

PCS 4000™

MULTI WELL CONTROLLER

CONTENTS

Controlling Multiple Wells	2	Remote Controller Report and Function Reference	9
Synchronized Well Production	2	Reports	9
Remote Communication	3	Program Functions	9
Communicating with Synchronized Wells.....	3	Remote Controller Reports	10
Basic Operations	4	How Pressure Operation Works	12
Master Controller’s Faceplate.....	4	Creating a Pressure-Operation Plunger Program	13
Turning the Master Controller On and Off.....	5	Pressure-Operation Selection Functions	13
Status Display	5	Pressure-Operation Control Functions	13
Units of Measurement	5	Features for Opening the A-Valve.....	14
Serial Port for Local Operator Input.....	5	Features for Closing the A-Valve	15
Working with Master Controller Reports and Functions	6	Features for Special Circumstances.....	15
Selecting the Master Controller	6	Sales-Line Safeguard Features.....	16
Reading Reports and Program Functions	6	Using Pressure Operation to Intermit a Well without a Plunger	17
Setting Program Functions	6	Pressure-Operation Selection Functions	17
Pausing Communication.....	6	Pressure-Operation Control Functions	17
Master Controller Reports	6	Features for Opening the A-Valve.....	17
Enabling and Disabling a Remote Controller	7	Features for Closing the A-Valve	17
Enabling a Remote Controller.....	7	Features for Special Circumstances.....	17
Disabling a Remote Controller.....	7	Sales-Line Safeguard Features.....	17
Working with Remote Controller Reports and Functions	8	Troubleshooting	18
Selecting a Remote Controller.....	8	Master Controller Display Problems	18
Operating a Well’s A-Valve and B-Valve Manually	8	Program Cycle Problems.....	18
Reading Reports and Program Functions	8	Solenoid (Shift Valve) Problems.....	21
Setting Program Functions	8	Transducer Problems.....	22
		Communication Problems	22
		Preventive Maintenance	23



CONTROLLING MULTIPLE WELLS

The PCS 4000 Multi Well Controller is a *master* controller that controls from 1 to 8 PCS RM 200 Well Controllers.

The PCS RM 200 Well Controllers are *remote* controllers at the site of each well. The remote controllers do not have keypads or status displays. They receive instructions from and report information to the master controller. In case of communication loss with the master controller, remote controllers can function on their own with some functionality restrictions.

The two main reasons to use a master controller connected to multiple remote controllers are to:

- Control multiple remote wells from one central location through radio communication
- Synchronize the production of multiple wells connected to one sales line and separator

Figure 1 shows 8 wells, each with a PCS RM 200 Well Controller connected via radio communication to a PCS 4000 Multi Well Controller.

Each remote controller's well is assigned to a well group. Wells that share a sales line and separator are assigned to the same well group.

SYNCHRONIZED WELL PRODUCTION

In synchronized well production, 2 to 8 wells in a well group share the same sales line, separator, and optional electronic flow measurement (EFM) device.

Each well in the group has a PCS RM 200 Well Controller. These remote controllers receive instructions from and report information to the PCS 4000 Multi-Well Controller.

Figure 1 shows 2 well groups with synchronized wells:

- Well group 1 has 4 synchronized wells sharing a sales line, separator, and EFM device.
- Well group 4 has 2 synchronized wells sharing a sales line and separator.

If the sales line includes an EFM device, each well in the group has the option to use it. In Figure 1, well group 1 and well group 2 have EFM devices.

Within a well group, the remote controller for each well runs its own operation program using any of the 4 operating modes:

- Mode 1: Time
- Mode 2: Tubing pressure minus sales line pressure
- Mode 3: Casing pressure minus tubing pressure
- Mode 4: Casing pressure minus sales line pressure

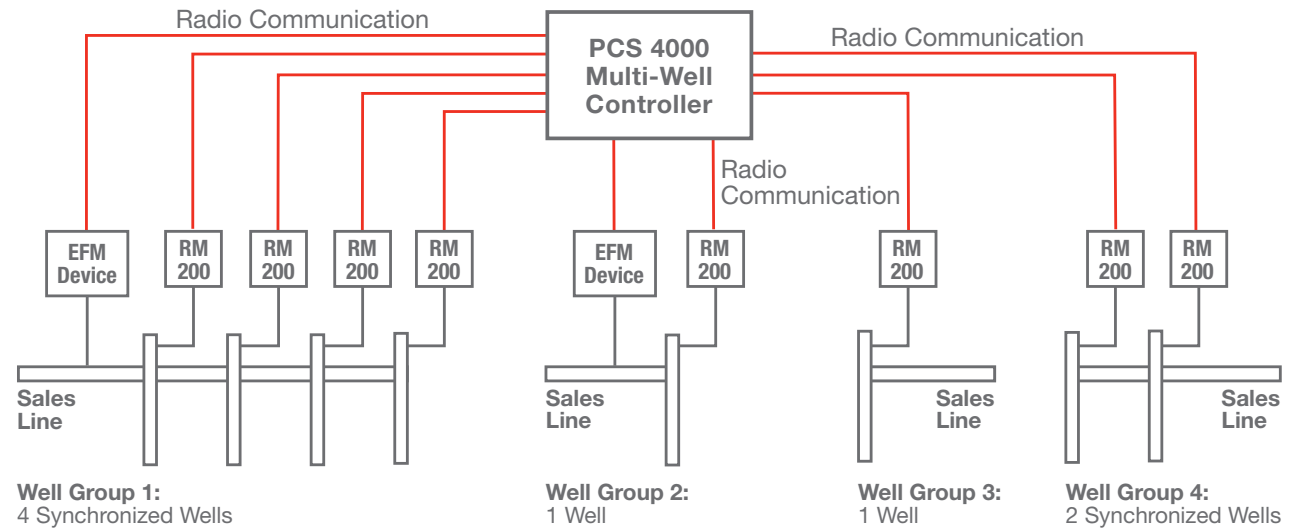


Figure 1 – Controlling Multiple Wells with a Master Controller

For information about the operating modes, see “How Pressure Operation Works” on page 12.

The operation program for each remote controller is set up using the master controller’s keypad and status display.

Each remote controller signals the master controller when it is ready to open its A-valve and sell gas.

In each well group, the master controller allows only 1 well at a time to open its A-valve and sell gas. In addition, the master controller monitors sales line pressure and flow rate for each well group.

The remote controllers monitor their well’s casing pressure and tubing pressure.

The master controller keeps a priority list of all wells in the well group. The well that sold gas last is at the bottom of the list. The well that is currently selling gas is at the top of the list. When that well finishes selling gas, the master controller signals the first well on the list that is ready to sell gas to open its A-valve. If the first well on the list is not ready to sell gas, the master controller by-passes it for the next well on the list that is ready to sell gas.

All by-passed wells retain their position on the priority list. The next time the master controller is ready to signal a well to open its A-valve, it checks the well at the top of the list. If that well was by-passed but is now ready to sell gas, the master controller signals it to open its A-valve.

Normally, only 1 well will be open at a time. However, 2 wells may be open for a brief period if an operator opens a well manually. As soon as the master controller receives information that a well has been opened manually, it closes the other well but allows that well to maintain its position on the priority list.

Note: Because of radio communication latency (delay time) or multiple wells waiting in “ready” mode, 2 wells may turn on briefly. The master controller will recognize this and shut in 1 well the next time that it scans the status of the remote controllers.

REMOTE COMMUNICATION

The master controller communicates with the 1-8 remote controllers and the 1-8 electronic flow measurement (EFM) devices approximately every 10 seconds, depending on the number of wells scanned and the quality of the radio signal.

Note: The master controller may be wired directly to 1 or more remote controllers and EFM devices. The master controller communicates with all devices, whether wired or wireless, approximately every 10 seconds.

During communication scans:

- Each EFM device sends sales line pressure and flow rate information to the master controller.
- Each remote controller sends its status (ready or not ready to sell gas) and its casing and tubing pressure readings to the master controller.
- The master controller sends sales line pressure and flow rate information to the remote controllers and optional information about which well is open to the EFM devices.

The remote controller that is selling gas sends a signal to the master controller when it closes.

After all scheduled communication is finished, the master controller sends each remote controller a sleep command. The remote controller turns off its radio for 10 seconds and goes into sleep mode to conserve power. MODBUS BUSY appears for a few seconds on the master controller’s status display when a remote controller is in sleep mode.

Communicating with Synchronized Wells

In a synchronized well group, the master controller does not signal a remote controller to open its well unless communication between the 2 controllers is stable. The master controller skips the remote controller if communication is not stable.

If communication between the master controller and a remote controller fails, the master controller records a communication error. STATUS UNKNOWN appears for that remote controller on the master controller’s status display.

If communication continues to be unstable, the master controller:

- De-activates the remote controller
- Attempts to communicate with the inactive remote controller only when all communication with active remote controllers is complete

If communication improves, the master controller re-activates the remote controller and places it at the bottom of the well priority list.

If communication between an inactivate remote controller and the master controller continues to fail, the master controller disables the remote controller and removes it from its well group. After a remote controller has been disabled, an operator must manually re-enable it. See “Enabling a Remote Controller” on page 7.

BASIC OPERATIONS

Master Controller's Faceplate

Figure 2 shows the PCS 4000 Multi Well Controller's faceplate with the power on/off switch, status display, keypad, and serial port for local operator input.

