

# LIQUILIFT™ III

OPERATOR'S MANUAL



**FERGUSON  
BEAUREGARD**

New Intelligence In Problem Solving<sup>SM</sup>

# LIQUILIFT™ III

## OPERATOR'S MANUAL

	PAGE
<b>PLUNGER LIFT OVERVIEW</b>	<b>1</b>
<b>THEORY OF OPERATION</b>	<b>3</b>
CONTROL MODE SELECTION	<b>3</b>
<b>MECHANICAL INSTALLATION</b>	<b>5</b>
DUAL VALVE OPTION	<b>6</b>
<b>ELECTRICAL INSTALLATION</b>	<b>6</b>
CONNECTOR WIRING	<b>7</b>
SOLAR PANEL WIRE INSTALLATION	<b>7</b>
MSO SWITCH WIRE INSTALLATION	<b>8</b>
3-LEAD MSO	<b>8</b>
2-LEAD MSO	<b>8</b>
OTHER AUXILIARY CONNECTIONS	<b>9</b>
<b>GETTING AROUND THE MENU</b>	<b>9</b>
F1 - SET TIMES	<b>9</b>
F2 - DATA HISTORY	<b>9</b>
F3 - SYSTEM INFORMATION	<b>10</b>
SCROLLING	<b>10</b>
CHANGING TIME SETTINGS	<b>10</b>
HOT KEYS	<b>11</b>
DISPLAY CONTRAST CONTROL	<b>12</b>



**FERGUSON  
BEAUREGARD**

New Intelligence In Problem Solving™

TABLE OF CONTENTS

	PAGE
<b>LIQUILIFT III OPERATING PARAMETERS</b>	<b>12</b>
F1 - SET TIMES (DESCRIPTION)	12
F2 - DATA HISTORY (DESCRIPTION)	15
F3 - SYSTEM INFORMATION (DESCRIPTION)	16
CONTROL MODE	17
PRIMARY BATTERY	17
FACTORY RESET	17
PASSWORD	17
<b>PRODUCTION OPERATING SCENARIOS</b>	<b>18</b>
<b>APPENDIX</b>	<b>21</b>
<b>FIGURE 1 - MECHANICAL INSTALLATION</b>	<b>21</b>
<b>FIGURE 2 - MECHANICAL INSTALLATION</b>	<b>22</b>
<b>FIGURE 3 - CONNECTOR WIRING</b>	<b>23</b>
<b>FIGURE 4 - MODULE WIRING</b>	<b>24</b>
<b>GAS REQUIREMENTS - 2" TUBING</b>	<b>25</b>
<b>GAS REQUIREMENTS - 2-1/2" TUBING</b>	<b>26</b>
<b>API FLUIDS DATA</b>	<b>27</b>
<b>SALTWATER DATA</b>	<b>28</b>
<b>GAS COLUMN PRESSURES</b>	<b>29</b>
<b>TUBING TABLES</b>	<b>31</b>
<b>COILED TUBING TABLES</b>	<b>32</b>
<b>RULES OF THUMB</b>	<b>33</b>
<b>CRITICAL FLOW RATES</b>	<b>34</b>
<b>COPY OF DOOR INSTRUCTIONS</b>	<b>35</b>
<b>COPY OF PIEZO FACEPLATE</b>	<b>36</b>



## PLUNGER LIFT OVERVIEW



The use of the plunger lift method of artificial lift in oil and gas wells is increasing at a rapid rate. Several reasons for this increase stem from general developments in the industry.

Plunger lift excels at producing high GLR oil wells and removing liquid accumulations from gas wells. As reservoirs deplete and flowing rates decline, the gas phase becomes less efficient at lifting the liquid phase to the surface. Allowed to continue, the flowing gradient will become heavier until the well loads up with liquid and stops flowing.

One of the most efficient methods of producing liquid involves the use of the cycle controlled plunger. The plunger makes continuous contact with the inside wall of the tubing string, thereby forming an effective seal between the lifting gas and the lifted liquid. Operation of the system is as follows.

- 1 The motor valve on the flowline is closed and the plunger is resting at the bottom of the tubing. Gas Pressure is building in both the tubing and the casing-tubing annulus.
- 2 By opening the motor valve at the surface, gas is produced to a lower pressure separator or gathering system allowing a reduction in tubing pressure. Gas accumulated in the annulus continues to expand into the tubing behind the rising plunger until it is forced to the surface. This pressure reduction is the energy source to move the plunger and liquid slug from the bottom of the tubing to the surface. Storage gas in the casing-tubing annulus and/or formation gas will be the drive mechanism for plunger movement.



- 3 Upon reaching the surface and removing the liquid slug from the tubing, the well controller can either shut-in on plunger arrival or continue to produce gas for a predicted interval.
- 4 When the motor valve closes on the surface flowline, the plunger falls back to the bottom of the tubing string due to gravity. The plunger is not a perfect sealing device and will fall through the fluid that has accumulated in the bottom of the tubing coinciding with the low pressure experienced during the flow cycle. Once enough time has elapsed for the plunger to reach the bottom, the well may be ready to cycle again. Depending on the reservoir, additional pressure build up may be required before another cycle can be made.

In gas wells, smaller tubing, a compressor, or plunger lift is installed to maintain flowing status. Neither the smaller tubing nor a compressor is a permanent solution. They increase the gas velocity initially so that the liquid will be removed from the tubing, however, at some time in the future the gas rate will again fall to an inadequate level and liquid will not be removed from the well creating a loaded or semi-loaded condition. Plunger lift provides a permanent solution at a lower price than any other method.

Once the well stops flowing (if the GLR is high enough), or earlier in an effort to lighten the flowing gradient and increase reservoir draw down pressure, plunger lift can be installed. Plunger lift can be expected to produce the well to depletion. There are no absolute maximum producing rates for plunger lift, as there are none for flowing wells. The limiting producing rate in both cases is as much dependent upon the inflow performance of the well as it is upon its outflow performance.

## THEORY OF OPERATION – LIQUILIFT™ III



The **LIQUILIFT™ III** Controller is an electronic time based well controller. It is a combination of previous designs, allowing the operator to select multiple solutions for well operations. The Customer has the ability to change **Control Modes** from Single Valve, Dual Valve or Intermittent Operation within the same control unit. A key feature with this controller is the **Menu Structure**. This type of operating system allows increased ease of:

- 1 setting operational parameters
- 2 retrieving data and
- 3 system evaluation

**Hot Key** features improve maneuvering from Data Groups and Data Entry. Other exciting enhancements have been added to give the Customer quick access to well and system performance.

The **LIQUILIFT III** Controller operates on time and/or pressure inputs. It does not make any adjustments for plunger speed variation but does have the capability to add off time (Recovery Mode) for a plunger not surfacing during the On Cycle.

### CONTROL MODES SELECTION

The Controller offers you 3 mode selections for well operations.

- 1 To operate with a single motor valve on the flowline select the **PLUNGER MODE**.
- 2 To operate with dual motor valves, perhaps one on the flowline and one redirecting flow to the stock tank, select **TANK MODE**. These 2 applications can operate in SYNChronized MODE and have RECOVERY MODE available for NO ARRIVALS.



- 3 To operate with a single motor valve on the flowline and not make any adjustments to the operation select **INTER MODE**. This mode has a reduced number of operating parameters (TBG ON, TBG OFF and H-L DELAY) and is available strictly for intermittent operation.

This unit can be utilized in a host of different scenarios but is primarily used with Plunger Lift. The controller is manufactured with a single latching solenoid valve for supplying source gas to a diaphragm operated motor valve. If the operator selects the dual valve option (TANK MODE), an external latch valve will be supplied to actuate the second motor valve.

Many features can be used to make the controller function as required. They are briefly described below:

- 1 Pressure switch gauges can be used as an override to turn the controller on or off.
- 2 The controller can be operated from differential pressure if two switch gauges are wired together.
- 3 The MSO switch will permit the controller to detect plunger arrival and Afterflow if time is programmed. If dual valve operation is used the second motor valve will close once the plunger arrival is detected.
- 4 The controller will keep track of the last 15 plunger arrival times and calculate the average run time automatically.
- 5 Selecting Recovery Mode allows additional Off Time if the plunger fails to surface during the On Time .
- 6 Selecting Sync Mode allows the controller to operate under constant time cycles.

- 7 The Intermittent Mode can be selected to simply operate a single motor valve with minimal settings.
- 8 Independent motor valve settings can be made using the TANK MODE.
- 9 The controller operates in hours, minutes and seconds.
- 10 High sales line pressure can signal the controller to shut-in and not attempt to cycle.

These are just a few of the selections and combinations that can be accomplished with this versatile controller.

## MECHANICAL INSTALLATION – LIQUILIFT III



The **LIQUILIFT III** Controller can be mounted directly to a motor valve by using the supplied installation kit.


See Figure 1, Page 21.

### Kit contents are listed below:

- 2 - 3/8-24 x 5/8 SS Bolt
- 1 - 0-30 psi SS Gage - 1/8" NPT Center Mount
- 1 - Combination Flat/Angle Bracket (Black Anodized)
- 1 - Screwdriver

- 1 Place the black combination bracket on the bottom of the enclosure with the short angle section next to the back of the valves. Insert (2) 3/8-24 SS bolts. Using a 9/16 wrench, tighten securely.
- 2 Remove 2 bolts and nuts from the motor valve diaphragm bonnet.
- 3 Attach the enclosure and combination bracket to the motor valve bonnet using the same bolts and nuts.
- 4 Install the 0-30 psi 1/8" NPT center mount gage to the front port for the valve manifold using a 7/16 open-end wrench.



- 5 Gas is supplied to the valve manifold from either the left or right side. The Unit is shipped with a 1/4" NPT plug in the right side of the single valve manifold.
- 6 Using a 1/4" NPT x 1/4 Tube brass straight gas can be supplied from a 30-psi (max) gas source, typically from the drip pot and regulator.
- 7 If an in-line gas filter is used, it is installed into the valve manifold prior to installing the brass straight.
- 8 The Sales Valve output pressure port is located on the bottom. It requires a 1/4" NPT x 1/4 tube, straight or 90, to make connection to the motor valve.  See Figure 2, Page 22.
- 9 Installation can also be made to 2" line pipe using the combination bracket. This requires rotating the combination bracket 180°. This also requires a 2" u-bolt (not supplied) to attach to the vertical 2" pipe.

## **DUAL VALVE OPTION**

If the **TANK MODE** option is selected, an external latch valve will be utilized to actuate the secondary motor valve. The external latch valve functions exactly like the valve manifold built in the Controller, but is contained inside a separate metal housing detached from the controller.


## **ELECTRICAL INSTALLATION – LIQUILIFT III**



The controller solenoid valve, D-Cell battery pack, and/or 6-Volt gel battery (Optional) are wired from the factory using special spring-loaded connectors to protect against electrical shorts and accidental mishaps. The electronic module is located on the back of the faceplate. Connector plugs for the auxiliary devices are provided unpopulated and are snapped into the sockets on the circuit board.


Typically, the only connections required may be the MSO switch and solar panel wire if applicable. A ground lug has been provided to protect the electronics and should be utilized with a copper ground rod to enhance the controller's immunity to transients.


## ■ ■ CONNECTOR WIRING

Plug wiring connectors are provided on the PCB module. Wiring to the plug connector is accomplished by inserting a small screwdriver (provided) into the smaller slot of the two openings located on the end of the plug. Once the screwdriver is inserted in the slot, rotate 90° to secure the screwdriver in place. This action will open the spring connector and allow the wire to be completely engaged to the plug. Removing the screwdriver will clamp the wire in place.  See figure 3, Page 23.

## ■ ■ SOLAR PANEL WIRE INSTALLATION (OPTIONAL)

Provisions have been made to bring the solar panel wire into the left side of the enclosure through a watertight connector.

 **NOTE:** The solar panel orientation should be toward the south or equator for optimum sunlight.

- 1 One wire is marked with a **white stripe** and should be connected to the **positive side** of the 2-pin solar plug connector. The other wire is connected to the negative. The wires are connected as mentioned previously.
- 2 Now that the wires are properly attached to the connector, the plug can be inserted into the socket marked SOLAR located on the module cover plate.  See Figure 4, Page 24.



## ■ MSO SWITCH WIRE INSTALLATION

The MSO switch wire can be brought into the enclosure through 1 of 2 watertight connectors provided on the bottom of the controller. The MSO switch wire can be 3-lead or 2-lead shielded wire. Connection to the plug connector is accomplished in the same manner as described above in the Solar Panel section. Both wire types are described below.

### ■ 3 - LEAD

The 3-lead wire contains 3 separate conductors, 1 RED, 1 WHITE and 1 BLACK.

- 1 Attach the RED wire to the RED + terminal on the plug connector.
- 2 Attach the WHITE wire to the WHITE + terminal on the plug connector.
- 3 Attach the BLACK wire to the BLACK - terminal on the plug connector.
- 4 Now that the wires are properly attached to the connector, the 3-pin plug can be inserted into the socket marked MSO located on the module cover plate.

### ■ 2 - LEAD

The 2-lead wire contains 2 separate conductors, 1 RED and 1 BLACK.

- 1 Attach the RED wire to the WHITE + terminal on the plug connector.
- 2 Attach the BLACK wire to the BLACK - terminal on the plug connector.
- 3 Now that the wires are properly attached to the connector, the 3-pin plug can be inserted into the socket marked MSO located on the module cover plate.


## ■ ■ OTHER AUXILIARY WIRE INSTALLATION

All other connectors are wired in the same manner as described above. The module can except inputs from switch gauges for ON, OFF and HIGH LINE. These all have individual terminals located in the 10 pin plug connector.

## GETTING AROUND THE MENU



The Controller **KEYPAD** is designed for the Operator to move through settings and commands in a **MENU** format. This is divided into 3 main groups as detailed below:

 **NOTE: Always press the MENU/ESC KEY to wake up the display.** This controller conserves battery life by turning off the display after 5 minutes of inactivity. The system is still operating, but nothing is displayed until the keypad is activated.

### ■ ■ F1 – SET TIMES

The **F1** key is a function key that locates you in the data entry section of the menu. This key will enable you to **VIEW** and/or **CHANGE** time settings for the controller to function. Pressing the **F1** key will display the first 4 lines of the controller settings.

### ■ ■ F2 – DATA HISTORY

The **F2** key is a function key that locates you in the data history section of the menu. This key will enable you to **VIEW** cycle counts, plunger arrivals, arrival history by window, plunger run times and cumulative on and off times. Pressing the **F2** key will display the first 4 lines of controller data history.



## ■■ F3 – SYSTEM INFORMATION

The **F3** key is a function key that locates you in the system information section of the menu. This key will enable you to **VIEW** and/or **CHANGE** control options passwords and controller diagnostics. Pressing the **F3** key will display the first 4 lines of controller system information.

## ■■ SCROLLING

Once you have pressed one of the function keys, you can move up or down through the settings and screens by pressing the up and down arrow keys. The up and down arrow keys are located in the lower right hand corner of the keypad.

## ■■ CHANGING TIME SETTINGS

Move through the MENU by pressing **F1** and scrolling to the appropriate time setting. A cursor will be flashing on the left side of the display to indicate which item you will be modifying. **As long as the cursor is on the left side of the display, you are only viewing the settings.** Once you have located the time setting to be changed **PRESS THE ENTER KEY**. This action will cause the cursor to move into the number field. Notice that the cursor is on the left most number. You can move to the right or left, by using the right or left arrow keys, which are located in the lower right hand corner of the keypad. Change the setting to the value that is appropriate and **PRESS THE ENTER KEY**. If you make a mistake or want to keep the same number that was previously shown, **PRESS THE ESC**

**KEY.** Either way, the cursor will always return to the left side of the display with the cursor flashing. This allows you to keep track of the line you just edited.

**REMEMBER:** To change settings – **PRESS ENTER** (change the value) then **PRESS ENTER** again.

To undo changes after entering the number field – **PRESS ESC.**

## ■ ■ HOT KEYS

Understanding how the MENU works is great, however, once you are comfortable with this method, it becomes time consuming to hop around the menu just to check a single setting or option. There is another way to hop from one section of the menu to another; this is done by using **HOT KEYS**. Notice on the door instructions most lines have a **blue** number on the left side. This number is the **HOT KEY** number. From most areas in the MENU structure you can **PRESS** the **1** or **2** digit number and **press ENTER**. The display will change to show the item you have selected. The cursor will be flashing on the left side of the item. You can hop around the MENU very quickly and efficiently to check data, system status or history.

**REMEMBER: BLUE HOT KEYS** – press the 1 or 2 digit number and **PRESS ENTER**.



## ■ ■ DISPLAY CONTRAST CONTROL

This controller contains electronic components, which compensate for ambient temperature conditions. The Liquid Crystal Display (LCD) will sometimes appear to be too dark or too light to read. Make sure that you are at the MAIN MENU by pressing the MENU/ESC KEY. Then, by repeatedly pressing the **LEFT** or **RIGHT ARROW KEYS**, the display contrast can be adjusted to your preference. The controller will remember this setting even after the display goes to sleep.

## LIQUILIFT III OPERATING PARAMETERS



The following is a description of all operating parameters in the **F1, F2** and **F3 MENU GROUPS**. All numbers shown in **BLUE** relate to **HOT KEY** numbers. Also note that all time settings are in **HRS: MIN: SEC** format.

### ■ ■ F1 – SET TIMES

- 03 TBG ON:** TUBING ON TIME is the total amount of time you want the well to stay on for the plunger to arrive at the surface. A good place to start in establishing an ON TIME is by dividing the depth of the tubing by 400.
- 04 TBG OFF:** TUBING OFF TIME is the total amount of time you want the well to stay off or shut in.

- 06 AFTFLW:** AFTERFLOW TIME is the time the well will be allowed to flow after the plunger has surfaced.
- 14 H-L DELAY:** HIGH LINE DELAY TIME is a delay feature for use with a line pressure switch gauge. This delay time allows the normal cycle to make and break contact with this switch during the early part of the ON CYCLE and continue to operate. If the line pressure remains high and the contact is not broken before the delay times out, the well will shut in. This will automatically start the OFF TIME.
- 23 SYNC MODE:** This is a special mode used when synchronized timing is required to reduce interference with other wells in the same gathering system. SYNC MODE enables constant cycles to be programmed. To enable SYNC MODE, select YES from the display. This will allow the FLOW TIME to be entered on the next line (#24). If the Tank Mode is selected, the SYNC MODE may be used to operate the two valves independently (see SCENARIO #2).
- 24 FLOW TIME:** This is the total time that the sales valve can be on. It is generally equal to the ON TIME + AFTERFLOW TIME. This function is not available unless the SYNC MODE is set to YES. The following is an example of time settings when using SYNC MODE and FLOW TIME.

For example:

ON TIME: 30 minutes  
AFTERFLOW TIME: 15 minutes  
FLOW TIME: 45 minutes  
OFF TIME: 1 hour

The total cycle time is OFF TIME + FLOW TIME = 1 hour 45 minutes. This allows afterflow.



**25 RECOVERY MODE:** RECOVERY MODE is a feature, which enables an alternate OFF TIME to be entered if the plunger does not arrive during the ON TIME. The RECOVERY TIME is entered on the next line (#26). If the plunger still does not arrive after the ALTERNATE OFF TIME is used it remains the same for the next cycle. After the plunger arrival is made during the ON CYCLE, the OFF TIME reverts back to the original setting.

**26 RCVRY TIME:** RECOVERY TIME is an alternate OFF TIME used when the plunger does not arrive during the TUBING ON TIME. Be careful with this time when using SYNC MODE. (See Scenario #1 at end of manual).

**30 TANK DELAY:** TANK DELAY TIME is the delay time before the second motor valve is allowed to turn on or open. TANK DELAY TIME always starts timing at the beginning of the TBG ON TIME. It is generally used to sell high-pressure gas down the gas sales line before having to open to a lower pressure to surface the plunger. If the plunger arrives before the delay time expires the TANK ON TIME is bypassed. This option is only available if the TANK MODE is selected.

**31 TANK ON:** TANK ON TIME is the total time the tank valve will be open (provided that the plunger has not arrived). The TANK ON TIME starts at the end of the TANK DELAY TIME. If the tank valve opens and the plunger arrives during the on time, the tank valve will close and the Tubing valve will either start the AFTERFLOW cycle or shut-in (depending on the program status). This option is only available if the TANK MODE is selected.

**32 TANK OFF:** TANK OFF time is the total time that the TANK VALVE is closed during the cycle. The TANK VALVE can be independently programmed from the TUBING VALVE. The TANK OFF time is only available when in TANK MODE and SYNC MODE is set to YES .

## ■ ■ F2 – DATA HISTORY

**50 TBG CYCLES:** TOTAL TUBING CYCLES are the total number of tubing cycles since the totals were last cleared.

**51 PLUNGER CTS:** PLUNGER COUNTS are the total number of plunger arrivals since the totals were last cleared.

**53 PLUNGER RUN TIMES:** PLUNGER RUN TIMES are the actual run times (last 15) and the average of these 15 run times. This line requires you to PRESS the ENTER KEY to retrieve the first 4 lines, then use the down arrow to review the rest of the individual times. These values are retained when you clear the totals.

**54 TTL TBG ON:** TOTAL TUBING ON TIME is the cumulative ON TIME including AFTERFLOW TIME that the TUBING VALVE has been open since the totals were last cleared.

**55 TTL TBG OFF:** TOTAL TUBING OFF TIME is the cumulative OFF TIME that the TUBING VALVE has been closed since the totals were last cleared.



- 56 CLEAR TOTALS:** CLEAR TOTALS does exactly what it says. You must move the cursor to highlight YES and PRESS the ENTER KEY if you want to clear totals. Press ESC or highlight NO and PRESS the ENTER KEY if you decide not to clear totals.
- 57 TANK CYCLES:** TOTAL TANK CYCLES are the total number of tank cycles since the totals were last cleared. This keeps track of how many times the tank valve opened which you can refer to the TBG CYCLES for comparison.
- 58 TTL TANK ON:** TOTAL TANK ON TIME is the cumulative time that the TANK VALVE has been open since the totals were last cleared.

### ■ F3 – SYSTEM INFORMATION

- 60 VERSION:** Software VERSION number.
- 61 SYSTEM STATUS:** SYSTEM STATUS allows you to check the battery voltage, solar panel voltage and any EXTERNAL CONTACTS.
- 62 CONTROL OPTIONS:** CONTROL OPTIONS is a grouping of control features that allow you to customize the Controller for your production needs. They are listed below and on the next page.
- **CONTROL MODE:** Used to change between PLNG (Plunger), TANK and INTER (Intermitter) MODES. When you press the ENTER KEY, you gain access to change the data field. Use the left or right arrow keys to toggle from one to another. PRESS the ENTER KEY to accept YES or NO.

- **PRIMARY BATTERY:** PRIMARY BATTERY can be changed from YES (D-CELL) or NO (GEL CELL). This feature affects the battery discharge rate internally for the circuit board operation. This should default to NO for the AUTO-CYCLE and YES for the LIQUILIFT III.
  
- **FACTORY RESET:** FACTORY RESET can reset the Controller to the original default settings that were programmed from the factory

**63 PASSWORD:** The PASSWORD is a 4-digit number that can be set by you for data protection. This password will go into effect after the LCD goes to sleep. Anyone can still view the settings in the Controller, but settings can not be modified without knowledge of the PASSWORD. When the Controller ask for the PASSWORD to be entered, you can make as many changes as necessary. If the keypad (LCD) goes to sleep, the password is reactivated. To reset the password for everyone to have access, type your password, then select the PASSWORD option again and set to 0000. This will disable any password protection.



## PRODUCTION OPERATING SCENARIOS



The combination of SYNC MODE and RECOVERY MODE allows for a variety of production scenarios. A few examples follow:

**SCENARIO #1:** The below scenario will allow the controller to stay in SYNC with other wells and switch to a longer Sales Off Time (Recovery Time) for a no arrival.

ON TIME: 30 minutes

AFTERFLOW TIME: 15 minutes

SYNC MODE: YES

FLOW TIME: 45 minutes (set by the operator for On Time + Afterflow)

OFF TIME: 1 hour

RECOVERY MODE: YES

RECOVERY TIME: 2 hours 45 minutes (OFF TIME + FLOW TIME + OFF TIME)



**NOTE:** The ON key must be pressed to insure that the controller starts timing properly when SYNC MODE is selected.

**SCENARIO #2:** The below scenario will allow two Sales Cycles for every one Tank Cycle. Notice that the Tank Cycle is twice that of the Sales Cycle.

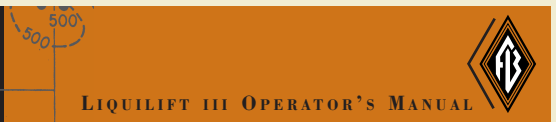
ON TIME: 30 minutes

AFTERFLOW TIME: 15 minutes

SYNC MODE: YES

FLOW TIME: 45 minutes (set by the operator for On Time + Afterflow)

OFF TIME: 1 hour



Sales Cycle = 1 hour 45 minutes (Flow Time + Off Time)

TANK DELAY TIME: 30 minutes

TANK ON TIME: 15 minutes

TANK OFF TIME: 2 hour 45 minutes

Tank Cycle = 3 hours 30 minutes (Tank Delay + Tank On +  
Tank Off)

**IMPORTANT:** It is up to the operator to select cycle times that are even multiples of each other. (i.e. 2 sales cycles per 1 tank cycle). The ON key must be pressed to insure that the controller starts timing properly when SYNC MODE is selected.

**SCENARIO #3:** The below scenario will allow one Tank Cycle for every Sales Cycle and keep the well in sync with other wells in the gathering system. Notice that the Sales Cycle equals the Tank Cycle.

ON TIME: 30 minutes

AFTERFLOW TIME: 15 minutes

SYNC MODE: YES

FLOW TIME: 45 minutes (set by the operator for On Time + Afterflow)

OFF TIME: 1 hour

Sales Cycle = 1 hour 45 minutes (Flow Time + Off Time)

TANK DELAY TIME: 20 minutes

TANK ON TIME: 10 minutes

TANK OFF TIME: 1 hour 15 minutes

Tank Cycle = 1 hour 45 minutes (Tank Delay + Tank On +  
Tank Off)



**SCENARIO #4:** The below scenario will allow one Tank Cycle for every Sales Cycle. Note that SYNC MODE is not enabled.

ON TIME: 30 minutes  
AFTERFLOW TIME: 15 minutes  
SYNC MODE: NO  
OFF TIME: 1 hour

TANK DELAY TIME: 20 minutes  
TANK ON TIME: 10 minutes

In this case the Tank Off time is not available because SYNC mode is not enabled. The TANK DELAY and subsequent tank cycle will automatically start when the Sales OFF time expires. Concurrently, the Sales Valve will open and start the SALES ON timer.

The new Liquilift III electronic controller is a state of the art product designed to ease of operation, and for maximum reliability.

For any questions or comments relating to this or any other Ferguson Beaugard product, please contact us at:

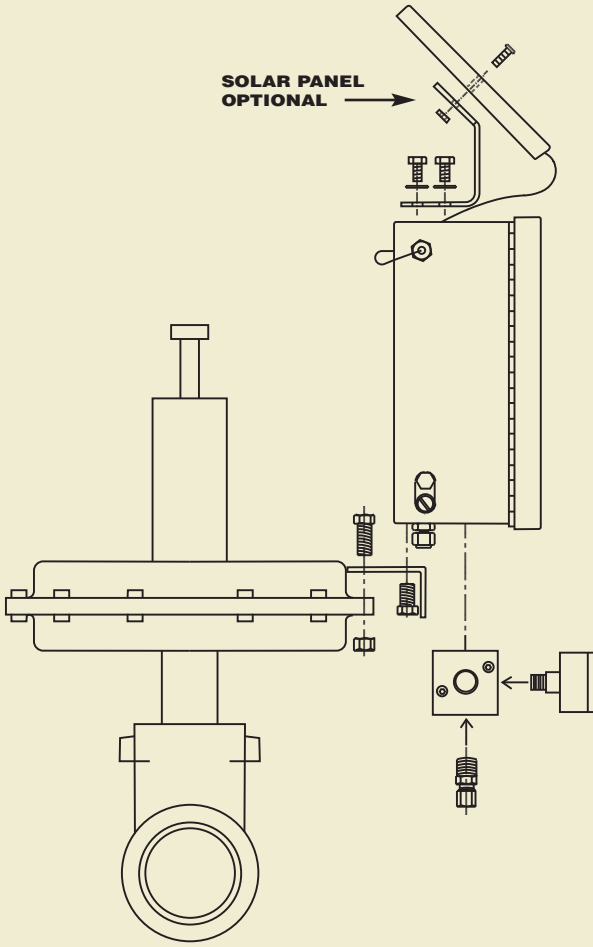
**FERGUSON BEAUREGARD**  
**P.O. Box 130158**  
**Tyler, Texas 75713**

**(903) 561-4851 phone**  
**(903) 561-6567 fax**

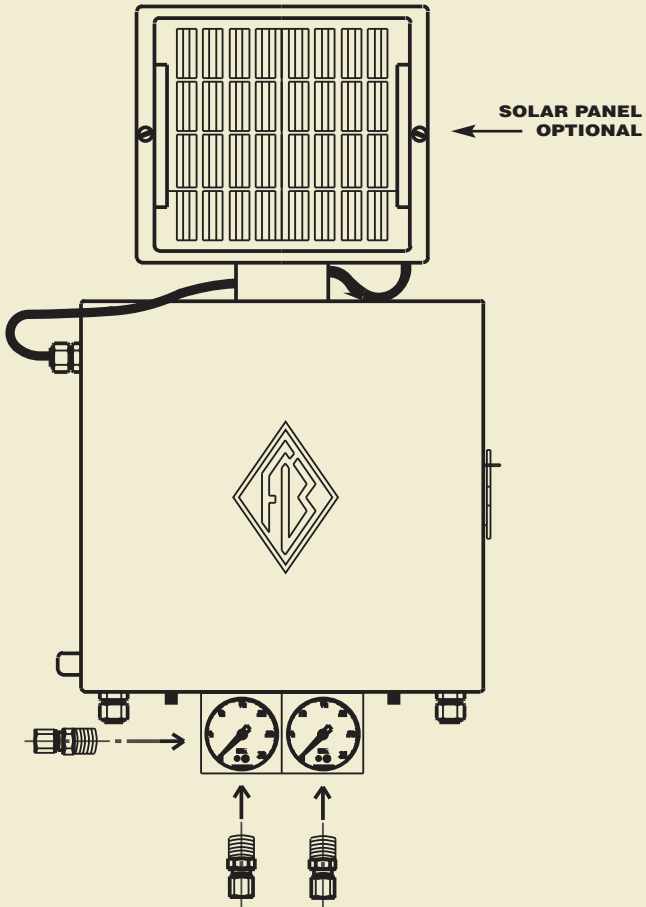
e-mail [staff@FergusonBeaugard.com](mailto:staff@FergusonBeaugard.com)  
Web Site [www.FergusonBeaugard.com](http://www.FergusonBeaugard.com)

Thank you for choosing Ferguson Beaugard.

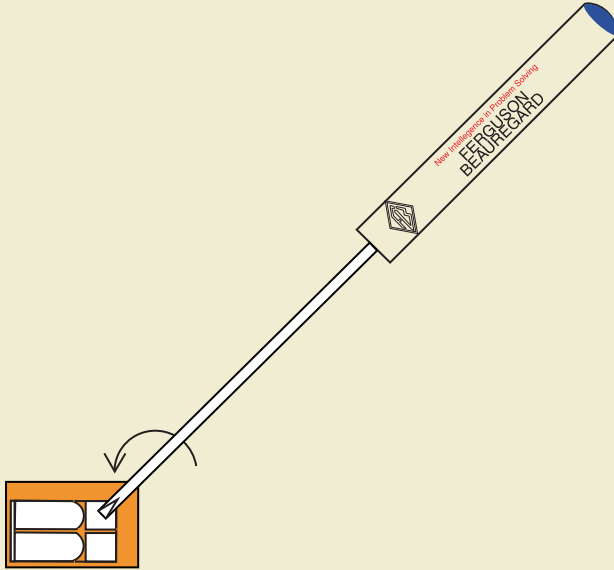
**FIGURE 1**



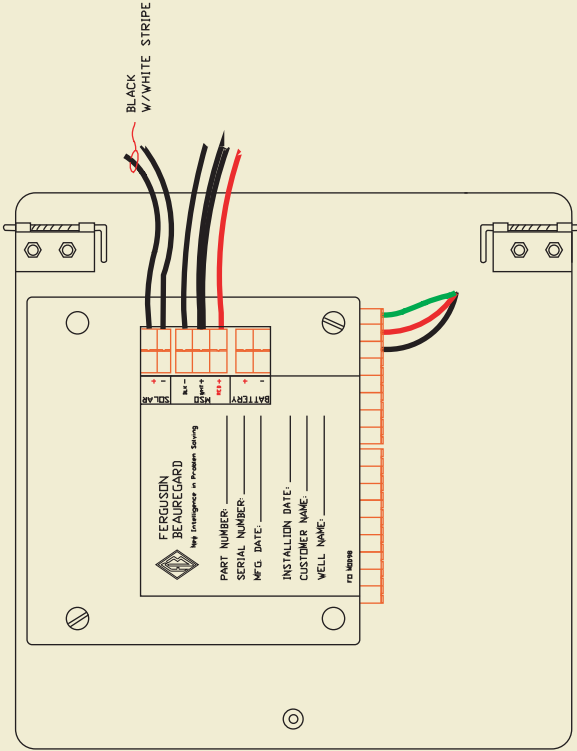
**FIGURE 2**



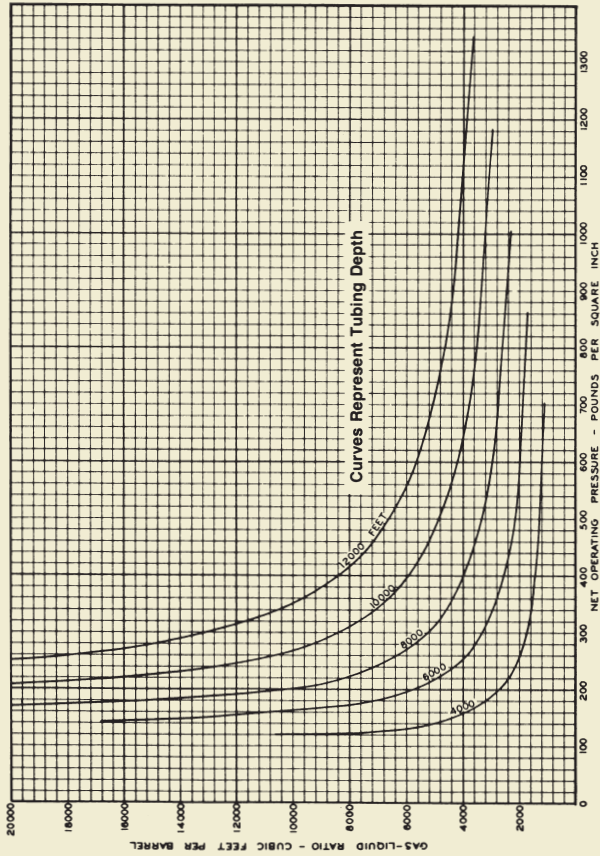
**FIGURE 3 - CONNECTOR WIRING**



**FIGURE 4 - MODULE WIRING**

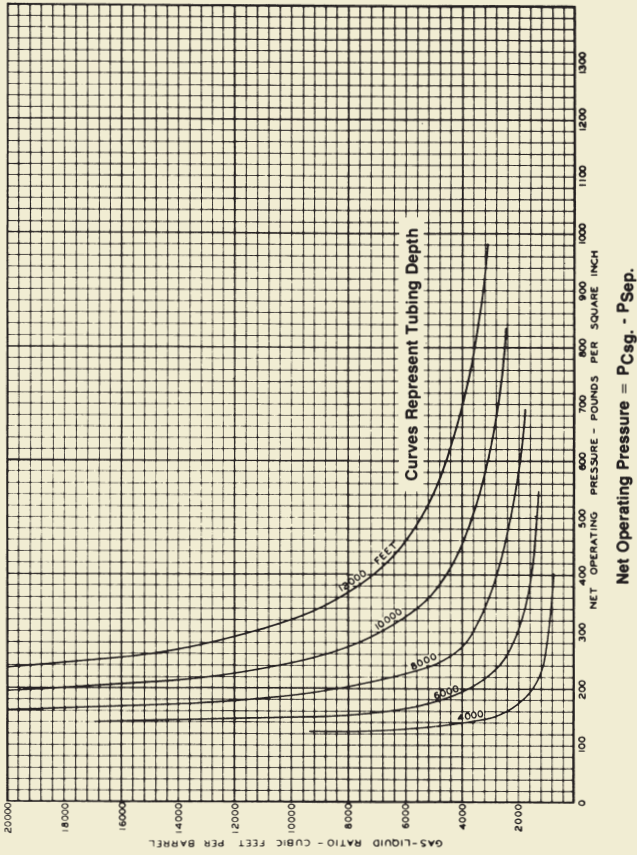


## GAS AND PRESSURE REQUIREMENTS 2-IN. TUBING



# GAS AND PRESSURE REQUIREMENTS

## 2 1/2-IN. TUBING



### APPENDIX

680 680 500 510 850 780 640



# API FLUIDS

Degree A.P.I.	Specific Gravity @ 60° F	Lbs / Gal @ 60° F	Pressure Gradient PSI / Ft	Degree A.P.I.	Specific Gravity @ 60° F	Lbs / Gal @ 60° F	Pressure Gradient PSI / Ft	Degree A.P.I.	Specific Gravity @ 60° F	Lbs / Gal @ 60° F	Pressure Gradient PSI / Ft
0	1.0760	8.9611	0.466	26	0.8984	7.462	0.389	52	0.7711	6.422	0.334
1	1.0679	8.894	0.462	27	0.8927	7.435	0.387	53	0.7669	6.387	0.332
2	1.0599	8.827	0.459	28	0.8871	7.388	0.384	54	0.7628	6.353	0.330
3	1.0520	8.761	0.456	29	0.8816	7.342	0.382	55	0.7587	6.319	0.329
4	1.0443	8.697	0.452	30	0.8762	7.297	0.379	56	0.7547	6.285	0.327
5	1.0366	8.633	0.449	31	0.8708	7.252	0.377	57	0.7507	6.252	0.325
6	1.0291	8.570	0.446	32	0.8654	7.207	0.375	58	0.7467	6.219	0.323
7	1.0217	8.508	0.442	33	0.8602	7.164	0.372	59	0.7428	6.186	0.322
8	1.0143	8.447	0.439	34	0.8550	7.120	0.370	60	0.7389	6.154	0.320
9	1.0071	8.387	0.436	35	0.8498	7.078	0.368	61	0.7351	6.122	0.318
10	1.0000	8.328	0.433	36	0.8448	7.035	0.366	62	0.7313	6.090	0.317
11	0.9930	8.270	0.430	37	0.8398	6.994	0.364	63	0.7275	6.059	0.315
12	0.9861	8.212	0.427	38	0.8348	6.952	0.361	64	0.7238	6.028	0.313
13	0.9792	8.155	0.424	39	0.8299	6.912	0.359	65	0.7201	5.997	0.312
14	0.9725	8.099	0.421	40	0.8251	6.871	0.357	66	0.7165	5.967	0.310
15	0.9659	8.044	0.418	41	0.8203	6.831	0.355	67	0.7128	5.937	0.309
16	0.9593	7.989	0.415	42	0.8156	6.792	0.353	68	0.7093	5.907	0.307
17	0.9529	7.935	0.413	43	0.8109	6.753	0.351	69	0.7057	5.877	0.306
18	0.9465	7.882	0.410	44	0.8063	6.715	0.349	70	0.7022	5.848	0.304
19	0.9402	7.830	0.407	45	0.8017	6.677	0.347	71	0.6988	5.819	0.303
20	0.9340	7.778	0.404	46	0.7972	6.639	0.345	72	0.6953	5.791	0.301
21	0.9279	7.727	0.402	47	0.7927	6.602	0.343	73	0.6919	5.762	0.300
22	0.9218	7.677	0.399	48	0.7883	6.565	0.341	74	0.6886	5.734	0.298
23	0.9159	7.627	0.397	49	0.7839	6.529	0.339	75	0.6852	5.707	0.297
24	0.9100	7.578	0.394	50	0.7796	6.493	0.338	76	0.6819	5.679	0.295
25	0.9042	7.530	0.391	51	0.7753	6.457	0.336	77	0.6787	5.652	0.294



## SALT WATER PRESSURE GRADIENTS

Specific Gravity	Approx. Chlorides PPM	Pounds per Gallon	Pressure Gradient PSI / Ft	Specific Gravity	Approx. Chlorides PPM	Pounds per Gallon	Pressure Gradient PSI / Ft
<b>1.010</b>	9,240	8.42	0.437	<b>1.120</b>	98,800	9.33	0.485
<b>1.020</b>	18,000	8.50	0.441	<b>1.130</b>	106,680	9.42	0.489
<b>1.030</b>	26,520	8.58	0.446	<b>1.140</b>	114,120	9.50	0.493
<b>1.040</b>	34,800	8.67	0.450	<b>1.150</b>	121,560	9.58	0.498
<b>1.050</b>	42,260	8.75	0.454	<b>1.160</b>	129,000	9.67	0.502
<b>1.060</b>	51,730	8.83	0.459	<b>1.170</b>	136,440	9.75	0.506
<b>1.070</b>	60,000	8.92	0.463	<b>1.180</b>	143,880	9.83	0.511
<b>1.080</b>	67,320	9.00	0.467	<b>1.190</b>	151,320	9.92	0.515
<b>1.090</b>	74,960	9.08	0.472	<b>1.200</b>	158,760	10.00	0.519
<b>1.100</b>	83,360	9.17	0.476	<b>1.210</b>	166,200	10.08	0.524
<b>1.110</b>	91,200	9.25	0.480	<b>1.220</b>	173,640	10.17	0.528



# GAS COLUMN PRESSURES

**FERGUSON BEAUREGARD**  
**FACTOR TABLE - GAS COLUMN PRESSURES**  
**BOTTOM HOLE PRESSURE (BHP) = CASING PRESSURE X P<sub>csg</sub> FACTOR**  
**GAS SPECIFIC GRAVITY: 0.65    COMPRESSIBILITY FACTOR: 0.95**

DEPTH FT	P <sub>csg</sub> FACTOR	DEPTH FT	P <sub>csg</sub> FACTOR	DEPTH FT	P <sub>csg</sub> FACTOR	DEPTH FT	P <sub>csg</sub> FACTOR	DEPTH FT	P <sub>csg</sub> FACTOR	DEPTH FT	P <sub>csg</sub> FACTOR
2000	1.0457	3050	1.0695	4100	1.0931	5150	1.1165	6200	1.1398	7250	1.1629
2050	1.0468	3100	1.0706	4150	1.0942	5200	1.1176	6250	1.1409	7300	1.1640
2100	1.0480	3150	1.0717	4200	1.0953	5250	1.1188	6300	1.1420	7350	1.1651
2150	1.0491	3200	1.0728	4250	1.0964	5300	1.1199	6350	1.1431	7400	1.1662
2200	1.0502	3250	1.0740	4300	1.0976	5350	1.1210	6400	1.1442	7450	1.1673
2250	1.0514	3300	1.0751	4350	1.0987	5400	1.1221	6450	1.1453	7500	1.1684
2300	1.0525	3350	1.0762	4400	1.0998	5450	1.1232	6500	1.1464	7550	1.1695
2350	1.0536	3400	1.0774	4450	1.1009	5500	1.1243	6550	1.1475	7600	1.1706
2400	1.0548	3450	1.0785	4500	1.1020	5550	1.1254	6600	1.1486	7650	1.1717
2450	1.0559	3500	1.0796	4550	1.1031	5600	1.1265	6650	1.1497	7700	1.1728
2500	1.0570	3550	1.0807	4600	1.1043	5650	1.1276	6700	1.1508	7750	1.1739
2550	1.0582	3600	1.0819	4650	1.1054	5700	1.1287	6750	1.1519	7800	1.1750
2600	1.0593	3650	1.0830	4700	1.1065	5750	1.1299	6800	1.1530	7850	1.1761
2650	1.0604	3700	1.0841	4750	1.1076	5800	1.1310	6850	1.1541	7900	1.1771
2700	1.0616	3750	1.0852	4800	1.1087	5850	1.1321	6900	1.1552	7950	1.1782
2750	1.0627	3800	1.0863	4850	1.1098	5900	1.1332	6950	1.1563	8000	1.1793
2800	1.0638	3850	1.0875	4900	1.1110	5950	1.1343	7000	1.1574	8050	1.1804
2850	1.0650	3900	1.0886	4950	1.1121	6000	1.1354	7050	1.1585	8100	1.1815
2900	1.0661	3950	1.0897	5000	1.1132	6050	1.1365	7100	1.1596	8150	1.1826
2950	1.0672	4000	1.0908	5050	1.1143	6100	1.1376	7150	1.1607	8200	1.1837
3000	1.0683	4050	1.0920	5100	1.1154	6150	1.1387	7200	1.1618	8250	1.1848



# GAS COLUMN PRESSURES

**FERGUSON BEAUREGARD**  
**FACTOR TABLE - GAS COLUMN PRESSURES**

**BOTTOM HOLE PRESSURE (BHP) = CASING PRESSURE X P<sub>cg</sub> FACTOR**

**GAS SPECIFIC GRAVITY: 0.65    COMPRESSIBILITY FACTOR: 0.95**

DEPTH FT	P <sub>cg</sub> FACTOR	DEPTH FT	P <sub>cg</sub> FACTOR	DEPTH FT	P <sub>cg</sub> FACTOR	DEPTH FT	P <sub>cg</sub> FACTOR	DEPTH FT	P <sub>cg</sub> FACTOR	DEPTH FT	P <sub>cg</sub> FACTOR
8300	1.1859	9300	1.2076	10300	1.2291	11300	1.2505	12300	1.2717	13300	1.2927
8350	1.1870	9350	1.2086	10350	1.2302	11350	1.2515	12350	1.2727	13350	1.2937
8400	1.1880	9400	1.2097	10400	1.2312	11400	1.2526	12400	1.2738	13400	1.2948
8450	1.1891	9450	1.2108	10450	1.2323	11450	1.2536	12450	1.2748	13450	1.2958
8500	1.1902	9500	1.2119	10500	1.2334	11500	1.2547	12500	1.2759	13500	1.2969
8550	1.1913	9550	1.2130	10550	1.2344	11550	1.2558	12550	1.2769	13550	1.2979
8600	1.1924	9600	1.2140	10600	1.2355	11600	1.2568	12600	1.2780	13600	1.2990
8650	1.1935	9650	1.2151	10650	1.2366	11650	1.2579	12650	1.2790	13650	1.3000
8700	1.1946	9700	1.2162	10700	1.2377	11700	1.2590	12700	1.2801	13700	1.3011
8750	1.1956	9750	1.2173	10750	1.2387	11750	1.2600	12750	1.2811	13750	1.3021
8800	1.1967	9800	1.2183	10800	1.2398	11800	1.2611	12800	1.2822	13800	1.3032
8850	1.1978	9850	1.2194	10850	1.2409	11850	1.2621	12850	1.2832	13850	1.3042
8900	1.1989	9900	1.2205	10900	1.2419	11900	1.2632	12900	1.2843	13900	1.3052
8950	1.2000	9950	1.2216	10950	1.2430	11950	1.2643	12950	1.2853	13950	1.3063
9000	1.2011	10000	1.2226	11000	1.2441	12000	1.2653	13000	1.2864	14000	1.3073
9050	1.2021	10050	1.2237	11050	1.2451	12050	1.2664	13050	1.2875	14050	1.3084
9100	1.2032	10100	1.2248	11100	1.2462	12100	1.2674	13100	1.2885	14100	1.3094



# TUBING TABLES

Nominal Size (In)	Wt/Ft w/Coupl.		O.D. (In)	I.D. (In)	Drift Dia. (In)	Cu. Ft. per Lin. Ft.		Lin. Ft. per Cu. Ft.		Barrels per Lin. Ft.	Lin. Ft. per Barrel	Nominal Size (In)
	Non Upset (Lbs/Ft)	Upset (Lbs/Ft)				Lin. Ft.	Cu. Ft.	Lin. Ft.	Cu. Ft.			
1 1/2"	---	2.40*	1.900	1.650	1.516	0.01485	67.35	0.00264	378.1	0.00264	378.1	1 1/2"
1 1/2"	---	2.76*	1.900	1.610	1.516	0.01414	70.73	0.00252	397.1	0.00252	397.1	1 1/2"
1 1/2"	2.75	2.90	1.900	1.610	1.516	0.01414	70.73	0.00252	397.1	0.00252	397.1	1 1/2"
1 1/2"	---	3.64	1.900	1.500	1.406	0.01227	81.49	0.00219	457.5	0.00219	457.5	1 1/2"
2 1/16"	3.20	3.25*	2.063	1.751	1.675	0.01672	59.80	0.00298	335.7	0.00298	335.7	2 1/16"
2"	4.00	---	2.375	2.041	1.947	0.02272	44.01	0.00405	247.4	0.00405	247.4	2"
2"	4.60	4.70	2.375	1.995	1.901	0.02171	46.07	0.00387	258.6	0.00387	258.6	2"
2"	---	5.30*	2.375	1.939	1.845	0.02051	48.77	0.00365	273.8	0.00365	273.8	2"
2"	5.80	5.95	2.375	1.867	1.773	0.01901	52.60	0.00339	295.3	0.00339	295.3	2"
2"	---	6.20*	2.375	1.853	1.759	0.01873	53.40	0.00334	299.8	0.00334	299.8	2"
2"	---	7.70*	2.375	1.703	1.609	0.01582	63.22	0.00282	354.9	0.00282	354.9	2"
2 1/2"	6.40	6.50	2.875	2.441	2.347	0.03250	30.77	0.00579	172.8	0.00579	172.8	2 1/2"
2 1/2"	---	7.90*	2.875	2.323	2.229	0.02943	33.98	0.00524	190.8	0.00524	190.8	2 1/2"
2 1/2"	8.60	8.70	2.875	2.259	2.165	0.02783	35.93	0.00496	201.7	0.00496	201.7	2 1/2"
2 1/2"	---	9.50*	2.875	2.195	2.101	0.02628	38.06	0.00468	213.7	0.00468	213.7	2 1/2"
2 1/2"	---	10.70*	2.875	2.091	1.997	0.02385	41.93	0.00425	235.4	0.00425	235.4	2 1/2"
2 1/2"	---	11.00*	2.875	2.065	1.971	0.02326	43.00	0.00414	241.4	0.00414	241.4	2 1/2"

\* Integral Joint Tubing



# COILED TUBING TABLES

Nominal Size (in)	Wt / Ft (Lbs/Ft)	Wall (in)	O.D. (in)	I.D. (in)	Barrels per 1000 Ft
1 3/4"	1.910	0.109	1.750	1.532	2.280
1 3/4"	2.056	0.118	1.750	1.514	2.227
1 3/4"	2.169	0.125	1.750	1.500	2.186
1 3/4"	2.313	0.134	1.750	1.482	2.134
1 3/4"	2.656	0.156	1.750	1.438	2.009
1 3/4"	2.978	0.175	1.750	1.400	1.904
2"	2.201	0.109	2.000	1.782	3.085
2"	2.503	0.125	2.000	1.750	2.975
2"	2.671	0.134	2.000	1.732	2.914
2"	3.072	0.156	2.000	1.688	2.768
2"	3.638	0.188	2.000	1.624	2.562
2"	3.896	0.203	2.000	1.594	2.468

Nominal Size (in)	Wt / Ft (Lbs/Ft)	Wall (in)	O.D. (in)	I.D. (in)	Barrels per 1000 Ft
1 1/4"	0.847	0.067	1.250	1.116	1.210
1 1/4"	0.941	0.075	1.250	1.100	1.175
1 1/4"	1.081	0.087	1.250	1.076	1.125
1 1/4"	1.172	0.095	1.250	1.060	1.091
1 1/4"	1.251	0.102	1.250	1.046	1.063
1 1/4"	1.328	0.109	1.250	1.032	1.035
1 1/4"	1.502	0.125	1.250	1.000	0.971
1 1/4"	1.597	0.134	1.250	0.982	0.937
1 1/4"	1.823	0.156	1.250	0.938	0.855
1 1/2"	1.426	0.095	1.500	1.310	1.667
1 1/2"	1.523	0.102	1.500	1.296	1.632
1 1/2"	1.619	0.109	1.500	1.282	1.597
1 1/2"	1.741	0.118	1.500	1.264	1.553
1 1/2"	1.836	0.125	1.500	1.250	1.518
1 1/2"	1.955	0.134	1.500	1.232	1.474
1 1/2"	2.239	0.156	1.500	1.188	1.371

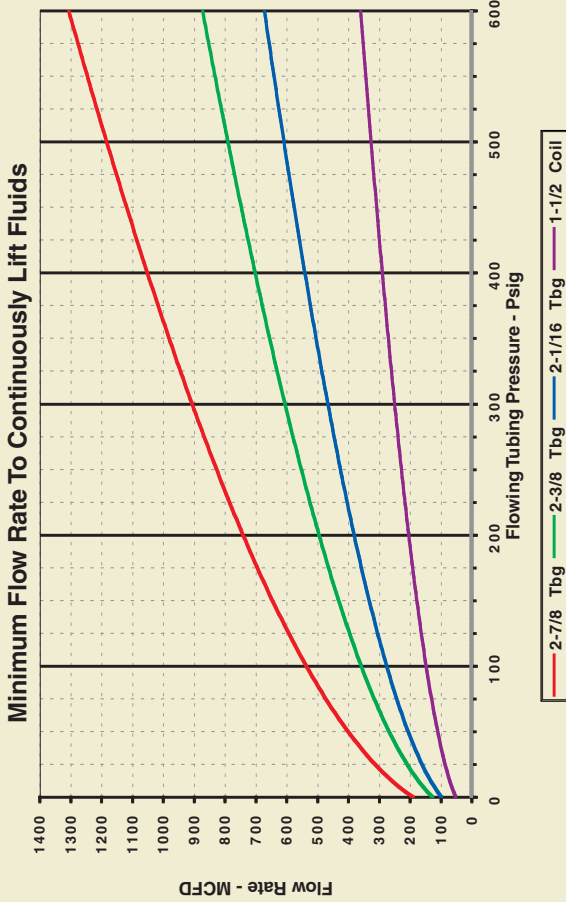


## RULES OF THUMB

- 1 Sufficient gas: 400 scf per barrel of fluid per 1000 feet.
- 2 Sufficient pressure if:  
**Casing Pressure > [2 x (Casing Pressure - Tubing Pressure) + Line Pressure] x 1.25**
- 3 Consistent plunger velocity > 400 FPM



# MINIMUM FLOW RATE TO CONTINUOUSLY LIFT FLUIDS



# LIQUILIFT III MENU SCREENS

**PRESS MENU KEY TO ACTIVATE DISPLAY**

## PLUNGER MODE = 1 VALVE      TANK MODE = 2 VALVES

### F1 SET TIMES

	CONTROL MODE	PLNG / TANK
3	TBG ON	(Tubing On Time)
4	TBG OFF	(Tubing Off Time)
6	AFTFLW	(Afterflow Time)
14	H-L DELAY	(High Line Delay)
23	SYNC MODE (Enable Constant Cycles)	YES/NO
24	FLOW TIME (ie: On Time + Afterflow)	
25	RECOVERY MODE (Enable Alt. Off Time)	YES/NO
26	RCVRY TIME	(Alternate Off Time)
30	TANK DELAY	(Tank Delay Time)
31	TANK ON	(Tank On Time)
32	TANK OFF	(Tank Off Time)

(+): Only available when SYNC mode and/or RECOVERY mode is "YES".

### F2 DATA HISTORY

50	TBG CYCLES	(Total Tubing Cycles)
51	PLUNGER CTS	(Plunger Arrival Counts)
53	PLUNGER RUN TIMES	(Last 15) →
54	TTL TBG ON	(Total Tubing On Time)
55	TTL TBG OFF	(Total Tubing Off Time)
56	CLEAR TOTALS	→
57	TANK CYCLES	(Total Tank Cycles)
58	TTL TANK ON	(Total Tank On Time)

#### HOT KEY USAGE:

Press 1 or 2 digit **HOT KEY #** and then press "ENTER" to view that item.

#### ( → ):

Press "ENTER" to go to next screen, "ESC" to return to previous screen.

#### CHANGE SETTINGS ( ← → ):

While cursor is on the item, press "ENTER" to edit value. After setting is modified, press "ENTER" to accept value or press "ESC" to cancel the change. The LEFT/RIGHT arrow keys can assist changes.

#### SCROLLING ( ↓ ↑ ):

From the Main Menu press (F1) "SET", (F2) "DATA" or (F3) "SYST" to access data groups. Use UP/DOWN arrow keys to view items.

#### NOTE:

**TANK FEATURES SHOWN IN RED.      HOT KEYS SHOWN IN BLUE.**  
All "YES/NO" or Control changes are made using the LEFT/RIGHT arrow keys.

### F3 SYSTEM INFORMATION

60	VERSION	(Software Version #)
61	SYSTEM STATUS	(See Below) →
62	CONTROL OPTIONS	(See Below) →
63	PASSWORD	

#### CONTROL OPTIONS

CONTROL MODE	PLNG, TANK, INTER
PRIMARY BATTERY (D-Cell)	YES/NO
FACTORY RESET	→

#### SYSTEM STATUS

BATTERY VOLTS  
SOLAR VOLTS  
EXTERNAL CONTACTS:

## INTERMITTER MODE

### F1 SET TIMES

	CONTROL MODE	INTER
3	TBG ON	(Tubing On Time)
4	TBG OFF	(Tubing Off Time)
14	H-L DELAY	(High Line Delay)

### F2 DATA HISTORY

50	TBG CYCLES	(Total Tubing Cycles)
51	PLUNGER CTS	(Plunger Arrival Counts)
53	PLUNGER RUN TIMES	(Last 15) →
54	TTL TBG ON	(Total Tubing On Time)
55	TTL TBG OFF	(Total Tubing Off Time)
56	CLEAR TOTALS	→

### F3 SYSTEM INFORMATION

60	VERSION	(Software Version #)
61	SYSTEM STATUS	(See Below) →
62	CONTROL OPTIONS	(See Below) →
63	PASSWORD	

#### CONTROL OPTIONS

CONTROL MODE	PLNG, TANK, INTER
PRIMARY BATTERY (D-Cell)	YES/NO
FACTORY RESET	→

#### SYSTEM STATUS

BATTERY VOLTS  
SOLAR VOLTS  
EXTERNAL CONTACTS:



**FERGUSON  
BEAUREGARD**  
New Intelligence In Problem Solving™



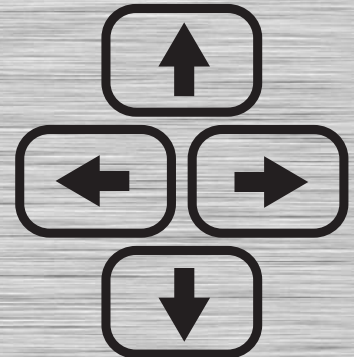
# FERGUSON BEAUREGARD

New Intelligence In Problem Solving<sup>SM</sup>

## LIQUILIFT III



U.S. Patent #4352376□  
U.S. Patent #5146991□  
MADE IN USA ©1998□  
Ferguson Beaugregard□  
(903)561-4851





# FERGUSON BEAUREGARD

New Intelligence In Problem Solving<sup>SM</sup>

P.O. Box 130158, Tyler, Texas 75713-0158

(903) 561-4851 • Fax (903) 561-6567

E-mail: [staff@FergusonBeauregard.com](mailto:staff@FergusonBeauregard.com) • [www.FergusonBeauregard.com](http://www.FergusonBeauregard.com)

This controller meets C.S.A. approval for hazardous locations, C.S.A. file number LR 60176.

Ferguson Beauregard products are designed and manufactured under ISO 9001 Certificate Number: 97-541.

©2001 Ferguson Beauregard. Liquilift is a trademark of Ferguson Beauregard/Delaware Capital Formation, Inc. and is manufactured under one or both of the following patent numbers: U.S. Patent #435376 and U.S. Patent #5146991. FS 1264.1