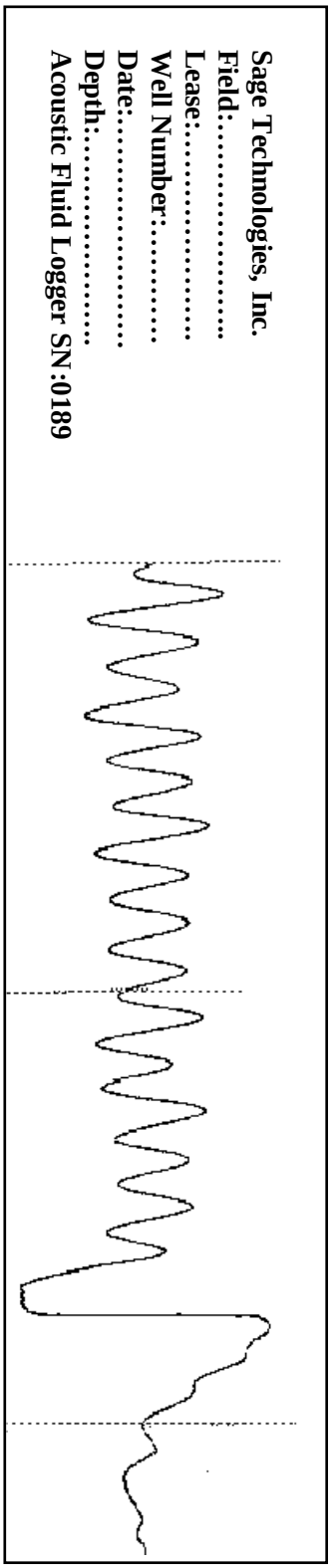
Sage

Precision oilfield products

Acoustic Fluid Logger

and Pressure Pulse Gas Gun

Reference Manual



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How to contact Sage Technologies

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The phone numbers must be prefixed with the United States International dialing code if you are trying to contact us from outside the United States.

Or you may contact us through the Internet:

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Introduction to Acoustic Fluid Logger

With Pressure Pulse Gas Gun and Microphone

The **Acoustic Fluid Logger** collects fluid level measurements on pumping oil and gas wells. Our intent is to allow consistent and accurate fluid level measurements without the need for any specialized knowledge. Therefore, there are no computers to operate. There is no need to make any filter adjustments. Our unit is rugged and operates largely on its own. With the push of a button, you have a fluid level.

The **Acoustic Fluid Logger**, in an advance over other fluid level devices, first stores its signals to memory and then prints them out to tape. This allows a very detailed view of the wellbore to be stored real time and then printed out. A simple count of tubing collars finds the distance to the liquid.

Also, we at **Sage Technologies, Inc.** take the stance that "what you see is what you got." The **AFL system** only outputs data that was gathered real time at the wellhead. No computer smoothing algorithms are applied to the data. We believe that our job is to faithfully reproduce the signals in your wellbore and that your job is to use that information to your advantage.

Included in the AFL system is the **Pressure Pulse Gun and Microphone.** Rated for working pressures of up to 1500 PSI, the stainless steel gas gun shoots a pulse of compressed CO^2 down the annulus of the well; the return signals are received on the internal microphone and transmitted to your recording device via the microphone cable. The gun, with a 2-inch thread, consists of a volume chamber, a valve assembly and a microphone. The gun may be easily disassembled for maintenance.

All of the products at 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 Acoustic Fluid Logger System

- 1 - Acoustic Fluid Logger
    - 6 – rolls thermal paper
    - 1 – Acoustic Logger System manual
    - 1 – wall-mount battery charger
    - 1 – microphone cable

- 1 - Pressure Pulse Gas Gun and Microphone
    - 1 - Charge hose
    - 1 - 2 ½ pound CO^2 bottle, empty
    - 1 - 4" Spanner wrench
    - 1 - Valve and o-ring maintenance tool
    - 1 - O-ring tool
    - 2 - 5/32" Allen wrenches
    - 1 -3/16" Balldrive wrench
    - 1 - O-ring and valve core replacement set
    - 1 - Waterproof carrying case

Other tools needed in the field

- CO^2 bottle must be filled with gas to provide the shot.

- 1 – Set 11-point dividers

- Adjustable wrench for the CO^2 hose and wellhead valves

- 1 - 9/16" wrench for the fittings

Shooting the pumping fluid level

Quick start instructions

- Close the backside valve on the well with an adjustable wrench before set-up.
- Connect the Pressure Pulse Gas Gun to the annulus of the well using the spanner wrench provided.
- Open the backside valve to pressure up the gun.
- Push the shuttle valve into the load position.
- Charge up gas gun chamber by feeding pressure into the gun from the CO^2 bottle thru the charge hose to achieve a positive differential pressure. To do this, stab the charge hose into the fill valve on the side of the gun, marked "Fill."
- Shut in the casing flow line valve, so the shot will not go down the flow line.
- Connect the microphone cable between the Acoustic Fluid Logger and the gun.
- Turn on the Acoustic Fluid Logger unit and verify that the header prints as the paper advances.
- **Press 4 and then C.** This puts the unit in the ¼ compressed mode that makes the tape ¼ of its usual length. This allows you to quickly see if you have a valid fluid level without waiting for a long tape printout.
- **Press *** to put the unit in the standby mode. The header will advance a small amount and the unit waits for your manual shot.
- Shoot the gun by pressing shuttle valve in the fire direction. The unit will start printing.
- Let the printer run until you have seen a valid fluid level kick. **Push Print** at this point to stop the tape.
- Inspect the chart for valid fluid and readable collars.
- If valid fluid is found, **push Print** to get an exact reprint of the same fluid level in its full-length form.
- Otherwise, follow the above procedures to shoot another shot on the well.