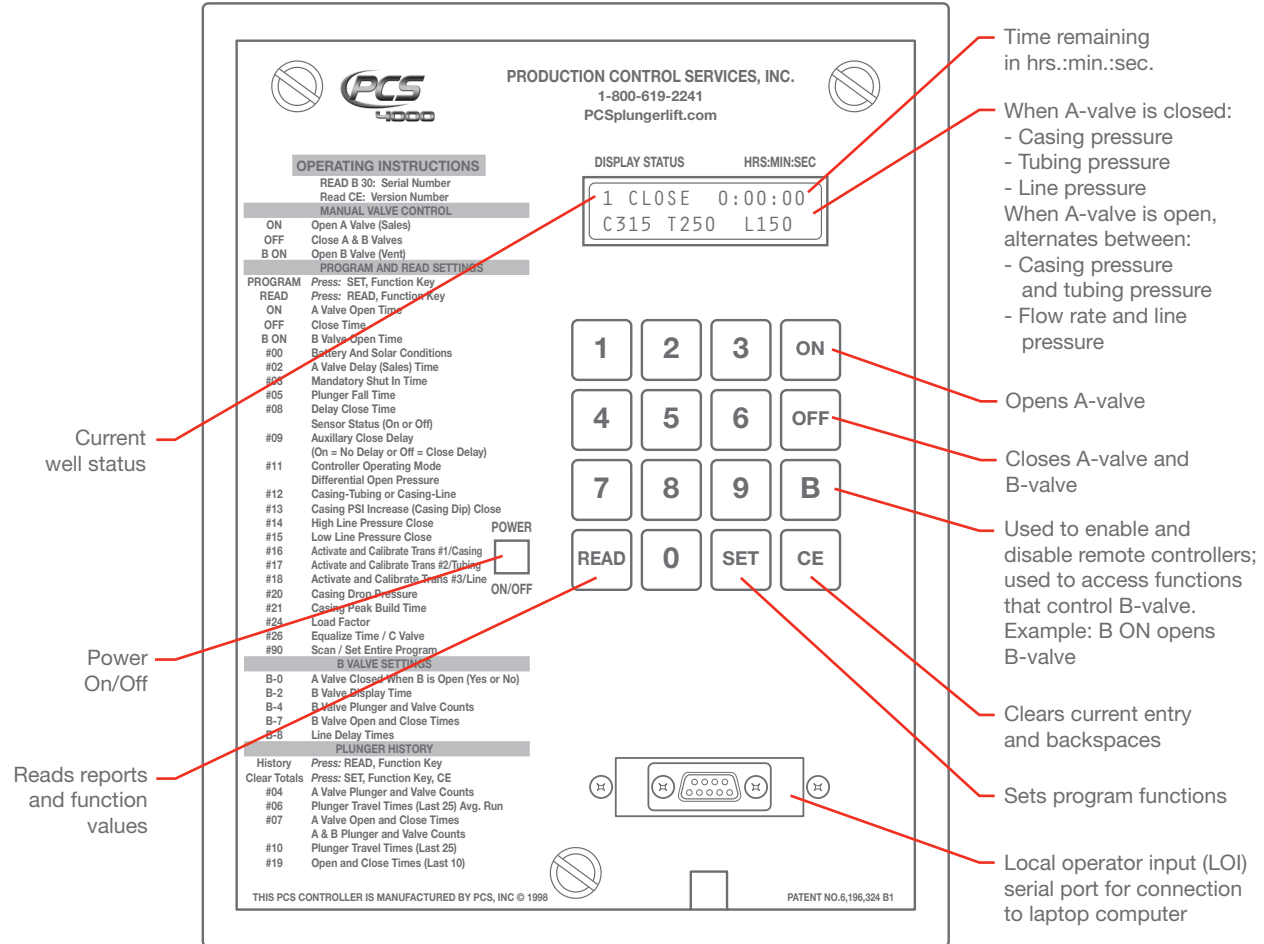


Figure 2 – Controller's Faceplate

Turning the Master Controller On and Off

To turn the PCS 4000 Multi Well Controller on or off, insert a screw driver into the slot marked POWER ON/OFF. See Figure 2.

Move the toggle switch to the left to turn the controller on. Move the toggle switch to the right to turn the controller off.

Status Display

After you turn the PCS 4000 Multi Well Controller on, the status display shows the status of the last well you displayed.

The status display remains on for 8 minutes after your last input and then goes to sleep.

STATUS UNKNOWN appears for a few seconds while the master controller establishes communication with a well's RM 200 Controller.

Note: STATUS UNKNOWN also appears when the master controller can't communicate with a well's remote controller or has disabled the remote controller. For more information, see "Communication Problems" on page 22.

As soon as communication is established, the first line of the status display shows the selected well, its currently running program function, and the time remaining.

When the A-valve is closed, the second line of the status display shows the casing pressure, tubing pressure, and sales line pressure.

Example for well 1:

```
1 FALL 0:2:45
C315 T250 L150
```

When the A-valve is open, the second line blinks between showing:

- Casing pressure and the tubing pressure
- Flow rate and sales line pressure

Examples for well 4:

```
4 OPEN 0:14:22
C315 T250
```

```
4 OPEN 0:14:22
F123 L150
```

Put the Controller to Sleep = SET 60

- To turn the controller's status display off, press SET 60.

Wake the Controller = 0

- To turn the controller's status display on, press 0.

Units of Measurement

Time is in hours:minutes:seconds.

Example: 08:15:00

Pressure is in pounds per square inch (psi).

Example: 00100

Depending on the setting of the METRIC function (SET 33), the unit of measurement for flow rate is either thousand cubic feet (mcf) or thousand cubic meters (E³M³).

Serial Port for Local Operator Input

You can connect a laptop computer with PCS 4000 Multi Well Controller software using this serial port. The PC software provides all the reports and program functions available using the master controller's keypad as well as additional reports and functions.

WORKING WITH MASTER CONTROLLER REPORTS AND FUNCTIONS

Using the master controller's keypad and status display, you can work with reports and program functions for the master controller or for any of the remote controllers.

Selecting the Master Controller

To work with the master controller's reports and program functions, you must first select the master controller.

Select the Master Controller = SET 50

- Press SET 50.

The status display shows:

```
MULTI-WELL
SYNCHRO MASTER
```

Reading Reports and Program Functions

Read a Report or the Value of a Program Function

If you have not already done so, select the master controller (SET 50).

- 1 Press READ.

The status display shows:

```
0 READ:
```

- 2 Enter the number of the master controller report or program function you want to display. Example: B4.

Setting Program Functions

Set a Program Function

- 1 Press SET.

The status display shows:

```
0 SET:
```

- 2 Enter the number of the program function you want to set. Example: B1.
- 3 Enter the value for the function.

To exit the function without changing its value, press CE.

Pausing Communication

Pause Communication with Remote Controllers and EFM Devices = SET 88

This function lets you pause communication with the remote controllers and EFM devices while you configure the PCS 4000 Multi Well Controller's communication board.

- 1 Press SET 88.

The status display shows:

```
COM PAUSED
PRESS ANY KEY
```

- 2 To resume communications, press any key.

For information about configuring the communication board, see the PCS 4000 Multi Well Controller's technical manual.

MASTER CONTROLLER REPORTS

If you have not already done so, select the master controller (SET 50).

Display Master Controller's Modbus Address = READ 22

The status display shows:

```
MODBUS ADDR: number
PRESS ANY KEY
```

where *number* is the master controller's 3-digit modbus address.

The master controller and all remote controllers communicating with it must each have a unique modbus address. Each EFM device communicating with the master controller must also have a unique modbus address.

Important! Be careful not to change the modbus address of the master controller or any of the remote controllers and EFM devices unless you intend to do so. The best way to change modbus addresses is with a laptop computer connected directly to the PCS 4000 Master Controller or to an RM 200 Remote Controller.

Display Master Controller's Serial Number = READ 30

Device serial numbers are necessary to track hardware revisions and updates.

Display Master Controller's Unit of Measurement =  READ 33

The status display shows whether the metric unit of measurement for flow rate is OFF or ON.

When OFF, the unit of measurement is thousand cubic feet (mcf). When on, it is thousand cubic meters (E³M³).

Use SET 33 to change the unit of measurement for flow rate.

Display Master Controller's Software

Version Report =  READ CE

This report displays the chip and software version numbers.

Example: VERSION 206-03

A newer version number may have functions that this *User Guide* does not document.

Display a Remote Controller's Well

Group =  READ B well number

For example, to read the well group for well 1's remote controller, press READ B1.

If a well is not assigned to a well group, the status display shows WELL NOT ENABLED.

ENABLING AND DISABLING A REMOTE CONTROLLER

Enabling a Remote Controller

Before you can work with a remote controller, you must enable it.

Important! If the master controller has disabled a remote controller because of unstable communication, you must re-enable the remote controller by following this procedure.

- 1 If you have not already done so, select the master controller (SET 50).
- 2 Press SET B *well number*.

For example, to enable well 1, press SET B1. To enable well 8, press SET B8.

The status display shows:
MODBUS ADDR: *number*

where *number* is the remote controller's 3-digit modbus address.

Important! Don't change the modbus address.

- 3 Press CE.

The status display shows:
WELL1 IN GROUP ?
? 1-8, 0=OFF

- 4 Press the number of the well group to which the well is assigned.
- 5 After you enter the number of the well group, press any key to confirm the change.

Important! To enable a well, you **must** assign it to a well group. If the well does not share a sales line with other wells, it should not share a well group with other wells.

Disabling a Remote Controller

To disable a remote controller manually:

- 1 If you have not already done so, select the master controller (SET 50).
- 2 Press SET B *well number*.

For example, to disable well 1, press SET B1.

The status display shows:
MODBUS ADDR: *number*

where *number* is the remote controller's 3-digit modbus address.

Important! Don't change the modbus address.

- 3 Press CE.

The status display shows:
WELL1 IN GROUP ?
? 1-8, 0=OFF

- 4 Press 0.

The status display shows:
WELL NOT ENABLED
PRESS ANY KEY

- 5 Press any key to confirm the change.

WORKING WITH REMOTE CONTROLLER REPORTS AND FUNCTIONS

After you have enabled a well's remote controller, you can display the remote controller's reports and set the remote controller's program functions from the master controller.

Selecting a Remote Controller

To work with a remote controller's reports and program functions, you must first select the remote controller.

Select a Remoter Controller = SET 5 well number

- Press SET 5 well number.

For example, to select well 1's remote controller, press SET 51. To select well 8's remote controller, press SET 58.

The status display shows the operation program for the well you selected.

Note: If the status display shows WELL NOT ENABLED, you must enable the well's remote controller. See "Enabling a Remote Controller" on page 7.

Operating a Well's A-Valve and B-Valve Manually

If you have not already done so, select the remote controller (SET 5 well number).

Open the A-Valve = ON

- Press ON.

ON overrides all of the well's programmed functions such as FALL TIME and MANDATORY SHUT-IN TIME.

ON does **not** override safeguard functions such as LOW LINE CLOSE PRESSURE and HIGH LINE CLOSE PRESSURE.

Note: When you manually open a well in a synchronized well group, the master controller signals the remote controller for the currently open well in the well group to close its A-valve. The master controller allows the closed well to maintain its position on the well priority list.

Open the B-Valve = B ON

- Press B ON.

Close the A-Valve (and B-Valve if Used) = OFF

- Press OFF.

OFF overrides all programmed functions such as OPEN TIME and DELAY TIME (SALES).

Note: When you manually close a well in a synchronized well group, the master controller moves the closed well to the bottom of the well priority list.

Reading Reports and Program Functions

Read a Report or the Value of a Single Program Function

If you have not already done so, select the remote controller (SET 5 well number).

- 1 Press READ.

For well 1, the status display shows:

1 READ:

- 2 Enter the number of the report or function you want to display. Example: 10.

Read the Values of All Program Functions = READ 90

The master controller displays the most recent values that it has received from the remote controller.

For a list of the program functions, see "READ 90 Program Function List" on page 9.

Setting Program Functions

Set a Single Program Function

If you have not already done so, select the remote controller (SET 5 well number).

- 1 Press SET.

For well 6, the status display shows:

6 SET:

- 2 Enter the number of the function you want to set. Example: 05.

- 3 Enter the value for the function. See "Units of Measurement" on page 5.

To exit the function without changing its value, press CE.

- 4 Wait at least 20 seconds.
- 5 Press READ and the number of the function you just set to verify that the remote controller has changed the value of the function.

Because you are sending values from the master controller to a remote controller over a radio network, you must verify that the remote controller has made the changes. The master controller and the remote controller may be performing other tasks. You must make sure that the radio communication has been successful.

- 6 Repeat the change if necessary until you have verified that the change has been made.

Set All Program Functions

The PCS 4000 Multi Well Controller does not support the SET 90 program function available on several other PCS controllers.

You must set a remote controller’s program functions 1 at a time, as explained in “Set a Single Program Function” on page 8.

REMOTE CONTROLLER REPORT AND FUNCTION REFERENCE

The tables in this section cross-reference the remote controller reports and program functions described in this *User Guide*.

To access these reports and program functions, first select the remote controller (SET 5 well number).

Reports

Report	READ	Page
Battery Status Report	00	11
Status of A-Valve when B-Valve Is Open	B0	13
A-Valve and Plunger Counts History	04	10
Plunger Travel Time History	06	10
A-Valve Total Time Report	07	10
A-Valve and Plunger Counts History, A-Valve Total Time Report, Accumulated Flow Report, and Plunger Travel Time History	10	10
Time Open and Closed History	19	11
Accumulated Flow Report	none	11

Clearing Report Values

Program Function	SET	Display Name	Page
Clearing Report Values	10	1 ZERO TOTALS	11

Program Functions

READ 90 Program Function List

Press READ 90 to display current times, pressures, and flow rate values programmed for all functions listed below.

SET Program Function List

To program a function listed below, press SET *parameter*. To display its current value, press READ *parameter*.

Note: The PCS 4000 Multi Well Controller does not support the SET 90 program function.

Program Function	SET or READ	Display Name	Page
OPEN TIME	ON	1 OPEN TIME	13
CLOSE TIME	OFF	1 CLOSE TIME	14
DELAY TIME (SALES)	02	1 DELAY TIME	16
MANDATORY SHUT-IN TIME	03	1 MAND. SHUT-IN	13
FALL TIME	05	1 FALL TIME	13
DELAY CLOSE TIME	08	1 DEL CLOSE TIME	14
Sensor Operation	09	1 SENSOR	13
Operating Mode	11	1 1. TIME 2. T-L 3. C-T 4. C-L	13
DIFFERENTIAL OPEN PRESSURE	12	1 OPEN PRESSURE	13
DIFFERENTIAL CLOSE PRESSURE (DIP)	13	1 CLOSE PRESSURE	13
HIGH LINE CLOSE PRESSURE	14	1 HI-LINE PRES.	16
LOW LINE CLOSE PRESSURE	15	1 LOW LINE PRES.	16
CASING DROP PRESSURE	20	1 CASING DROP	15
CASING PEAK TIME	21	1 CASING TIME	14
LOW FLOW RATE	23	1 MIN. FLOW RATE	15
LOAD FACTOR	24	1 LOAD FACTOR	15
CRITICAL FLOW K FACTOR	25	1 TURNER FLOW CONSTANT	15
DELAY LINE CLOSE TIME	26	1 LINE DEL TIME	16

Additional Program Functions

To program these functions, press SET *parameter*. To display their current values, press READ *parameter*.

Program Function	SET or READ	Display Name	Page
Status of A-Valve when B-Valve Is Open	B0	A VALVE IS OPEN WITH B VALVE	13
B OPEN TIME	B ON	1 B OPEN TIME	13
B DELAY TIME	B2	1 B DELAY TIME	16

REMOTE CONTROLLER REPORTS

If you have not already done so, select the remote controller (SET 5 *well number*).

The number at the start of the status display's first line shows the remote controller selected: 1 for well 1's remote controller, and so on up to 8 for well 8's remote controller. All the examples in this section show 1 for well 1's remote controller.

Plunger Travel Time History = READ 06

This report provides information about the 10 most recent plunger travel times. The first display shows the number of times the plunger surfaced and the average travel time.

Example:

```
1 GOOD RUNS: 25
AVE: 0:08:22
```

Use the READ button to scan through the report.

The next 10 displays show the 10 most recent plunger travel times.

- This example shows the most recent plunger run. The plunger surfaced after 8 minutes and 15 seconds of OPEN TIME.

```
LAST PLUNGER- 0
A 0:08:15
```

- This example shows the 2nd most recent plunger run.

```
LAST PLUNGER- 1
A 0:08:15
```

- This example shows the 10th most recent plunger run.

```
LAST PLUNGER- 9
A 0:08:15
```

- This example shows the most recent plunger run. The plunger surfaced after 10 minutes and 40 seconds of OPEN TIME and B OPEN TIME.

```
LAST PLUNGER- 0
B 0:10:40
```

- This example shows the most recent plunger run. The CASING DROP PRESSURE was reached before the plunger arrived.

```
LAST PLUNGER- 0
C 0:09:26
```

- This example shows the most recent plunger run. The plunger did not surface.

```
LAST PLUNGER- 0
NO PLUNGER
```

To exit the report at any display, press CE.

A-Valve and Plunger Counts History, A-Valve Total Time Report, Accumulated Flow Report, and Plunger Travel Time History = READ 10

This reporting option displays the A-Valve and Plunger Counts History (READ 04), the A-Valve Total Time Report (READ 07), the Accumulated Flow Report (no READ option), and the Plunger Travel Time History (READ 06).

To display the next report:

- Press READ.

The third status display shows the well's accumulated flow for today and yesterday.

Example:

```
1 TOD. FLO: 5287
YEST. FLOW: 6432
```

Note: If the well does not have an EFM device or if the accumulated flow feature is not active, the report shows flow values of 0.

A-Valve and Plunger Counts History = READ 04

This report shows how many times the A-valve opened, and how many times the plunger arrived while the A-valve was open.

Example:

```
1 PLUNGER= 92
VALVE = 96
```

In the example:

- VALVE = 96 shows that the A-valve opened 96 times.
- PLUNGER= 92 shows that the plunger arrived 92 times while the A-valve was open.
- 96-92=4. The plunger did not arrive 4 times while the A-valve was open.

Note: If the well has a B-valve, this report shows 2 A-valve counts for each time the B-valve opens. If the plunger did not arrive 4 times while the A-valve was open, the plunger may have arrived up to 2 times while the B-valve was open.

A-Valve Total Time Report = READ 07

This report shows 2 times of up to 999 hrs., 59 min., 59 sec. accumulated since the report was last cleared:

- TOT O: Total OPEN TIME and DELAY TIME (SALES).
- TOT C: Total time that the controller was closed. MANDATORY SHUT-IN (if any), FALL TIME (if any), and CLOSE TIME are accumulated under TOT C time.

