

APPENDIX II - 5000 PSI GAS GUN, IMPLOSION/EXPLOSION OPERATING MANUAL SUPPLEMENT

NOTE - The following covers both the new and the old models of the 5000 psi gas gun.

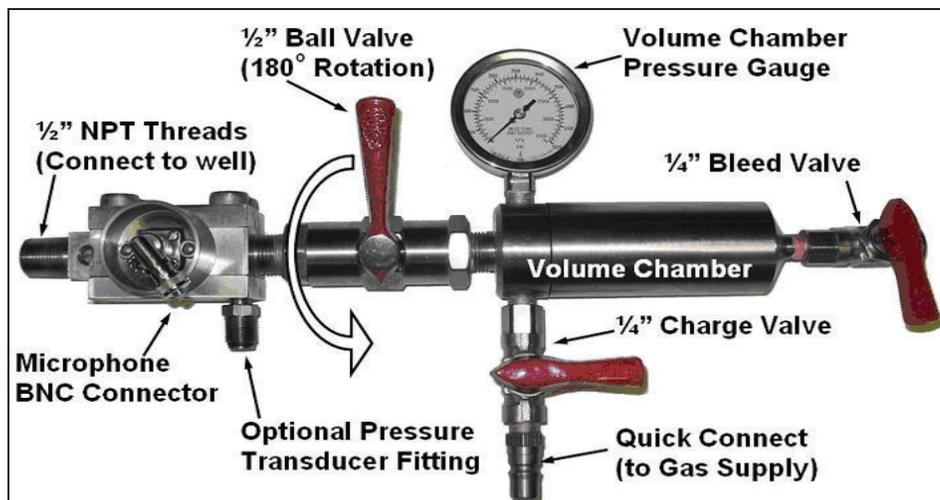
A - SAFETY

Read the operating manual and all pertinent safety information before using this equipment. Always use good safety practices. Contact Echometer Co. (info@echometer.com) if you have any questions about this equipment. Do not exceed 5000 PSI or safe working pressure at any time.

B - GENERAL - GUN OPERATION IN IMPLOSION MODE

The 5000 PSI gas gun is a general purpose gas gun which can be used below the working pressure of 5000 PSI. The gas gun is attached to a valve which opens into the casing annulus or tubing depending upon which is to be tested. The pressure pulse is generated by releasing gas from the well through the (new 180 degree rotation) 1/2" ball valve into the volume chamber.

Figure 1 – New model of 5000 psi gas gun including 180 degree rotation valve, 1/4" charge valve and optional pressure transducer fitting



Depending upon the well, from 100 to 500 PSI well pressure is required for satisfactory operation. The amplitude of the initial pulse can be controlled by the differential pressure between the well and the volume chamber. Generally, a differential pressure of 100 PSI should be sufficient. However, use enough differential pressure so that collars are counted all -the way-to the liquid level and the liquid level signal is distinct if possible.

B1-OPERATING TECHNIQUE -IMPLOSION MODE

1. Verify that the well pressure is less than 5000 PSI. Open the valve to the well and bleed a small amount of gas from the well if possible. Check that liquid is not present at the surface valve. This also removes foreign particles and grease from the valve so that these foreign materials will not be released into the gas gun.
2. Attach the gas gun securely to the valve or fitting on the well. Attach the pressure transducer to the gas gun when the optional pressure transducer is used with the Well Analyzer.
3. Open the 1/2" ball valve (see figure below), and close the 1/4" bleed valve and the 1/4" charge valve.