Fluid Level Set-up Photographs

Mount the gun on the well with the Spanner wrench provided (shown below).

Open the backside casing valve with a crescent wrench.

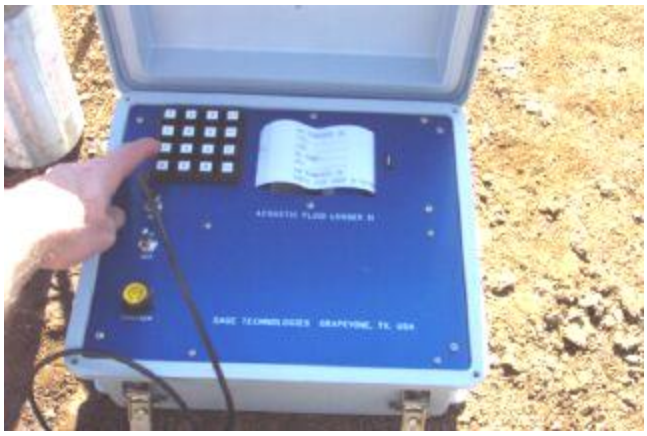
Push the Shuttle Valve into the load position.

Charge up the gun with the charge hose.

Attach the microphone cable from the gun to the unit.

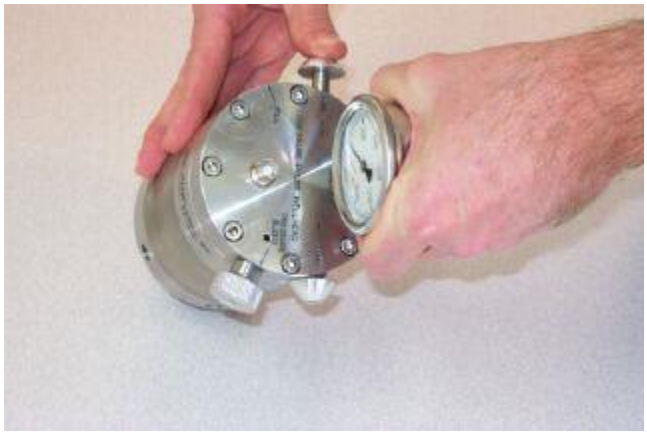
Turn on the unit with the on-off switch.

The header will print the tape after the unit is turned on.



The tape will advance and print the header after pressing 4 C * .

Shoot the gun by pressing the shuttle valve in the fire direction.



The paper tape begins to run when the gun shoots. Let the tape run until a fluid kick is observed.

To remove the gun from the well, start by shutting the casing valve (shown below).

Open bleed valve to release pressure on gun.

Press shuttle valve into the neutral position, to fully release pressure from the gun.

With the bleed valve open and the shuttle valve in the neutral position the gun is ready for removal from the well.

Use the Spanner wrench to loosen gun from wellhead.

Once loose, the gun may be removed from the well by hand.

Keypad and Interface

1	**2**	**3**	**Auto**
4	**5**	**6**	**Man**
7	**8**	**9**	**C**
*****	**0**	**#**	**Print**

* - Wait mode

The wait mode is the standard way to use the Acoustic Fluid Logger.

The **wait mode** allows you to use any manual gun – such of the Pressure Pulse Gas Gun -- with your Acoustic Fluid Logger. By **pressing *** you tell the unit that you will be using a manual gun. To put the unit into the wait mode, **press ***. Then fire a manual shot. When the unit senses that a shot has been fired, it begins to collect the signal.

The wait mode works in tandem with all of the normal operating modes on the Acoustic Fluid Logger. For example, **press 4 C** followed by ***** to place the unit in the 1/4 compression mode, waiting on a shot.

C - (Compressed)

Compressed allows you to print shorter, tighter echoes to tape. Using compressed allows a quick check for fluid level in the field. To use this mode, enter a number between 2 and 8 on the keypad, then **push C.** The number part of the entry is the divisor -- the fraction the unit will use to divide the tape length.

- **2 C** will give you a tape 1/2 the normal length.
- **4 C** is 1/4 the normal length.
- **8 C** is 1/8 the normal length, and so on. Use any number as the divisor -- 2 through 8.

For example, **Press 4 C** and then ***** to put the unit in the standby mode. Then shoot the gun. You will get an echo that is 1/4 the normal length. After identifying that you have a valid fluid level, push **PRINT** to stop the compressed echo and the printer. Then push **PRINT** again to reprint a full-length echo.

PRINT

PRINT has two functions, depending on whether the printer is currently printing or waiting.

1) If the printer is in the process of printing, pushing the **PRINT** key will the stop the current signal from being printed and will return the Acoustic Fluid Logger to the ready state.

2) If the Acoustic Fluid Logger has printed the header and is waiting for instructions, pushing the **PRINT** key will print the current digitized signal in memory. If there is no signal, nothing will be printed.

AUTO

AUTO is used only if you have a remote fire gun.

Generally, the Acoustic Fluid Logger (AFL) is used with the Pressure Pulse Gas Gun – which is a manual gun. To use the Auto mode, you would need to have an AFL with an additional external gun port installed.

If a remote fire gun is to be used, first connect the remote fire gun cable. Then the operator presses **AUTO**, which produces a shot and a tape.