Example:

```
1 TOT O 16:31:13
TOT C 8:12:45
```

Clearing Report Values =  SET 10

The display shows:

```
1 ZERO TOTALS
ON=YES OFF=NO
```

Press the ON button to clear all of the valve and plunger counts (READ 04) and total times (READ 07).

This option does not clear the Plunger Travel Time History (READ 06) and the Time Open and Closed History (READ 19). History information is always available.

Note: Press the OFF button to exit the Clearing Report Values function without clearing any of the report values.

Accumulated Flow Report

The READ 10 reporting option displays the well's accumulated flow for today and yesterday. See "A-Valve and Plunger Counts History, A-Valve Total Time Report, Accumulated Flow Report, and Plunger Travel Time History" on page 10.

Time Open and Closed History =  READ 19

This report provides information about the last 10 times the A-valve was open, and the last 10 times the A-valve was closed.

- LO-0 shows the most recent open and close information.
- LO-1 shows the 2nd most recent open and close information.
- LO-9 shows the 10th most recent open and close information.

Example:

```
1 L0-0M 0:20:00
LST-CLC 0:15:00
```

LO information shows:

- How long the A-valve was open. Time Open includes:
 - OPEN TIME
 - DELAY TIME (SALES)
 - DELAY CLOSE TIME (if any)
 Time Open does **not** include B OPEN TIME (if any).
- A letter that explains why the A-valve closed:
 - F = low flow rate input or critical flow K value input
 - G = switch gauge input
 - H = high sales line pressure input
 - L = low sales line pressure input
 - M = manual close
 - O = open time ran out
 - S = increase in casing pressure input
 - U = drop in casing pressure input

LST-CL information shows:

- How long the A-valve was closed
- A letter that explains why the A-valve opened:
 - C = CLOSE TIME counted down to zero
 - D = differential open pressure input
 - M = manual open
 - R = load factor input

Note: If the A-valve opens because a close input stops, there is no letter. For example, the A-valve closes in response to a close input caused by low or high sales line pressure. When the sales line pressure returns to normal, the A-valve opens. The LST-CL information does not include a letter.

Operating Mode Report =  READ 11

The controller's operating mode:

- TIME MODE (mode 1)
- TUBING-LINE (mode 2)
- CASING-TUBING (mode 3)
- CASING-LINE (mode 4)

For more information, see "How Pressure Operation Works" on page 12.

Battery Status Report =  READ 00

This report displays the current voltage of the battery and the solar panel.

Example:

```
BATTERY = 7.00V
SOLAR = 9.24V
```

Sensor Status =  READ 09

This report shows whether the sensor is ON or OFF.

Note: The sensor must be ON to read the sensor input.

When using the Time operating mode, you can set the sensor to OFF. PCS recommends setting the sensor to off only if you are not running a plunger.

HOW PRESSURE OPERATION WORKS

When set to a pressure operating mode, the remote controller opens the A-valve based on the difference between 2 pressure values. The pressure values used are:

- Mode 1: Time only input (no pressure)
- Mode 2: Tubing pressure minus sales line pressure
- Mode 3: Casing pressure minus tubing pressure
- Mode 4: Casing pressure minus sales line pressure

Note: When set to Mode 1 or time mode, the remote controller opens and closes the A-valve and B-valve based on time input. It does not respond to pressure input or flow rate input.

Here are the steps in the pressure operation cycle.

- 1 The remote controller closes the A-valve and counts down the FALL TIME (SET 05). This gives the plunger time to fall to the bottom of the well. The status display shows: 1 CLOSE 0:00:00.

Note: CLOSE TIME is normally set to 00:00:00 because the remote controller opens the A-valve in response to changes in pressure.

- 2 While the A-valve is closed, the casing pressure and tubing pressure rise.
- 3 The remote controller monitors:
 - Tubing pressure minus line pressure differential in Mode 2
 - Casing pressure minus tubing pressure differential in Mode 3
 - Casing pressure minus line pressure differential in Mode 4

The remote controller opens the A-valve when:

- The difference between the 2 pressures is equal to or greater than the DIFFERENTIAL OPEN PRESSURE (SET 12) value (see “DIFFERENTIAL OPEN PRESSURE” on page 13), **and**
- The FALL TIME countdown has reached zero.

Note: In synchronized well production, the remote controller does not open the A-valve when it is ready to sell gas. It signals the master controller that it is ready. The status display shows 1 CLOSE 0:00:00. When the remote controller reaches the top of the well priority list, the master controller signals the remote controller to open the well’s A-valve. See “Synchronized Well Production” on page 2.

If the DIFFERENTIAL OPEN PRESSURE value is reached during the FALL TIME countdown, the status display shows the FALL TIME remaining.

Note: You can use any “open” function together with or in place of DIFFERENTIAL OPEN PRESSURE. After the FALL TIME countdown has reached zero, the remote controller opens the A-valve as soon as it receives input from any “open” function. For more information, see “Features for Opening the A-Valve” on page 14.

- 4 The remote controller opens the A-valve and counts down the OPEN TIME (SET ON).
 - If the plunger arrives during the OPEN TIME countdown, the remote controller goes to step 6.
 - If the plunger does not arrive during the OPEN TIME countdown, the remote controller goes to step 5.
- 5 The remote controller opens the optional B-valve and counts down the B OPEN TIME (SET B ON).
 - If the plunger arrives during the B OPEN TIME countdown, the controller goes to step 6.
 - If the plunger does not arrive during OPEN TIME or B OPEN TIME, the controller closes the A-valve and B-valve and counts down the MANDATORY SHUT-IN TIME (SET 03). When this countdown reaches zero, the controller goes back to step 4.

Note: In synchronized well production, the remote controller does not open the A-valve when it is ready to sell gas. It signals the master controller that it is ready.

- 6 The remote controller counts down the DELAY TIME (SALES) (SET 02) while monitoring the casing pressure, flow rate, or both for a minimum value.

Note: DELAY TIME (SALES) is the maximum time the well is allowed to stay open after the plunger arrives. The remote controller responds to the first input to close the well. The close input may be:

- Casing pressure – see step 7.
- Low flow rate – see page 15.
- Critical flow K factor – see page 15.
- DELAY TIME (SALES) countdown reaches zero – see page 16.
- Another close input unrelated to casing pressure, low flow rate, critical flow K factor, or time. For example: low or high sales line pressure, a manual input to close the well, and so on.

- 7 Casing pressure normally drops while the plunger rises. When the casing pressure starts to build, the remote controller monitors the increase in pressure. When the increase equals the DIFFERENTIAL CLOSE PRESSURE (DIP) value, the remote controller goes to step 8. Usually, a minimal increase in pressure, such as 1 or 2 psi, is desirable.

- 8 The remote controller counts down the DELAY CLOSE TIME (SET 08). When the DELAY CLOSE TIME countdown reaches zero, the remote controller checks the casing pressure again to see if it has still increased by the DIFFERENTIAL CLOSE PRESSURE (DIP) value.
- If the increase is a brief spike in pressure, the controller continues the DELAY TIME (SALES) countdown. The controller goes back to step 7.
 - If the increase is an actual or solid pressure increase, the controller goes back to step 1.

CREATING A PRESSURE-OPERATION PLUNGER PROGRAM

Pressure-Operation Selection Functions

Operating Mode = SET 11

Set the operating mode, which specifies the 2 pressures that the controller uses for the DIFFERENTIAL OPEN PRESSURE set point:

- Mode 2: tubing pressure minus sales line pressure
- Mode 3: casing pressure minus tubing pressure
- Mode 4: casing pressure minus sales line pressure

Sensor Operation = SET 09

- Set SENSOR to ON.

Status of A-Valve when B-Valve Is Open = SET B0

The controller works on wells that require the A-valve to be either open or closed when the B-valve is open.

- To keep A-valve open when B-valve is open, press ON.
- To close A-valve when B-valve is open, press OFF.

Pressure-Operation Control Functions

FALL TIME = SET 05

FALL TIME guarantees a minimum shut-in time for the plunger to fall to the bottom of the well.

DIFFERENTIAL OPEN PRESSURE = SET 12

DIFFERENTIAL OPEN PRESSURE is the pressure value that must be reached before the controller opens the A-valve. See step 3 on page 12.

The 2 pressures that determine the DIFFERENTIAL OPEN PRESSURE vary depending on the mode of operation:

- Mode 2, tubing pressure minus sales line pressure
- Mode 3, casing pressure minus tubing pressure
- Mode 4, casing pressure minus sales line pressure

Choose an appropriate value for your well by adjusting the DIFFERENTIAL OPEN PRESSURE based on the plunger travel time. The optimal plunger speed is between 500 and 1000 feet per minute.

- If the plunger is running fast, lower the DIFFERENTIAL OPEN PRESSURE.
- If the plunger is running slow, increase the DIFFERENTIAL OPEN PRESSURE.

OPEN TIME = SET ON

OPEN TIME is when the well is first opened and gas is flowing through the A-valve (motor valve). During OPEN TIME, the plunger starts to surface and the well sells its initial head gas.

B OPEN TIME = SET B ON Optional

B OPEN TIME is after the well has sold its initial head gas, but the plunger has not arrived. During B OPEN TIME, the plunger surfaces with the liquid load it is carrying. Typically, gas during B OPEN TIME is vented to the low side of the separator or to a tank.

If you are not using a B-valve, set B OPEN TIME to 00:00:00.