4. Open the well valve slowly and fully. For best results, the opening between the gas gun and the well should be ½ inch or larger. Needle valves and/or small openings will reduce the accuracy of acoustic liquid level depth measurements. The pressure gauge on the volume chamber indicates well pressure. Do not exceed 5000-PSI WP.
5. Connect the Well Analyzer or Model M amplifier/recorder to the gas gun microphone BNC connector using the Echometer coaxial microphone cable. Follow the directions in the operating manuals concerning operation of the Well Analyzer or Model M amplifier/recorder. Connect the pressure transducer cable if the Well Analyzer and pressure transducer are used.
6. Close the 1/2" ball valve. Open the 1/4" bleed valve and bleed the volume chamber pressure so that the differential pressure between the volume chamber and the well is at least 100 PSI. A larger differential pressure will result in larger reflections from collars, anomalies and the liquid level. Close the 1/4" bleed valve. The pressure pulse is generated by rapidly opening the 1/2" ball valve when a differential pressure exists across the 1/2" ball valve. The valve should be rapidly opened and closed by rotating the valve 180o from the closed position to the open position to the closed position.
7. The well can easily be re-tested by following the steps in (6). If collars are not obtained all the way to the liquid level, use a larger differential pressure. Bleed the volume chamber pressure to 0 PSI if necessary.
8. When finished obtaining acoustic tests, close the valve to the well. Open both the 1/2" ball valve and the 1/4" bleed valve. Then, the Echometer gas gun can be removed from the well.

C - GENERAL - GUN OPERATION IN EXPLOSION MODE

The 5000-PSI gas gun can be used in the explosion mode when the well pressure is low and does not permit satisfactory operation in the implosion mode. In the explosion mode, an external gas source is used to pressurize the volume chamber to at least 200 PSI in excess of well pressure. Then, this gas is rapidly released into the well to generate the acoustic pulse. The volume chamber can be pressurized using CO₂ gas or nitrogen gas. To pressurize the volume chamber, connect the high-pressure hose Quick-Connector Fitting from the CO₂ or N₂ supply bottle to the Quick-Connect Fitting located on the gas gun volume chamber (see figure below). With the 1/2" ball valve and the 1/4" bleed valve in the closed position, slowly open the 1/4" charge valve and pressure the gas gun volume chamber to at least 200 psi above the well pressure. Close the 1/4" charge valve on the gas gun before firing the shot. The acoustic pulse is generated by rapidly rotating the 1/2" ball valve handle 180o and allowing gas to discharge from the volume chamber into the well.

C1 -OPERATING TECHNIQUE- EXPLOSION MODE

1. Verify that the well pressure is less than 5000 PSI. Open the valve to the well and bleed some gas from the well if possible. Check to insure that liquid is not present. This also removes foreign particles and grease from the valve so that these foreign materials will not be released into the gas gun.
2. Attach the gas gun securely to the valve on the well. Attach the pressure transducer to the gas gun when the pressure transducer is used with the Well Analyzer.
3. Open the 1/2" ball valve and close the both 1/4" bleed valve and the 1/4" charge valve.
4. Open the well valve slowly and fully. For best results, the opening between the gas gun and the well should be ½ inch or larger. Needle valves and/or small openings will reduce the accuracy of acoustic liquid level depth measurement. The pressure gauge on the volume chamber indicates well pressure. Do not exceed 5000-PSI WP.
5. Attach the Well Analyzer or Amplifier/recorder to the gas gun microphone BNC connector using the Echometer microphone coaxial cable. Attach the pressure transducer cable if the Well Analyzer is used. Follow the directions in the operating manuals concerning operation of the Echometer Well Analyzer or Amplifier/recorder.
6. Note the pressure in the volume chamber that is the well pressure. Close the 1/2" ball valve. To pressurize the volume chamber, connect the high-pressure hose Quick Connect Fitting from the CO₂ or N₂ supply bottle to the Quick Connect Fitting located on the gas gun volume chamber. Open the gas supply container valve. Add gas using the 1/4" charge valve to charge the volume chamber pressure at least 200 psi above the well pressure. Close the 1/4" charge valve to the gas supply before firing the

shot. The pressure pulse is generated by rapidly rotating the 1/2" ball valve handle 180° when a positive differential pressure exists between the gas gun volume chamber and the well.

7. If satisfactory reflections are not obtained from the collars and the liquid level, try again with a higher pressure in the volume chamber. Do not exceed 5000 PSI.