You may also use the compressed mode along with **AUTO**. For example, pressing **4 C**, then **AUTO** would produce a ¼ size tape with a remote fire **AUTO** shot. Or, enter any number between 0 and 255, and then push **AUTO**. Entering a small value number means that only the largest events will be seen. Entering a value of 255 means that the Acoustic Fluid Logger has been set to its maximum-gain value.

The number part of the entry sets only the initial value the Acoustic Fluid Logger will use to gather data for the first 1/4 second. After that, the Acoustic Fluid Logger automatically controls all sensitivity settings.

MAN (Manual mode)

MAN (Manual mode) turns off both the variable collar tracking and variable fluid tracking functions of the Acoustic Fluid Logger.

When in the **MAN** mode, the signal size is not controlled by the Acoustic Fluid Logger. This allows the operator to set the unit to a single setting, where it will remain for the duration of the shot. You may enter any value from 0 to 255. A small value means that only the largest events will be seen. A value of 255 means that the Acoustic Fluid Logger has been set to its maximum-gain value for the duration of the shot.

*Note: Once you push **MAN** the unit immediately starts recording data. So, if you have a manual fire gun, you will have to calibrate the tape from the location of the shot blast on the tape, not from the start of the tape as usual.*

Well Analysis

Identifying the fluid level kick

These tips will help in reading and analysis of the fluid level information printed to tape by the Acoustic Fluid Logger.

- Fluid level is usually the ***deepest kick*** in the well.
- Fluid level is the ***only signal able to move*** on a collar count basis. (If the acoustic velocity of the gas in the well changes due to casing pressure changes, other signals in the well can appear to move, but only as far as return time is considered.)
- Check the fluid level by allowing the printer to run long enough to print out the second reflection of the fluid level at a distance equal to twice the original fluid level. A ***double reflection from the fluid level*** is an excellent confirmation of true fluid level.

What to do if more than one kick is observed

- Allow the casing pressure to build. And, the ***kick that moves*** on a collar basis will be the fluid level.
- ***Shut down the pumping unit*** and give the well noise time to die down (i.e., one to two minutes). Check for other sources of noise while this is going on. Then shoot the well again.
- ***Shut the casing flow line***. When the casing flow line is left open, sound also reflects down the flow line and sometimes can interfere with the shot taken on the well.
- ***Check the tubing tally*** for things like tubing anchor depth, liner depth, depth of special oversized tools in the string, etc.
- Do you have paraffin in this well? ***Paraffin*** rings can cause false fluid levels in wells even in the face of increasing backpressure.

Calculating depth to the fluid in collars

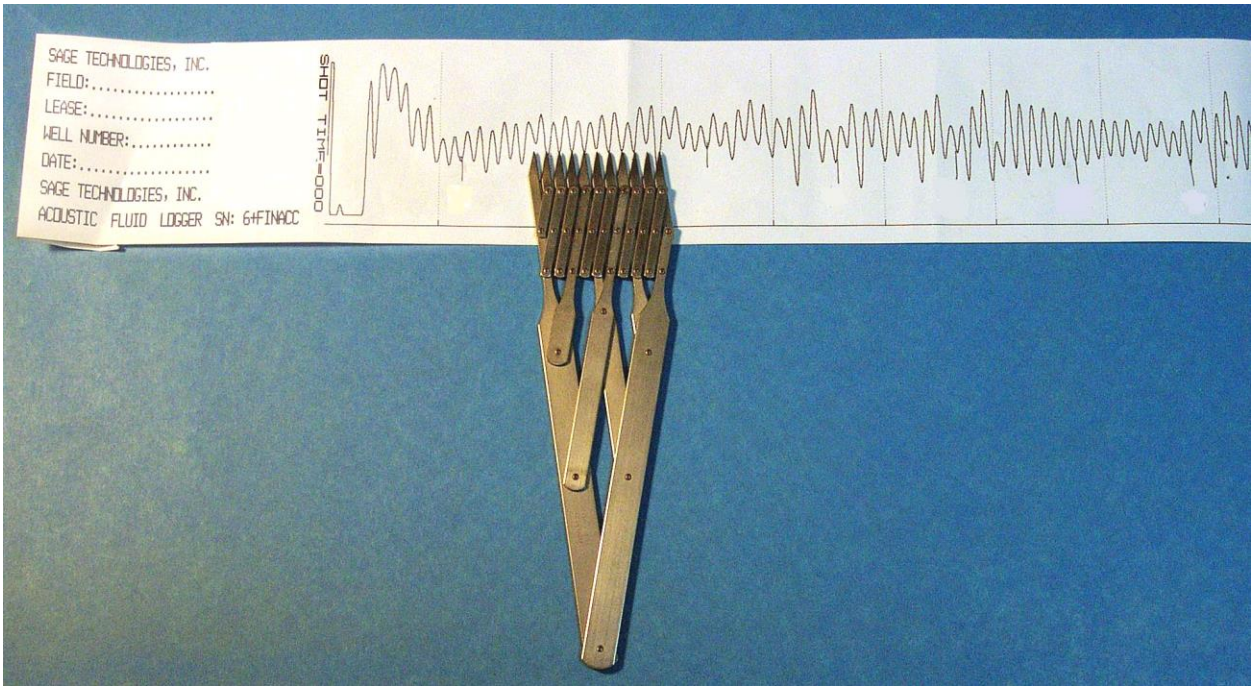
Tubing collars are easily identifiable on most wells. And, by using an **average joint length** for each tubing joint, along with the total number of observed joints, it is possible to calculate the depth to the fluid.

Methods for determining number of joints to the fluid level

Use the ***11-point dividers*** included with the Acoustic Fluid Logger to count each collar from the surface to the fluid level. When collars are not present all the way to the bottom of the well, then the divider setting for the last readable collars should be used to estimate the remaining unreadable collars to the fluid level.

