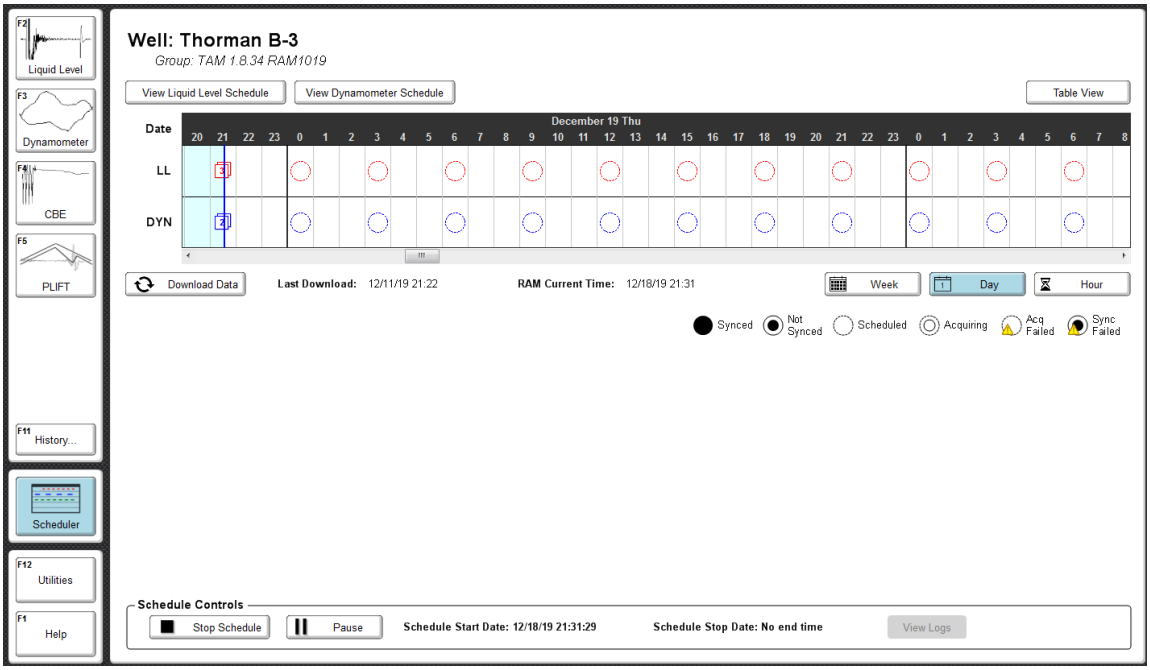
If this is not what the user wants then either the dynamometer schedule needs to be modified to the new schedule or the fluid level schedule can be returned to the original schedule.

The following figure shows how to edit the fluid level schedule and return it back to one acoustic shot every 3 hours. First, reopen the fluid level schedule:

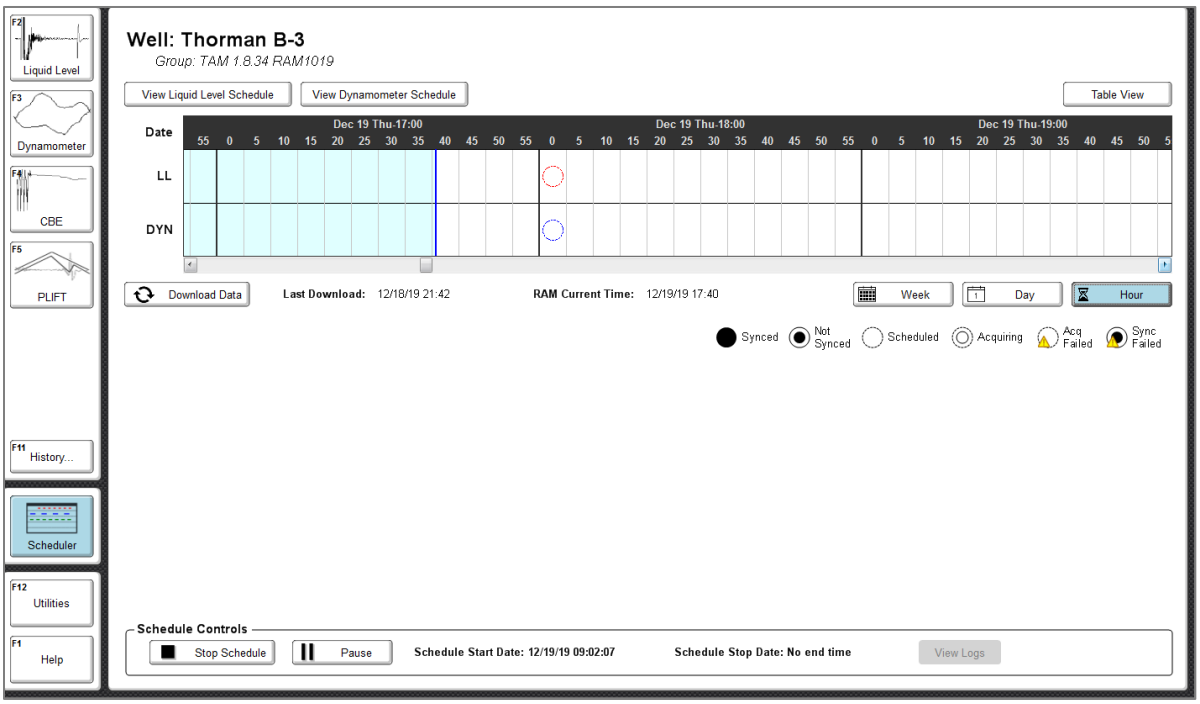


a) Reset the Time Interval to 180 minutes,
b) Click “Modify Schedule”,
c) Click “Resume Schedule”.

The RAM has not been reset to the original schedule with LL and DYN being acquired at the same time every 3 hours.



NOTE: With the “Day” scale, the fluid level and dynamometer records appear to be in-phase but it is a good practice to verify this by changing the time scale to “Hour” as shown in the next figure.



Monitor and Retrieve Data from Schedule

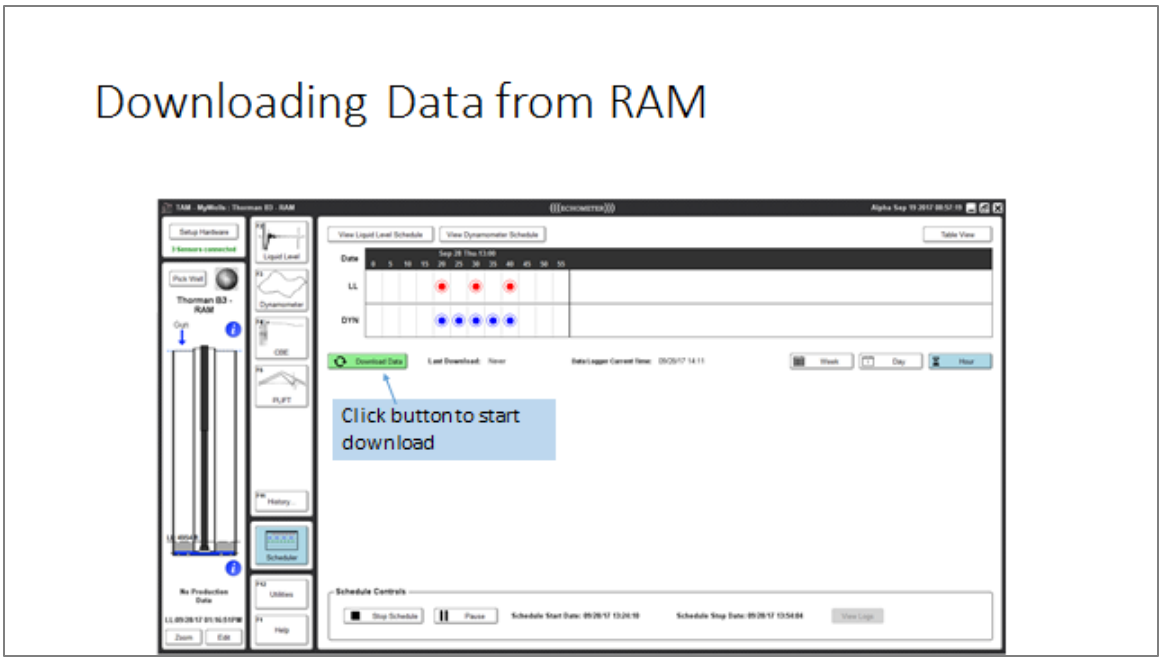
All data that has been acquired by the schedule or remotely by the user can be downloaded to the computer that is connected to the RAM either locally or via the Cloud.