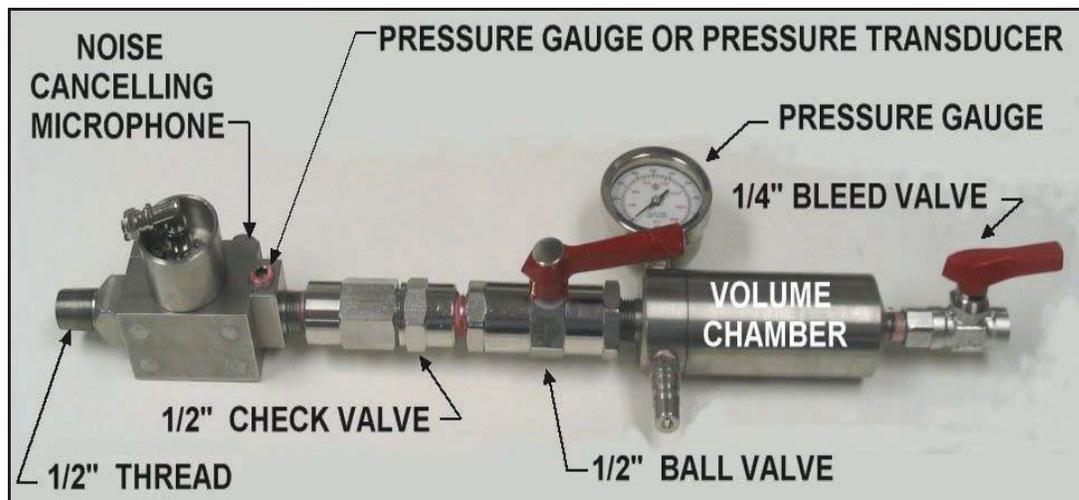
8. When finished obtaining acoustic tests, close the well valve between the gas gun and the well. Close the gas supply container valve. Open the 1/4" bleed valve, the 1/4" charge valve and the 1/2" ball valve to bleed gas from the gas gun, the volume chamber and the hose to atmosphere. Disconnect the gas supply by releasing the Quick Connect Fitting on the hose from the Quick Connect Fitting on the gas gun.

D - GENERAL - OLD MODEL OF THE 5000 PSI GAS GUN

Older models of the 5000 psi gas gun were assembled with a one way check valve designed to suppress internal reflections that cause excessive acoustic noise. The acoustic signal produced by the microphone in the 5000 psi gas gun is affected by pressure resonating in the gas gun volume chamber. When a high energy pressure pulse in the acoustic reflection is detected by the 5000 psi gas gun microphone, the pressure pulse continues into the volume chamber and the volume chamber begins to resonate at a frequency of between 45 and 75 hertz. The resonating frequency of the volume chamber depends on the acoustic velocity of the gas, the higher the acoustic velocity, then the higher the resonating frequency.

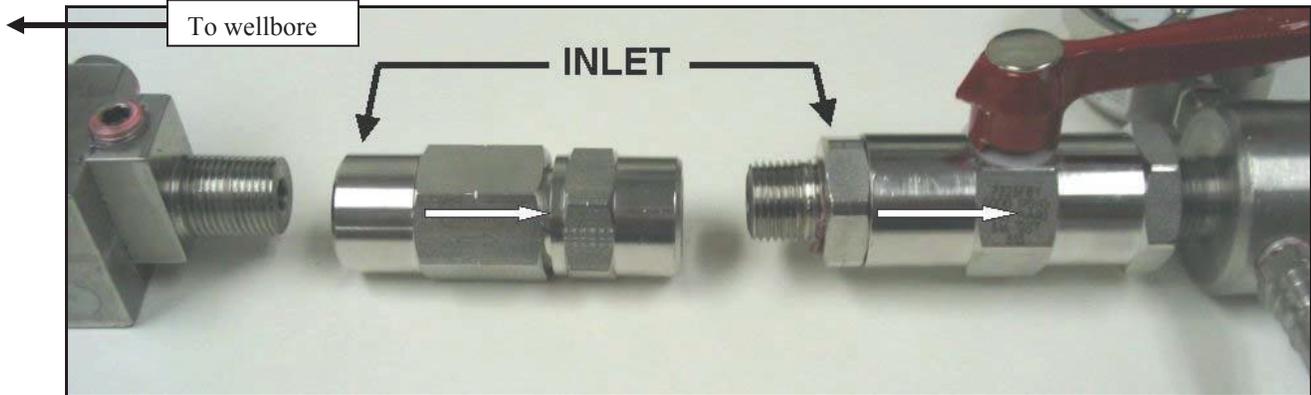
The resonating frequency from the volume chamber can interfere with collar reflections and make counting the tubing collar reflections more difficult. The resonating signal can make the determination of the exact location of liquid level kick more difficult. The purpose of the one-way gas flow check valve is to allow high pressure gas to implode into the volume chamber on the gas gun, but any resonating energy is not reflected back out of the volume chamber because the check is closed (isolating the volume chamber from the microphone). By removing the resonating effect of the volume chamber, the one-way gas flow check valve improves the quality of the acoustic trace from the 5000 psi gas gun and makes analysis of the acquired data easier and more accurate.