MANDATORY SHUT-IN TIME = SET 03 Optional

This time is used when a plunger does not surface. Usually, after the A-valve and B-valve are opened, but a plunger does not surface, a well likely needs more time to rebuild pressure for the next plunger attempt.

Set the MANDATORY SHUT-IN TIME to at least twice the time required to build enough pressure to surface the plunger. For example, if a well usually takes 2 hours to build enough pressure to surface the plunger, set MANDATORY SHUT-IN TIME to 4 hours or more.

Note: The MANDATORY SHUT-IN TIME must be greater than FALL TIME (and CLOSE TIME, if any). If the plunger does not surface, MANDATORY SHUT-IN TIME replaces FALL TIME. MANDATORY SHUT-IN TIME is not in addition to FALL TIME.

If you are not using MANDATORY SHUT-IN TIME, set it to 00:00:00.

DIFFERENTIAL CLOSE PRESSURE

(DIP) = SET 13 Optional

After the plunger surfaces, the casing pressure falls and then levels off. The casing pressure then starts to build as liquids accumulate at depth. The higher you set the DIFFERENTIAL CLOSE PRESSURE (DIP), the longer the well attempts to sell gas.

Example: During an operation cycle, the controller records the well's minimum casing pressure at 150 psi.

- If the DIFFERENTIAL CLOSE PRESSURE (DIP) is 3 psi, the controller stops the sale of gas and closes the well when the casing pressure rises to 153 psi.
- If the DIFFERENTIAL CLOSE PRESSURE (DIP) is 10 psi, the controller stops the sale of gas and closes the well when the casing pressure rises to 160 psi.

A good DIFFERENTIAL CLOSE PRESSURE (DIP) setting for many wells is 1, 2, or 3 psi.

The casing pressure flutters up and down as it falls. For example, the casing pressure may go: 160, 159, 160, 159, 158, 159, 158, 157, 158, 157, 156 psi. To keep the controller from closing the well too soon, use DIFFERENTIAL CLOSE PRESSURE (DIP) together with DELAY CLOSE TIME (see below).

Important! A good minimum DIFFERENTIAL CLOSE PRESSURE (DIP) is 1 psi. If you set the DIFFERENTIAL CLOSE PRESSURE (DIP) to 0 psi and the DELAY CLOSE TIME (see below) to 00:00:00, the controller closes the well as soon as the casing pressure flutters up. Because the casing pressure is still falling, the controller has closed the well too soon.

DELAY CLOSE TIME = SET 08

This time ensures that the casing pressure increase is not a brief spike in pressure. During the level period before the casing pressure starts to build, the pressure may flutter up and down. The controller delays closing the A-valve to make sure that the casing pressure has not dropped again.

If you set DIFFERENTIAL CLOSE PRESSURE (DIP) to 1, 2, or 3 psi, set DELAY CLOSE TIME to 10, 20, or 30 seconds.

Important! Don't set the DELAY CLOSE TIME to 00:00:00. If you do, the controller may close the well too soon, while the casing pressure is still falling. A good minimum DELAY CLOSE TIME is 10-30 seconds.

Features for Opening the A-Valve

Note: In synchronized well production, the remote controller does not open the A-valve when it is ready to sell gas. It signals the master controller that it is ready.

CLOSE TIME = SET OFF

CLOSE TIME is normally set to 00:00:00 because the controller opens the A-valve in response to changes in pressure.

If you want to open the A-valve after a period of time, regardless of pressure changes, you can set the CLOSE TIME. If you do program a CLOSE TIME, make sure to set the time no lower than your FALL TIME. This will ensure that the plunger has time to reach the bottom of the tubing before the controller opens the A-valve.

If the controller opens the well when the CLOSE TIME countdown reaches zero, you are using the controller to operate the well based on time instead of pressure.

CASING PEAK TIME = SET 21

CASING PEAK TIME is normally set to 99:00:00 when the feature is not used.

When you use this feature, the controller opens the A-valve after the casing pressure peaks. The controller monitors the casing pressure independently of the DIFFERENTIAL OPEN PRESSURE. The controller counts down the CASING PEAK TIME. It restarts the countdown whenever the casing pressure increases by 1 psi.

For example, the CASING PEAK TIME is 10 minutes. When the A-valve closes, the controller counts down the CASING PEAK TIME. If the casing pressure builds 1 psi within 10 minutes and the FALL TIME has reached zero, the controller restarts the CASING PEAK TIME countdown. If the casing pressure does not build 1 psi within 10 minutes, the controller counts down the CASING PEAK TIME to zero. It then checks the FALL TIME countdown. It opens the A-valve when both the CASING PEAK TIME and FALL time countdowns have reached zero.

Note: While the controller counts down the CASING PEAK TIME, the display shows CLOSE 0:00:00.

Typical CASING PEAK TIME values for a well with casing pressure that builds fast are 10-12 minutes. For a well with casing pressure that builds slowly, a typical value is 30 minutes.

Note: You can use both DIFFERENTIAL OPEN PRESSURE and CASING PEAK TIME to control the well. If you want to use only CASING PEAK TIME to open the well, set the DIFFERENTIAL OPEN PRESSURE to a high value that will never be reached.

LOAD FACTOR = SET 24

LOAD FACTOR is a feature used with Mode 2 (tubing pressure minus line pressure) or Mode 4 (casing pressure minus line pressure). Load Factor helps insure that the liquid load in the tubing is less than the energy needed to lift the load to surface. When Load Factor is enabled, the controller will not open the well until 2 set points are met:

- The controller compares the line pressure to the tubing pressure (Mode 2) or the casing pressure (Mode 4).
- In both modes, the controller compares casing, tubing, and line pressures as a ratio to determine the net lifting energy. See the calculation below.

When both set points and all other “open” criteria are met, the controller opens the well to production.

A well’s load factor is the ratio of casing pressure minus tubing pressure to casing pressure minus line pressure.

$$\text{LOAD FACTOR} = \frac{\text{Casing Pressure} - \text{Tubing Pressure}}{\text{Casing Pressure} - \text{Line Pressure}}$$

If you set the LOAD FACTOR to 50, the controller opens the A-valve when the ratio is 50% or lower (and the other “open” criteria have been met).

Example:

- Casing Pressure - Tubing Pressure = 100 psi
- Casing Pressure - Line Pressure = 500 psi
- 100/500 = 20%
- If the LOAD FACTOR is set to 20% or a lower value, the controller opens the A-valve.

Normal values for LOAD FACTOR range from 40% to 60% depending on the well’s individual characteristics.

If you are not using LOAD FACTOR, set it to 00 percent.

Features for Closing the A-Valve

LOW FLOW RATE = SET 23

If you want the controller to close the A-valve when the sales line’s flow rate falls below a specified value, set the LOW FLOW RATE. For example, if you set the LOW FLOW RATE to 300, the controller closes the A-valve when the flow rate falls below 300 mcf. This function keeps the flow rate from dropping to the point where liquids fall back into the tubing.

You can use this function by itself or together with CRITICAL FLOW K FACTOR.

PCS provides a Microsoft® Windows® critical flow calculator program to help calculate LOW FLOW RATE and CRITICAL FLOW K FACTOR values for your well. For more information, call your PCS sales and service representative.

Note: If you have metric (SET 33) on, the flow rate unit of measurement is thousand cubic meters (E³M³).

CRITICAL FLOW K FACTOR = SET 25

If you want the controller to close the A-valve when the sales line’s flow rate falls below a critical flow rate computed with Turner’s equation, you can set both the LOW FLOW RATE and the CRITICAL FLOW K FACTOR. The K factor is a gas constant that allows for fluctuating sales line pressures. These 2 functions together keep the flow rate – in combination with fluctuating sales line pressure – from dropping to the point where liquids fall back into the tubing.

Example:

- Set CRITICAL FLOW K FACTOR to 65506.
- Set LOW FLOW RATE to 300 mcf.
- The controller closes the A-valve when the flow rate falls below 300 mcf **or** the critical flow K factor falls below 65506.

Features for Special Circumstances

CASING DROP PRESSURE = SET 20

CASING DROP PRESSURE is used in these 3 situations:

- The wellhead configuration affects the plunger travel into the lubricator. The plunger arrives but the plunger arrival sensor can’t sense the plunger arrival every time. Use CASING DROP PRESSURE as a backup.
- A well is intermitted without a plunger. CASING DROP PRESSURE allows the well to flow if it unloads.
- The plunger arrival sensor malfunctions, and the operator does not have an immediate replacement. Use CASING DROP PRESSURE as a temporary fix.

Note: If the arrival sensor malfunctions, the CASING DROP PRESSURE function prevents the B-valve from opening if the well is unloading. This may save wear and tear on the plunger.

If the casing pressure drops by the specified value, the controller starts the DELAY TIME (SALES) countdown even if it does not receive an input from the arrival sensor.

- 1 Note the casing pressure at the moment when the A-valve opens, for example, 400 psi.
- 2 Note the casing pressure when the plunger surfaces, for example, 300 psi.
- 3 Set the CASING DROP PRESSURE to the difference between these 2 values (400 – 300 = 100). Add an additional 10-15 psi, for example, 115 psi.

The additional 10-15 psi makes sure the plunger surfaces before the CASING DROP PRESSURE is reached. If the CASING DROP PRESSURE replicates a plunger arrival too closely, it may be reached before the plunger surfaces. The Plunger Travel Time History then shows a C when the CASING DROP PRESSURE is reached.

Example:

```
1 LAST PLUNGER - 0
  C    0:10:20
```

The C in the example above shows that the CASING DROP PRESSURE was reached after 10 minutes and 20 seconds of OPEN TIME (and B OPEN TIME, if any). The plunger did not surface during that time or the arrival sensor malfunctioned. Test the sensor. If it is OK, the CASING DROP PRESSURE may need to be increased.

If you are not using CASING DROP PRESSURE, set it to 0 psi.

B DELAY TIME = SET B2

B DELAY TIME is normally set to 00:00:00.

For those few wells that have liquid trailing behind the plunger, you may want to set a few seconds of B DELAY TIME to let the liquid clear out of the dump valve on the separator.

When the B DELAY TIME is set and when the plunger arrives during the B OPEN TIME countdown, the controller delays closing the B-valve by starting the B DELAY TIME countdown. When the countdown reaches zero, the controller closes the B-valve and starts the DELAY TIME (SALES) countdown.

Sales-Line Safeguard Features

LOW LINE CLOSE PRESSURE = SET 15

If the sales line pressure reaches this low value, the controller prevents the A-valve from opening and closes the A-valve if it is open. If you don't want the controller to monitor low sales line pressure, set LOW LINE CLOSE PRESSURE to 0 psi.

HIGH LINE CLOSE PRESSURE = SET 14

If the sales line pressure reaches this high value, the controller prevents the A-valve from opening and closes the A-valve if it is open. You can use HIGH LINE CLOSE PRESSURE to shut-in the well when the line pressure increases to the point where the plunger will not surface.

Venting: If the HIGH LINE CLOSE PRESSURE is reached during B OPEN TIME, which is used to vent the well, the controller does not close the B-valve.

DELAY LINE CLOSE TIME = SET 26

If you are using HIGH LINE CLOSE PRESSURE, LOW LINE CLOSE PRESSURE, or both, you can use DELAY LINE CLOSE TIME to keep the controller from shutting in the well if there is a brief spike or drop in sales-line pressure. Brief spikes in pressure often occur when the controller opens the well after an extended shut-in period.

When the controller opens the A-valve, it does not monitor the sales line pressure during the DELAY LINE CLOSE TIME period.

Example:

- DELAY LINE CLOSE TIME is set at 6 minutes.
- When the controller opens the well and starts to count down the OPEN TIME, there is a 3 to 5 minute spike in line pressure
- For the first 6 minutes of the OPEN TIME countdown, the controller does not shut in the well even if the HIGH-LINE CLOSE PRESSURE is reached.
- After 6 minutes, the controller shuts in the well if the high line condition still exists.

DELAY TIME (SALES) = SET 02

DELAY TIME (SALES) sells gas through the A-valve after the plunger has arrived.

Set DELAY TIME (SALES) to the maximum time that you want to sell gas.

Example: A well normally sells gas for 5 hours. Set DELAY TIME (SALES) to 6 hours.

If you want to limit how long the well flows after a plunger arrival for any reason, program DELAY TIME (SALES).

Important! You **must** set the DELAY TIME (SALES). The controller closes the A-valve in response to the first "close" input: DIFFERENTIAL CLOSE PRESSURE (DIP), LOW FLOW RATE, CRITICAL FLOW K FACTOR, or DELAY TIME (SALES). If DELAY TIME (SALES) is 00:00:00, the controller closes the A-valve when the plunger arrives. In pressure operation, you want the controller to close the A-valve in response to pressure or flow rate input.

USING PRESSURE OPERATION TO INTERMIT A WELL WITHOUT A PLUNGER

Pressure-Operation Selection Functions

Follow the plunger instructions for “Pressure-Operation Selection Functions” on page 13 to program these functions:

- Operating Mode = SET 11
- Sensor Operation = SET 09
- Status of A-Valve when B-Valve Is Open = SET B0

Note: Make sure the SENSOR (SET 09) is ON. Don't turn it off.

Pressure-Operation Control Functions

FALL TIME = SET 05

Set FALL time to 00:00:00.

FALL TIME is not needed because there is no plunger.

MANDATORY SHUT-IN TIME = SET 03

Set MANDATORY SHUT-IN TIME to 00:00:00.

MANDATORY SHUT-IN TIME is not needed because there is no plunger.

Other Functions

Follow the plunger instructions for “Pressure-Operation Control Functions” on page 13 to program these functions:

- DIFFERENTIAL OPEN PRESSURE = SET 12
- OPEN TIME = SET ON
- B OPEN TIME = SET B ON
- DIFFERENTIAL CLOSE PRESSURE (DIP) = SET 13
- DELAY CLOSE TIME = SET 08

Features for Opening the A-Valve

In addition to the basic functions for intermitting a well with pressure operation, you can use any of the features for opening the A-valve. For more information, see “Features for Opening the A-Valve” on page 14.

Tip! CASING PEAK TIME works great in this situation. See “CASING PEAK TIME” on page 14.

Features for Closing the A-Valve

In addition to the basic functions for intermitting a well with pressure operation, you can use any of the features for closing the A-valve. For more information, see “Features for Closing the A-Valve” on page 15.

Features for Special Circumstances

CASING DROP PRESSURE = SET 20

Because the well does not have a plunger, the controller can't start the DELAY TIME (SALES) when the plunger surfaces during OPEN TIME or B OPEN TIME. Instead, the controller monitors the casing pressure. When the casing pressure drops by the CASING DROP PRESSURE value, the controller starts the DELAY TIME (SALES) countdown.

To specify the CASING DROP PRESSURE, follow these instructions.

- 1 Note the casing pressure at the moment when the A-valve opens. Example: A well, intermitting without a plunger into a 100 psi sales line and trying to produce 1 barrel of water each cycle, should have a beginning casing pressure near 400 psi.
- 2 Then note the casing pressure when the fluid hits surface. Example: 300 psi.
- 3 Set the CASING DROP PRESSURE to the difference between these 2 values. Example: 100 psi.

The Plunger Travel Time History shows a C when the CASING DROP PRESSURE is reached.

Example:

```
1 LAST PLUNGER-0
  C    0:10:20
```

The C in the example above shows that the CASING DROP PRESSURE was reached after 10 minutes and 20 seconds of OPEN TIME (and B OPEN TIME, if any).

Sales-Line Safeguard Features

Follow the plunger instructions for “Sales-Line Safeguard Features” on page 16 to program these functions:

- LOW LINE CLOSE PRESSURE = SET 15
- HIGH LINE CLOSE PRESSURE = SET 14
- DELAY LINE CLOSE TIME = SET 26
- DELAY TIME (SALES) = SET 02

TROUBLESHOOTING

If you have a problem with the master controller, with a remote controller, or with communication between the master controller and its remote controllers, try these troubleshooting tips. If they don't solve the problem, call your PCS sales and service representative.

Master Controller Display Problems

Master controller won't turn on

- 1 With a screwdriver, move the power switch to off (see page 5).
- 2 Wait a few seconds and then move the power switch back to on.
If the display remains blank, go to Test 1.

Test 1: Check master controller's fuse.

- 1 With a screwdriver, move the power switch to off.
- 2 Remove the master controller's faceplate.
- 3 Remove the fuse from its yellow casing.
 - If the fuse is defective, replace it with a 5 amp, 250 volt fuse. The controller's box contains 1 extra fuse. When you are done, replace the controller's faceplate and move the power switch to on.
 - If the fuse is OK, go to Test 2.

Test 2: Check master controller's battery and wire connection.

The battery life is approximately 1 to 3 years.

- 1 Check the battery voltage with a volt meter.
Replace the battery if it is below 6 volts.
- 2 Check the battery wire connection.
- 3 Replace the master controller's faceplate.
- 4 With a screwdriver, move the power switch to on.
 - If the display is still blank, call your PCS sales and service representative.
- 5 If the master controller's display is now working and if you replaced the battery, check the manufacture date on the battery. If the battery is less than 3 years old, check the solar panel. Go to Test 3.

Test 3: Check master controller's solar panel.

- 1 Disconnect the solar panel from the terminals. Use a volt meter to obtain the voltage and amperage. A good solar panel reading in full sun exposure is 10.7 volts and 350-430 mA.
- 2 If the solar panel is defective, change it.

- 3 Check the solar panel installation.
 - The solar panel should face south.
 - The tilt of the solar panel should be the latitude of the location plus 15 degrees. Example: if the latitude is 45 degrees, tilt the solar panel 60 degrees with respect to the horizon.
 - The element should be free from dirt, oil, and so on.
 - Check for cracks in the solar panel.
 - Check whether the solar panel is shaded during any part of the day. If it is, position it so it receives the most sunlight each day.
- 4 Check the solar panel wire connection.
- 5 Make sure the power switch is on. The master controller's display should be on.
- 6 If the solar panel tests good, but the batteries are not lasting as long as they should, call your PCS sales and service representative.

Master controller's display is scrambled

Static electricity may have made the master controller lose its place in the program cycle.

- 1 Reset the master controller: With a screwdriver, move the power switch to off (see page 5). Wait a few seconds and then move the power switch back to on.
- 2 If the display is still scrambled after this test, call your PCS sales and service representative.

Program Cycle Problems

Remote controller won't run program cycle or won't open motor valve

- 1 Select the remote controller, and press READ 14 to check the HIGH LINE CLOSE PRESSURE. Make sure the pressure is set above the well's:
 - Expected casing peak pressure **and**
 - Normal high line pressure
- 2 Go to Test 1.

Test 1: Check transducer and transducer wire.

The master controller's display must show values for the 2 pressures specified by the operating mode.

- 1 Check the transducers' calibration. If necessary, re-calibrate the transducers.
- 2 If a transducer won't hold the calibration:
 - Change the remote controller to Time Mode. Press SET 11 and enter 1.
 - Call your PCS sales and service representative.

Test 2: Check remote controller's battery and wire connection.

The battery life is approximately 1 to 3 years. The remote controller has a safety feature. If the battery voltage is low, the controller closes the motor valve and shuts in.

- 1 With a screwdriver, turn the screw at the top center of the remote controller's faceplate to release the tab that holds the top of the faceplate to the case. Pull the faceplate away from the controller's case. A hinge connects the bottom of the faceplate to the case.
- 2 Move the OFF/ON power switch on the circuit board to OFF.
- 3 Check the battery voltage with a volt meter. Replace the battery if it is below 6 volts.
- 4 Check the battery wire connection.
- 5 Move the OFF/ON power switch to ON.
- 6 Replace the controller's faceplate and turn the screw until the tab holds the top of the faceplate to the case.
- 7 Check whether the remote controller is operating properly.
 - If the remote controller is now operating properly and if you replaced the battery, check the manufacture date on the battery. If the battery is less than 3 years old, check the solar panel. Go to Test 3.
 - If the remote controller still won't run the program cycle or open the motor valve, go to Test 4.

Test 3: Check remote controller's solar panel

- 1 Disconnect the solar panel from the terminals. Use a volt meter to obtain the voltage and amperage. A good solar panel reading in full sun exposure is 10.7 volts and 350-430 mA.
- 2 If the solar panel is defective, change it.
- 3 Check the solar panel installation.
 - The solar panel should face south.
 - The tilt of the solar panel should be the latitude of the location plus 15 degrees. Example: if the latitude is 45 degrees, tilt the solar panel 60 degrees with respect to the horizon.
 - The element should be free from dirt, oil, and so on.
 - Check for cracks in the solar panel.
 - Check whether the solar panel is shaded during any part of the day. If it is, position it so it receives the most sunlight each day.
- 4 Check the solar panel wire connection.
- 5 Make sure the remote controller's power switch is on.
- 6 If the solar panel tests good, but the batteries are not lasting as long as they should, call your PCS sales and service representative.

Test 4: Check solenoid (shift valve).

- 1 Press ON.
- 2 If the solenoid won't open, clean the supply hoses and puck inside the solenoid valve.
- 3 Retest.
- 4 If they are good, replace the puck or the entire solenoid.

Test 5: Check gas supply pressure, filter, and regulator(s).

- 1 Check the gas supply pressure to the motor valve. The recommended supply pressure is 25-35 psi. If the pressure is too low or too high, it will not open the motor valve.
- 2 Check the filter and regulator(s) for debris and ice.

After CLOSE TIME has counted down to zero, controller goes directly to DELAY TIME (SALES)

- Select the remote controller, and press READ 06 to check the Plunger Travel Time History. If the display shows a few seconds of plunger travel time, such as A 0:00:03, the controller went through the opening and closing part of the program even though the plunger did not arrive.

Test 1: Check the sensor wire connections.

- 1 If a wire was spliced in because of the distance between the remote controller and the sensor, check the connection where the wire was spliced. The wire may be corroded and causing a short.
- 2 If the sensor wire connections are good, go to Test 2.

Test 2: Check remote controller by disconnecting the sensor.

- 1 Disconnect the sensor from the sensor and ground terminals on the inside of the remote controller's faceplate.
- 2 At the master controller, press ON. The remote controller should count down the OPEN TIME.
 - If the remote controller goes from OPEN TIME to DELAY TIME (SALES), the remote controller's circuit board is not working properly. Call your PCS sales and service representative.
 - If the remote controller does not go to DELAY TIME (SALES), continue with the next step.
- 3 Use a wire to short the sensor and ground terminals. The remote controller is OK if it goes to DELAY TIME (SALES).
- 4 Reconnect the sensor to the terminals. Make sure the wires are put back in correctly.

Test 3: Check plunger.

- 1 Check whether the plunger is stuck in the lubricator.
- 2 If the plunger is not stuck in the lubricator, go to Test 4.

Test 4: Check the sensor.

- 1 Remove the sensor from the wellhead.
- 2 At the master controller, press ON.
 - If the remote controller counts down the OPEN TIME, go to step 3.
 - If the remote controller goes straight into DELAY TIME (SALES), there is a short. Either the wire going to the remote controller is bad, or the sensor must be replaced. Go to step 5.
- 3 Hold the sensor in your hand, and move a steel wrench through the sensor band.
 - If the remote controller goes to DELAY TIME (SALES), the problem may be a wellhead electrical current.
 - Go to step 4.
- 4 Possible causes of a wellhead electrical problem:
 - The sensor or sensor wire may be defective, or
 - The well may need PCS newest style 2-coil sensor. This sensor is available in 2-wire or 3-wire connections.
- 5 Call your PCS sales and service representative.
Short-term fix for the sensor problem: Use the CASING DROP PRESSURE feature (see page 15).

Plunger has surfaced, but OPEN TIME does not go to DELAY TIME (SALES)

- Make sure the sensor is turned on: Select the remote controller and press READ 09. The master controller's display should show SENSOR: ON.
 - If the display shows SENSOR: ON, go to Test 1.
 - If the display shows SENSOR: OFF, press SET 09 and then press ON. Go to Test 2, step 2.

Test 1: Check remote controller by disconnecting the sensor.

- 1 Disconnect the sensor from the sensor and ground terminals on the inside of the remote controller's faceplate.
- 2 At the master controller, press ON. The remote controller should count down the OPEN TIME.
 - If the remote controller goes from OPEN TIME to DELAY TIME (SALES), the remote controller's circuit board is not working properly. Call your PCS sales and service representative.
 - If the remote controller does not go to DELAY TIME (SALES), continue with the next step.
- 3 Use a wire to short the sensor and ground terminals. The remote controller is OK if it goes to DELAY TIME (SALES).
- 4 Reconnect the sensor to the terminals. Make sure the wires are put back in correctly.

Test 2: Check sensor.

- 1 At the master controller, press ON.
- 2 Run a steel wrench along the back of the sensor.
 - If the remote controller goes to DELAY TIME (SALES), the sensor is OK.
 - If the remote controller does not go to DELAY TIME (SALES), call your PCS sales and service representative.

Test 3: Check sensor alignment.

- 1 Realign the sensor by 90 degrees.
Example: If the sensor is aligned on the north or south side, realign it on the east or west side.
- 2 If realigning the sensor does not solve the problem, call your PCS sales and service representative.
Short-term fix for the sensor problem: Use the CASING DROP PRESSURE feature (see page 15).

Plunger has surfaced, but Plunger Travel Time History (READ 06) shows NO PLUNGER instead of a travel time

- Make sure the sensor is turned on: Select the remote controller and press READ 09. The master controller's display should show SENSOR: ON.
 - If the display shows SENSOR: ON, go to Test 1.
 - If the display shows SENSOR: OFF, press SET 09 and then press ON. Go to Test 2, step 2.

Test 1: Check remote controller by disconnecting the sensor.

- 1 Disconnect the sensor from the sensor and ground terminals on the inside of the remote controller's faceplate.
- 2 At the master controller, press ON. The remote controller should count down the OPEN TIME.
 - If the remote controller goes from OPEN TIME to DELAY TIME (SALES), the remote controller's circuit board is not working properly. Call your PCS sales and service representative.
 - If the remote controller does not go to DELAY TIME (SALES), continue with the next step.
- 3 Use a wire to short the sensor and ground terminals. The remote controller is OK if it goes to DELAY TIME (SALES).
- 4 Reconnect the sensor to the terminals. Make sure the wires are put back in correctly.

Test 2: Check sensor.

- 1 At the master controller, press ON.
- 2 Run a steel wrench along the back of the sensor.
 - If the remote controller goes to DELAY TIME (SALES), the sensor is OK.
 - If the remote controller does not go to DELAY TIME (SALES), call your PCS sales and service representative.

Test 3: Check sensor alignment.

- 1 Realign the sensor by 90 degrees.
Example: If the sensor is aligned on the north or south side, realign it on the east or west side.
- 2 If realigning the sensor does not solve the problem, call your PCS sales and service representative.

Short-term fix for the sensor problem: Use the CASING DROP PRESSURE feature (see page 15).

Plunger has surfaced, but Plunger Travel Time History (READ 06) shows C instead of A or B

- Make sure the sensor is turned on: Select the remote controller and press READ 09. The master controller's display should show SENSOR: ON.
 - If the display shows SENSOR: ON, go to Test 1.
 - If the display shows SENSOR: OFF, press SET 09 and then press ON. Go to Test 3, step 2.

Test 1: Check CASING DROP PRESSURE.

- 1 Press READ 20.
- 2 Make sure the CASING DROP PRESSURE is high enough that the plunger surfaces before the pressure is reached. For instructions, see page 15.
If the CASING DROP PRESSURE is set correctly, go to Test 2.

Test 2: Check remote controller by disconnecting the sensor.

- 1 Disconnect the sensor from the sensor and ground terminals on the inside of the remote controller's faceplate.
- 2 At the master controller, press ON. The remote controller should count down the OPEN TIME.
 - If the remote controller goes from OPEN TIME to DELAY TIME (SALES), the remote controller's circuit board is not working properly. Call your PCS sales and service representative.
 - If the remote controller does not go to DELAY TIME (SALES), continue with the next step.
- 3 Use a wire to short the sensor and ground terminals. The remote controller is OK if it goes to DELAY TIME (SALES).
- 4 Reconnect the sensor to the terminals. Make sure the wires are put back in correctly.

Test 3: Check sensor.

- 1 At the master controller, press ON.
- 2 Run a steel wrench along the back of the sensor.
 - If the remote controller goes to DELAY TIME (SALES), the sensor is OK.
 - If the remote controller does not go to DELAY TIME (SALES), call your PCS sales and service representative.

Test 4: Check sensor alignment.

- 1 Realign the sensor by 90 degrees.
Example: If the sensor is aligned on the north or south side, realign it on the east or west side.
- 2 If realigning the sensor does not solve the problem, call your PCS sales and service representative.

Short-term fix for the sensor problem: Use the CASING DROP PRESSURE feature (see page 15).

Solenoid (Shift Valve) Problems**Solenoid (shift valve) does not operate at any time or does not operate at night**

If the solenoid does not operate at night, the solar panel may be powering the controller during the day.

Test 1: Check remote controller's fuse.

- 1 With a screwdriver, turn the screw at the top center of the remote controller's faceplate to release the tab that holds the top of the faceplate to the case. Pull the faceplate away from the controller's case. A hinge connects the bottom of the faceplate to the case.
- 2 Move the OFF/ON power switch on the circuit board to OFF.
- 3 Remove the fuse from its yellow casing.
 - If the fuse is defective, replace it with a 5 amp, 250 volt fuse. The controller's box contains 1 extra fuse. When you are done, move the OFF/ON power switch to ON. Replace the controller's faceplate and turn the screw until the tab holds the top of the faceplate to the case.
 - If the fuse is OK, go to Test 2.

Test 2: Check remote controller's battery and wire connection.

The battery life is approximately 1 to 3 years. The remote controller has a safety feature. If the battery voltage is low, the remote controller closes the motor valve and shuts in.

- 1 Check the battery voltage with a volt meter.
Replace the battery if it is below 6 volts.
- 2 Check the battery wire connection.
- 3 Move the OFF/ON power switch to ON.
- 4 Replace the controller's faceplate and turn the screw until the tab holds the top of the faceplate to the case.
- 5 Check whether the solenoid is operating properly.
 - If the solenoid is now operating properly and if you replaced the battery, check the manufacture date on the battery. If the battery is less than 3 years old, check the solar panel. Go to Test 3.
 - If the solenoid still does not operate, go to Test 4.

Test 3: Check remote controller's solar panel

- 1 Disconnect the solar panel from the terminals. Use a volt meter to obtain the voltage and amperage. A good solar panel reading in full sun exposure is 10.7 volts and 350-430 mA.
- 2 If the solar panel is defective, change it.
- 3 Check the solar panel installation.
 - The solar panel should face south.
 - The tilt of the solar panel should be the latitude of the location plus 15 degrees. Example: if the latitude is 45 degrees, tilt the solar panel 60 degrees with respect to the horizon.
 - The element should be free from dirt, oil, and so on.
 - Check for cracks in the solar panel.
 - Check whether the solar panel is shaded during any part of the day. If it is, position it so it receives the most sunlight each day.
- 4 Check the solar panel wire connection.
- 5 Make sure the remote controller's power switch is on.
- 6 If the solar panel tests good, but the batteries are not lasting as long as they should, call your PCS sales and service representative.

Test 4: Check solenoid (shift valve).

- 1 Press ON.
- 2 If the solenoid won't open, clean the supply hoses and puck inside the solenoid valve.
- 3 Retest.
- 4 If they are good, replace the puck or the entire solenoid.

Transducer Problems**Display shows transducer reading of 0 psi**

The surge protector or the transducer may be defective, or the transducer wire may have been completely cut.

- 1 Re-calibrate the transducer.
- 2 If the transducer won't hold the calibration, change the remote controller to Time Mode: Select the remote controller, press SET 11, and enter 1.
- 3 Call your PCS sales and service representative.

Display shows fluctuating or false transducer reading

The transducer wire may be defective.

- 1 Re-calibrate the transducer.
- 2 If the transducer won't hold the calibration, change the remote controller to Time Mode: Select the remote controller, press SET 11, and enter 1.
- 3 Call your PCS sales and service representative.

Communication Problems**Display shows STATUS UNKNOWN for remote controller**

- 1 Check whether the well has been disabled. Press SET 5 *well number*. For example, for well 6, press SET 56. If the status display shows WELL NOT ENABLED, re-enable the well. See "Enabling a Remote Controller" on page 7.
- 2 Make sure the remote controller's power switch is on.
 - With a screwdriver, turn the screw at the top center of the remote controller's faceplate to release the tab that holds the faceplate to the case. Pull the faceplate away from the controller's case. A hinge connects the bottom of the faceplate to the case.
 - Make sure the OFF/ON power switch on the circuit board is set to ON.
- 3 If you can't re-enable the well, go to Test 1.

Test 1: Check remote controller's fuse.

- 1 Move the OFF/ON power switch on the circuit board to OFF.
- 2 Remove the fuse from its yellow casing.
 - If the fuse is defective, replace it with a 5 amp, 250 volt fuse. The controller's box contains 1 extra fuse. When you are done, move the OFF/ON power switch to ON. Replace the controller's faceplate and turn the screw until the tab holds the top of the faceplate to the case.
 - If the fuse is OK, go to Test 2.

Test 2: Check remote controller's battery and wire connection.

The battery life is approximately 1 to 3 years.

The remote controller has a safety feature. If the battery voltage is low, the remote controller closes the motor valve and shuts in.

- 1 Check the battery voltage with a volt meter. Replace the battery if it is below 6 volts.
- 2 Check the battery wire connection.
- 3 Move the OFF/ON power switch to ON.
- 4 Replace the controller's faceplate and turn the screw until the tab holds the top of the faceplate to the case.
- 5 Check whether STATUS UNKNOWN has disappeared from the master controller's display and the master controller is communicating with the remote controller.
 - If the master controller is communicating with the remote controller and if you replaced the battery, check the manufacture date on the battery. If the battery is less than 3 years old, check the solar panel. Go to Test 3.
 - If the master controller still is not communicating with the remote controller, go to Test 4.

Test 3: Check remote controller's solar panel

- 1 Disconnect the solar panel from the terminals. Use a volt meter to obtain the voltage and amperage. A good solar panel reading in full sun exposure is 10.7 volts and 350-430 mA.
- 2 If the solar panel is defective, change it.
- 3 Check the solar panel installation.
 - The solar panel should face south.
 - The tilt of the solar panel should be the latitude of the location plus 15 degrees. Example: if the latitude is 45 degrees, tilt the solar panel 60 degrees with respect to the horizon.
 - The element should be free from dirt, oil, and so on.
 - Check for cracks in the solar panel.
 - Check whether the solar panel is shaded during any part of the day. If it is, position it so it receives the most sunlight each day.
- 4 Check the solar panel wire connection.
- 5 Make sure the remote controller's power switch is on.
- 6 If the solar panel tests good, but the batteries are not lasting as long as they should, call your PCS sales and service representative.

Test 4: Check solenoid

- 1 Select the remote controller, and press ON.
- 2 If the solenoid won't open, clean the supply hoses and puck inside the solenoid valve.
- 3 Retest.
- 4 If they are good, replace the puck or the entire solenoid.

Test 5: Check the sensor wire connections.

- 1 If a wire was spliced in because of the distance between the remote controller and the sensor, check the connection where the wire was spliced. The wire may be corroded and causing a short.
- 2 If the sensor wire connections are good, go to Test 6.

Test 6: Check remote controller by disconnecting the sensor.

- 1 Disconnect the sensor from the sensor and ground terminals on the inside of the remote controller's faceplate.
- 2 At the master controller, press ON. The remote controller should count down the OPEN TIME.
 - If the remote controller goes from OPEN TIME to DELAY TIME (SALES), the remote controller's circuit board is not working properly. Call your PCS sales and service representative.
 - If the remote controller does not go to DELAY TIME (SALES), continue with the next step.
- 3 Use a wire to short the sensor and ground terminals. The remote controller is OK if it goes to DELAY TIME (SALES).
- 4 Reconnect the sensor to the terminals. Make sure the wires are put back in correctly.

Test 7: Check sensor.

- 1 At the master controller, press ON.
- 2 Run a steel wrench along the back of the sensor.
 - If the remote controller goes to DELAY TIME (SALES), the sensor is OK.
 - If the remote controller does not go to DELAY TIME (SALES), call your PCS sales and service representative.

Test 8: Check antenna and cabling.

- 1 Check the antenna and cabling for integrity.
- 2 Check for broken wires.

For further troubleshooting, see the PCS 4000 Multi Well Controller technical manual or call your PCS sales and service representative.

PREVENTIVE MAINTENANCE**Master Controller's Battery**

Always replace the master controller's battery when it is 3 years old.

Remote Controller's Battery

Always replace the remote controller's battery when it is 3 years old.

You can get more information about the PCS products at: ProductionControlServices.com



3771 Eureka Way
Frederick, CO 80516
1.800.619.2241

Warranty: Production Control Services, Inc. warrants all PCS manufactured equipment to be free of defects in material and workmanship for ONE YEAR from date of purchase by original buyer only. Warranty is completely void if abuse, neglect, misuse or misapplication is the cause of the malfunction. Determination of abuse or damage to be made solely by PCS.

PCS 4000™ is a trademark of Production Control Services, Inc.

Copyright ©2008 Production Control Services, Inc.
All rights reserved. 5/22/08