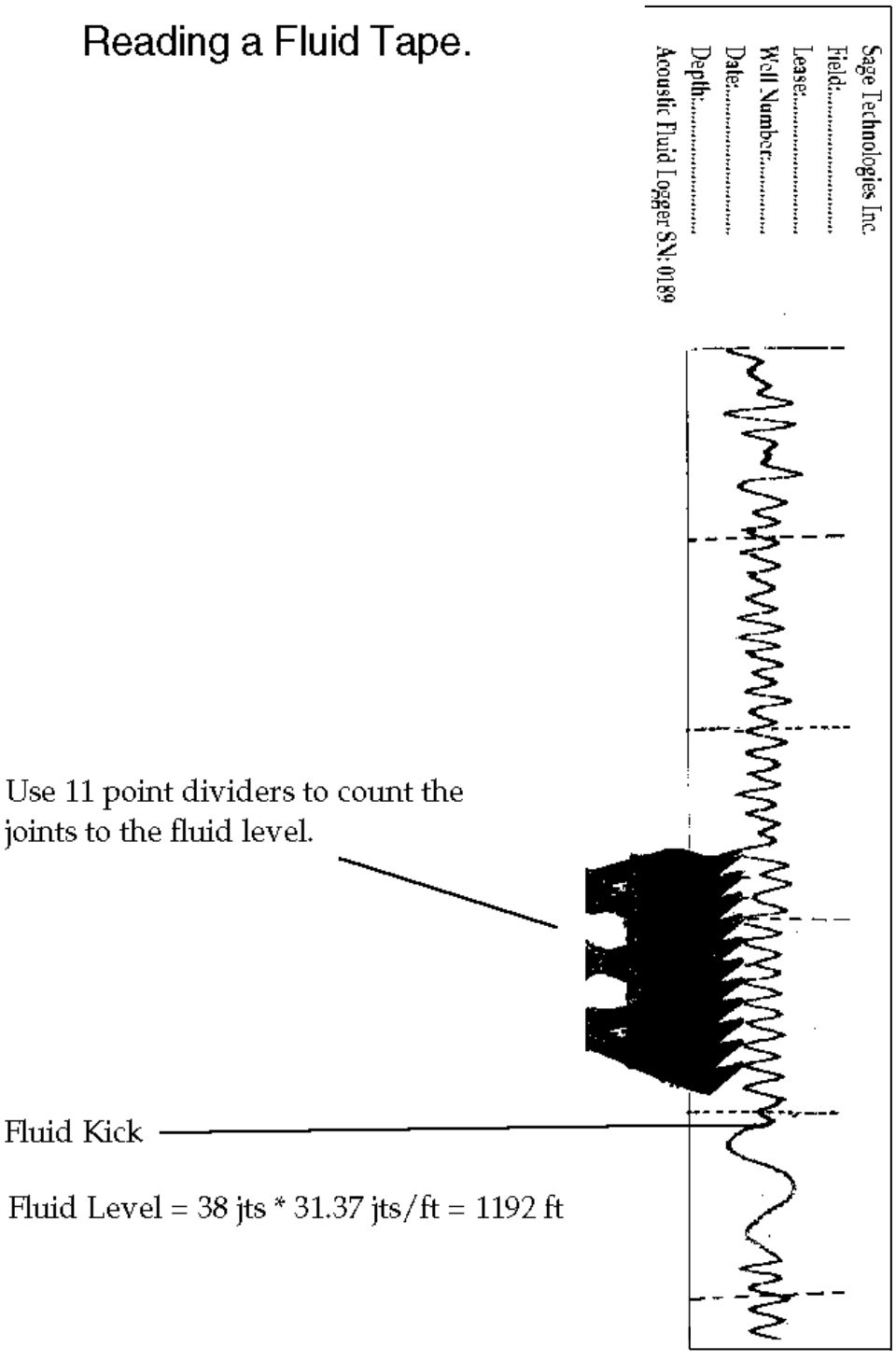
Since the Acoustic Fluid Logger stores charts digitally in memory and then prints after collection, there are no chart speed errors involved as with other fluid level devices.

Reading a Fluid Tape



Use 11-point dividers to count the joints to the fluid level.

Reading a Fluid Tape.



Converting joints to fluid level in feet

Most accurate method

The ***most accurate method*** is to add the actual measured lengths from a tubing tally. This method is time consuming and on older pumping wells a tubing tally may no longer be accessible in the records.

Most common method

The ***most common method*** of getting the fluid depth is to multiply the number of collars by the average joint length. Remember that the depth to perforations is normally measured from the kelly bushing (K.B.) or from the rig floor.

Example:	**in feet**
K.B.	10.00
Hanger	.75
1 pup joint	6.12
180 joints tubing	5625.72
Anchor catcher	2.68
1 joint tubing	31.31
SN (seating nipple)	1.57
1 joint	31.45
Slotted Mud Anchor	28.90
Tubing Landed at	5738.50

5738.50 - 28.90 = 5709.60 feet

Since the pump intake is at the top of the mud anchor we use all lengths from K.B. to the top of the mud anchor to determine the average joint length.

5709.60 feet / 182 jts. = 31.37 feet/jt

The number of joints measured multiplied times the average joint length will give the fluid level in feet from the K.B.

When no joint length is available

When no average joint length is available, then using 31.00/jt is a rule of thumb, with the understanding that there are inaccuracies involved.

Questions and Answers

What affects collar readability?

- Shallow wells are the easiest on which to count the collars all the way down to the fluid level.
- Wells with higher casing pressure are easier than low pressure wells, i.e. wells under 15 psig.
- The tighter the fit between the casing and the tubing collars, the harder it is to get deep collars. Slim hole completions are some of the toughest, as it is very hard for the shot to make its way down the annulus area.

How do I know if the gun is leaking?

- After pressuring up the gun, does the pressure in the gun quickly drop to well bore pressure before you can shoot? If so, you probably need to rebuild the gun.

How do I know if the microphone is dead?

- Disconnect the gun from the microphone and unit. Hook the microphone *only* to the unit with the microphone cable. Test the microphone by pressing **4 C** followed by **1 MAN.** This turns down the sensitivity of the unit. Then, cover the exposed hole on the microphone with your thumb and squeeze, then release. Repeat several times, sealing and unsealing the hole with your thumb. Remember that what you see on the tape is printed **after** it is recorded so wait a couple of seconds for a response. If the microphone is properly sensitive, you should see a large echo for each time the microphone was sealed and unsealed.

Why didn't I get a shot from the gun?

- Check bottle for CO^2.
- Did you charge up the gun?
- Is the microphone cable hooked up properly?
- Is the unit turned?
- Is the battery charged?

Why won’t the unit come on?

- Is the unit turned on?
- Is the battery charged?
- Did the header print? If so, the unit is on and something else is wrong.

Why is the unit printing lightly or printing strange shapes?

- Has the unit been charged lately?

Care and Maintenance

Pressure Pulse Gun - Maintenance Photographs

Supplies needed for maintaining the Pressure Pulse Gas Gun are seven O-rings (two small black, two medium black, one small white and one large black), valve core, maintenance tool, ball-end socket, Allen wrench and channel-lock pliers, as shown below. All are provided with purchase of the gun.

Photo 1, Gun rebuild tools

When disassembling the gun for maintenance, first remove the internal microphone. To remove the internal microphone, first remove the microphone retainer bolt from the bottom of the gun, using a flathead screwdriver or your maintenance tool, as shown below.

Photo 2, Loosen retainer bolt

Photo 3, Remove retainer bolt

Disassemble the gun by removing the eight screws on the top. Remove the screws in opposing fashion, using the ball-end socket, first removing one screw, then the one across from it (not adjacent to it), as shown below. Continue removing screws, alternating opposing sides.

Photo 4, Loosen screws on top of gun

After removing the eight screws from the top, separate the top and bottom pieces for maintenance. Replace and grease the large O-ring on the gun top, as shown below right.

Photo 5, Separate top and bottom of gun

Photo 6, Replace large black O-ring on gun top

Then, replace the small O-ring at the end of the blast tube, as shown below. Clean the inside of the gun by spraying it with petroleum solvent and/or by wiping the surface clean. Grease threads and O-rings liberally with lubricant before reassembling.

Photo 7, Replace small black O-ring on blast stem

Then, remove the Shuttle Valve assembly by using the two Allen wrenches as shown below. Pull the shuttle valve out of the bonnet.

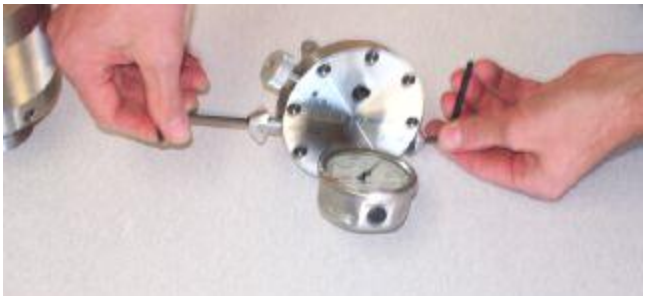


Photo 8, Remove shuttle valve with two Allen wrenches

Cut off damaged O-rings with an X-acto knife. Then replace the one clear and two black O-rings on the shuttle. The o-rings can be loaded onto the shuttle valve with the maintenance tool. Separate the maintenance tool into two pieces. Then use the tapered piece to screw onto the end of the shuttle valve. The o-rings can then be pushed onto the end of the tool.

Photo 9, Remove shuttle valve from gun top

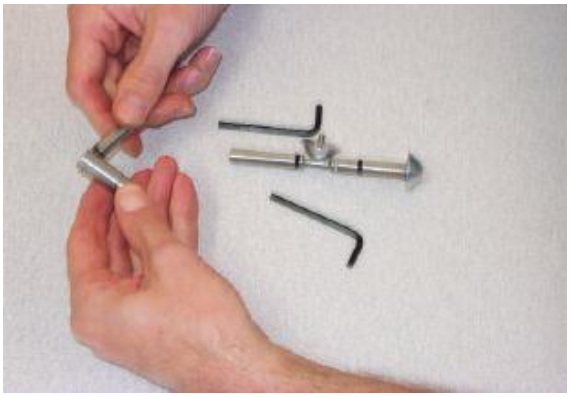


Photo 10, Separate parts of maintenance tool

Photo 11, Attach tapered end of maintenance tool to shuttle, slide replacement o-rings onto shaft

The inside of the gun may be cleaned by spraying it with petroleum solvent and/or by wiping the surface clean. Grease threads and O-rings liberally with lubricant before reassembling.

To reassemble, reinstall the Shuttle Valve in the bonnet top. Then, replace the bonnet top on gun, aligning the microphone holes on the top and bottom. Replace and tighten screws as you would a flange -- tighten in opposing fashion by tightening one screw loosely, then the one across from it (not beside it). After all screws are tightened loosely, tighten with ball-end socket wrench, again in opposing fashion.

For maintenance on the fill valve, use the fill valve cover removal tool to remove the cover exposing the valve core. Use the valve core removal tool to remove the old valve core and replace it with a new one.

Photo 12, Remove fill valve cover to replace valve core

Charging the battery

The rugged, self-contained AFL unit requires a minimum of maintenance. Batteries should be charged regularly after each day's use, using the standard wall-mount charger that accompanies the unit. Simply insert the round, yellow end of the charger cable over the charger port on the unit and tighten the black thumb ring. Then plug the other end of the charger into a standard 110-volt wall outlet. Usually an overnight charge will be sufficient.

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

Occasionally, a damaged battery will need to be replaced. We recommend shipping the unit back to our repair shop for replacement of the battery. While it is possible to replace the battery yourself, it is absolutely necessary to use caution not to damage the internal circuit boards or cut the cables. Prior to replacing the battery, however, efforts should be made to charge the unit with the accompanying battery charger for at least 24 hours.

Note: When storing the AFL unit, always make sure the switch is in the off position, to avoid running down the battery.

Loading thermal paper

Thermal paper rolls must be replaced as they are consumed.

To replace the thermal paper rolls, simply remove the old spool, then replace it with a new spool with the paper unrolling from the bottom, with the tail extending to the right. Place the tail over the silver bar. Turn on the unit, and the automatic paper sensor will see the paper as you push it under the platen. The paper will then thread through the printer and print a header strip when the unit is turned on.

Battery Replacement Procedure and Photographs

Supplies needed for changing the battery on the Acoustic Fluid Logger are: large flathead screwdriver, medium and small Phillips screwdrivers, 5/16" wrench, new 12-volt 7.0 amp standard motorcycle battery.

First, using the medium Phillips screwdriver, remove the four anchoring screws at the four corners of the Acoustic Fluid Logger Front panel, being careful to retain the lockwashers with the screws. (Caution: Dropping a lockwasher or screw into the unit could cause a short on the circuit board during use.)

Photo 1, Remove front panel from Acoustic Fluid Logger

Lift up the front panel, noting that cables connect it to the bottom panel of the unit. Do not disconnect the cables. Move the front panel to the side. Disconnect the red and black battery connections.

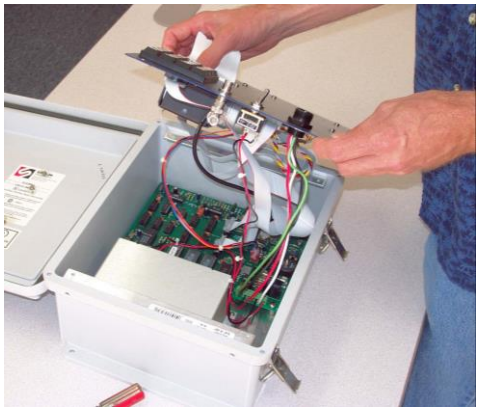


Photo 2, Set the front panel beside the unit

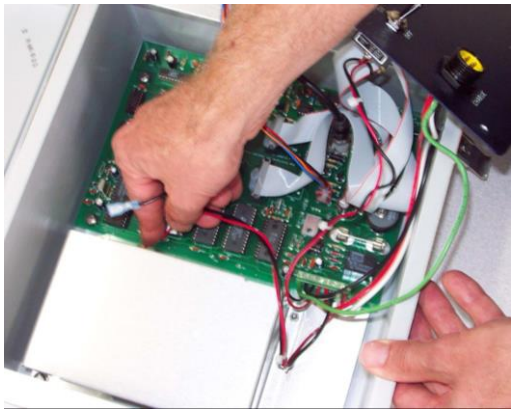


Photo 3, Remove red and black battery connection wires

Next, with the Phillips screwdriver, remove the screws from the four corners of the circuit board to disconnect the circuit board from the bottom plate. Again, be careful to retain all four screws and lockwashers. Then without breaking the wire or cable connections, carefully set aside the circuit board and front panel. This will expose the bottom battery plate.

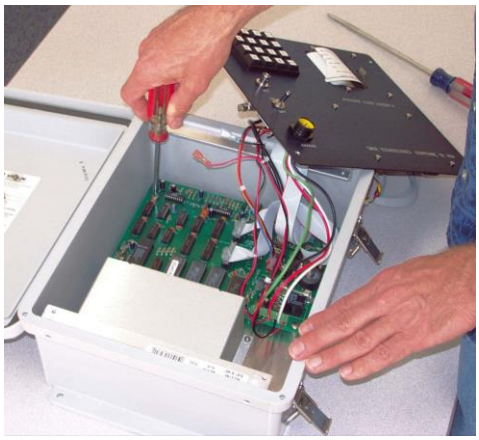


Photo 4, Remove four circuit board screws

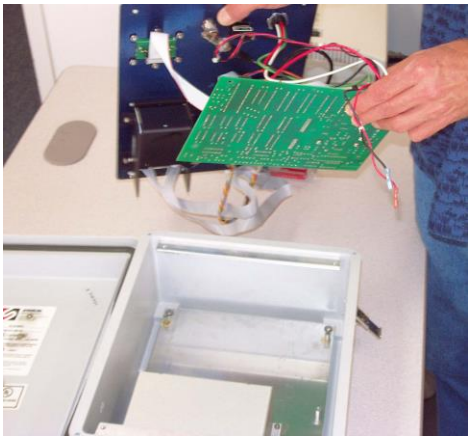


Photo 5, Remove circuit board and front panel

To remove the bottom battery plate, use the large flathead screwdriver to remove the four screws at the corners of the plate. Be careful to retain all four screws and flatwashers.

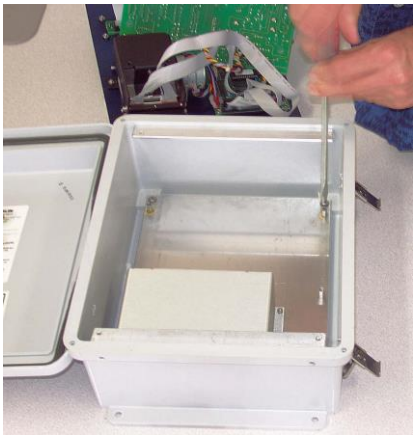


Photo 6, Remove bottom plate screws

Photo 7, Remove battery plate from box

Use the small Phillips screwdriver and a 5/16" wrench to remove the six screws that hold the battery box onto the bottom plate. Retain all six screws, lockwashers and nuts for reuse.

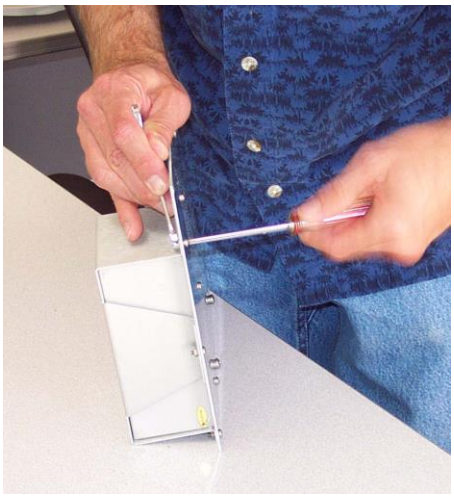


Photo 8, Remove all six battery box screws

The replacement battery is a standard motorcycle battery, and should be readily available at a motorcycle shop. Or if preferred, call Sage Technologies at 817-488-2579 for a replacement. The battery is a 12-volt 7.0 amp standard motorcycle battery.

Photo 9, Replace with standard motorcycle battery, 12-volt, 7.0 amp

Place the battery in the battery box, being careful to assure that the red battery connection faces away from the metal box, and the black connection fits down inside the battery box. When the battery box is placed back onto the bottom plate, the red battery connection will be next to the bottom plate, and the black connection will be toward the top. Note: Place the battery box so that the red connection facing the center of the battery panel, and is directly next to one of the 1/2" standoffs for the circuit board, as shown below.

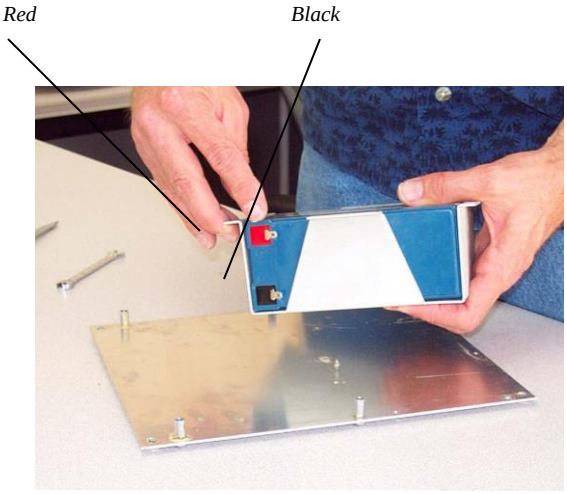


Photo10, Place red battery connection away from base of battery box

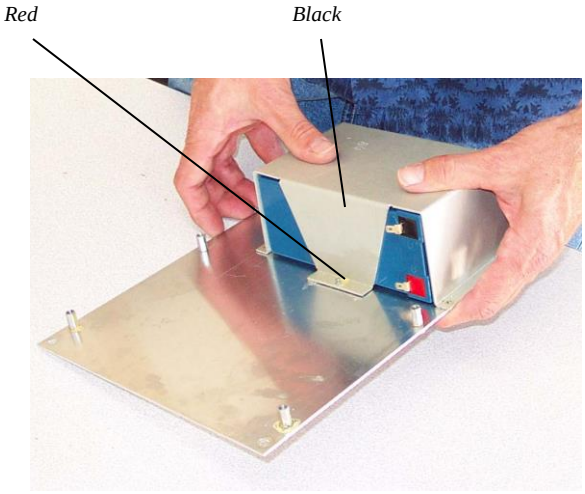


Photo11, Remove all six battery box screws

Replace screws in battery box, pushing screw through bottom plate and through battery box, then replacing the lockwasher and nut on top of the battery box side. Tighten all screws completely. (Note: Screws are #6-32, 3/8" if replacement of lost screws is necessary.)