Figure 2 – Old model of 5000 psi gas gun with check valve installed



D1 - OPERATING TECHNIQUE -IMPLOSION MODE

The following picture shows how the one-way check valve and 7223F8Y ball valve are installed for implosion gun operation.



Check that the well pressure is less than 5000 PSI. Open the valve to the well and bleed a small amount of some gas from the well if possible. Check to insure that liquid is not present. This also removes foreign particles and grease from the valve so that these foreign materials will not be released into the gas gun.

Attach the gas gun securely to the valve on the well.

Open the 1/2" ball valve and close the 1/4" ball valve.

Open the well valve slowly. Open the well valve fully. Do not exceed 5000 PSI WP.

Attach the Well Analyzer or Model D amplifier/recorder to the gas gun using the Echometer cable. Follow the directions in the operating manuals concerning operation of the Well Analyzer or Model D amplifier/recorder.

Close the 1/2" ball valve. Open the 1/4" ball valve and bleed the volume chamber pressure so that the differential pressure between the volume chamber and the well is more than 100 PSI. A larger differential pressure will result in larger reflections from collars, anomalies and the liquid level. Close the 1/4" ball valve. The pressure pulse is generated by rapidly opening the 1/2" ball valve.

The well can easily be re-shot. Close the 1/2" ball valve. Bleed the volume chamber by opening the 1/4" valve. Then, close the 1/4" valve. Rapidly open the 2" ball valve to re-shoot. If collars are not obtained all the way to the liquid level, use a larger differential pressure. Bleed the volume chamber pressure to 0 PSI if necessary. However, a differential pressure of 100 PSI will be satisfactory on many wells.

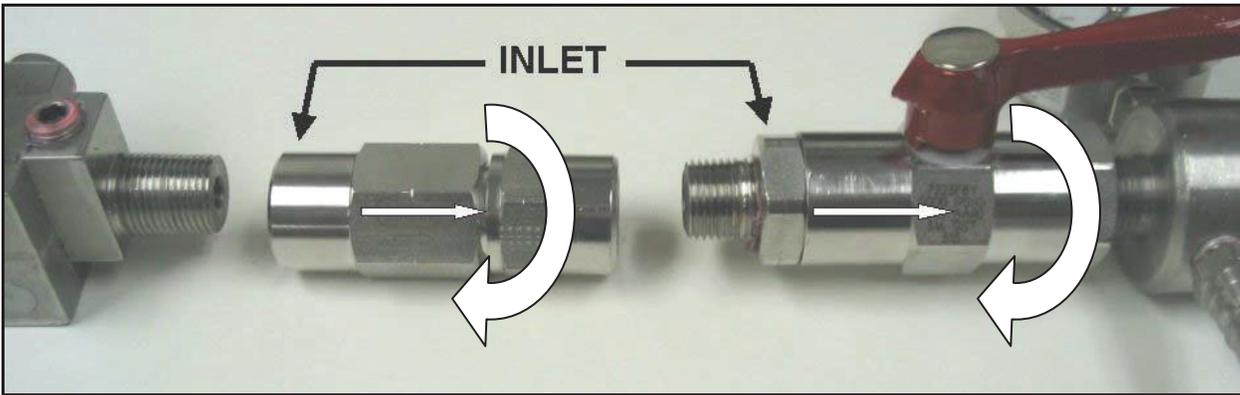
When finished obtaining acoustic records, close the valve to the well. Open both the 1/2" and the 1/4" valves. Then, the Echometer gas gun can be removed from the well.