Recommended Procedure for Downloading Scheduled Data

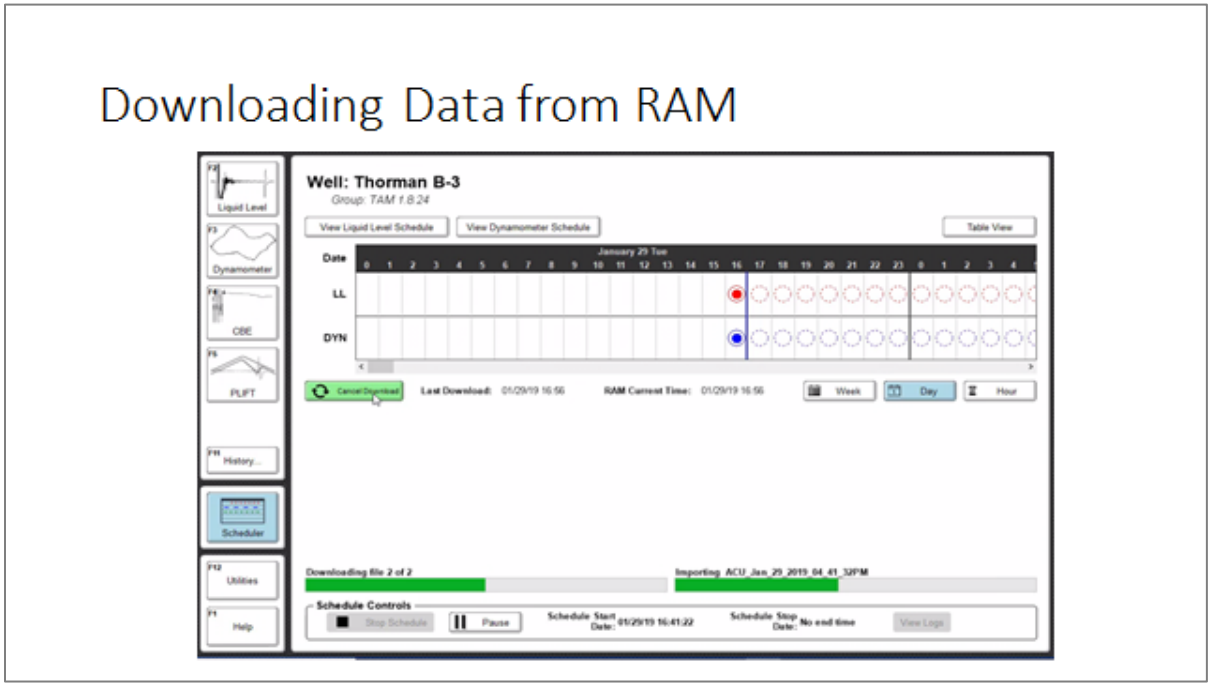
Reconnect to RAM if not already connected

1. Start TAM Application
2. Select “Setup Hardware” button
    a. Local Connection
        1. Select the “RAM” option from the dropdown list
        2. On login screen enter password for RAM
        3. Validate the hub address and the network configuration. Verify the latest version of the RAM Application is on the RAM.
        4. Verify Base is being detected by the RAM
    b. Cloud Connection
        1. Select the “Cloud” option from the dropdown list
        2. On login screen enter password for the Cloud
        3. List of RAMs user has access to will show
        4. If RAM that you would like to connect to is not already Online, wakeup the RAM (this could take up to 3 mins)
        5. Once RAM is online then log into the RAM
        6. Verify Base and sensors come online (this could take up to 1.5 mins)
3. Select Scheduler
4. View Status of test - TAM shows tests that have been performed: what is scheduled, what has been synced previously to your computer, and tests that have failed
5. Select the Download Data button. Tests will start being transferred and processed onto your computer
6. Verify Scheduled LL Test
    a. Select LL Module
    b. Select the tab with the active schedule session date range
    c. View and Validate Individual Tests
7. Verify Schedule DYN Test
    a. Select DYN Module
    b. Select the tab with the active schedule session date range
    c. View and Validate Individual Tests
8. Logout of RAM
    a. Select “Setup Hardware” button
    b. Local Connection
        1. Select RAM icon
            1. Logout of RAM
        2. Cloud Connection
            1. Select RAM icon
            2. Logout of RAM
            3. Logout of Cloud

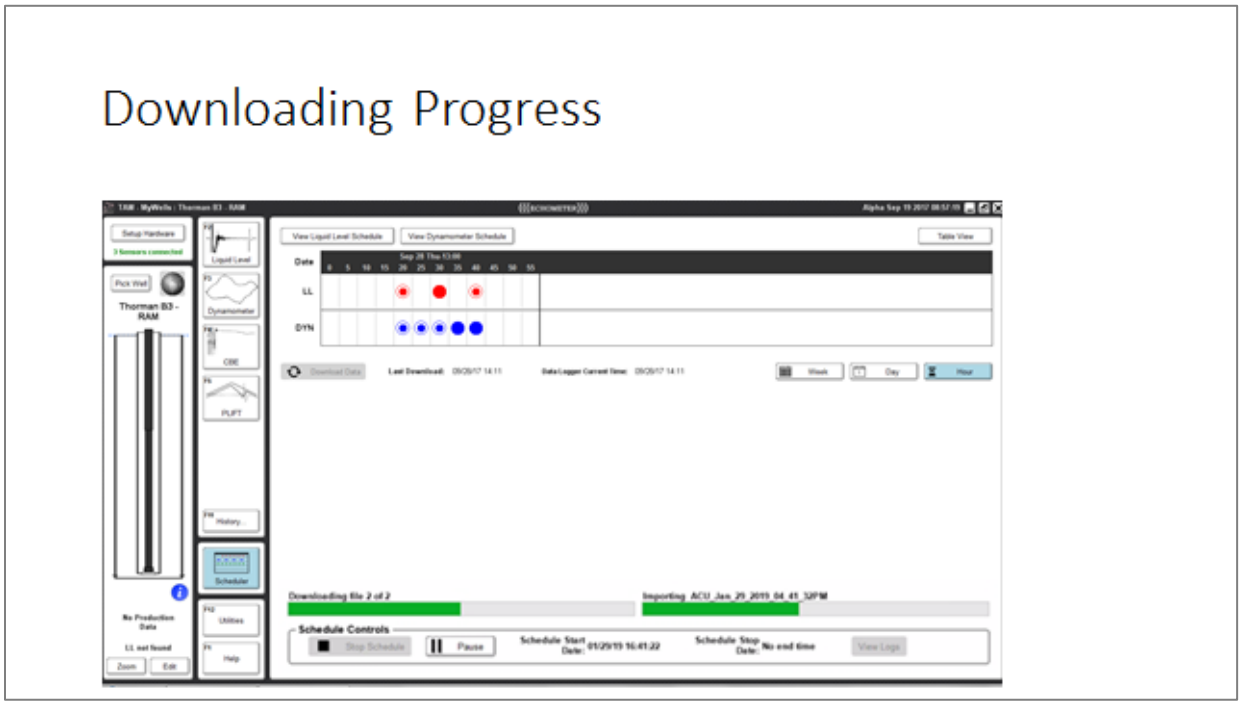
Acquired data can be downloaded to the user’s computer (locally or remotely) at any time except when RAM is in the process of acquisition of scheduled data.



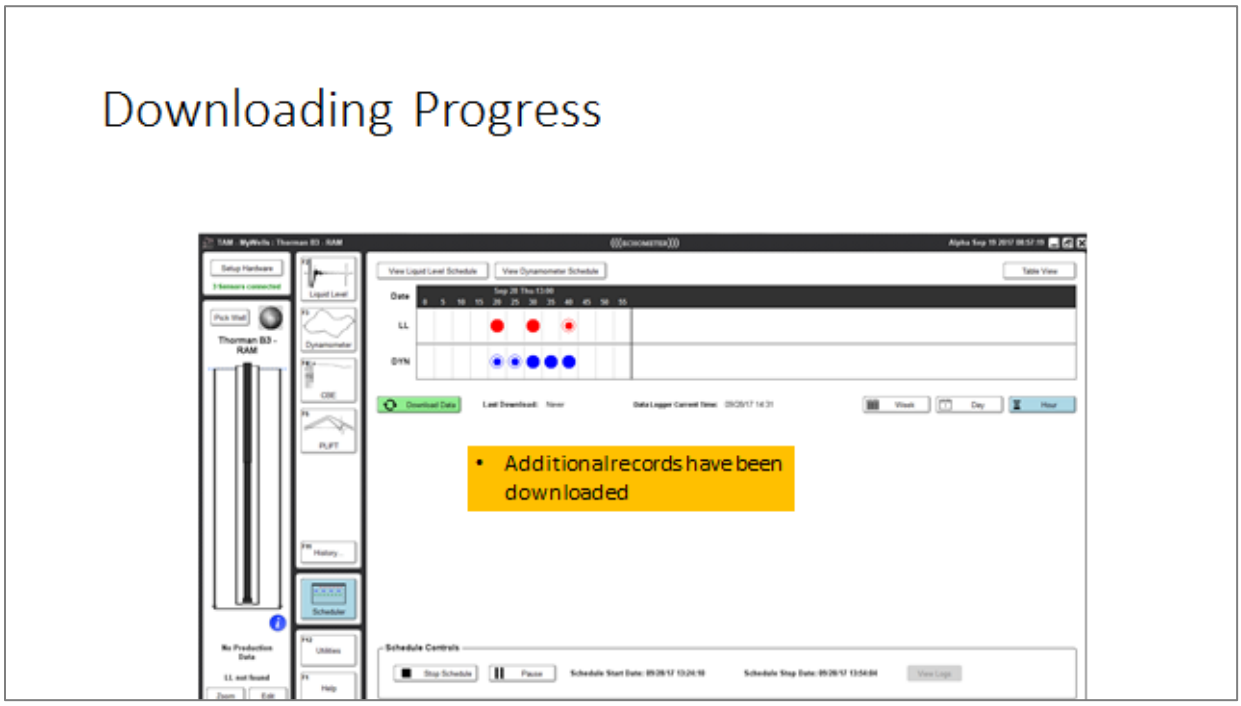
The speed of downloading acquired data depends on the availability and transmission rate of the internet connection used by the RAM. Generally, the acquired records are downloaded in a few minutes. In the event the internet connection is lost, it will be necessary to reconnect to the RAM and continue the download. TAM will append the additional records to the session where the data were first downloaded.



Downloading starts. TAM displays the information of the record being downloaded.



Once download is initiated, as each record is downloaded the large dotted circles in the schedule are filled completely with the corresponding color.

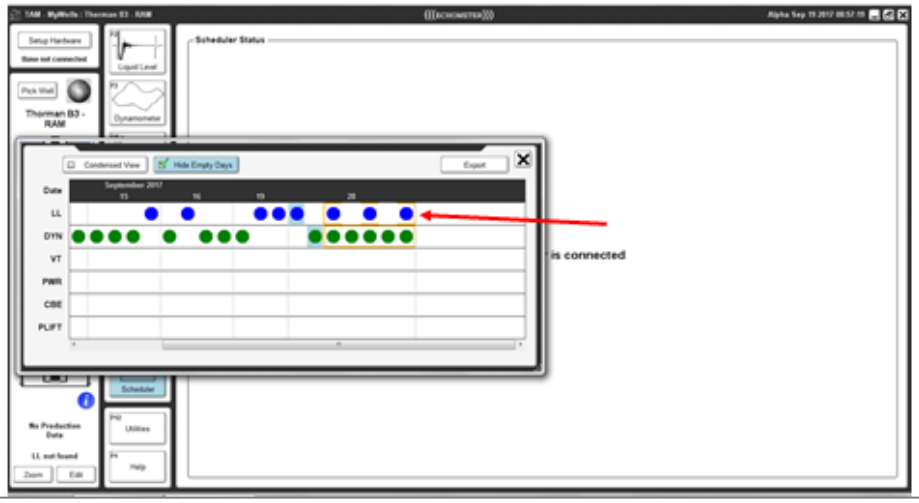


Large solid circles indicate the records that have been successfully downloaded to the user's computer.

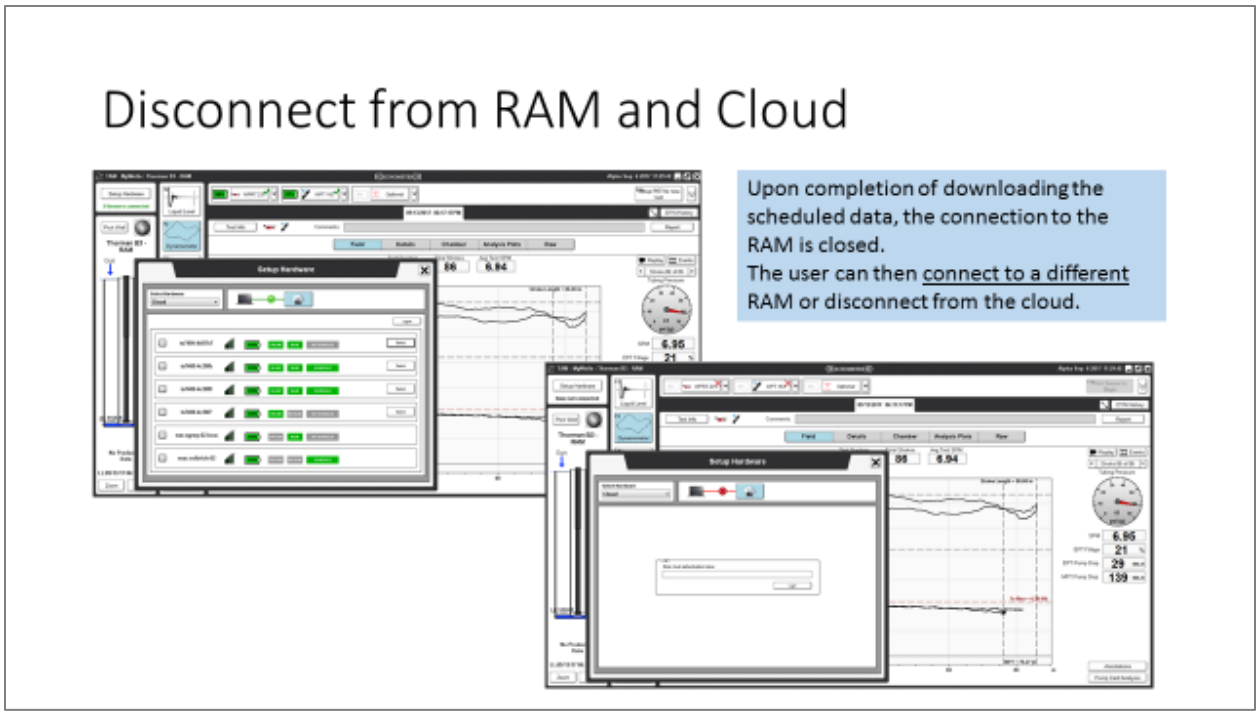
Downloading Completed

Large solid circles indicate all the records that have been downloaded to the user's computer.

TAM History Bar Updated with Schedule



Once the scheduled shots have been downloaded to the user's computer, they are shown in the TAM History bar highlighted with a rectangular red outline.



Upon completion of downloading the scheduled data, the connection to the RAM is closed. The user can then connect to a different RAM or disconnect from the cloud.

Stopping a Schedule

Reconnect to the RAM if not already connected

1. Start the TAM Application.
2. Select the “Setup Hardware” button.
    a. Local Connection
        1. Select the “RAM” option from the dropdown list.
        2. On login screen enter password for RAM.
        3. Validate the hub address and the network configuration. Verify the latest version of the RAM Application is on the RAM.
        4. Verify the Base is being detected by the RAM.
    b. Cloud Connection
        1. Select the “Cloud” option from the dropdown list.
        2. On login screen enter password for the Cloud.
        3. A list of RAMs the user has access to will be displayed.
        4. If the RAM the user would like to connect to is not already Online, wakeup the RAM (this could take up to 3 mins).
        5. Once the RAM is online, log into the RAM.
        6. Verify the Base and sensors come online (this could take up to 1.5 mins).
3. Select Scheduler.
4. View Status of test.
5. Select Download data.
6. After data has been downloaded then select “Stop Schedule”.

IMPORTANT NOTE

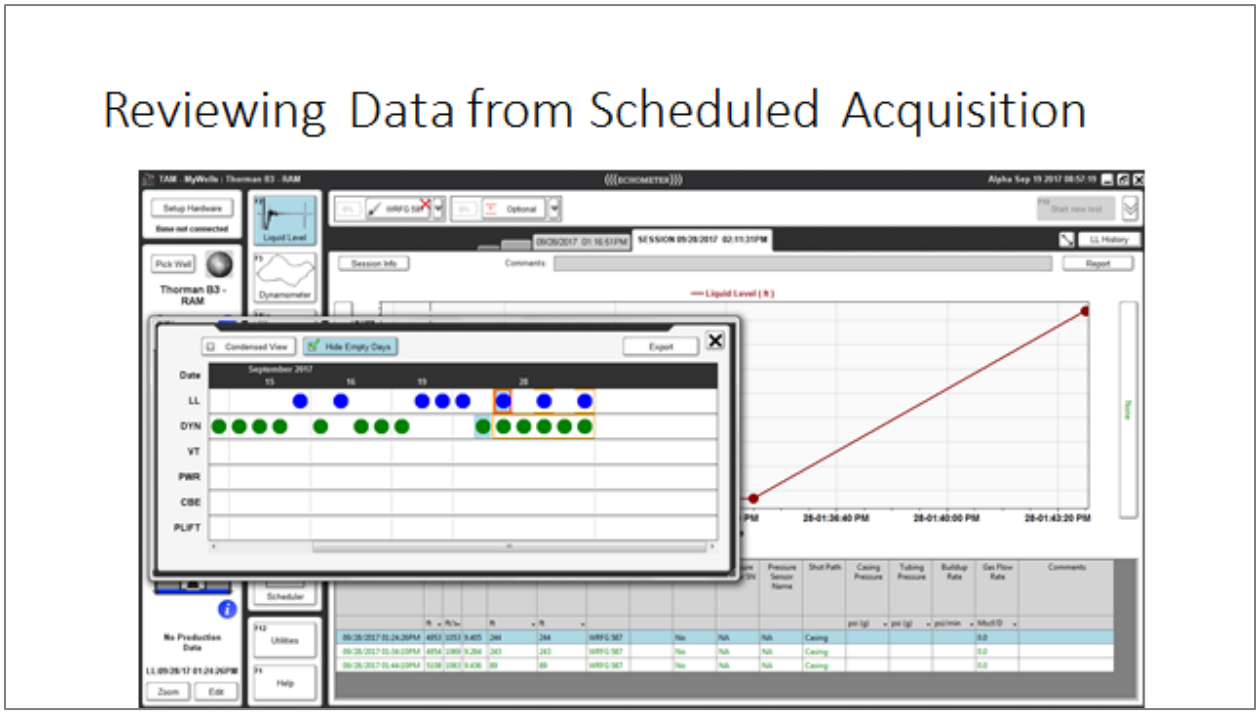
Stopping a schedule will automatically initiate downloading the data to the user’s computer. After the download is completed, the scheduled data will no longer be accessible by reconnecting to the RAM.

Viewing Previously Acquired Schedules within TAM

Data acquired by a schedule can be analyzed in TAM using all the tools and following the same procedures as analyzing data acquired conventionally with a wireless or wired Echometer system.

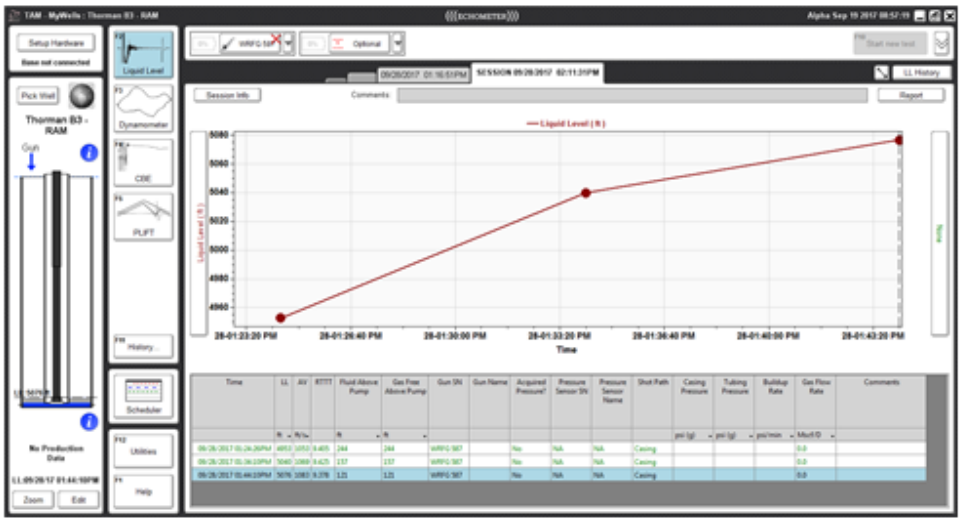
The only difference is that the data is grouped by sessions and managed and presented using a special set of tables and graphs as shown in the following figures.

RAM Liquid Level Data Management



- Schedule Data is accessed from TAM History and is displayed with red highlight.
- Clicking on a blue solid circle opens the Session View for liquid levels.

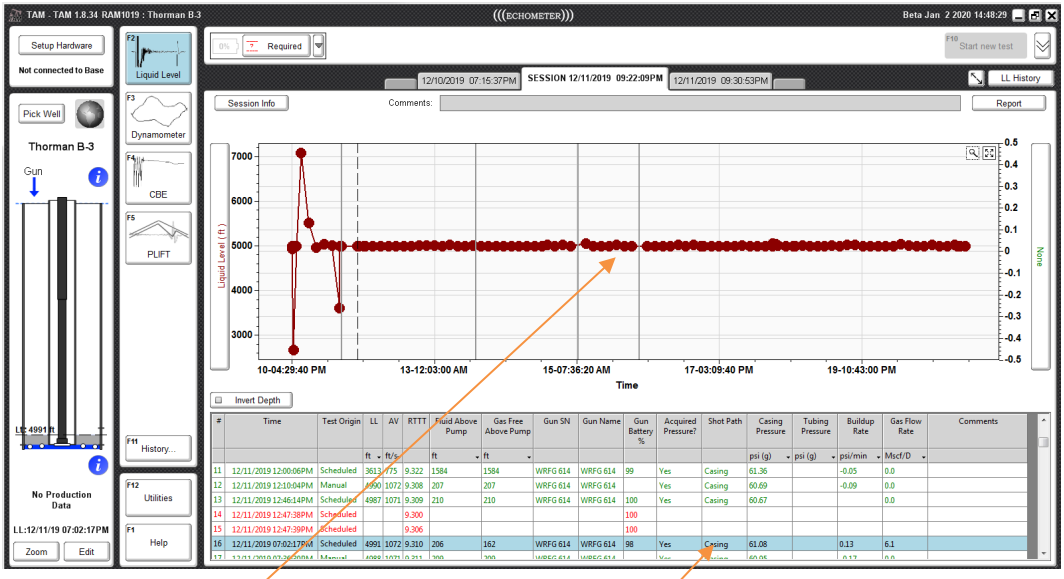
Liquid Level Session View



Graphical presentation of selected variables is plotted as a function of time.

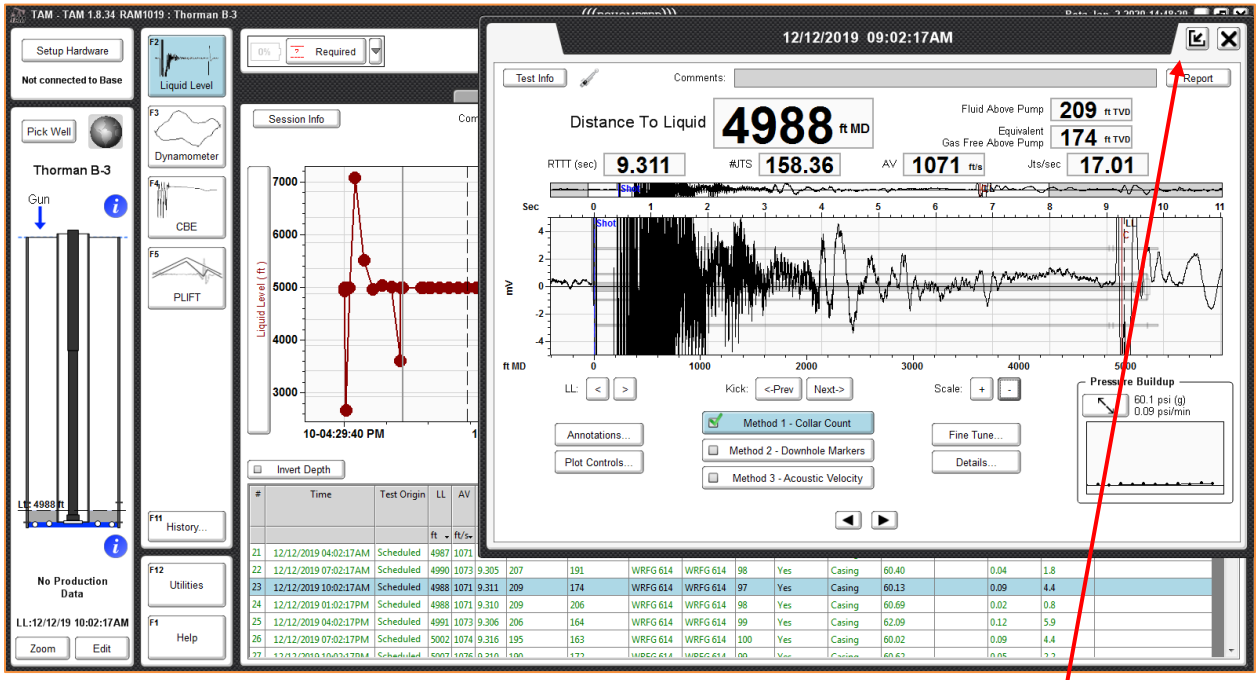
The variable displayed by the vertical axis is selected by clicking on the axis label button. The spreadsheet at the bottom lists all the fluid level shots within the schedule.

Display of Individual Records in Schedule



Clicking on a dot in the graph or on the highlighted row in the spreadsheet opens the corresponding record as shown in the next slide.

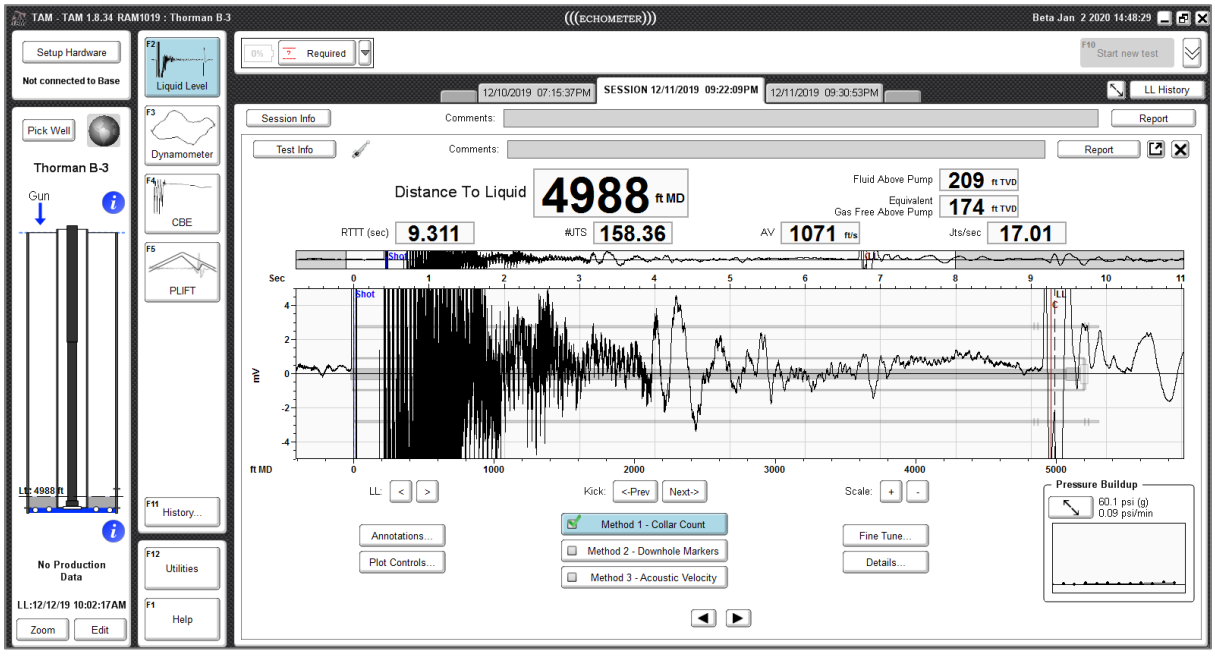
Acoustic Record displayed in Schedule Session View



The selected record is shown on an overlay window and can be analyzed in this schedule window with the usual TAM tools.

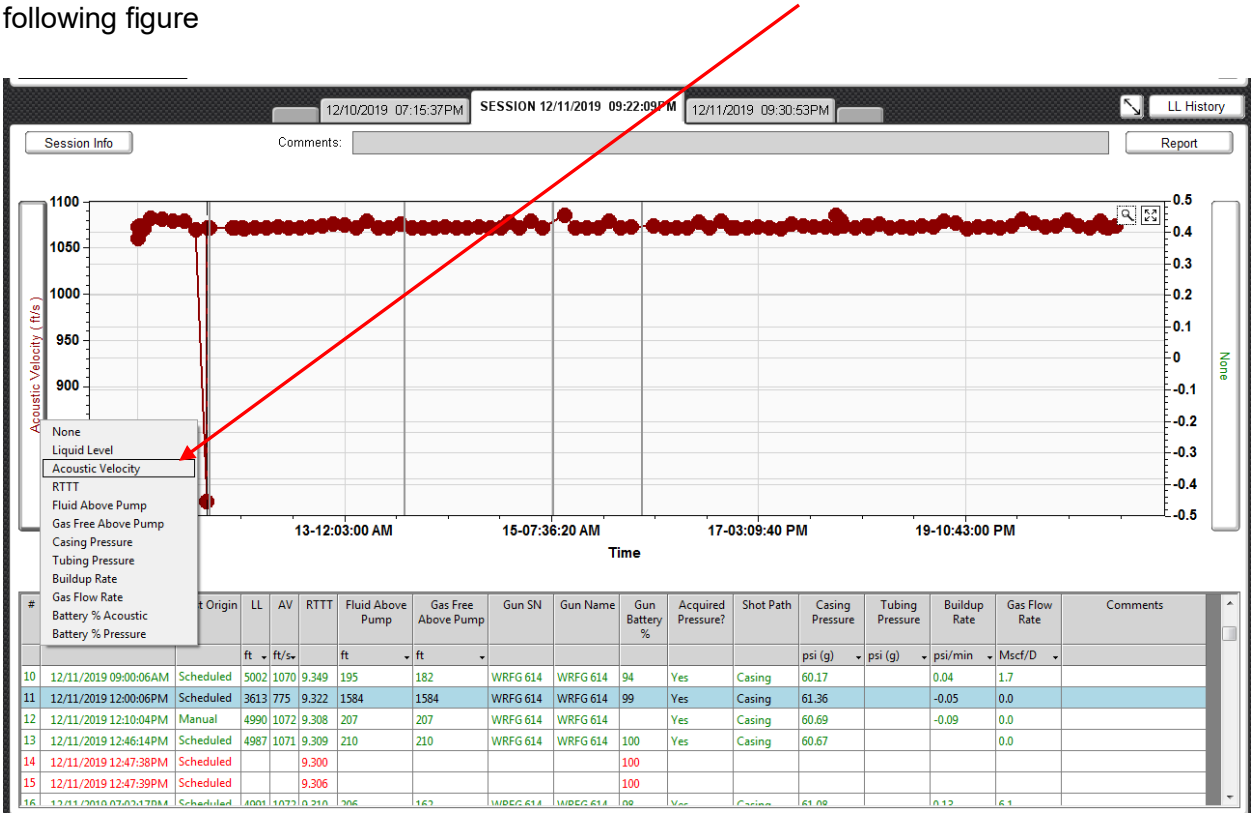
Viewing and Expanded Record in TAM

If the user wants to see an expanded scale the record can be viewed in a full TAM window by clicking on the “Expand” button:



Viewing Time History Plot of Other Measured Parameters

For the acoustic records the displayed parameter by default is the distance to the liquid level. The user can select other variables to be plotted using the pull-down menu as shown in the following figure

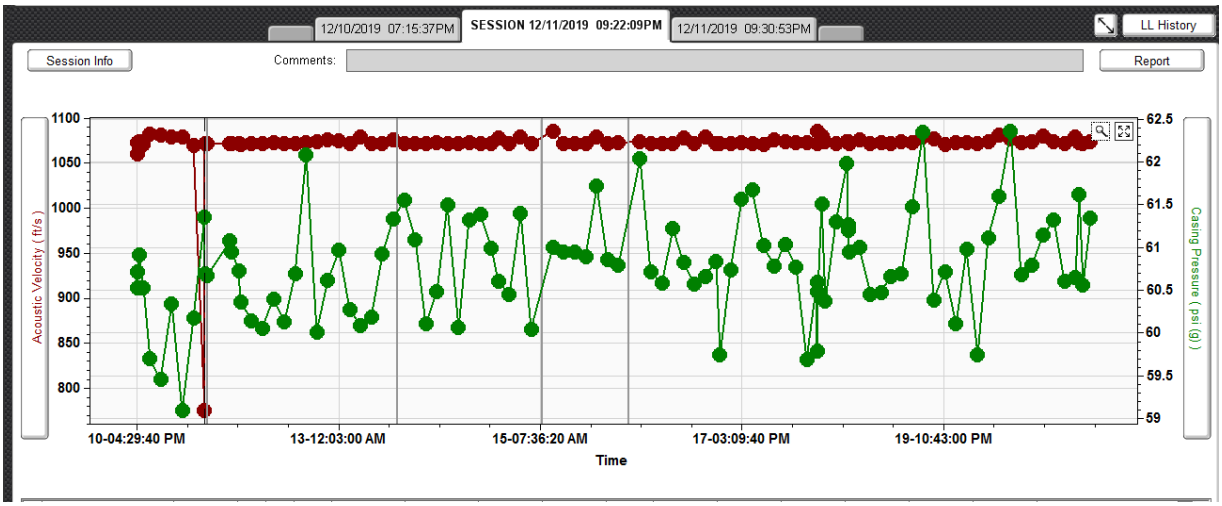


#		Origin	LL	AV	RTTT	Fluid Above Pump	Gas Free Above Pump	Gun SN	Gun Name	Gun Battery %	Acquired Pressure?	Shot Path	Casing Pressure	Tubing Pressure	Buildup Rate	Gas Flow Rate	Comments
			ft	ft/s		ft	ft						psi (g)	psi (g)	psi/min	Mscf/D	
10	12/11/2019 09:00:06AM	Scheduled	5002	1070	9.349	195	182	WRFG 614	WRFG 614	94	Yes	Casing	60.17		0.04	1.7	
11	12/11/2019 12:00:06PM	Scheduled	3613	775	9.322	1584	1584	WRFG 614	WRFG 614	99	Yes	Casing	61.36		-0.05	0.0	
12	12/11/2019 12:10:04PM	Manual	4990	1072	9.308	207	207	WRFG 614	WRFG 614		Yes	Casing	60.69		-0.09	0.0	
13	12/11/2019 12:46:14PM	Scheduled	4987	1071	9.309	210	210	WRFG 614	WRFG 614	100	Yes	Casing	60.67			0.0	
14	12/11/2019 12:47:38PM	Scheduled			9.300					100							
15	12/11/2019 12:47:39PM	Scheduled			9.306					100							

The trend vs. time of the Acoustic Velocity is used to perform a visual check of the accuracy of the computed values.

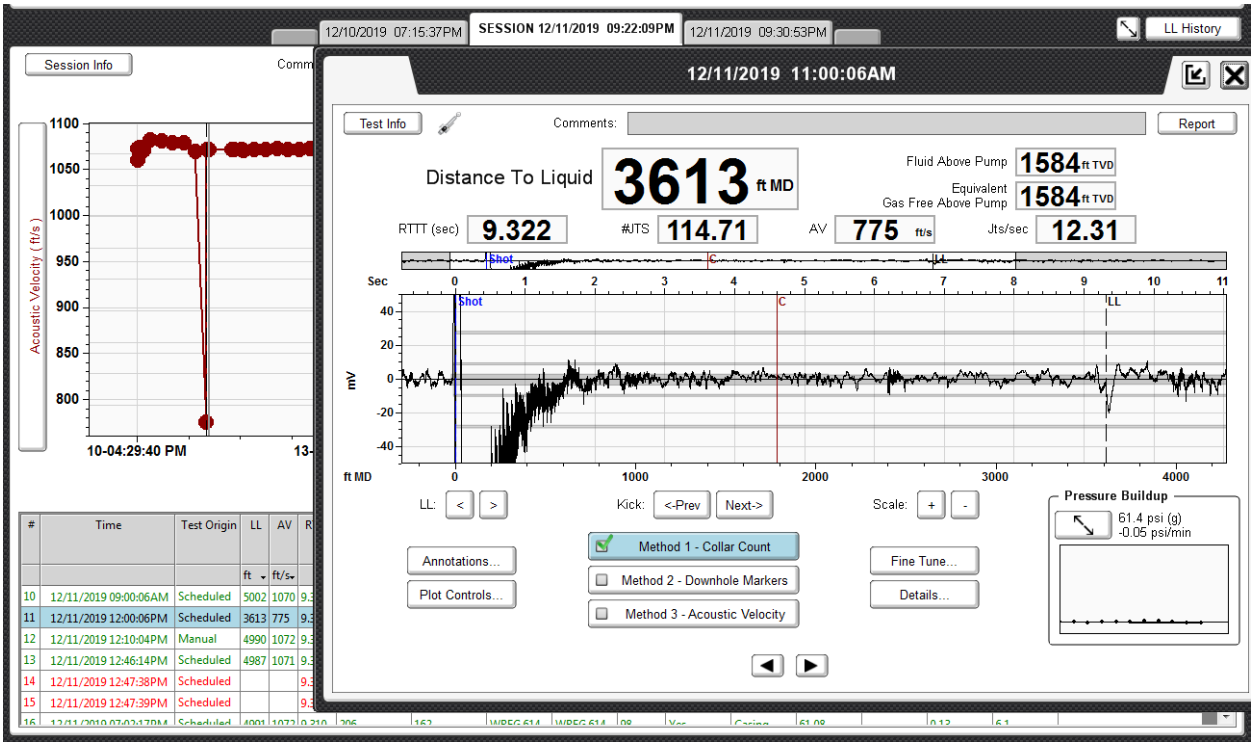
Any sudden changes from the general trend could indicate a problem with the accuracy of the calculated value.

It is possible to plot two variables simultaneously, with different vertical axes, to see if the variations that are observed are due to changes in well conditions. For example, changes in casing pressure affecting the value of the acoustic velocity as seen in the dual plot of the following figure.



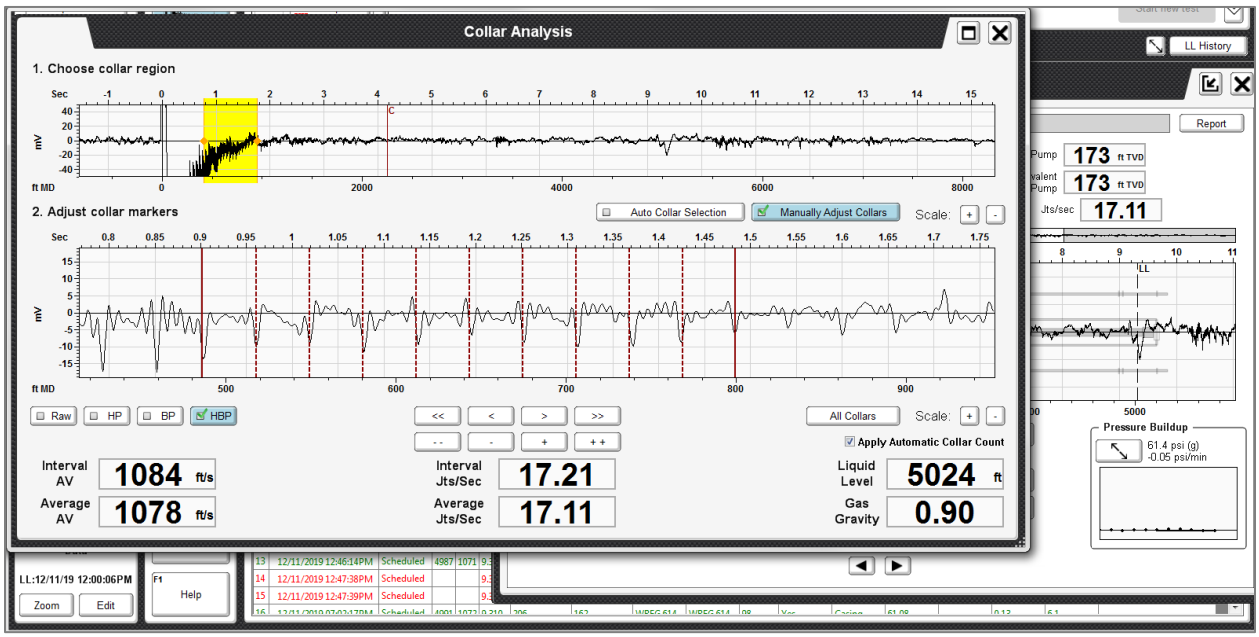
Note that the casing pressure scale is greatly expanded which gives the impression of large random variations while in reality the values only oscillate between 59 and 62 psi. Consequently, one would expect that the acoustic velocity for the gas in the wellbore should be relatively constant over the total schedule time. The single point (near the left of the graph) showing a very low acoustic velocity of 775 ft/sec is probably due to an erroneous analysis.

To verify the calculations, that specific acoustic record is opened by double clicking on the corresponding dot on the plot or on the blue row in the table:

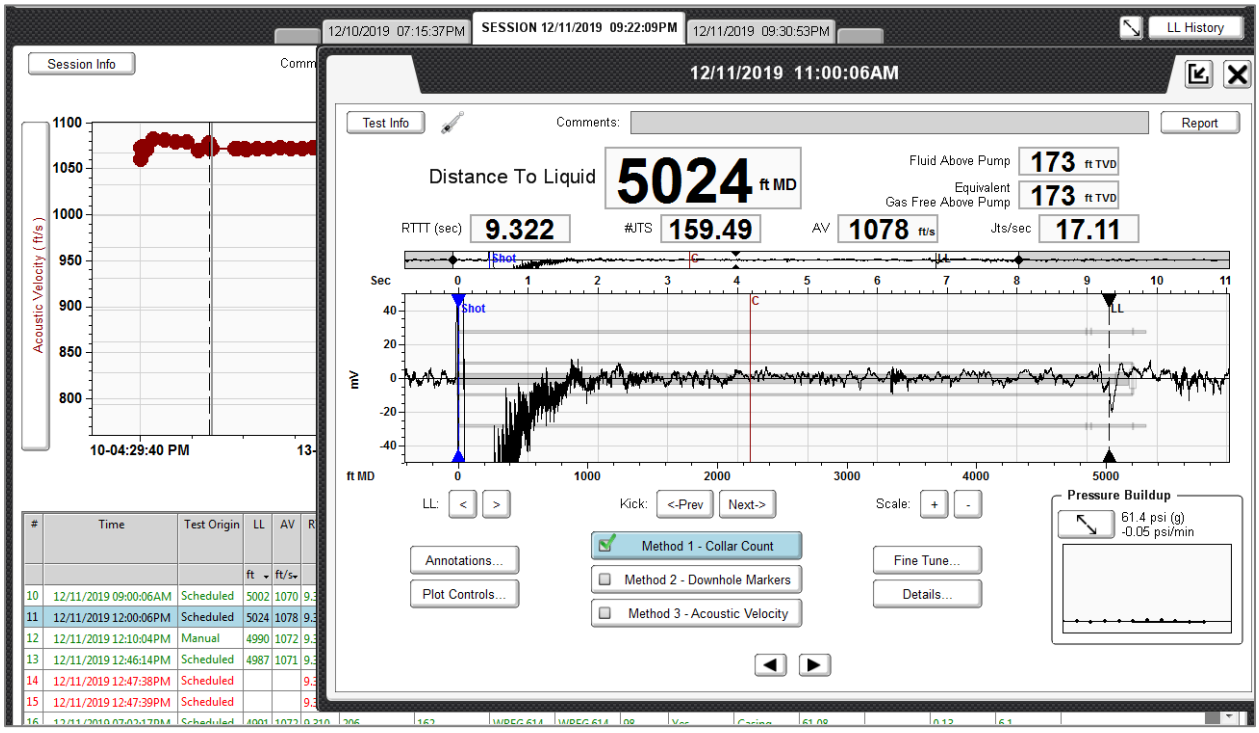


The graph shows the automatic analysis is giving the value of velocity of 775 ft/s which is too low to be realistic. The analysis is reviewed by clicking on the Collar Count button to open the count screen:

In the event the program automatically selects the wrong frequency of the collar echoes, the user will need to select a more representative sequence of collar echoes as shown in the next figure. A different section of the record and a different filter (HBP) is used to better identify the collar echoes.



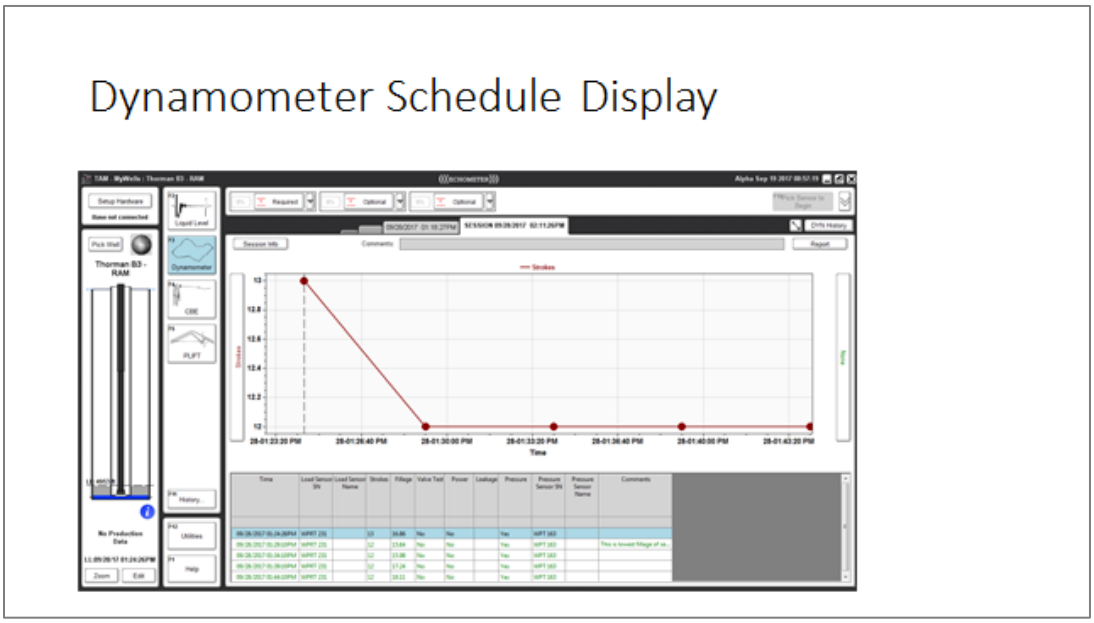
The new acoustic velocity of 1078 ft/s is in agreement with those computed from the other records and is used for this analysis.



This example illustrates the importance of using the schedule history graph to check the accuracy of the computed results.

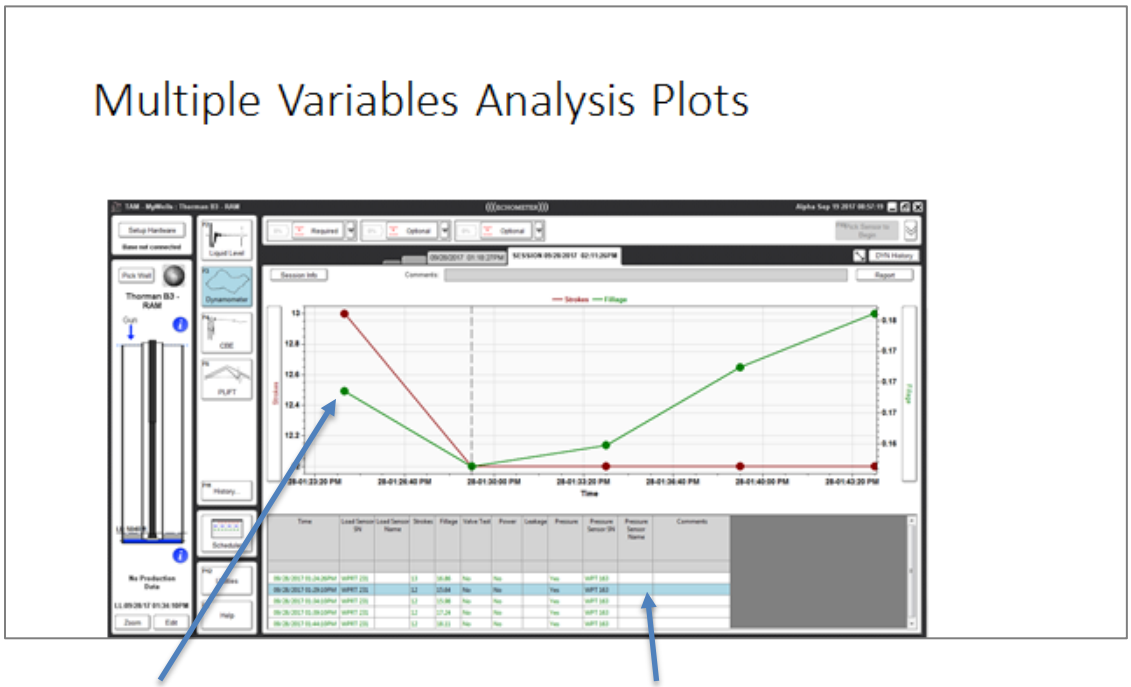
RAM Dynamometer Data Management

The analysis procedure is similar to the Acoustic analysis



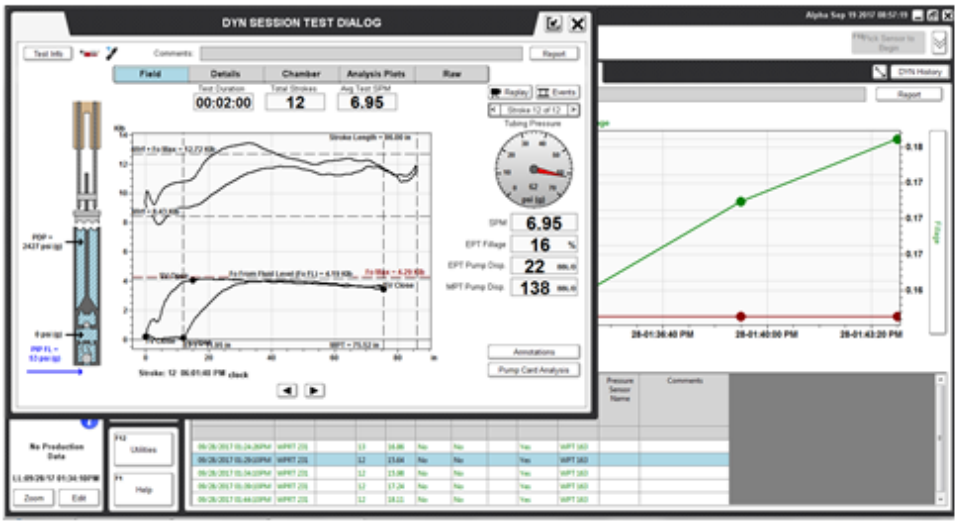
Individual Dynamometer Variables of Interest are displayed graphically.

Individual Dynamometer Records are listed in the spreadsheet.



Clicking on a dot in the graph or on the highlighted row in the spreadsheet opens the corresponding record as shown in the next slide.

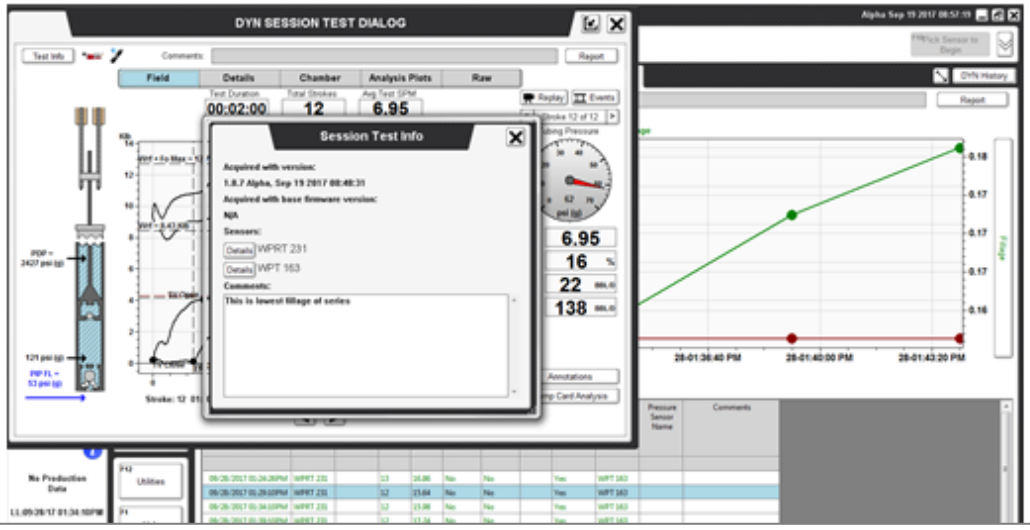
Dynamometer Session Screen in Schedule View



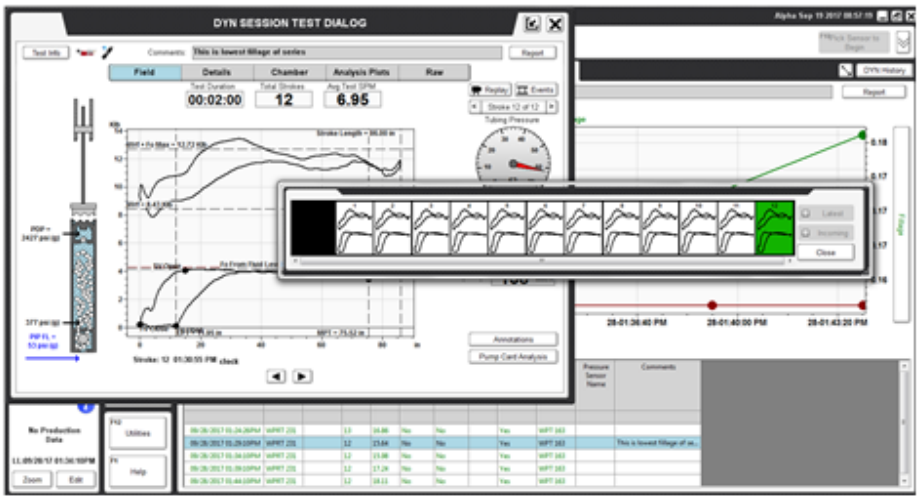
The dynamometer record can be viewed and analyzed in the conventional manner.

All TAM tools, including Replay and Movie making are active as shown in the following figures.

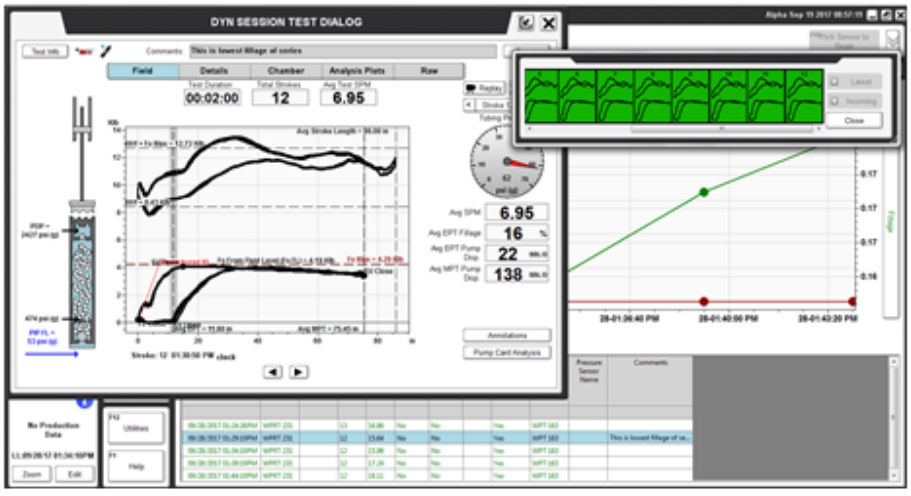
Schedule Session Test Information and Comments



Display of All Dynamometer Strokes

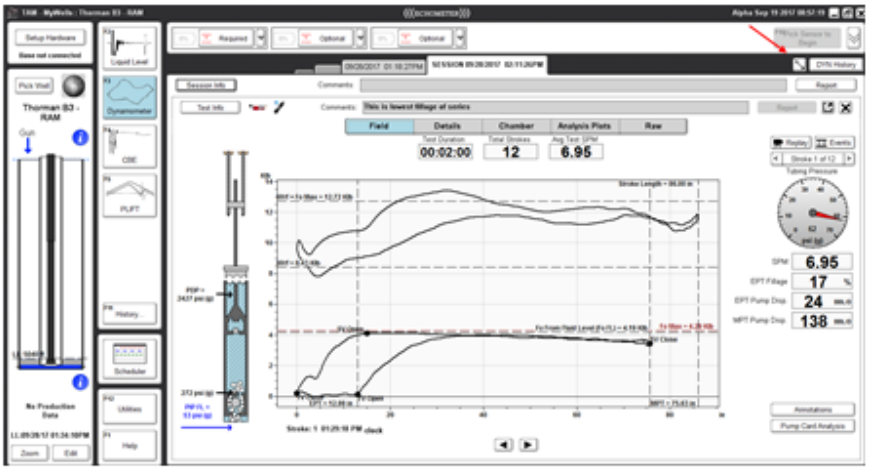


Overlay of All Strokes



Playback of Dynamometer Records

Display and Analysis of Dynamometer Record in TAM Window



The record can be viewed in a full TAM window by clicking on the “Expand” button.