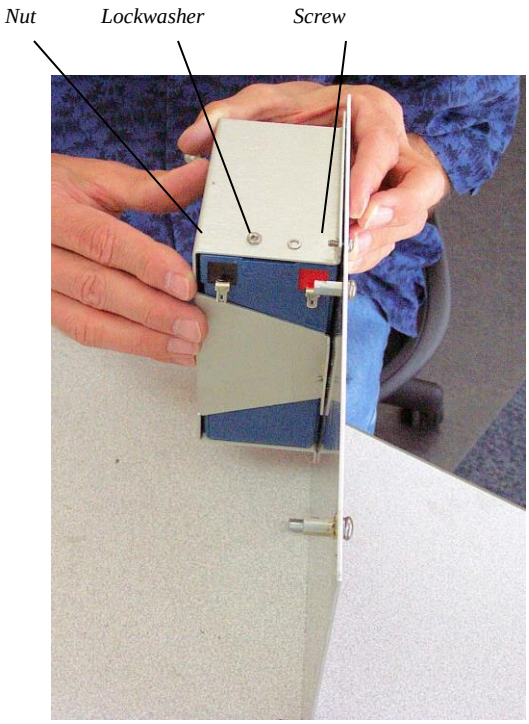


Photo 12, Replace lockwasher and nut on each of six battery box screws

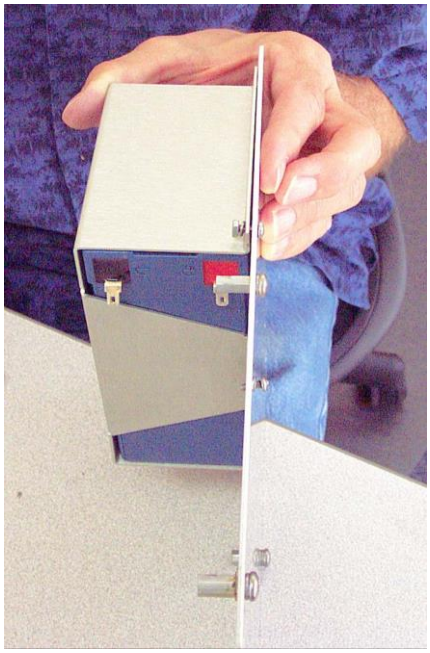


Photo 13, Tighten all six nuts with Phillips screwdriver and 5/16"wrench

To complete battery replacement, reassemble the unit, first reinstalling the battery box with the four #10 3/8" flathead screws and flatwashers. Second, reinstall the circuit board with the four #10 1/4" Phillips screws and lockwashers.

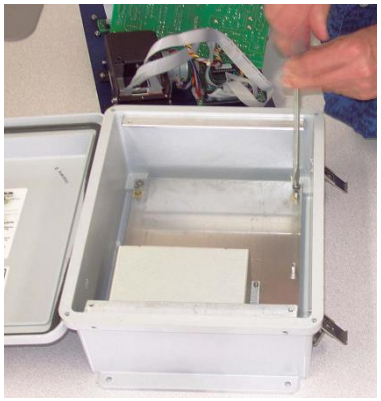


Photo14, Reinstall bottom plate

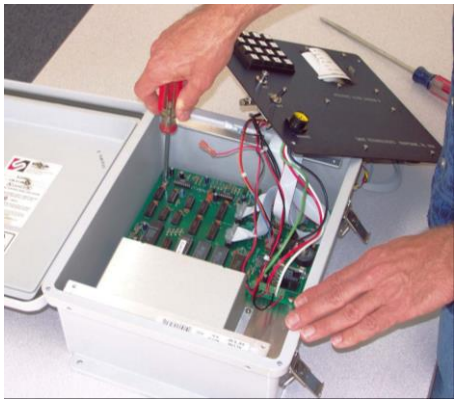


Photo 15, Reinstall circuit board

Next, reconnect the battery cables, being sure to connect the red cable to the red battery connection, and the black cable to the black battery connection. *Important: At this point tilt the box to one side to make sure no hardware has fallen into the box and is lodged under the circuit board. Remove any stray hardware to avoid shorting the circuit board.* Last, refit the top panel to the box, careful not to pinch and of the ribbon cables under the panel. Then, reinstall the front panel with the four #6-32 3/4" screws and lockwashers.

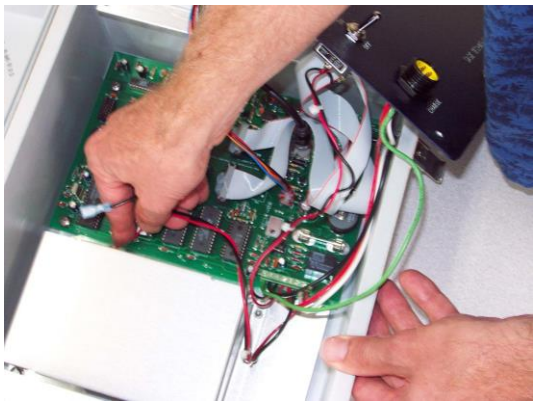


Photo 16, Reconnect battery wires, black cable to black connection and red cable to red connection

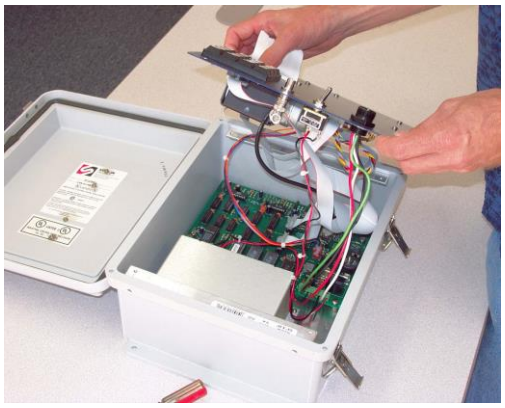


Photo 17, Reinstall front panel on Acoustic Fluid Logger

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This Sage Technologies, Inc.'s product is warranted to be free from defects in material and workmanship for twelve (12) months from the date of original sale by Sage Technologies, Inc. to its customer. This warranty shall extend only to the electronic components incorporated in the product subject to this limited warranty and is available only to wholesale customers who purchase the product directly from Sage Technologies, Inc. The customer shall be solely responsible for all shipping, custom and duty charges necessary for transport of the product to and from Sage Technologies, Inc. and those charges must be prepaid by customer prior to Sage Technologies, Inc.'s obligation to receive the damaged product from customer and return the repaired product to customer.

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