D2 - OPERATING TECHNIQUE -EXPLOSION MODE

Although the 5000 PSI gas gun is generally used in the implosion mode it can also be used in the explosion mode when the well pressure is too low and does not permit satisfactory implosion operation. A modification of the valve connection needs to be made as detailed below. In the explosion mode, external gas is used to pressurize the volume chamber to a pressure at least 100 PSI in excess of well pressure. If satisfactory operation cannot be obtained by releasing gas from the well into the gas gun, the volume chamber on the gas gun can be pressurized using CO₂ gas or nitrogen gas. To fill the volume chamber, the 1/4" ball valve is connected to a gas supply. The 1/4" ball valve is opened and the 1/2" ball valve is closed. Open the valve on the gas supply and fill the volume chamber 100 PSI above well pressure or safe working pressure, whichever is lower. Then close the 1/4" ball valve. The acoustic pulse is generated by rapidly opening the 1/2" ball valve and allowing gas to discharge from the volume chamber into the well. The well can be re-shot by closing the 1/2" ball valve and refilling the volume chamber through the 1/4" ball valve utilizing the gas in the external supply bottle. Then close the 1/4" ball valve. The gas pulse will be generated when the 1/2" ball valve is rapidly opened.

E - VALVE CONNECTION MODIFICATION

The following picture shows how the one-way check valve and 7223F8Y ball valve are normally installed for implosion gun operation. IN ORDER TO FIRE THE 5000 PSI GAS GUN IN EXPLOSION MODE, THE VALVES NEED TO BE ROTATED 180 DEGREES AND INSTALLED IN THE GUN WITH THE **INLET OF THE CHECK VALVE AND THE INLET OF BALL VALVE** FACING TOWARD THE VOLUME CHAMBER OF THE GUN AND AWAY FROM THE MICROPHONE. Well debris tends to cause the ball valve to leak pressure, if the ball valve is not rotated 180 degrees when used in explosion mode.



Check that the well pressure is less than 5000 PSI. Open the valve to the well and bleed some gas from the well if possible. Check to insure that liquid is not present. This also removes foreign particles and grease from the valve so that these foreign materials will not be released into the gas gun.

Attach the gas gun securely to the valve on the well.

Open the 1/2" ball valve and close the 1/4" ball valve.

Open the well valve slowly. Open the well valve fully. Do not exceed the 5000 PSI WP.

Attach the Well Analyzer or amplifier/recorder to the gas gun using the Echometer cable. Follow the directions in the operating manuals concerning operation of the Echometer.

Note the pressure in the volume chamber which is the well pressure. Close the 1/2" ball valve and connect the 1/4" ball valve to a gas supply source. Open the gas supply source. Slowly open the 1/4" ball valve until the volume chamber pressure increases to approximately 500 PSI above well pressure. Then, close the 1/4" ball valve. The pressure pulse is generated by rapidly opening the 1/2" ball valve when a positive differential pressure exists between the gas gun volume chamber and the well.

The well can easily be re-shot. Simply close the 1/2" ball valve. Slowly open the 1/4" ball valve and fill the volume chamber pressure 10500 PSI above well pressure. If greater responses are desired from the collars and the liquid level reflections, increase the volume chamber pressure to 1000 PSI above well pressure. Close the 1/4" ball valve. To generate the pressure pulse, rapidly open the 1/2" ball valve. If satisfactory reflections are not obtained from the collars and the liquid level, try again with a higher pressure in the volume chamber. Do not exceed 5000 PSI.

When finished obtaining acoustic records on the gas gun, close the valve to the well between the gas gun and the well. Close the 1/4" ball valve and the 1/2" ball valve. Disconnect the gas supply. Slowly open the 1/4" and 1/2" ball valves to bleed gas from the gas gun and volume chamber to atmosphere. When not in use, leave both valves open.

F - MAINTENANCE

Very little maintenance is required for this gas gun except for inspection to insure that the threads, parts and materials are in good condition and have not been subjected to excessive wear or corrosion.

G - INSTALLATION OF THE 5000 PSI GAS GUN TO ACQUIRE ACOUSTIC RECORD

Rig-up for shooting through Tubing: If possible, use a ½ inch NPT to 2 inch High Pressure nipple adaptor, as shown below.



For best results, before attaching the gun to the wellhead, replace any needle valves with ½ inch ball valves in order to minimize energy loss through connection as shown below:

