Quizix®

PumpWorks User's Manual

Chandler Engineering Company L.L.C.
P.O. Box 470710, Tulsa, Oklahoma 74147-0710 U.S.A.
Phone: (918) 250-7200 Fax: (918) 459-0165
E-mail: chandler.mail@ametek.com Website: http://www.chandlereng.com

CHANDLER ENGINEERING®

March 2013
PumpWorks Version 7.01

AMETEK®

1 OVERVIEW

PumpWorks© is a software program that allows complete and automated control of QUIZIX® fluid pumps and runs on Windows-based computers. PumpWorks is easy to install and can be used with any Quizix pump, or an entire pump system. When installing PumpWorks for Windows software, an installation wizard guides the user through the entire process. Your computer must meet the following requirements.

- PC–compatible computer (486 or Pentium®based, 66 mhz minimum)
- Windows 95, Windows 98, Windows NT, Windows 2000, Windows XP, Vista, or Windows 7 operating systems
- CD drive
- At least 10 Mb of available hard drive space
- Color monitor

PumpWorks has many advantages, including the following:

- PumpWorks serves as a two-way communication channel between the user and their pump system.
- PumpWorks gives the user highly sophisticated control over their pump system.
- The user can regulate every aspect of the pump system, allowing an extensive amount of flexibility.
- The user can view the pump system's operation at a glance on their computer monitor.
- The pump can be programmed to deliver a user-set amount of fluid, or operate for a user-set amount of time, and then automatically stop.
- PumpWorks includes a data log feature which allows the user to record data from their experiment onto a log. The user can view the data log, write remarks to the data log, or copy the data log.
- PumpWorks has a Dynamic Data Exchange capability which allows the user to share data with, or control pump operations from, other programs.

In this overview, we will briefly explain the PumpWorks application. There are four major elements, as follows:

- **Title Bar.** Contains the name of the window that is open and active.
- **Menu Bar.** Contains nine pull-down menus from which the user can access additional pump options.
- **Pump Data and Controls Window.** Also referred to as the **main window**. This is where operating information is displayed for all pumps. Also in this window, pumps can be started or stopped, pressure and flow rate can be set, an operating mode can be chosen, piston direction can be set, and the valves can be opened or closed.

- **Status Bar.** Shows the condition of the pumps at a glance.

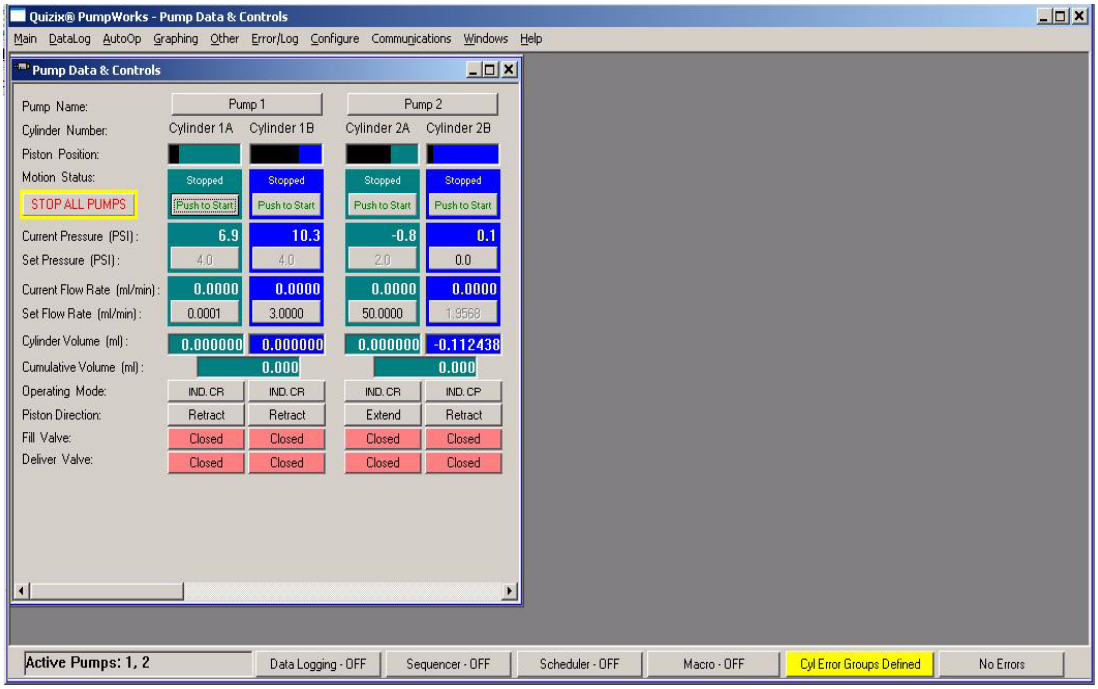


Figure 1-1 PumpWorks Application

1.1 Title Bar

The Title Bar appears at the top of the PumpWorks application. The title bar lists the currently active window.

1.2 Menu Bar

The Menu Bar is also located at the top of the PumpWorks application and contains nine pull-down menus, as follows.

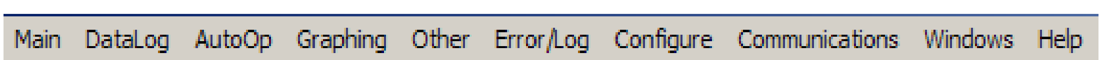


Figure 1-2 Menu Bar

- Main Menu, Section 1.2.1
- Data Log Menu, Section 1.2.2
- AutoOp Menu, Section 1.2.3
- Graphing Menu, Section 1.2.4
- Other Menu, Section 1.2.5
- Error/Log Menu, Section 1.2.6
- Configure Menu, Section 1.2.7

- Communications Menu, Section 1.2.8
- Window Menu, Section 1.2.9
- Help Menu, Section 1.2.10

Each menu offers the user additional PumpWorks options.

1.2.1 Main Menu

Through the Main menu, the user is able to start or stop the pump cylinders, set the pump pressure, flow rates and safety pressure, reset the cylinder volume count to zero, check the status of password protection, and log in/out as the administrator.

1.2.2 Data Log Menu

The Data Log menu allows the user to automatically record an experiment's data into a logged data file. The user has control over which data is to be recorded and how often, and can choose to view the data log, write remarks to the data log, or copy the data log to a disk.

1.2.3 AutoOp Menu

The AutoOp menu allows the user advanced automatic control over their pump system. Through the AutoOp menu, the user can:

- Set Up and Control Ramping Operation, which is the gradual change from one flow rate or set pressure to another over a specified period of time.
- Set Up and Control Automautic Volume/Time Operation, which allows a pump cylinder or cylinder pair to stop pumping, automatically, after a specific amount of fluid has been pumped or a specific amount of time has elapsed.
- Control Sequencer Operation, which allows automatic control of pumps and PumpWorks using if/then type logic from a user-created file.
- Set Up Schedules, which allows the user to define a sequence of automatic ramp operations for pumps.
- Control Scheduler, which allows execution of a sequence of automatic ramp operations on pumps.
- Macro Control, which allows recording and playback of sets of commands called macros.

1.2.4 Graphing Menu

The graphing menu allows the user to set up multiple graph configurations, and then open graphing windows to graph data using those configurations. Each graph configuration specifies which data to graph, how fast to sample data points, the format of the graph, and so on.

1.2.5 Other Menu

The Other menu allows the user to set up and control miscellaneous system components and operations, which include:

- Software pressure transducer calibration.
- Auxiliary analog input signals.
- Auxiliary digital input signals.
- Control (user-added) auxiliary valves.
- Auxiliary digital output.
- View fluid volume data from a (user-added) separator.
- Control a (user-added) back pressure regulator.
- View and configure/control timers, user-entered mathematical equations and internal variables.
- View and configure pump maintenance status and maintenance intervals.

1.2.6 Error/Log Menu

The following options are available through the Error/Log menu:

- System Status. View the status of error conditions in the pump system, at a glance.
- Current Error Log. View the most recent system errors.
- Previous Errors and Events. View previous errors and events from an historical log.
- Cylinder Switch Status. View a pump cylinder’s switch status. This is useful if there is an error message related to the piston position or control switches.
- Select Events/Errors to View. A user chooses which type of errors and events will be displayed in the error/log and the error state capture log.
- Force Error State Capture Entry. A user can “force” an error entry into the Current Error Log and the Previous Errors file. This helps the user to capture an event, that was just observed, into the error state capture file.
- Switch to Error State Capture Mode. This is a PumpWorks diagnostic feature where a user can return the pump information display to the way it was around the time of a user-chosen error condition.
- Create Diagnostic File. This feature allows the user to save all of the PumpWorks diagnostic and error information, gathered from the Error/Events Log, the Error State Capture file and the PumpWorks.ini file, into one compressed file.

1.2.7 Configure Menu

The Configure menu is used to configure the pump system to best suit a user’s experiment. Through the Configure menu a user can choose the following:

- Set up Displayed Units and Decimal Places. Sets up the units of measure and number of decimal places the user wishes to display for pressure, flow rate and volume.
- Set Up Pump Operating Parameters. Sets up a pump's basic operating parameters.
- Set up Pressure Control. Sets up pressure control servo constants.
- Scale Pump Flow Rates. Sets up the pump's rate scaler values.This feature is used in constant rate operating modes when the fluid will either expand or contract.
- Set Up Recirculating Parameters. Sets parameters for recirculating pump systems.
- Set Up Default System. Sets default settings for safety pressure, flow rate or set pressure which allow the user to establish settings for all pumps with one click.
- Set Up Error Masking. Here a user can set up certain error(s) to be ignored by PumpWorks.
- Set Up Resource Mapping. Configures logical mapping for auxiliary analog inputs, digital inputs, digital outputs and auxiliary valves.
- Set Up Data Averaging. Configures parameters for averaging data for data logging and/or display.
- Set Up Sequences. Maps user-named sequences to sequence files.
- View Pump Information. Here pump information can be viewed, such as cylinder type, controller type, controller identification number, COM and expander ports and communication status for all pumps that are connected.
- Reassign Pump Number. A pump can be assigned a different pump number, which is the number PumpWorks and the pump recognize it to be.
- Uninstall Pump. A pump can be uninstalled.
- Error State Capture Settings. Here a user can decide how many seconds before and after an error condition occurs PumpWorks will record pump data. The maximum error state capture file size can also be set in this window.
- Extended Analog Input Settings. Allows the user to attach and configure additional sensors to the Quizix pump system.
- System Settings. Allows a user to choose to close windows automatically after sending a command, start / stop pump cylinders with function keys, list pump cylinders individually or in pairs on PumpWorks main window, set the pressure that will trigger a valve warning message, or set the minimum disk space necessary for data logging to occur.
- Controller Setup. Allows a user to configure the pump controller to the pump system's hardware.
- Cylinder Stop Action Settings, Allows a user to configure desired valve commands to be issued when a cylinder stops, either due to an emergency stop condition, some other error condition, or anytime a cylinder stops.

- Overpressure/Underpressure Action Settings. Allows a user to configure desired valve commands to be issued when an overpressure or underpressure condition occurs.
- Cylinder Error Groups. Allows a user to group pump cylinders together so that if one stops due to an error, other pumps will automatically be stopped.
- Auto Tune Cylinders. Allows users to tune cylinders (set optimal proportional and differential gains) using an automated procedure.

1.2.8 Communications Menu

The Communications menu is used to set up or change the link between PumpWorks and the pump(s). Through this menu the user can do the following:

- Search for Pumps. PumpWorks will automatically search for pumps and install them.
- Search Options. The user can set up how and when PumpWorks will search for new pumps.
- Pump Communications. The user can view basic communication information and set communication intervals and parameters.
- Separator Communications. If the user has added one or more separators to their pump system, this window allows the user to configure the separator communication intervals.
- Back Pressure Regulator Communications. If a user has added a back pressure regulator to their pump system, its communications parameters can be configured here.
- Host Mode Communications. A program running on a remote computer can interface with PumpWorks via a serial RS-232 data line. Host Mode Communications is where a user configures the communication parameters with that remote computer.
- Auxiliary Transducer Communications. If the user has added one or more auxiliary transducers to their system, this window allows the user to detect and configure them.
- View Communication Status. Displays basic communication information and whether communication is in progress or not, for any specified COM port.
- Baud Rate Options. Allows the user to specify using a high speed baud rate, and also allows the user to specify whether communication is in broadcast mode.
- Update Front Panel Software. Enables a user to update their Front Panel software, as new versions become available.
- Update Pump Controller Software. Enables a user to update their pump controller software, as new versions become available.

1.2.9 Window Menu

The Window Menu allows the user to choose how multiple windows will be arranged on the desktop. This is also where all open windows are listed.

1.2.10 Help Menu

The Help Menu provides access to easy-to-use software versions of the Pump Manuals and PumpWorks User's Manual, as well as a way to view the currently installed software versions of PumpWorks and the pump controllers.

1.3 Pump Data & Controls Window*

PumpWorks Pump Data & Controls window, also referred to as the main window, appears when PumpWorks is initialized. See Figure 1-3 below. The main window is the core of PumpWorks and displays information and settings for up to eight pumps (sixteen pump cylinders). This window is covered in detail in Chapter 4, Section 4.3.

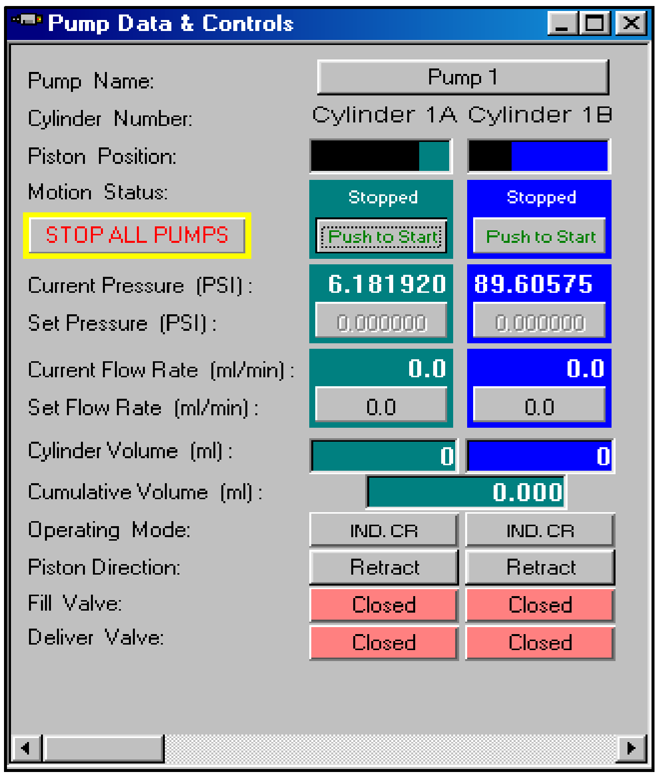


Figure 1-3 Pump Data & Controls Window (Main Window)

1.4 Status Bar

The status bar, which is located below the main window, displays messages messages regarding the status of the pump controller(s), data logging, sequencer, scheduler, macros, and error messages. The Status Bar allows the user to view the status of the pump cylinders quickly, as well as the status of other various PumpWorks features. The status bar has six sections, which are explained below.

Figure 1-4 Status Bar

1.4.1 Active Pumps

This part of the status bar shows which pumps are installed onto and communicating with PumpWorks. The pump number of each pump installed onto PumpWorks will appear following the words “Active Pumps”. For Example, Active Pumps 1, 3, 4 would means pump numbers 1, 3 and 4 are installed. If no pumps are installed, the words “No Active Pumps” will appear.

1.4.2 Data Logging

This part of the status bar shows whether or not data is being logged to a data logging file. It will read either Data Logging ON, or Data Logging OFF. Clicking on this button will open the View Data Log File, as described in Chapter 7, Section 7.5.

1.4.3 Sequencer

This part of the status bar shows whether at least one of the Sequencers is running or not. It will read either Sequencer ON, or Sequencer OFF. Clicking on this button will open the Control Sequence Operation windows for all currently runing or paused Sequencers, as described in Chapter 8, Section 8.3.10.

1.4.4 Scheduler

This part of the status bar shows whether the Scheduler is running for any cylinder or not. It will read either Scheduler ON, or Scheduler OFF. Clicking on this button will open the Control Scheduler Window, as described in Chapter 8, Section 8.4.2.

1.4.5 Macro

This part of the status bar shows whether PumpWorks is recording and/or playing back a macro. It will read either Macro - OFF, Macro Record Active, Macro Playback Active, or Macro Record and Playback Active. Clicking on this button will open the Macro Action Control Window, as described in Chapter 8, Section 8.5.5.

1.4.6 Cylinder Error Group

This part of the status bar shows whether any of the pumps that are communicating are part of one or more cylinder error groups. It will read either "Cyl Error Groups Defined" or "No Cyl Error Groups Defined." Clicking on this button will open the Cylinder Error Group window, as described in Chapter 12, Section 12.20.

1.4.7 Errors

This part of the status bar shows whether errors are present or not. The status bar can show the following four different error messages:

- **No Errors**
- **Errors Present**
  This message indicates there are currently one or more error conditions present in the pump system.

- **Check Error Log**
  This message warns the user an error has occurred, but the error has gone away or was resolved. When the user checks the error log, a specific error message will be described. Once the user views and acknowledges the errors, the message “No Errors” returns to the status bar.

- **Unresolved Errors**
  This message reminds the user there is still an error present in the pump system that has not been resolved, even though it has been acknowledged in the error log.

Clicking on this button will open the Current Error Log window, as described in Chapter 11, Section 11.3.

THIS PAGE INTENTIONALLY LEFT BLANK.

2 INSTALLING PUMPWORKS

Chapter 2 describes how to install PumpWorks software. PumpWorks can be used with one Quizix pump, or up to eight Quizix pumps. Installation is easy and utilizes a setup program that guides the user through the entire process.

2.1 Pre-Installed PumpWorks

If you purchased a computer from Chandler Engineering with your pump system, PumpWorks has already been installed for you. Go to Chapter 3, Section 3.2, How to Set Up Your Communications.

2.2 Installing PumpWorks on Your Computer

Before installing PumpWorks onto your computer, make sure your account has administrator privileges (see note below), and make sure your computer meets the following hardware requirements.

- PC–compatible computer (486, or Pentium®based, 66 mHz minimum)
- Windows 95, Windows 98, Windows NT, Windows 2000, Windows XP, Vista, or Windows 7 operating systems
- CD Drive, or CD ROM Drive
- At least 10Mb of available hard drive space
- Color monitor

If your computer meets the above requirements, follow the steps below to install PumpWorks.

1. Insert the PumpWorks CD into your computer.
2. If the installation does not start within a few seconds, using either Windows Explorer or File Manager, click on or run "setup.exe".
3. The installation program will ask if this is an upgrade from a previous version of PumpWorks. If this is the first time you've ever installed PumpWorks, click on the No button, and you'll move to the next step (choosing the destination folder for PumpWorks.exe - see item 8 below). If you've been running a previous version of PumpWorks on this computer, click on Yes.
4. If this is an upgrade, the installation program will prompt you to read the readme.txt file on the installation CD. It's extemely important to read this file and understand the ramifications of the answers to the next few questions, and to understand if/how previous configuration and other generated files will be relocated and/or converted. The installation program will not let you continue until you answer that you have read the readme.txt file.
5. If this is a PumpWorks upgrade, you will be asked whether you want to copy configuration files from a previous PumpWorks session. If this is an upgrade from a version of PumpWorks 6.15 or earlier, and you want to retain your configuration data,

click on Yes, and specify the directory the configuration files reside in. IF, AND ONLY IF, YOU'RE UPGRADING FROM A VERSION OF PUMPWORKS 6.15 OR EARLIER, the configuration files will be located in the same directory that your previous pumpworks.exe file was located - default location is c:\Program Files\Quizix PumpWorks. IF YOU ARE UPGRADING FROM A VERSION OF PUMPWORKS LATER THAN 6.15, **DO NOT** SELECT THE SAME DIRECTORY WHERE YOUR PREVIOUS PUMPWORKS.EXE RESIDES. Doing so will cause you to lose your previous configuration data, as versions of PumpWorks later than 6.15 store the configuration files in a common shared documents directory. If you are upgrading from a version of PumpWorks later than 6.15, your previous configuration data will automatically be used by the newer PumpWorks that you are installing. If you accidentally clicked on Yes (you want to copy configuration data from a previous PumpWorks session), and then realize that you do NOT want to copy the old configuration data (e.g. you're upgrading from a version of PumpWorks later than 6.15), simply click on the Cancel button instead of selecting a directory, and you'll move to the next step (choosing the destination folder for PumpWorks.exe - item 8, below).

6. After you select the directory of the previous configuration files, the installation program will look to see if existing configuration files already exist in the common shared documents directory. If they do already exist (implying that a version of PumpWorks subsequent to version 6.15 has already been installed and/or run), you will be prompted twice, to confirm that you really want to overwrite the existing configuration data with previous configuration data from another directory. If you change your mind, and do not want to overwrite the data in the common shared documents directory with the other configuration data, simply click on No, and you'll move to the next step (choosing the destination folder for PumpWorks.exe - item 8, below).
7. If you choose to copy previous configuration data, all files, including ones in subdirectories, will be copied to the new file location (the common shared documents directory). It's important to note that while the files in the old location will not be deleted by the installation program, they will no longer be accessed by PumpWorks. It may be prudent for the user to delete these old files, **once they have verified that the files were copied to the new location successfully**, to avoid confusion.
8. Next, the Choose Destination Location window appears. This is the location where PumpWorks.exe will be installed. If you want to install to the default directory (Program Files / PumpWorks) listed, click on Next.

   If you wish to install to a different directory, click on Browse and locate that directory. You may also type in a directory location. PumpWorks will create the directory if it does not already exist. When you are finished, click on OK. When Setup returns to the Choose Destination Location window, click on Next.

Very Important Note: Chandler Engineering strongly discourages choosing a directory other than the default directory, especially if running under Vista or Windows 7. File sharing issues and virtual files for different users are important NEGATIVE issues with Vista or Windows 7, and will result in unexpected behavior if a directory is chosen outside of the Program Files directory tree.

9. The Setup Type window appears next. Users can choose between the following setups:
    - Typical Setup: installs all the necessary files, the on-line help files, and some example files.
    - Compact Setup: installs the files necessary to run PumpWorks, but not the on-line help files or the sample files.
    - Custom Set-up: The user can select which sets of files to install.

After the setup type has been selected, click on Next.

10. After a few seconds, a progress bar will be displayed and updated as PumpWorks is installed.
11. Setup will display a message conveying that PumpWorks has been installed successfully.
12. Store the PumpWorks CD in a safe place. Use this CD if you need to restore or re-install PumpWorks.
13. You are given an option to view the Readme File, which contains the latest release information about PumpWorks.

NOTE: If your account does not have administrator privileges when you install PumpWorks, you will not be able to successfully un-install PumpWorks later.

Go to Chapter 3, COMMUNICATIONS - SETTING UP A LINK WITH YOUR PUMP

THIS PAGE INTENTIONALLY LEFT BLANK.

3 COMMUNICATIONS - SETTING UP A LINK WITH YOUR PUMP

Now that PumpWorks has been installed onto your computer, Chapter 3 will describe how to set up a communications link between your computer and pump, which is easy to accomplish. After your pump and computer are connected, your pump is installed onto PumpWorks.

The following sections are included in this chapter:

- Serial Expander/Isolator, Section 3.1
- How to Set Up Your Communications, Section 3.2
- Installing Your Pump When PumpWorks Initializes, Section 3.3
- Installing Your Pump From PumpWorks Main Window, Section 3.4

3.1 Serial Expander/Isolator

The serial expander/isolator, shown in Figure 3-1, is a device which takes one serial port of a computer and expands it into four data ports. It is used with all current Quizix pump systems including the QX Series Pump, the QL-700 pump and any pump system with a CMD-5000 or CN-6000 controller. Older pump systems which include a SC-2400 controller do not use a serial expander/isolator.

The serial expander/isolator, shown in Figure 3-1, is important for two main reasons. First, since computers come with a limited number of serial ports, the serial expander/isolator allows up to four dual-cylinder Quizix pumps to be connected to a single computer serial port. Therefore, the user does not have to add serial ports to their computer. One computer serial port, with one serial expander/isolator connected to it, can operate any four Quizix dual-cylinder pumps, or eight pump cylinders

Figure 3-1 Serial Expander/Isolator

The serial expander/isolator also serves a second purpose. It provides electrical isolation between the computer running PumpWorks and the data signals that go to the user's pumps. The RS-232 data signals from the computer are optically isolated via an opto-coupler from the electrical data signals of the user's pumps. Thus, each pump controller is electrically isolated from the computer and from every other pump controller.

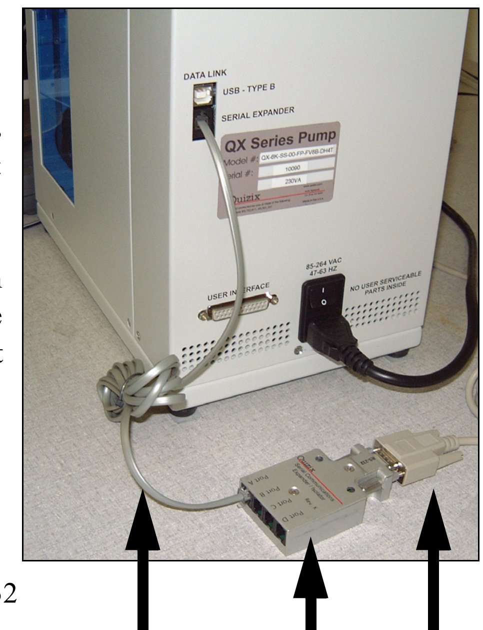
This isolation is provided to prevent ground loops and system grounding problems when the pumps and computer are plugged into different power circuits. It is not designed to protect against incorrectly wired AC power circuits.

3.2 How to Set Up Your Communications

In this section, we will instruct how to connect the communication cables and/or the serial expander/isolator.

- For Serial Communication:

Figure 3-2 RS-232 Cable Connection



  - Connect the RS-232 Cable (9 pin D style connector) to “Communications Port 1" on the back of the computer PumpWorks is installed on. (Communications Port 1 may be labeled Serial A or Serial 1 on your computer.) If Communications Port 1 is already in use, you may use any other available serial port. If your computer does not have enough serial ports, you will need to purchase a serial port expansion card for your computer. Contact Chandler Engineering for suggestions.
  - Connect the other end of the RS-232 Cable into the serial expander/ isolator. See Figure 3-2.
  - Connect one end of the data communications cable (phone-type) into the first available port on the serial expander/isolator.
  - For the QX Series and QL-700 Pumps, connect the other end of the data communications cable to the “Data Link” port on the pump.For the 5000 Series or the 6000 Series pumps, connect the data communications cable to the “Data Link” port on the pump controller.

NOTE FOR 6000 SERIES PUMPS: The serial expander/isolator is typically mounted directly onto the CN-6000 controller, so the data communications cable is extremely short.

NOTE FOR 5000 SERIES, QX SERIES. and QL-700 PUMPS: If the user wishes, the serial expander/isolator can be attached directly to the computer’s serial port, eliminating the need for the RS-232 cable. If using the RS-232 cable, the QL-700 pump or CMD-5000 controller can be placed up to 50 feet away from the computer.

If PumpWorks is not already initialized and running, go to Installing Your Pump When PumpWorks Initializes, Section 3.3. If PumpWorks is already initialized and running on your computer, go to Installing Your Pump From PumpWorks Main Window, Section 3.4.

3.3 Installing Your Pump When PumpWorks Initializes

Now that PumpWorks is installed and the communications cables have been connected, this section instructs how to install your pump(s) onto PumpWorks.

- For the QX Series and QL-700 Pumps, turn on all pumps to be installed. The on/off power switch is located immediately above where the AC power cord is attached to the pump. Allow ten seconds for your pump to initialize. A detailed description of the initialization process is given in your pump manual. Please refer to it for this information.

- For the 5000 Series pump systems, turn on the pump controller.

- For 6000 Series pump systems, turn on the pump controller and the motor driver, which is attached to the pump cylinder.

- From the computer, click on Start | Program | PumpWorks.

By having your pump controller(s) connected and turned on when starting PumpWorks, the software will automatically find your new pump by searching all communication ports and looking for a Quizix pump.

When a pump is found, the New Pump Found window appears as shown in Figure 3-3 below.

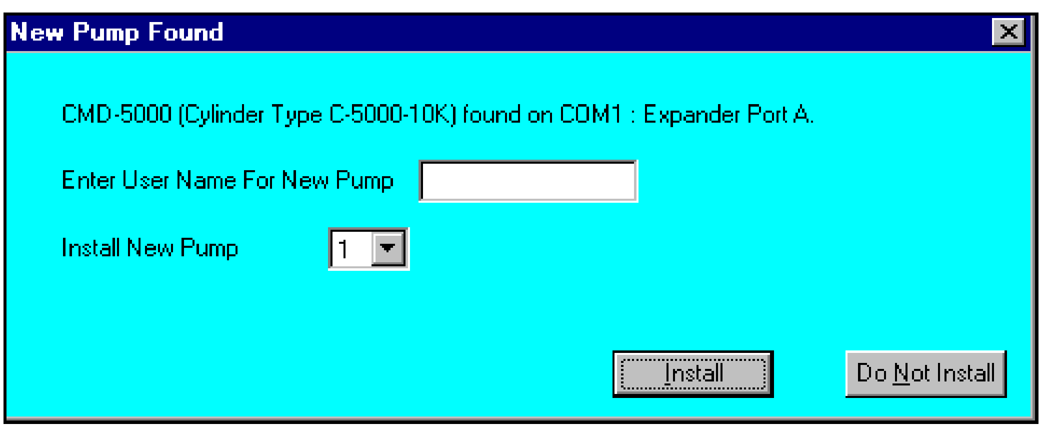


Figure 3-3 New Pump Found Window

The New Pump Found window displays the type of pump found, the COM port and if a COM port, the serial expander/isolator port where it will be installed.

- “Enter User Name for New Pump”.

Enter a name for your pump if you wish. The default pump name is Pump 1, Pump 2, and so on. You may choose to give your pump a different name, for example, "Oil Pump". PumpWorks will add the user name to its current name; for example, "Pump 1 - Oil Pump". You do not have to rename your pump now. You may do so at any time from the Pump Data & Controls window by clicking on the "Pump" name button.

- "Install New Pump".
  This refers to the pump's screen location - where the pump will be displayed on the PumpWorks main window. For example, the pump can be located as Pump 1, Pump 2, and so on. The user has a choice of eight pump locations. The default pump location is the lowest available pump number. (Once installed, the user can always change a pump's screen location from PumpWorks main window.) To enter a different screen location:
  - Click on the down arrow located on the right side of the Install New Pump text box.
  - Highlight the number that correlates to the screen position where you want your pump to be located.
- When finished, click on Install.

PumpWorks will install the pump and search for additional new pumps. If additional new pumps are found, another New Pump Found screen will appear. If no additional new pumps are found, PumpWorks initializes and a window called Pump Data & Controls automatically opens, along with any windows that were open when/if PumpWorks was previously shutdown.

3.4 Installing Your Pump From PumpWorks Main Window

A pump can be installed from PumpWorks main window by doing a Search for Pumps from the Communications menu. PumpWorks will search all user-specified COM ports, and all associated serial expander ports, for an uninstalled Quizix pump. If a user is already operating PumpWorks, especially if an experiment is already running on a different pump, the user may not want to exit PumpWorks to add the new pump automatically upon PumpWorks initialization. In this case, Search for Pumps will install the new pump onto PumpWorks without interfering with on-going experiments. To install a pump:

- From the menu bar, select Communications | Search for Pumps. PumpWorks will search all user-specified COM ports and all associated serial expander ports for an uninstalled Quizix pump. When found, a New Pump Found window opens, as shown in Figure 3-4 below.

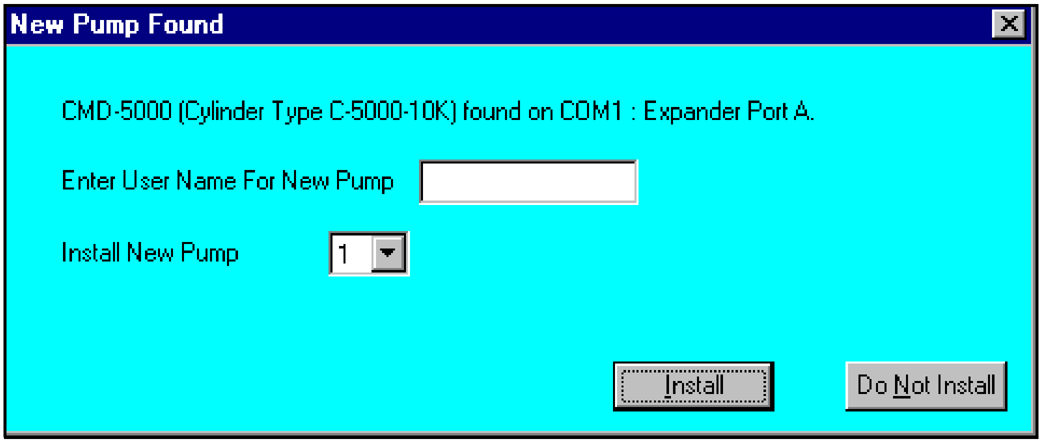


Figure 3-4 New Pump Found Window

The New Pump Found window displays the type of pump found, the COM port, and if a COM port, the serial expander/isolator port where it will be installed.

- "Enter User Name for New Pump"
  Enter a name for your pump if you wish. The default pump name is Pump 1, Pump 2, and so on. You may choose to give your pump a different name, for example, "Oil Pump". PumpWorks will add the user name to its current name; for example, "Pump 1 - Oil Pump". You do not have to rename your pump now. You may do so at any time from the Pump Data & Controls window by clicking on the "Pump" name button.

- "Install New Pump"
  This refers to the pump's screen location - where the pump will be displayed on the PumpWorks main window. For example, the pump can be located as Pump 1, Pump 2, and so on. The user has a choice of eight screen locations. The default location is the lowest available pump number. (Once installed, the user can always change a pump's screen location from PumpWorks main window.) To enter a different pump screen location:

  - Click on the down arrow located on the right side of the Install New Pump text box.

  - Highlight the number that correlates to the screen position where you want your pump to be located.

- When finished, click on Install.
  PumpWorks will install the pump and search for additional new pumps. If additional new pumps are found, another New Pump Found screen will appear.

3.5 Character Buffer Overrun Communication Errors and the Serial Communication Card

If you experience an excessive amount of "character buffer overrun" communication errors, there is most likely an error on the serial communication card in your computer. (These errors would be logged in the error log file, which can be viewed by selecting "Previous Errors and

Events" from the "Error/Log" menu on the menu bar in PumpWorks.) If you see a lot of these errors, and it appears to be a recurring problem, please contact your computer vendor for information on how to test and/or replace the card.

4 PUMPWORKS BASICS

In Chapter 4 we will discuss the basics of operating PumpWorks. Included in this chapter are the following sections:

- Introduction to PumpWorks, Section 4.1
- PumpWorks Color Coding, Section 4.2
- Pump Data & Controls Window (Main Window), Section 4.3
- Changing the Units of Measurement, Section 4.4
- Changing Names in PumpWorks, Section 4.5
- Starting and Stopping Pump Cylinders, Section 4.6

4.1 Introduction to PumpWorks

In this section, we will discuss the basics of the PumpWorks Application.

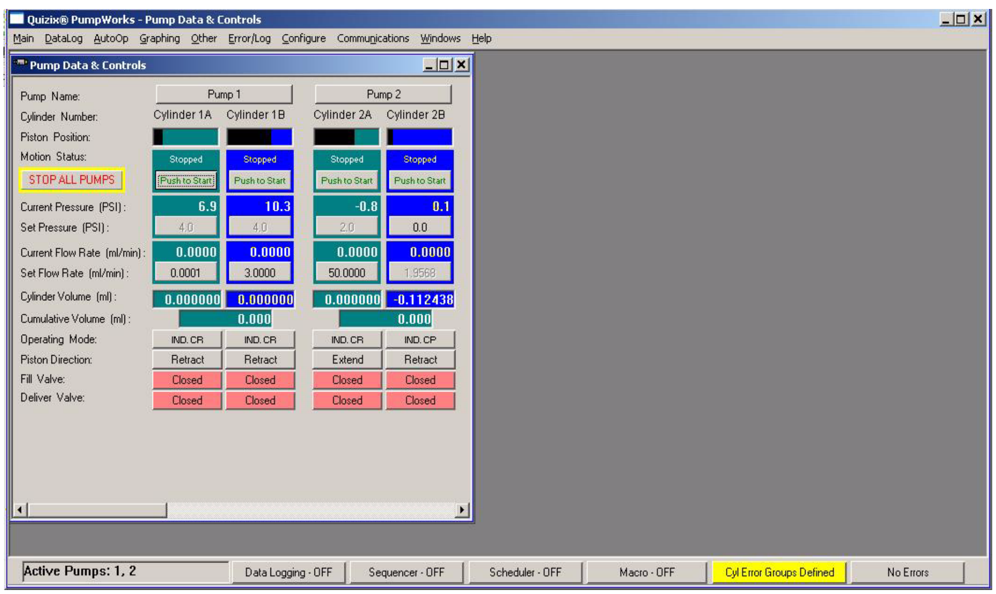


Figure 4-1 PumpWorks Application

4.1.1 Windows

PumpWorks is a windows-based software program. Most of the menu options, when accessed, cause a window to open. When more than one window is open, the user can choose to either tile, individually arrange, or cascade the open windows. The tile command arranges all open windows across a screen, giving each one the same amount of space. The cascade command arranges all open windows in an overlapped fashion, so just their title bars show. To make a window active, click on the desired window.

When entering data for most windows, there is either an OK button which implements any changes made within the window, or a button with another name indicating that it will DO something (for example, Send Rates to Pump(s)), and a Cancel or Close button which allows you to close the window without saving any changes made within the window. In general, just entering text into a field will not cause a change to take effect. There are a few qualifications/exceptions to these "rules".

- There are a few windows (for example, Set Up Datalog and Set Up Data Averaging windows) that contain buttons which open dialog boxes containing OK and Cancel buttons. If the OK button is clicked in one of these dialog boxes, changes made within the dialog box will be saved, even if the user clicks the Cancel button of the "parent" window after the dialog box is closed.
- The resource mapping windows (Analog Input Mapping, Auxiliary Valve Mapping, and so on) have "combo boxes" that allow the user to choose a number out of a list. Whenever a number is selected out of these lists, the change is implemented/saved immediately.

4.1.2 Title Bar

The title bar appears at the top of the PumpWorks application. The title bar lists the currently active window.

Figure 4-2 Title Bar

4.1.3 Menu Bar

The menu bar also appears at the top of PumpWorks application, directly below the title bar. The menu bar has nine pull-down menus. Each pull-down menu contains options which allow the user to regulate an aspect of their pump system. See Figure 4-3.

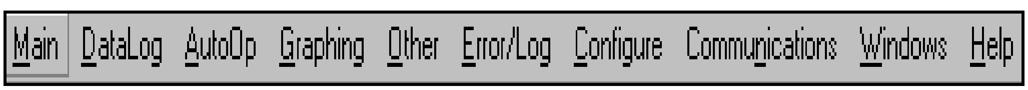


Figure 4-3 Menu Bar

4.1.4 Pump Data & Controls Window (Main Window)

The Pump Data & Controls window, also referred to as the main window, appears when PumpWorks is initialized. See Figure 4-4. The main window is the core of PumpWorks and displays information and settings for up to eight pumps (sixteen pump cylinders). Please refer to Section 4.3 for more information.

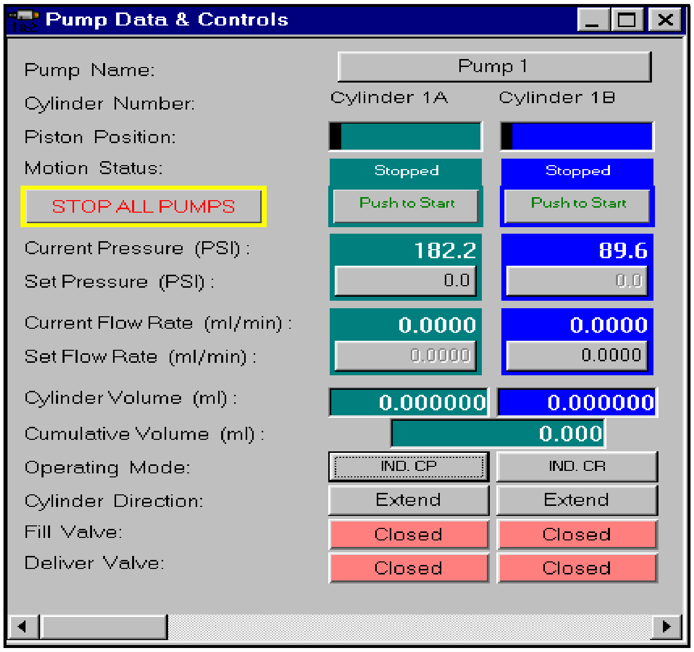


Figure 4-4 Pump Data & Controls Window (Main Window)

4.1.5 Status Bar

The status bar appears at the bottom of PumpWorks application. The status bar displays messages regarding the status of the pump, data logging, sequencer, and error messages. See Figure 4-5.

- Clicking on the Datalog status button will open the View Data Log File window, as described in Chapter 7, Section 7.5.

- Clicking on the Sequencer status button will open the Control Sequencer Operation windows for all currently running or paused Sequencers, as described in Chapter 8, Section 8.3.10.

- Clicking on the Scheduler status button will open the Control Scheduler window, as described in Chapter 8, Section 8.4.2.

- Clicking on the Macro status button will open the Macro Action Control window, as described in Chapter 8, Section 8.5.5.

- Clicking on the Cyl Error Groups button will open the Cylinder Error Groups window, as described in Chapter 12, Section 12.20.

- Clicking on the Error status button will open the Current Error Log window, as described in Chapter 11, Section 11.3.

Figure 4-5 Status Bar

4.1.6 Dialog Boxes

PumpWorks makes extensive use of dialog boxes when some menu selections or commands are initialized. Dialog boxes contain areas of information, as well as areas where information may be required from the user.

Dialog boxes have a light blue background and windows have a gray background. Functionally, dialog boxes require users to respond in some way before PumpWorks will allow them to move on to another task. In contrast, windows do not **require** (although they often permit) a user's response. Multiple windows can be open at the same time, but only one dialog box can be open at a time.

The same rules stated in Chapter 4, Section 4.1.1, " Windows" about entering / changing data in windows apply to dialog boxes.

4.1.7 Keypad Feature

Throughout PumpWorks wherever a user has the option to enter a number into an entry field the user has two options for doing so. The user can either type in a new number or the user can double-click on the field and a keypad dialog box will open, as shown in Figure 4-6.

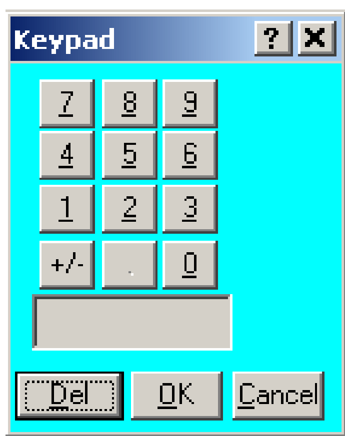


Figure 4-6 Keypad

If you choose the keypad function, do the following:

- Click on the keypad numbers desired.
- Click on OK

For example, in the Set Pump Safety Pressure window, double-click in the Enter New Pressure text box and a keypad appears. The number(s) clicked on the keypad are automatically entered into the text box in the Enter New Pressure text box.

4.2 PumpWorks Color Coding

PumpWorks is color–coded for the user's convenience and safety. PumpWorks has assigned a color code to each pump cylinder, as shown in Figure 4-7.

PUMP CYLINDER	COLOR
Pump Cylinder A	Green
Pump Cylinder B	Blue

Figure 4-7 Pump Color Code

The above color coding is used for all pumps in a system. When the user chooses an action for pump cylinder A, the dialog box that appears has a green border. Similarly, for pump cylinder B, dialog boxes have a blue border. The colors are used to help the user avoid making a careless error by confusing pump cylinders.

Color coding in PumpWorks also includes the following:

- While a pump cylinder is operating, the "Push to Start/Push to Stop" button is Yellow with red letters. This button changes to gray with green letters when the pump cylinder is stopped.
- The Fill Valve and Deliver Valve buttons are green when the valve is open and orange/red when the valve is closed.
- Black lettering on a button means the information can be set or changed by the user. White lettering appears for data displays that cannot be altered by the user.
- Red backgrounds or borders usually indicate errors or warnings. The red used to indicate errors and warnings is a different color of red than the orange/red used to indicate a closed valve.
- Windows have a gray background and dialog boxes have a light blue background. In a dialog box the user must respond in some way before PumpWorks allows you to move on to another task.

4.3 Pump Data & Controls Window (Main Window)

The Pump Data & Controls window, also referred to as main window, contains key operating information about each pump cylinder in a pump system. This information is continually updated while the pumps are running. Titles appear in the left column and data appears to the right of the titles.

The following information is available on the Pump Data and Controls window:

- Pump Name
- Cylinder Number
- Piston Position
- Motion Status
- Start/Stop Pumps
- Current Pressure
- Set Pressure
- Current Flow Rate
- Set Flow Rate
- Cylinder Volume
- Cumulative Volume
- Operating Mode
- Piston Direction
- Fill and Deliver Valve Status

In the following sections, we will discuss each of the above items in depth.

4.3.1 Pump Name

PumpWorks assigns a default name for each pump. The default names are Pump 1, Pump 2 and so on. A pump can be given a different name at any time. The user may wish to assign a name that clarifies the pump's use, as in "Oil Pump" or "Brine Pump"; or type of pump, as in QX Pump or 5000-10K Pump. If English is not the user's primary language, the pump name can be changed into the user's own language. The user-assigned name will be appended to the default name for that pump. For example, if the user chooses to give Pump 1 the name "Oil Pump", the pump will then be titled: "Pump 1 - Oil Pump."

4.3.2 Cylinder Number

A pump will normally have two separate pump cylinders, since two pump cylinders are required for continuous fluid flow. PumpWorks assigns a label to each pump cylinder. The default labels are: Cylinder 1A and Cylinder 1B for Pump 1, Cylinder 2A and Cylinder 2B for Pump 2, and so on. The user can change the pump cylinder numbers to Cylinder 1, Cylinder 2, and so on by doing the following:

- From the main menu, select Configure | System Settings.
- In the Cylinder Name Style box, choose "individual" to label the cylinders 1, 2, 3, 4, and so on. Choose "paired" to label the cylinders 1A, 1B, 2A, 2B, and so on.

4.3.3 Piston Position

The piston position field is a visual display of the position of the piston. The motion status field (described in the next section) is a written description of the action of the piston. By watching the piston position and motion status fields, a user can know each piston's location and its actions.

The piston position field is a graphic representation of each pump cylinder's piston moving in and out of the cylinder barrel. The black portion of this field represents the piston; the blue or green portion represents the fluid in the cylinder barrel. As the piston extends into the cylinder barrel, it is shown moving towards the right. Thus, this display is "read" from left to right, which is consistent with any English text.

The piston can be fully retracted, called Max Retract; fully extended, called Max Extend; or somewhere in between.

- When at Max Extend, the piston is fully extended into the cylinder barrel and the black portion on the piston position display extends all the way to the right side of the Piston Position field, showing a nearly solid black box.

- When at Max Retract, the piston is fully retracted out of the cylinder barrel and the piston position box displays only a small black area on the left hand edge.

4.3.4 Motion Status

The motion status field describes what each pump cylinder's piston is doing at any given time. Figure 4-8 explains the possible motion status conditions, which are divided into three main categories: stopped conditions, run conditions and other conditions.

Motion Status Conditions	
CONDITION	**DESCRIPTION**
STOPPED CONDITIONS	
Stopped	The piston is stopped. See the piston position display to see how far the piston is extended into the cylinder barrel. The piston can be stopped near Max Extend, near Max Retract, or anywhere in between.
Max Extend	The piston is extended as far into the cylinder barrel as it will go. This is the piston's maximum, or most extended, position possible. The cylinder barrel is empty of fluid when the piston is in the Max Extend position.
Max Retract	The piston is retracted as far out of the cylinder barrel as it will go. Max Retract is the maximum or most retracted position possible. The cylinder barrel is full of fluid when the piston is in the Max Retract position.
RUN CONDITIONS	
Extending	The piston is in the process of extending, or moving forward, into the cylinder barrel. While the piston is extending it is displacing the fluid, causing it to be pumped out of the cylinder barrel. This is known as delivering fluid.
Retracting	The piston is in the process of retracting, or moving backwards, withdrawing from the cylinder barrel. While the piston is retracting, fluid is being pulled into the cylinder barrel and filling it. This is known as receiving fluid.
Stopping	The piston is in the process of stopping. It is slowing down. Normally the piston is in the stopping condition for only a brief period before it is fully stopped.

Motion Status Conditions	
CONDITION	**DESCRIPTION**
Hold Ext	Both the Hold Extend and Hold Retract conditions indicate that the pump is running, but the piston is not moving. The pump is running at a zero rate. If a pump cylinder is operating in a constant rate mode, “Hold Extend” appears in the motion status field when the piston direction is set to extend, and the flow rate has been set to zero. By setting the flow rate to zero, the hold conditions provide a way to stop a pump cylinder. If a pump cylinder is operating in a constant pressure mode, Hold Extend appears in the motion status field when the piston direction is set to extend, and the pump cylinder has matched, or servoed, on the desired pressure. At the moment that the pump cylinder has matched the desired pressure, a hold extend message appears in the motion status field. This message means the pump cylinder does not need to retract or extend any further.
Hold Ret	The Hold Retract condition is the same as Hold Extend, except that the piston will retract when it moves again.
Servo Ext	Both the Servo Extend and Servo Retract conditions indicate that the pump cylinder is in the process of servoing on a given pressure. Servoing means the pump is trying to achieve, or match, a given pressure. This occurs in paired operating modes when the standby pump cylinder is brought to the delivery pressure of the active pump cylinder. It also occurs when the pump cylinder is being operated in a constant pressure mode. The Servo Extend condition indicates that the piston is in the process of extending to achieve the desired pressure. It differs from the Extending condition because the piston will continue to extend only until the desired pressure is reached, and then will hold. When a pump cylinder is servoing, you can watch the motion status conditions hover around the servo and hold conditions. For example, the pump cylinder will Servo Extend until the desired pressure is reached, Hold Extend for a moment, then Servo Extend again, Servo Retract because the pressure moved too high, then Hold again, etc.
Servo Ret	The Servo Retract condition is the same as the Servo Extend position, except that the piston is retracting in order to achieve a desired pressure. It differs from the Retracting condition because the piston continues to retract only until the desired pressure is reached, and then will hold.
OTHER CONDITIONS	
Not Inst.	The pump controller constantly verifies that all of the hardware necessary to properly operate a pump cylinder is present and properly connected. If any hardware is not present, a Not Inst (not installed) message appears in the motion status field. This message is the result of one or more of the following cables being disconnected: transducer cables, motor cables, sensor cables, or valve cables. A Not Installed message will also appear if the user has intentionally uninstalled a pump.
Error	This message appears as a result of any of the error conditions shown on the Current Error field on the status bar. Typical errors may include overpressure conditions or the activation of a soft limit on the sensor board.

Motion Status Conditions	
CONDITION	DESCRIPTION
Undefined	No pump has been installed to this location.
Disabled	A pump has been installed but is not currently active. Users can choose to disable a pump.

Figure 4-8 Motion Status Conditions

4.3.5 Stop All Pumps

Instead of individually stopping each operating pump cylinder, the user can choose STOP ALL PUMPS from PumpWorks main window (refer to Figure 4-9). Immediately, all operating pump cylinders are stopped.

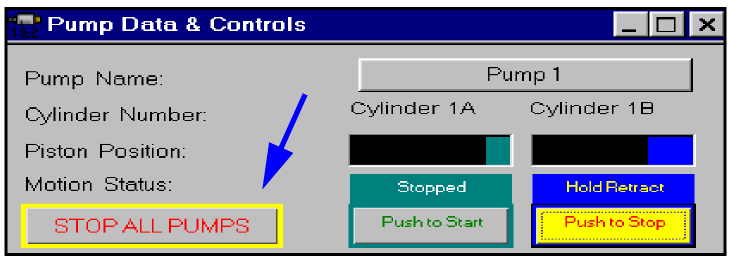


Figure 4-9 Stop All Pumps Button

4.3.6 Current Pressure

The Current Pressure field displays a measurement of the pressure currently inside of the cylinder barrel. This measurement reading is taken from a pressure transducer. Each pump cylinder has one pressure transducer connected to it. The current pressure of each pump cylinder is displayed on the main window.

The default unit of measure for pressure is PSI (pounds per square inch). The user can change the unit of measure displayed to bar, millibar, kiloPascals, or MegaPascals by doing the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places. The window shown in Figure 4-10 opens.

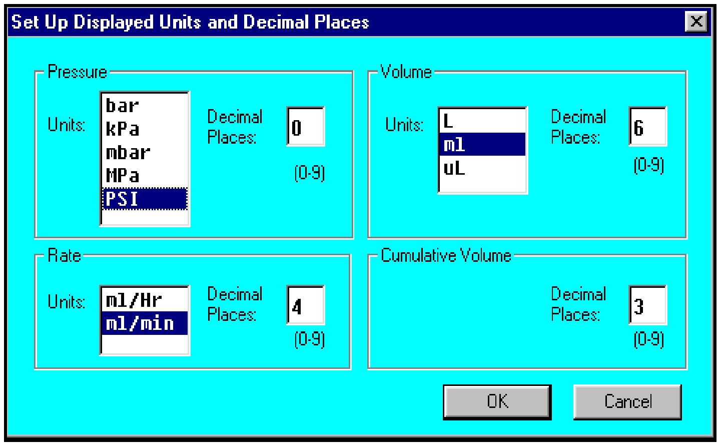


Figure 4-10 Set Up Displayed Units and Decimal Places Window

In the Set Up Displayed Units and Decimal Places window, the user can set the unit of measure for pressure, flow rate and volume. The number of digits following the decimal point can be set for pressure, flow rate, volume and cumulative volume.

- In the Units box(es), click on the unit of measure desired.
- In the Decimal Places box(es), highlight the current number and enter how many numbers PumpWorks should display after the decimal point.
- Click on OK when finished.

4.3.7 Set Pressure

The Set Pressure field allows a user to change the previously set pressure of a pump cylinder to a different pressure. The newest pressure entered becomes the pressure at which the pump cylinder will operate. When the set pressure is changed, the pump immediately adjusts to the new set pressure. Note that the pressure can only be set or changed for a pump cylinder that is in a Constant Pressure or Constant Delta Pressure operating mode.

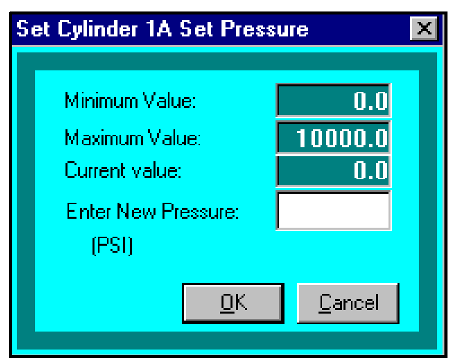


Figure 4-11 Set Cylinder # Set Pressure

4.3.7.1 Changing a Set Pressure

To change the set pressure of a Single Pump Cylinder:

- From the main window, click on the Set Pressure button. The Set Cylinder # Set Pressure window appears (see Figure), displaying the minimum, maximum and current values, or pressures. The maximum value is the highest pressure your pump cylinder model has been configured to run at. This is automatically entered by PumpWorks and cannot be changed.

- Click in the Enter New Pressure text box and enter a new pressure.
- When finished, click on OK.
- The new pressure setting is immediately entered for the selected pump cylinder.

4.3.7.2 Changing Multiple Set Pressures

To change the set pressure of two or more pump cylinders simultaneously:

- From the menu bar, select Main | Set Pump Pressure. The Set Pump Pressure window opens.
- Enter a new number in the Enter New Pressure box(es) of one or more pump cylinders.
- Click on Send Pressures to Pump(s).

This method allows the user to set pump pressures for more than one pump cylinder at the same time.

NOTE: The Set Pressure button will be grayed (unavailable) on any pump cylinders set to a constant flow rate operating mode.

4.3.8 Current Flow Rate

The Current Flow Rate field displays the rate at which the pump cylinder is extending or retracting. The default unit of measure for flow rate is milliliters per minute (ml/min). To change the unit of measure:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the lower left corner is the "Rate" box. Click on the unit of measure you wish, either ml/hour, ml/min, or ul/min.
- In the Decimal Places box, highlight the current number and enter how many numbers PumpWorks should display after the decimal point.
- When finished, click on OK.

4.3.9 Set Flow Rate

The Set Flow Rate field allows a user to change the previously set flow rate of a pump cylinder to a different flow rate. The newest flow rate entered becomes the flow rate at which the pump cylinder will operate. When a flow rate is changed, the pump immediately adjusts to the new set flow rate. Note that the set flow rate can only be set or changed when a pump cylinder is in a Constant Rate operating mode and is only allowed in paired constant rate mode if the remote rate feature is turned off (refer to Chapter 12, Section 12.2.9).

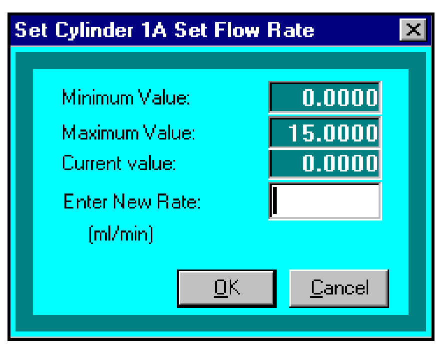


Figure 4-12 Set Cylinder # Set Flow Rate

4.3.9.1 Changing a Set Flow Rate

To change the set flow rate for a single pump cylinder:

- From the main window, click on the Set Flow Rate button. The Set Cylinder # Set Flow Rate window appears (see Figure •), displaying the minimum, maximum and current values.
- Click in the Enter New Rate text box and enter a new flow rate.
- When finished, click on OK.
- The new set flow rate is immediately entered.

4.3.9.2 Changing Multiple Set Flow Rates

To change the flow rate for two or more pump cylinders simultaneously:

- From the menu bar, select Main | Set Pump Flow Rates. The Set Pump Flow Rates window opens.
- Enter a new number in the Enter New Flow Rate box of one or more pump cylinders.
- Click on Send Rates to Pump(s).

This method allows the user to set flow rates for more than one pump cylinder at the same time.

NOTE: The Set Flow Rate button will be grayed (unavailable) on pump cylinders set to a constant pressure or constant delta pressure operating mode.

4.3.10 Cylinder Volume

The Cylinder Volume field displays the displaced volume with respect to the piston position when the controller was turned on or when the cylinder volume was reset. The default unit of measure for cylinder volume is milliliters (ml). The unit of measure can be displayed in either milliliters, liters, or microliters. To change the unit of measure do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places. The Set Up Displayed Units and Decimal Places window appears.
- In the top right is the Volume box. In the units box click on either L for liters, ml for milliliters, or ul for microliters.
- In the Decimal Places box, highlight the current number and enter how many numbers PumpWorks should display after the decimal point.
- When finished with the Set Up Displayed Units and Decimal Places box, click on OK.

4.3.11 Cumulative Volume

The Cumulative Volume field displays the combined volume pumped by a pump cylinder pair (1A and 1B, or 2A and 2B, and so on). This information is valid only when pump cylinders are operating in a paired mode, with one fluid continuously pumped alternately by two pump cylinders.

The unit of measure used for cumulative volume must be the same as that used for cylinder volume. To specify the number of decimal places displayed, enter how many digits should follow the decimal point in the appropriate box of the Set Up Displayed Units and Decimal Places window.

4.3.12 Operating Modes

The Quizix pump system offers many different operating modes. With the exception of two operating modes that are used for recirculating pump operation only, each operating mode includes the following three characteristics:

1. Pump Cylinder Configuration--operating the pump cylinders either independently (as single pump cylinders) or as a pair. Three or more pump cylinders can also be set to a combination of paired and independent operating modes.

2. Pump Cylinder Method--operating the pump cylinders either in constant rate, constant pressure or constant delta pressure.

3. Direction of Fluid Flow--operating the pump cylinders in deliver, receive or bi-directional mode, or cycling between delivering and receiving fluid with a single cylinder. In a paired operating mode, the user must decide which pump cylinder in the pair will be the active pump cylinder and which will be the standby. Put another way, the user must choose which pump cylinder will deliver fluid first and which pump cylinder will refill first.

To choose an operating mode:

- From the main window, click on the operating mode button for a particular pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 4-13.

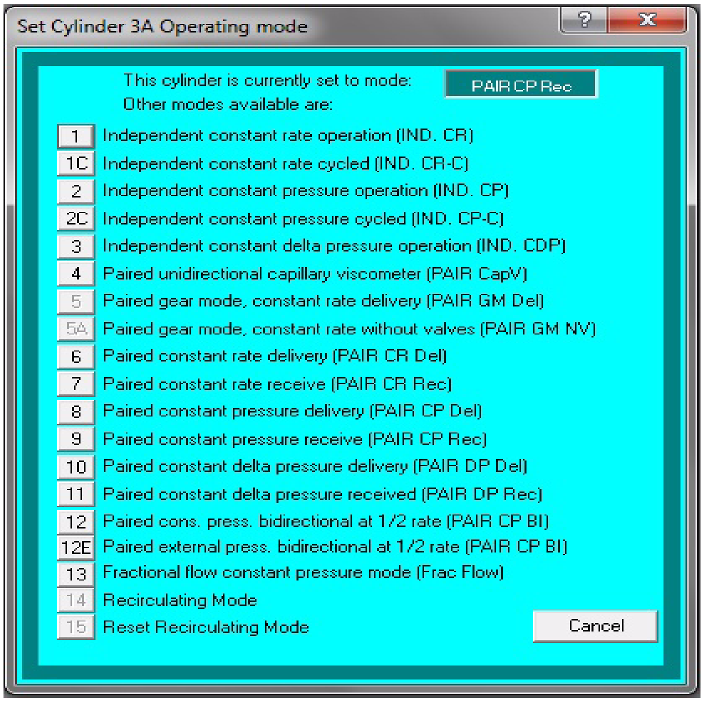


Figure 4-13 Set Cylinder # Operating Mode

The Set Cylinder # Operating Mode window gives the user a list of possible operating modes available for their pump system. An operating mode is grayed if it is not currently available for the user's pump system. To set an operating mode do the following:

- In the Set Cylinder # Operating Mode window, click once on the operating mode's number. This is located to the left of the operating mode name. Your pump cylinder is changed to the new operating mode immediately and the Set Cylinder # Operating Mode screen automatically closes. (There are a few operating modes, specifically the delta pressure modes, Fractional Flow Constant Pressure mode, and Recirculating mode, that require a few extra steps to set up/select.The instructions for these modes are in Chapter 5, following the description of the specific mode.)

NOTE: While a pump cylinder is in servo mode, the operating mode button on the Pump Data & Controls window will turn yellow. When the pump cylinder is ramping or operating in automatic volume, the operating mode name will be preceeded by the word "Auto".

WARNING
Chandler Engineering strongly recommends that you become familiar with all of the operating modes. Chapter 5 of this manual explains operating modes in depth, and should be clearly understood before operating any Quizix Pump.

4.3.13 Piston Direction

The piston, which is inside of the cylinder barrel, either extends into the cylinder barrel or retracts out of the cylinder barrel. As the piston moves forward it extends into the cylinder barrel causing fluid to be displaced and pumped out of the cylinder barrel. The pump cylinder is therefore delivering the fluid, either to an experiment, or to a container. When the piston retracts, it pulls out of the cylinder barrel. As the piston pulls out of the cylinder barrel, fluid is pulled into the cylinder barrel. The pump cylinder is therefore receiving fluid, or filling.

4.3.14 Setting the Piston Direction

There is only one operating mode where the user must choose and set the piston direction. That operating mode is independent constant rate operating mode (#1). For pump cylinders used in this mode, the user sets the piston direction for the pump cylinder and opens or closes the fill and deliver valves. If operating two pump cylinders, each in independent constant rate mode, the user may set the direction of each pump cylinder differently or the same, whichever is desired.

To set the piston direction do the following:

- From the main window, click on the Piston Direction box for the appropriate pump cylinder. The Set Direction Confirmation window appears, as shown in Figure 14.

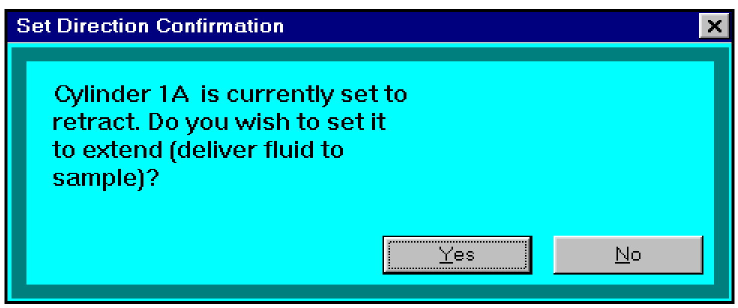


Figure 4-14 Set Direction Confirmation Window

- In the Set Direction Confirmation window, click on Yes to reverse the pumping direction. Click on No to leave the pumping direction unchanged.

4.3.15 Fill and Deliver Valves

The fill and deliver valves are important for the successful operation of the pump. PumpWorks color codes the fill and deliver valve buttons green when the valve is open and orange/red when the valve is closed. For independent constant rate and constant pressure, non-cycled operating modes, the user manually sets the valves to open or close as desired. For all other operating modes, the valves are automatically opened or closed, as needed, for proper pump operation.

4.3.16 Setting the Fill and Deliver Valves

- To open (or close) a fill valve (or deliver valve), click on it for the appropriate pump cylinder. A Valve Toggle Confirmation window appears to confirm your decision.

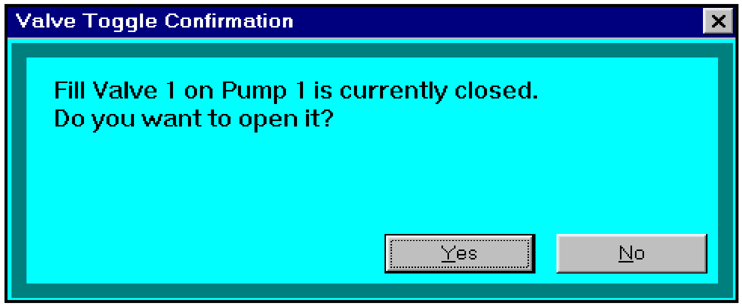


Figure 4-15 Valve Toggle Confirmation Window

- In the Valve Toggle Confirmation window, click on Yes to confirm the action. Click on No to leave the valve unchanged.

A warning message will appear if the user indicates they want to open a valve in either of the following situations:

1. If the pressure in the pump cylinder is greater than the valve pressure threshold that has been previously set by the user. (Refer to Section 12.2, Set Up Pump Operating Parameters.)

2. If either the fill or deliver valve is already open and the user indicates they want to open the other valve. If both the fill and deliver valves for a pump cylinder are open simultaneously, the pump cylinder will lose pressure.

4.4 Changing the Units of Measurement

The Set Up Displayed Units and Decimal Places option allows a user to choose both the unit of measure and how many numbers will display to the right of a decimal point for pressure, rate, volume and cumulative volume.

If a user opens the "Set Up Displayed Units and Decimal Places" window, a warning message will appear in either of the following situations:

1. If Data Logging is currently is progress, a warning message will inform the user that if units of measure are changed, data logging units will change, with no indication made in the data log.

2. Every time the "Set Up Displayed Units and Decimal Places" window is opened, a warning message will remind the user that the Sequencer uses current units of measure and will be affected by a change in this window.

If the units of measurement are changed, the change is **not** compensated for in the Data Log or the Sequencer. The user must remember to calculate any conversions necessitated by the change in units. Caution is advised.

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places. The window shown in Figure 4-16 appears.

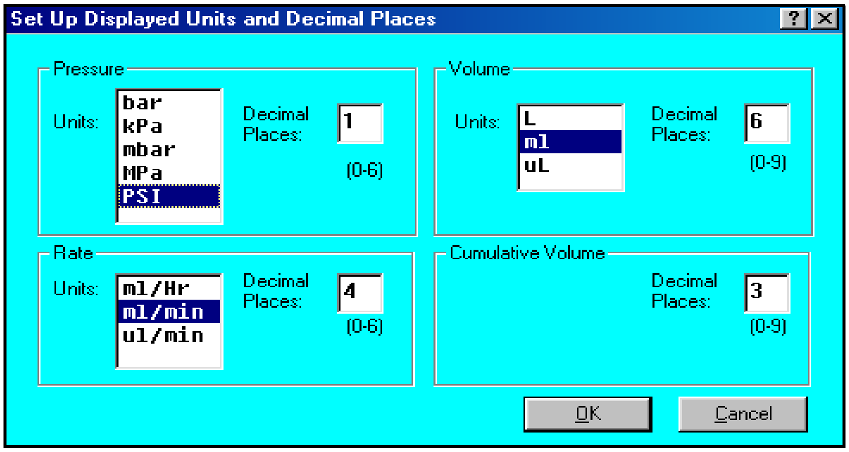


Figure 4-16 Set Up Displayed Units and Decimal Places Window

4.4.1 Displaying Pressure

Pressure can be displayed in any of the following units of measure.

- bar (bar)
- kiloPascals (kPa)
- millibar (mbar)
- MegaPascals (MPa)
- pounds per square inch (PSI)

The default unit of measure is pounds per square inch (PSI). To choose a different unit of measure for pressure, do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, click on the desired unit of measure for pressure.
- When finished with this window, click on OK.

4.4.2 Displaying Flow Rate

Rate can be measured and displayed in either of the following units of measure. (A milliliter is the same as a cubic centimeter.)

- milliliters per minute (ml/min)
- milliliters per hour (ml/hr)
- microliters per minute (ul/min)

The default unit of measure for flow rate is milliliters per minute (ml/min). To choose a different unit of measure:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.

- In the Set Up Displayed Units and Decimal Places window, click on the desired unit of measure for flow rate.
- When finished with this window, click on OK.

4.4.3 Displaying Volume

Volume may be displayed in any of the following units:

- liters (L)
- milliliters (ml)
- microliters (ul)

The default unit for volume is milliliters (ml). To change to a different unit of measure, do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, click on the desired unit of measure for volume.
- When finished with this window, click on OK.

4.4.4 Decimal Places

PumpWorks allows the user to choose how many numbers will be displayed to the right of the decimal point. This can be chosen for pressure, rate, volume and cumulative volume. For rates and pressures, the user can set from zero to six numbers to be displayed to the right of a decimal point. For volumes and cumulative volumes, the user can set from zero to nine numbers to be displayed to the right of the decimal point. If the user enters a zero, a whole number will be displayed. The more numbers displayed to the right of the decimal point, the more precise the displayed number will be.

To set how many numbers will be displayed to the right of the decimal point, do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, highlight the number showing in the decimal places text box for either pressure, rate, volume or cumulative volume.
- Enter the number of places to be displayed to the right of the decimal point.
- When finished with the Set Up Displayed Units and Decimal Places window, click on OK.

4.5 Changing Names in PumpWorks

PumpWorks allows the user to change the following names: pump names, auxiliary analog input names, auxiliary digital input names, auxiliary digital output names, auxiliary valve names, and equation names. A user may want to change the name of any of these items in order to clarify its use or provide a name that is more readily understandable to the user.

4.5.1 Changing a Pump's Name

PumpWorks assigns a default name for each pump. The default names are Pump 1, Pump 2, and so on. The user may assign a name that clarifies the pump's use, as in "Oil Pump" or "Brine Pump". A name that clarifies the type of pump, as in QX Pump or 5000-10K Pump is also an option. If English is not the user's primary language, the pump name can be changed into the user's own language. If the user changes the pump's name, the user-assigned name will be appended to the default name for that pump. For example, if the user chooses to give Pump 1 the name "Oil Pump" the pump will then be titled: "Pump 1 - Oil Pump".

To change a Pump's Name, do the following:

- From the main window click on the box where the pump's current name is displayed. This is to the right of the "Pump Name" field title. See Figure 4-17 below. A window appears that is titled Change Pump # User Name.

Figure 4-17 Pump Name Button

- The Change Pump # User Name window, shown in Figure 4-18, gives information about the pump cylinder, pump controller, COM port, expander port and current user name.

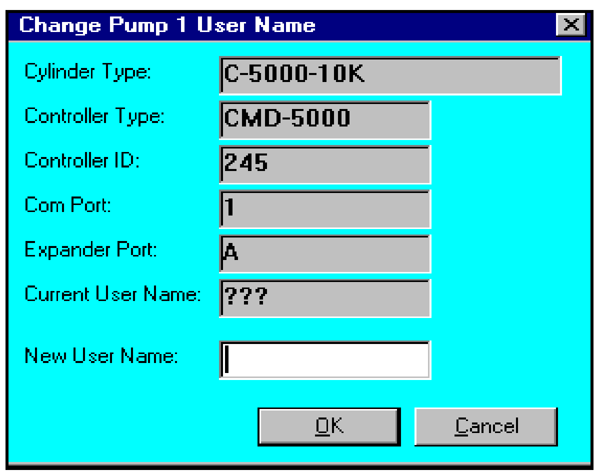


Figure 4-18 Change Pump # User Name Window

- In the New User Name text box, enter the name you wish. It can contain up to 12 alphabetic and/or numeric characters.
- Click on OK.
- The new name appears.

4.5.2 How to Change an Auxiliary Analog Input Signal Name

- From the menu bar, select Other | Auxiliary Analog Input Signals.
- Click on a Set Up box for the appropriate auxiliary analog input signal. A window titled Set Up Auxiliary Analog Input Parameters for Channel (#) opens.
- In the Field Title text box, highlight the current name and enter a new name.
- When finished, click OK.

4.5.3 How to Change an Auxiliary Digital Input Signal Name

- From the menu bar, select Other | Auxiliary Digital Input Signals.
- Click on the auxiliary digital input signal name you wish to change. A window titled Digital Input Signal Change Title box opens.
- In the New Title text box, enter a new name.
- When finished, click OK.

4.5.4 How to Change an Auxiliary Valve's Name

- From the menu bar, select Other | Auxiliary Valves.
- Click on the auxiliary valve's name you wish to change. A dialog box opens called, Auxiliary Valve Change Title.
- In the New Title text box, enter the new auxiliary valve name.
- When finished, click OK.

4.5.5 How to Change an Auxiliary Digital Output Name

- From the menu bar, select Other | Auxiliary Digital Output.
- Click on auxiliary digital output name you wish to change. A window titled Digital Output Change Title box opens.
- In the New Title text box, enter the new name.
- When finished, click on OK.

4.5.6 How to Change an Equation Name

- From the menu bar, select Other | Equations and Timers. The Equation and Timers window will appear.
- In the Equation and Timers window, click on an Equation Name under the column heading "Title," and the Equation # window will appear. (This window can also be accessed when a user is setting up data logging of an equation by selecting Data Log | Set Up Data Logging and clicking on the Set Up Equation Logging button. Then click on the Equation Name button.)

- In the Equation # window, click in the Equation Title text box and highlight the current title.

- Enter the name you wish to use for this equation.

- When finished, click OK.

4.6 Starting and Stopping Pump Cylinders

In this section we will discuss ways to start and stop the pump cylinders in all operating modes.

4.6.1 Starting and Stopping in Paired Operating Modes

Starting and stopping pump cylinders, while in paired operating modes, will be discussed in the following sections:

If you are operating two pump cylinders in a paired operating mode, the pair can be started by starting <u>either</u> of the pump cylinders in the pair. The pump cylinder with which the pair is started is the active pump cylinder on the first piston stroke. The other pump cylinder in the pair is the standby pump cylinder on the first piston stroke. On the second piston stroke, the pump cylinders reverse roles.

When operating two pump cylinders in a paired operating mode, the pair can be stopped by stopping <u>either</u> of the pump cylinders in the pair.

The following explains the action of the pump cylinders for deliver, receive and bidirectional operating modes:

- <u>Deliver Operating Modes</u>
  Active Cylinder: extends on first piston stroke
  Standby Cylinder: retracts on first piston stroke

- <u>Receive Operating Modes</u>
  Active Cylinder: retracts on first piston stroke
  Standby Cylinder: extends on first piston stroke.

- <u>Bidirectional Operating Modes</u>
  Starts like deliver modes, but can also receive fluids.

For example: If you want to start pump cylinders 1A and 1B, which will be operating as a pair in a **delivery** mode, starting pump cylinder 1A will cause it to extend or deliver first. If, however, you want pump cylinder 1B to extend or deliver first, start pump cylinder 1B so that it will extend or deliver on the first piston stroke.

4.6.2 Methods of Starting and Stopping Pump Cylinders

There are three ways to start a pump cylinder and many ways to stop a pump cylinder. We will discuss these ways in the following sections.

- Function Keys to Start/Stop Pump Cylinders, Section 4.6.2.1
- Push to Start/Stop from the Main Window, Section 4.6.2.2
- Start/Stop Pumps on the Main Menu, Section 4.6.2.3
- Stop All Pumps, Section 4.6.2.4

4.6.2.1 Function Keys to Start/Stop Pump Cylinders

Function keys can be used to start or stop pump cylinders. Using the function keys to stop a pump cylinder has the advantage of stopping the pump cylinder quickly--even if the Pump Data & Controls window is not open.

In order to use the function keys for starting and stopping cylinders, the user must first enable them by clicking the appropriate box in the System Settings window, which is a Configure menu option (Refer to Chapter 12, Section 12.16). Function keys F1 through F12 on the computer keyboard correspond to particular pump cylinders. See Figure 4-19.

FUNCTION KEY	PUMP CYLINDER CONTROLLED
	Paired (Individual)
F1	1A (1)
F2	1B (2)
F3	2A (3)
F4	2B (4)
F5	3A (5)
F6	3B (6)
F7	4A (7)
F8	4B (8)
F9	5A (9)
F10	5B (10)
F11	6A (11)
F12	6B (12)

Figure 4-19 Function Key Chart

Figure 4-19 shows which function keys control which pump cylinders. Only those function keys that correspond to an actual pump cylinder in your pump system will operate.

To start a pump cylinder, press its corresponding function key. For example, to start pump cylinder 1A, press function key F1. Pressing the appropriate function key will always bring up a Start Cylinder Confirmation window to start a pump cylinder that is stopped.

A Start Cylinder Confirmation window (see Figure 4-20) appears to make certain the user knows the conditions of a pump cylinder before starting it. This dialog box displays the pump cylinder’s operating mode, piston direction and safety pressure. A question, “Do you want to start this cylinder?” requires a yes response before PumpWorks will start the pump cylinder.

To stop an operating pump cylinder, press its corresponding function key. For example, to stop pump cylinder 1A, press function key F1. When pressing a function key to stop an operating pump cylinder, no confirmation box appears.

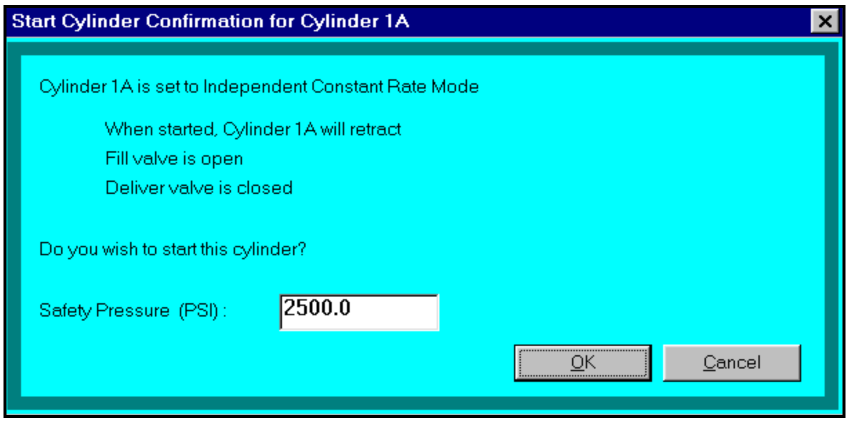


Figure 4-20 Start Cylinder Confirmation Window

4.6.2.2 Push to Start/Stop from the Main Window

From PumpWorks main window, click on “Push to Start” for the appropriate pump cylinder to start its operation.

A Start Cylinder Confirmation window appears to make certain the user knows the conditions of a pump cylinder before starting it. (Refer to Figure 4-21.) This dialog box displays the pump cylinder’s operating mode, piston direction and safety pressure. A question, “Do you want to start this cylinder?” requires a yes response before PumpWorks will start the pump cylinder.

Click on “Push to Stop” and the pump cylinder will immediately stop.

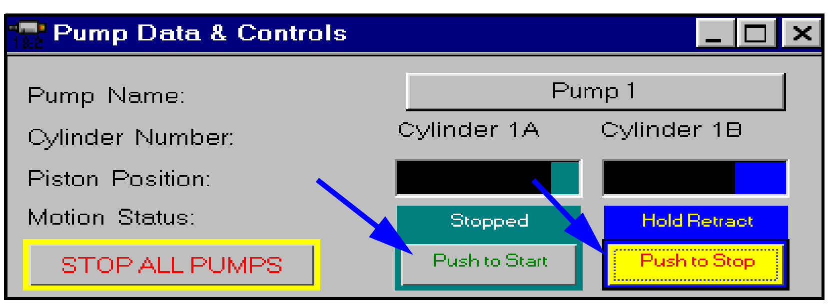


Figure 4-21 Push to Start/Stop Buttons

4.6.2.3 Start/Stop Pumps on the Main Menu

To start/stop a pump cylinder from PumpWorks Main menu do the following:

- From the menu bar, select Main | Start/Stop Pumps

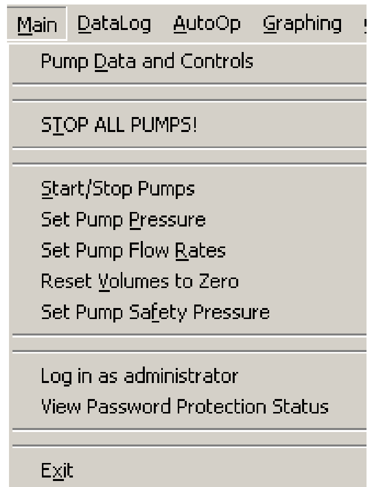


Figure 4-22 Main Menu

- Go to “Choose which Cylinder(s) to Start/Stop”

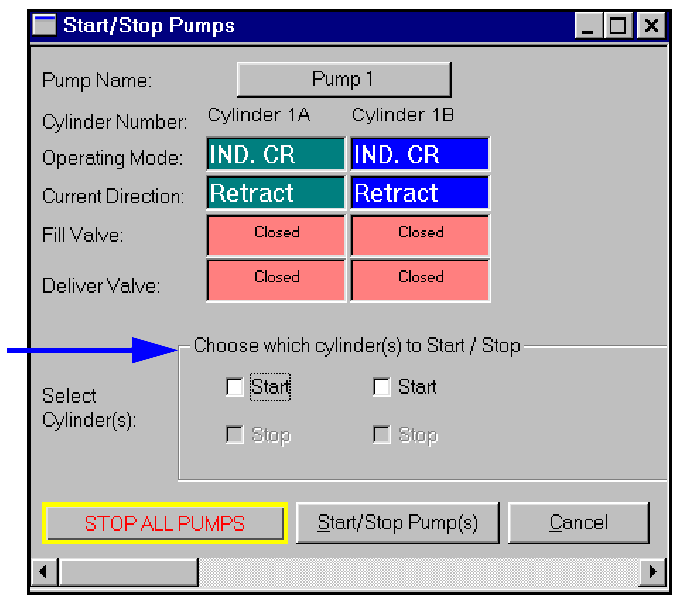


Figure 4-23 Start/Stop Pumps Window

- Click in the Start box below the pump cylinder(s) you wish to start. A check mark appears once a box is selected.
- Clicking on the cancel button will allow the user to clear any selected start/stop check boxes and close the window.
- When finished, click on Start/Stop Pump(s).

NOTE: This is a good way to start two independent pump cylinders or two pairs of pump cylinders (four total) nearly simultaneously. Please note there will be no Start Cylinder Confirmation dialog box when starting pump cylinders using this method.

4.6.2.4 Stop All Pumps

To stop all operating pumps, instead of individually stopping each pump cylinder, choose STOP ALL PUMPS from PumpWorks main window. Immediately all operating pump cylinders are stopped.

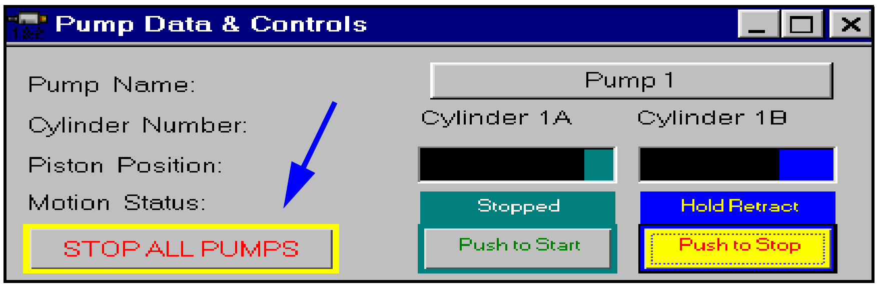


Figure 4-24 Stop All Pumps Button

There are three ways to activate the STOP ALL PUMPS option. One way is to click on the STOP ALL PUMPS button on the main window of PumpWorks. (Refer to Figure 4-24.) A second way is from the menu bar. Select Main | STOP ALL PUMPS. (Refer to Figure 4-25.)

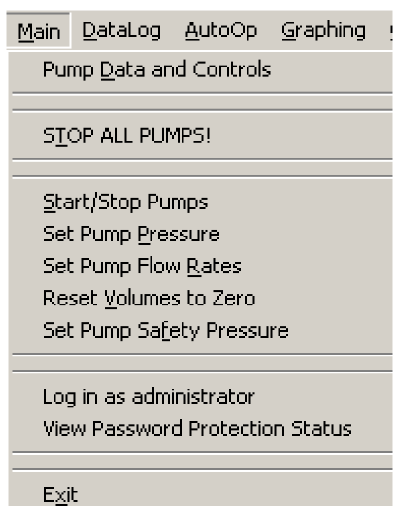


Figure 4-25 Start/Stop Pumps

A third way is from the Start/Stop Pumps window. The STOP ALL PUMPS button is located in the lower left corner of this window. (Refer to Figure 4-24).

THIS PAGE INTENTIONALLY LEFT BLANK.

5 UNDERSTANDING OPERATING MODES

The user can select from a wide range of operating modes that are available in PumpWorks. Understanding and choosing the correct operating mode is important for achieving satisfactory results. In this chapter we will examine operating modes in depth and explain the benefits of each one.

To select an operating mode for a pump cylinder or cylinder pair:

- From the main window, click on the operating mode button for the pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the desired mode number.

For most operating modes, that's all that is necessary. The pump cylinder will immediately begin operating in the selected mode.

For a few operating modes that require additional steps, specifically the delta pressure modes, Fractional Flow Constant Pressure mode, and Recirculating mode, the instructions are specified in this chapter after the particular operating mode's description.

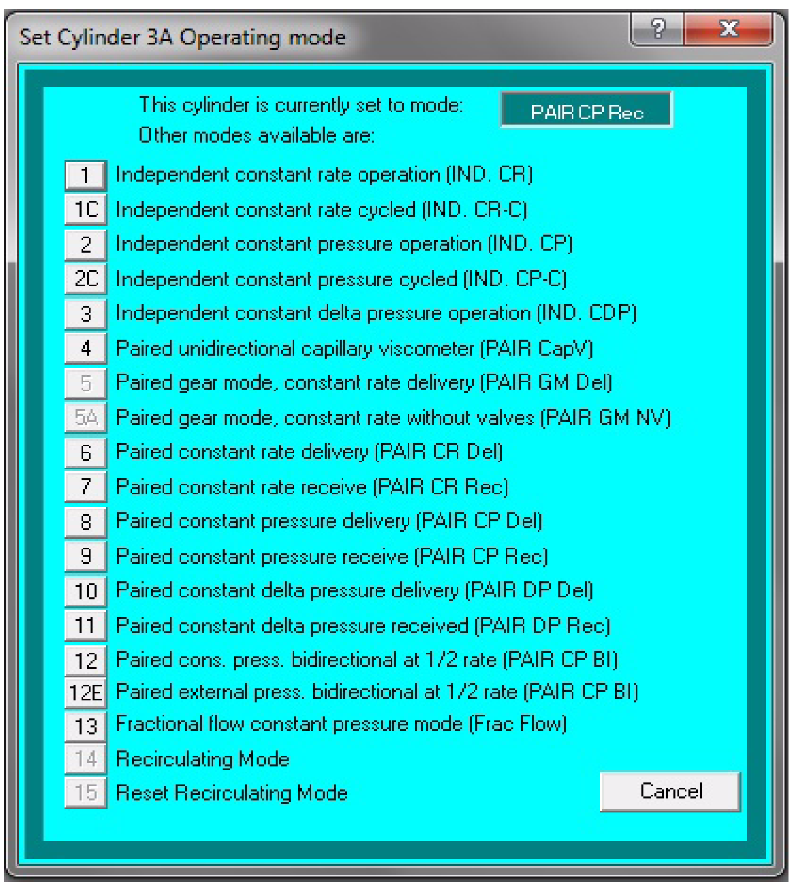


Figure 5-1 Set Cylinder # Operating Mode window

5.1 Pump Cylinder Configurations

One pump cylinder can only be configured as an independently operated pump cylinder. However, two pump cylinders can be configured as either two independently operating pump cylinders or as one pair in a paired operating mode. A paired operating mode is necessary for continuous pulse-free fluid flow. A pump system that contains three or more pump cylinders can be configured as a combination of independent and paired operating modes.

5.2 Combining Operating Modes in a Pump System

Choosing any combination of independent and paired operating modes is possible for Quizix pump systems. For example, a four cylinder pump system may be operated as two pairs, as four independent pump cylinders, or as one pair and two independent pump cylinders. However, pump cylinders operating as a pair must share the same controller. For example, pump cylinders 2A and 2B can be a pair, but pump cylinders 1B and 2A cannot.

The user can select different operating modes for each pump cylinder or pump cylinder pair. For example, in a 3–cylinder pump system, two of the pump cylinders can be operated in paired constant rate deliver mode and one pump cylinder can be operated in independent constant pressure mode.

5.3 Piston Direction

The piston, which is inside of the cylinder barrel, either extends into the cylinder barrel or retracts out of the cylinder barrel. As the piston moves forward it extends into the cylinder barrel, causing fluid to be displaced and pumped out of the cylinder barrel. The pump cylinder is therefore delivering the fluid, either to an experiment or a container. When the piston retracts, it pulls out of the cylinder barrel. As the piston pulls out of the cylinder barrel, fluid is pulled into the cylinder barrel. The pump cylinder is therefore receiving fluid, or filling.

For pump cylinders used in paired operating modes, two pump cylinders alternately extend and retract. In a paired operating mode, the user can start the pair of pump cylinders by starting **either** pump cylinder in the pair. Whichever pump cylinder in the pair is used to start the pair is the active pump cylinder and will travel in the direction dictated by the operating mode (deliver or receive) for the first piston stroke. The other pump cylinder in the pair will automatically be the standby pump cylinder and will travel in the opposite direction for the first piston stroke. At the end of the first piston stroke, switchover occurs. The active pump cylinder becomes the standby pump cylinder; and the standby pump cylinder becomes the active pump cylinder.

The following explains the action of the pump cylinders for deliver, receive and bidirectional operating modes.

- Paired Deliver Operating Modes
  Active Cylinder: extends on first piston stroke
  Standby Cylinder: retracts on first piston stroke

- Paired Receive Operating Modes
  Active Cylinder: retracts on first piston stroke
  Standby Cylinder: extends on first piston stroke.

- Paired Bidirectional Operating Modes
  Starts like deliver modes, but can also receive fluids.

For example: If you want to start pump cylinders 1A and 1B, which will be operating as a pair in a delivery mode, starting pump cylinder 1A will cause it to extend or deliver first. If, however, you want pump cylinder 1B to extend or deliver first, start the pair with pump cylinder 1B.

5.4 Independent Constant Rate Modes

In all independent operating modes, one pump cylinder works alone to pump fluid. In independent constant rate operating mode (#1), the user sets the fluid flow rate when the cylinder is started. The user also sets the fill and deliver valves (open or closed) and the piston direction (retract or extend). When the pump is started, the fluid will flow at the rate and in the direction the user has set. The fluid pressure is established by the flow resistance and the flow rate. At the end of a single piston stroke, the pump cylinder stops and the user must again set the fill and deliver valves, set the piston direction and re-start the pump cylinder.

Independent constant rate is the only operating mode where the user must choose and set the piston direction. If operating two pump cylinders, each in independent constant rate mode, the user may set the direction of each pump cylinder differently or the same, whichever is desired.

The amount of fluid the pump can deliver or receive in an independent operating mode is limited to the volume in one piston stroke. This is equal to the capacity of the cylinder barrel. Operating a pump cylinder independently is most useful when the volume to be pumped is less than the cylinder barrel volume.

5.4.1 Piston Position for Independent Constant Rate Deliver

In independent constant rate deliver operation (#1), one pump cylinder works alone to deliver fluid at a user-set constant rate. The following examples will help the user to understand starting piston positions.

- The user can deliver fluid if the pump cylinder is at Max Retract because the pump cylinder is full of fluid to deliver.
- If the user wants to deliver fluid and the pump cylinder is at 50% extended, only half of the fluid volume is available to deliver because half has already been delivered.
- The user cannot deliver fluid if the pump cylinder is at Max Extend because the fluid has already been delivered and the pump cylinder is empty.

5.4.2 Piston Position for Independent Constant Rate Receive

In independent constant rate receive operation (#1), one pump cylinder works alone to receive fluid at a user-set constant rate. The following examples will help the user to understand starting piston positions.

- If the user wants to receive fluid, and the pump cylinder is at Max Extend, the pump is ready to receive a full cylinder barrel of fluid.
- If the user wants to receive fluid and the pump cylinder is at 50% extended, the pump cylinder is already half full of fluid so the user can only receive half more.
- If the pump cylinder is at Max Retract, the user cannot receive fluid. The cylinder barrel is already full of fluid.

5.4.3 Independent Constant Rate Cycled Mode

In independent constant rate cycled mode (#1C), a single pump cylinder automatically cycles between filling and delivering fluid. The fluid is delivered at a user-set constant rate and the pump cylinder refills (retracts) at a user-set piston return rate. When the end-of-stroke is detected, the fill and deliver valves and the piston direction are automatically changed and the pump cylinder continues alternately pumping and refilling.

The piston return rate is calculated automatically by PumpWorks using the return rate multiplier times the flow rate. If the value calculated is less than the return rate minimum, PumpWorks will use the return rate minimum as the piston return rate. (Refer to Section 12.2.) Since no fluid is delivered while the pump cylinder is filling, the delivery flow rate is intermittent and is therefore not pulse-free. The independent constant rate cycled mode will continue cycling until the user stops the pump. The pistons can be in any position when starting independent constant rate cycled operation.

5.5 Independent Constant Pressure Modes

In independent constant pressure operating modes (#2), one pump cylinder works alone to deliver or receive fluid at a user-set constant pressure. The pump adjusts the flow rate, as needed, to maintain that pressure. Before each piston stroke, the user sets (opens or closes) the fill and deliver valves and starts the pump cylinder.

For independent constant pressure operating modes, the piston direction (extend/deliver or retract/receive) is determined by whether the system pressure needs to be increased (extend) or decreased (retract) to achieve the set pressure. If the user wants to use the pump to raise the pressure of a fluid, then the piston should be placed in a retracted position so that it can deliver fluid when it is started. If the user wants to decrease the pressure in a system, then the piston should be positioned like a receive mode, with the piston in an extended position. If the pressure will go both up and down, then positioning the piston near the middle of its stroke would be a good starting point.

The amount of fluid the pump can deliver or receive in all independent operating modes is limited to one piston stroke, or the capacity of the cylinder barrel. Operating a pump cylinder independently is most useful when the volume to be pumped is less than the cylinder barrel volume.

5.5.1 Piston Position for Independent Constant Pressure Deliver

In independent constant pressure deliver operation (#2), one pump cylinder works alone to deliver fluid at a user-set constant pressure. The following examples will help the user to understand starting piston positions for independent constant pressure deliver operations.

- The user can deliver fluid if the pump cylinder is at Max Retract because the pump cylinder is full of fluid to deliver.
- If the user wants to deliver fluid and the pump cylinder is at 50% extended, only half of the fluid volume is available to deliver because half has already been delivered.
- The user cannot deliver fluid if the pump cylinder is at Max Extend because the fluid has already been delivered and the pump cylinder is empty.

5.5.2 Piston Position for Independent Constant Pressure Receive

In independent constant pressure receive operation (#2), one pump cylinder works alone to receive fluid at a user-set constant pressure. The following examples will help the user to understand starting piston positions for independent constant pressure receive operation.

- If the user wants to receive fluid, and the pump cylinder is at Max Extend, the pump is ready to receive a full cylinder barrel of fluid.
- If the user wants to receive fluid and the pump cylinder is at 50% extended, the pump cylinder is already half full of fluid so the user can only receive half more.
- The user cannot receive fluid if the pump cylinder is at Max Retract because the cylinder barrel is already full of fluid.

5.5.3 Independent Constant Pressure Cycled Mode

In independent constant pressure cycled mode (#2C), a single pump cylinder cycles between delivering and refilling to maintain the user-set constant pressure. The piston direction, as well as the valves, are automatically controlled.

In independent constant pressure cycled mode, fluid is delivered at a constant pressure until the piston reaches Max Extend and fluid delivery stops. Then the pump automatically switches the fill and deliver valves, and the piston direction, and fills the pump cylinder until the piston reaches Max Retract. The pump cylinder then repressurizes to the desired set pressure and opens the deliver valve, closes the fill valve, and continues the constant pressure operation. This cycle repeats until the user stops the pump’s operation.

The piston will retract at a rate determined by the return rate minimum multiplied by the return rate multiplier. If auto return rate is operating, the piston will return at its maximum return rate. The independent constant pressure cycled mode will continue cycling until the user stops the pump.

5.6 Independent Constant Delta Pressure Mode

In independent constant delta pressure mode (#3), the piston will either extend or retract, as needed, to maintain delta pressure. Before each piston stroke, the user must set the fill and deliver valves and start the pump cylinder. The piston direction, however, is determined by whether the piston must extend or retract to achieve the desired delta pressure. Independent constant delta pressure operation ends when the pump cylinder reaches either the maximum extend or maximum retract limit.

NOTE: In order to use this mode, or any other delta pressure operating mode (#10 and #11), the user must install a delta pressure transducer as an auxiliary analog input signal and set up mapping for the signal. (Refer to Chapter 10, Auxiliary Analog Input Signals, Section 10.2.) The user must also select which auxiliary analog input to use as their delta pressure transducer when this mode is selected.

To select Independent Constant Delta Pressure mode:

- From the main window, click on the operating mode button for the desired pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Independent Constant Delta Pressure mode number (#3). The Select Delta Pressure Source window shown in Figure 5-2 will appear.

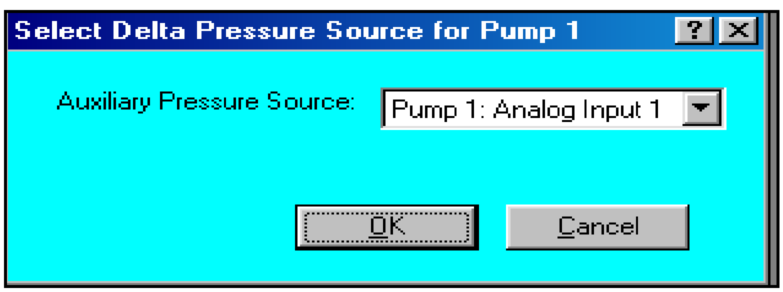


Figure 5-2 Select Delta Pressure Source

- To display the available sources from which to monitor the delta pressure, click on the arrow on the right side of the combo box. Click on the desired pressure source.
- Click on OK. The pump cylinder will immediately begin operating in Independent Constant Delta Pressure mode.

5.7 Paired Unidirection Capillary Viscometer Mode

In paired unidirection capillary viscometer mode (#4), two pump cylinders operate in a geared fashion, where one pump cylinder extends while the other retracts. In this mode, as well as modes #5 and #5A, the motion of each pump cylinder is a mirror image of the other. (Modes #4, #5, and #5A differ from each other in how and when the valves are switched.) As soon as the active pump cylinder reaches the end of its stroke, it changes direction. At the same time, the standby pump cylinder changes direction. Because the standby pump cylinder does not pre-pressurize prior to switchover, there are pressure pulses at switchover. Therefore, this mode does not exhibit pulse-free flow. The user sets the flow rate for this mode, and the pressure of each cylinder is monitored to determine when the valves will switch.

In this mode the valves are switched to keep the flow going in one direction and this is done when the active pump cylinder's pressure is greater than the pressure in the standby pump cylinder. When this mode is used, it is assumed that the user has connected the valves to a viscometer and that the fluid is flowing in one direction in a closed loop system. The best piston starting position for this operating mode is to have one pump cylinder at Max Retract and the other pump cylinder at Max Extend.

5.8 Paired Gear Mode Constant Rate Deliver

In paired gear mode constant rate deliver (#5), two pump cylinders extend and retract continuously to deliver fluid at a constant user-set flow rate. Like modes #4 and #5A, the motion of each pump cylinder is a mirror image of the other. As soon as the active pump cylinder reaches the end of its stroke, it changes direction. At the same time, the standby pump cylinder changes direction. Because the standby pump cylinder does not pre-pressurize prior to switchover, there are pressure pulses at switchover. Therefore, this mode does not exhibit pulse-free flow. The user sets the flow rate for this mode.

In this mode the valves are switched when the active cylinder reaches the end of its stroke. Unlike mode #4, pressures are not used to switch the valves in this mode. The best piston starting position for this operating mode is to have one pump cylinder at Max Retract and the other pump cylinder at Max Extend.

NOTE: Gear Modes are not supported by the QX-Series pumps.

5.9 Paired Gear Mode Constant Rate Without Valves

In paired gear mode constant rate without valves (#5A), two pump cylinders extend and retract continuously to deliver fluid at a constant user-set flow rate. Like modes #4 and #5, the motion of each pump cylinder is a mirror image of the other. As soon as the active pump cylinder reaches the end of its stroke, it changes direction. At the same time, the standby pump cylinder changes direction. Because the standby pump cylinder does not pre-pressurize prior to switchover, there are pressure pulses at switchover. The user sets the flow rate for this mode.

This operating mode is unique because the valves are not active (do not switch). This mode is useful for doing dynamic leak testing (pistons are moving) since two pump cylinders can be connected together and the geared operation keeps the sum of the cylinder volumes constant. Fluid is then pushed out of one pump cylinder and into the other. The best piston starting position for this operating mode is to have one pump cylinder at Max Retract and the other pump cylinder at Max Extend, with the fluid pressurized at the desired operating pressure.

To obtain the desired operating pressure when operating two pump cylinders as a pair,

- Begin with one piston at Max Retract and one close to Max Extend.

- Close both valves.
- Extend the piston that is almost at Max Extend, watching the pressure carefully on the main window. Stop the pump cylinder when the desired pressure is reached. Ideally, this will occur when the piston is at Max Extend.

NOTE: Gear Modes are not supported by the QX-Series pumps.

5.10 Paired Delivery Modes

In paired delivery modes, two pump cylinders take turns to continuously deliver fluid. Paired delivery operation will continue until the user stops the pump. PumpWorks includes the following paired delivery operating modes:

- Paired Constant Rate Delivery Mode, Section 5.10.1
- Paired Constant Pressure Delivery Mode, Section 5.10.2
- Paired Constant Delta Pressure Delivery Mode, Section 5.10.3

For paired delivery operation, the active pump cylinder extends (delivers fluid) first while the standby pump cylinder retracts. Because the standby pump cylinder pre-pressurizes to the pressure level of the active pump cylinder before switchover, the fluid flow is pulseless. When the active piston has completed one piston stroke, the two pump cylinders switch. The pump cylinder that was standby (receiving fluid and pre-pressurizing), now becomes the active pump cylinder (delivering fluid). The pump cylinder that was active, now becomes the standby pump cylinder.

In order to obtain pulseless flow, the standby pump cylinder must complete its stroke and pre-pressurize before the active pump cylinder completes its stroke. The standby pump cylinder has time to pre-pressurize because it returns (retracts) at a faster rate than the active pump cylinder extends.

When starting a pair of pump cylinders in a paired delivery mode, the pump cylinder selected by the user to start the pair becomes the active pump cylinder. The other pump cylinder in the pair will automatically become the standby pump cylinder. Because the standby cylinder needs time to pre-pressurize, the starting positions of the cylinders must be considered. A simple rule of thumb for paired delivery modes is to place the standby pump cylinder at Max Retract before starting the pump cylinder pair. The standby pump cylinder is then already filled and only needs to pre-pressurize before switchover, therefore minimizing the time necessary for the standby cylinder to get ready. The following examples will help the user to understand piston starting positions for paired delivery operation.

- If both pump cylinders are near Max Retract when starting, the pump will operate properly. Because the standby pump cylinder is already near Max Retract, it will have enough time to fully retract and pre-pressurize while the active pump cylinder delivers fluid.
- If both pump cylinders are near Max Extend when starting, there will not be enough time for both pump cylinders to do their job properly. The standby pump cylinder will

not have enough time to retract and pre-pressurize before the active pump cylinder has delivered all of its fluid and reaches Max Extend.

In the first example, above, both pump cylinders start at Max Retract and operate properly. In the second example, both pump cylinders start at Max Extend and do not operate properly. Pump cylinders can also be anywhere in between when the user wants to start the pump.

- If pump cylinder 1A is at Max Retract and pump cylinder 1B is at Max Extend, the user should press F1 to start pump cylinder 1A as the active pump since it has the fluid ready to deliver.
- If pump cylinder 1A is at 60% extended and pump cylinder 1B is 25% extended, press F2 to start pump cylinder 1B and make it the active pump. By starting with pump cylinder 1B, the active pump cylinder will have 75% of its stroke to travel towards Max Extend while the standby pump cylinder has only 60% of its stroke to travel towards Max Retract and pre-pressurize.
- If both pump cylinders are at 75% extended, this is not a good starting position. The active pump cylinder only has 25% of its stroke to travel towards Max Extend, but the stand-by pump cylinder has 75% of its stroke to travel towards Max Retract and pre-pressurize. This does not leave enough time for the standby pump cylinder to get ready.

If the standby pump cylinder does not have enough time to pre-pressurize before switchover, the user will see a large pressure variation in the outlet pressure. This will result in frequent switchovers and pressure pulses occurring at switchover. However, in most cases the pump will run and eventually will get the pistons to the correct locations.

5.10.1 Paired Constant Rate Delivery Mode

In paired constant rate delivery mode (#6), two pump cylinders take turns continuously delivering fluid at a user-set constant rate. The fluid pressure is determined by the flow rate times the fluid flow resistance of the system. The pump cylinder with which the pair is started will be the active pump cylinder and will deliver fluid first at a user-set constant rate. The other pump cylinder in the pair will be the standby pump cylinder and will retract (receive fluid) first.

5.10.2 Paired Constant Pressure Delivery Mode

In paired constant pressure delivery mode (#8), two pump cylinders take turns continuously delivering fluid at a user-set constant pressure. The flow rate is determined by the flow needed to maintain the desired pressure. The pump cylinder with which the pair is started will be the active pump cylinder and will deliver fluid first at a user-set constant pressure. The other pump cylinder in the pair will be the standby pump cylinder and will retract first. The standby pump cylinder will refill, then pre-pressurize in preparation for switchover.

5.10.3 Paired Constant Delta Pressure Delivery Mode

In paired constant delta pressure deliver mode (#10), two pump cylinders take turns continuously delivering fluid at a constant delta pressure. The fluid delivery rate is determined by the flow needed to maintain the desired delta pressure. The pump cylinder with which the pair is started will be the active pump cylinder and will deliver fluid first at a user-set constant delta pressure. The other pump cylinder in the pair will be the standby pump cylinder and will retract (receive fluid) first.

NOTE: In order to use this mode, or any other delta pressure operating mode (#3 and #11), the user must install a delta pressure transducer as an auxiliary analog input signal and set up mapping for the signal. (Refer to Chapter 10, Auxiliary Analog Input Signals, Section 10.2.) The user must also select which auxiliary analog input channel to use as their delta pressure transducer when this mode is selected.

To select Paired Constant Delta Pressure Delivery mode:

- From the main window, click on the operating mode button for the desired pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Paired Constant Delta Pressure Delivery mode number (#10). The Select Delta Pressure Source window shown Figure 5-3 will appear.

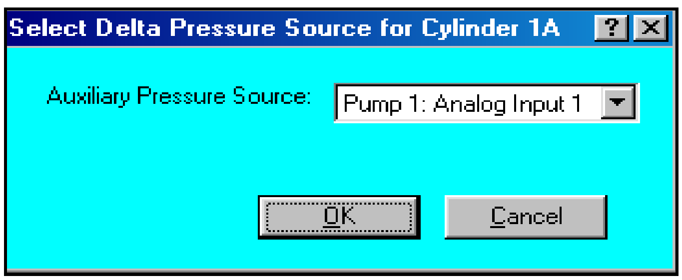


Figure 5-3 Select Delta Pressure Source

- To display the available sources from which to monitor the delta pressure, click on the arrow on the right side of the combo box. Click on the desired pressure source.
- Click on OK. The pump cylinder will immediately begin operating in Paired Constant Delta Pressure Delivery mode.

5.11 Paired Receive Modes

In paired receive modes, two pump cylinders take turns continuously receiving fluid. PumpWorks includes the following paired receive operating modes:

- Paired Constant Rate Receive Mode, Section 5.11.1
- Paired Constant Pressure Receive Mode, Section 5.11.2
- Paired Constant Delta Pressure Receive Mode, Section 5.11.3

In a receive operating mode, the active pump cylinder retracts (receives) fluid first while the standby pump cylinder extends. The standby pump dumps its fluid and then pre-pressurizes to the active cylinder’s pressure. When the active pump cylinder has completed one stroke and is at Max Retract, the two pump cylinders switch. Because the standby cylinder is at the proper pressure, fluid flow is pulseless. The pump cylinder that was standby now becomes the active pump cylinder and receives the fluid. The pump cylinder that was active now becomes the standby pump cylinder and dumps its fluid before pre-pressurizing. Paired receive operation will continue until the user stops the pump.

During paired receive operation, the standby pump cylinder must dump fluid and pre-pressurize in the same amount of time as the active pump cylinder is receiving fluid. The time for pre-pressurization is available because the standby pump cylinder extends (returns) at a faster rate than the active pump cylinder retracts. Because the standby cylinder needs time to pre-pressurize, the starting positions of the pump cylinders must be considered. A simple rule of thumb for paired receive modes is never start with a pump cylinder at Max Retract or Max Extend, but start with the pump cylinders at about the 75% extended position.

When starting a pair of pump cylinders in a paired receive mode, the pump cylinder selected by the user to start the pair becomes the active pump cylinder and will receive fluid first. The other pump cylinder in the pair will automatically become the standby pump cylinder on the first piston stroke. The user must carefully consider which pump cylinder is chosen to become the active pump.

The following examples will help the user to understand piston starting positions for paired receive modes. Note that in most of these examples for paired **receive** modes, the user should do the opposite of what they would do in the examples given in Section 5.10 for paired **delivery** modes.

- If both pump cylinders are at or very near Max Extend when starting, the pump cannot operate. Each pump cylinder needs to have some of its stroke in order for the active pump cylinder to reach the operating pressure and/or, the standby pump cylinder to pre-pressurize.
- If both pump cylinders are near Max Retract when starting, the pump cannot operate. The active pump cylinder has already received its fluid and the standby pump cylinder still needs to dump its fluid and pre-pressurize, and there is not enough time to do this.
- If pump cylinder 1A is at 80% extended and pump cylinder 1B is at Max Retract, start pump cylinder 1A, making it the active pump cylinder. Pump Cylinder 1B cannot be the active pump cylinder as it has already received its fluid.
- If pump cylinder 1A is at Max Retract and pump cylinder 1B is at Max Extend, start pump cylinder 1B first. Pump Cylinder 1A cannot be the active pump cylinder as it has already received its fluid.
- If pump cylinder 1A is at 75% extended and pump cylinder 1B is 25% extended, the user can start either pump cylinder first. If the user makes pump cylinder 1A active, the standby pump cylinder 1B will extend the remaining 75% of its stroke to dump the rest of its fluid and pre-pressurize, and it has enough time to do this.

  If, instead, pump cylinder 1B is made the active cylinder, this will also work because the standby pump cylinder has already dumped most of its fluid and has time to pre-pressurize before pump cylinder 1B finishes with the 25% of its piston stroke left.
- If both pump cylinders are at 75% extended, this is a good start position. The active pump cylinder has 75% to travel as it retracts. The standby pump cylinder has dumped most of its fluid and can pre-pressurize with 25% of its piston stroke left.

For paired receive operating modes, the active pump cylinder retracts first and the standby pump cylinder extends first.

5.11.1 Paired Constant Rate Receive Mode

In paired constant rate receive mode (#7), two pump cylinders take turns continuously receiving fluid at a user-set constant rate. The fluid pressure may vary and will be set by whatever source is providing fluid to the pump. The pump cylinder with which the pair is started will be the active pump cylinder and will receive fluid first at a user-set constant rate. The other pump cylinder in the pair will be the standby pump cylinder and will extend (dump fluid) first, then pre-pressurize in preparation for switchover.

5.11.2 Paired Constant Pressure Receive Mode

In paired constant pressure receive mode (#9), two pump cylinders take turns continuously receiving fluid at a user-set constant pressure. The flow rate may vary and will be determined by the flow needed to maintain the desired pressure. The pump cylinder with which the pair is started will be the active pump cylinder and will receive fluid first at a user-set constant pressure. The other pump cylinder in the pair will be the standby pump cylinder and will extend (dump fluid) first, then pre-pressurize in preparation for switchover.

5.11.3 Paired Constant Delta Pressure Receive Mode

In paired constant delta pressure receive mode (#11), two pump cylinders take turns continuously receiving fluid at a constant delta pressure. The flow rate may vary and will be determined by the flow needed to maintain the desired delta pressure. The pump cylinder with which the pair is started will be the active pump cylinder and will receive fluid first at a user-set constant delta pressure. The other pump cylinder in the pair will be the standby pump cylinder and will extend (dump fluid) first, then pre-pressurize in preparation for switchover.

NOTE: In order to use this mode, or any other delta pressure operating mode (#3 and #10), the user must install a delta pressure transducer as an auxiliary analog input signal and set up mapping for the signal. (Refer to Chapter 10, Auxiliary Analog Input Signals, Section 10.2.) The user must also select which auxiliary analog input channel to use as their delta pressure transducer when this mode is selected.

To select Paired Constant Delta Pressure Receive mode:

- From the main window, click on the operating mode button for the desired pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Paired Constant Delta Pressure Receive mode number (#11). The Select Delta Pressure Source window shown in Figure 5-4 will appear.

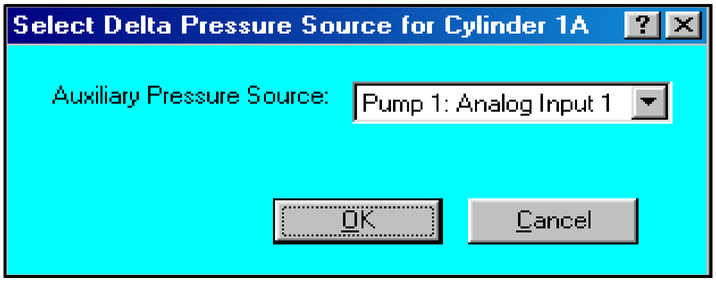


Figure 5-4 Select Delta Pressure Source

- To display the available sources from which to monitor the delta pressure, click on the arrow on the right side of the combo box. Click on the desired pressure source.
- Click on OK. The pump cylinder will immediately begin operating in Paired Constant Delta Pressure Delivery mode.

5.12 Paired Constant Pressure Bi-Directional Operating Mode

Paired constant pressure bi-directional operating mode (#12), runs at a constant pressure by switching between delivering and receiving to maintain the desired pressure. This is useful for pumping operations where the user cannot predict whether fluid delivery or fluid reception will be required. When operating in a bi-directional mode, the user can start with both pistons at 50% extended, or any position close to the middle of the stroke, and the pump will operate properly.

5.13 Paired External Pressure Bi-Directional Operating Mode

Paired external pressure bi-directional operating mode (#12E), is similar to paired constant pressure bi-directional mode (#12), except that it maintains a constant pressure using an external pressure source (via an auxiliary analog input signal) instead of the cylinder pressure transducer. (Please refer to Chapter 5, Section 5.12 for more of an explanation of paired constant pressure bi-directional mode.)

To select Paired Extenal Pressure Bi-Directional mode:

- From the main window, click on the operating mode button for the desired pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Paired External Pressure Bi-Directional mode number (#12E). The Select External Pressure Souce window shown Figure 5-5 will appear

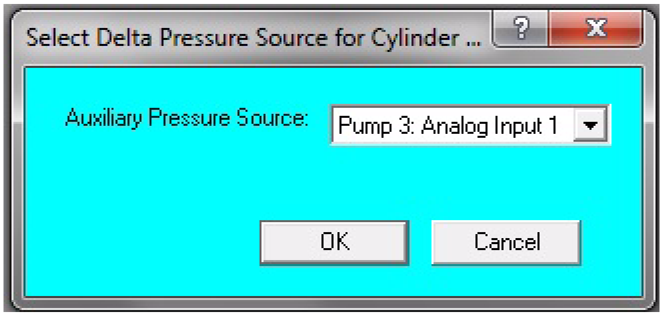


Figure 5-5 Select External Pressure Source

- To display the available sources from which to monitor the external pressure, click on the arrow on the right side of the combo box. Click on the desired pressure source.
- Click on OK. The pump cylinder will immediately begin operating in Paired External Pressure Bi-Directional mode.

5.14 Fractional Flow Constant Pressure Operating Mode

In fractional flow constant pressure operating mode (#13), two pumps work together to maintain a constant pressure, with each pump providing a user-specified fraction of the fluid delivery. Fluid is pumped at a constant pressure. The pressure transducer used as the basis for constant pressure fractional flow operation can be the output pressure transducer of either pump, or any pressure transducer connected to one of the auxiliary analog input channels of either pump. Fractional flow mode is not available for the 5000 and 6000 Series Pumps controlled with SC-2400 controllers.

To select Fractional Flow Constant Pressure mode:

- From the main window, click on the operating mode button for the desired pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Fractional Flow mode number (#13). The Pump Selection for Fractional Flow Mode window shown in Figure 5-6 will appear.

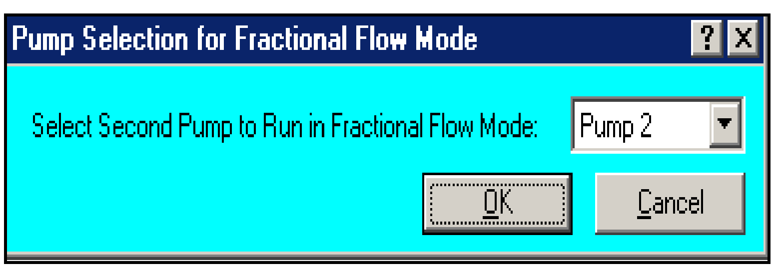


Figure 5-6 Pump Selection for Fractional Flow Mode

- To display the available pumps to be used as the other pump for the fractional flow operation, click on the arrow on the right side of the combo box. Click on the desired pump, and then click on OK. The Pressure Source Selection for Fractional Flow Mode window shown in Figure 5-7 will appear.

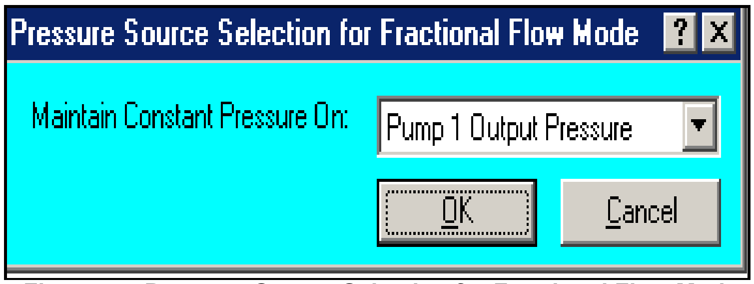


Figure 5-7 Pressure Source Selection for Fractional Flow Mode

- To display the available sources from which to monitor the pressure, click on the arrow on the right side of the combo box. Click on the desired pressure source, and then click on OK. If one of the output pressures is selected, the Fractional Flow Constant Pressure Control window will appear as shown in Figure 5-10, and the pumps will immediately start running in Fractional Flow Constant Pressure mode. If one of the auxiliary a/d channels was selected, the Set Up Analog Input Pressure Range window shown in Figure 5-8 will appear.

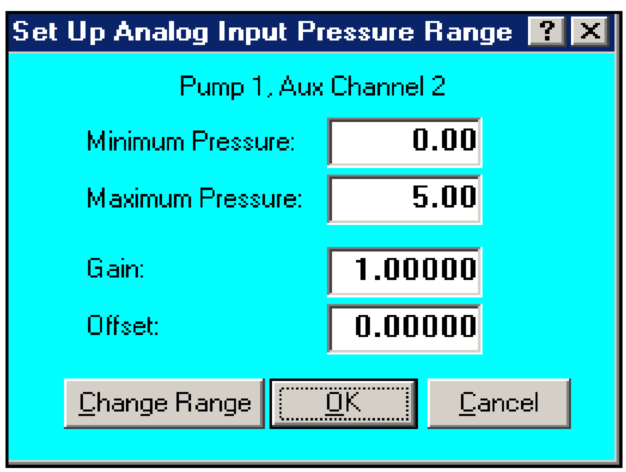


Figure 5-8Set Up Analog Input Pressure Range

- If the pressure range is correct, simply click on OK. The Fractional Flow Pressure Control window will appear, and the pumps will immediately start running in Fractional Flow Constant Pressure mode.
- If the pressure range is not correct, click on the Change Range button. The Set New Pressure Range button shown in Figure 5-9 will appear.

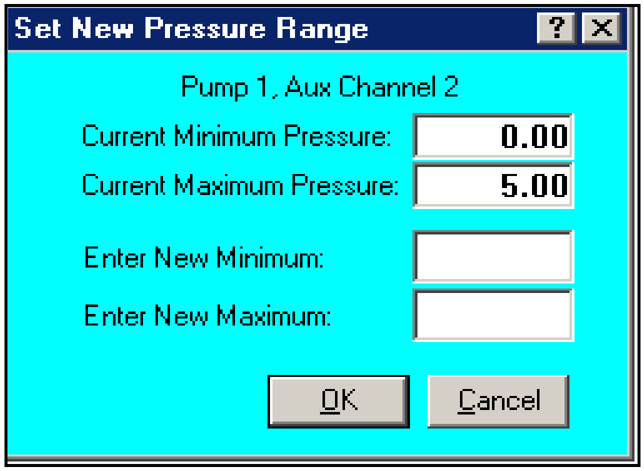


Figure 5-9 Set New Pressure Range

- Enter the new minimum and maximum pressures in the text boxes and click on OK. The new minimum and maximum pressures will be shown in the Set Up Analog Input Pressure Range window. In addition, the new offset and gain values are shown, automatically re-calculated, based on the new minimum and maximum pressures. If everything is correct, click on OK. The Fractional Flow Pressure Control window will appear, as shown in Figure 5-10, and the pumps will immediately start running in Fractional Flow Constant Pressure mode.

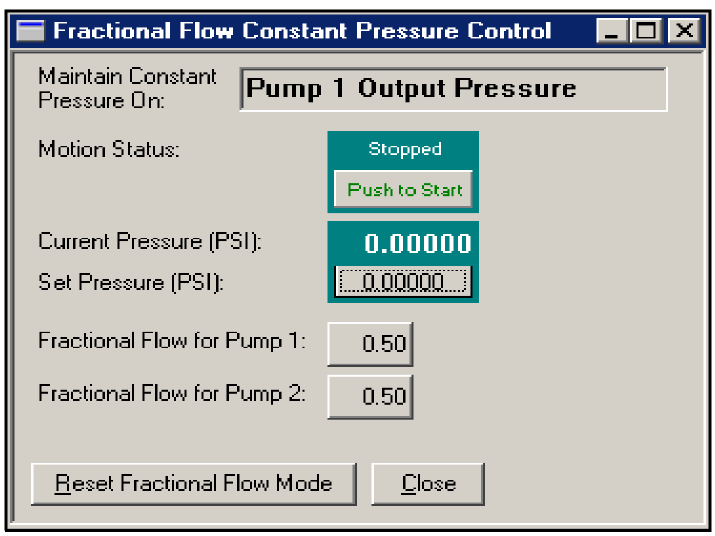


Figure 5-10 Fractional Flow Constant Pressure Control

PumpWorks will always default to 50% flow from each pump. To change this ratio:

- Click on either of the buttons showing the fraction of flow for the pumps. The pop up window shown in Figure 5-11 will appear.

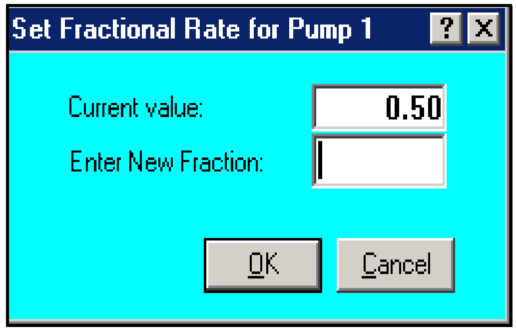


Figure 5-11 Set Fractional Rate for Pump #

- Enter the desired fraction (in decimal format) for the selected pump. (For example, if you want 60% of the fluid pumped to come from pump A, select the button for pump A and enter “0.6”.)
- Click on OK. The fraction for the other pump will automatically change, and the new ratio will be utilized immediately.

The Fractional Flow Constant Pressure Control window may be closed at any time. The selected pumps will continue to operate in Fractional Flow mode. To reopen the window:

- From the main window, click on the operating mode button for any of the pumps running in Fractional Flow mode.

To get out of Fractional Flow mode:

- From the Fractional Flow Constant Pressure Control window, click on the Reset Fractional Flow Mode button. The pumps will return to paired constant rate mode, after which the operating mode can be set to something different by clicking on the operating mode button from the main window.

NOTE: Because PumpWorks performs calculations during fractional flow operation, which enable constant pressure to be maintained, PumpWorks must be running for fractional flow operating mode to be used.

5.15 Recirculating Mode Using 3, 5 or 7 Cylinders

The recirculating operating mode (#14) maintains a constant flow rate into a closed (constant volume) experimental system, while maintaining constant pressure coming out of the system. Since this mode operates on a closed system, the same fluid is continuously recycled; that is, the fluid coming out of the experiment is re-injected as the constant flow rate fluid. One, two or three fluids can be recirculated using 3, 5 or 7 pump cylinders in a closed loop system. This mode is a special case of constant rate flow because it requires an extra pressure compensation pump cylinder in addition to the pump cylinder pair(s) needed to deliver the fluid(s). Specialized software is also needed for recirculation operation. There is also an option for a 2nd pressure compensation cylinder to be used in parallel with the first one to allow higher flow rates in the other pump cylinders. This option is referred to as a “plus one” mode (for example, a 5 + 1 Cylinder recirculating mode refers to using cylinders 1A, 1B, 2A and 2B as the flow cylinders and cylinders 3A and 3B as the pressure compensation cylinders.) This recirculation capability is sold as an option to the standard pump hardware and software.

There are several user settable parameters that impact the operation of recirculating mode. Please see Section 12.5 for a description of these parameters and instructions on how to change them.

There is also a way to determine the range of motion that the compensation cylinder will go through while running in recirculation mode based on a set of specified parameters. This predicted range of motion shows a worst case scenario for the compensation cylinder, and is important to look at if you are running a long term experiment that you don't want to have to abort due to the compensation cylinder(s) running out of stroke. Please see Section for details on how to use this feature.

To select Recirculating mode:

- From the main window, click on the operating mode button for the desired pump cylinder. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Recirculating mode number (#14). The Set Up Recirculating Mode Type window shown in Figure 5-12 will appear.

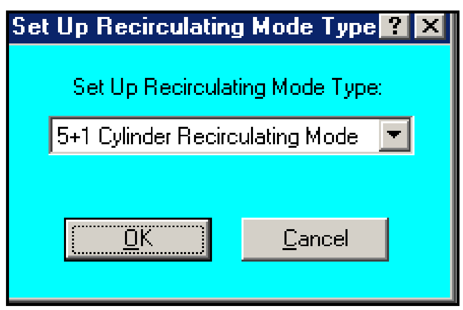


Figure 5-12 Set Up Recirculating Mode Type

- To display the available mode types, click on the arrow on the right side of the combo box. Click on the desired mode type, and then click on OK. The Cylinder Recirculating Mode Set Up window shown in Figure 5-13 will appear.

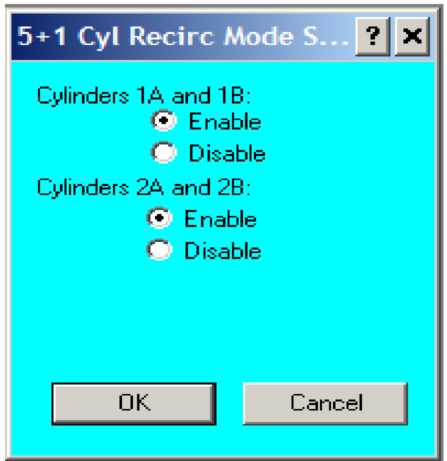


Figure 5-13 Recirculating Mode Set Up

- Click on the enable or disable buttons to enable or disable each pair for recirculating mode.
- Click on OK.
- If PumpWorks predicts, based on recirculating parameters described in Section 12.5 along with the starting position of the cylinders, that there is a chance that running in recirculating mode may eventually fail due to lack of available compensation cylinder stroke volume, a warning will pop up.
    - If PumpWorks is only warning that the compensation cylinder will be close to running out of stroke (“Running in recirculation mode will be marginally successful”), simply click on the OK button to acknowledge the warning.
    - If PumpWorks predicts eventual failure (“Running in recirculation mode will likely fail”), PumpWorks gives a choice of continuing or canceling the mode change. To continue changing to recirculating mode, click on the Yes button. To cancel the mode change, click on the No button.

    If either of these warnings pop up, the Predict Compensation Cylinder Motion window will also be opened. For more information about predicting the success of running in recirculating mode, See Section .

The main window operating mode buttons will display recirculating mode for the enabled cylinder pairs and whatever the current mode is for disabled cylinder pairs. To change the enabled state of cylinder pairs:

- From the main window, click on the operating mode button of any cylinder in the recirculating system. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Recirculating mode button (#14). A warning window that one or more cylinders are already in recirculating mode will appear. Click on OK. The Cylinder Recirc Mode Set Up window shown in Figure 5-13 will appear.

- Click on the cylinder pair enable/disable buttons to toggle to the desired state.
- Click on OK. The main window operating mode buttons will display recirculating mode for the enabled cylinder pairs and whatever the current mode is for disabled cylinder pairs.

To get out of Recirculating mode:

- From the main window, click on the operating mode button of any cylinder in the recirculating system. The Set Cylinder # Operating Mode window opens, as shown in Figure 5-1.
- Click on the Reset Recirculating Mode button (#15). Pump cylinders that were in recirculating mode (Whether enabled or disabled) will be put into Independent Constant Rate mode, and can then be set to any other desired mode.

6 MAIN MENU

The options available from the "Main" menu allow the user to display and change pump cylinder settings and manage password protection. From the menu bar, select Main and the following choices are displayed:

- Pump Data and Controls, Section 6.1
- Stop All Pumps, Section 6.2
- Start/Stop Pumps, Section 6.3
- Set Pump Pressure, Section 6.4
- Set Pump Flow Rates, Section 6.5
- Reset Volumes to Zero, Section 6.6
- Set Pump Safety Pressure, Section 6.7
- Password Protection, Section 6.8
    - Log In/Out as Administrator (Section 6.8.2)
    - View Password Protection Status (Section 6.8.3)
- Exit, Section 6.9

6.1 Pump Data and Controls

The Pump Data and Controls window, also referred to as the main window, opens when PumpWorks is initialized. The main window is the core of PumpWorks and displays information and settings for up to eight pumps (sixteen pump cylinders).

If you close the main window, this is how to reopen it:

- From the menu bar, select Main | Pump Data and Controls

Please refer to Chapter 4, PUMPWORKS BASICS, for detailed information about the Pump Data and Controls window.

6.2 Stop All Pumps

To stop all operating pumps, instead of individually stopping each pump cylinder, choose STOP ALL PUMPS. Immediately, all operating pump cylinders are stopped.

There are three ways to activate the STOP ALL PUMPS option. One way is to click on the STOP ALL PUMPS button on the main window of PumpWorks. A second way is to select Main | STOP ALL PUMPS from the menu bar. A third way is to click on the STOP ALL PUMPS button on the Start/Stop Pumps window, which is also accessed from the Main menu.

6.3 Start/Stop Pumps

The Start/Stop Pumps option allows the user to select one or more specific pump cylinders to start or stop. The user may also choose to stop all operating pump cylinders.

- From the menu bar, select Main | Start/Stop Pumps and the window shown in Figure 6-1 in appears.

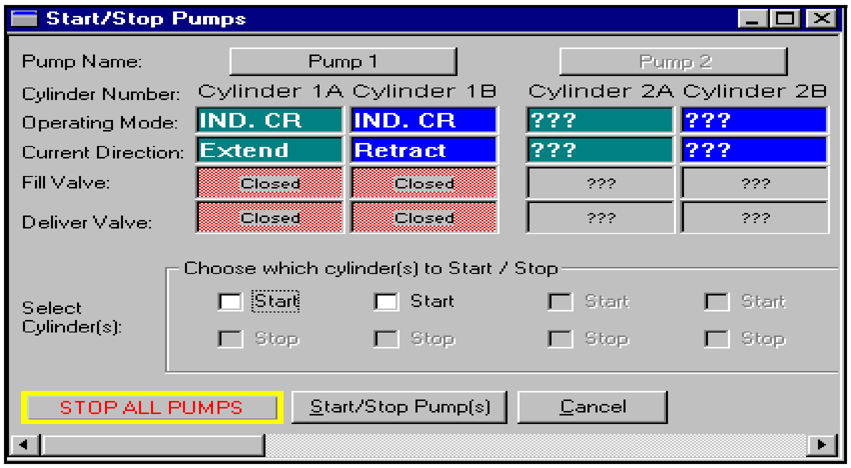


Figure 6-1 Start/Stop Pumps Window

The Start/Stop Pumps window displays each pump cylinder's operating mode, cylinder direction, fill valve and deliver valve.

- From the Start/Stop Pumps window, go to "Choose which Cylinder(s) to Start/Stop"
- Click in either the Start or Stop box below the pump cylinder(s) you wish to change. A check mark appears once a box is selected.
- Clicking on the Cancel button will allow the user to clear all selected start/stop boxes and close the window.
- When finished, click on Start/Stop Pump(s).

NOTE: The pump cylinders selected will start or stop immediately. No start pump confirmation box will appear.

6.4 Set Pump Pressure

The Set Pump Pressure option allows the user to set a pressure for one or more pump cylinders at the same time. The pump will deliver or receive fluid at the user-set pressure when the pump cylinder is operated in a constant pressure or constant delta pressure mode. Changing the set pressure for one pump cylinder, operating in a paired constant pressure mode, changes the set pressure for both pump cylinders in that pair. PumpWorks will automatically enter the same pressure for the other pump cylinder in the pair.

NOTE: The user needs to specify a pressure only if the pump cylinder is operating in a constant pressure or constant delta pressure mode. The user cannot specify a pressure for a pump cylinder that is set to operate in a constant rate mode.

- From the menu bar, select Main | Set Pump Pressure and the window shown in Figure 6-2 appears.

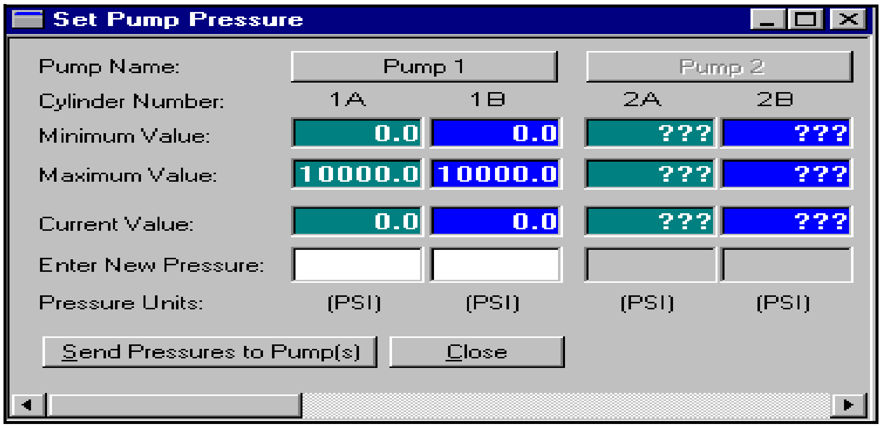


Figure 6-2 Set Pump Pressure Window

The Set Pump Pressure window displays the pump name, cylinder number, and the minimum, maximum and current pressure values. The maximum value is the highest pressure your pump has been configured to operate at, based on your pump cylinder model. This is automatically entered by PumpWorks and cannot be altered by the user. To enter new pressures do the following:

- From the Set Pump Pressure window, click in the Enter New Pressure text box and enter a pressure.
- Repeat until you have entered all the pressures to be changed.
- When finished, click on Send Pressures to Pump(s).

The new pressure settings are immediately entered for the selected pump cylinders. If a pump is operating when the pressure is changed, it immediately goes to the new pressure.

Another way to change the set pressure is to click on the Set Pressure button of a specific pump cylinder on the main window. In the Set Cylinder # Set Pressure window, enter a new pressure in the Enter New Pressure text box then click on OK. This method allows the user to change only one set pressure at a time, whereas the Set Pressure window allows the user to change two or more set pressures at the same time.

6.5 Set Pump Flow Rates

The Set Pump Flow Rate option allows the user to set a flow rate for one or more pump cylinders at the same time. The flow rate is the rate, or speed, at which the pump cylinder will either pump fluid or receive fluid, when operated in a constant rate mode. Note that the set flow rate can only be set or changed when a pump cylinder is in a Constant Rate operating mode, and is only allowed in paired constant rate mode if the remote rate feature is turned off (refer to Chapter 12, Section 12.2.9. Setting the flow rate for one pump cylinder, operating in a paired operating mode, sets the flow rate for both pump cylinders in the pair. PumpWorks automatically sets the same flow rate for the other pump cylinder in the pair.

- From the menu bar, select Main | Set Pump Flow Rates and the window shown in Figure 6-3 appears.

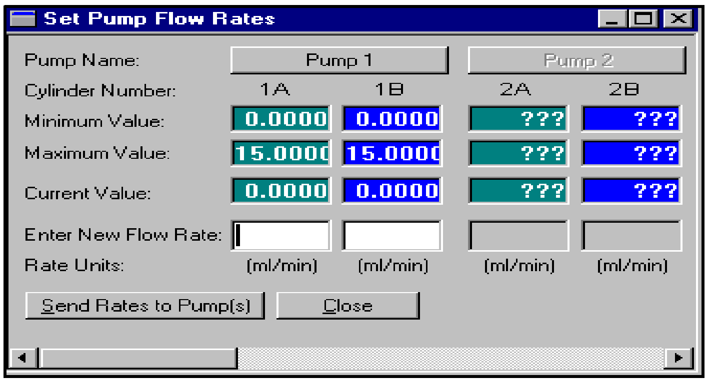


Figure 6-3 Set Pump Flow Rates Window

The Set Pump Flow Rates window displays the pump name, cylinder number, and the minimum, maximum, and current pump flow rates. The maximum value is the highest flow rate your pump has been configured to flow at, based on your pump cylinder model. This is automatically entered by PumpWorks and cannot be altered by the user.

To enter new pump flow rates do the following:

- In the Set Pump Flow Rates window, click in the appropriate Enter New Flow Rate text box and enter a new rate.
- Repeat until you have entered all the flow rates to be changed.
- When finished, click on Send Rates to Pump(s).

Another way to change the pump flow rate is to click on the Set Pump Flow Rate button of a specific pump cylinder on the main window. In the Set Cylinder # Set Flow Rate window, enter a new number in the Enter New Rate text box then click on OK. This method allows the user to set only one flow rate at a time, whereas the Set Pump Flow Rates window allows the user to set two or more flow rates at the same time.

6.6 Reset Volumes to Zero

PumpWorks displays a cylinder barrel's delivered fluid volume, displayed in milliliters, microliters or liters. The Reset Volumes to Zero window enables a user to do just that - reset the cylinder barrel's displayed volume to zero. Typically, a user should set the cylinder volume to zero when the pump cylinder is at Max Retract and is therefore full of fluid ready to be delivered. As the piston extends, the cylinder volume display will show the amount of fluid delivered out of the cylinder barrel.

- From the menu bar, select Main | Reset Volumes To Zero and the window shown in Figure 6-4 appears.

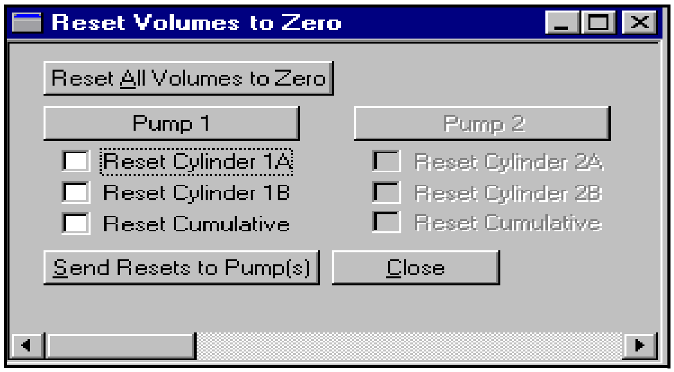


Figure 6-4 Reset Volumes to Zero Window

Along with resetting a cylinder barrel's volume display to zero, the user can reset the cumulative volume display to zero. The cumulative volume is the total fluid either delivered or received by two pump cylinders operating in a paired mode. The volume is counted from when the cumulative volume was last zeroed by the user. PumpWorks includes the option to either reset the cumulative volume to zero or allow the cumulative volume to continue counting. If the number shown is a negative number, that indicates that the fluid is being received. If the number shown is a positive number, that indicates that the fluid is being delivered.

6.6.1 Resetting All Volume Displays to Zero

To reset the volume displays of all pump cylinders to zero, do the following:

- From the menu bar, select Main | Reset Volumes to Zero.
- From the Reset Volumes to Zero window, click on the Reset All Volumes To Zero button.
- The volume displays of all pump cylinders, including cumulative volume displays, will be immediately reset to zero and the window closes automatically.

6.6.2 Resetting Specific Volume Displays to Zero

To reset the volume display of a specific pump cylinder to zero, do the following:

- From the menu bar, select Main | Reset Volumes to Zero.
- From the Reset Volumes to Zero Window, click on the box(es) next to the appropriate pump cylinder(s) to be reset. A check mark appears once a box is selected.
- After selecting all volume displays to be reset, click on Send Resets to Pump(s).

6.6.3 Resetting Cumulative Volume Displays to Zero

To reset the cumulative volume displays to zero, do the following:

- From the menu bar, select Main | Reset Volumes to Zero.
- From the Reset Volumes to Zero Window, click in the Reset Cumulative box next to appropriate pump cylinder. A check mark appears once a box is selected.
- After selecting all volume displays to be reset, click on Send Resets to Pump(s).

All volume displays check marked will be reset to zero, at the same time.

6.7 Set Pump Safety Pressure

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to set the safety pressures unless no safety pressure has yet been set for a given pump cylinder. Please refer to Chapter 6, Section 6.8for details on the password protection feature.

PumpWorks requires the user to set up this safety pressure feature. The pump controller will automatically stop a pump cylinder when the pump's user-set safety pressure has been reached. For example, if the set safety pressure for pump cylinder 1A is 5,000 PSI, then pump cylinder 1A will automatically stop when its pressure exceeds 5,000 PSI. If pump cylinder 1A is operating in a paired mode, then both pump cylinders 1A and 1B will stop. If pump cylinder 1A is part of a recirculating system, then all pump cylinders in the recirculating system will stop if the safety pressure is reached in any one of them.

To set the pump safety pressure:

- From the menu bar, select Main | Set Pump Safety Pressure and the window shown in Figure 6-5 appears.

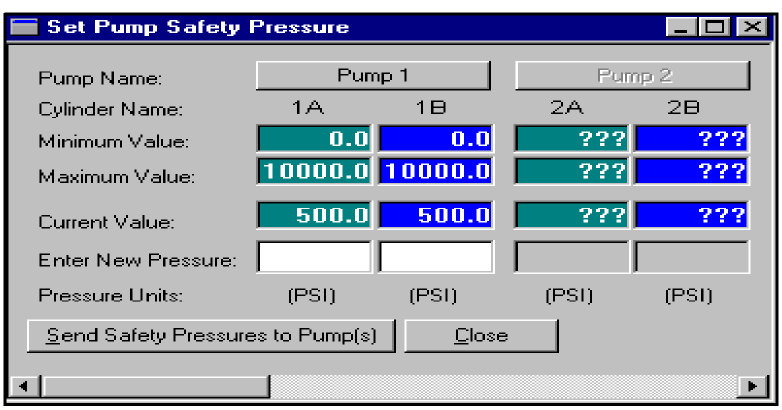


Figure 6-5 Set Pump Safety Pressure Window

The Set Pump Safety Pressure window displays the pump cylinders with their minimum, maximum, and current values. The maximum value is the highest pressure your pump has been configured to operate at, based on your pump cylinder model. This is automatically entered by PumpWorks and cannot be altered by the user. To change the safety pressure:

- In the Set Pump Safety Pressure window click in the appropriate Enter New Pressure text box.
- Enter a new safety pressure for each pump cylinder you wish to set.
- Click on Send Safety Pressures to Pump(s).

The user may change the safety pressure of a pump cylinder at any time, even while the pump is operating. If a safety pressure is reset to a different pressure while the pump cylinder is operating, PumpWorks immediately operates at the new safety pressure. The pump will stop if its current pressure exceeds the new safety pressure.

When a pump is first powered ON, the controller resets the safety pressures to a negative pressure value. The pump cylinders, therefore, cannot be operated since the current pressure exceeds the safety pressure. This forces the user to enter an appropriate safety pressure. Once the user resets the safety pressure, then the digital overpressure error goes away and the pump cylinders can be operated.

6.8 Password Protection

Password protection is supported for certain critical areas of PumpWorks. This is an optional feature - users can opt to not use the password protection feature, allowing all users to have access to all PumpWorks features.

If password protection is desired, a designated system administrator(s) will need to set the password, specify whether to enable password protection or not, and determine which of the following critical portions of PumpWorks are to be protected:

- Safety Pressure Window
- Transducer Calibration Window
- Equations and Timers Window
- Set Up Operating Parameters Window
- Set Up Pressure Control Window
- Set Up Default Window
- Controller Setup Window
- Auto Tuning Window

6.8.1 Setting up Initial Password Protection

To initially set up password protection, the password needs to be specified. To intially specify the password:

- From the menu bar, select Log In as Administrator. The window shown in Figure 6-6 will appear.

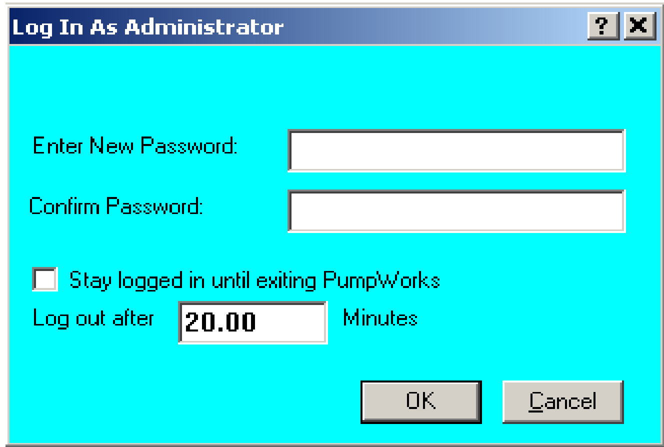


Figure 6-6 Initial Log In as Administrator window

- Enter the desired password in both the Enter New Password field and the Confirm Password field. The password is case sensitive, and must be the same in both fields.
- If you want to remain logged in as the administrator indefinitely, click on the "Stay logged in until exiting PumpWorks" check box until it is checked. If you want to be automatically logged out after a certain time period each time you log in, click on this check box until it is not checked, and then enter the amount of time, in minutes, that you want to stay logged in.
- Click the OK button to continue the setup and logging in procedure, or click the Cancel button to abort the set up procedure.
- If OK was clicked, a warning shown in Figure 6-7 will appear, warning you to remember the password.

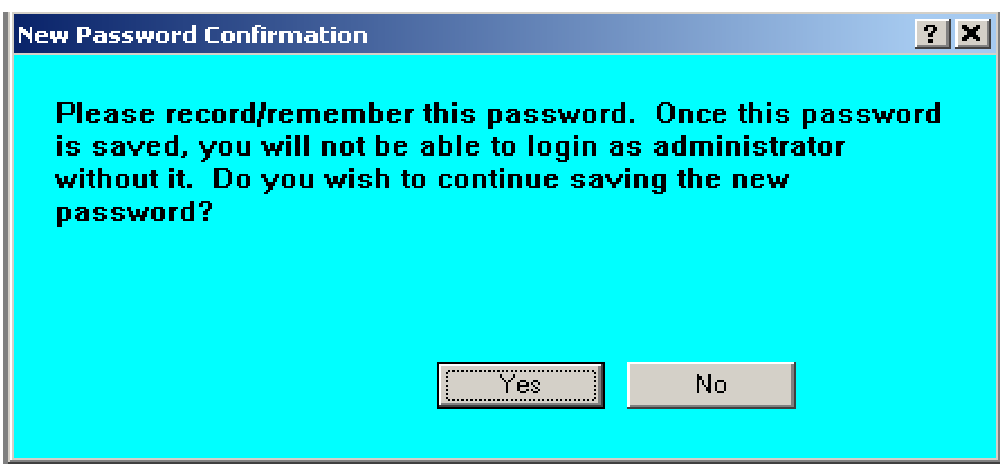


Figure 6-7 Remember Password Warning

- Once you record your password in a secure manner, click the Yes button to complete the setup and logging in procedure, or click the No button to abort the set up procedure.

If the Yes button was clicked, you will be logged in as the administrator, and will continue to be logged in until you explicitly log out, until the specified log in time expires, or until you exit from PumpWorks.

After the Yes button is clicked, another window, shown in Figure 6-8, will appear to allow the administrator to specify whether password protection will be enabled, and if so, which windows will be protected.

Figure 6-8 View Password Protection Status window

To specify protection:

- Click on the Enable Password Protection check box to set the desired state; if the box is checked, password protection will be enabled, otherwise it will be disabled, meaning that any user can access all features of PumpWorks.
- If password protection is enabled, click on the remaining check boxes to enable or disable protection for each of the individual windows. Windows associated with the checked boxes will be protected and will act as "read only" windows when not logged in as administrator. The windows associated with the unchecked boxes will be fully functional for all users, regardless of the logged in status.
- Click on the OK button to save the set up, or click on the Cancel button to ignore changes made. Note that the administrator will still be logged in if the Cancel button is clicked.

6.8.2 Log In or Out as Administrator

If password protection has been previously set up (please refer to Chapter 6, Section 6.8.1), Pumpworks will start up in a protected state, with the user not logged in as administrator. To log in as administrator:

- From the menu bar, select Log In as Administrator. The window shown in Figure 6-9 will appear.

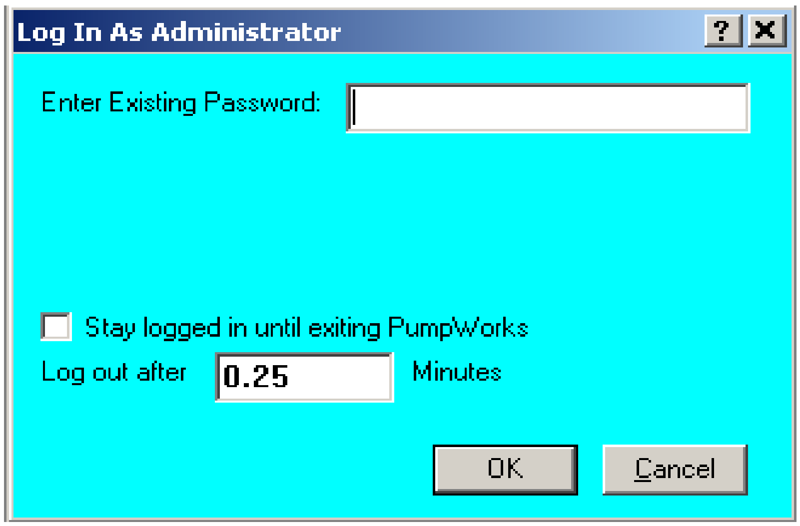


Figure 6-9 Log In as Administrator window

- Enter the previously set password in the Enter Existing Password field. The password is case sensitive, and must be the same as the password previously set up.
- If you want to remain logged in as the adminstrator indefinitely, click on the "Stay logged in until exiting PumpWorks" check box until it is checked. If you want to be automatically logged out after a certain time period, click on this check box until it is not checked, and then enter the amount of time, in minutes, that you want to stay logged in.
- Click the OK button to log in, or click the Cancel button to abort the log in procedure.

If the OK button was clicked, you will be logged in as the administrator, and will continue to be logged in until you explicitly log out, until the specified log in time expires, or until you exit from PumpWorks.

After the OK button is clicked, a second window, shown in Figure 6-10 will appear, to allow the administrator to specify whether password protection will be enabled, and if so, which windows will be protected.

Figure 6-10 View Password Protection Status window

To specify protection:

- Click on the Enable Password Protection check box to set the desired state; if the box is checked, password protection will be enabled, otherwise it will be disabled, meaning that any user can access all features of PumpWorks.
- If password protection is enabled, click on the remaining check boxes to enable or disable protection for each of the individual windows. Windows associated with the check boxes will be protected and will act as "read only" windows when not logged in as administrator. The windows associated with the unchecked boxes will be fully functional for all users, regardless of the logged in status.
- Click on the OK button to save the set up, or click on the Cancel button to ignore changes made. Note that the administrator will still be logged in if the Cancel button is clicked.

To explicitly log out as administrator, from the menu bar, select Log Out as Administrator.

6.8.3 View / Set Password Protection Status

To view the current password protection status, or to set/change the password protection status:

- From the menu bar, select View Password Protection Status. The window shown in Figure 6-11 will appear.

Figure 6-11 View Password Protection Status window

- If the Enabled Password Protection check box is checked, password protection is enabled, otherwise it is disabled, meaning that any user can access all features of PumpWorks.
- If password protection is enabled, the remaining check boxes indicate whether specific windows are protected. Windows associated with the check boxes will be protected and will act as "read only" windows when not logged in as administrator. The windows associated with the unchecked boxes will be fully functional for all users, regardless of the logged in status.

If the user is not currently logged in as administrator, the check boxes described above will be disabled (user cannot change the status). The user can attempt to log in by clicking the Log In as Administrator button, and following the directions in Chapter 6, Section 6.8.2.

If the user is currently logged in as the administrator, the window will actually look like the window shown in Figure 6-12, where the check boxes can be checked/unchecked by clicking on the check boxes.

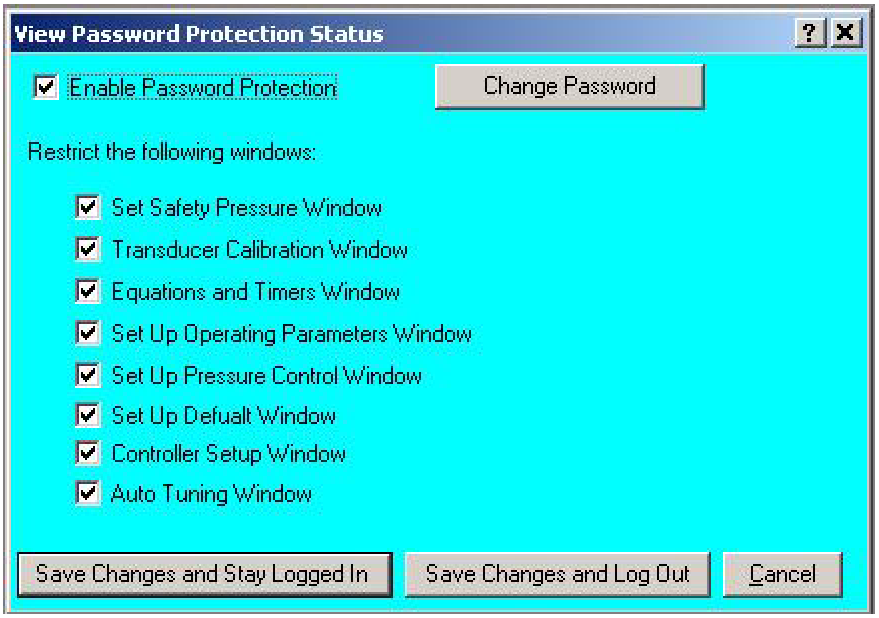


Figure 6-12 View Password Protection Status window

The user can also change the password by clicking on the Change Password button, and following the directions in Chapter 6, Section 6.8.4. To save changes made to the protection status, either click on the Save Changes and Stay Logged In button, or the Save Changes and Log Out button.

6.8.4 Change Password

To change the password, you must already be logged in as administrator. To change the password:

- From the menu bar, select View Password Protection Status. The window shown in Figure 6-12, above, will appear.
- Click on the Change Password button. The window shown in Figure 6-13 will appear.

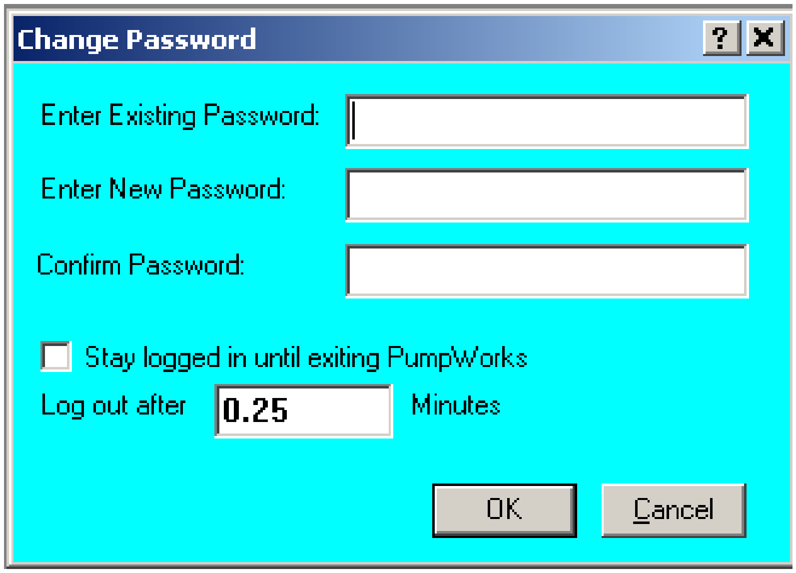


Figure 6-13 Change Password window

- Enter the current password in the Enter Existing Password field.
- Enter the desired new password in both the Enter New Password field and the Confirm Password field. The password is case sensitive, and must be the same in both fields.
- If you want to remain logged in as the administrator indefinitely, click on the "Stay logged in until exiting PumpWorks" check box until it is checked. If you want to be automatically logged out after a certain time period, click on this check box until it is not checked, and then enter the amount of time, in minutes, that you want to stay logged in.
- Click the OK button to save the new password, or click the Cancel button to abort the change.

If the OK button is clicked, you will be logged in as the administrator, and will continue to be logged in until you explicitly log out, until the specified log in time expires, or until you exit from PumpWorks.

After the OK button is clicked, the View Password Protection Status window will be opened (please refer to Chapter 6, Section 6.8.3).

6.8.5 Resetting the Password

In the unfortunate instance where the administrator has forgotten a password, or an emergency arises that requires that the password be reset, there is a way to recover. To reset the password, contact customer support at Chandler Engineering (918-250-7200).

6.9 Exit

To close PumpWorks:

- From the menu bar, select Main | Exit.
- A text box will ask you, "Are you sure you want to terminate the PumpWorks application?"
- Click on Yes to close PumpWorks. Click on No to return to PumpWorks.

NOTE: The following features require PumpWorks to be operating in order to function normally. If the user indicates they want to exit PumpWorks in any of these situations, a warning appears, and the user is given the option to exit anyway.

- **Automatic Volume/Time Operation:** If the user exits PumpWorks during automatic volume or time operation, the pump cylinder(s) will **not** be automatically shut down after the set volume is pumped or the set amount of time has elapsed. The pump cylinder(s) will continue to run indefinitely until the user stops them.
- **Data Logging:** If the user exits PumpWorks during Data Logging, the pump cylinders will continue to run, but data logging will not occur.
- **Fractional Flow and Recirculating operating modes:** Both the fractional flow constant pressure operating mode (Mode #13) and the recirculating operating mode (Mode #14), require PumpWorks to be running while they are in use. Do not exit PumpWorks while you are using either of these operating modes.
- **Ramping:** If the user exits PumpWorks during automatic ramping, the pump cylinder(s) will continue to operate at the last rate or pressure sent to them by the controller and the ramping operation will be discontinued.
- **Sequencer:** If the user exits PumpWorks during a Sequencer operation, the sequencer program will no longer function, although the pump cylinder(s) will continue to operate.
- **Updating Pump Controller Software or Front Panel Software:** Updating software requires PumpWorks to be running during the software update. If PumpWorks is exited during this process, updating of the software will be aborted, and pump controller(s) / front panel(s) will have no code. User will get an error message next time they try to communicate with the controller(s) / front panel(s) that the controllers have no code and the software update will have to be initiated again.

THIS PAGE INTENTIONALLY LEFT BLANK.

7 DATA LOG MENU

The Data Log feature allows a user to automatically record all operating data directly to the computer's hard drive, where it can be reviewed, analyzed and graphed. In this chapter we will discuss the Data Log Menu options as follows:

- Set Up Data Log, Section 7.1
- Begin Data Logging, Section 7.3
- End Data Logging, Section 7.4
- View Data Log File, Section 7.5
- Write Remarks to Data Log File, Section 7.6
- Copy Data Log File, Section 7.7
- Converting Text Datalog Files to CSV Format, Section 7.8
- How to Print a Data Log, Section 7.9

7.1 Set Up Data Log

The Set Up Data Log option allows the user to choose which information will be recorded to a data log file. After setting up a data log, the user can either start data logging immediately or at a later time. The data log file will be ready when the user chooses to start data logging.

- From the menu bar, select Data Log | Set Up Data Log and the window shown in Figure 7-1 appears.

NOTE: Before attempting to set up a data log file, check the status bar, located on the bottom of PumpWorks application. Make sure it says "Data Logging - OFF". A data log file can only be set up if data logging is not currently running. All fields will be grayed, except for log interval, if data logging is currently in use.

7.1.1 User I.D. Text

To have an optional test name or title appear at the top of your Data Log, do the following:

- From the Set Up Data Log window, click in the User ID Text box and enter a test name or title.
- Click in the "User ID Text" check box to the left of the test name text box. A check mark will appear.
- When finished with the Set Up Data Log window, click on OK.

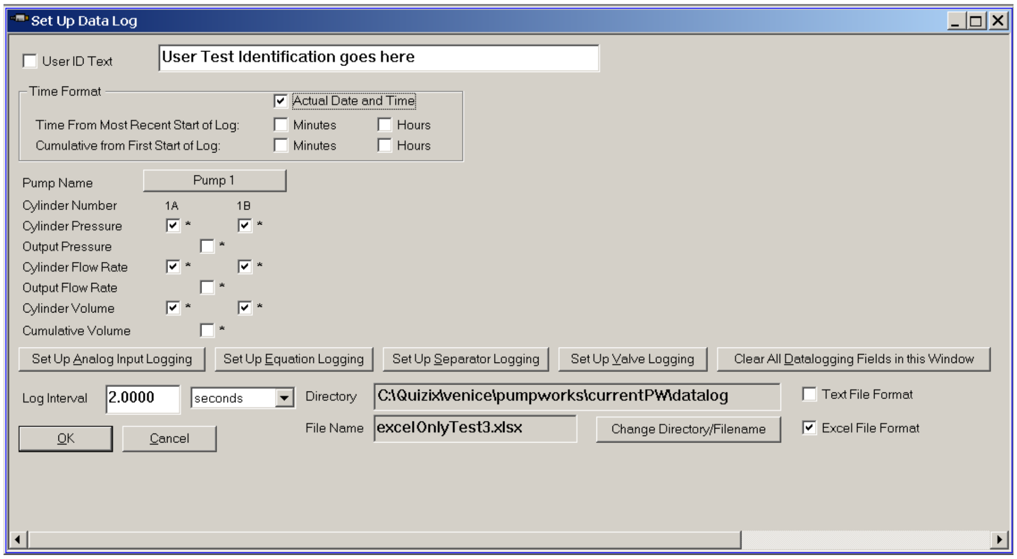


Figure 7-1 Set Up Data Log Window

7.1.2 Time Format

Select a time format. The three possible formats for recording time onto a data log file are:

- Actual Date and Time
- Time From Most Recent Start of Log
- Cumulative Time From First Start of Log

A user can choose to record one, two or even all time options for a single data log file.

7.1.2.1 Actual Date and Time

To record the actual date and time onto a data log, as set in the Date/Time Properties of your computer, do the following:

- In the Set Up Data Log window, click in the Actual Date and Time box. Date is recorded as MM/DD/YY. Time is recorded as HH/MM/SS for standard United States computers. This format is set by your computer date and time format.

7.1.2.2 Time From Most Recent Start of Log

To record the time that has elapsed since the data log was most recently started, do the following:

- In the Set Up Data Log window, click in the Time From Most Recent Start of Log box.
- Click on either minutes, hours or both.

7.1.2.3 Cumulative Time From First Start of Log

If the user starts and stops data logging at several points during an experiment, a useful option is to keep track of the cumulative time from the first time data was entered into the Data Log file. To do this:

- In the Set Up Data Log window, click in the Cumulative From First Start of Log box.
- Choose either minutes, hours or both.

7.1.3 Recording Operating Data to a Data Log

The following operating data can be recorded onto a data log file; pump cylinder pressure, paired pump output pressure, cylinder flow rate, paired pump output flow rate, cylinder volume, paired pump cumulative volume, auxiliary analog input values, results of equation(s) created by the user, and/or separator data. Data is recorded in the data log in the units and with the decimal places specified in Set Up Displayed Units and Decimal Places. Refer to Chapter 12, Section 12.1 for more information.

To record operating data to a data log file, do the following:

- In the Set Up Data Log File window, there are check boxes for each operating data item available to be logged. Each operating data item has a separate box for each pump cylinder. Click in each box to check or uncheck the item. To uncheck all data items shown in this window, click on the Clear All Datalogging Fields in this Window button. Data will be recorded for each checked item when datalogging is started.
- Click on OK when finished with the Set Up Data Log window.
- PumpWorks will open a Data Log Start Confirmation dialog box which asks “Do you want to start logging? Click on Yes to start logging immediately. Click on No and the data log set up will be saved for use at a later time.
- If Yes was clicked and the data log file already exists, the user will be asked if they want to append the data to the existing file. If the user does not want to append the data to the existing file, click on No. Then go to DataLog | Set Up Data Log and click on the Change Directory/File Name button in the lower right corner of the Set Up Data Log window to enter a different file name.

7.1.3.1 Cylinder Pressure

The cylinder pressure is a measurement of the pressure inside of the cylinder barrel at the time the data was recorded. The measurement reading is taken from a pressure transducer, which is connected to the pump cylinder.

7.1.3.2 Output Pressure

The output pressure is a measurement of the pressure maintained by the pump while in paired operating modes. The output pressure measurement is taken from either pump cylinder A or pump cylinder B, depending on which is the active pump cylinder, or calculated from both pump cylinders during switchover.

7.1.3.3 Cylinder Flow Rate
The cylinder flow rate is the operating rate of fluid flow at the time that the data was being recorded to the data log.

7.1.3.4 Output Flow Rate
The output flow rate is a measurement of the rate of the fluid flow being delivered from the pump while in paired operating modes. The measurement is taken from pump cylinder A or pump cylinder B, depending on which is the active pump cylinder, or calculated from both pump cylinders during switchover.

7.1.3.5 Cylinder Volume
The cylinder volume is the volume of fluid in the cylinder at the time that data is being recorded to the data log, relative to when the user last reset the volume to zero.

7.1.3.6 Cumulative Volume
The Cumulative Volume is the total amount of fluid that has been delivered by a pump pair since the cumulative volume was zeroed.

7.1.4 Set Up Auxiliary Analog Input Logging

PumpWorks includes the option of logging up to 48 auxiliary analog input signals. Before an auxiliary analog input signal can be logged, the following three steps need to be completed.

- **First, Connecting an Auxiliary Analog Signal.** To connect the auxiliary analog signal, please refer to Appendix A, B or C.
- **Second, Mapping an Auxiliary Analog Signal.** To map an auxiliary analog signal to a channel number, please refer to Chapter 10, Section 10.2, for instructions.
- **Third, Setting Up the Auxiliary Analog Signal.** To set up an auxiliary analog signal, refer to the next section (Section 7.1.4.1).

7.1.4.1 Setting Up an Auxiliary Analog Signal
To set up an auxiliary analog input signal do the following:

- From the menu bar, click on Data Log | Set Up Data Log. The Set Up Data Log window appears. (Please refer to Figure 7-1.)
- From the Set Up Data Log window, click on Set Up Auxiliary Analog Input Logging. The window shown in Figure 7-2 appears.

Figure 7-2 Set Up Analog Input Data Logging Window

- From the Set Up Analog Input Data Logging window, click on Auxiliary 1 (or any other Auxiliary, numbers 2 through 48). The window shown in Figure 7-3 appears.

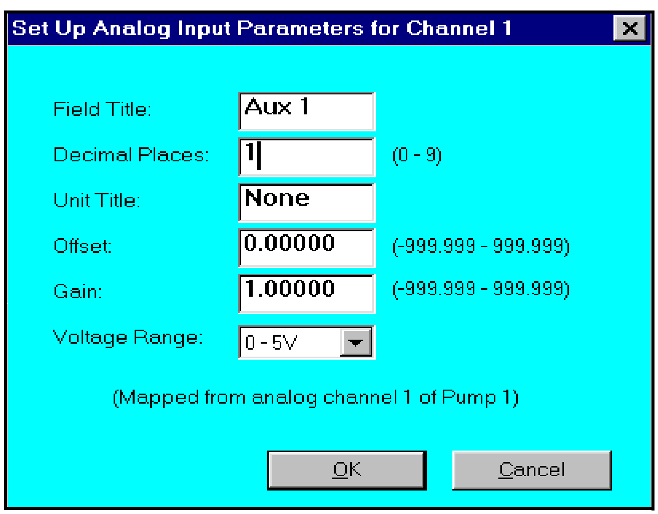


Figure 7-3 Set Up Aux Analog Input Parameters for Channel # Window

7.1.4.1.1 Field Title

Field title refers to the name of the auxiliary analog input channel. To change the field title:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the Field Title text box and highlight the current title.
- Enter the title you wish this auxiliary analog input channel to have.

- When finished with this window, click on OK.

7.1.4.1.2 Decimal Places

Decimal places refers to how many numbers follow the decimal point. The user may choose from zero to nine numbers to be displayed to the right of the decimal point. For example, if the user enters a zero, the log will show a whole number. If the user enters a 2, the log will show two numbers to the right of the decimal point. To change the decimal places:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the Decimal Places box and highlight the current number.
- Enter the number of places you wish displayed to the right of the decimal point.
- When finished with this window, click on OK.

7.1.4.1.3 Unit Title

The unit title allows the user to enter a unit of measurement which will be displayed at the top of each column of data in the data log. The unit title entered here is a visual reminder only. <u>Entering a unit of measurement here does not change the selected auxiliary analog input channel to that unit of measurement.</u>

To enter a Unit Title, do the following:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the Unit Title text box and highlight the current title.
- Enter the unit title desired.
- When finished with this window, click on OK.

7.1.4.1.4 Setting the Offset

Offset allows the user to correct for an offset error in an auxiliary device. The offset conversion allows for addition to or subtraction from the final value.

The calculated value is equal to (input voltage multiplied by the gain) plus the offset.

To enter an offset:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the Offset text box and highlight the current offset.
- Enter the desired offset number.
- When finished with this window, click on OK.

7.1.4.1.5 Gain

The gain allows the user to scale the output of an auxiliary device to any desired unit of measure. To enter a gain:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the Gain text box and highlight the current gain.

- Enter the desired gain.
- When finished with this window, click on OK.

7.1.4.1.6 Voltage Range

Depending on the source of the auxiliary analog input signal, the user may be able to select the voltage range of the input. If this function is available for the device mapped to a channel, then the proper voltage range may be selected by doing the following:

- Click on the arrow in the voltage range box
- Highlight the desired voltage range.
- When finished with this window, click on OK.

7.2.4.2 Logging an Auxiliary Analog Input Channel

To select a previously set up auxiliary analog input channel to be logged onto a data log, do the following:

- In the Set Up Analog Input Data Logging window (Refer to Figure 7-2), click in the check box to the left of the Auxiliary Channel(s) to check or uncheck each item. To uncheck all data items shown in this window, click on the Clear All A/D Datalogging items. Data will be recorded for each checked item when datalogging is started.
- When finished with this window, click on OK.

NOTE: If all fields are grayed, then check the status bar of the main window. Make sure it says “Data Logging - OFF”. A data log file can only be set up if data logging is not currently running.

7.2.4.3 Clear All A/D Data Logging Fields

Any individual analog input field that is checked in the Set Up Analog Input Data Logging window may be cleared by clicking on the field again. To clear all the checked fields in the Set Up Analog Input Data Logging window, click on the Clear All A/D Datalogging Fields button.

7.2.5 Set Up Equation Logging

With Set Up Equation Logging, PumpWorks will calculate and display the results of a user-defined mathematical equation. The equation results appear on the computer screen and can be recorded in a data log. The components of the equation can include any pump system data or constants displayed by PumpWorks and the standard mathematical operations of add, subtract, multiply, and divide, as well as the mathematical functions of sine, cosine, tangent, logarithm (base 10), natural logarithm and exponential.

7.2.5.1 Writing an Equation

In Set Up Equation Logging, the user is choosing which equations to log to a data log. Before equation data can be logged, the equation needs to be defined. To actually define up to sixteen equations, in the Set Up Data Logging window click on the SET UP EQUATIONS button (Refer to Figure 7-4) or go to the main menu and click on Other | Equations and Timers and click on the SET UP EQUATIONS button. For more information and instructions regarding defining equations, please refer to Chapter 10, Section 10.8.

7.2.5.2 Logging an Equation on a Data Log

After one or more equations have been defined, the user can select which equations are to be entered onto a data log, as follows:

- From the menu bar select Data Log | Set Up Data Logging | Set up Equation Logging and the Set Up Equation Data Logging window appears.

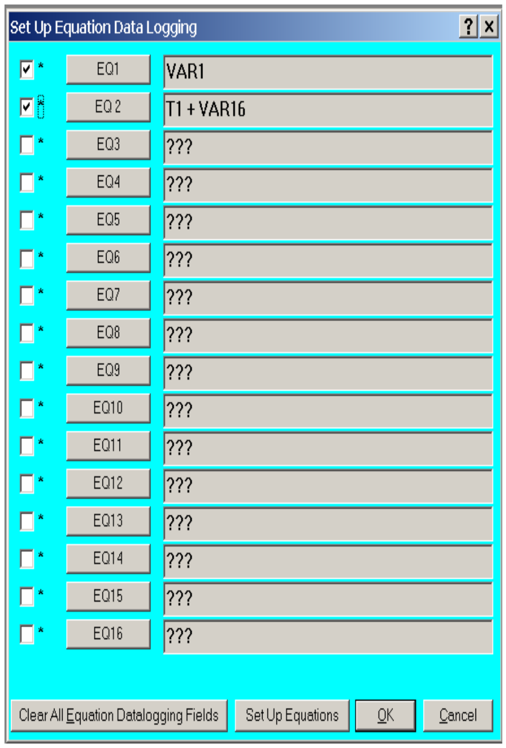


Figure 7-4 Set Up Equation Data Logging Window

Previously set up equations are displayed to the right. The equation name appears to the left of the equation and a check box appears to the left of the equation name. To choose one or more equations to be entered onto a data log, do the following:

- In the Set Up Equation Data Logging window, click in the appropriate check box to the left of the equation(s) to check or uncheck each item. To uncheck all data items shown in this window, click on the Clear All Equation Datalogging Fields box. Data will be recorded for each checked item when datalogging is started.
- When finished with this window, click on OK.

7.2.5.3 Clearing Checked Fields

Any individual equation field that is checked in the Set Up Equation Data Logging window may be cleared by clicking on the field again. To clear all the checked fields in the Set Up Equation Data Logging window, click on the Clear All Equation Datalogging Fields button.

7.2.6 Set Up Separator Logging

A separator is a device that separates two fluids which have different density properties. Before a separator can be logged,

- **First:** it must be connected to a computer.
- **Second:** PumpWorks must be set up to communicate with the separator before data from the separator can be logged to a data log file. (Refer to Chapter 13, Section 13.4.)

After a separator has been connected and the separator communications set up, follow the instructions below to set up data logging for the separator.

- From the menu bar select Data Log | Set Up Data Log | Set Up Separator Logging. The window shown in Figure 7-5 appears.

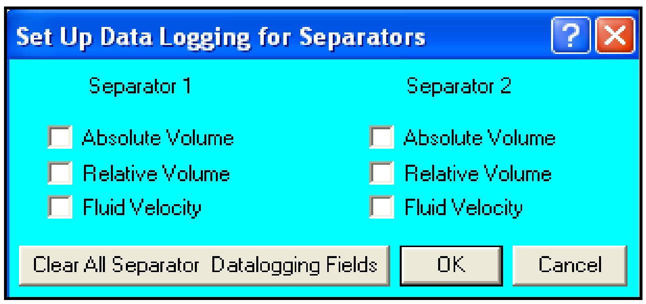


Figure 7-5 Set Up Data Logging for Separators

The Set Up Data Logging for Separators window allows a user to choose which separator information will be logged to a data log file. Possible separator information that can be logged to a data log are explained below.

NOTE: The NISEP three-phase separator is treated like two individual two-phase separators. Absolute volume, relative volume, and fluid velocity must be check-marked for both Separator 1 and Separator 2 in order for all data to be recorded.

- **Absolute Volume** is the actual amount of the lower or denser fluid.
- **Relative Volume** is how much of one fluid there is, compared to when the volume was last reset to zero.
- **Fluid Velocity** is the speed of sound in the lower or denser fluid.

7.2.6.1 Setting Up Data Logging for Separators

To set up data logging for separators, do the following:

- In the Set Up Data Logging for Separators window, click in the appropriate check box(es) to check or uncheck each item. To uncheck all data items shown in this window, click on the Clear All Separator Datalogging Fields box. Data will be recorded for each checked item when datalogging is started.

- When finished with this window, click on OK to return to the Set Up Data Log window.

7.2.6.2 Separators Supported by PumpWorks

Please refer to Chapter 13, Section 13.4.2.

7.2.6.3 Clear All Separator Datalogging Fields

Any individual separator field that is checked in the Set Up Separator Data Logging window may be cleared by clicking on the field again. To clear all the checked fields in the Set Up Separator Data Logging window, click on the Clear All Separator Datalogging Fields button.

7.2.7 Set Up Valve Logging

PumpWorks includes the option of logging each pump's valve states. To set up an auxiliary analog input signal, do the following:

- From the menu bar, click on Data Log. The Set Up Data Log window appears. (Refer to Figure 7-1.)
- From the Set Up Data Log window, click on Set Up Valve Logging. The window shown in Set Up Data Log WindowFigure 7-6 appears.

Figure 7-6 Set Up Data Log Window

In the Set Up Valve Data Logging window, there are check boxes for a fill and deliver valve for each pump cylinder. Click in each box to check or uncheck the item. To uncheck all data items shown on this window, click on the Clear All Valve Datalogging Fields button. Data will be recorded for each checked item when datalogging is started. When finished with this window, click on OK to return to the Set Up Data Log window.

7.2.8 Clear All Datalogging Fields in this Window

Any individual data logging field that is checked in the Set Up Data Log window may be cleared by clicking on the field again. To clear all the checked fields in the Set Up Data Log window, click on the Clear All Datalogging Fields in this Window button. This will NOT clear fields set up in the separate analog input, equation, separator or valve set up windows. Each of these windows has their own "clear all" buttons.

7.2.9 Log Interval

The Log Interval is the amount of time between data log recordings. It is specified in hours, minutes, or seconds. For example, if the log interval is 5.00 minutes, every five minutes data will be recorded to the data file. The log interval may be changed at any time, even while data logging is in progress.

- Click in the Log Interval text box and enter a time interval for the data log.
- Choose the unit of measure for the log interval by clicking on the arrow on the right side of the log interval field, and clicking on the desired unit (seconds, minutes or hours).

The data log interval is limited to .1 second. Note, however, that the **data sampling interval,** is based on the communications cycle interval set up in Chapter 13, Section 13.3. For example, if the communications cycle interval is 2 seconds and the data log interval is 0.25 seconds, PumpWorks will log data every 0.25 seconds, but it won't be new data. New data will be sampled and available to be logged only every 2 seconds, in this example. Thus, at very fast data log intervals, the communications cycle interval should also be considered and, if necessary, adjusted.

7.2.10 Directory and File Name

The default directory for datalog files is a "datalog" subdirectory under the Quizix PumpWorks directory in the shared documents or (public documents) directory. (Please refer to the boxed note in Chapter 2, Section 2.2 for an explanation about the shared documents directory and a warning about locating files outside of this directory treee.)

The directory the user enters in the Set Up Data Log window must already exist. PumpWorks will not create a directory, however, PumpWorks will create a file. To enter or change a directory and file name:

- In the Set Up Data Log window, click on the Change Directory/Filename button, and a window appears which allows the user to browse for a different directory and file name to store the data log in.
- Choose or enter a file name. Click on Open.

7.2.11 Choosing the Data Log Format

PumpWorks can log data in a text file format, an Excel file format, or both. To choose the file format(s), click on the appropriate check boxes ("Text file Format" and/or "Excel File Format") to toggle their state. If the box is checked, that format will be applied. At least 1 box must be checked.

7.2.12 Completing the Data Log Set Up

When you are finished setting up your data log file:

- Click on OK.
- A Data Log Start Confirmation dialog box appears asking, “Do you want to start data logging now?”.

- Click Yes to start data logging immediately. If you do not wish to start data logging, click on NO. The data log information will be saved for later use.

- If Yes was clicked and the data log file already exists, the window shown in Figure 7-7 appears.

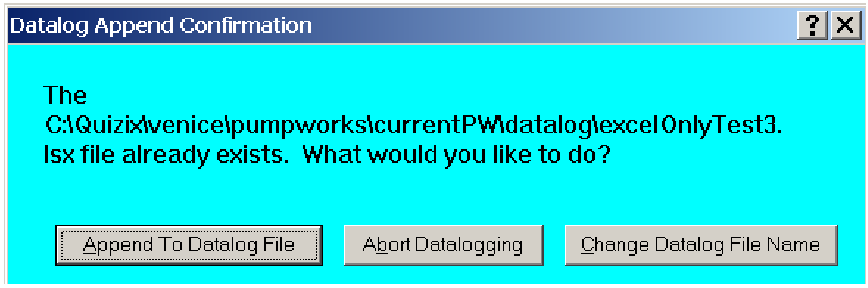


Figure 7-7 Append to Datalog Confirmation

- If the user wishes to append the new data on to the existing file, click the Append to Datalog File button.

- If the user wishes to change the data log directory and/or file name, click on the Change Datalog File Name button. This will take the user back to the Set Up Data Log window, where the user can select the Change Directory/Filename button, and follow the instructions detailed in Section 7.2.10.

- If the user wishes to simply cancel the data logging operation, click on the Abort Datalogging button. If this option is selected, data logging will not be started, but any changes made to the datalog set up WILL be saved.

NOTE: The status bar at the bottom of the PumpWorks application will show "Data Logging ON" the entire time that a data log is activated

7.3 Begin Data Logging

The Begin Data Logging option is activated when the user has already set up a data log file and is ready to start logging data.

NOTE: Data Logging will not begin if the hard drive has less than 1 megabyte of space. Also, data logging will automatically stop if the hard drive has less than 1 megabyte of hard drive space. A warning will be given. If this happens, create more space on the hard drive by moving or deleting unused data or programs. Then begin data logging again.

7.3.1 How to Begin Data Logging

When you are ready to begin data logging, do the following:

- From the menu bar, select Data Log | Begin Data Logging.

If this is the first time the specified file has been recorded onto, PumpWorks will automatically start data logging. The status bar on the PumpWorks application will show "Data Logging ON"

If the selected datalog file already exists, the datalog append confirmation dialog box shown in Figure 7-7 (above) will appear.

- If the user wishes to append the new data on to the existing file, click the Append to Datalog File button.
- If the user wishes to change the data log directory and/or filename, click on the Change Datalog File Name button. This will take the user back to the Set Up Data Log window, where the user can select the Change Directory/Filename button, and follow the instructions detailed in Section 7.2.10.
- If the user wishes to simply cancel the data logging operation, click on the Abort Datalogging button. If this option is selected, data logging will not be started, but any changes made to the datalog set up WILL be saved.

If the Excel file format has been selected (in the datalog set up), the Excel application will automatically be started, and PumpWorks will start logging to this application. The data will automaticall be saved to the previously specified Excel file each time a new entry is logged.

IMPORTANT NOTE: DO NOT CLOSE the Excel application while PumpWorks is logging. Closing the application will cause PumpWorks to stop logging until user explicitly restarts, and no indication will be written in the log to note that logging was stopped. To stop logging gracefully, follow the directions in Chapter 7, Section 7.4. Once logging has been stopped, it's safe to close the Excel application, if the user wishes.

7.3.2 IAltering Parameters During Data Logging

Once data logging has begun, only the Log Interval can be changed in the Set Up Data Log window. No other items can be added to or removed from the data log. If the user needs to change any other parameter, stop data logging by doing the following:

- From the menu bar, select Data Log | End Data Logging.
- Make changes using the Data Log Set Up window.
- When finished making changes, restart data logging.

7.4 End Data Logging

To stop data logging:

- From the menu bar, select Data Log | End Data Logging.

Data logging will immediately stop. The status bar of the main window in PumpWorks will show "Data Logging Off".

7.5 View Data Log File

The View Data Log File option allows the user to view the currently selected datalog file. To view a data log do the following:

- From the menu bar, select Data Log | View Data Log File. If the Text File Format has not been selected in the Set Up Data Log window, the Excel application will be opened with the currently selected datalog file. Otherwise the View Data Log File window shown in Figure 7-8 will appear, displaying the data from the curently selected datalog file. If the user chooses to view the data log while data logging is active, PumpWorks continues to update the View Data Log File window and/or the opened Excel application, as well as the log file itself. However, depending on the position of the verical scroll bar in the View Data Log File window, the window may not automatically scroll down to show new entries. The user should use the scroll bar on the right side of the window to check new entries. A sample data log file appears in Figure 7-8. The top pane of the window shows the appropriate datalog header (indicating which data items are logged in the pane below).

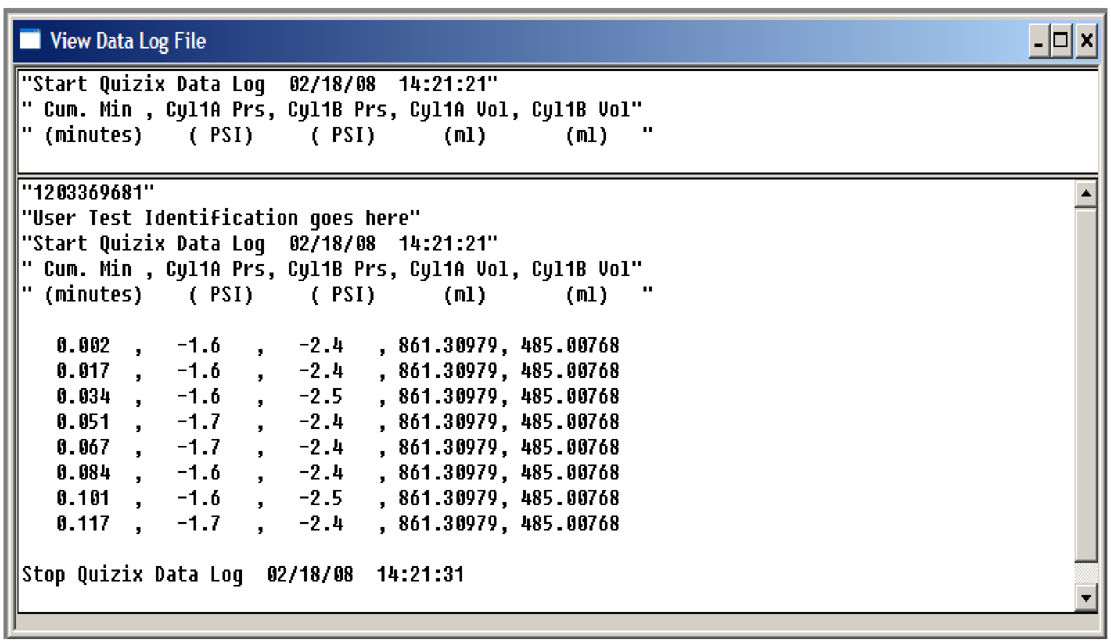


Figure 7-8 View Data Log File Window

Each item of data that was recorded is displayed as a separate column in the data log. Each row of data represents a different time data was recorded. For example, if you chose to record data every ten minutes, after an hour there will be six rows of data and one column for each item selected in the Data Log Setup window. With very large data files, the user may need to scroll to view all parts of the data log.

The View Data Log File window may take several seconds to open depending on the size of the data log file to be viewed.

NOTE: The View Data Log File window and/or the Excel application showing the log file may also be opened by clicking on the Datalog status button in the status bar.

7.6 Write Remarks to Data Log File

The Write Remarks to Data Log File option allows the user to enter comments or notes in the data log as an experiment is in progress. When viewing or printing a data file, the remark will be noted with the date and time it was entered. To write a remark to a data log file do the following:

- From the menu bar select Data Log | Write Remarks to Data Log File. The window shown in Figure 7-9. appears.

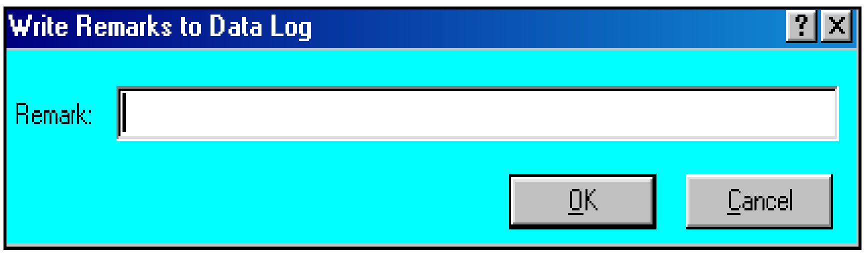


Figure 7-9 Data Log Remark Window

To enter a remark:

- In the Data Log Remark window, click in the text box.
- Enter your remark.
- Click on OK to enter your remark, or click on cancel if you do not wish to enter a remark.

Your remark will be entered in the data log, along with the date and time it was recorded.

7.7 Copy Data Log File

The Copy Data Log File option allows the user to save the information contained in the current data log file to another specified file. Copying the data log file to another file allows the user to "backup" the data log file for security, to use in another program without distrubing the PumpWorks data logging, etc. To copy the data log file, do the following:

- From the menu bar, select Data Log | Copy Data Log File. The window shown in Figure 7-10 appears.

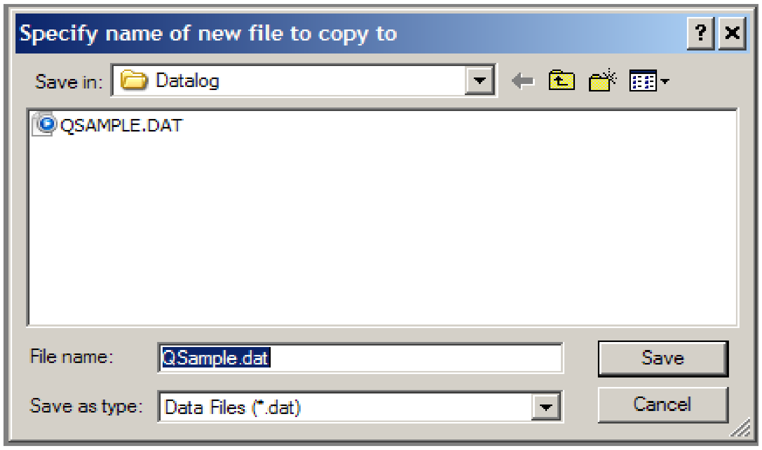


Figure 7-10 Copy Data Log File Window

- Select the directory and filename of the new file in which to copy the data log, and click on the Save button.
- The information stored in the current data log file will be copied to the new file.

7.8 Converting Text Datalog Files to CSV Format

To view a text datalog file with Excel, it is recommended that the user first convert the datalog file to a csv format. To convert the file:

- From the menu bar, select Data Log | Convert text datalog file to csv format. The standard file dialog box shown in Figure 7-11 appears.

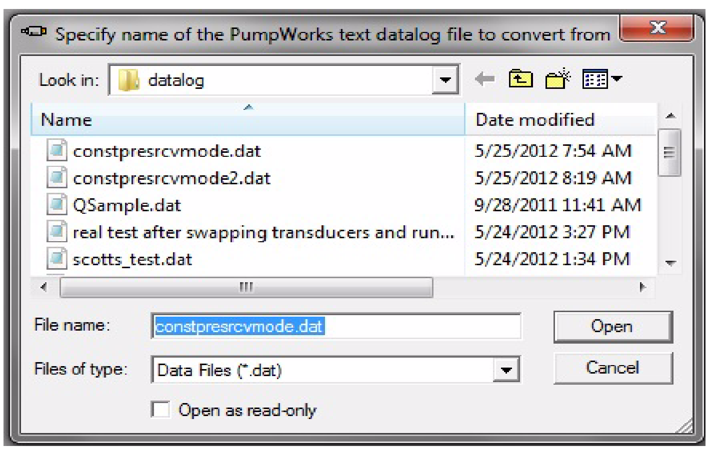


Figure 7-11 Specify Text Dialog file to be Converted

- Find the text datalog file with the browser, click on the file, and then click the Open button at the bottom of the window. The standard file dialog box shown in Figure 7-12 will then appear.

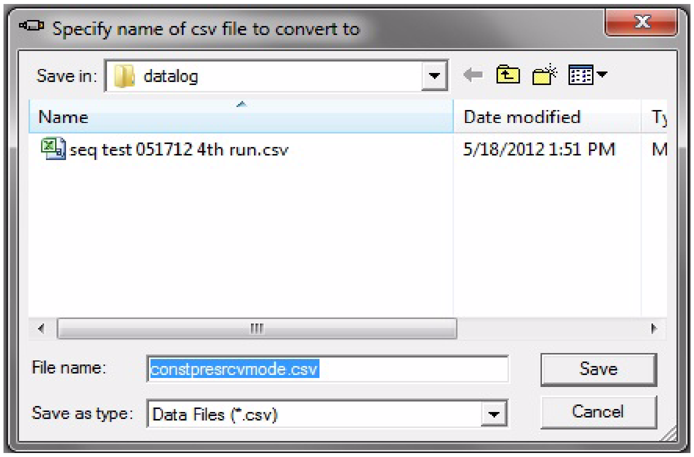


Figure 7-12 Specify Name of the New CSV Datalog File to be Created

- Enter the name of the csv file to be created and click on the Save button at the bottom of the window. You should see a pop up window showing "Datalog file converted successfully."

If the conversion is not successful, check to make sure the specified text file exists and is not open in another application, and that the new file either does not exist, or if it does exist, is not open in another application.

7.9 How to Print a Data Log

If the Excel File Format option was selected in the Set Up Data Log window, you can print and/or process data directly from the Excel application.

If the Excel File Format option was not selected, the data log file will be a standard ASCII text file, in quote and comma delimited format (data separated by commas, all lines of text surrounded by quotation marks). This data can be read, analyzed, printed and graphed using a spreadsheet program (after the file is imported into that program).

The data log file should appear in print the same as it appears when viewed on PumpWorks. For example, there should be one row of data for each time data was recorded. There should be one column for each type of data recorded. Depending on the import options of the spreadsheet or word processing program chosen, labels and comments may or may not be printed. Also, if the data is longer than the paper it is being printed onto, the data will wrap to the next line down when printed. In many spread sheet or word processing programs, users may highlight a portion of the data and print only that portion.

THIS PAGE INTENTIONALLY LEFT BLANK.

8 AUTO OP MENU

Advanced automatic control over the entire pump system is available through the AutoOp Menu. Click on AutoOp and the following three menus are displayed.

- Set Up and Control Ramping Operation, Section 8.1
- Set Up and Control Automatic Volume/Time Operation, Section 8.2
- Control Sequencer Operation, Section 8.3

8.1 Set Up and Control Ramping Operation

One of the features within PumpWorks is Automatic Ramping. Ramping is a gradual change from one flow rate or pressure to another, over a user-specified period of time. For example, two pump cylinders operating in paired constant rate delivery mode could ramp from 5 ml/minute to 10 ml/minute over 60 minutes. PumpWorks allows the user to specify a different ramping operation for each pump cylinder or cylinder pair, if desired. Automatic ramping is extremely useful if a smooth transition or "ramp" in the flow rate, pressure or delta pressure is desired.

During automatic ramping, PumpWorks must be operating. Automatic ramping cannot occur without communication between PumpWorks and the pump.

- From the menu bar, select AutoOp | Set Up and Control Ramping Operation and the window shown in Figure 8-1 appears.

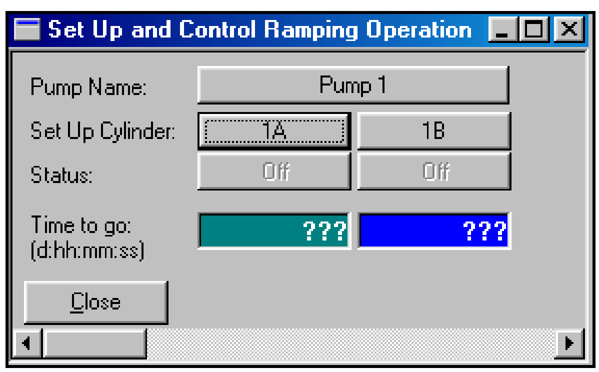


Figure 8-1 Set Up and Control Ramping Operation Window

8.1.1 Setting Up Automatic Ramping

To set up an automatic ramping operation, do the following:

- In the Set Up and Control Ramping Operation window, click on the Set Up Cylinder button for the pump cylinder you want to ramp. If operating a pump in a paired operating mode, click on the first pump cylinder of the pair (the other one will be grayed out). The settings you make will automatically apply to both pump cylinders in the pair.

- The Set Up Ramping Operation for Cylinder # window appears, as shown in Figure 8-2 below.

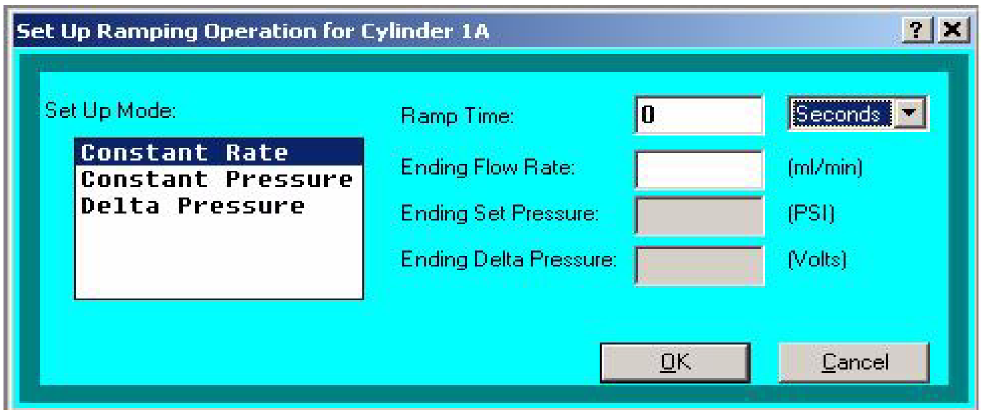


Figure 8-2 Set Up Ramping Operation For Cylinder # Window

8.1.1.1 Set Up Mode

In the Set Up Ramping Operation for Cylinder # window, click on a type of operating mode in the Set Up Mode box. For example, Constant Rate, Constant Pressure, or Constant Delta Pressure. When ramping begins, the type of operating mode specified here must match the type of operating mode actually in use with the pump cylinder(s) being ramped. Make sure you highlight the correct type of operating mode.

8.1.1.2 Ramp Time

To specify the ramp time, first select the units of time in the combo box to the right of the ramp time field. You can select between seconds, minutes, hours, or days. Then enter the desired ramp time in the specified time units. The ramp time is the amount of time it will take for the beginning flow rate or pressure to gradually change to the ending flow rate or pressure.

8.1.1.3 Ending Flow Rate, Set Pressure or Delta Pressure

Depending on the type of operating mode already chosen in the Set Up Mode box (see Section 8.1.1.1), one of the following text boxes will be white and available to be set.

- Ending Flow Rate
- Ending Set Pressure, or
- Ending Delta Pressure

The other two text boxes will be gray and not available.

- Click in the appropriate text box and enter the ending flow rate, ending set pressure or ending delta pressure. This is the flow rate, set pressure or delta pressure you want the pump cylinder(s) to be at when ramping is finished.

- When finished with this window, click OK.

8.1.2 Starting Automatic Ramping

It is assumed, at this point, that the user has already set up an automatic ramping operation. (Refer to Setting Up Automatic Ramping, Section 8.1.1.)

Once an automatic ramping operation is set up, the user can choose when to start it. The pump must already be in one of the proper modes, and running, when a ramping operation is started."

To ramp a pair of pump cylinders that are running in a paired operating mode, turn on ramping for the first pump cylinder of the pair (the other one will be grayed out). During ramping, PumpWorks will gradually increase or decrease from the current flow rate, pressure or delta pressure to the desired flow rate, pressure or delta pressure in the user-set amount of time. During a ramp, the safety pressure and volume counts can be reset, but the operating mode and direction are locked. Also, the Set Up Ramping Operation for Cylinder # text boxes are grayed until the ramping operation is completed.

To start an automatic ramping operation, do the following:

- From the menu bar, select AutoOp | Set Up and Control Ramping Operation.

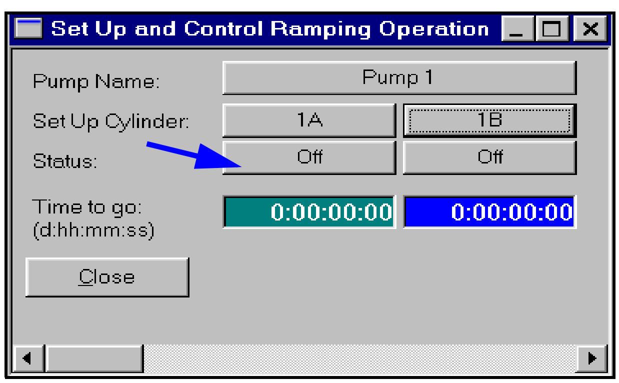


Figure 8-3 Set Up and Control Ramping Operation Window

- In the Set Up and Control Ramping Operation window, notice the word "status" on the left hand side. To the right of "status" click on the "Off" button for the appropriate pump cylinder. A Ramping Operation Confirmation window appears, as shown in Figure 8-4 below.

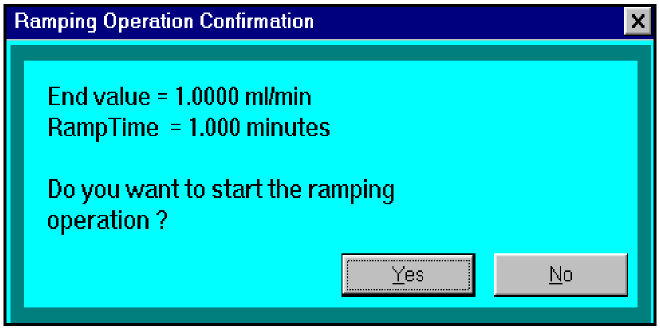


Figure 8-4 Ramping Operation Confirmation Window

- The Ramping Operation Confirmation window shows the end setting for either flow rate, pressure or delta pressure and the length of the ramp time.

- "Do you want to start the ramping operation" will also be displayed.

- If the pump cylinder is not already running, you will be given an option to start the pump cylinder. If you click Yes, the Cylinder Start Confirmation window shown in Figure 8-5 appears. If you click on No, the ramping operation will be aborted.

- If the pump cylinder is already running, the status button will immediately display "On," and your ramping operation has begun. The pump must be running for ramping to occur. If the pump stops while a ramp is in progress, the ramping also stops.

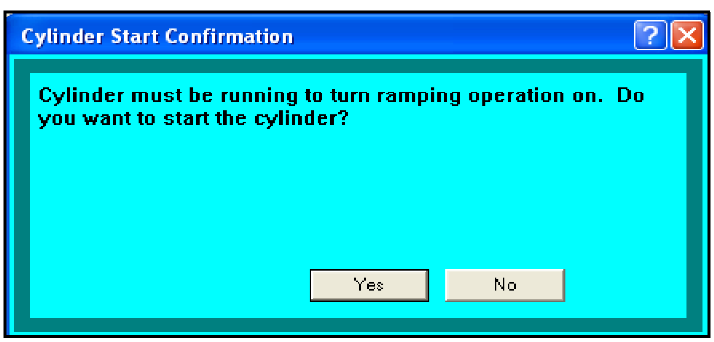


Figure 8-5 Cylinder Start Confirmation Window

- The Cylinder Start Confirmation window gives a final warning that the pump cylinder must be running to turn ramping operation On. If you click Yes, the Start Cylinder Confirmation for Cylinder # window show in Figure 8-6 opens. If you click No, the ramping operation will be aborted.

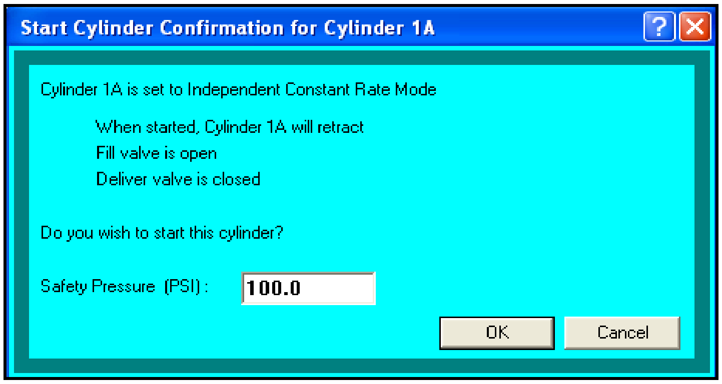


Figure 8-6 Start Cylinder Confirmation for Cylinder # Window

- In the Start Cylinder Confirmation for Cylinder # window, if you click Cancel the ramping operation will be aborted. If you click OK, the status button will immediately display "On," and your ramping operation has begun. The pump must be running for ramping to occur. If the pump stops while a ramp is in progress, the ramping also stops.

- During ramping, the "Time To Go" text box will display the amount of time left until the ramping operation is completed.

- On the main window of PumpWorks, the word "Auto" will appear in front of the user-chosen operating mode, for the pump cylinder being ramped. For example, if a pump cylinder is ramping in Independent Constant Rate mode it will show as Auto Ind. CR.

NOTE: Ramping may not be turned on while updating software to the pump controller or front panel.

8.1.3 Ending Automatic Ramping

Automatic ramping ends when any of the following situations occur:

1. **The user-specified time interval and the ending flow rate or pressure is reached.** When the user-specified time interval has elapsed and the ending flow rate, pressure or delta pressure is reached, the word "Auto" will disappear from the operating mode button on the main window. The pump cylinders will continue to run at the ending flow rate, pressure or delta pressure.

2. **The end ramping operation command is used**. Automatic ramping can be stopped part way through a ramp. In this case, the pump cylinder will maintain the flow rate or pressure it was operating at when automatic ramping was stopped. To stop an automatic ramping operation, do the following:

   - From the menu bar, select AutoOp | Set Up and Control Ramping Operation. Notice the status button displays On.
   - In the Set Up and Control Ramping Operation window, click on the On status button.

- A Ramping Operation Confirmation box appears asking: “Do you want to stop the ramping operation?”
- Click on Yes to stop the current ramping operation.

If you restart automatic ramping, the entire user-set ramp time is used to reach the ending flow rate, pressure or delta pressure. For example, if the user specified a 60 minute ramp time and stopped automatic ramping after 40 minutes, and then restarted automatic ramping, it will take one hour to reach the end point. If the user wants PumpWorks to take 20 minutes, the ramp time in the Set Up Ramping Operation window must be changed to 20 minutes.

3. **A pump cylinder is intentionally stopped.** Automatic ramping is cancelled when a pump cylinder is stopped by the user. Two ways a pump cylinder can be stopped are by clicking on the “push to stop” button on the main window or using the Start/Stop Pumps window accessed from the min menu.

4. **There is an Error Condition That Causes A Pump Cylinder To Stop**. The user must resolve the error, restart the pump cylinder, and then restart automatic ramping.

8.2 Set Up and Control Automatic Volume/Time Operation

The Automatic Volume/Time Operation option causes a pump cylinder or cylinder pair to stop pumping, automatically, after a user-set amount of fluid has been pumped or a user-set amount of time has elapsed. Each pump cylinder or cylinder pair can be set to a different volume or time operation, if desired.

During automatic volume/time operation, PumpWorks must be operating. Automatic operation cannot occur without communication between PumpWorks and the pump.

8.2.1 Setting Up a Volume/Time Operation

PumpWorks can be set to operate a pump cylinder or cylinder pair for a specific amount of time, or until a specific amount of fluid has been pumped.

From the menu bar, select AutoOp |Set Up and Control Automatic Volume/Time Operation and the window shown in Figure 8-7 appears.

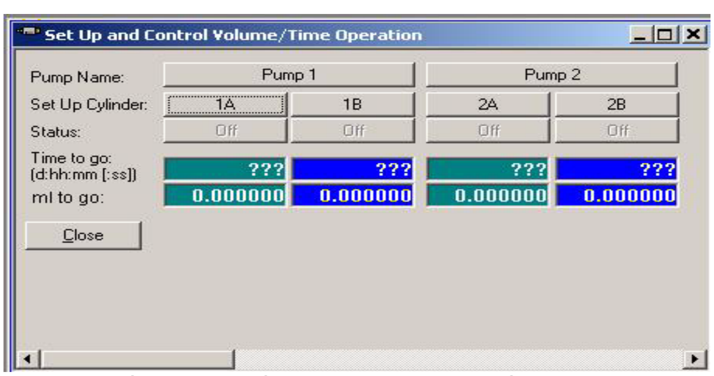


Figure 8-7 Set Up and Control Volume/Time Operation Window

To set up an automatic volume or time operation, do the following:

- From the Set Up and Control Volume/Time Operation window, click on the Set Up Cylinder button for the appropriate pump cylinder. If operating in a paired mode, click on the first pump cylinder of the pair (the other one will be grayed out). The settings you make will automatically apply to both pump cylinders in the pair. The Setup and Control Volume/Time Operation for Cylinder # window appears, as shown in Figure 8-8 below.

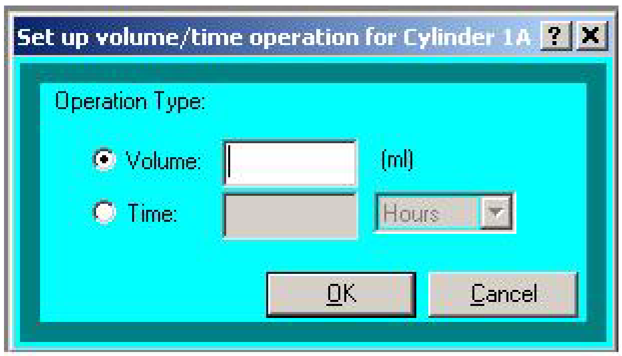


Figure 8-8 . Set Up Volume/Time Operation for Cylinder # Window

8.2.1.1 Volume Operation

If a volume operation is desired, do the following:

- Click on the Volume button.
- Click inside the white text box and enter the volume you wish to pump.
- When finished, click on OK to return to the Set Up and Control Volume/Time Operation window.

8.2.1.2 Time Operation

If a time operation is desired, do the following:

- Click on the Time button.
- Select the units of time in the combo box to the right of the time field. You can select between seconds, minutes, hours, or days. Then enter the desired time in the specified time units.
- When finished, click on OK to return to the Set Up and Control Volume/Time Operation window.

8.2.2 Starting a Volume/Time Operation

It is assumed at this point that the user has already set up a Volume/Time operation. (Refer to Setting Up a Volume/Time Operation, Section 8.2.1.)

- From the menu bar, select AutoOp | Set Up and Control Automatic Volume/Time Operation. Notice the status button displays Off.

- When you are ready to begin your volume or time operation, click on the Off status button. The Volume/Time Confirmation box shown in Figure 8-9 appears.

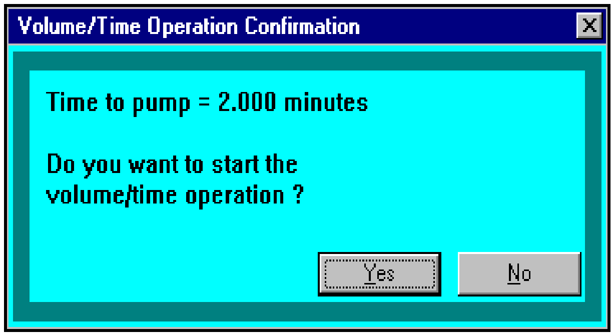


Figure 8-9 Volume/Time Operation Confirmation Window

- The Volume/Time Operation Confirmation window will display your operation settings. For example, “volume to pump = 3 ml” or “time to pump = 5 minutes”. “Do you want to start the volume/time operation?” will also be displayed.

- Click on Yes to start the operation immediately. The status button on the Set Up and Control Volume/Time Operation will immediately display “On”. Your operation has begun. Click on No to return to the previous window.

- If you chose a volume operation, the volume count displayed will decrease until the volume operation is completed.

- If you chose a time operation, the minutes displayed in the “minutes to go” box will decrease until the operation is completed.

The status button will display OFF when the operation is finished.

NOTE: Once the volume or time operation has begun, the user cannot make any changes to the volume or the time.

If a volume or time operation is stopped, and then restarted, the operation begins again at the beginning. For example, if 1 minute is scheduled for the timed operation and after 30 seconds it is stopped, when restarted the timed operation begins at 1 minute again.

NOTE: The Auto Volume/Time feature may not be turned on while updating software to the pump controller or front panel.

8.2.3 Ending Volume/Time Operation

There are only two reasons an automatic volume/time operation ends. They are:

1. **The volume or time that was set by the user is reached, so the operation ends**.

2. **The user stops the volume or time operation** by doing the following:

   - From the menu bar, select AutoOp | Set Up and Control Automatic Volume/Time Operation.
   - The status button will display ON. Click on the status button.
   - The Volume/Time Operation Confirmation window appears asking "Do you want to stop volume/time operation?" Click on Yes to stop the operation.

If a pump cylinder that is operating on automatic volume or time is stopped intentionally by the user, or due to an error condition, neither automatic volume nor automatic time operations are stopped. Both continue to count down. When the pump cylinders are restarted, if either automatic volume or time operations are still running, a warning is displayed.

8.3 Control Sequencer Operation

PumpWorks comes with a built-in feature called the Sequencer. A sequence is comprised of a series of program steps which can control a pump, pump system, or other PumpWorks internals. PumpWorks supports up to 20 concurrently running sequencers, and an unlimited number of configured sequences.

8.3.1 Understanding the Sequencer

A Sequencer allows for automatic control by setting up a group of steps which use "IF... THEN... ELSE" style logic, called the sequence. A sequence is written in a text editor program, such as Notepad, and saved in a text file. (The Notepad text editor comes with Windows Computer Operating Systems and is usually started from Start | Programs |Accessories | Notepad.)

A Sequencer is also capable of implementing tests on values to allow branching, including a test for the stability of a value, and can implement most commands that can be issued by the user via the PumpWorks user interface. Branching is when the computer jumps to a different step in the sequence.

8.3.2 Sequence Steps

A step is a single written line of a sequence. Each step includes tests for PumpWorks to evaluate and commands to execute if a test is passed. A sequence is a collection of all the steps needed to automatically perform the desired set of operations.

All sequence steps have the same format.

1. **Step Number** – The step number is used by the GOTO command and is also displayed in the Control Sequencer Operation window. Step numbers must be in order, such as, 1, 10, 20, 23, 25, 30, etc.

2. **Expression 1** – Each expression has the effect of saying "If Test 1 is true for a specified time period AND/OR Test 2 is true for a specified time period THEN execute a Command."
3. **Command 1** - Executed if Expression 1 is true.
4. **Expression 2** – This second expression is tested simultaneously with Expression 1. Whichever expression tests true first, only the command for that expression is executed.
5. **Command 2** - Executed if Expression 2 is true.
6. **Timeout** – The timeout command is executed if neither expression tests true within a specified amount of time.

In this section we will define the parts that make up one step of a sequence. While reading this section it will be useful if you refer to Table 8-1 which shows a step structure.

Step	Expression 1			Command 1	Expression 2		
	Test1		Test2		Test3		Test4
1,	CR11, =, 0, 2,	|,	CP12,%, 1, 3,	1:set_cyl1_on, 1,	0, <, 0, 0,	&,	0, <, 0, 0,

Command 2	Timeout
NULL, 0,	120, 1:set_cyl2_off, 0

Table 8-1. Sequencer Step Structure

The vertical lines in the step example, above, are for clarity only. When the actual step is written, it will look like the following:

1, CR11, =, 0, 2, |, CP12,%, 1, 3, 1:set_cyl1_on, 1, 0, <, 0, 0, &, 0, <, 0, 0, NULL, 0, 120, 1:set_cyl2_off, 0

Every sequence has the following structure:

step, param, cond, param, time, oper, param, cond, param, time, cmd, cmd_val, param, cond, param, time, oper, param, cond, param, time, cmd, cmd_val, timeout, cmd, cmd_val

8.3.2.1 Step Number (step)

A step number is the first item in a step. A step number is simply a number which is used to identify a specific line of the sequence. A step number is used by the GOTO command and is also displayed in the Sequencer dialog box.

Each successive step number must be higher than the previous step number. For example: 1, 20, 23, 25, 30 and so on. While step numbers must be higher than the previous step number, there can be gaps between numbers as in the example. This is so the programmer can return and add more steps in between without renumbering the entire sequence.

8.3.2.2 Expression 1

An expression comes immediately after the step number. There are three parts to an expression;

- the first test
- a test operator (oper)
- the second test

Every expression must include all three parts. An expression has the effect of saying “IF Test 1 is true for a specified time period AND/OR Test 2 is true for a specified time period THEN execute a Command.”

8.3.2.2.1 Test 1

A test consists of the following parts:

- Parameter (param)
- Condition Operator (cond)
- Parameter (param)
- Time (time)

- **Parameter (param):** The parameters which may be included in a sequence test include parameters relating to pressure, flow rate, volume, user-defined equations, timer values, and data from auxiliary devices such as analog input signals, digital input signals, and separators. For a complete list of parameters, refer to Figure 8-2. Parameters can be a part of the pump system being monitored, or a parameter can be a constant. For example, a number (0, 1, 2, 0.7 and so on) can be a parameter.

- **Condition Operator:** The condition operator is a mathematical symbol used to define the test. Condition operators include:

  “<” for less than,
  “>” for greater than,
  “=” for equal to,
  “<=” for less than or equal to,
  “>=” for greater than or equal to,
  “!=” for not equal to, and
  “%” for remains within the percentage range of.

- **Parameter (param):** Described above.

- **Time (time):** The user states an amount of time that the test condition must remain true in order to pass. Time is defined in seconds or in hh:mm:ss format. If time is set to 0, the test condition only needs to be met once.

8.3.2.2.2 Test Operator (Oper)

A test operator can be either “**AND**” or “**OR**”. The operator’s job is to tell:

- If both test 1 AND test 2 must be true, in which case "&" is used, or

- If either test 1 OR test 2 can be true, in which case the "(shift key + back slash key)" "|" is used.

8.3.2.2.3 Test 2

This is a second test which, like Test 1, consists of:

- Parameter (param)
- Condition (cond)
- Parameter (param)
- Time (time)

For more information, refer to Test 1 above.

8.3.2.3 Command 1

Command 1 actually consists of two parts, the command (cmd) and the command value (cmd val). Both are described below.

- **Command**: A command is an order that tells the Sequencer to perform an action. A command can be anything from an action performed on the pump to an order to pause, stop, go to a user-specified step number, call a subroutine, etc.

- **Command Value**: A command value is the number or value the command is instructed to utilize. For example, if the command is to set the flow rate, the command value is the number that represents the flow rate that is to be set. A sequence parameter (See Figure 8-2) may also be used as a command value if it is enclosed in square brackets.

8.3.2.4 Expression 2

Every step must have two expressions. Expression 2 is simply a second expression and must be written in the same format as expression 1. Expression 1 and expression 2 are tested by the Sequencer at the same time. The first expression that the Sequencer determines to be true is executed.

8.3.2.5 Command 2

Refer to Command 1, Section 8.3.2.3, for a description. Remember that only one command can be executed per step. For example, if expression 1 is found true before expression 2 is found true, then command 1 is executed. Command 2 will not be executed even if expression 2 is true.

8.3.2.6 Timeout

The timeout portion of each includes timeout period, command and command value.

- **Timeout period**: A value which is the length of the timeout period in seconds. This value can be specified as a constant value, or alternatively, any of the parameters listed in Figure 8-2 can be used if the symbol for the parameter is enclosed in brackets. (For example, [EQ1])

- **Command**: The timeout command which will execute when the timeout period has expired, if neither Expression 1 nor Expression 2 has been found true during the timeout period.
- **Command Value**: The value associated with the timeout command.

Both expressions in a sequence step are evaluated twenty times per second throughout the length of time specified as the timeout period. If either expression is true, then the associated command is executed and the sequence immediately moves on to the next step. If neither expression is true by the end of the timeout period, then the timeout command is executed and the Sequencer goes on to the next step. So, timeout is basically the user-specified amount of time the Sequencer has to evaluate and execute a sequence step before PumpWorks goes on to the next sequence step.

If the timeout is set to 0, no timeout will occur. In this case, the Sequencer will evaluate both expressions in a step for an unlimited amount of time until one of the expressions is true.

8.3.3 Sequencer Parameters (param)

The parameters that can be monitored are listed in Table 8-2. Each sequence step will include eight parameters; two in each test, four tests in a step. In addition to the parameters in this table, a parameter can also be a constant, such as 0, 1, 0.2, or any other number. Parameters may also be used as command values or timeout periods, if enclosed in square brackets (e.g. [EQ1]). All parameter values are in currently defined display units.

NOTE: While either style listed below can be used in the sequencer, “New Format Notatioin” is compatible with DDE definitions.

NOTE: Parameters listed below using the "New Format Notation" begin by specifying the pump number. This pump number (designated in the table below by "u" can be a constant number (1-8), or can be specified by a sequence parameter itself (listed in Table 8-2 below) enclosed in square brackets.

Parameter	Old Style	New Format Notation
Current Pressure	CP**uc**	**u**:RAW_PRESS**c**
Output Pressure (used in paired modes)	OP**uc**	**u:**OUTPUT_PRESS
Set Pressure	RP**uc**	**u**:CYL**c**_SET_PRESS
Safety Pressure	SP**uc**	**u**:CYL**c**_SAFE_PRESS
Current Flow Rate	CR**uc**	**u**:CYL**c**_R_DATA
Output Flow Rate (used in paired modes)	OR**uc**	**u**:OUTPUT_RATE
Set Flow Rate	RR**uc**	**u**:CYL**c**_SET_RATE

Current Cylinder Volume	CV**uc**	**u**:CURR_VOL**c**
Current Cumulative Volume	CCV**u**	**u**:CUMUL_VOL1_2
Auto-Volume status of controller	VOLSTAT**uc**	**u**:VOLSTAT**c**
Cylinder Run Status	RUN**uc**	**u**:CYL_RUN**c**
Max Extend	MAXEXT**uc**	**u**:MAXEXT**c**
Max Retract	MAXRET**uc**	**u**:MAXRET**c**
Error Status	Cyl_ERR**uc**	**u**:CYL_ERR**c**
Start Error Status	CYL_START-ERR**uc**	**u**:SYL_START_ERR**c**
Direction	DIR**uc**	**u**:DIR**c**
Retract Trigger	RET_TRIG**uc**	**u**:RET_TRIG**c**
Retract Limit	RET_LIM**uc**	**u**:RET_LIM**c**
Extend Trigger	EXT_TRIG**uc**	**u**:EXT_TRIG**c**
Extend Limit	EXT_LIM**uc**	**u**:EXT_LIM**c**
Cylinder Position	CYL_POS**uc**	**u**:CYL_POS**c**
Operating Mode	MODE**uc**	**u**:MODE**c**
Minimum Pressure	PRESS_MIN**uc**	**u**:PRESS_MIN**c**
Maximum Pressure	PRESS_MAX**uc**	**u**:PRESS_MAX**c**
Minimum Rate	RATE_MIN**uc**	**u**:RATE_MIN**c**
Maximum Rate	RATE_MAX**uc**	**u**:RATE_MAX**c**
Max Press for Rate Mode	USER_PRESS_MAX**uc**	**u**:USER_PRESS_MAX**c**
Max Rate for Press Mode	USER_RATE_MAX**uc**	**u**:USER_RATE_MAX**c**
Deliver Valve Status	DEL VALVE**uc**	**u**:DEL_VALVE**c**
Fill Valve Status	FILL_VALVE**uc**	**u**:FILL_VALVE**c**
Fill Valve Pressure Threshold	FILL_VALVE_PRESS_THRESH**u**	**u**:FILL_VALVE_PRESS_THRESH
Return Rate Minimum	RET_RATE_MIN**uc**	**u**:RET_RATE_MIN**c**
Return Rate Multiplier	RET_RATE_MULT**uc**	**u**:RET_RATE_MULT**c**
Proportional Servo Gain (Open Valve)	PROP_GAIN**uc**	**u**:PROP_GAIN**c**
Proportional Servo Gain (Closed Valve)	PROP_CV_GAIN**uc**	**u**:PROP_CV_GAIN**c**
Differential Servo Gain (Open Valve)	DIFF_GAIN**uc**	**u**:DIFF_GAIN**c**

Differential Servo Gain (Closed Valve)	DIFF_CV_GAIN**uc**	**u:**DIFF_CV_GAIN**c**
Emergency Stop	ESTOP**u**	**u:**ESTOP
Normal Stop	NSTOP**u**	**u:**NSTOP
Current Back Pressure Regulator Set Pressure	BPR	9:CYL1_SET_PRESS
Current Auxiliary A/D Values	AUX**a**	9:RAW_AD**a**
Current Auxiliary Valves	AUXVALVE**x**	9:AUXVALVE**x**
Current Digital Input Values	DIG**d**	9:DIG_INP**d**
Current Digital Outputs	DIGOUT**o**	9:DIGOUT**o**
Current Separator **s** absolute volume	ABS**s**	
Current Separator **s** relative volume	REL**s**	
Current Separator **s** fluid velocity	VEL**s**	
User Defined Data Logging Equations	EQ**e**	
Timer Value (in seconds)	T**t**	
Pi Constant	PI	
Variable	VAR**v**	
Notes: **a** = Auxiliary analog input number (1 – 48) **c** = Pump cylinder number enter “1” for pump cylinder A enter “2” for pump cylinder B **d** = Digital input number (1 - 32) **e** = Equation number (1-16) **o** = Digital output number (1-16) **s** = Separator number (1 - 2) **t** = Timer number (1 - 4) **u** = Pump number (1 – 8) **v** = Variable number (1 - 16) **x** = Auxiliary valve number (1-96)	All parameters which are “current. . .” can be preceded by an “A” to use the time averaged value. (Time averaging is discussed in other documentation.) Time averaging of PI, timers, or variables is not currently supported.	

Table 8-2. Sequence Parameters

NOTE: The value of any of the parameters listed in Table 8-2 may be used as a command value (the number following the comma in the command) or a timeout value by enclosing the symbol for the parameter in square brackets. For example, 1:SET_PRESS1, [AUX12] would set pressure for pump1, cylinder 1 to the current value of AUX12.

8.3.4 Understanding Sequencer Commands (cmd)

A command is an order that tells the Sequencer to perform an action. A sequencer command can control a pump or various PumpWorks internals, including control of the sequencer itself.

Commands must be written in a specific manner and must be followed by a command value. A command value is the number utilized by the command. For example, if the command is to set the flow rate, the command value is the number that represents the flow rate that is to be set. Parameters, as listed in Table 8-2, can also be used as command values if the symbol for the parameter is enclosed in brackets.

Commands that can be used in a sequence, and a description of what they do, are listed below. For each command listed, the variable(s) are shown in boldface type. There are two categories of commands:

- User Interface Commands, Section 8.3.4.1
- Pump Operation Commands - Main Window and Main Menu Equivalents, Section 8.3.4.2

8.3.4.1 User Interface Commands

The commands listed in this section have to do with PumpWorks only, and do not relate directly to the pumps. These are commands in which the user is causing PumpWorks or the Sequencer itself to do something, for example, to change the interval at which PumpWorks logs data into the data log, or to start or stop a timer, or to pause or resume a sequence, etc.

Because all commands must be followed by a command value, note that zero (0) is used as a place holder for the command value in several of these commands.

DATALOG, **i**	Changes the log interval to **i** minutes per record. The log interval, **i,** can range from a minimum of 0.017 minutes (1 second) to a maximum of 9999 minutes.
GOTO,**[f:]s**	Jumps to another step number(**s)** and continues evaluating steps from there on. User can optionally specify a filename (**f**) in which to locate the step.
NULL, 0	Does nothing except go to the next sequence step.
PAUSE, 0	Pauses the Sequencer, which means the Sequencer steps will stop being evaluated or executed. The user can resume Sequencer operation on that step by pressing the Sequencer "Resume" button.
STOP, 0	Stops the Sequencer, but not the pumps. This is the same as pressing the Sequencer "Stop" button.
TIMER_START**, t**	Starts or resets the timer.
TIMER_STOP, **t**	Stops the timer. (Does not reset the value.)
SET_VAR**v,val**	Sets variable **v** to value **val**.

ADD_VAR**v**, **val**	Adds **val** to value of variable **v**.
SUB_VAR**v**, **val**	Subtracts **val** from value of variable **v**.
MULT_VAR**v**, **val**	Multiplies **val** times value of variable **v**.
DIV_VAR**v**, **val**	Divides value of variable **v** by **val**.
SUBROUTINE, **fs**	Calls a subroutine found in a file named **f**, starting at step number **s**. The file name should not include any path/directory information, and may include an extension, but one is not required. If the filename with no extension is not found, the same filename, with a ".txt" extension, is searched for. All subroutine files must reside in the same directory as the main sequence file.
INT_VAR**v, va**l	Sets variable **v** to the integer (truncated) value of variable **v** (ignores the command value **val**)
MOD_VARv,**val**	Sets variable **v** to the result of "variable **v** % **val**" (modulo function)
RETURN, 0	Returns from a subroutine call.
SET_SEQ_ERROR,**val**	Pops up an error message with the error text corresponding to the error code specified by **val**

Table 8-3. User Interface Commands

8.3.4.2 Pump Operating Commands

The commands in this section are used to control the pumps. Most of the commands in this group relate to functions or controls that can be accessed from the windows under the main menu, AutoOp menu, Configure menu, or Other menu of PumpWorks. Each of these commands is the equivalent of the user changing some aspect of pump operation from one of the listed menus/windows.

Note: All pump operation commands begin by specifying the pump number. This pump number (designated in the table below by "**u**") can be a constant number (1-8), or can be specified by a sequence parameter (please refer to Table 8-2) enclosed in square brackets.

u:RESET**z**, 0	This command resets the cylinder volume to zero. Replace **u** with a pump number. Replace **z** with: • "1" to reset pump cylinder A's cylinder volume to zero. • "2" to reset pump cylinder B's cylinder volume to zero. • "12" to reset pump cylinders A & B's cumulative volume to zero.
u:RESET_ALL, 0	Resets cylinders A, B, and cumulative volume to zero for pump **u.**
u:SET_CYL**c**_ON, 1	Starts a pump cylinder. This command has the same effect as pushing the start button on the main window. Replace **u** with a pump number. Replace **c** with a pump cylinder number.

u:SET_CYL**c**_OFF, 0	Stops a pump cylinder. This command has the same effect as pushing the stop button on the main window. Replace **u** with a pump number. Replace **c** with a pump cylinder number.
u:SET_DIR**c**, **d**	Changes the direction of the pump cylinder. This command has the same effect as pushing the Extend/Retract button on the main window. Usually, the direction cannot be changed unless the pump cylinder is stopped. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The direction is represented by **d.** Replace **d** with: • "1" for extend • "2" for retract.
u:SET_MODE**c**, **m**	Changes the operating mode. This command has the same effect as selecting a mode on the main window. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The operating mode is represented by **m**. Replace **m** with an operating mode number (sometimes followed by a letter). This number / number & letter is listed next to the operating mode description on the set operating mode window.
u: SET_DP_CHAN**c**, **s**	Sets the pressure source for delta pressure modes. This command has the same effect as selecting the delta pressure source in PumpWorks after a delta pressure mode has been selected. Replace **u** with a pump number. Replace **c** with a pump cylinder number. Replace the **s** with the auxiliary analog signal channel number (1-4) associated with the specified pump.
u:SET_PRESS**c**, **p**	Changes the set pressure. This command has the same effect as entering a set pressure on the main menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The set pressure is represented by a **p**. Replace **p** with a valid set pressure in the user-set unit of measure (PSI, mbar, kiloPascal, etc.).
u:SET_RATE**c**, **r**	Changes the set rate on pump **u**, pump cylinder **c** to rate **r**. The rate, **r**, is any valid rate in the current units (ml/min or ml/hour). This command has the same effect as typing in a set rate on the main window. Replace **u** with a pump number. Replace **c** with a pump cylinder number. Replace **r** with a flow rate, which must be in the user-set unit of measure (ml/min or ml/hour).

u:SET_SAF_PRESS**c**, **p**	Changes the safety pressure. This command has the same effect as using the set pump safety pressure window on the main menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The safety pressure is represented by **p**. Replace **p** with a valid safety pressure in the user-specified unit of measure (PSI, mbar, kiloPascal, etc.).
u:SET_VALVE**v**_ON, 1	Opens a valve. This command has the same effect as clicking on a closed valve button on the main window. Replace **u** with a pump number. The valve is represented by **v**. Replace **v** with: • “1” for the fill valve on pump cylinder A. • “2” for the deliver valve on pump cylinder A. • “3” for the fill valve on pump cylinder B. • “4” for the deliver valve on pump cylinder B.
u:SET_VALVE**v**_OFF, 0	Closes a valve. This command has the same effect as clicking on an opened valve button on the main window. Replace **u** with a pump number. The valve is represented by **v**. Replace **v** with: • “1” for the fill valve on pump cylinder A. • “2” for the deliver valve on pump cylinder A. • “3” for the fill valve on pump cylinder B. • “4” for the deliver valve on pump cylinder B.
9:SET_A_VALVE_ON, **v**	Opens the auxiliary valve **v**. The valve, **v**, is determined in the Set Up Resource Mapping | Auxiliary Valves window. This command has the same effect as clicking on the “Closed” button on the Auxiliary Valves window. (See the documentation on the User Interface Connector for your specific model of controller for instructions on how to properly wire in an auxiliary valve.) Replace **v** with a number from 1 - 96 to specify the valve to open.
9:SET_A_VALVE_OFF, **v**	Closes the auxiliary valve **v**. The valve, **v**, is determined in the Set Up Resource Mapping | Auxiliary Valves window. This command has the same effect as clicking on the “Open” button on the Auxiliary Valves window. Replace **v** with a number from 1 - 96 to specify the valve to close.
u:SET_MINc, **r**	Changes the return rate minimum. This command has the same effect as changing the return rate minimum in the Set Up Pump Operating Parameters window on the Configure Menu. Replace **u** with a pump number. Change **c** to a pump cylinder number. The return rate minimum is represented by **r**. Replace **r** with a valid return rate minimum in the user-specified unit of measure (ml/min or ml/hour). Refer to Chapter 12, Section 12.2.4 for more information about the return rate minimum.

u:SET_MULT**c**, **x**	Changes the piston return rate multiplier. This command has the same effect as changing the Piston Return Rate Multiplier in the Set Up Pump Operating Parameters window on the Configure Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The piston return rate multiplier is represented by **x**. Change **x** to a valid piston return rate multiplier, which is a number from 1.0 to 2.99. Refer to Chapter 12, Section 12.2.3 for more information about the piston return rate multiplier.
u:SET_P_S_GAIN**c**, **g**	Changes the proportional servo gain for an open valve. This command has the same effect as changing the proportional servo gain for an open valve in the Set Up Pressure Control window on the Configure Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The proportional gain is represented by **g**. Replace **g** with an integer between 0 and 65535. Refer to Chapter 12, Section 12.3.1 for more information about proportional gain.
u:SET_D_S_GAIN**c**, **g**	Changes the differential servo gain for an open valve. This command has the same effect as changing the differential servo gain for an open valve in the Set Up Pressure Control window on the Configure Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The differential gain is represented by **g.** Replace **g** with an integer between 0 and 65535. Refer to Chapter 12, Section 12.3.1 for more information about differential gain.
u:SET_P_S_GAIN_CV**c, g**	Changes the proportional servo gain for a closed valve. This command has the same effect as changing the proportional servo gain for a closed valve in the Set Up Pressure Control window on the Configure Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The proportional gain is represented by **g.** Replace **g** with an integer between 0 and 65535. Refer to Chapter 12, Section 12.3.1 for more information about proportional gain.
u:SET_D_S_GAIN_CV**c**, **g**	Changes the differential servo gain for a closed valve. This command has the same effect as changing the differential servo gain for a closed valve in the Set Up Pressure Control window on the Configure Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The differential gain is represented by **g.** Replace **g** with an integer between 0 and 65535. Refer to Chapter 12, Section 12.3.1 for more information about differential gain.

u:SET_FILL_VALVE_ THRESHOLD, **p**	Sets the fill valve pressure threshold for pump **u** to **p**. This command has the same effect as changing the fill valve pressure threshold in the Set Up Operating Parameters window on the Configure Menu. Replace **u** with the pump number (1 - 8). Replace **p** with the desired fill valve pressure threshold, in the user specified unit of measure. Refer to Chapter 12, Section 12.2.12 for more information about the fill valve pressure threshold.
u:SET_CALI_OFF**c**, **o**	Changes the pressure calibration offset. This command has the same effect as setting the pressure transducer calibration offset in the Software Pressure Transducer Calibration window on the Other Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The pressure calibration offset is represented by **o**. Replace **o** with a valid pressure offset number in the user-specified unit of measure (PSI, mbar, kilopascal, etc.).
u:CLR_CALI_OFF**c**, 0	Clears the pressure calibration offset. This command has the same effect as setting the current offset to zero in the Software Pressure Transducer Calibration window on the Other Menu. Replace **u** with a pump number. Replace **c** with a pump cylinder number. The pressure calibration offset will be reset to 0 (zero).
u:SET_CALI_PRES**c**, **p**	Sends the current "known pressure" **p** for pump cylinder **c** to pump **u**, so that the pump controller can calculate the appropriate calibration gain. This command has the same effect as entering the Known Pressure in the Change Transducer Gain window, under the Other | Software Pressure Transducer Calibration window. Replace **u** with the pump number (1 - 8), **c** with the cylinder number (1 or 2), and **p** with the known pressure, in the user specified unit of measure. Refer to Chapter 9, Section 9.1.3 for more information on setting transducer calibration gains.
u:RAMP,**c**; **a**; **mt**; **r**; **v** [;**s**]	Starts / Stops ramping operation for pump unit **u**, pump cylinder **c**. When **a** is "OFF" ramping is stopped. (All following parameters, if present, are ignored - they do not have to be there.) When **a** is "ON", **mt** specifies the mode type (1= Constant rate, 2 = Constant pressure, 3 = Delta pressure), **r** specifies ramp time (in minutes), and **v** specifies end value in current units. The user can optionally specify the start value [**s**] in current units, as well. If the start value is not specified in this command, the current set value is used as the start value. **WARNING**: If a command has just been sent to set the rate or pressure of pump cylinder, it may not be reflected in the "current" set value by the time ramping starts. It is much safer to specify the start value if it is a known value.

u:SET_VOLUME_PAUSE**c**, **v**	Sends a command to pump **u** to cause cylinder **c** to pump a specified volume **v** (in current units) before setting the flow rate to 0. This command is only valid for versions 57.23 or later for QL pumps, and version 57.24 or later for QX, CMD, or CN series pumps. To use this command, the pump cylinder must be in an independent mode, and it must be currently running.
u:SET_RATE_VOL**c**, **r**; **v**	Sends a command to pump **u** to cause cylinder **c** to pump a specified volume **v** at a specified flow rate **r** (both in current units) before setting the flow rate to 0. This command is only valid for versions 57.23 or later for QL pumps, and version 57.24 or later for QX, CMD, or CN series pumps.
u:SET_RATE_TIME**c**, **r**; **s**	Sends a command to pump **u** to cause cylinder **c** to pump at a specified flow rate **r** (in current units) for a specified number of seconds **s** before setting the flow rate to 0. This command is only valid for versions 57.23 or later for QL pumps, and version 57.24 or later for QX, CMD, or CN series pumps.
u:SET_VOLUME_STOP**c**, **v**	Sends a command to pump **u** to cause the "automatic volume" status of cylinder c to be on, and sets up the set amount of volume to pump to **v** (in current units). The cylinder must not be running when this command is sent and it must be in an independent mode. Once the SET_CYL**c**_ONV command is received, the set volume (**v**) will be pumped, and then the cylinder will be stopped. This command is only valid for versions 57.23 or later for QL pumps, and version 57.24 or later for QX, CMD, or CN series pumps.
u:SET_CYL**c**_ONV, 1	Sends a command to pump **u** to start cylinder **c**, and then stop it after a set volume of fluid is pumped (set by the SET_VOLUME_STOP**c** command). This command is only valid for versions 57.23 or later for QL pumps, and version 57.24 or later for QX, CMD, or CN series pumps. To use this command, the pump cylinder must be in an independent mode, and the SET_VOLUME_STOP command must have been previously sent.

u:RAMP_VOL, **c**; **a**; **mt**; **r**; **v** [;**s**]	Starts/Stops ramping operation for Pump **u**, Cylinder **c,** but first sends a SET_VOL command to the controller to set the rate to 0 when ramping has been completed. When **a** is “OFF” ramping is stopped. (All following parameters, if present, are ignored – they do not have to be there.) When **a** is “ON”, **mt** specifies the mode type (1 = Constant rate, 2 = Constant pressure, 3 = Delta pressure), **r** specifies ramp time (in minutes), **v** specifies end value in current units, and **s** specifies the start value in current units. If the start value is not specified in this command, the current set value is used as the start value. **WARNING:** If a command has just been sent to set the rate or pressure of a cylinder, it may not be reflected in the “current” set value by the time ramping starts. It is much safer to specify the start value if it is a known value. The difference between this command and the RAMP command, is that the cylinder flow rate is set to 0 after ramping has been completed.
u:AUTOVOL,**c;a;v**	Starts/Stops the automatic volume operation for Pump **u**, Cylinder **c**. Using this command is analogous to using the automatic volume operation from the Auto menu in PumpWorks. When "**a**" is "OFF" the automatic volume operation is stopped. (If the command is stopping auto volume operation, the v parameter, if present, is ignored - it does not have to be there.) When "**a**" is "ON", "**v**" specifies the volume to pump, in current units.
u:R,0	Resets the separator volumes for separator **u** (1 or 2). The command value is ignored, but some value needs to be there as a place holder.
u:SET_SMART_START, **s**	Sets the smart start status for pump **u** to status **s** (1-on 0-off).
u:SET_DEPRESS,**t**	Sets the depressurization time for pump **u** to **t** seconds.

Table 8-4.Pump Operation Commands

8.3.5 Writing a Sequence Step

When writing a sequence step, it is important to use the correct step format (step number, expression 1, expression 2, and timeout). It is equally important to follow the rules described below.

1. Each part of the step is separated by a comma “,”.

2. All parts of the step must be present, even if they are not going to be used.

   For example, expression 1 and expression 2 must be present, even if only one expression is needed for the desired sequence. Tests which are never true (0, >, 0,) can be used to prevent an expression from executing. Tests which are always true, (0, =, 0,) can be used to cause an expression to execute right away. The NULL command can also be used to cause the Sequencer to do nothing except go to the next step.

3. Each step can execute only one command.

   Although each step has Command 1 and Command 2, either the command associated with Expression 1, or the command associated with Expression 2, or Timeout, will execute. Only one command will execute from any one step. If multiple commands are needed to accomplish the task you desire to perform, you will need multiple steps.

4. The A Sequencer will evaluate the current step of a sequence twenty times per second.

   - The Sequencer will evaluate expression 1 and expression 2 at the same time. The command associated with the first expression which is evaluated to be true will be the commnd that is executed.

   - When an expression is true, the Sequencer will immediately issue the command associated with that expression, and then immediately evaluate the next sequence step.

   - If neither expression is true, the Sequencer will continue to evaluate both expressions twenty times per second for the length of time specified as the timeout period, or until one of the expressions is true, whichever comes first. At the end of the timeout period, if neither expression is true, the timeout command is executed, and the Sequencer immediately evaluates the next sequence step.

   - When several consecutive steps with true expressions occur, they will execute as fast as the Sequencer can process them.

5. The pressure, volume, and flow rate units used by the Sequencer are those which the user set in PumpWorks. Be sure to set the same unit of measurement for pressure (PSI, mbar, kiloPascal, etc.), flow rate (ml/hr, ml/min or ul/min), and volume (Liter, ml, or ul) in PumpWorks that the sequence being utilized was written for. If you plan to use the Sequencer often, it is advised to establish a set of units early, and never change them. If you are running the pump system with a different unit of measurement than that used in a sequence, the sequence will **NOT** perform the necessary conversions and the sequence will **NOT** perform as intended.

6. Changing the decimal places (number of digits after the decimal point) does not affect any Sequencer test or command.

7. Any line within the sequence file which begins with a “#” will not be executed. Use this feature to write remarks within the sequence text file.

8.3.6 Step Examples

Now that we understand a step structure better, let’s review our example of a step structure, which is shown below, and figure out what task the step structure was written to perform.

8.3.6.1 Sequence Step Example 1

1, CR11, =, 0, 2, |, CP12,%, 1, 3, 1:set_cyl1_on, 1, 0, <, 0, 0, &, 0, <, 0, 0, NULL, 0, 120, 1:set_cyl2_off, 0

In the sequence step example above, the following is written:

- 1 The step number is 1
- CR11 Test 1 passes when the Current Rate (CR) of pump number 1, pump cylinder A
- = equals
- 0, 2, zero for at least two seconds.
- | The operator is "or", so if either Test 1 or Test 2 pass then Command 1 will execute.
- CP12 Test 2 passes when the Current Pressure of pump number 1, pump cylinder B
- %, 1, 3 remains within a 1% stability range for at least 3 seconds.
- 1:set_cyl1_on, 0, Command 1 directs that pump number 1, cylinder A be set to ON, or started.
- 0< 0, 0, Test 3 and Test 4 are always false, so they will never pass and Command 2 will never execute.
- 120, 1:set_cyl2_off, 0, After the timeout period of 120 seconds has passed (and neither Test 1 nor Test 2 is true before the 120 seconds is over), the timeout command will execute (causing pump number 1, pump cylinder B, to stop).

8.3.6.2 Step Example 2: Immediate Command Execution

To create a step that executes a command right away:
step, 0, =, 0, 0, &, 0, =, 0, 0, *cmd*, *cmd value*, 0, >, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
This step executes *cmd* and evaluates the next step immediately.

8.3.6.3 Step Example 3: Time Delay

To insert a time delay step:
step, 0, =, 0, *time*, &, 0, =, 0, 0, NULL, 0, 0, >, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
This step will wait until *time* seconds have passed and then go to the next step.

8.3.7 Reporting Errors In a Sequence

The Sequencer command SET_SEQ_ERROR allows the reporting of errors, via a pop up message, within the sequence logic. The error text displayed is based on the error code given in the command value, and is specified in the sequence file BEFORE any sequence steps, as follows:

[SequenceErrors]

ErrorText1=User specified Error message 1
ErrorText2=User specified Error message 2
ErrorText3=User specified Error message 3
.
.
.
START_SEQUENCE:

The "START SEQUENCE:" line must follow the error text specifications, and immediately precede the first actual sequence step.

When the Sequencer executes the SET_SEQ_ERROR command, it causes PumpWorks to pop up an error message with the error text specified in the beginning of the sequence file corresponding to the error code in the command value.

8.3.8 Sequence Examples

Following are two sequences, to serve as examples.

8.3.8.1 Sequence Example 1

Example1
Opens and closes fill valve on pump 1, cylinder B if pressure less than 100 (PSI)
Sequence designed for pressure units of PSI. Rate and volume units not used.
#
Stop Pump 1, cylinder B
1, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_CYL2_OFF, 0, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
If current pressure of pump 1, cylinder B is less than 100 (PSI) for 3 seconds, open fill valve
Otherwise, timeout in 4 seconds and do nothing (move to next line).
10, CP12, <, 100.0, 3, &, 0, =, 0, 0, 1:SET_VALVE3_ON, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 4, NULL, 0
Wait 3 seconds and then close pump 1, cylinder B fill valve
50, 0, =, 0, 3, |, 0, <, 0, 0, 1:SET_VALVE3_OFF, 0, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
End of sequence
100, 0, =, 0, 0, |, 0, <, 0, 0, STOP, 0, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0

8.3.8.2 Sequence Example 2

Example2
Extends pump 1, cylinder A until it stops, then retracts it again.
Designed for rate units of ml/min. Pressure and volume units not used.
#
Stop pump 1, cylinder A
1, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_CYL1_OFF, 0, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Wait at least half a second to give the pump cylinder time to ramp down and stop.
10, 0, =, 0, 0.5, |, 0, <, 0, 0, NULL, 0, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Open fill valve on pump 1, Cyl A
50, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_VALVE1_ON, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Change mode on pump 1, cyl A to mode 1, independent constant rate
100, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_MODE1, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0

Set direction to extend
110, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_DIR1, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Set rate to 5.5 (ml/min)
120, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_RATE1, 5.5, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Start pump 1, Cyl A
130, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_CYL1_ON, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Wait until pump 1, cylinder A current rate is zero for three seconds, then stop pump cylinder
It is probably already stopped, but it might have been set to run at a rate of 0.0 ml/min
200, CR11, =, 0.0, 3, |, 0, <, 0, 0, 1:SET_CYL1_OFF, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Set direction to retract
210, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_DIR1, 2, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
Start Pump 1, Cyl A
220, 0, =, 0, 0, |, 0, <, 0, 0, 1:SET_CYL1_ON, 1, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0
End of sequence
1000, 0, =, 0, 0, |, 0, <, 0, 0, STOP, 0, 0, <, 0, 0, &, 0, >, 0, 0, NULL, 0, 0, NULL, 0

8.3.9 Setting Up a Sequence

After the user has written one or more sequences, the sequences must be "Set Up" in PumpWorks before they may be run. "Setting Up" a sequence entails associating a sequence filename with a meaningful user-specified name. To set up a sequence:

:

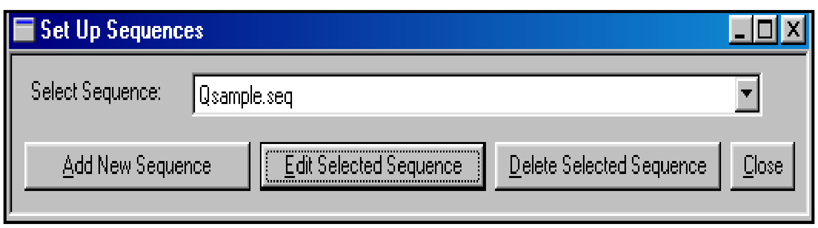


Figure 8-10 Set Up Sequences Window

- From the menu bar, select Configure | Set Up Sequences and the Set Up Sequences window appears. (Refer to Figure 8-10.)

- Click on Add to add a new sequence, Edit to change the name or filename of a previously set up sequence, or Delete to delete the configured sequence. (NOTE: Clicking the Delete button will only remove the sequence from the PumpWorks "configuration". The actual sequence file will still exist and can be used in other configurations, or in the future.)

- If Add New Sequence was clicked, select the desired sequence filename. Please refer to the boxed note in Chapter 2, Section 2.2 for an explanation about the shared documents directory and a warning about locating files outside of this directory tree.

- In the Set Up Sequence dialog box, enter the desired name to be associated with that sequence. (This is the name that will be shown in the Control Sequencer Operation window.)

•Click on OK to save the Set Up.

8.3.10 Starting a Sequencer

It is assumed, at this point, that the user has already written a sequence. (Refer to Writing a Sequence Step, Section 8.3.5.) It is also assumed that the user has set up a sequence. (Refer to Setting Up a Sequence, Section 8.3.9.)

Up to 20 sequencers can be run concurrently. To start a sequence, from the menu bar, select AutoOp | Control Sequencer Operation | Sequencer X, where X is 1-20, depending on which sequencer you want to start/control. One of the two windows shown below (Figure 8-11 or Figure 8-12) appears, depending on the set up in Configure | System Settings.

Figure 8-11 Control Sequencer Operation Window for Basic Users

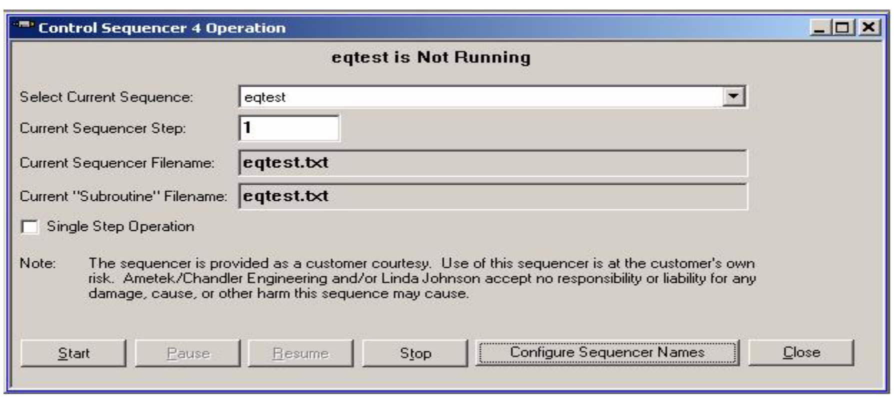


Figure 8-12 Control Sequencer Operation Window for Advanced Users

- In the Control Sequencer Operation window, click in the Select Current Sequence text box and select a sequence name.
- If the Sequencer has been set up for advanced users, in the Current Sequence Step box, enter the step you want the sequence to begin with when it is started.
- Click on Start and the sequence will load and run.

NOTE: Sequencers may not be started while updating software to any pump controllers or front panels.

NOTE: The Control Sequencer Operation windows may also be opened by clicking on the Sequencer status button in the status bar. Only Control Sequencer Operation windows for currently running/paused sequencers will be opened.

8.3.11 Pausing a Sequence

While a sequence is running, the Pause button is available on the Control Sequencer Operation windows. To pause a sequence:

- If the desired Control Sequencer Operation window is not already open, from the menu bar, select AutoOp | Control Sequencer Operation | Sequencer X.
- Click on Pause.

When a sequence is paused, the evaluations are no longer made on the sequence selected for that sequencer. (However, any other running sequencers continue to operate as normal.) When Sequencer is resumed, sequence step evaluations continue, starting with the step the Sequencer was evaluating when it was paused. This “Current Sequencer Step” is displayed and can be edited in the “Advanced” Control Seqencer Operation windows, but is not displayed if the “Basic” Sequencer user level has been selected. You can choose advanced or basic in the Configure | System Settings window. For more information, refer to Chapter 12, Section 12.16.

8.3.12 Resuming a Sequence

While a sequence is in the pause mode, the Resume button is available on the Control Sequencer Operation windows. To resume a sequence:

- If the desired Control Sequencers Operation window is not already open, from the menu bar, select AutoOp | Control Sequencers Operation | Sequencer X.
- Click on Resume.

When a sequence is paused, the evaluations are no longer made on the sequence selected for that sequencer. (However, any other running sequencers continue to operate as normal.) When Sequencer is resumed, sequence step evaluations continue, starting with the step the Sequencer was evaluating when it was paused. This “Current Sequencer Step” is displayed, and can be edited, in the advanced Control Sequencer Operations windows, but is not displayed if the basic Sequencer User level has been selected. You can choose advanced or basic in the Configure | System Settings window. For more information, refer to Chapter 12, Section 12.16. The user can also change the current sequence step before resuming, if they want to resume with a different step.

NOTE: Sequencers may not be resumed while updating software to any pump controllers or front panels.

8.3.13 Ending a Sequence

To end a sequence, do the following:

- If the desired Control Sequencer Operation window is not already open, from the menu bar, select AutoOp | Control Sequencer Operation | Sequencer X..

- Click on the Stop button.

If any of the Sequencers are running, the status bar of the main window reads Sequencer - ON, and is yellow. If all sequencers are stopped, the status bar of the main window reads Sequencer - OFF, and is gray.

8.3.14 Single Stepping the Sequence

Single stepping through a sequence (causing the sequencer to pause after the execution of each sequence step) can be a useful way to debug a sequence, as well as add user control to the operation of the sequence. To operate the sequencer in the single step mode, click on the single step check box in the Control Sequencer Operation window until the box is checked, and click on start. Click on the Resume button each time the next step is to be executed. If at any point you wish to run in normal mode, click on the single step check box to uncheck it, and then click on the Resume button.

8.4 Scheduler

The PumpWorks Scheduler feature allows the user to automatically execute a series of ramping commands to be executed at specified times (times relative to the time the user starts the schedule).

A "schedule" is made up of several ramping commands, each command specifying a starting ramp value (rate or pressure), and ending ramp values, and a ramp time (the time it will take to ramp from the starting ramp value to the ending ramp value).

A schedule can be set up and run for multiple cylinders at once, and starting schedules can be "synchronized" to start or stop schedules for multiple cylinders at the same time.

Schedules can also be set up to "loop" or repeat themselves until explicitly stopped by the user.

CAUTION: Ramping values are saved as absolute values and are interpreted in current display units at the time the schedules are run. If you change display units (for example, from PSI to bar) after a schedule has been created, you should edit that schedule to ensure the desired behavior.

8.4.1 Setting Up Schedules

Before selecting and executing a schedule, it must be configured to do the desired ramping operations. To set up a schedule, do the following:

- From the menu bar, select AutoOp | Set Up Schedules. The Set Up Schedules window shown in Figure 8-13 opens.

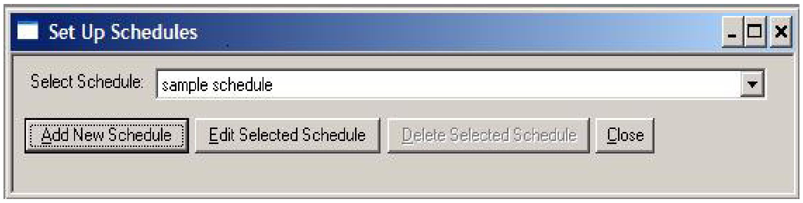


Figure 8-13 Set Up Schedule Window

A new schedule can now be created (added), or if there are previously set up schedules, they can now be edited or deleted following the directions in Chapter 8, Section 8.4.1.1 through Chapter 8, Section 8.4.1.3.

NOTE: If an existing schedule is currently being executed, it cannot be edited or deleted. (Clicking on the Edit button will allow the user to view the schedule, but not make any changes to it.)

After all of the desired schedules have been set up, close the Schedule Set Up window, by clicking on the Close button.

8.4.1.1 Adding a New Schedule

To create a new schedule, do the following:

From the Set Up Schedules window (shown in Figure 8-13), click on the Add new Schedule button. The Add/Edit Schedule window shown in Figure 8-14 will open.

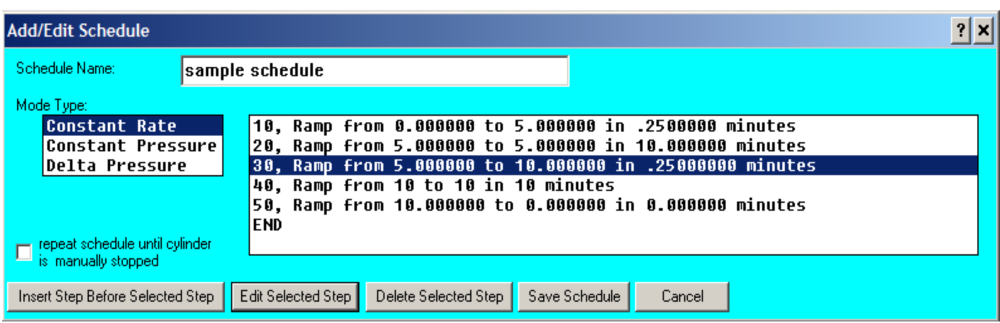


Figure 8-14 Add/Edit Schedule Window

- Enter the user-defined name of the schedule in the Schedule Name field. This is the name used to identify the particular schedule when starting a schedule.

- Select the desired mode type (constant rate, constant pressure, or delta pressure) for the schedule. (When starting the schedule, PumpWorks will verify that the cylinder is running in a compatible mode.)

- To define the ramping commands the Scheduler will execute, click on the Insert Step Before Selected Step button. The Schedule Step Up window, shown in Figure 8-15 will open.

Figure 8-15 Schedule Step Set Up Window

- Enter the starting ramp value in the left-most box, the ending ramp value in the next box, the ramp time in the next box, and select the desired time units in the right-most combo box. The ramp value units will depend on the mode previously selected for the schedule, as well as the currently defined units. CAUTION: Ramping values are saved in schedules as absolute values and are later interpreted at the time the schedules are run in the display units defined at that point. If you changed display units (for example, from PSI to bar) after a schedule has been created, you should edit that schedule to ensure the desired behavior at run time.

- Click OK to save the schedule step, or cancel to abort the step specification.

- Continue to insert schedule steps as desired. A few helpful hints in specifying schedule steps are:

    - If you want the cylinder to remain at a particular rate or pressure once you've ramped to that point, add a step following the one that ramped to that rate/ pressure with one that specifies that same rate/pressure for both the starting ramp value and the ending ramp value, and set the ramp time for the amount of time you want the cylinder to remain at that rate/pressure.

    - To "stop" a cylinder for a period of time, set the start and ending ramp values to 0, and the ramp time for the desired stop time. Note that this will only work for schedules set up for constant rate mode.

- If you want to change a schedule step, click on the desired step, and then click the Edit Selected Step button at the bottom of the window. The Schedule Step Set Up window shown in Figure 8-15 will appear again, with the ramping values for the selected step filled in. Change any of the fields, and then click OK to save the changes to the step, or click Cancel to cancel the changes. (Note that the END step may not be edited.)

- If you want to delete a step, click on the desired step, and then click the Delete Selected Step button at the bottom of the window. (Note that the END step may not be deleted.)

- Once all of the desired schedule steps have been added, and you are satisfied with the schedule, check or uncheck the box to repeat the schedule. If this box is checked, the schedule will repeat itself until the user either explicitly stops the schedule, or until the cylinder is stopped.

- When finished, click the Save Schedule button to save the schedule. The schedule will now be available to select when trying to actually start/execute a schedule.

Repeat this set of instructions to set up any number of schedules for future use.

8.4.1.2 Editing and Existing Schedule

To edit an existing schedule, do the following:

- From the Set Up Schedules window (shown in Figure 8-13), select the schedule to be edited by clicking on the arrow to the right of the Select Schedule field, and clicking on the name of the desired schedule.

- Click on the Edit Selected Schedule button. The Add/Edit Schedule window shown in Figure 8-14 will be open.

- Edit any of the fields in this window, or add/edit/delete schedule steps following the instructions in Section 8.4.1.1.

NOTE: If the selected schedule is executing, clicking on the Edit Selected Schedule button will open the Add/Edit Schedule window, so that the schedule may be viewed, but no changes to the schedule will be allowed.

8.4.1.3 Deleting an Existing Schedule

To delete a previously configured schedule:

- From the Set Up Schedules window (shown in Figure 8-13), select the schedule to be deleted by clicking on the arrow to the right of the Select Schedule field, and clicking on the name of the desired schedule.

- Click on the Delete Selected Schedule button on the bottom of the window. The selected schedule will be removed from the list of configured schedules.

NOTE: If the selected schedule is executing, or if less than two schedules have been defined, the Delete Selected Schedule button will be disabled (grayed out).

8.4.2 Controlling Schedules

CAUTION: Ramping values are saved in schedules as absolute values and are later interpreted at the time the schedules are run in display units defined at that time. If you changed display units (for example, from PSI to bar) after a schedule has been created, you should edit that schedule to ensure the desired behavior.

Once the schedules have been set up, the schedules may be started and stopped for specified cylinders. To control the schedules, do the following:

- From the menu bar, select AutoOp | Control Scheduler. The Control Scheduler window shown in Figure 8-16 will open.

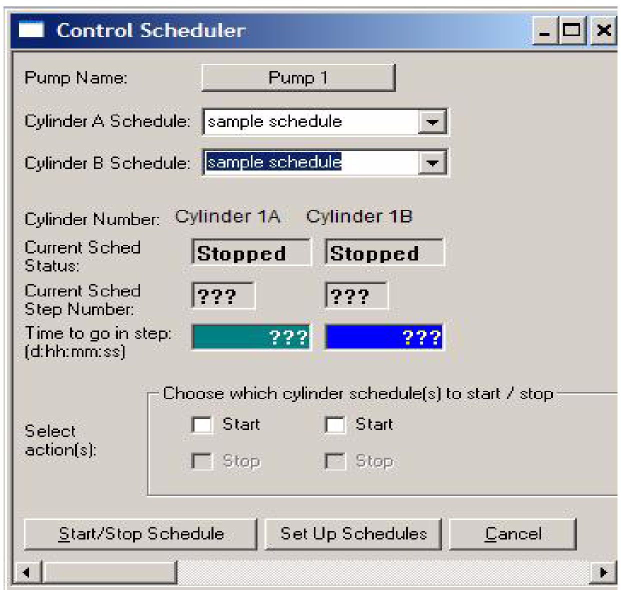


Figure 8-16 Control Scheduler Window

- For each applicable cylinder, select the desired schedule by clicking on the arrow to the right of the fields for selecting the Cylinder A or B schedules, and click on the desired schedule listed in the drop down box. If there is already a schedule running for a cylinder, thsi selection box will be disabled. The selection box will also be disabled for cylinder B if the cylinder is in paired mode. (When cylinders are in paired mode, the schedule is applicable to the pair. Selecting a schedule for cylinder A will select the schedule for the cylinder pair.)

- Check the boxes in the Select Action(s) section for the cylinders for which you would like to start or stop a schedule.

- Click on the Start/Stop Schedules button to actually start or stop the specified schedules for the selected cylinders.

There are several fields displayed in the Control Scheduler window to indicate the status of the Scheduler.

- The Current Sched Status boxes indicate whether a schedule is running or stopped for each cylinder.

- The Current Sched Step boxes indicate which schedule step the Scheduler is currently executing for each cylinder.

- The "Time to go in step" boxes indicate how much time is remaining for the current schedule step for each cylinder.

Clicking on the Set Up Schedules button on the bottom of the Control Scheduler window is another way to open the Set Up Schedules window, to add/edit/delete schedules. (Please refer to Chapter 8, Section 8.4.1 on instructions for the Set Up Schedules window.)

8.5 Macro Record and Playback

The PumpWorks Macro feature can help in situations where a set of commands needs to be sent to pump controllers frequently (like going through a set of steps in preparation for an experiment - setting modes, set points, etc.).

When a macro is being created or "recorded," PumpWorks automatically notes every command that it sends to any of the pump controllers (due to user’s setting modes, setting rates/pressures, etc., as well as commands sent due to ramping, sequencing, dde commands, etc.), along with the time delay between each of these commands.

When a macro is "played back," PumpWorks will send all of the commands recorded in the macro to the appropriate pump controllers, either all at once (untimed playback) or with the same time delay between commands as when the commands were originally recorded in the macro (timed playback).

You can even play back a macro while recording another macro (e.g. if you have several macros that perform subsets of the total set of commands you want to execute, you can start recording a "master" macro, then while it’s recording, playback each of the macros that contain a subset of the comands you waant to record, and then stop recording the "master" macro).

8.5.1 Recording a Macro

To record a macro:

- From the menu bar, select AutoOp | Record Macro.

- Specify the name of the macro file, using the standard file dialog box shown in Figure 8-17. (Please refer to the boxed note in Chapter 2, Section 2.2 for an explanation about the shared documents directory and a warning about locating files outside of this directory tree.)

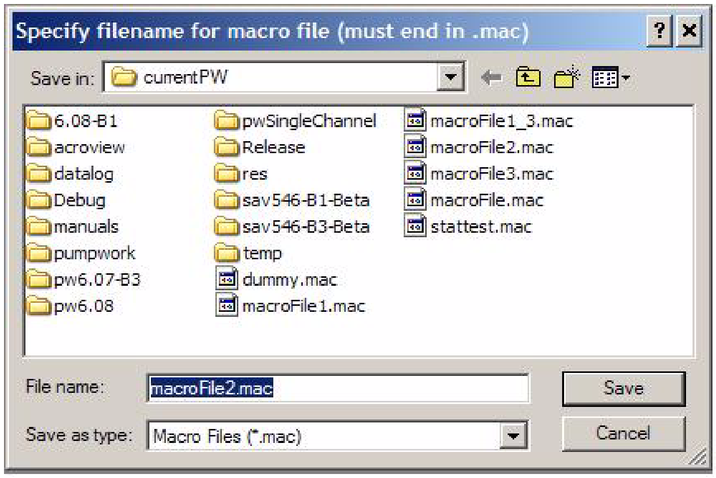


Figure 8-17 Macro File Selection window

Once the file has been selected, the macro button in the status bar (bottom of the application display) will indicate that macro record is active (please refer to Chapter 8, Section 8.5.5). As long as the macro record is active, any commands that get sent to any of the pump controllers will now be recorded in the specified macro file, until the "Stop Recording Macro" option is selected.

8.5.2 Stop Recording a Macro

To stop recording a macro:

- From the menu bar, select AutoOp | Stop Recording Macro.

The macro button in the status bar will change to indicate that a macro is no longer recording (please refer to Chapter 8, Section 8.5.5). The macro file is now complete, and ready for playback.

8.5.3 Macro Playback

Playing back a macro reads a previously recorded macro file and sends the same set of commands to the pump controllers as when the macro was recorded.

Macros can be played back in two different ways. Timed playback will send the commands to the pump controllers with the same elapsed time between commands as was there when the macro was recorded. Untimed playback will send the commands to the pump controllers with no time delay between the commands.

IMPORTANT NOTE: Untimed playback helps to speed things up, when timing between the commands is not important. However, some sequence of commands that work when manually entered may not have the same effect when they are sent all at once.

For instance, if a cylinder operating mode is changed to a rate mode, and then a rate is set, trying to replay these commands with untimed playback may fail if the controller has not finished changing to the rate mode before the set rate command is received. Another example would be if a user stops a cylinder, and then issues a command that is only allowed when the cylinder is stopped. In untimed playback, the cylinder will not have enough time to stop before the next command is received. The untimed playback feature is useful, and has its place, but caution is advised when using it.

8.5.3.1 Starting Timed Macro Playback

To playback a macro in the timed manner:

- From the menu bar, select AutoOp | Start Timed Macro Playback.
- Specify the name of the macro file to playback, using the standard file dialog box shown in Figure 8-18.

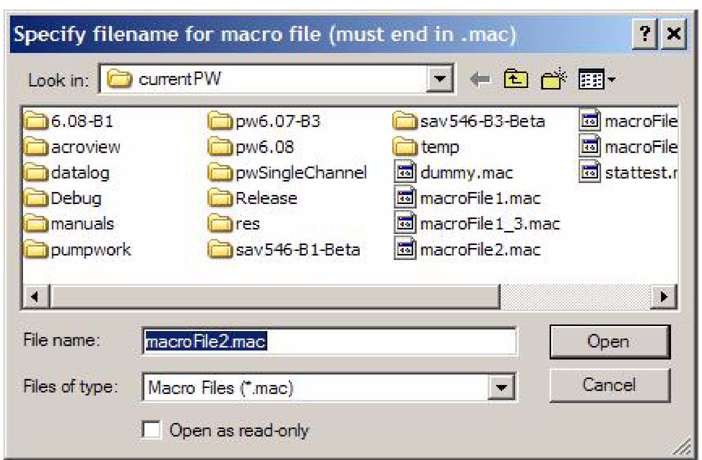


Figure 8-18 Macro File Selection window

Once the file has been selected, the macro button in the status bar (bottom of the application display) will indicate that macro playback is active (please refer to Chapter 8, Section 8.5.5). When PumpWorks has finished playing back the macro, the macro button in the status bar changes to indicate that a macro is no longer playing back.

8.5.3.2 Starting Untimed Macro Playback

(Please see the cautionary note in Chapter 8, Section 8.5.3.) To playback a macro in the untimed manner:

- From the menu bar, select AutoOp | Start Untimed Macro Playback.

- Specify the name of the macro file to playback, using the standard file dialog box shown in Figure 8-18.

Once the file has been selected, the macro button in the status bar (bottom of the application display) will indicate that macro playback is active (please refer to Chapter 8, Section 8.5.5). When PumpWorks has finished playing back the macro, the macro button in the status bar changes to indicate that PumpWorks is no longer playing back a macro.

8.5.4 Stop Macro Playback

PumpWorks will automatically stop a macro playback when it finishes sending the commands from the specified macro file. However, the macro playback may be aborted early, if desired. To stop a macro playback before it finishes on its own:

- From the menu bar, select AutoOp | Stop Macro Playback.

When the macro playback has stopped, the macro button in the status bar (bottom of the application display) will change to indicate that PumpWorks is no longer playing back a macro. (Please refer to Chapter 8, Section 8.5.5.)

8.5.5 Macro Control from the Macro Status Bar Button

The status bar at the bottom of the application display contains a button that indicates whether PumpWorks is currently recording a macro, playing back a macro, or both. This button may also be used as an alternative method of controlling the macro record/playback operations.

To control the macro operations:

- Click on the macro button in the status bar. The window shown in Figure 8-19 will appear.

Figure 8-19 Macro Action Control Window

- Click on the desired macro action, and then refer to the following sections for further instructions:

    - Start Recording Macro - please refer to Chapter 8, Section 8.5.1
    - Stop Recording Macro - please refer to Chapter 8, Section 8.5.2
    - Start Timed Macro Playback - please refer to Chapter 8, Section 8.5.3.1
    - Start Untimed Macro Playback - please refer to Chapter 8, Section 8.5.3.2
    - Stop Macro Playback - please refer to Chapter 8, Section 8.5.4

The macro button on the status bar not only has text to indicate the macro status, but is also color coded. The button may indicate one of four states:

- Macro - OFF (Gray)
- Macro Record Active (Red)
- Macro Playback and Record Active (Orange)
- Macro Playback Active (Yellow)

THIS PAGE INTENTIONALLY LEFT BLANK.

9 GRAPHING MENU

PumpWorks provides a means of graphing data in a scientific graph format. Up to sixteen different graphs may be run simultaneously, each with up to four different items to graph. The following sections describe how to control the look and behavior of the graphs, and how to actually graph data.

9.1 Setting Up Graphs

Before a graph window can be opened to graph data, the graph must be set up. To set up a graph, do the following:

- From the menu bar, select Graphing | Set Up Graphs. The Set Up Graphs window shown in Figure 9-1 opens.

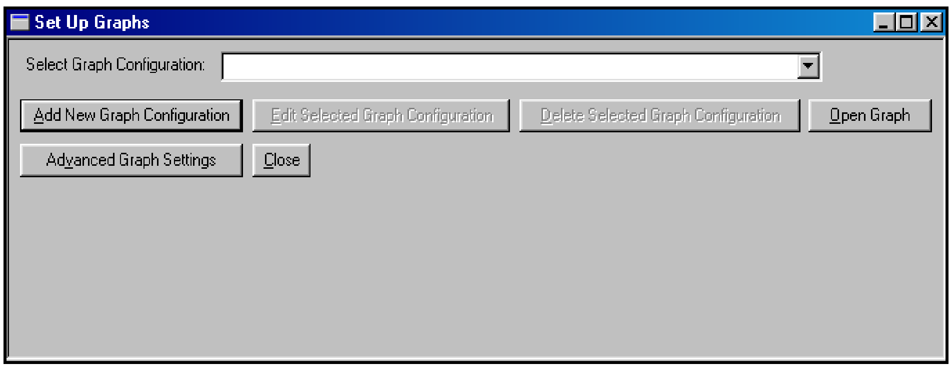


Figure 9-1 Set Up Graphs Window

- A new graph configuration can now be set up (added), or if there are previously set up graph configurations, they can now be edited or deleted following the directions in Section 9.1.1 through Section 9.1.4.

After the graphs have been set up, you can close the Graph Set Up window, by clicking on the Close button, open a graph following the instructions in Section 9.1.5 or set up advanced graphing features following the instructions in Section 9.1.6.

9.1.1 Adding a New Graph Configuration

To add a new graph configuration, do the following:

- From the Set Up Graphs window (shown in Figure 9-1), click on the Add New Graph Configuration button. The Set Up Graph Configuration window shown in Figure 9.2 opens.

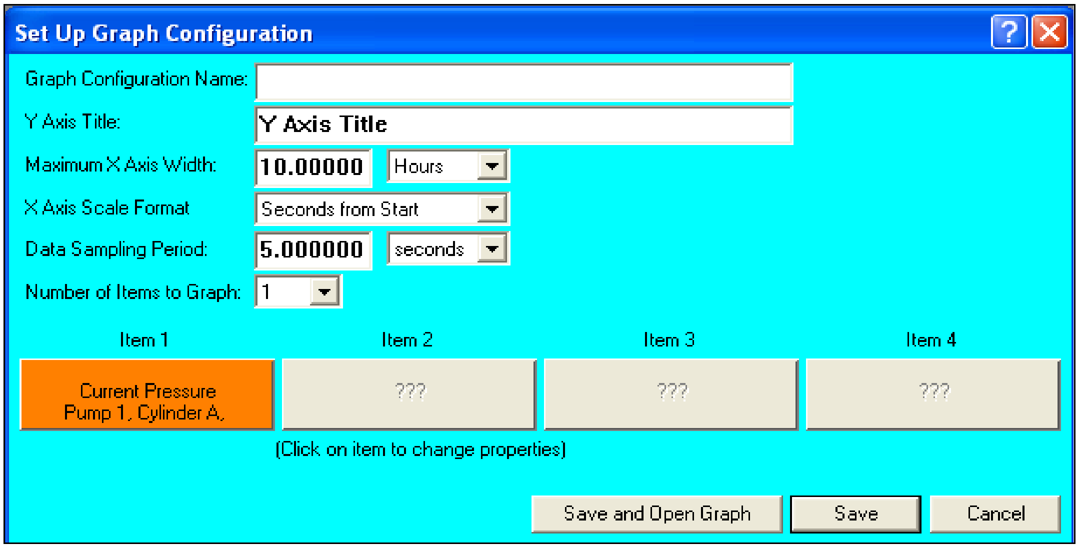


Figure 9-2 Set Up Graph Configuration

- Enter the user-defined name of the graph configuration in the Graph Configuration Name field. This is the name used to identify the particular graph configuration when opening a graphing window.
- Enter the desired text for the Y axis in the Y Axis Title field. This text will be shown vertically along the left edge of the graph.
- Enter the desired width of the graph in the Maximum X Axis Width field and select the associated units of time by clicking on the arrow to the right of the units field and clicking on the desired time units. This will determine how much data is available to see at any given point. After graphing data for longer than this specified period, the graph will begin to "scroll" like a strip chart, always showing the most recent data (See note below on performance limitations.)
- Click on the arrow to the right of the X Axis Scale Format field to select the desired X axis scale format. Selecting seconds, minutes or hours from Start will cause the X axis on the graph to show how many seconds, minutes or hours have elapsed since the selected graph started graphing data. Selecting Actual Date/Time will cause the X axis on the graph to show the date and time the data was graphed. If all data was collected on the same day, the date will be shown in the bottom left corner of the window, and just the time will be shown on the X axis.
- Enter the data sampling period (how much time between points to be graphed) in the Data Sampling Period field, and select the associated units of time by clicking on the arrow to the right of the units field and clicking on the desired time units. (See note below on performance limitations.)
- Select the desired number of items to be graphed by clicking on the arrow to the right of the Number of Items to Graph field, and clicking on the desired number of items.

- For each item to be graphed, click on the Item button. The Configure Item # window shown in Figure 9-3 will appear. Follow the instructions in Section 9.1.2.

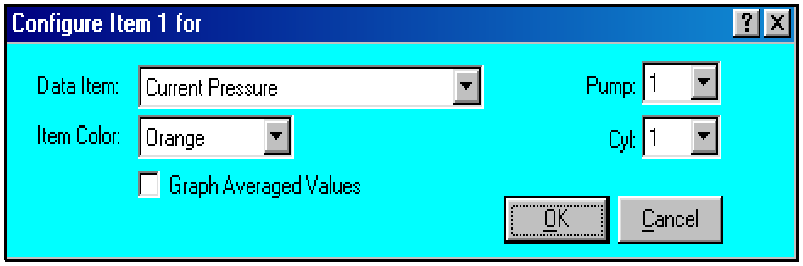


Figure 9-3 Configure Item # Window

- After all items to be graphed have been configured, click on the Save button to simply save the configuration and close the window, or, click on the Save and Start Graph button to save the configuration and open a graph window to run the new graph.
- Clicking on the Cancel button at any time will close the window and lose all changes made since the window has opened.

NOTE: Performance when actually graphing data may be affected by the amount of data required to be stored. The two parameters that affect this amount of data are the maximum X axis width, and the data sampling period. The number of points stored can be calculated by the number of items graphed, multiplied by the maximum X axis width (in seconds), divided by the data sampling rate (in seconds). PumpWorks suggests a practical limit of 150,000 data points, which should not impact PumpWorks performance significantly for newer (faster) computers, but this limitation my not be stringent enough for older/slower computers, or computers that run other applications which require significant CPU resources. If PumpWorks' performance appears to suffer while running a graph (one obvious symptom is the cursor visibly flashing into the hour glass symbol), stop the graph, and reduce the number of points stored by reducing the maximum X axis width, or increasing the data sampling period. (Refer to Section 9.1.3). Also, see Advanced Graph Settings, Section 9.1.6, for instructions on how to set the maximum total number of points to graph.

9.1.2 Configuring an Item to be Graphed

To configure an item to be graphed, or change the configuration of a previously configured item:

- From the Set Up graph Configuration window, click on the desired Item button. (Be sure to select the desired number of items first, to ensure that the desired item buttons are not grayed out.)
- Select the data item to be graphed by clicking on the arrow to the right of the Data Item field, and then clicking on the desired item type.
- Select the pump number, if applicable, by clicking on the arrow to the right of the Pump field and clicking on the appropriate pump number. If the pump field is disabled (grayed out), a pump number is not applicable.

- Select the cylinder number or other identifying number, if applicable, by clicking on the arrow to the right of that field and clicking on the appropriate number. (The name of this field will change based on the data item type selected.) If this field is disabled (grayed out), an identifying number is not applicable.
- Select the color the item is to be graphed with by clicking on the arrow to the right of the Item Color field and selecting the desired color.
- Click on the Graph Averaged Values box to toggle the status of this field. If the box is checked, averaged values will be graphed. (See Section 12.9 for information on averaging values.)
- Click on the OK button to “save” the item configuration, or Cancel to close the window without saving the changes.

CAUTION: Clicking on the Save button will only temporarily save the configuration for the Set Up Graph Configuration window (Figure 9.2). If the Cancel button is clicked in the Set Up Graph Configuration window, any changes to the item configurations will be lost.

9.1.3 Editing a Graph Configuration

To edit a previously configured graph configuration:

- From the Set Up Graphs window (shown in Figure 9-1), select the graph configuration to be edited by clicking on the arrow to the right of the Select Graph Configuration field, and clicking on the name of the desired graph configuration.
- Click on the Edit Selected Graph Configuration button. The Set Up Graph Configuration window, shown in Figure 9.2 opens. If there is a graph currently running using the selected graph configuration, only the data sampling period and maximum X axis width information may be edited. Otherwise, all fields may be changed.
- Edit the user-defined name of the graph configuration by highlighting the text in the Graph Configuration Name field, and typing in the new name. This is the name used to identify the particular graph configuration when opening a graphing window.
- Edit the Y axis title by highlighting the text in the Y Axis Title field and typing in the new title. This text will be shown vertically along the left edge of the graph.
- Edit the maximum X axis width by highlighting the number in the Maximum X Axis Width field, and typing in the new width. Select the associated units of time by clicking on the arrow to the right of the units field and clicking on the desired time units. This will determine how much data is available to see at any given point. After graphing data for longer than this specified period, the graph will begin to “scroll” like a strip chart, always showing the most recent data. (See the note about performance limitations at the end of this section.)
- Edit the X axis scale format by clicking on the arrow to the right of the X Axis Scale Format field and clicking the desired format. Selecting Seconds from the Start will cause the X axis on the graph to show how many seconds have elapsed since the selected graph started graphing data. Selecting Actual Date/Time will cause the X axis on the graph to

show the date and time the data was graphed. (If all data was collected the same day, the date will be shown in the bottom left corner of the window, and just the time will be shown on the X axis.

- Edit the data sampling period (how much time between points to be graphed) by highlighting the number in the Data Sampling Period field and typing in the desired period. Also, the associated units of time may be edited by clicking on the arrow to the right of the units field and clicking on the desired time units. (See the note about performance limitations at the end of this section.)
- Edit the desired number of items to be graphed by clicking on the arrow to the right of the Number of Items to graph field, and clicking on the desired number of items.
- Edit the configuration of the items to be graphed by clicking on the desired Item button. The Configure Item window, shown in Figure 9-3 will appear. Follow the instructions in Section 9.1.2.
- After all desired changes have been made, click on the Save button to simply save the configuration and close the window, or click on the Save and Start Graph button to save the configuration and open a graph window to run the new graph.
- Clicking on the Cancel button at any time will close the window and lose all changes made since the window was opened.

NOTE: Performance when actually graphing data may be affected by the amount of data required to be stored. The two parameters that affect this amount of data are the maximum X axis width, and the data sampling period. The number of points stored can be calculated by the number of items graphed multiplied by the maximum X axis width (in seconds), divided by the data sampling rate (in seconds). PumpWorks suggests a practical limit of 150,000 data points, which should not impact PumpWorks performance significantly for newer, faster computers. This limitation may not be stringent enough for older, slower computers, or computers that run other applications which require significant CPU resources. If PumpWorks performance appears to suffer while running a graph (one obvious symptom is the cursor visibly flashing into the hour glass symbol), stop the graph and reduce the number of points stored by reducing the maximum X axis width, or increasing the data sampling period (see above). Also, see Advanced Graph Settings, Section 9.1.6, for instructions on how to set the maximum total number of points to graph.

9.1.4 Deleting a Graph Configuration

To delete a previously configured graph configuration:

- From the Set Up Graphs window (shown in Set Up Graphs Window, shown in Figure 9-1, select the graph configuration to be deleted by clicking on the arrow to the right of the Select Graph Configuration field, and clicking on the name of the desired graph configuration.
- Click on the Delete Selected Graph Configuration button. The selected graph configuration will be removed from the configuration list.

NOTE: If less than two graph configurations have been defined, the Delete Selected Graph Configuration button will be disabled (grayed out).

9.1.5 Starting a Graph Configuration

There are two ways to open a graph window. To open a graph from the Set Up Graphs window:

- From the Set Up Graphs window (shown in Figure 9-1), select the desired graph configuration by clicking on the arrow to the right of the Select Graph Configuration field and then clicking on the name of the desired graph configuration.
- Click on the Open Graph button.
- When the graph window opens, it will immediately start graphing data using the selected graph configuration.

Alternatively, to open a graph from the Graphing menu:

- Click on the desired graph window to open.
- When the window opens, it will immediately start graphing data using the graph configuration previously selected for this window. To change to a different configuration, follow the instructions in Graphing Data, Section 9.2.

9.1.6 Advanced Graph Settings

PumpWorks provides the ability for the user to set the maximum number of points that may be graphed. Setting the maximum total points to graph helps protect PumpWorks from overloading the CPU and “crashing”. This number can be changed, since this threshold varies with individual computers/systems, based on computer hardware, operating system and number of applications being run simultaneously. This number will be used both at the time the graphs are configured and at the time graphs are started. The number of points to be graphed for a single graph is calculated by multiplying the number of items to be graphed by the sampling frequency, and then multiplying that by the number of seconds “wide” the graph is (the Maximum X Axis Width field, converted to seconds). This calculated number cannot exceed the maximum total number of points to graph when the graph is configured. In addition, there is a check made when a graph is started to make sure that the sum of total number of points to graph (calculated using the afore-mentioned method) for all running graphs does not exceed the specified maximum. In all cases, PumpWorks will issue a warning, and prevent the user from setting up or starting a graph that will exceed this maximum.

The default for this setting is 150,000 data points which should not impact PumpWorks performance significantly for newer, faster computers. This limitation may not be stringent enough for older, slower computers, or computers that run other applications which require significant CPU resources. If PumpWorks performance appears to suffer while running a graph (one obvious symptom is the cursor visibly flashing into the hour glass symbol), reduce this number. If a relatively fast computer is being used, and 150,000 data points appears too limiting, the user may try increasing this number, but it is STRONGLY recommended that graphing with larger number of points be tested without any crucial experiments running first, to determine whether the user's system can handle the graph processing without degrading PumpWorks performance.

To set the maximum total number of points to graph:

- From the Set Up Graphs window (shown in Figure 9-1), select the Advanced Graph Settings button. The Advanced Graph Settings window shown in Figure 9-4 opens.
- Highlight the current Maximum Total Number of Points to Graph, and enter the new desired number of points.
- Click on OK.

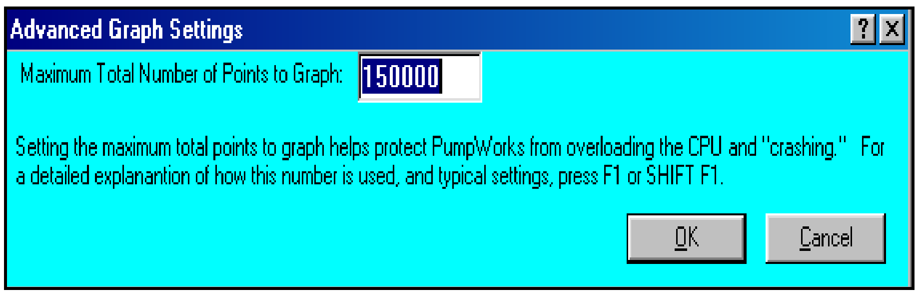


Figure 9-4 Advanced Graph Settings Window

9.2 Graphing Data

In order to graph data, a graph configuration must first be set up. (See Section 9.1). Once the graph configurations have been defined, graph windows can be opened and data can be graphed. There are also other miscellaneous graphing features that are described in the sections below.

9.2.1 Opening Graph Windows

Up to sixteen different graph windows may be open at any given time. To open a graph window:

- From the menu bar, select Graphing | Graph #. (Replace # with 1 through 16, depending on desired window). The Graphing Window # opens as shown in Figure 9-5. (A graph window may also be opened from the Set Up Graphs window, as described in Starting a Graph Configuration, Section 9.1.5).

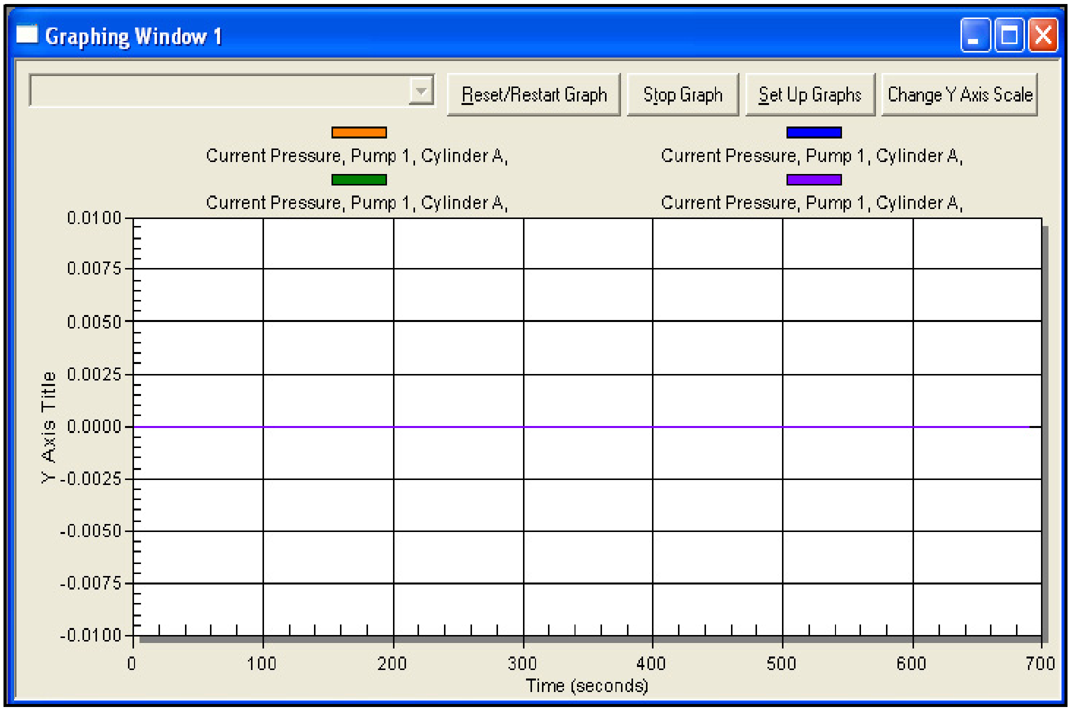


Figure 9-5 Graphing # Window

- When the window opens, it will immediately start graphing data using the graph configuration previously selected for this window. To change to a different configuration, follow the directions in Changing the Graph Configuration to be Graphed, Section 9.2.4.
- The configured X and Y axis titles will be displayed on the graph. If more than one item is to be graphed, the "legend", showing the data item names and their associated colors, will be displayed above the graph.

9.2.2 Resetting/Restarting a Graph

When a graph window is opened, it will immediately start graphing data, using the graph configuration previously selected for this window. When the Reset/Restart Graph button is clicked, the old data will be erased, and new data will be plotted.

NOTE: Performance, when actually graphing data, may be affected by the amount of data required to be stored. The two parameters that affect this amount of data are the maximum X axis width, and the data sampling period. The number of points stored can be calculated by the number of items graphed multiplied by the maximum X axis width (in seconds), divided by the data sampling rate (in seconds). Pumpworks suggests a practical limit of 150,000 data points, which should not impact PumpWorks performance significantly for newer, faster computers. This limitation may not be stringent enough for older, slower computers, or computers that run other applications which require significant CPU resources. If PumpWorks performance appears to suffer while running a graph (one obvious symptom is the cursor visibly flashing into the hour glass symbol), stop the graph, and reduce the number of points stored by reducing the maximum X axis width, or increasing the data sampling period (see Section 9.1.3). Also, see Advanced Graph Settings, Section 9.1.6, for instructions on how to set the maximum total number of points to graph.

9.2.3 Stopping A Graph

To stop plotting data, click on the Stop Graph button. New data will cease being collected/plotted, but the graph of the data collected before stopping will remain visible.

9.2.4 Changing the Graph Configuration to be Graphed

To select a different graph configuration in an opened graph window:

- Stop the current graph by clicking on the Stop Graph button
- Select the desired graph configuration to be used by clicking on the right arrow in the graph configuration name field in the top left hand corner, and clicking on the name of the desired graph configuration. When a graph is actually plotting data (running), this field will be disabled (grayed out). When a graph is not running, the selected graph configuration may be changed.
- Click on the Reset/Restart Graph button to start plotting data.

9.2.5 Change Y Axis Scale

The Y axis is automatically scaled based on data points plotted. If desired, the Y axis scaling can be temporarily manually set. To manually set the Y axis scale:

- Click on the Change Y Axis Scale button. The window shown in Figure 9-6 appears.

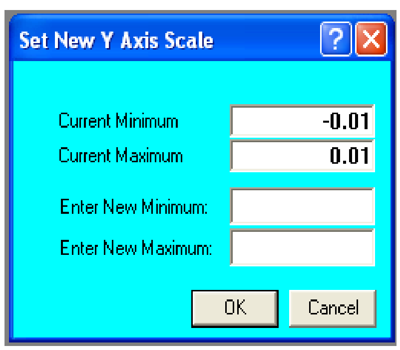


Figure 9-6 Set New Pressure Range Window

- Enter the desired minimum and maximum values for the scale limits.
- Click on OK.

The graph will use the newly defined Y axis scale until a new point to be plotted falls outside the specified “viewable” area, at which time the new Y axis scale will be automatically calculated and used.

9.2.6 Setting Misc. Graph Parameters

In addition to the graphing parameters specified in the "graph configuration" set up in the Set Up Graphing Configuration window, there are other parameters that can be customized from the graphing window. There are two methods to access these customizations; double clicking the mouse in the graph area, which will open a customization window, or right clicking the mouse inside the graph area, which will pop up a customization menu.

9.2.6.1 Graph Customization Window

The graph customization window allows the user to customize various aspect of the graph. To open the Graph Customization window, double click the mouse in the graph area of a graph window. The window in Figure 9-7 appears.

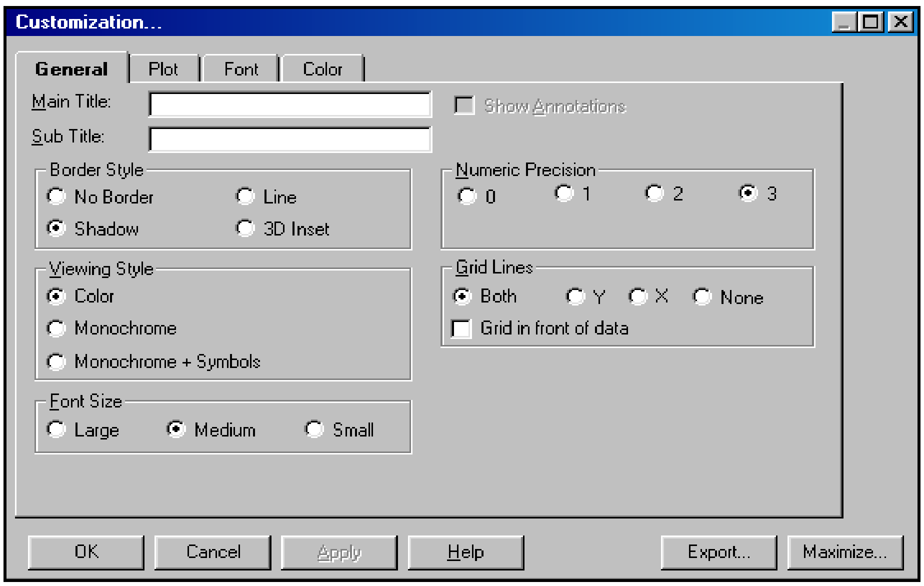


Figure 9-7 Graph Customization Window

The graphing parameters that can be set are divided into four groups: general, plot, font and color. The user can select which group to view/edit by selecting the appropriate tab at the top of the window. The following parameters are displayed in the four groups:

- The "General" group specifies the main and sub titles, border style, viewing style, font size, numeric precision and gridlines.
- The "Plot" group specifies plot style, 3D effects and whether individual data points will be marked.
- the "Font" group specifies font styles for titles and labels.
- The "Color" group specifies colors used for desk and graph foregrounds/backgrounds, as well as shadow color. The buttons under the "Quick Styles" group contain preset groups of colors to choose from.

Specific information on each of these parameters can be found by clicking on the Help button at the bottom of the window. There are 5 other buttons at the bottom of this window:

- Click on the OK button to save any changes that have been made and close the Customization window.
- Click on the apply button to save any changes that have been made and leave the Customization window open.
- Click on the Cancel button to close the window without saving changes. (If the Apply button was clicked on, only the changes made after the Apply button was clicked will be lost.)
- Click on the export button to save or print the current graph (see Section 9.2.8).
- Click on the Maximize button to maximize the current graph. If this button is selected, the graph itself (not the graphing window) is maximized. This means the graph configuration selection box and all the other graph control buttons at the top of the graphing window will no longer be accessible To undo the maximize feature, simply click on the top border of the graph, or press the ESC key.

9.2.6.2 Graph Customization Menu

The graph customization menu allows the user to customize various aspect of the graph. To access the Graph Customization menu, right click the mouse in the graph area of a graph window. The menu shown in Figure 9-8 appears.

Figure 9-8 Graph Customization Menu

The menu options control many of the same parameters as the customization window, including viewing styles, border styles, fonts, numeric precision, plotting methods, shadowing, grid options, and data points. In addition the menu can control whether the legend is visible (identifying data item names.colors at the top of the graph), whether data point labels will be visible, and allows the user to undo any zooming that has been performed. The menu also allows the user to maximize the graph, and allows access to the Graph Customization window, the Graph Export window, and the Graph Help window. For specific information on any of the settable parameters, select help at the bottom of this menu.

9.2.7 Zooming/Unzooming the View Area of a Graph

To zoom in on an area of a graph, simply click and drag the mouse to mark a rectangular area to "blow up". To unzoom, press the z key, or right click the mouse in the graph area and select "Undo Zoom".

9.2.8 Printing/Saving the Current Graph

There are two ways to access the Graph Export window, which will allow printing and/or saving the current graph:

- From the Graph Customization Window (see Section 9.2.6.1), click on the "Export..." button, OR
- From the Graph Customization Menu (see Section 9.2.6.2), click on the Export Dialog button. The export window in Figure 9-9 appears.

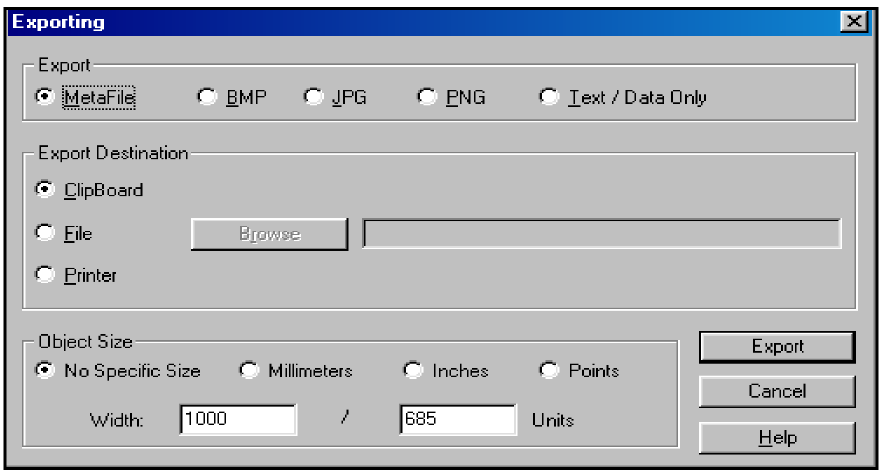


Figure 9-9 Exporting Window

- To print the current graph:
    - Click on MetFile in the Export group.
    - Click on Printer in the Export Destination group.
    - Specify a print size if desired.
    - Click on the Print button. A standard print dialog window will appear.
    - Click the Setup button to change any settings, or click on the OK button to print the graph.
- To Save the current graph, click on the desired file format in the Export group, click on File in the Export Destination group, click on Browse and specify the name of the file in which to save the graph, specify a graph size, if desired, and click on the export button. The graph will be saved to the specified file.

10 OTHER MENU

The Other menu allows the user to calibrate the pressure transducers, view data from or control any auxiliary devices the user has added to their system, and set up and use equations and timers. From the menu bar, click on the Other menu and the following choices are displayed:

- Software Pressure Transducer Calibration, Section 10.1
- Auxiliary Analog Input Signals, Section 10.2
- Auxiliary Digital Input Signals, Section 10.3
- Auxiliary Valves, Section 10.4
- Auxiliary Digital Output Signals, Section 10.5
- Separator Data, Section 10.6
- Back Pressure Regulator, Section 10.7
- Equations and Timers, Section 10.8
- Maintenance Timers and Counters, Section 10.9

Section 10.2 through Section 10.7 of this chapter discuss auxiliary devices that the user has the option of adding to their pump system. How the resulting data from these devices is displayed on PumpWorks and how the user can control these devices through PumpWorks is covered in these sections. Information regarding how to physically connect an auxiliary device to a pump system via the serial expander/isolator is contained in the Appendices to this manual.

10.1 Software Pressure Transducer Calibration

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to change any of the calibration values. Please refer to Chapter 6, Section 6.8 for details on the password protection feature.

A pressure transducer is located on each pump cylinder. Pressure transducers must be properly calibrated for pulseless flow to occur. When pressure transducers are properly calibrated, there is no pressure change at switchover during paired cylinder operation. The pressure transducers on the Quizix pumps need to be recalibrated periodically. During normal use, they should be recalibrated every 12 months. If usage is heavy, or if the pump has been subjected to unusual circumstances such as pressures above its rated pressure range, then recalibration should be performed. Also, pressure transducers should be recalibrated after being taken apart and put back together.

Calibration keeps the pressure transducers on the pump cylinders reading the correct pressure. The pump controller uses these pressures to match the standby pump cylinder's pressure to the active pump cylinder's pressure, in order to eliminate pressure variations at switchover. If the pressure transducers are not matched to each other, then the pressure in one pump cylinder will not be the same as the pressure in the other pump cylinder, even though the readings on the display will match.

The easiest way to check if the pump cylinders are matched is to use one pump cylinder to pressurize **both** pressure transducers (connect the outlets of the pump cylinders together) and record the pressure of **both** pressure transducers over the pressure range of interest.

10.1.1 What is a Pressure Transducer?

A pressure transducer is a device that converts a pressure to an electrical signal proportional to that pressure. In Quizix pumps, the signal generated by the pressure transducer is sent directly to an A/D (analog-to-digital) converter, which converts the analog electrical signal of the amplifier to a 20-bit digital signal that is then displayed on the computer. This yields a pressure resolution of better than 1 part in 1,000,000, resulting in excellent pressure control.

Each individual pressure transducer will have slight variations in output voltage at zero pressure (zero offset) and at full pressure (gain). In Quizix pumps these variations are compensated for in the controller software. The process of adjusting the offset and gain compensation values is called calibration.

10.1.2 Methods of Calibrating the Pump System

There are two basic methods of pressure transducer calibration for a Quizix QX Series or QL-700 Pump or any pump system with a CMD-5000 or CN-6000 pump controller. The first method is to attach a secondary calibrated gauge, such as a quartz transducer, to the system. With this method, the pressure for the calibration procedure will be generated by the Quizix pump. Then the pressure read by the Quizix system is adjusted until the pump system's transducer readings match the reading by the calibrated gauge (CG).

The second method is to use an external pressure source, such as a "dead-weight tester." With this method the user connects the external calibrated pressure source (PS) to the pump system. The pressure provided by this source is then read by the Quizix system and the Quizix pressure reading is adjusted until it matches the pressure of the pressure source. Figure 10-1 is a schematic illustration of both methods.

10.1.2.1 Calibrated Gauge Method

1. As shown in the Calibration Setup Diagram in Figure 10-1, connect a calibrated gauge (CG) to the fluid outlet of your Quizix Pump System. Be sure your fill valves are connected to a fill reservoir at atmospheric ("zero gauge") pressure.

2. Set the system to "zero gauge pressure" as follows: for the cylinder(s) being calibrated, open the fill valve(s) so the cylinder pressure is at atmospheric or "zero" pressure. The deliver valve(s) can also be opened, if desired.

3. Go to PumpWorks main window. From the menu bar select Other | Software Pressure Transducer Calibration. The window shown in Figure 10-2 appears.

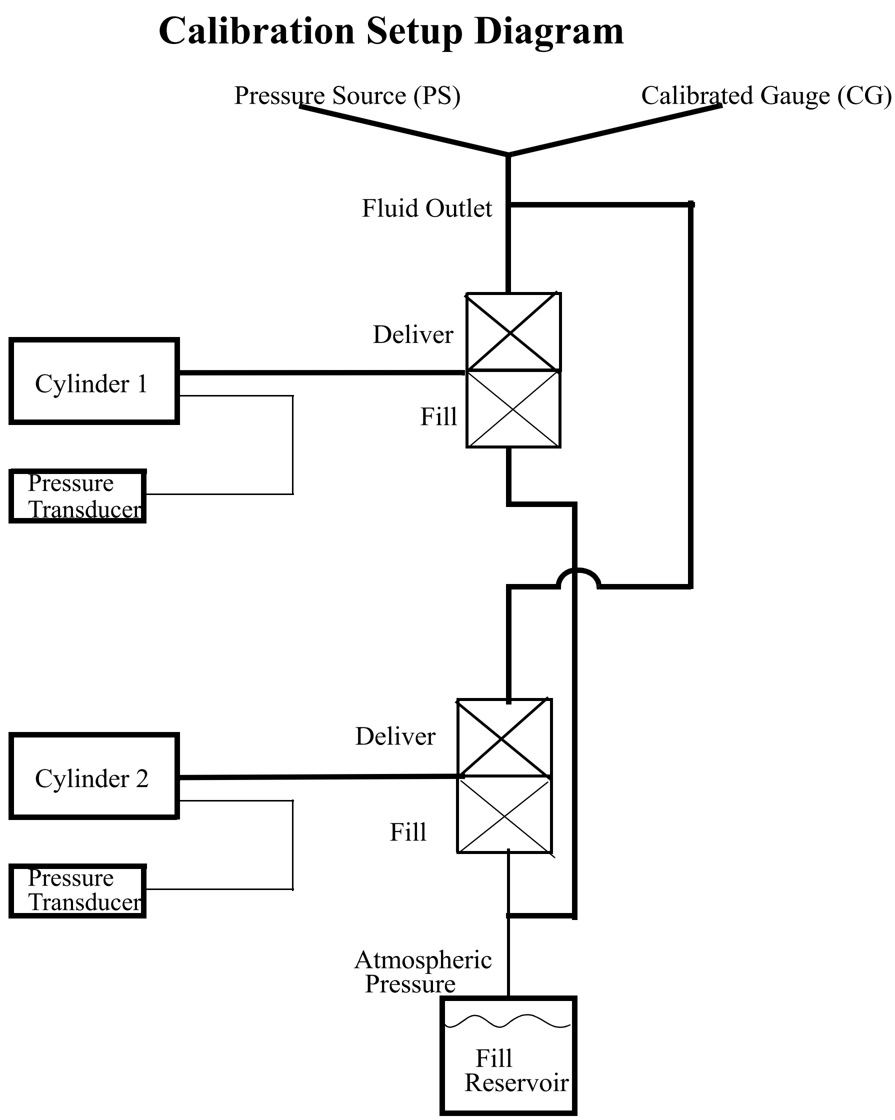


Figure 10-1 Calibration Setup Diagram

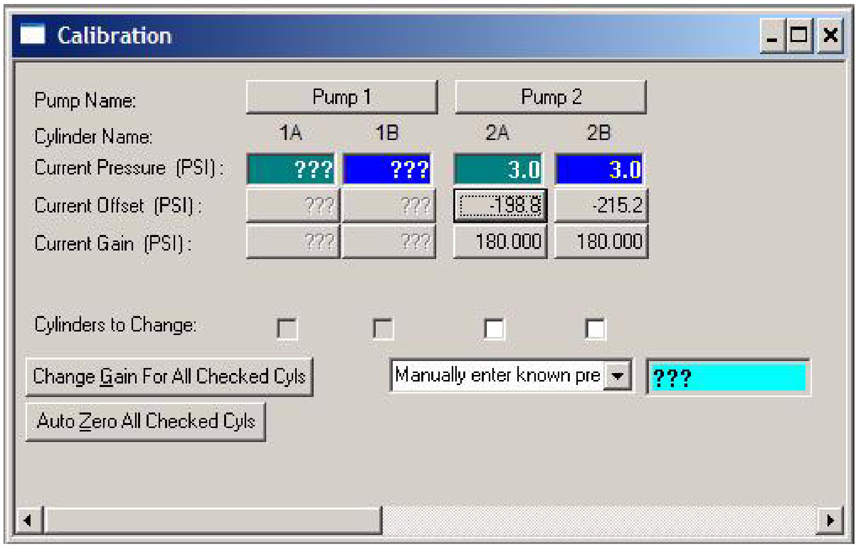


Figure 10-2 Software Pressure Transducer Calibration Window

4. To adjust the offset in the Software Pressure Transducer Calibration window, select "Current Offset" for a specific pump cylinder, and the window shown in Figure 10-3 appears.

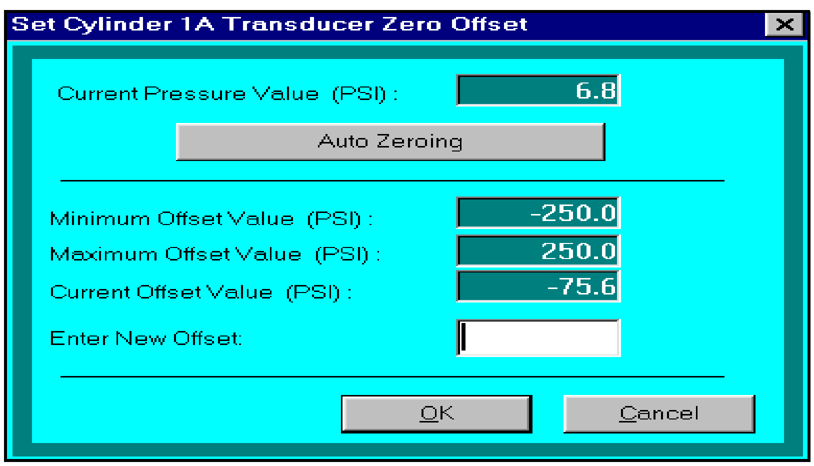


Figure 10-3 Set Cylinder # Transducer Zero Offset Window

5. The easiest way to adjust the offset is to click on "Auto Zeroing" in the Set Cylinder # Transducer Zero Offset window. Clicking on auto zeroing will result in the computer calculating the necessary offset to have the display read zero pressure. The range of zero offset is limited so that a malfunctioning transducer, or a transducer with significant pressure accidentally left on it, will not be able to be zeroed.

   This completes the correction for the zero offset.

   Alternatively, the user can compute the desired offset and enter this value into the appropriate box. With this option, a value other than zero pressure can be shown on the display, even when zero pressure is present. This can be used if absolute pressure readings are desired.

NOTE: To use this method on multiple cylinders at one time, please refer to Section 10.1.2.3.

6. The gain now needs to be set to complete the calibration sequence.

   NOTE: If your system is typically operated at a pressure significantly less than the pump's maximum rating (for example, typical usage at 100 PSI for a 5,000 PSI pump), then in step #10, stop the pressure at the system's typical operating pressure to obtain a more accurate calibration.

7. For the pump cylinder(s) being calibrated, open the deliver valve(s) and close the fill valve(s).

8. Set the safety pressure to 95% of the system's maximum rated pressure.

9. Use PumpWorks to set the pump cylinder you are calibrating to extend in constant rate independent mode (#1), at 1 ml/minute. Start the pump cylinder and monitor the pressure with the calibrated gauge.

10. Stop the pump when the pressure reaches 90% of the system's maximum pressure. If you forget to stop the pumps, the safety pressure will automatically shut the pumps down at the 95% pressure point set in step 8.

IMPORTANT
When you raise the system's pressure, the temperature of the pump's internal fluid will temporarily rise. As this fluid cools, the system pressure will drop. In this situation it is best to wait five minutes after reaching your high pressure before proceeding, so that the pressure is not changing while you are trying to calibrate.

11. In the Software Pressure Transducer Calibration window (refer to Figure 10-2 above), select "Current Gain" for the appropriate pump cylinder, and the window shown in Figure 10-4 appears.

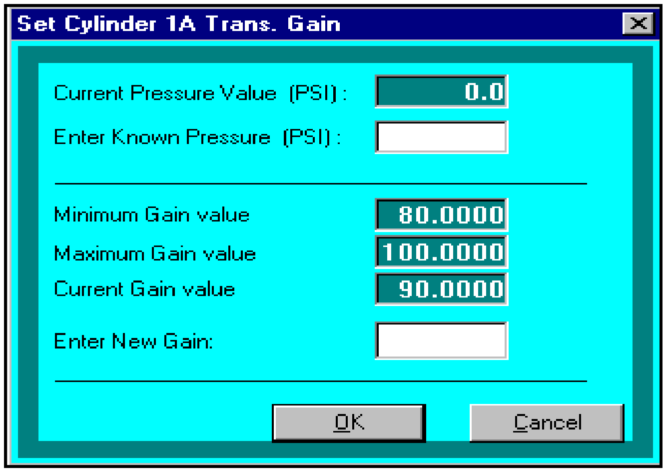


Figure 10-4 Set Cylinder # Transducer Gain Window

12. The easiest way to adjust the gain of a pressure transducer is to enter the current pressure value into the Enter Known Pressure box. The known pressure is from an external standard such as a quartz transducer, or from a pressure source such as a dead weight tester. Only enter the known pressure if it is from an accurate device. By entering a known pressure, PumpWorks will automatically calculate the necessary gain and adjust the pressure reading to display this value automatically. Remember to always adjust the offset prior to adjusting the gain.

    The user may also calculate the desired gain by hand and then enter the desired value into the software. The range of gains is limited to prevent faulty and malfunctioning transducers from being calibrated and giving the illusion of working.

NOTE: To use this method on multiple cylinders at one time, please refer to Section 10.1.2.4.

10.1.2.2 Calibrated Pressure Source Method

1. As shown in the Calibration Setup Diagram in Figure 10-1, connect a calibrated pressure source (PS) to the fluid outlet of your Quizix Pump System. Be sure your fill valves are connected to a fill reservoir at atmospheric (“zero gauge”) pressure.

2. Set the system to “zero gauge pressure” as follows: for the cylinder(s) being calibrated, open the fill valve(s) so the cylinder pressure is at atmospheric or “zero” pressure. The deliver valve(s) can also be opened, if desired.

3. Go to PumpWorks main window. From the menu bar select Other | Software Pressure Transducer Calibration. The window shown in Figure 10-5 appears.

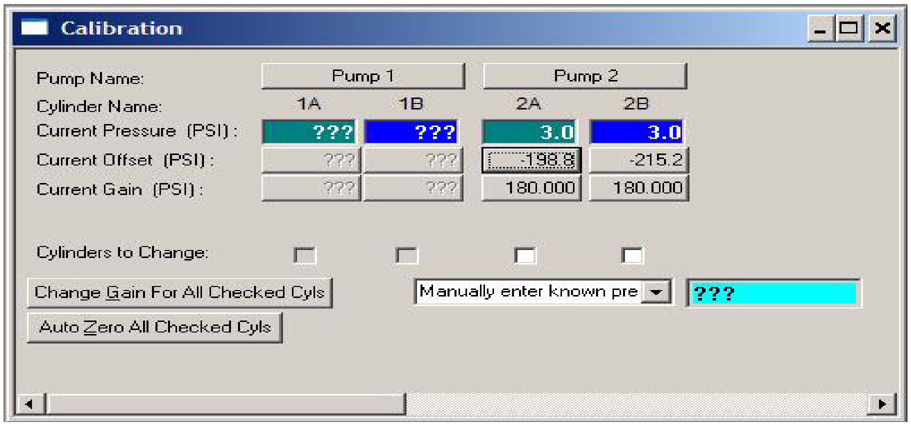


Figure 10-5 Software Pressure Transducer Calibration Window

4. To adjust the offset, from the Software Pressure Transducer Calibration window, click on "Current Offset" and the window shown in Figure 10-6 appears.

.

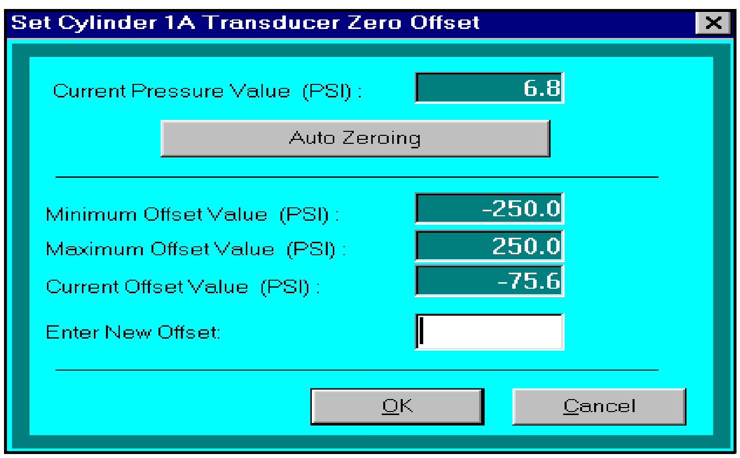


Figure 10-6 Set Cylinder # Transducer Zero Offset Window

5. The easiest way to adjust the offset is to click on "Auto Zeroing" in the Set Cylinder # Transducer Zero Offset window. Clicking on auto zeroing will result in the computer calculating the necessary offset to have the display read zero pressure. The range of zero offset is limited so that a malfunctioning transducer, or a transducer with significant pressure accidentally left on it, will not be able to be zeroed.

   Alternatively, the user can compute the desired offset and enter this value into the appropriate box. With this option, a value other than zero pressure can be shown on the display, even when zero pressure is present. This can be used if absolute pressure readings are desired.

NOTE: To use this method on multiple cylinders at one time, please refer to Section 10.1.2.4.

6. The gain now needs to be set.

NOTE: If your system is typically operated at significantly less than the pump's maximum rating (for example, typical usage at 100 PSI for a 5,000 PSI pump), then the pressure in step 9 may be set at the system's typical operating pressure to obtain a more accurate calibration.

7. For the pump cylinder(s) being calibrated, open the deliver valve(s) and close the fill valve(s).

8. Set the safety pressure to 95% of the system's maximum rated pressure.

9. Set the pressure source to bring the pressure up to the desired level, typically 90% of the maximum operating pressure. Be careful about your settings since PumpWorks cannot keep an overpressure condition from happening with an external pressure source.

10. In the Software Pressure Transducer Calibration window (see Figure 10-5), select "Current Gain" for the appropriate pump cylinder, and the window shown in Figure 10-7 appears.

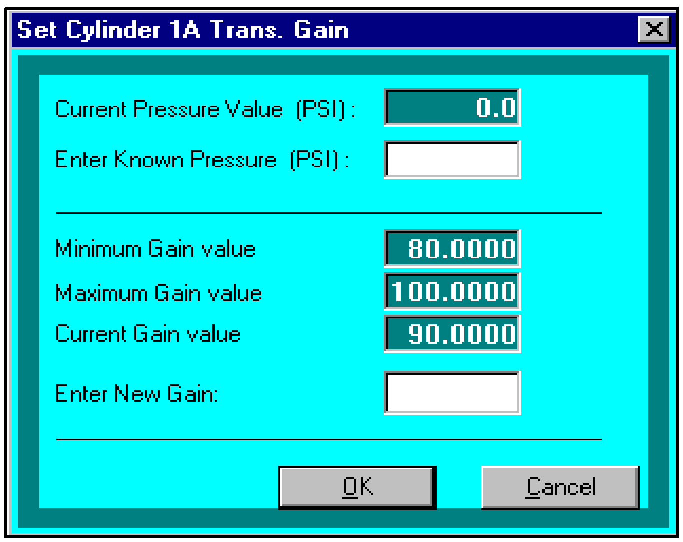


Figure 10-7 Set Cylinder # Transducer Gain

11. The easiest way to adjust the gain of a pressure transducer is to enter the current pressure value into the Enter Known Pressure box. The known pressure is usually from an external standard, such as a quartz transducer or a dead weight tester. Only enter the known pressure if it is from an accurate device. By entering a known pressure, PumpWorks will automatically calculate the necessary gain and adjust the pressure reading to display this value automatically. Remember to always adjust the offset prior to adjusting the gain.

    The user may also calculate the desired gain by hand and then enter the desired value into the software. The range of gains is limited to prevent faulty and malfunctioning transducers from being calibrated and giving the illusion of working.

NOTE: To use this method on multiple cylinders at one time, please refer to Section 10.1.2.4.

10.1.2.3 Zeroing the Offset for Multiple Cylinders at Once

You can Zero the offset for multiple cylinders at once by checking the desired "Cylinders To Change" check boxes, and then clicking on the "Auto Zero All Checked Cyls" button. This will have the equivalent effect of clicking the cylinder offset button, and then clicking the "Auto Zeroing" button for each cylinder.

10.1.2.4 Setting the Gain for Multiple Cylinders at Once

You can set the gain for multiple cylinders:

- Check the desired “Cylinders To Change” check box.
- Select the known pressure source from the combo box to the right of the “Change Gain for All Checked Cyls” button. You can choose to enter the known pressure manually, or select from a list of pressure sources.
- Click on the “Change Gain for All Checked Cyls”.
- If something other than the “Manually Enter Known Pressure” source was selected in the previous step, the new gains will be calculated and set immediately. If the “Manually Enter Known Pressure” source was selected in the previous step, the dialog box shown in Figure 10-8 will appear. Enter the known pressure (in psi), and click OK. The new gains will then be automatically calculated and set.

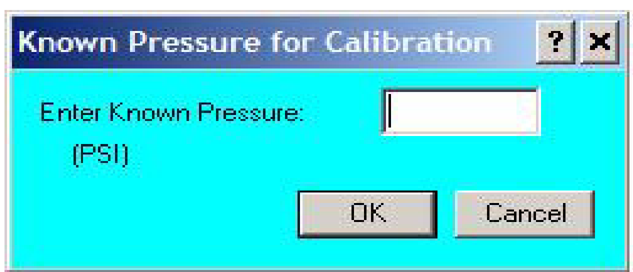


Figure 10-8 Known Pressure for Calibration

This will have the equivalent effect of following the instructions in Section 10.1.2.1 or Section 10.1.2.2 for setting the gain separately for each cylinder.

10.1.3 How to Calculate an Offset and Gain

The Software Pressure Transducer Calibration window allows the user to enter an offset number so that a pressure transducer reads zero with no pressure applied, or a pressure transducer provides the correct reading when the true pressure level is known.

The software zero offset range is ±2-1/2% of the maximum operating pressure of the pressure transducer. For example, for a pressure transducer with a zero to 10,000 PSI operating range, the zero offset range is ±250 PSI (an offset value between –250 and 250 may be entered).

The software gain range is approximately ±10% of the nominal gain value for a specific pressure transducer. For example, a pressure transducer with a 0 to 10,000 PSI operating pressure has a nominal gain value of 90 and a user-set range of 80 to 100.

In general, pressure calibration can be thought of in terms of the standard algebraic equation in which x represents the data from the pressure transducer and y represents the calibrated pressure reading.

$$y = ax + b$$

where:
"a" is the slope or the gain,
"b" is the intercept or the offset,
"y" represents the calibrated pressure level, and
"x" is the actual transducer reading.

Limits are placed on the offset and gain ranges to identify a malfunctioning transducer and prevent careless mistakes that could significantly change pressure readings.

The Pressure Transducer May Be Malfunctioning if:
• Larger offsets or gains than the permitted range are needed, or • Pressure transducers cannot be matched within the limits of the offset and gain.

10.2 Auxiliary Analog Input Signals

An auxiliary sensor device can be connected to the Quizix pump system via the "user interface" connector. The user can also add an extended analog input board, described in Chapter12, Extended Analog Input Settings, Section 12.15 and/or Auxiliary Transducers, described in Chapter 13, Section 13.7. Analog signals received from an auxiliary device are converted to a digital number by the controller and sent to PumpWorks for display. We call this conversion "auxiliary analog input conversion." PumpWorks then takes the digital number and maps it to an auxiliary analog input channel. The auxiliary analog input signal data is available to view on the Auxiliary Analog Input Signals window.

Auxiliary analog input channels are useful for compiling additional pressure transducer, temperature sensor, or other sensor data, from any device with an analog voltage output. Data from an auxiliary analog input signal can be included in a data log or used in an equation or sequence.

Auxiliary analog input channels are available on all Quizix pumps. Each CMD-5000 Dual Controller Driver, CN-6000 Controller, QX Series Pump and QL-700 Pump includes three auxiliary analog input channels that accept voltage inputs. The newer QX Series Pumps and some versions of the CMD-5000 pumps (Model C and later) also include a 4^{th} channel that accepts 0-32 mA current input.

- From the menu bar, select Other | Auxiliary Analog Input Signals and the window shown in Figure 10-9 appears.

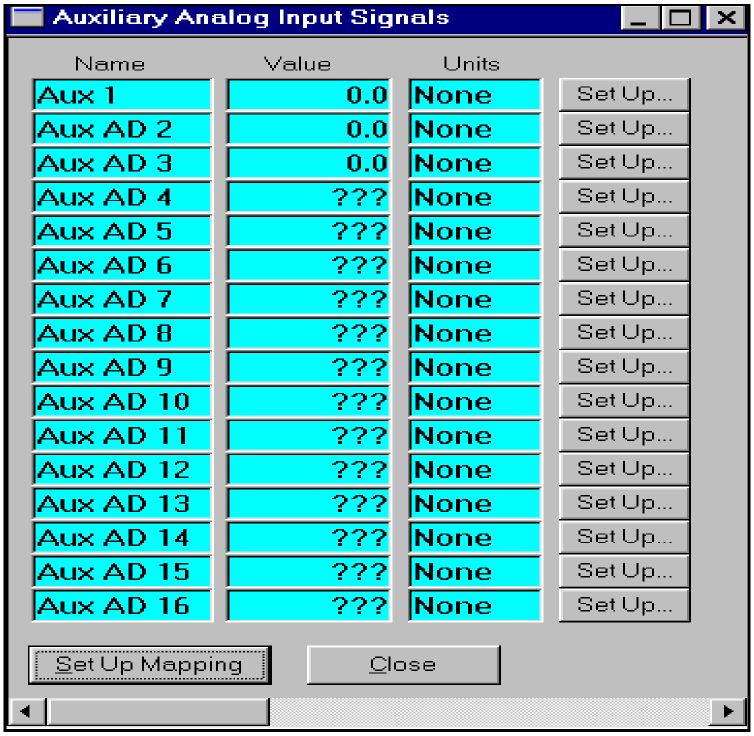


Figure 10-9 Auxiliary Analog Input Signals Window

The Auxiliary Analog Input Signals window displays the name, value and units for each analog input signal. The window also includes a Set Up button that allows the user to configure the input parameters for each signal. There are 48 channels available for viewing on this window; use the scroll bar on the bottom of the window to view channels 17 - 48.

10.2.1 How to Set Up Auxiliary Analog Input Parameters

- From the menu bar, select Other | Auxiliary Analog Input Signals.
- In the Auxiliary Analog Input Signals window, click on the Set Up button for an auxiliary analog input channel and the window shown in Figure 10-10 appears.

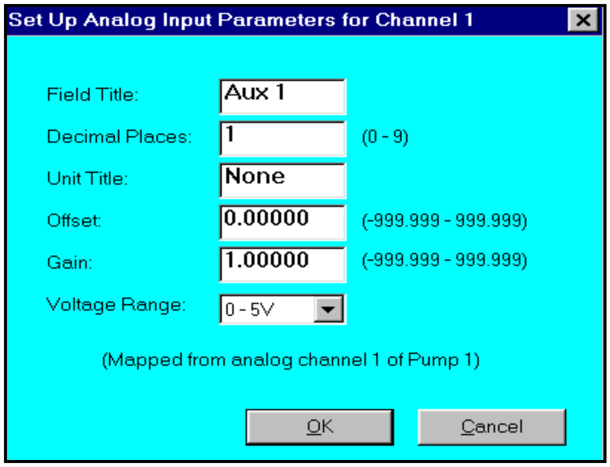


Figure 10-10 Set Up Aux. Analog Input Parameters for Channel # Window

10.2.1.1 Field Title

To change the name of an auxiliary analog input channel:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the Field Title text box.
- Highlight the current field title.
- Type in the new title. Up to eight alphabetic or numeric characters will be displayed.

10.2.1.2 Decimal Places

Decimal Places refers to how many numbers appear to the right of the decimal point. The more numbers appearing to the right of the decimal point, the more precise the number displayed will be.

To set the decimal places, do the following:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the decimal places text box.
- Highlight the current number displayed.
- Enter the number of places to be displayed to the right of the decimal point (from 0 to 9).

10.2.1.3 Unit Title

The Unit Title allows the user to enter a unit of measurement for the data displayed. The unit of measurement entered is a visual reminder only. Entering a unit of measurement here does not change the auxiliary analog input channel to that unit of measurement. To enter a unit title, do the following:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, highlight the current unit title.
- Enter the unit title.

10.2.1.4 Offset

The offset and gain calibration formula utilized by PumpWorks is as follows:

Displayed Value = (A/D Signal x Gain) + Offset

To change the offset:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click in the offset field.
- Highlight the current number.
- Enter a new offset.

After the auxiliary A/D signal has been multiplied by the gain, the offset will be added. The number entered can be in the range of -999,999 to 999,999.

10.2.1.5 Gain

The offset and gain calibration formula utilized by PumpWorks is as follows:

Displayed Value = (A/D Signal x Gain) + Offset

To change the gain:

- In the Set Up Auxiliary Analog Input Parameters for Channel # window, click on the gain field.
- Highlight the current number.
- Enter a new gain.

The incoming signal will be multiplied by the gain number entered here. The number entered can be in the range of -999,999 to 999,999.

NOTE: If you wish for the unaltered analog to digital converter reading to be displayed on the Auxiliary Analog Input Value text box, enter a “1” for the gain and a “0” for the offset.

10.2.2 How to Map an Auxiliary Analog Input Signal

You will notice words in parentheses at the bottom of the Set Up Auxiliary Analog Input Parameters for Channel # window (refer to Figure 10-10). An example is: (Mapped from aux channel 1 of pump 1). This is telling the user exactly where this analog signal is being received from. In this example, it is being received from pump number one, channel number one. If no pump is attached to a particular signal, or the field has not been set up to receive a signal, it would read: (No Mapping). Mapping each auxiliary signal is simply a way of assigning it a screen location on the Auxiliary Analog Input Signals window, so that PumpWorks knows in which box to display the data from that signal.

When a new pump is installed onto PumpWorks, auxiliary analog inputs are automatically assigned an auxiliary analog input number and corresponding screen position on the Auxiliary Analog Input Signals window. To change where a particular signal will be displayed on that window:

- From the menu bar, select Other | Auxiliary Analog Input Signals.
- Click on the Set Up Mapping button at the lower left hand corner. The window shown in Figure 10-11 appears.

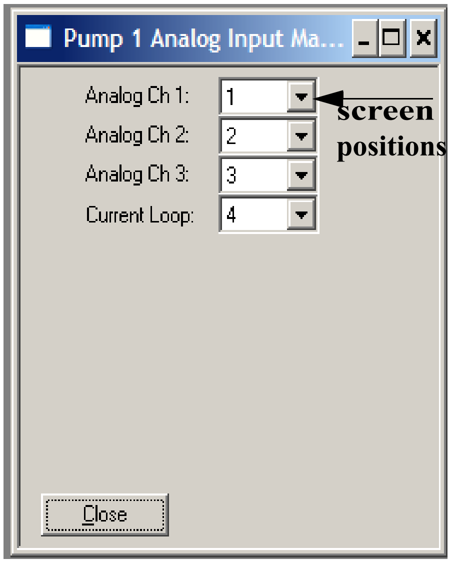


Figure 10-11 Analog Input Mapping Window

The Analog Input Mapping Window includes the three analog channels available from each QX Series Pump, QL-700 pump, CMD-5000 or CN-6000 pump controller in your system. (If your system includes a QX Series pump controller or a CMD-5000, Model C or later, a fourth Current Loop channel will be available. If your system includes an SC-2400 pump controller, the fourth analog channel field will also be available.)

To change where a signal's data will be displayed on the Auxiliary Analog Input Signals window:

- In the Auxiliary Analog Input Mapping window, find the auxiliary analog input signal you wish to change. Click on the arrow to the right of the signal.
- Click on the screen position number (1-48) of the box where you wish the signal data to be displayed on the Auxiliary Analog Input Signals window.

  NOTE: Auxiliary Input Signal mapping may not be changed while updating software to a pump controller or front panel.Only available positions will be displayed. To assign an auxiliary signal to a number that is occupied, first assign that auxiliary analog input signal to a different number, or unassign it by assigning it to "none"--which can be scrolled up to (above #1).
- When finished, click on the Close button at the bottom left hand corner of the window.

The auxiliary analog input signal data is immediately displayed to the new screen position on the Auxiliary Analog Input Signals window. For example, for Pump 1, analog channel 1, if the user enters "1" (as shown in Figure 10-11), then the data from this signal will appear in the first Value field in the Auxiliary Analog Input Signals window (Figure 10-9). If, however, as another example, the user enters "5", then the data from that signal would appear in the fifth value field, next to "Aux A/D 5".

Another way to open the Auxiliary Analog Input Mapping window is:

- From the menu bar, select Configure | Set Up Resource Mapping | Set Up Auxiliary Analog Input Mapping.

10.2.3 How to Map an Extended Analog Input Signal

After setting up the optional extended analog input hardware and setup described in Chapter12, Extended Analog Input Settings, Section 12.15, the extended analog input channels must be mapped before they can be used. To map the channels:

- From the menu bar, select Configure |Set Up Resource Mapping | Set Up Analog Input Mapping | Extended Analog Input. Figure 10-12 appears. The number of fields enabled on this window is dependent upon how many channels were selected in the Extended Analog Input Parameter Settings window described in Chapter12, Extended Analog Input Settings, Section 12.15.

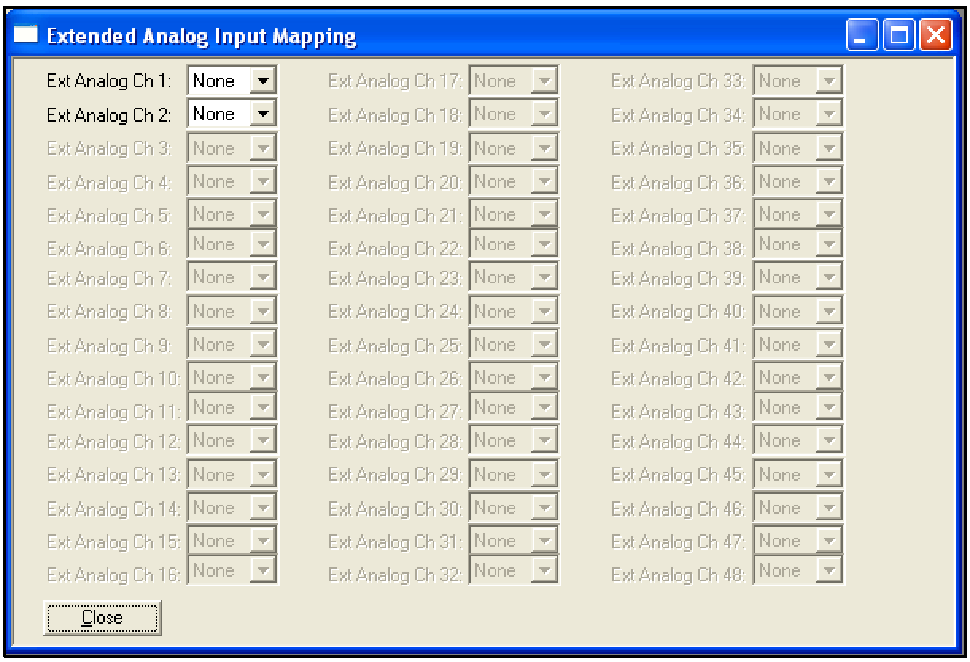


Figure 10-12 Extended Analog Input Mapping Window

- Find the extended analog input channel you wish to map, and click on the arrow to the right of that channel.
- Click on the screen position number (1 - 48) of the box where you wish the signal data to be displayed on the Auxiliary Analog Input Signals window.

NOTE: Only available positions will be displayed. To assign an extended analog signal to a number that is occupied, first assign the occupying analog input signal to a different number, or unassign it by assigning it to “none” - which can be scrolled up to (above #1).

When finished, click on the Close button at the bottom left hand corner of the window. The extended analog input data is immediately displayed in the new screen position on the Auxiliary Analog Input Signals window.

10.2.4 How to Map an Auxiliary Transducer

After setting up the optional Auxiliary Transducers, described in Chapter 13, Section 13.7, the auxiliary transducer data must be mapped before it can be used. To map the transducer data:

- From the menu bar, select Configure | Set Up Resource Mapping | Set Up Analog Input Mapping | Auxiliary Transducers. The window shown in Figure 10-13 appears. The number of fields enabled on this window is dependent upon how many transducers were found or enabled in the Auxiliary Transducers Setup window described in Chapter 13, Section 13.7.

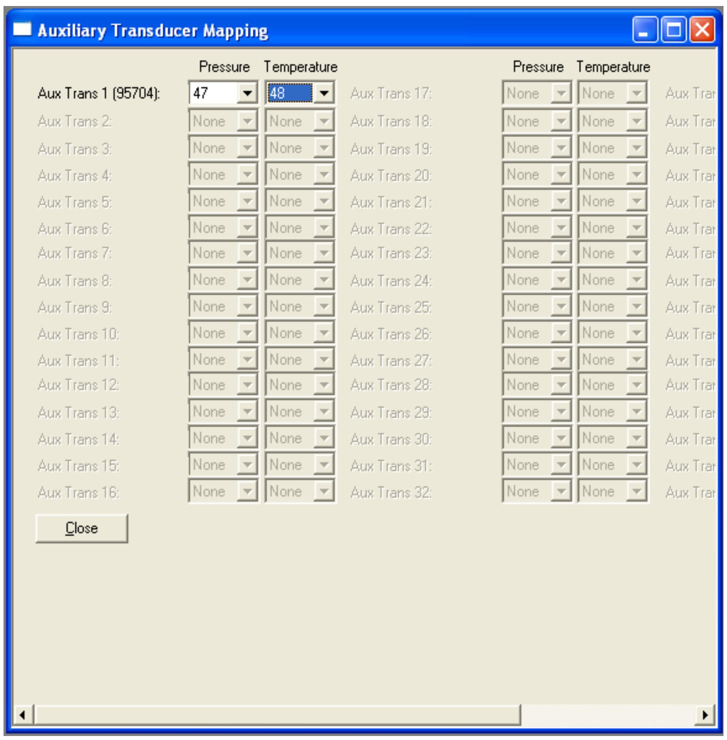


Figure 10-13 Auxiliary Transducer Mapping Window

- Find the transducer data item you wish to map, and click on the arrow to the right of that item.
- Click on the screen position number (1-48) of the box where you wish the transducer data item value to be displayed on the Auxiliary Analog Input Signals window.

NOTE: Only available positions will be displayed. To assign a transducer data item to a number that is occupied, first assign the occupying analog input signal to a different number, or unassign it by assigning it to "none" -- which can be scrolled up to (above #1).

When finished, click on the Close button at the bottom left hand corner of the window. The transducer data item values are immediately displayed in the new screen positions on the Auxiliary Analog Input Signals window.

10.3 Auxiliary Digital Input Signals

The Auxiliary Digital Input Signals option allows the viewing of up to 32 auxiliary digital inputs. There are two auxiliary digital input signals available per QX Series or QL-700 Pump, CMD-5000 Dual Controller Driver, or CN-6000 Controller. (For users with older systems, there are eight digital input signals available per SC-2400 Pump Controller.)

- From the menu bar, select Other | Auxiliary Digital Input Signals and the window shown in Figure 10-14 appears.

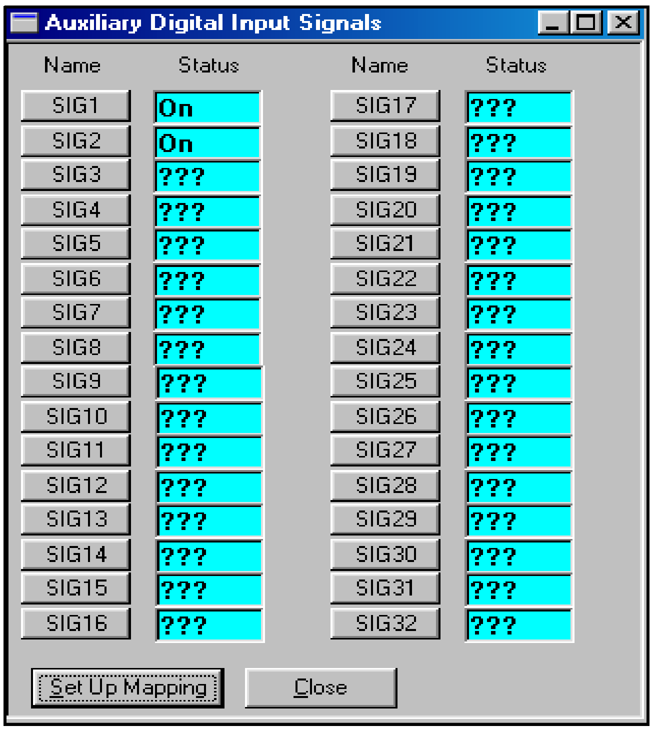


Figure 10-14 Auxiliary Digital Input Signals Window

When the user connects a digital input or other on/off device to a pump system using the user interface connector, the current status of the device appears in the Auxiliary Digital Input Signals window. This window displays the signal's title (name) and shows the signal's on/off status. The screen will show "on" for a logic high voltage of 3.6 volts or higher. The screen will show "off" for a logic low voltage, typically less than 0.8 volts. There is also a Set Up Mapping button, used for assigning a screen position to each digital input signal.

10.3.1 How to Change the Auxiliary Digital Input Signal Title

The window shown in Figure 10-14 displays the default names for all the auxiliary digital input signals.To change the title of an Auxiliary Digital Input Signal, do the following:

- From the menu bar, select Other | Auxiliary Digital Input Signals.
- Click on a SIG # button. The window shown in Figure 10-15 appears.

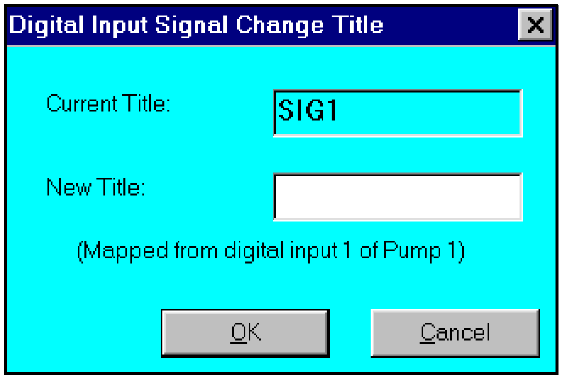


Figure 10-15 Digital Input Signal Change Title Window

- In the Digital Input Signal Change Title window, the Current Title will be displayed.
- Click in the New Title field.
- Enter a new title. Up to eight alphabetic or numeric characters will display.
- When finished, click on OK.

10.3.2 How to Map an Auxiliary Digital Input Signal

You will notice words in parentheses at the bottom of the Digital Input Signal Change Title window shown in Figure 10-15. An example is: (Mapped from digital input 1 of pump 1). This is telling the user exactly where this digital input signal is being received from. In this example, it is from pump number 1, digital input 1. If the field has not been set up to receive a signal, or no pump is attached to a particular signal, it would read: (no mapping). Mapping is simply a way of assigning each signal a screen location on the Auxiliary Digital Input Signals window, so that PumpWorks knows in which field to display the data from that signal.

When a new pump is installed onto PumpWorks, auxiliary digital inputs are automatically assigned an auxiliary digital input number and corresponding screen position on the Auxiliary Digital Input Signals window. To change where a particular signal will be displayed on that window:

- From the menu bar, select Other | Auxiliary Digital Input Signals.
- Click on Set Up Mapping in the lower left hand corner and the window shown in Figure 10-16 appears.

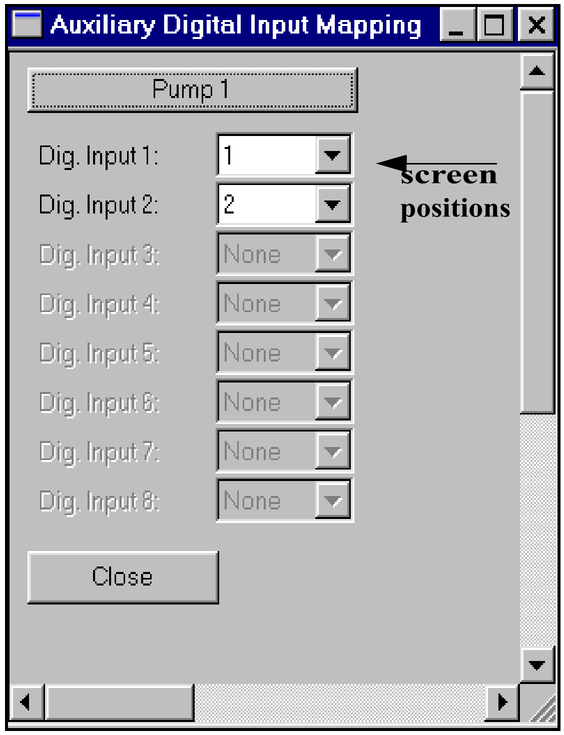


Figure 10-16 Auxiliary Digital Input Mapping Window

The Digital Input Mapping Window includes the two digital input channels available from each QX Series, QL-700, CMD-5000 or CN-6000 in your system. (If your system includes an SC-2400 pump controller, eight digital input channels will be available from it.)

To change where a signal's on/off status will be displayed on the Auxiliary Digital Input Signals window:

- In the Auxiliary Digital Input Mapping window, click on the arrow at the right hand side of the auxiliary digital input signal you wish to change.
- Click on the screen position number (1 - 32) where you wish the signal status to be displayed on the Auxiliary Digital Input Signals window.

  NOTE: Only available positions will be displayed. To assign an auxiliary signal to a number that is occupied, first assign that auxiliary digital input signal to a different number, or unassign it by assigning it to "none"--which can be scrolled up to (above #1).
- When finished with this window, click on the Close button at the lower left corner of the window.

The auxiliary digital input signal information is immediately displayed to the new screen position on the Auxiliary Digital Input Signals window.

Another way to open the Auxiliary Digital Input Mapping window is:

- From the menu bar, select Configure | Set Up Resource Mapping | Set Up Auxiliary Digital Input Mapping.

10.4 Auxiliary Valves

The Auxiliary Valves window is where a user can control the on or off status of any auxiliary valve(s) that the user has added to the pump system. In other words, the user can open or close an auxiliary valve from this window.

From the menu bar, select Other | Auxiliary Valves. The window shown in Figure 10-17 appears.

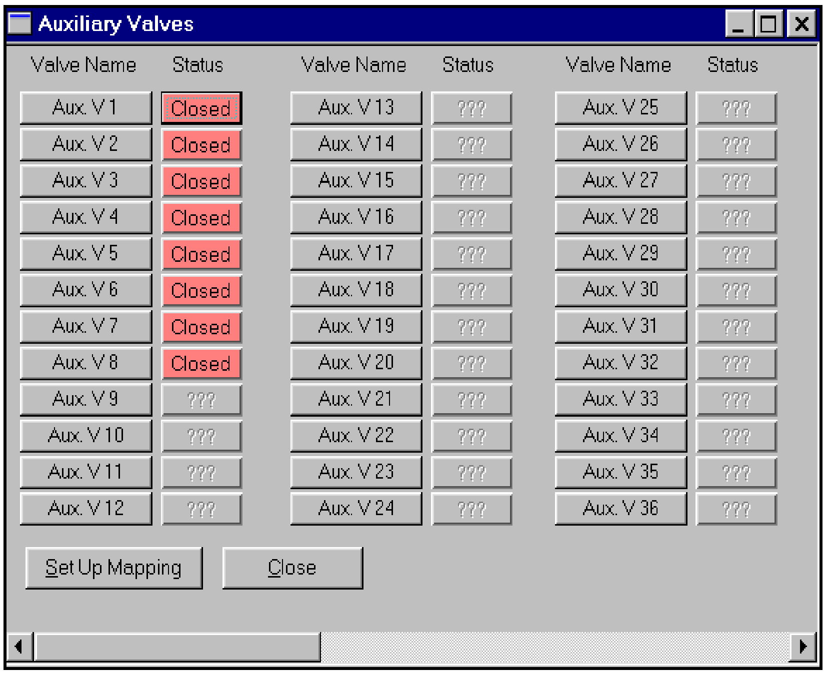


Figure 10-17 Auxiliary Valves Window

The Auxiliary Valves Window displays the name of the auxiliary valve and its open/closed status. There are 64 channels available on this window; use the scroll bar on the bottom of the screen to view channels 37 - 64.

10.4.1 How to Change the Title of an Auxiliary Valve

The window shown in Figure 10-17 displays the default names for the auxiliary valves. To change the title of an auxiliary valve, do the following:

- From the menu bar, select Other | Auxiliary Valves.
- Click on an auxiliary valve button and the window shown in Figure 10-18 appears.

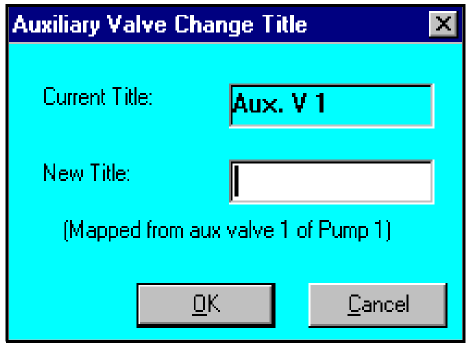


Figure 10-18 Auxiliary Valve Change Title Window

- In the Auxiliary Valve Change Title window, the current title, or name, will be displayed.
- Click in the "New Title" field.
- Enter a new title. Up to eight alphabetic or numeric characters will display.
- When finished with this window, click on OK.

10.4.2 How to Map an Auxiliary Valve Signal

You will notice words, in parentheses, at the bottom of the Auxiliary Valve Change Title window. The example shows (Mapped from aux valve 1 of Pump 1). This is telling the user exactly where the auxiliary valve signal is being received from. In this example, it is from Pump 1, Auxiliary Valve channel 1. If the field has not been set up to receive a signal, or no pump is attached to a particular signal, it would read: (No Mapping). Mapping each auxiliary valve is simply a way of assigning it a screen location on the Auxiliary Valves window, so that PumpWorks knows in which field to display the status of that valve.

When a new pump is installed onto PumpWorks, auxiliary valves are automatically assigned an auxiliary valve number and corresponding screen position on the Auxiliary Valves window. To change the auxiliary valve number assigned, do the following:

- From the menu bar, select Other | Auxiliary Valves.
- Click on Set Up Mapping in the lower left hand corner and the window shown in Figure 10-19 appears.

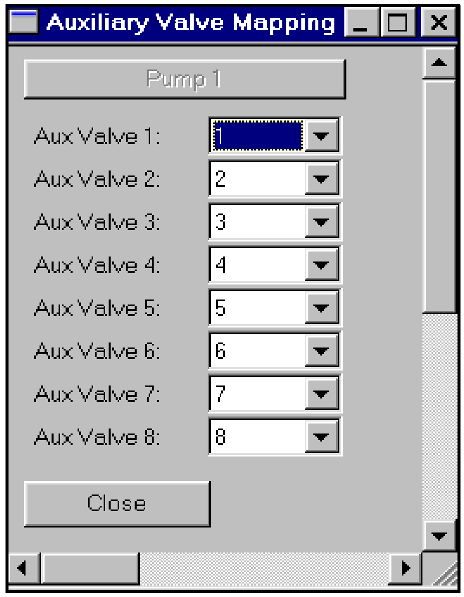


Figure 10-19 Auxiliary Valve Mapping Window

The Auxiliary Valve Mapping window includes eight auxiliary valve channels for each QX Series Pump, QL-700, CMD-5000, or CN-6000 pump controller in your system.

- In the Auxiliary Valve Mapping window, click on the arrow at the right hand side of the auxiliary valve signal you wish to change.
- Click on the auxiliary valve number (1-64) where you wish the signal status to be displayed on the Auxiliary Valves window.

  NOTE: Only available auxiliary valve positions will be displayed. To assign an auxiliary valve to a number that is occupied, first assign that auxiliary valve to a different number, or unassign that valve by assigning it to “none”--which can be scrolled up to (above #1).
- When finished with this window, click on Close to return to the Auxiliary Valves window.

Another way to open the Auxiliary Valve Mapping window is:

- From the menu bar, select Configure | Set Up Resource Mapping | Set Up Auxiliary Valve Mapping.

10.5 Auxiliary Digital Output Signals

The Auxiliary Digital Output Signals option allows the user to control the on or off status of up to 16 digital outputs. In other words, this window allows the user to turn a switching device on or off. The Auxiliary Digital **Input** Signals option, by contrast, allows the user to **view** the status of a switching device, but not control it.

The auxiliary digital output signals work by changing the voltage level of the signal. A logic high voltage of 3.6 volts or higher will turn the device on; a logic low voltage of less than 0.8 volts will turn the device off. These voltages are the same as those used for digital input signals.

- From the menu bar, select Other | Auxiliary Digital Output. The window shown in Figure 10-20 appears.

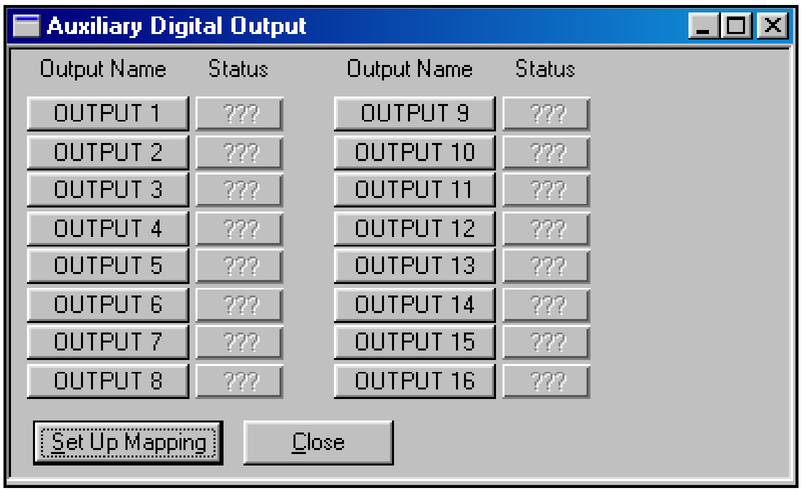


Figure 10-20 Auxiliary Digital Output Window

The Auxiliary Digital Output window displays the title (name) and on/off status for each digital output. There are 16 channels available on this window.

NOTE: Digital outputs are only valid for QX Series, QL-700, CMD or CN controller models with a controller code version of 57.60 or later. If the remote start/stop feature has been enabled for a controller (in the Pump Operating Parameters window), the Auxiliary Digital Output mapped to channel 1 of that controller is associated with the remote start/stop control, and therefore cannot be controlled via PumpWorks.

10.5.1 How to Change the Auxiliary Digital Output Title

The window shown in Figure 10-20 displays the default names for the auxiliary digital outputs. To change the name of an auxiliary digital output, do the following:

- From the menu bar, select Other | Auxiliary Digital Output.
- Click on an auxiliary digital output name button and the window shown in Figure 10-21 appears.

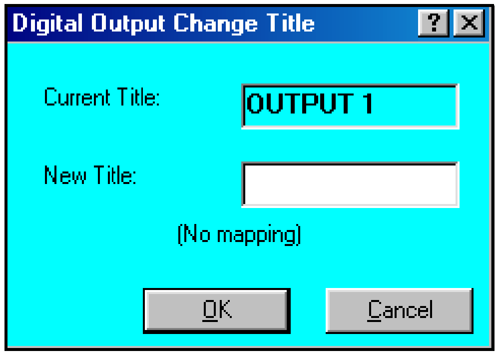


Figure 10-21 Digital Output Change Title window

- In the Digital Output Change Title window, the current title will be displayed.
- Click in the New Title field.
- Enter a new title. Up to eight alphabetic or numeric characters will display.
- When finished with this window, click on OK to return to the Auxiliary Digital Output window.

10.5.2 How to Map an Auxiliary Digital Output

You will notice words, in parentheses, at the bottom of the Digital Output Change Title window. The example shows (Mapped from digital output 1 of Pump 1). This is telling the user exactly where the auxiliary digital output signal is being received from. In this example, it is from Pump 1, auxiliary digital output channel 1. If the field has not been set up to receive a signal, or no pump is attached to a particular signal, it would read: (No Mapping). Mapping each auxiliary digital output is simply a way of assigning it a screen location on the Auxiliary Digital Output window, so that PumpWorks knows in which field to display the status of that signal.

When a new pump is installed onto PumpWorks, auxiliary digital outputs are automatically assigned an auxiliary digital output number and corresponding screen position on the Auxiliary Digital Output window. To change the auxiliary digital output number assigned, do the following:

- From the menu bar, select Other | Auxiliary Digital Output.
- Click on Set Up Mapping in the lower left hand corner and the window shown in Figure 10-22 appears.

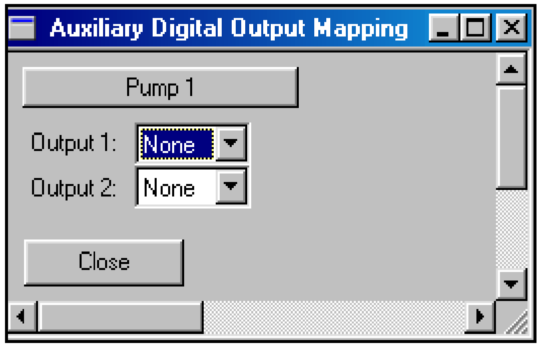


Figure 10-22 Auxiliary Digital Output Mapping window

The Auxiliary Digital Output Mapping window includes two auxiliary digital output channels for each QX Series, QL-700, CMD-5000, or CN-6000 pump controller in your system.

- In the Auxiliary Digital Output Mapping window, click on the arrow at the right hand side of the digital output you wish to change.
- Click on the number (1-16) where you wish the signal status to be displayed on the Auxiliary Digital Output window.

  NOTE: Only available auxiliary digital output positions will be displayed. To assign an auxiliary digital output to a number that is occupied, first assign that auxiliary digital output to a different number, or unassign that output by assigning it to "none"--which can be scrolled up to (above #1).
- When finished with this window, click on Close to return to the Auxiliary Digital Output window.

Another way to open the Digital Output Mapping window is:

- From the menu bar, select Configure | Set Up Resource Mapping | Set Up Auxiliary Digital Output Mapping.

10.6 Separator Data

A separator is a device which can be added to a pump system by the user. When two fluids that do not mix are together (for example, water and oil), a separator is used to determine the volume of each fluid The liquid that is more dense will gravitate to the bottom of the container, while the liquid that is less dense will rise to the top. The separator is a device that emits a high frequency acoustic signal, which hits the fluid interface and bounces back. Because the speed that the acoustic signal travels is known, the volume of each fluid is reported to PumpWorks. A separator may be added to a pump system and the data acquired from it logged to a data log file.

The Separator Data Window displays information about separators which have already been set up. If a separator has not been set up, then no data will be displayed. To set up a separator, from the menu bar, click on Communications | Separator Communications. Please refer to Chapter13, Separator Communications, Section 13.4.

For a list of separators supported by PumpWorks, please refer to Chapter13, Separators Supported by PumpWorks, Section 13.4.2.

To open the Separator Data window, do the following:

- From the menu bar, select Other | Separator Data. The window, shown in Figure 10-23 opens.

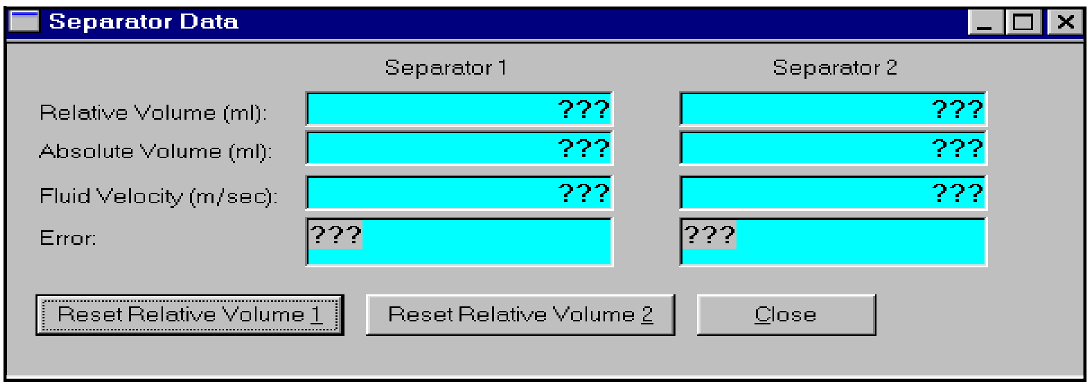


Figure 10-23 Separator Data Window

- **Relative Volume:** In the Separator Data window, the relative volume text box displays the change in the denser or lower fluid volume, since the last time the volume was zeroed.
- **Absolute Volume:** The absolute volume text box displays the denser or lower fluid volume. An increase in the absolute volume means there is more of the denser fluid than previously. A decrease in the absolute volume means there is less of the denser fluid than previously.
- **Fluid Velocity:** The fluid velocity of the denser or lower fluid is reported to PumpWorks and shown in the fluid velocity text box.
- **Error:** If the separator signals no longer can detect the fluid levels, then an error message will be displayed.
- **Reset Relative Volume:** The “Reset Relative Volume 1" or “Reset Relative Volume 2" buttons will reset the relative volume of that separator to zero. The reset button will not be functional if the DDE interface for the separator is used.

10.7 Back Pressure Regulator

A back pressure regulator is a device that can be added to a pump system by the user. A back pressure regulator maintains a specific pressure level, or can vent pressure, but cannot build pressure to a higher level.

The Back Pressure Regulator window displays information about a back pressure regulator for which communications has already been configured. If a back pressure regulator has not been configured, then no data will be displayed. To configure a back pressure regulator:

- From the menu bar, click on Communications | Back Pressure Regulator. Please refer to Chapter13, Back Pressure Regulator Communications, Section 13.5.

For a list of back pressure regulators supported by PumpWorks, please refer to Chapter13, Back Pressure Regulators Supported by PumpWorks, Section 13.5.1

10.7.1 Back Pressure Regulator Control

- From the menu bar, select Other | Back Pressure Regulator. The window shown in Figure 10-24 appears.

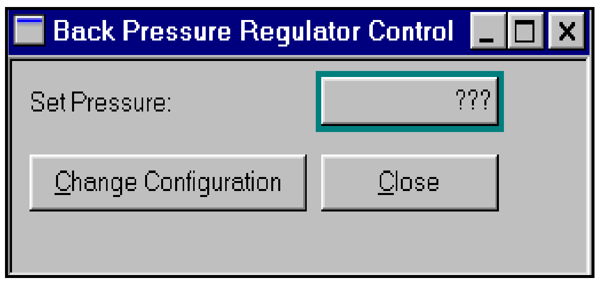


Figure 10-24 Back Pressure Regulator Control Window

10.7.2 Set Back Pressure

- In the Back Pressure Regulator Control window, click on the set pressure button and the window shown in Figure 10-25 appears.

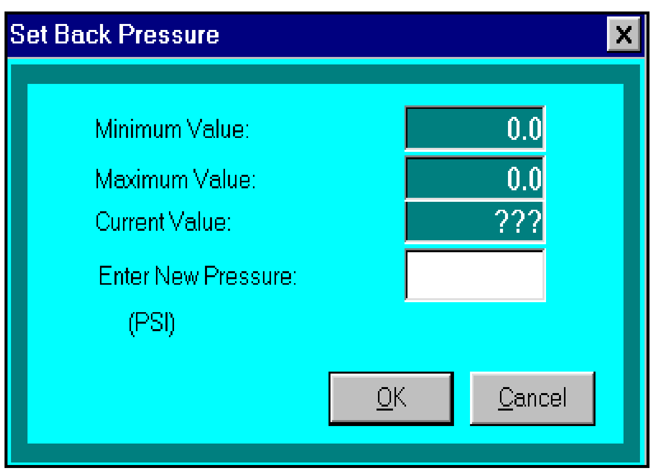


Figure 10-25 Set Back Pressure Window

In the Set Back Pressure window, a user can set the back pressure regulator's pressure by doing the following:

- In the Set Back Pressure window, click in the Enter New Pressure window. Enter a pressure.
- When finished with this window, click on OK to return to the Back Pressure Regulator Control window.

10.7.3 Enable Back Pressure Regulator

To enable a Back Pressure Regulator, do the following:

- From the menu bar, select Other | Back Pressure Regulator. The Back Pressure Regulator Control window appears.(Refer to Figure 10-24.)
- In the Back Pressure Regulator Control window, click on Change Configuration and the window shown in Figure 10-26 appears.

Figure 10-26 Configure Communication for Back Pressure Regulator Window

- In the Configure Communication for Back Pressure Regulator window, click on Enable Regulator.

NOTE: Once enabled, the Enable Regulator button will change to Disable Regulator, so a user can disable a back pressure regulator.

Another way to open the Configure Communications for Back Pressure Regulator window is:

- From the menu bar, select Communications | Back Pressure Regulator.

10.8 Equations and Timers

PumpWorks can calculate the answers for up to sixteen user-specified mathematical equations. The equations are normally calculated four times per second, using current data, but are calculated more frequently during sequencer operation to avoid timing problems.

In addition, PumpWorks allows users to monitor and control 16 variables that can be used in equations, sequencers, etc. The value of each of the 16 variables are shown in the right side of the equation window.

PumpWorks can record the equation answers to a data log. Equation results can also be used in sequences. To view the equations and their results, along with the variables, do the following:

- From the menu bar, select Other | Equations and Timers. The window shown in Figure 10-27 appears.

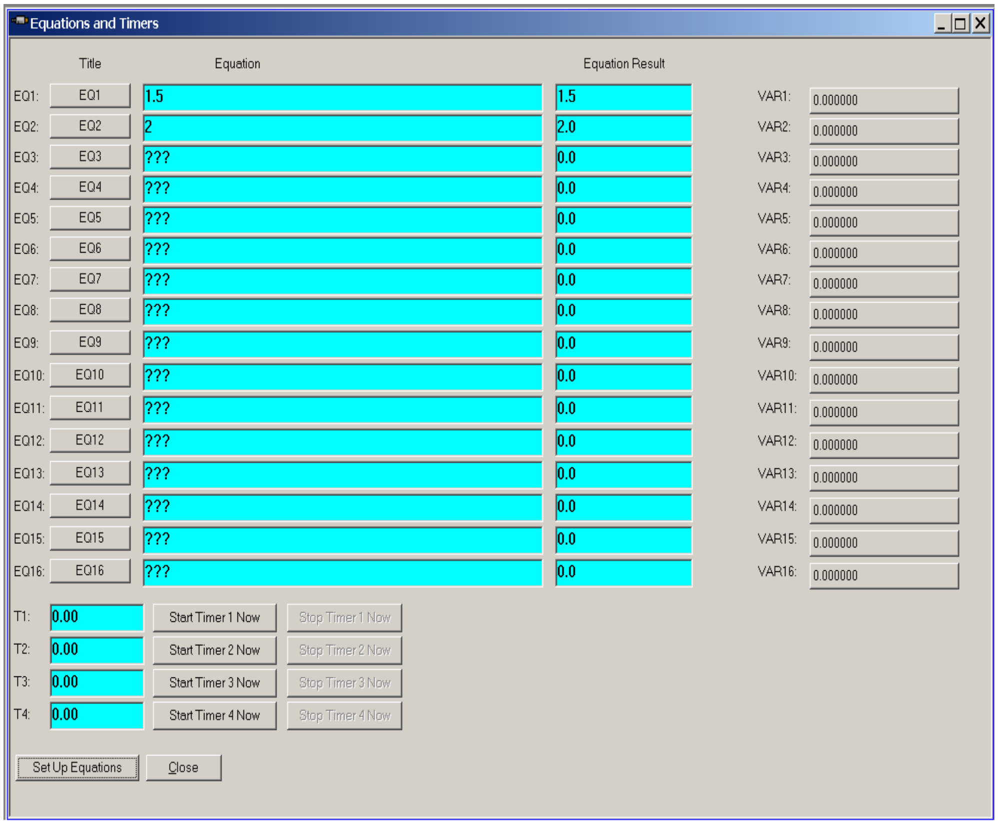


Figure 10-27 Equations and Timers Window

Title: In the Equations and Timers window, the title column shows the name the user has assigned to each equation.

Equation: The Equation column displays the user's equations. Up to sixteen equations may be set up.

Equation Results: The Equation Results column displays the equation answers.

Variables: Next to each variable title (VAR1 - VAR16) is a button showing the current value of each variable.

Timers: There are four timers available, labeled T1 through T4. The user may start and then stop a timer by clicking on the buttons to the right of the timer field. When a timer is started, it automatically resets to zero.

10.8.1 Changing an Equation Title, Unit Title and Decimal Places

To change an equation title, units, or number of decimal places displayed to the right of the decimal point, do the following:

- From the menu bar, select Other | Equations and Timers.
- In the Equations and Timers window, click on an Equation Name and the window shown in Figure 10-28 appears.

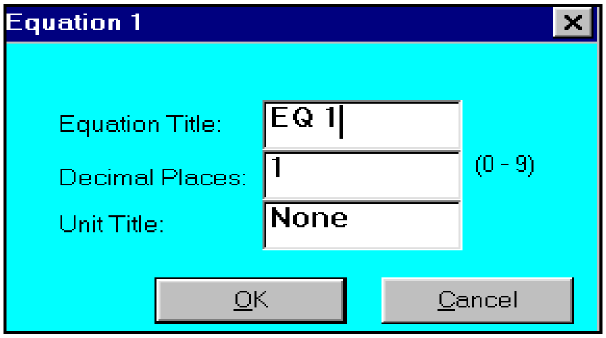


Figure 10-28 Equation # Window

10.8.1.1 Equation Title

Enter the name you wish to use for this equation in the Equation Title text box of the Equation # window by doing the following:

- Highlight the current title.
- Enter the name you wish for the equation.

10.8.1.2 Decimal Places

In the Decimal Places text box, enter the number of places you wish displayed to the right of the decimal point. For example, if you enter a zero, the number will be a whole number. If you enter a two, there will be two numbers to the right of the decimal point. To change the decimal places, do the following:

- In the Equation # window, click in the Decimal Places text box and highlight the current number.
- Enter how many numbers you wish to display to the right of the decimal point.
- When finished with this window, click on OK.

10.8.1.3 Unit Title

The Unit Title allows the user to enter a unit of measurement for the displayed equation. The unit of measurement entered is a visual reminder only. Entering a unit of measurement here does not change the equation data to that unit of measurement. To enter a unit title, do the following:

- In the Equation # window, click in the Unit Title text box and highlight the current unit title.
- Enter the unit of measurements title.
- When finished with this window, click on OK.

10.8.2 Writing an Equation

The following guidelines will help you in writing equations:

- Equations can use any of the math symbols, arguments, or pump parameters shown in Figure 10-29 below, and Figure 8-2 in Chapter 8, Section 8.3.3.
- Equation answers can be either positive or negative.
- Multiplication and division have priority over addition and subtraction.
- If all operations have equal priority (all are multiplication and division, or addition and subtraction), then PumpWorks will compute the answer from left to right.
- Operations inside of parentheses will be evaluated first.
- Equations can be any length.
- Spaces are ignored and do not alter an equation.
- Parameters can be used the same way as a number would be used.

10.8.2.1 Math Functions Usable in Equations

The math functions usable in equations and accepted by PumpWorks are shown in Figure 10-29 below. An argument is an input to a function. An argument must be in parentheses and can be a numeric entry, pump parameter (as shown in Figure 10-30 in the following section), timer, or arithmetic expression.

MATH FUNCTIONS / SYMBOLS	DESCRIPTION
+	Add
-	Subtract
*	Multiply
/	Divide
()	Parentheses
LOG (argument)	Natural Logarithm
EXP (argument)	Exponential
LOG10 (argument)	Logarithm (base 10)
POW (argument 1, argument 2)	Raises argument 1 to the argument 2 power

SIN (argument)	Sine
COS (argument)	Cosine
TAN (argument)	Tangent
Pi	3.14159...
For Sine, Cosine, and Tangent the argument is in radians, not degrees.	
The argument must be in parentheses and can be a numeric entry, pump parameter, timer or arithmetic expression.	

Figure 10-29 Math Functions Usable in Equations

10.8.2.2 Pump Parameters Usable in Equations

The PumpWorks pump parameters usable in equations are the same parameters usable in the sequencer, shown in Figure 8-2, in Chapter 8, Section 8.3.3. While either style can be used in equations, “New Format Notation” is compatible with DDE definitions. All parameter values are in currently defined display units.

10.8.3 Setting Up an Equation

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to change any of the equations. Please refer to Chapter 6, Section 6.8 for details on the password protection feature.

To set up an equation, do the following:

- From the menu bar, select Other | Equations and Timers.
- In the Equations and Timers window, click on the Set Up Equations button at the bottom, left hand corner of the window. The window shown in Figure 10-30 appears.

Figure 10-30 Set Up Equations Window

- To set up an equation, click in an available text box in the Set Up Equations window.
- Highlight the current equation. (Three question marks will appear if no equations have been set up.)
- Enter an equation.
- When finished with the Set Up Equations window, click on OK to return to the Equations and Timers window where the answer to your mathematical equation will immediately appear.

To have an equation logged to a data log file, do the following:

- From the menu bar, select Data Log | Set Up Data Log.
- Click on Set Up Equation Logging and the Set Up Equation Logging window appears.
- Click in the check box to the left of the equation(s) you wish logged.
- When finished with this window, click on OK.

10.8.4 Variables

Variables can be used in equations, as well as sequences, and passed to other applications via DDE. The value of these variables can also be manipulated by the sequencers, as well as by other applications via the DDE (please refer to Chapter 8, Section 8.3.3, and Chapter 15, Section 15.2 for more details). The current value of each of the 16 variables are displayed in the buttons on the right side of the Equations and Timers window. To change the value of a variable from the Equations and Timers window:

- Click on the appropriate variable button.
- If the variable is controlled (not just monitored) by a currently running sequence, a warning will pop up asking for a confirmation that you still want to change the variable.
- If no variable is being controlled by a current sequence, or if you confirm that you still want to change the variable, the Set Variable dialog box, shown in Figure 10-31 appears.

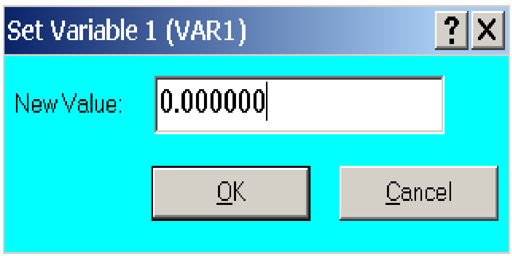


Figure 10-31 Set Variable window

- Enter the new value for the variable, and click on OK.

10.8.5 Timers

Timers can be used in equations in which the user wants to include a period of time as part of the calculation. Timers can also be used in sequence steps for control purposes if the user wants to include a period of time as part of a test, or as part of a command. (Refer to Section 8.3 for more information on sequences.)

To start a timer, simply click on the "Start Timer # Now" button for the desired timer. The accumulated time will be displayed in the adjacent field. To stop the timer, click on the "Stop Timer # Now" button. Each time the Start Timer Now button is clicked on (the button text will change to "Restart Timer Now" when the timer is on), the timer will reset to zero and start accumulating time all over again. The timer will retain its value when it is stopped until the next time it is started. The timers may also be started and stopped via the sequencer.

10.9 Maintenance Timers and Counters

Periodic maintenance is required on all pumps. The maintenance to be performed is pump specific, and is detailed in the pump manuals. For versions 60.6 or later on QX pumps, or for versions 57.227 or later on other pumps, PumpWorks provides a feature to remind users when a pump is due for maintenance.

NOTE: If a front panel is present with a QX pump, the front panel version must be 1.104.0 or greater in order for this feature to be supported.

10.9.1 Viewing the Maintenance Status for Pumps

To view the maintenance status for all communication pumps, do the following:

- From the menu bar, select Other | Maintenance Timers and Counters. The Maintenance Timers and Counters window shown in Figure 10-32 opens.

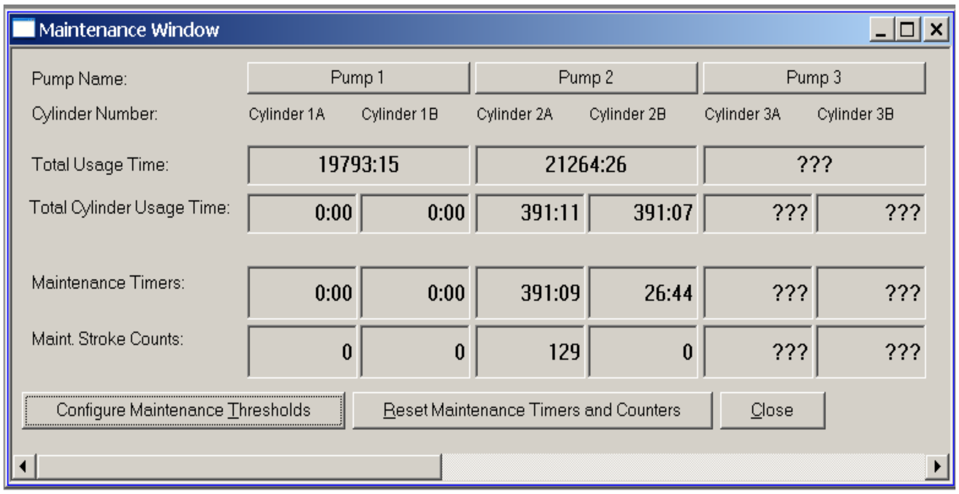


Figure 10-32 Maintenance Timers and Counter Window

- **Total Usage Time** indicates the total time the pump controller has been powered up, for the life of the pump.
- **Total Cylinder Usage Time** indicates the amount of time the cylinder has been running, for the life of the cylinder.
- **Maintenance Timers** indicate the amount of time the cylinder has been running since the last time the timer was reset (the user resets this timer when maintenance has been performed - please refer to Chapter 10, Section 10.9.2 for instructions on resetting this timer).
- **Maintenance Counters** indicate the number of strokes the cylinder has cycled through since the last time the counter was reset (user resets this counter when maintenance has been performed - please refer to Chapter 10, Section 10.9.2 for instructions on resetting this counter).

NOTE: All times are shown in format hour:minute. Each stroke count consists of an extend and retract cycle.

The maintenance timer and counter fileds are color coded. If the field is yellow, it means that maintenance is due soon. (Field turns yellow when 80% of the stroke count threshold has been exceeded.) When either the stroke count threshold or operating time threshold has been exceeded, the filed turns red. When any of the fields are red, maintenance should be performed as soon as reasonably possible. The maintenance thresholds are factory set, but can be adjusted. See Chapter 10, Section 10.9.2 for detailed instructions on changing the maintenance thresholds.

NOTE: In addition to color coding the fields in the Maintenance Timer and Counter window, when maintenance on a pump is overdue, PumpWorks will pop up a warning window notifying the user that it is tme to perform maintenance. An example of the warning is shown in Figure 10-33

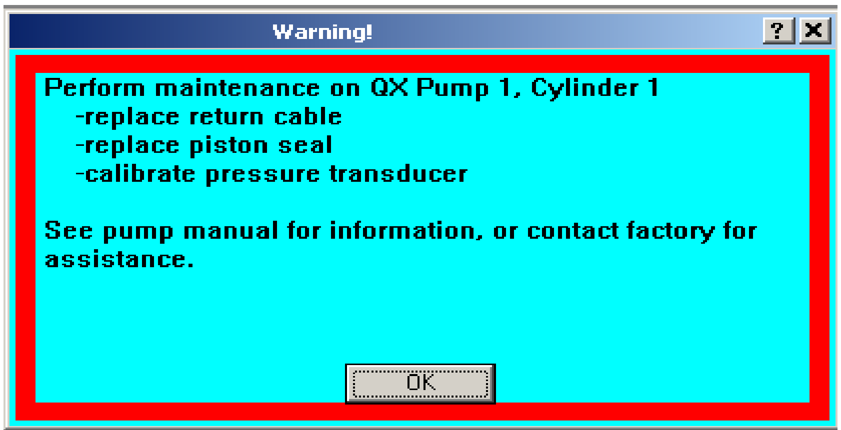


Figure 10-33 Pump Maintenance Warning

10.9.2 Resetting the Maintenance Timers and Counters after Performing Required Maintenance

After performing the required maintenance on a pump, the maintenance timers and counters for both cylinders need to be reset, so that PumpWorks can keep track of when the next time maintenance is due. To reset the timers/counters, do the following:

- From the menu bar, select Other | Maintenance Timers and Counters. The Maintenance Timers and Counters shown in Figure 10-32 opens. (If this window is already open, skip this step and continue with the next step.)
- Click on the Reset Maintenance Timers and Counters button. The Maintenance Reset window shown in Figure 10-34 opens.

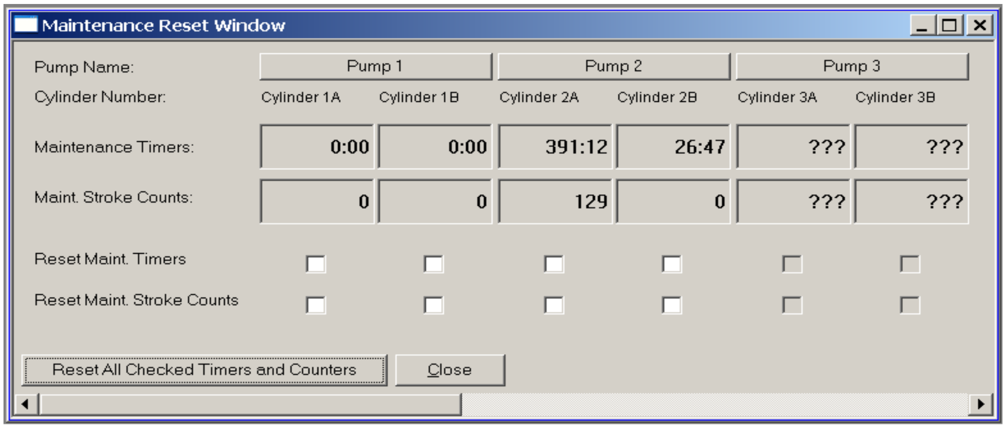


Figure 10-34 Maintenance Reset Window

- Click on both the timer and counter check boxes for the cylinders on which you've performed maintenance (make sure the appropriate boxes are checked), and then click on the Reset All Checked Timers and Counters button at the bottom of the window. You should see the maintenance values reset to 0 for the cylinders that you reset.
- When finished, click on the Close button to close the window.

10.9.3 Changing Maintenance Thresholds

The maintenance thresholds are intially set by the factory to recommended values. If there is a need to change these thresholds (for example, because of operating conditions or past experience, you prefer to perform scheduled maintenance more often), open the Maintenance Configuration window by doing the following:

- From the menu bar, select Other | Maintenance Timers and Counters. The Maintenance Timers and Counters shown in Figure 10-32 opens. (If this window is already open, skip this step and continue with the next step.)
- Click on the Configure Maintenance Thresholds button. The Maintenance Configuration window shown in Figure 10-35 opens.

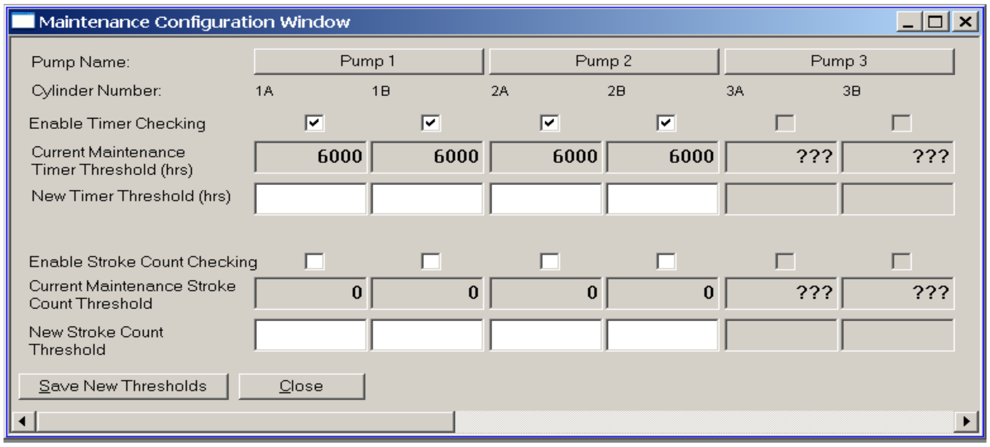


Figure 10-35 Maintenance Configuration Window

- Enter any thresholds you wish to change in the appropriate fields.

PumpWorks will automatically give a warning when maintenance is past due. The default logic for determining when to give a warning is based on pump type. Normally, for QX pumps, the stroke counts are monitored but NOT the usage time, and for all other pump types, the usage time is monitored, but not the stroke counts. If you wish to change this logic, for example, to monitor the time instead of the stroke counts, or to monitor both, or even to monitor neither (effectively disabling the warning logic), you may do so by checking and/or unchecking the appropriate check boxes for enabling timer checking and/or enabling stroke count checking. Clicking on the check boxes will toggle their state between checked and unchecked.

- When all thresholds have been set to their desired values, and the check boxes are in their desired states, click on the Save New Thresholds button at the bottom of the window to save your changes.
- When finished, click on the Close button. Note that clicking on the Close button will NOT save any changes you made. To save and apply any changes, click on the Save New Threshold button.

11 ERROR/LOG MENU

The Error/Log Menu includes the following items, which will be discussed in this chapter.

- System Status (1-4), Section 11.1
- System Status (5-8), Section 11.2
- Current Error Log, Section 11.3
- Previous Errors and Events, Section 11.4
- Cylinder Switch Status, Section 11.5
- Select Events/Errors to View, Section 11.6
- Force Error State Capture Entry, Section 11.7
- Switch to Error State Capture Mode, Section 11.8
- Error State Capture Mode, Section 11.9
- Switch to Normal Communications Mode, Section 11.10
- Create Diagnostic Zip File, Section 11.11

11.1 System Status (1-4)

The System Status (1-4) window allows the user to view the error conditions of pumps 1 through 4.

- From the menu bar, select Error/Log | System Status (1-4) and the window shown in Figure 11-1 appears.

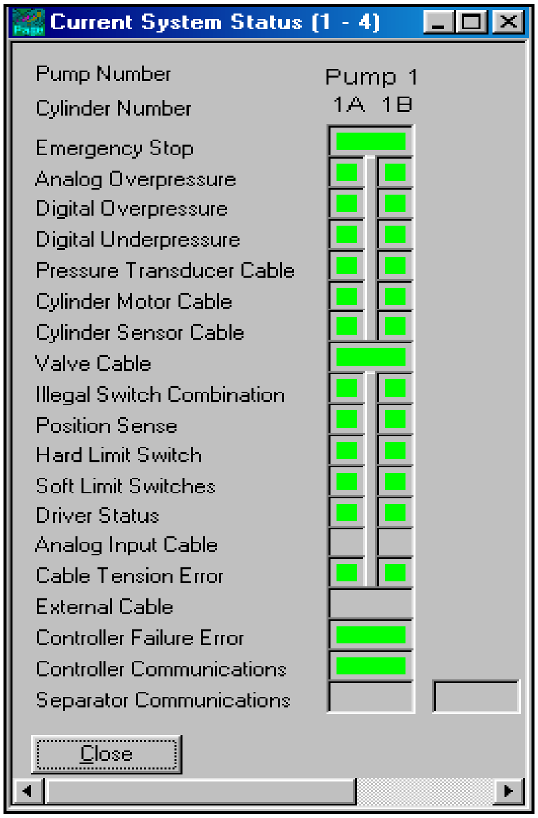


Figure 11-1 System Status (1-4) Window

In the System Status window, green indicates no errors are present while red indicates that an error is present. Pumps that are not operating, and errors that are not used, are grayed. Figure 11-2 gives a list of error conditions that are covered in the System Status window.

System Status Error Condition	
PUMP PART	**ERROR CONDITION**
Emergency Stop	The emergency stop switch has been activated.
Analog Overpressure	The signal leading from the pressure transducer is greater than the maximum allowed.
Digital Overpressure	The pump pressure is greater than the user-set safety pressure.
Digital Underpressure	The pressure transducer is disconnected or malfunctioning.
Pressure Transducer Cable	The pressure transducer cable is disconnected or faulty.

Cylinder Motor Cable	The cylinder motor cable is disconnected or faulty.
Cylinder Sensor Cable	The cylinder sensor cable is disconnected or faulty.
Valve Cable	The valve cable is disconnected or faulty.
Illegal Switch Combination (SC-2400 Only)	Cylinder sensor board indicates physically impossible switch combination.
Position Sense	The piston position sensors do not agree with the trigger and limit switches.
Hard Limit Switch	The hard limit switch was activated.
Soft Limit Switch	The soft limit switch was activated.
Driver Status	Power failure fault detected (may not be powered on).
Auxiliary A/D Cable	Auxiliary A/D cable is disconnected or faulty.
Cable Tension Error	There is not enough tension in the motor drive cable.
External Cable	Not used.
Spare Error	Not used.
Controller Failure Error	Internal Controller Error
Controller Communications	Controller communications lost.
Separator Communications	Separator communications lost.

Figure 11-2 System Status Error Conditions

11.2 System Status (5-8)

The System Status (5-8) window is the same as the System Status (1-4) window, above, except that the user can view the error conditions of pumps 5 through 8.

11.3 Current Error Log

The Current Error Log window lists the most recent errors registered by the pump system, with new errors added at the bottom of the screen.

- From the menu bar, select Error/Log | Current Error Log and the window shown in Figure 11-3 appears.

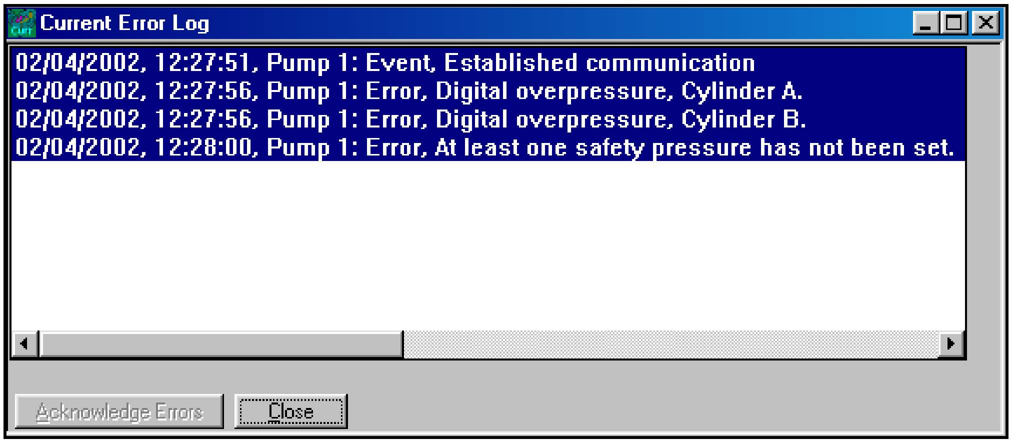


Figure 11-3 Current Error Log Window

The Current Error Log contains information, divided by a comma, and followed by a space. The following information can be found on a log entry.

Error Date, Error Time, Error Message

In earlier versions of PumpWorks, there may be fields to the left of the error date. These would be used for synchronization with the error state capture mode and can be ignored.

11.3.1 Acknowledge Errors

The Current Error Log window has an "Acknowledge Errors" button at the bottom of the window. Clicking on this button means the user has acknowledged that an error has occurred. All errors not acknowledged have a dark background. All errors that have been acknowledged are displayed with a white background.

- In the Current Error Log window, click on the Acknowledge Errors button to acknowledge new errors appearing in the window.

NOTE: Acknowledging an error means the user has read the error message. It does not remove the error condition.

11.3.2 Status Bar Error Messages

The status bar at the bottom of the main window of PumpWorks can show the following four different error messages:

1. **No Errors**
2. **Check Error Log**
   This message warns the user an error has occurred, but the error has gone away or was resolved. When the user checks the error log, a specific error message will be described. Once the user views and acknowledges the error log, the message No Errors returns to the status bar.

3. **Errors Present**
   This message indicates there are currently one or more error conditions present in the pump system and that these errors have not been acknowledged or resolved.
4. **Unresolved Errors**
   This message reminds the user there is still an error present in the pump system that has not been resolved, even though it has been acknowledged in the error log.

Clicking on this button will open the Current Error Log window, shown in Figure 11-3.

11.4 Previous Errors and Events

The Previous Errors and Events window option allows users to view errors and events that have occurred in their pump system, including current errors.

- From the menu bar, select Error/Log | Previous Errors and the window shown in Figure 11-4 appears.

.

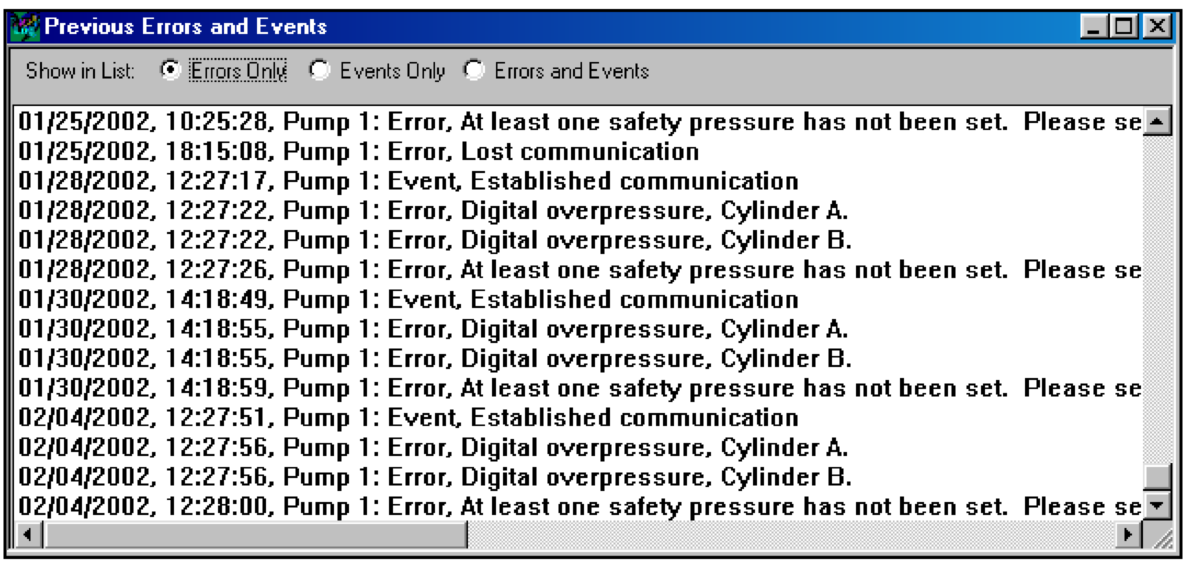


Figure 11-4 Previous Errors Window

The Previous Errors and Events window allows the user to view errors and/or events. Use the buttons at the top of the window to select errors, events, or errors and events. The number of errors/events a user can view in this window is limited to the most recent 5000 entries. This number includes all errors and events, as opposed to just those that are visible, based on the user's settings of errors and events to view. (Refer to Section 11.6.)

As an error occurs, an entry is recorded both to the Current Error Log, which contains the 100 most recent errors, and to the Previous Errors file, which holds a maximum of 1 MB of data. As an Event occurs, it is recorded to the event file, which holds a maximum of 2 MB of data. The Previous Errors file is saved to the hard drive of a user's computer under the name QUIZIX1.ERL and/or QUIZIX2.ERL, and the Events file is saved under the name QUIZIX1.EVN and/or QUIZIX2.EVN. Both are located in the PumpWorks directory. When the Previous Error or Events file exceeds the maximum size, the oldest errors/events are discarded.

When an error occurs, PumpWorks captures the error and writes to the computer's hard drive all the information available from the controller for 180 seconds before to 30 seconds after the error. This data is very useful in determining the cause of an error and is stored in the file "pumpwork1.est" and/or "pumpwork2.est", which are limited to a maximum length of 8 megabytes. Each time an event is recorded, the same information is captured, except only data from 5 seconds before to 2 seconds after the event. The user can set how many seconds they wish PumpWorks to record information before and after an error or event, as well as the maximum size of the "pumpwork1.est" and/or "pumpwork2.est" files by using Configure | Error State Capture Settings. Please refer to Chapter 12, Error State Capture Settings, Section 12.14 for further information. To review the pump conditions at the time of an error, please refer to Switch to Error State Capture Mode, Section 11.8.

11.5 Cylinder Switch Status

The Cylinder Switch Status option displays the current readings obtained from the motion sensor board of the pump cylinders. The sensor board indicates the position of the piston. The Switch Status window is useful if there is an error message related to the piston position or control switches.

- From the menu bar, select Error/Log | Cylinder Switch Status and the desired pump/cylinder, as shown in Figure 11-5.

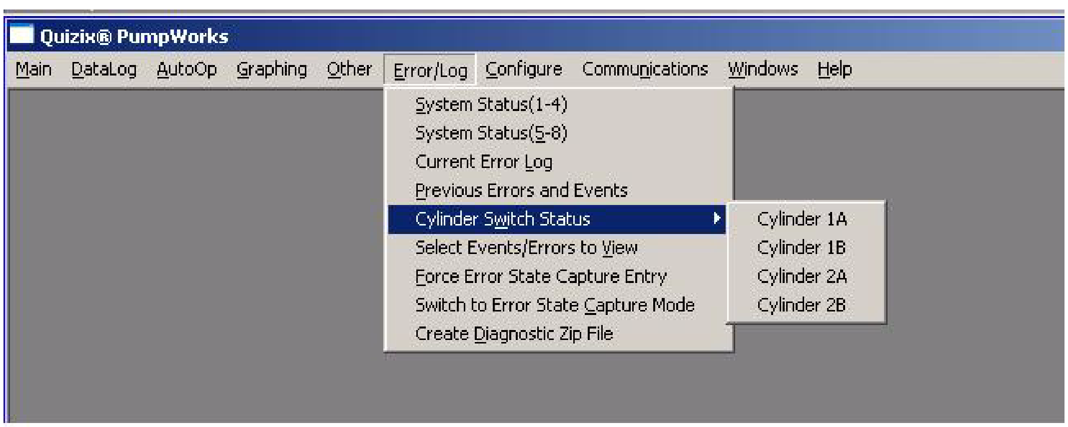


Figure 11-5 Cylinder Selection for Switch Status Window

- The window shown in Figure 11-6 appears.

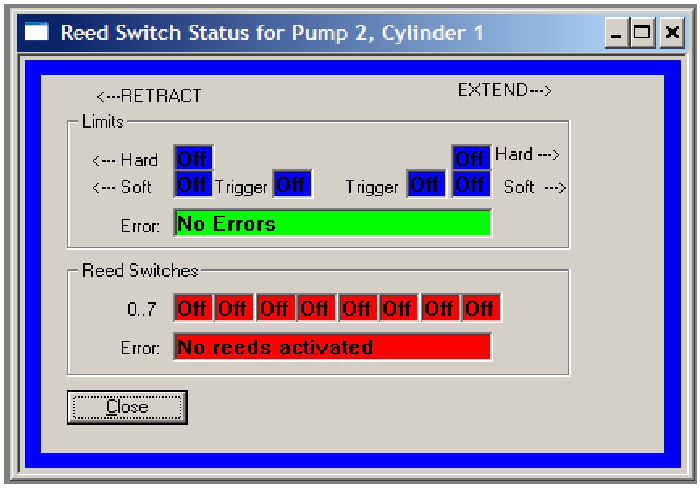


Figure 11-6 Cylinder # Switch Status Window

The Cylinder # Switch Status window displays the selected pump cylinder's switch parameters. It is a highly simplified schematic of a cylinder sensor board. Green indicates a switch is on, blue indicates a switch is off, and red means a switch is registering an error condition.

The switch parameters shown include the triggers, soft limits, hard limits, and, for the 5000 and 6000 series pumps, reed switches. The error condition of the sensor board is also displayed. The switch parameters are described in the following sections.

11.5.1 Trigger

When a Trigger Switch is activated, it indicates that the piston has reached the end of its stroke, either Max Extend or Max Retract. The trigger switch is normally activated at the end of every stroke and is not an error condition.

11.5.2 Soft Limit

Activation of a Soft Limit indicates that the piston has gone beyond the normal end of its stroke. A soft limit constitutes an error condition and prevents the pump controller from sending any more pulses, which prevents the piston from moving further in the direction it had been moving.

The soft limit switch is a one–way limit. If the soft limit is reached at the extend end of a piston stroke, the pump controller is not allowed to extend the piston any farther, but it can retract. Likewise, if a soft limit is reached at the retract end of a piston stroke, the pump controller is not allowed to retract the piston any further, but it can extend. The piston stops quickly when it reaches a soft limit.

11.5.3 Hard Limit

Activation of a Hard Limit Switch indicates that the piston has gone beyond the normal end of its stroke, AND that the soft limit switch has failed. For the SC-2400 controllers only, it is a two–way limit, which means when a hard limit is activated, any further motion of the piston, in either direction, is prevented.

The hard limit switch is a back–up safety feature. In normal use, it should never be activated. Hitting a hard limit indicates a serious problem, such as failure of a motor driver.

11.5.4 Reed Switches

The Sensor Boards on the 5000 and 6000 Series Pumps also include eight Reed Switches. A magnet is located just behind the cam roller, which is attached to the piston. As the piston travels along its stroke, the magnet activates each reed in succession. Depending on where the piston is, one, two, or three adjacent reeds may be activated. Activation of non–adjacent reeds, four or more reeds, or no reeds, constitutes an error condition.

11.6 Select Events/Errors to View

The Select Events/Error to View window is used to choose the type of events/errors to be displayed in the Previous Errors and Events window. The options are:

- Controller Commands
- General User Interface Events
- Sequencer Commands
- Ramping Commands
- Automatically Generated Events
- Other Events
- Errors
- Warnings

With the exception of the sequencer and ramping commands, all errors/events will be logged to the errorlog/eventlog **file**, regardless of these settings. They just won’t be shown in the Previous Errors and Events window if the setting is unchecked. Therefore, if the user later decides to change the error/events to view, all the errors/events that occurred before the user changed the settings will be available to be viewed. However, because the ramping and sequencer commands can be so numerous, PumpWorks has been designed to **not** log these commands to the eventlog if the user has chosen not to view them. So, if the user has previously chosen not to view these events, and then later changes the settings to view them, none of the sequencer and/or ramping commands that happened previous to the change will be available to view. (User’s will still be able to see when sequencing and/or ramping was started/stopped, just not the controller commands themselves.)

To open the Select Events/Error to View window, do the following:

- From the menu bar, select Error/Log | Select Events/Error to View and the window shown in Figure 11-7 appears.

To change the events/errors to view:

- Click on the event or error types to add a check mark next to items to be viewed. Click again to remove a check mark for items you do not want to view. Click OK. (Only check marked items will be displayed.)

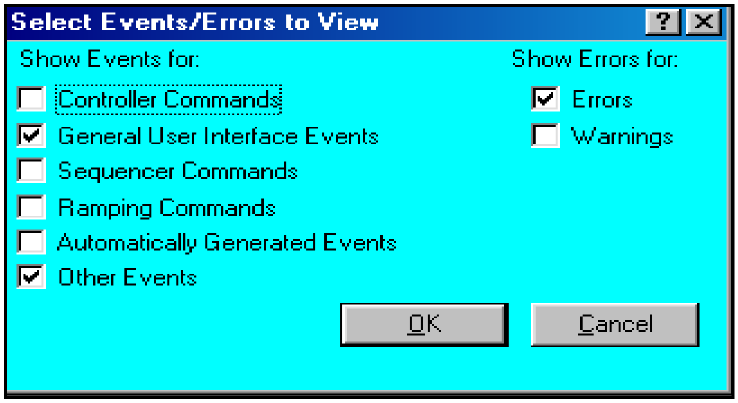


Figure 11-7 Events/Errors to View Window

11.7 Force Error State Capture Entry

Force Error State Capture Entry forces an error entry into the Current Error Log and Previous Errors files and forces a capture of pump operating data for a user-specified number of seconds before and after the forced entry time. This capture allows for analysis of an observed unusual or abnormal event. The error entry will read: “Forced Error State Capture Entry”.

With Error State Capture Mode a user can view the pump’s operating information as it was before, during or after an error occurred. By understanding the pump’s operating conditions, the user can better understand what was happening when the error occurred.

If a user observes something they want to understand better, forcing an error entry allows a user to mark that point as an “error”, which can then be accessed later using the Error State Capture feature (see Section 11.9).

- From the menu bar, select Error/Log | Force Error State Capture and the window shown in Figure 11-8 opens.

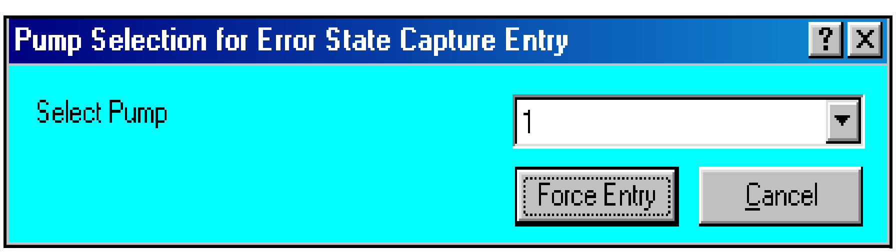


Figure 11-8 Pump Selection For Error State Capture Entry Window

To Force An Error State Capture Entry, do the following:

- In the Pump Selection for Error State Capture window, click on the down arrow to the right of the Select Pump text box.
- Click on the pump number that the error occurred on.
- Click on Force Entry.

Forcing an error state capture entry means an error entry is being recorded to the current error log. An example of a forced error state capture entry is shown in Figure 11-9.
.

04/12/2000, 13:07:14, Pump 1: Forced Error State Capture Entry

Figure 11-9 Forced Error State Capture Entry

11.8 Switch to Error State Capture Mode

In the same way that a video camera can capture an event, PumpWorks can capture data around an error or event. When an error or event occurs, PumpWorks records the error/event and all pump operating information. This captured information is saved to the computer's hard drive in a file named "pumpwork1.est" and/or "pumpwork2.est", located in the PumpWorks directory. The pump's operating conditions are recorded from a user-specified number of seconds before and after the error/event occurred. A user can then view an error/event as if it were occurring again--a type of instant replay of the error/event. By viewing the state of the pump system when the error/event occurred, the cause of a problem can often be determined.

A transaction consists of either a command or a request for data, initiated by PumpWorks, and the pump's response. Transactions are recorded by PumpWorks. A user can put PumpWorks into Error State Capture Mode and then choose an error/event to view. In Error State Capture Mode all pump operating information displays return to the way they were during the error/event. One transaction can be viewed or a user can easily scroll to other transactions.

11.8.1 Entering Error State Capture Mode

To enter Error State Capture Mode:

- From the menu bar, select Error/Log | Switch to Error State Capture Mode.

A Mode Switch Confirmation dialog box appears and asks, "Are you sure you want to switch to error state capture mode?"

- Click on Yes.

At this point, if PumpWorks is currently data logging or the Sequencer is operational, a dialog box will appear warning the user that data logging or sequencing will be terminated. If this is OK, the user can confirm and continue entering Error State Capture Mode by clicking on "Yes". If this is not OK, the user can continue in normal mode by clicking on "No". The user can then gracefully stop data logging and/or sequencing before trying to enter Error State Capture mode again.

NOTE: The words “Error State Capture Mode” will appear on the status bar with a red background. This is confirmation that you are in the error state capture mode.

11.8.2 Choosing an Error/Event to View

Upon entering Error State Capture mode, the Error State Capture Control window is automatically opened (See Figure 11-11). If it has subsequently been closed, it can be re-opened by selecting Error/Log | Error State Capture Control. The errors and/or events are displayed in the list box at the bottom of the window. The user can choose to view errors only, events only, or errors and events by selecting the appropriate button just above the list box, on the left. The user can also choose whether to view/process transactions for all pumps or just the ones associated with a selected error/event by clicking on the appropriate button just above the list box, on the right.

To choose an error/event to view:

- In the Error State Capture Control window, double click on the error/event you wish to view.

The main window of PumpWorks will immediately return to the conditions at the time of the error/event, called the error state.

11.9 Error State Capture Mode

Error State Capture is an advanced diagnostic feature in PumpWorks that allows users to “play back” a certain block of PumpWorks activity surrounding a particular error/event. After entering error state capture mode, the user selects an error/event, and PumpWorks will “recreate” the condition of the pump system at the time of the error or event. The user can then scroll backwards or forwards through “time”, transaction by transaction (the packet of data used to communicate between the user’s computer and pump controllers), to see exactly what happened before, during and after the error/event occurred. As each transaction is scrolled through, PumpWorks decodes the transaction as if it were receiving it from the pump controller, and updates the values on the PumpWorks windows, just as it did when the data was actually collected from the pump controllers.

NOTE: When running in error state capture mode, PumpWorks does not functionally communicate with the pump controllers. Therefore, even though pumps continue to run, things that are dependent upon PumpWorks operation, such as DDE communication, sequencing, ramping, auto volume, fractional flow rate, and so on will cease to function. Also, data logging will be terminated.If currently updating software to pump controller(s) or front panel(s), software update will be aborted and pump controller(s) / front panel(s) will have no software. User will get an error message next time they try to communicate with the controller(s) / front panel(s) that the controllers have no code & the software update will have to be initiated again.

Be sure the pump system is in an acceptable state before you switch to Error State Capture Mode.

11.9.1 Running Error State Capture Mode

There are two ways to run PumpWorks in Error State Capture Mode:

- Switching to Error State Capture Mode while running PumpWorks in normal mode, or
- Starting up PumpWorks in Error State Capture Mode.

To switch to Error State Capture mode while PumpWorks is already running in normal mode, select Error/Log | Switch to Error State Capture Mode from the menu bar and confirm that you really want to switch to Error State Capture Mode.

To start PumpWorks in Error State Capture Mode:

- From the Windows task bar, select Start | Run.
- use the Browse feature to select the desired PumpWorks executable.
- Append "\e" to the command line to run using files (ini file, error log, event log, and error state capture file) from the same folder as the PumpWorks executable, or "\f" to run using files from a specified directory.

11.9.2 Error State Capture Control

In the Error State Capture Control window, a user is able to view one transaction or scroll to other transactions. Information such as the date and time that the error occurred is displayed. The Error State Capture Control option becomes available on the Error/Log menu, only when PumpWorks is in the Error State Capture Mode. To control error state capture mode, do the following:

- If the Error State Capture Control window is not already open, from the menu bar, select Error/Log | Error State Capture Control and the window shown in Figure 11-10 appears.

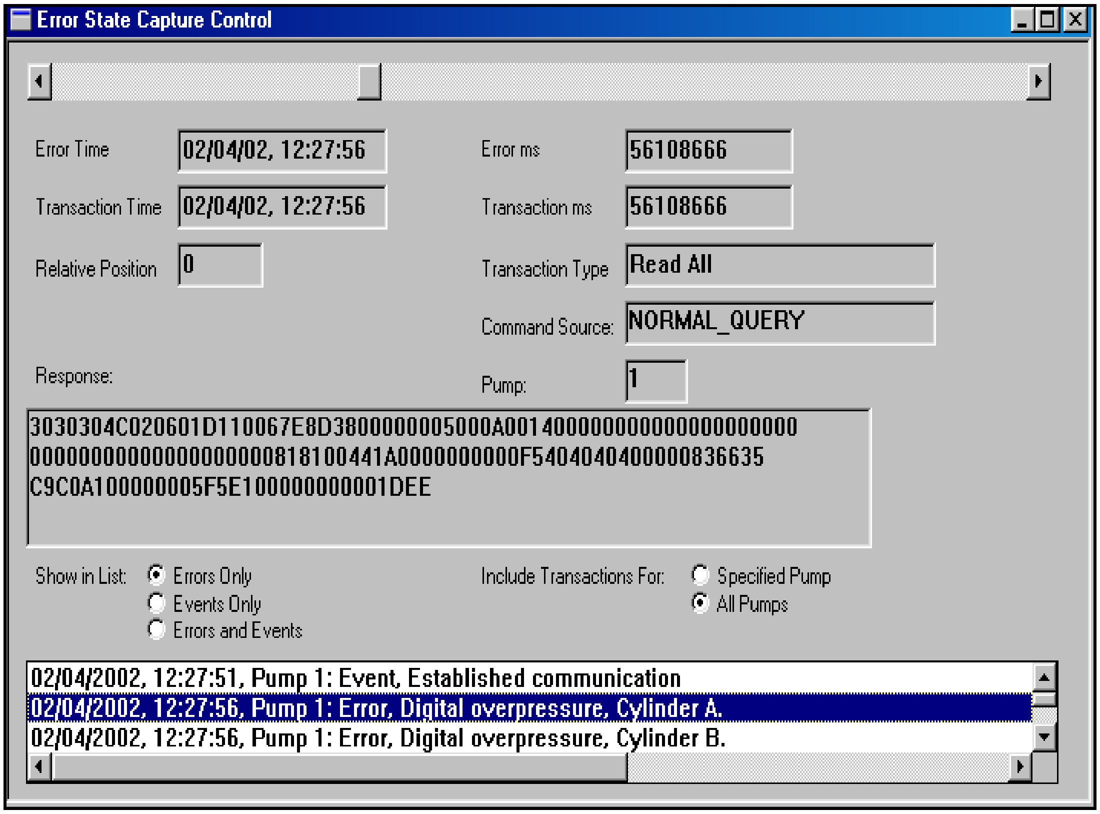


Figure 11-10 Error State Capture Control Window

- Select whether you want to view errors, events or both based on instructions in Section 11.9.2.9.
- Select whether you want to decode/view data fro all pumps, or just for the pump associated with the error/event, based on instructions in Section 11.9.2.10.
- Double-click on the error/event of interest.
- Use the scroll bar to “rewind”, “playback”, or “fast forward” through transactions.
- Double-click on a new error/event at any time, to look at a different “point in time”.
- When finished, select “Switch to Normal Communications Mode” from the Error/Log menu. (Only applicable if PumpWorks was started up in normal mode.)

11.9.2.1 Error State Capture’s Scroll Bar

There is a scroll bar at the top of the Set Up Error State Capture window. Click on the arrows to the left or right of the scroll bar to display/process the next or previous transaction. Transactions can be displayed/processed, in steps, from a user specified number of seconds before and after the error/event occurred.

11.9.2.2 Error State Capture’s Error Time

The actual date and time that an error or event occurred is recorded in the Error/Event Time text box. The date is displayed in the MM/DD/YY format. The time is displayed in the

HH:MM:SS format. The error/event time is also recorded in milliseconds since the computer was booted up. This is recorded in the text box to the right of error/event time (Error/Event ms).

11.9.2.3 Error State Capture's Transaction Time

The transaction time is the date and time that was recorded at the moment a particular transaction occurred. As a user selects a different transaction, the transaction time changes to the date and time of that transaction. The transaction time is also recorded in milliseconds since the computer was booted up. This is recorded in the text box to the right of the transaction time (Transaction ms).

11.9.2.4 Error State Capture's Relative Position

When the Set Up Error State Capture window first opens, the relative position box shows a "0". Zero represents the moment that the user-chosen error/event occurred.

Move the scroll bar arrow to the left and the relative position number becomes a negative number. This number refers to the number of transactions before the error/event occurred. The higher the negative transaction number, the more transactions before the error/event occurred. For example, relative position -5 means the fifth transaction recorded before the error/event occurred.

Move the scroll bar to the right and the relative position number increases. When the relative position number becomes a positive number again, (1, 2, 3, and so on) it refers to the number of transactions after the error/event occurred. The higher the positive number, the more transactions have been recorded since the error/event occurred. For example, relative position 5 means the fifth transaction recorded after the error/event.

11.9.2.5 Error State Capture's Transaction Type

The transaction type refers to what type of command or request PumpWorks initiated. For example, did PumpWorks request a "Read Rates" command, or a "Read Volumes" command? There are many possible transaction types. The Transaction Type window will display a brief message of the type of transaction requested by PumpWorks.

11.9.2.6 Command Source

This field gives information on where or why the command or request was initiated (i.e. from a DDE client, from the sequencer, from the PumpWorks user interface, etc.).

11.9.2.7 Pump

This field shows which pump number the displayed transaction was from.

11.9.2.8 Response

The response field shows the pump's actual response to a command (or request for data) initiated by PumpWorks.

11.9.2.9 Errors/Events Viewing

The user has the option of showing in their list errors only, events only or errors and events.

11.9.2.10 All Pumps vs Single Pump

The user can choose between viewing error/events for a specified pump, or for all pumps in the user's pump system.

11.10 Switch to Normal Communications Mode

When finished with Error State Capture Mode, do the following to return to normal communications.

- From the menu bar, select Error/Log | Switch to Normal Communications Mode.
- A Mode Switch Confirmation window opens, as shown in and asks, "Are you sure you want to switch to normal communications mode?"

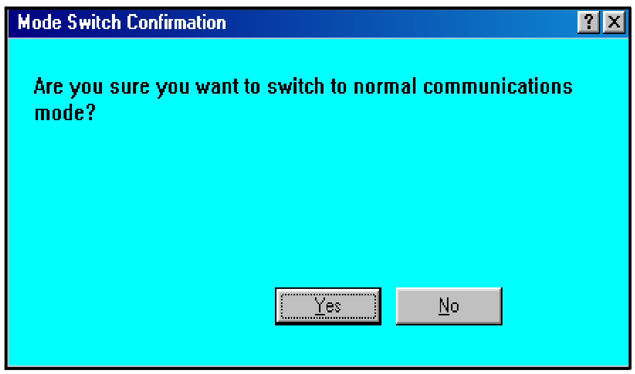


Figure 11-11 Mode Switch Confirmation Window

- Click on Yes.
- PumpWorks immediately returns to normal communications mode.

11.11 Create Diagnostic Zip File

This option allows the user to create a zip file containing the error log file, event file, error state capture file, and other pertinent files. This is most useful when receiving customer support from Chandler Engineering.

To create a diagnostic zip file, you must first specify a file name.

- From the menu bar, select Error/Log | Create Diagnostic Zip File and the window shown in Figure 11-12 appears.

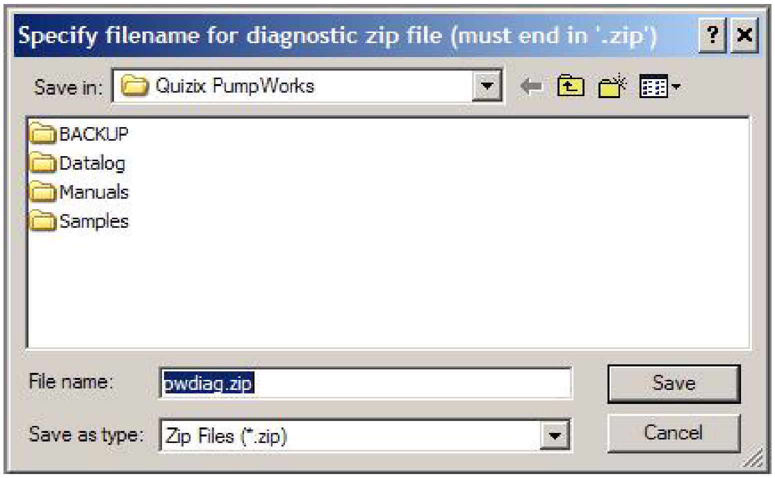


Figure 11-12 Specify Filename for Diagnostic Zip File Window

- Select the directory and file name for the diagnostic file being created. Remember to end the file name with ".zip".
- If an existing file is specified, an overwrite confirmation dialog appears. Select the appropriate option ("Yes" to overwrite, "No" to cancel the zip operation).
- Next you will be given an opportunity to enter comments to be attached to your zip file. The Zip File Comment window, shown in Figure 11-13, will open.

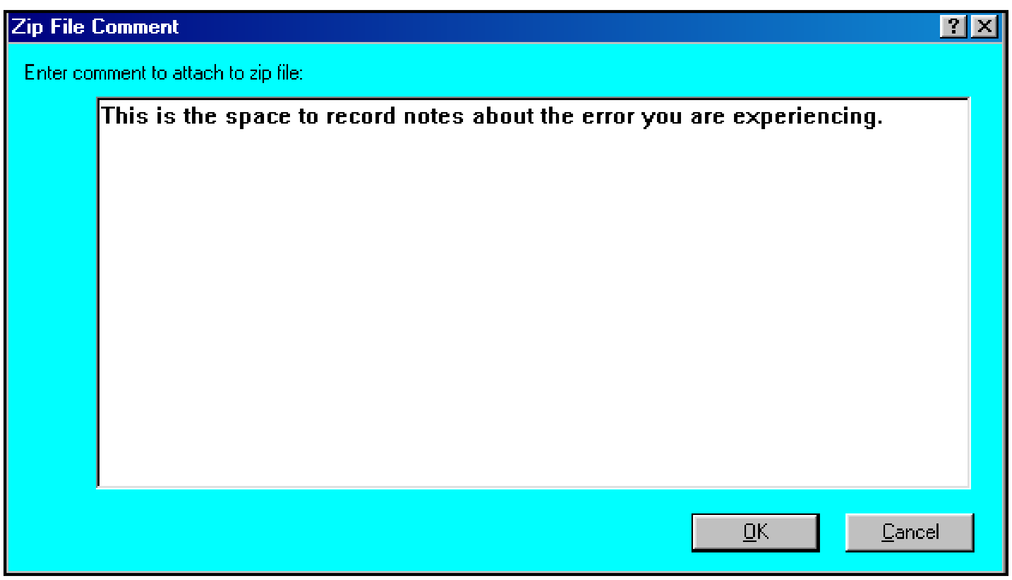


Figure 11-13 Zip File Comment Window

- Enter any appropriate comments in the Zip File Comment dialog box. Use the ENTER key to start a new line for multiple line comments. When all comments are entered, click on OK.

The zip file will then be created in the specified directory.

12 CONFIGURE MENU

The Configure menu is used to set up the pump system parameters to best suit a user's experiment or application. Click on Configure and the following options are available:

- Set Up Displayed Units and Decimal Places, Section 12.1
- Set Up Pump Operating Parameters, Section 12.2
- Set Up Pressure Control, Section 12.3
- Scale Pump Flow Rates, Section 12.4
- Set Up Recirculating Parameters, Section 12.5
- Set Up Default System, Section 12.6
- Set Up Error Masking, Section 12.7
- Set Up Resource Mapping, Section 12.8
- Set Up Data Averaging, Section 12.9
- Set Up Sequences, Section 12.10
- View Pump Information, Section 12.11
- Reassign Pump Number, Section 12.12
- Uninstall Pump, Section 12.13
- Error State Capture Settings, Section 12.14
- Extended Analog Input Settings, Section 12.15
- System Settings, Section 12.16
- Controller Setup, Section 12.17
- Cylinder Stop Action Settings, Section 12.18
- Overpressure/Underpressure Action Settings, Section 12.19
- Cylinder Error Groups, Section 12.20

12.1 Set Up Displayed Units and Decimal Places

The Set Up Displayed Units and Decimal Places option allows a user to choose the unit of measure for pressure, rate, and volume, and how many numbers to display to the right of a decimal point for pressure, rate, volume, and cumulative volume.

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places. A warning about sequences using currently selected units of measure will appear. Select OK to continue. If Pumpworks is currently data logging, a similar warning about data logging using current units of measure will appear. Select OK to continue. The window shown in Figure 12-1 will then appear.

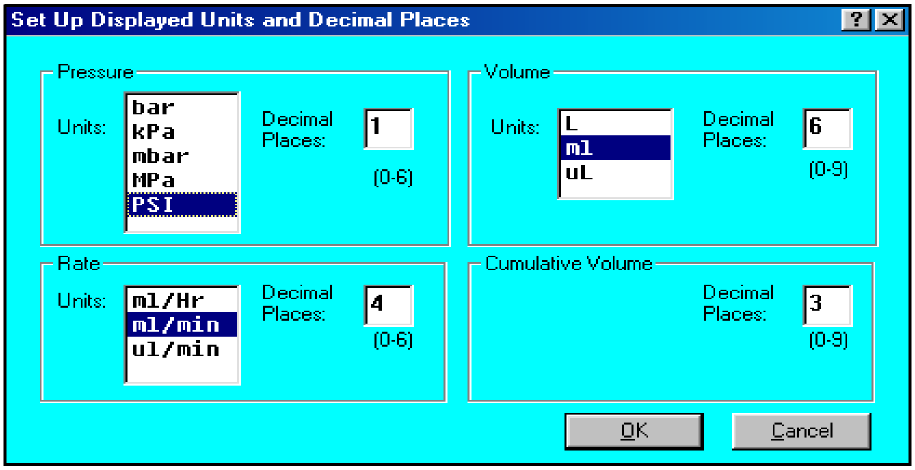


Figure 12-1 Set Up Displayed Units and Decimal Places Window

12.1.1 Decimal Places

PumpWorks allows the user to choose how many numbers will be displayed to the right of the decimal point. This can be chosen for pressure, rate, volume and cumulative volume. For rates and pressures, the user can set from zero to six numbers to be displayed to the right of a decimal point. For volumes and cumulative volumes, the user can set from zero to nine numbers to be displayed to the right of the decimal point. If the user enters a zero, a whole number will be displayed. The more numbers displayed to the right of the decimal point, the more precise the displayed number will be.

To set how many digits will be displayed to the right of the decimal point, do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, highlight the number showing in the decimal places text box for either pressure, rate, volume or cumulative volume.
- Enter the number of places to be displayed to the right of the decimal point.
- When finished with the Set Up Displayed Units and Decimal Places window, click on OK.

12.1.2 Displaying Pressure

Pressure can be displayed in any of the following units of measure.

- bar (bar)
- kiloPascals (kPa)
- millibar (mbar)
- MegaPascals (MPa)

- pounds per square inch (PSI)

The default unit of measure is pounds per square inch (PSI). To choose a different unit of measure for pressure, do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, click on the desired unit of measure for pressure.
- When finished with this window, click on OK.

12.1.3 Displaying Flow Rate

Rate can be measured and displayed in either of the following units of measure. (A milliliter is the same as a cubic centimeter.)

- milliliters per minute (ml/min)
- milliliters per hour (ml/hr)
- microliters per minute (ul/min)

The default unit of measure for flow rate is milliliters per minute (ml/min). To choose a different unit of measure:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, click on the desired unit of measure for flow rate.
- When finished with this window, click on OK.

12.1.4 Displaying Volume

Volume may be displayed in any of the following units:

- liters (L)
- milliliters (ml)
- microliters (ul)

The default unit for volume is milliliters (ml). To change to a different unit of measure, do the following:

- From the menu bar, select Configure | Set Up Displayed Units and Decimal Places.
- In the Set Up Displayed Units and Decimal Places window, click on the desired unit of measure for volume.
- When finished with this window, click on OK.

12.2 Set Up Pump Operating Parameters

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to change any of the pump operating parameters. Please refer to Chapter 6, Section 6.8 for details on the password protection feature.

The Set Up Pump Operating Parameters option allows the user to change the following operating parameters:

- Smart Start Status
- Auto Return Rate Status
- Understanding the Piston Return Rate Multiplier
- Understanding the Return Rate Minimum
- Maximum Pressure for Rate Modes
- Prevent Users from Opening Fill Valve and Deliver Valve at Same Time
- Stop Pump if Fill Valve Pressure Threshold Not Met When Depressurizing
- Remote Start/Stop
- Remote Rate Control
- Wash Area Status
- Maximum Rate for Pressure Modes
- Fill Valve Pressure Threshold
- Emergency Stop ConfigurationEmergency Stop Configuration

From the menu bar, select Configure | Set Up Pump Operating Parameters. The window shown in Figure 12-2 appears.

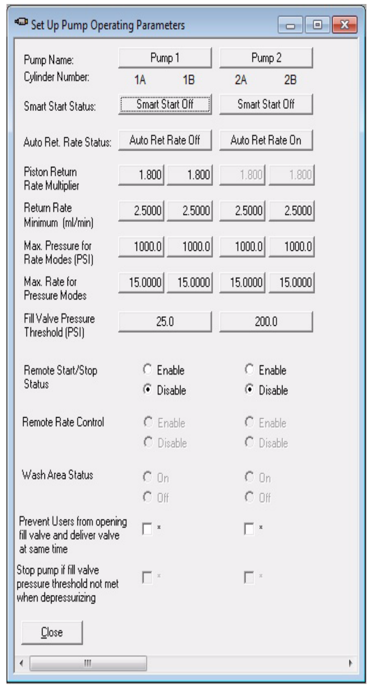


Figure 12-2 Set Up Pump Operating Parameters

12.2.1 Smart Start Status

Smart Start is a PumpWorks feature that assists the user in starting pump cylinders operating in a paired operating mode. When starting pump cylinders in a paired mode, the pump cylinder the user selects to start must be in a position such that it can continue to extend until the other pump cylinder in the pair has finished fully retracting. When Smart Start is "on", PumpWorks automatically checks the position of the pump cylinders, to make sure that this condition is met. If PumpWorks determines that the pump cylinder selected to be started is not in an acceptable position, but that the other pump cylinder of the pair **is** in an acceptable position, the Smart Start feature will automatically start the other pump cylinder. Since Smart Start simplifies starting up pump cylinders in paired operating modes, it should normally be left on. If the Smart Start feature is off, and a user attempts to start a pump cylinder in an unacceptable position, the pump controller will simply return an error. The Smart Start feature has no effect on pump cylinders operating in independent modes.

To change the Smart Start status:

- Click on the appropriate Smart Start button.
- Click on Yes, when a confirmation is requested.

NOTE: The Smart Start feature is only available for pump controller versions 57.58 or greater.

12.2.2 Auto Return Rate Status

The return rate is the rate, or speed, at which the standby pump cylinder will return when operating in a paired operating mode. Automatic Return Rate is a PumpWorks feature where the best return rate is automatically determined by the software. It is available on all pumps with a code version of 51 or higher, except those controlled by an SC-2400 Pump Controller. To determine your code version, refer to Chapter 14, Section 14.2.2. When the automatic return rate button (Auto Ret. Rate Status) is ON, the return rate multiplier button will be grayed.

12.2.3 Understanding the Piston Return Rate Multiplier

When two pump cylinders are operating in a paired operating mode, PumpWorks sets the return rate of the standby pump cylinder to be faster than the delivery rate of the active pump cylinder--when in a delivery operating mode. (Similarly, in a receive operating mode, the return rate of the standby pump cylinder is faster than the receive rate of the active pump cylinder.) The ratio between the standby pump cylinder's return rate to the active pump cylinder's rate is known as the return rate multiplier. The range for the return rate multiplier is from 1.00 to 2.99. If the return rate multiplier is set to 1.00, the return rate is equal to the delivery rate. If the return rate multiplier is set to 2.00, the return rate is twice as fast as the delivery rate.

The default return rate multiplier, in most pump systems, is 1.8. This multiplier should work well for most normal speed applications. For high speed applications, or highly compressible fluids (gas, for example), a higher return rate multiplier may be needed. Calculating and setting the return rate multiplier is most important for recirculating pump systems.

In paired deliver operating modes, the return rate of the standby pump cylinder must be faster than the delivery rate of the active pump cylinder. A faster return rate gives the standby pump cylinder time to complete its return stroke (fill with fluid) and pre–pressurize. This must be done before the active pump cylinder completes its stroke. Since pre–pressurization usually takes approximately 10 seconds, the standby pump cylinder must complete its stroke 10–15 seconds faster than the active pump cylinder.

12.2.3.1 Setting the Piston Return Rate Multiplier

To change the piston return rate multiplier:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- Click on the Piston Return Rate Multiplier button for the appropriate pump cylinder.

A Set Cylinder # Piston Return Rate Multiplier dialog box opens, as shown in Figure 12-3 below.

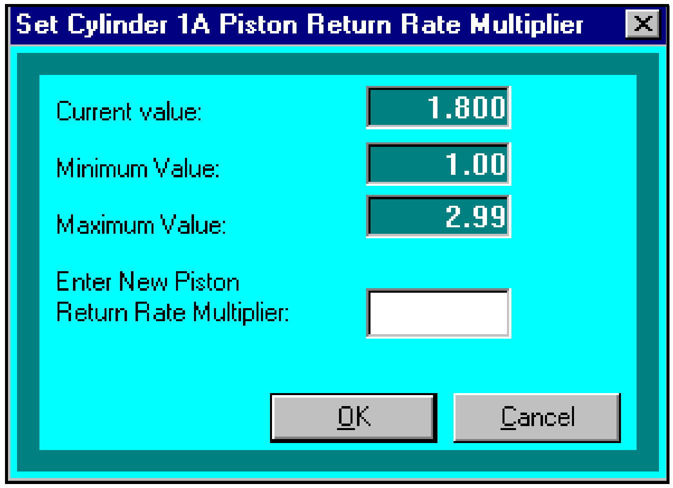


Figure 12-3 Set Cylinder # Piston Return Rate Multiplier

To enter a new multiplier:

- In the Set Cylinder # Piston Return Rate Multiplier window, click in the Enter New Piston Return Rate Multiplier text box and enter a new number.
- When finished, click on OK.

12.2.4 Understanding the Return Rate Minimum

The Return Rate Minimum is the slowest rate the piston in the standby pump cylinder will return. The Return Rate Minimum is only used in paired operating modes and independent cycled modes.The pump cylinder can be either receiving fluid or delivering fluid at the return rate minimum.

The return rate for the standby pump cylinder is calculated from the current delivery rate of the active pump cylinder. The return rate minimum is used if the calculated return rate is less than the return rate minimum. The default return rate minimum is 2.5 ml per minute.

12.2.4.1 Calculating the Return Rate Minimum

The time that the standby pump cylinder takes to pre–pressurize is called the standby time.

- **Standby Time** equals the active pump cylinder’s stroke time, minus the standby pump cylinder’s return stroke time.
- **Stroke Time** equals the current flow rate divided by the cylinder’s stroke volume. (The stroke volume is the amount of fluid pumped with a single piston stroke when the cylinder barrel is full. It is the volume of the cylinder barrel.)
- **Return Rate** equals the stroke time minus the standby time.

The return rate minimum is calculated as follows:

$$RR_{min} = \cfrac{1}{1 - \left(\text{Standby Time}\left[\cfrac{\text{Current Flow Rate}}{\text{Stroke Volume}}\right]\right)}$$

Figure 12-4 Return Rate Minimum Calculation

Where the Standby Time = 0.167 minutes (10 seconds) and the Current Flow Rate is in ml/min.

The stroke volume for various Quizix pump models is shown in Figure 12-5 below.

Quizix Pump Model	Stroke Volume
QX Series Pumps*	
QX-500	130 ml
QX-1500	46 ml
QX-6000	12 ml
QX-20000	3.3 ml
QL-700 Series Pumps	
QL-700-1k	27.3 ml
QL-700-5K	6.8 ml
5000 Series Pump Cylinder	
Q5000-2.5K	38.75 ml
Q5000-5K	22 ml
Q5000-7.5K	22 ml
Q5000-10K	9.75 ml
Q5000-15K	5.5 ml
Q5000-20K	5.5 ml
6000 Series Pump Cylinder	
Q6000-5K	575 ml
Q6000-10K	275 ml
Q6000-15K	130 ml
Q6000-20K	130 ml

Figure 12-5 Pump Cylinder Stroke Volumes

*All QX Pumps are self-contained dual cylinder pumps. Stroke volume is indicated for each cylinder.

12.2.4.2 Setting the Return Rate Minimum

To change the return rate minimum, do the following:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- Click on the Return Rate Minimum button for the appropriate pump cylinder. A Set Cylinder # Return Rate Minimum window opens as shown in Figure 12-6.

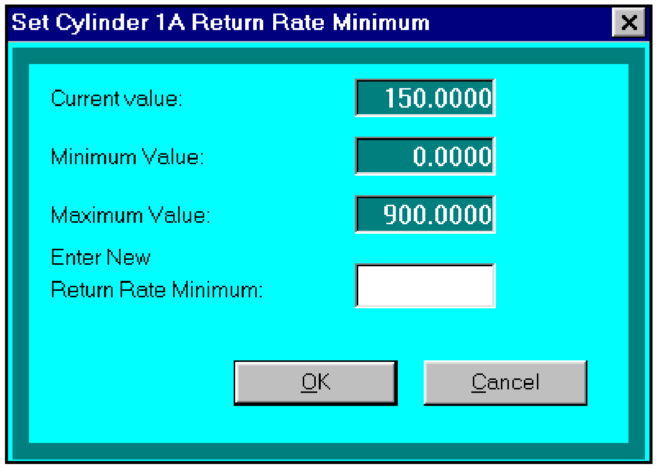


Figure 12-6 Set Cylinder # Return Rate Minimum Window

To enter a new return rate minimum:

- In the Cylinder # Return Rate Minimum window, click in the Enter New Return Rate Minimum text box.
- Enter a new number.
- When finished, click on OK.

12.2.5 Maximum Pressure for Rate Modes

Maximum Pressure for Rate Modes specifies the maximum allowable pressure when a pump is operating in a constant rate mode. If the maximum pressure is reached, the pump will automatically servo to limit the pressure. Constant rate flow resumes when the pressure falls below the specified maximum. This value can only be changed for pump controller versions 57.60 or greater.

To define the maximum pressure for rate modes, do the following:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- Click on Maximum Pressure for Rate Modes. The Set Maximum Pressure for Cylinder # window appears, as shown in Figure 12-7.

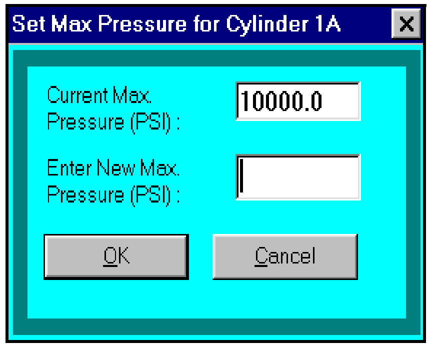


Figure 12-7 Set Maximum Pressure for Cylinder # Window

- In the Set Maximum Pressure for Cylinder # window, click in the Enter New Maximum Pressure text box.
- Enter a new maximum pressure.
- When finished with this window, click on OK.

12.2.6 Prevent Users from Opening Fill Valve and Deliver Valve at Same Time

This feature offers some protection from users opening both the deliver valve and fill valve at the same time. If this field is checked, the user will not be able to open the fill valve if the deliver valve is already open and vice versa. **Note that this feature only protects users from opening valves from the main window.** No protection exists for opening valves via other means (DDE, sequencer, etc.).

To turn this protection on or off:

- From the menu bar, select Configure | Set Up Operating Parameters.
- To the right of the label "Prevent Users from Opening Fill Valve and Deliver Valve at Same Time," for each pump, click on the appropriate check box to check or uncheck it. Check the box to turn this protection on, or uncheck it to turn the protection off.

12.2.7 Stop Pump if Fill Valve Pressure Threshold Not Met When Depressurizing

In normal pump operation in paired or cycled mode, when a pump is depressurizing in preparation for refilling, the pump will attempt to retract with the both valves closed until the cylinder pressure drops below the fill valve threshold specified by the user before opening the fill valve. (Please refer to Chapter 12, Section 12.2.12 for an explanation of this value.) If the pressure has not dropped below the fill valve threshold after a reasonable amount of stroke has been used, the pump will give up trying to depressurize, and just open the fill valve and refill.

There are some cases where this behavior may not be acceptable. The user can specify that the pump should stop and report an error if this condition occurs, rather than continue. Note that this feature is currently only available for QX pumps, and only for Pump Controller Software versions 60.18 and greater.

To control this feature:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- To the right of the label “Stop Pump if Fill Valve Pressure Threshold Not Met When Depressurizing,” for each pump, click on the appropriate check box to check or uncheck it. Check the box to cause the pump to stop, or uncheck it to allow the pump to continue.

12.2.8 Remote Start/Stop

The Remote Start/Stop feature allows a user to start or stop a pump remotely by using a control line connected to a pump’s user interface connector.

The status of this feature can only be changed when the pumps are stopped. To change the status:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- Click on the associated Enable or Disable button to specify the desired status.

12.2.9 Remote Rate Control

The remote rate control feature allows a user to set the flow rate of a pump remotely when in a paired constant rate mode by using a control line connected to a pump’s user interface connector.

The status of this feature can only be changed when the pumps are stopped. To change the status:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- Click on the associated Enable or Disable button to specify the desired status.

NOTE: If this feature is enabled, attempting to set the flow rate using the PumpWorks application will not be effective. The remote rate control will override the PumpWorks commands. This feature is only available for QX pumps, and only for those with controller code version 57.118 or later.

12.2.10 Wash Area Status

The wash area is a feature available only on the QX series pumps, version 57.118 or later, that is used to wash the piston, in order to prevent the accumulation of precipitates on the piston and seal area. The user can turn this feature on or off as needed.

The status of this feature can only be changed when the pumps are stopped. To change the status:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.

- Click on the associated Enable or Disable button to specify the desired status.

NOTE: This feature is only available for pump controllers with code version 57.118 or higher.

12.2.11 Maximum Rate for Pressure Modes

Maximum Rate for Pressure Modes specifies the maximum rate allowed when a pump is operating in a constant pressure operating mode. This value can only be changed for pump controller versions 57.60 or greater. To define a maximum rate for pressure modes, do the following:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.
- Click on Maximum Rate for Pressure Modes. The Set Max Rate for Cylinder # window appears as shown in Figure 12-8.

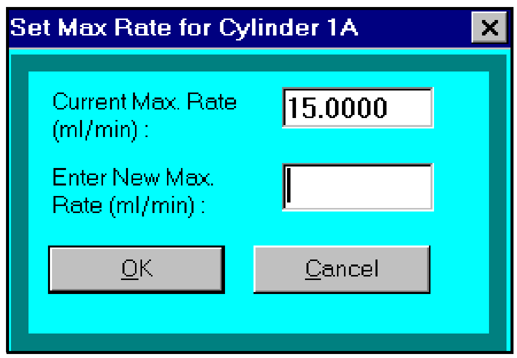


Figure 12-8 Set Maximum Rate for Cylinder # Window

- In the Set Maximum Rate for Cylinder # window, click in the Enter New Maximum Rate text box.
- Enter a new maximum flow rate.
- When finished with this window, click on OK.

12.2.12 Fill Valve Pressure Threshold

The Fill Valve Pressure Threshold is the pressure at which the fill valve is allowed to automatically open in paired mode. When running in paired mode, after a pump cylinder has fully extended, the deliver valve closes and the fill valve opens so that the pump cylinder can refill itself with fluid. However, before the fill valve is allowed to open, the pump cylinder must depressurize. The pressure at which the fill valve is allowed to open can be set by the user and is called the fill valve pressure threshold. The default setting for this is 200 PSI. Pumps whose maximum pressure is less than 200 psi will not be able to set this value. This value can only be changed for pump controller versions 57.60 or greater.

To change the fill valve threshold:

- From the menu bar, select Configure | Set Up Pump Operating Parameters.

- Click on the appropriate Fill Valve Pressure Threshold. The Set Fill Valve Pressure Threshold for Pump # window appears as shown in Figure 12-9 below.

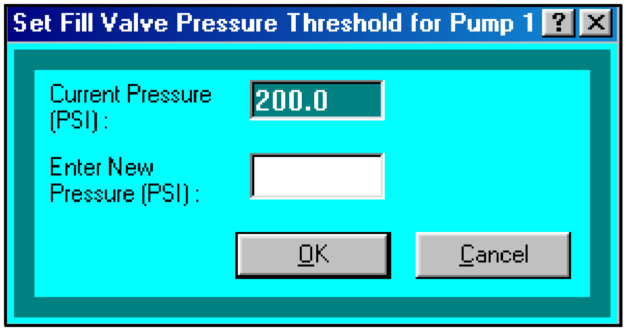


Figure 12-9 Set Fill Valve Pressure Threshold for Pump # WIndow

- Enter the new pressure.
- Click on OK

12.2.13 Emergency Stop ConfigurationEmergency Stop Configuration

For CMD-5000 Pumps Model C and later, interpretation of the Emergency Stop signal can be configured. (All other pumps are hardwired to interpret the Emergency Stop signal as normally open.) To configure the Emergency Stop signal:

- From the menu bar, select Configured | Set Up Pump Operating Parameters.
- Click on the Normally Opened or Normally Closed button to specify the desired configuration.

12.3 Set Up Pressure Control

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to change any of the gains in this window. Please refer to Chapter 6, Section 6.8 for details on the password protection feature.

In the Set Up Pressure Control window, the user can set the Proportional and Differential Servo Gains.

- From the menu bar, select Configure | Set Up Pressure Control. The Set Up Pressure Control window appears, as shown in Figure 12-10.

.

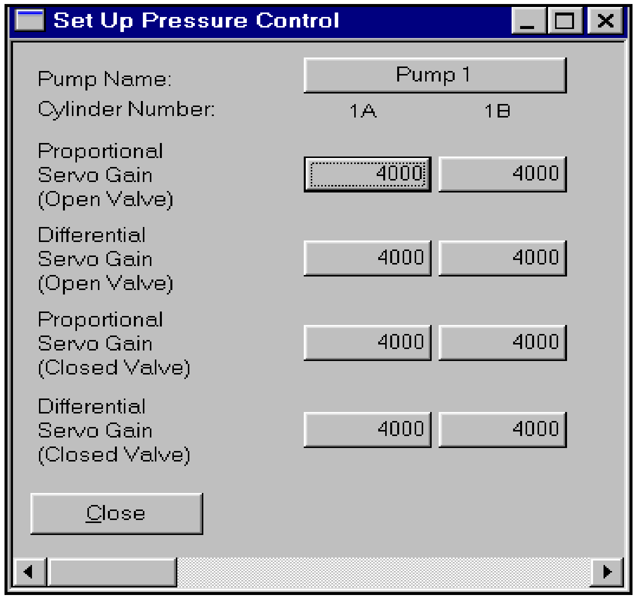


Figure 12-10 Set Up Pressure Control Window

12.3.1 Understanding Proportional / Differential Servo Gains

PumpWorks provides user-set servo gain constants for both “Open Valve” and “Closed Valve” situations. When the deliver valve is open and the pump is connected to a larger fluid volume, the open-valve servo gains apply. When the deliver valve is closed and the fluid volume is limited to that within the pump cylinder, the closed-valve servo gains apply.

PumpWorks makes it easy for the user to change servo gains so that response can be optimized to the user’s specific requirements. The setting of servo gains is a process that requires experimentation and observation. (To observe the pressure behavior, configure a graph showing set pressure and current pressure for a given pump cylinder, and watch the graph while experimenting. For instructions on setting up/running graphs, please refer to Chapter 9.) If the response to the change in rate is too quick, the pressure control may overshoot and trigger an over–pressure error. If the response to the change in rate is too slow, the standby pump cylinder may not pressurize fully before switchover occurs, resulting in pressure drops at switchover. If the response to the change in rate is unstable, the pressure may never settle down to the correct setpoint.

There are two gains that are available: the proportional gain (first difference) and the differential gain (second difference). The servo algorithm implemented is a standard “proportional, integral, and derivative” (PID) type servo where the integral term has been set to zero. This is done to take advantage of the unique pressure control available with a low–friction pump system.

The standard gain settings shipped with the pump are optimized for a closed pump cylinder barrel fully filled with water. This is done because it is the most common situation that the servos encounter. If the user wants to control pressure on a much larger volume, or has a much more compressible fluid or pump system, changing the proportional or differential servo gains may be necessary to obtain the desired performance.

12.3.2 Understanding Proportional Error

The proportional error is the difference between the desired servo pressure (setpoint) and the current pressure. This difference is computed by the servo algorithm, then multiplied by the proportional servo gain to generate an error signal that is used to alter motor speed. If the gain is too high, the flow rate is changed too quickly and the desired pressure is over–shot. Figure 12-11 shows an example of the proportional gain being set too high.

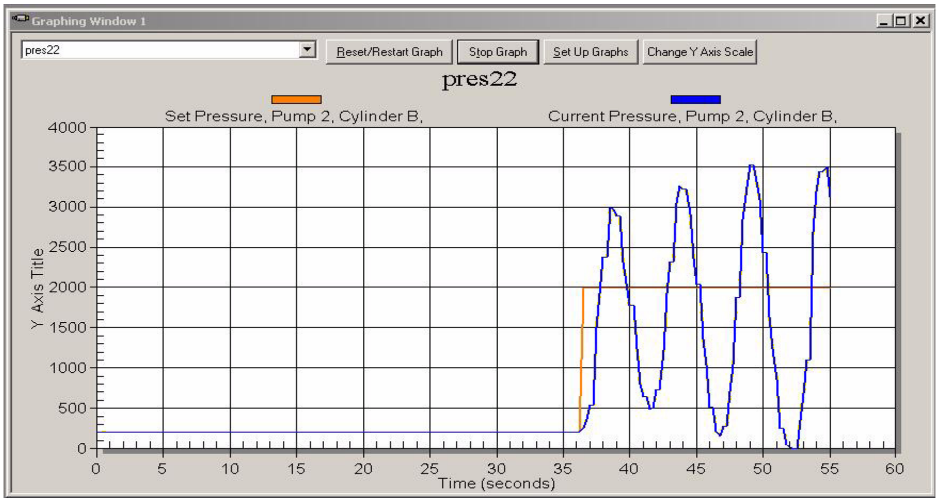


Figure 12-11 Pressure Change with Proportional Gain Set too High

If the gain is too low, the flow rate is changed very slowly and the desired pressure is obtained, but very slowly. Figure 12-12 shows an example of the proportional gain being set too low. There is an optimum gain for every specific situation (fluid volume and compressibility). However, this optimum gain changes as the situation changes (as the volume changes) so a compromise gain setting is often required.

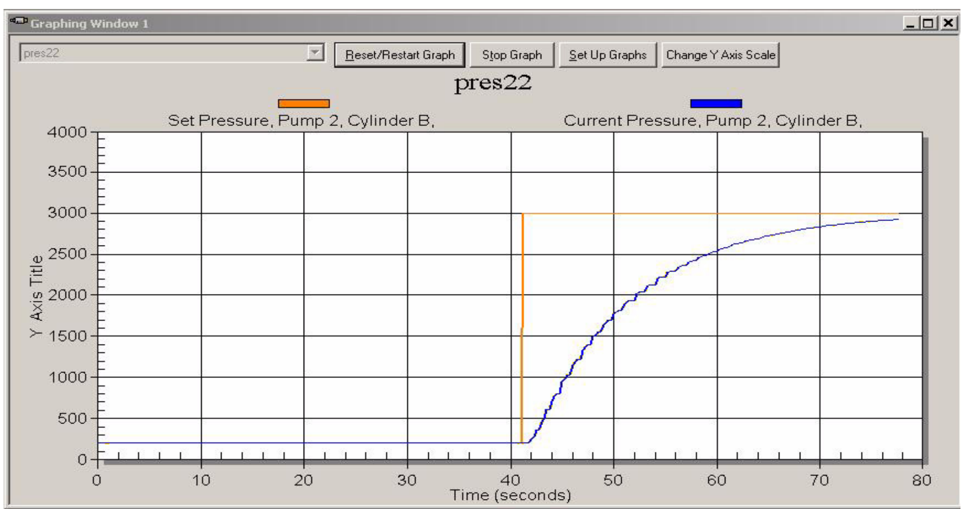


Figure 12-12 Pressure Change with Proportional Gain Set too Low

12.3.3 Understanding Differential Error

Differential error can be defined as the rate at which the actual pressure is approaching the setpoint. The differential error is obtained by taking the difference between the previous proportional error and the current proportional error, called the second difference. This differential error is then multiplied by the differential gain and used as an error signal to alter motor speed. If only proportional error is used, the pump system has a strong tendency to overshoot and undershoot (ring) the desired setpoint. The differential gain can be used to eliminate this problem by providing a damping or settling effect. Figure 12-13 shows an example of a differential gain being set so low that ringing occurs.

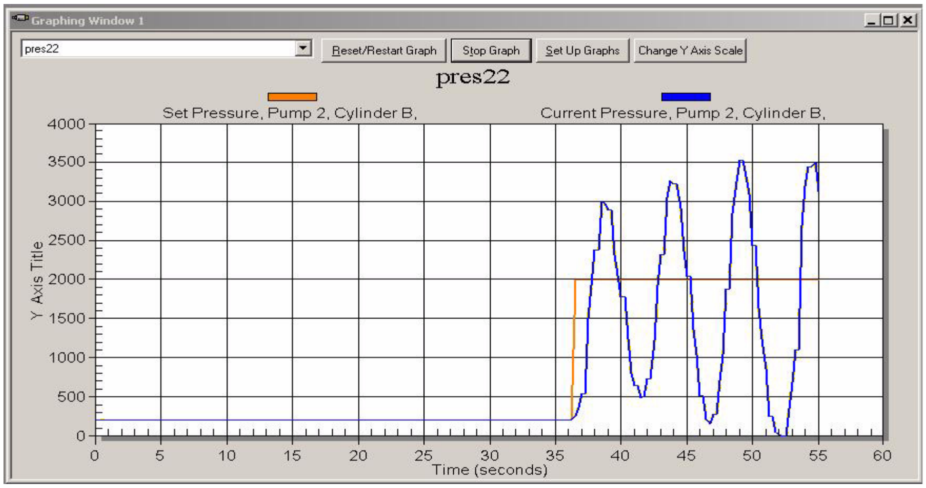


Figure 12-13 Pressure Change with Diff Gain Set So Low That Ringing Occurs

Figure 12-14 shows an example where the differential gain is set too low, but high enough that it only causes a large overshoot that eventually settles, vs. the ringing shown in the previous example.

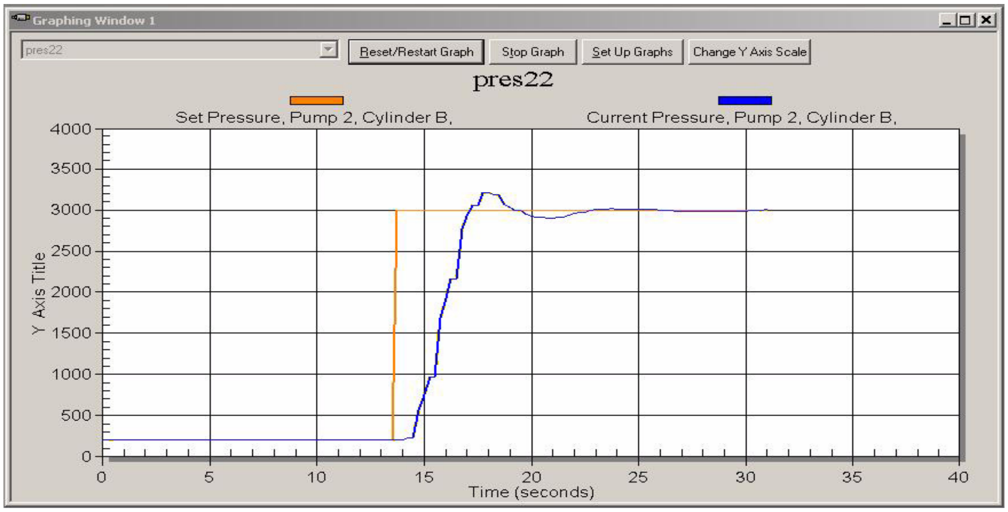


Figure 12-14 Pressure Change with Diff Gain Set too Low

Figure 12-15 shows an example of a differential gain being set so high that overshoot does not occur, but the time it takes to reach the new set pressure is very long.

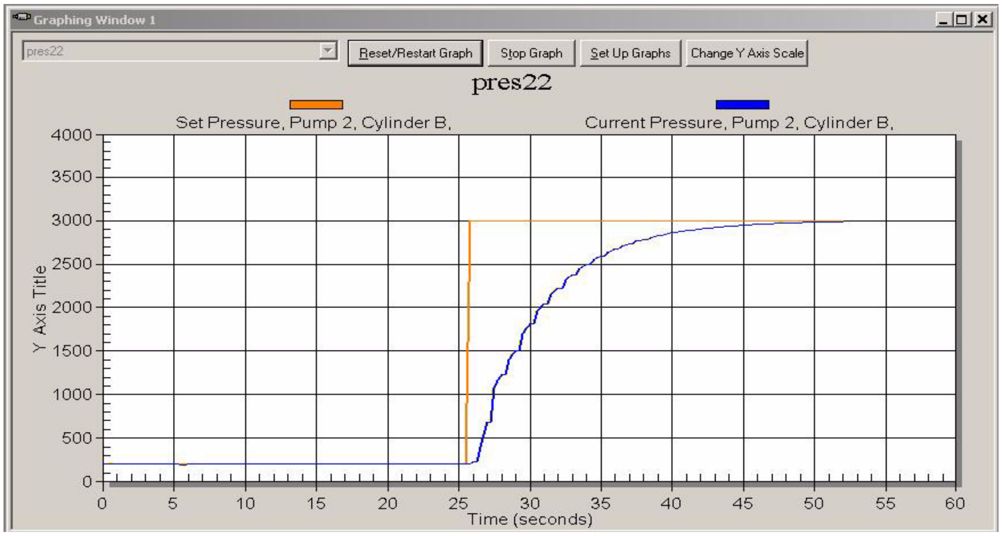


Figure 12-15 Pressure Change with Diff Gain Set too High

Figure 12-16 shows an example of reasonably tuned system (proportional and differential gains are set to acceptable values).

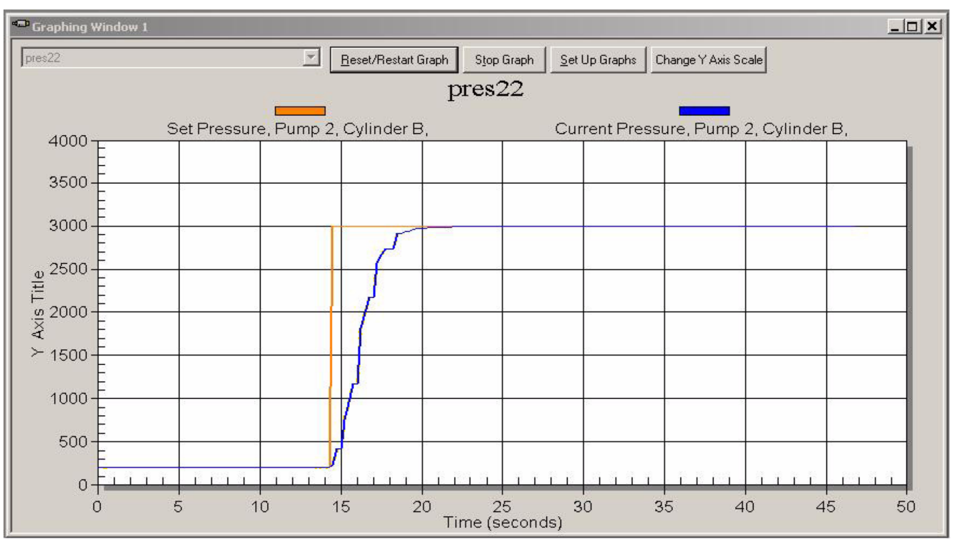


Figure 12-16 Pressure Change with Acceptable Gain Settings

12.3.4 Optimum Setting for Proportional Gain

Use the following approach to determine the optimum setting for proportional gain:

- First, set the pump system up in the manner that it will be used (volumes and fluids).
- Set the pump system to servo at the desired operating pressure.

- Start with a low proportional gain setting.
- You will need to determine the critically damped differential gain for that setting. The critically damped differential gain is when no significant overshoot is present and the pressure setpoint is reached in a timely manner. (See Optimum Setting for Differential Gain, Section 12.3.5.)
- Time the system for several step responses.
- Choose a higher proportional gain and repeat this procedure.
- Continue to choose higher and higher proportional gains until the system shows signs of being unstable (as shown is Figure 12-11).
- Using the response times obtained in the lower gain tests, choose a proportional gain setting that is fast enough for your application but is as low as possible to stay away from the area of instability.

In no case should a gain be chosen that is close to an unstable region. In fact, it is best to operate as far away from unstable gains as possible.

12.3.5 Optimum Setting for Differential Gain

To determine optimum differential gain:

- First, set the pump system up in the manner that it will be used (volumes and fluids).
- Set the pump system to servo at the desired operating pressure.
- Once the pump system has stabilized, change the setpoint pressure by 100 psi and watch the response of the actual pressure versus time. The system will either:
    - Overshoot - exceed the new setpoint, then drop back (as shown in Figure 12-14).
    - Undershoot - take a very long time to reach the desired pressure (as shown in Figure 12-15).
    - Be critically damped - reach the desired pressure in a smooth manner without overshooting (as in Figure 12-16).
- Now reset the pressure to the original setpoint and watch the pressure decay. The pressure rise and decay should follow the same type of response.

Based on the observations of overshoot and undershoot, change the differential gain until you have correctly identified the critically damped differential gain that corresponds to the value of proportional gain for your system.

Since overshoot is easier to detect, if you want you can start with a high setting and decrease the differential gain until you see overshoot.

- If you have overshot, increase the differential gain.
- If you have undershot, decrease the differential gain.

Once this has been determined, recheck this differential gain setting by making larger pressure changes. That is, change the setpoint by about 1,000 psi and observe the actual pressure versus time response.

Once a good value of differential gain is determined, record it and the corresponding proportional gain. Then change the proportional gain to a new value and repeat.

You should note that small signal servo response is affected by the choice of proportional and differential gains. However, at very low levels (i.e. a few psi in a 10,000 psi system), other factors can predominate so that improving tuning may not further improve small signal response. The most significant factor affecting small signal response is the amount of random or spike noise on the control signal.

12.3.6 Setting a Proportional Servo Gain

To change a proportional servo gain:

- From the menu bar, select Configure | Set Up Pump Pressure Control.
- In the Set Up Pressure Control window, click on the Proportional Servo Gain button for the appropriate pump cylinder and valve setting. A Set Cylinder # Proportional Servo Gain window opens, as shown in Figure 12-17.

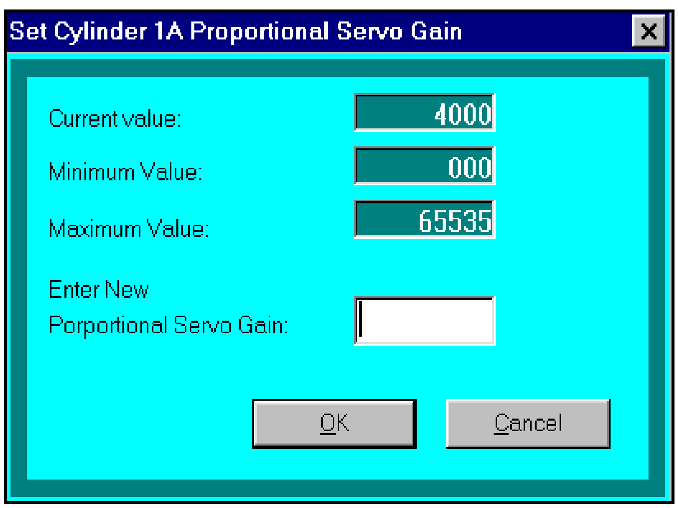


Figure 12-17 Set Cylinder # Proportional Servo Gain Window

To enter a proportional servo gain:

- In the Set Cylinder # Proportional Servo Gain window, click in the Enter New Proportional Servo Gain text box.
- Enter a new number.
- When finished, click on OK.

12.3.7 Setting a Differential Servo Gain

- From the menu bar, select Configure | Set Up Pressure Control.

- In the Set Up Pressure Control window, click on the Differential Servo Gain button for the appropriate pump cylinder and valve setting. A Set Cylinder # Differential Servo Gain window opens, as shown in Figure 12-18.

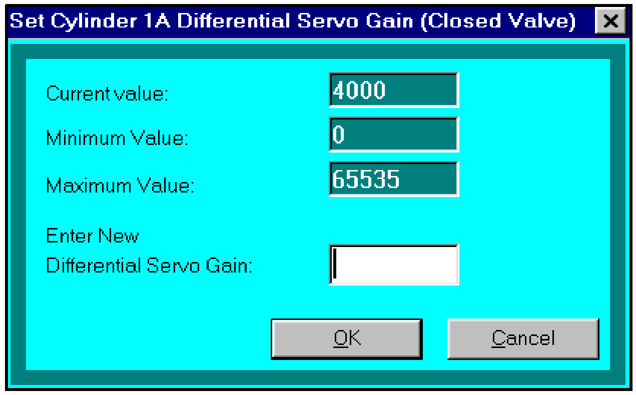


Figure 12-18 Set Cylinder # Differential Servo Gain Window

To enter a differential servo gain:

- In the Set Cylinder # Differential Servo Gain window, click in the Enter New Differential Servo Gain text box.
- Enter a new number.
- When finished, click on OK.

12.4 Scale Pump Flow Rates

The Scale Pump Flow Rates option is used when operating in constant rate modes. Scale Pump Flow Rates takes a fluid's expansion rate (heated fluid) or contraction rate (cooled fluid) into account so the user-set constant rate is maintained. Scale Pump Flow Rates is useful in the following situations:

- **When fluid is being heated but the pump cylinders are not placed in an oven.** The purpose of Scale Pump Flow Rates is to account for the expansion that occurs when a fluid is heated. When a user pumps 1.0 ml of unheated fluid into an oven, it will expand to slightly more than 1.0 ml when heated.
- **When a fluid is being cooled down and will contract.**

12.4.1 Calculating the Pump Flow Rate Scale

To determine the Pump Flow Rate Scale, the user needs to know how much the fluid being pumped will contract per degree. The Pump Flow Rate Scale can be calculated as follows:

$1 / x$ = the Rate Scaler

where x is the volume you expect 1 ml of fluid to become when it is heated. For example, if 1.0 ml of the fluid you are using will expand to 1.02 ml when heated in the oven, then the

Scale Pump Flow Rate calculation would be: 1/1.02 which would equal 0.98. The allowable range for Scale Pump Flow Rate is 0.9 to 1.1.

If a pump flow rate scale is set to 0.98 and the flow rate is set to 1.00 cc/minute, the pump will actually deliver fluid at 0.98 cc/minute, which will become 1.00 cc/minute after fluid expansion occurs.

12.4.2 Entering a Pump Flow Rate Scale

To enter a Pump Flow Rate Scale, do the following:

- From the menu bar, select Configure | Scale Pump Flow Rates. The window shown in Figure 12-19 appears.

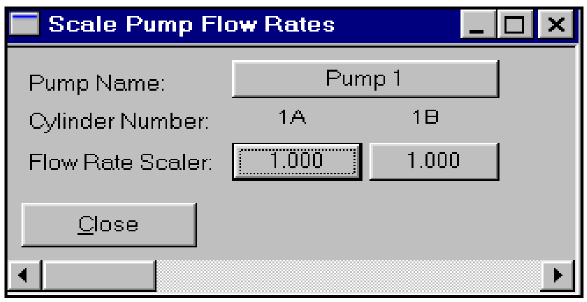


Figure 12-19 Scale Pump Flow Rates Window

To enter a different flow rate scaler, do the following:

- In the Scale Pump Flow Rate window, click on the Flow Rate Scaler button for the appropriate pump cylinder. A Set Cylinder # Flow Rate Scaler window appears, as shown in Figure 12-20.

.

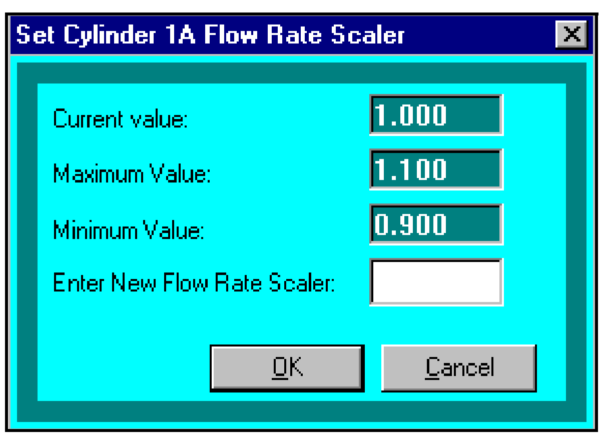


Figure 12-20 Set Cylinder # Flow Rate Scaler

- In the Set Cylinder # Flow Rate Scaler window, click in the Enter New Flow Rate Scaler text box.
- Enter the desired number.

- When finished, click on OK.

NOTE: If a flow rate is scaling at the time that PumpWorks is initiating, the following warning will appear: “At least one rate scaler is not equal to 1.0".

12.5 Set Up Recirculating Parameters

Recirculating mode is an operating mode which allows a pulse-free constant flow rate of one or more fluids while maintaining a constant outlet pressure, using one or two pump cylinders as pressure compensation cylinders. Recirculating mode is most commonly used to perform steady state relative permeability tests. Please refer to Recirculating Mode Using 3, 5, or 7 Cylinders, Chapter 5, Section 5.15 for details on this mode and how to set it.

The Set Up Recirculating Parameters menu option is used to set recirculating mode operating parameters and to predict the success of running pumps in recirculating mode based on those parameters. To open the Set Up Recirculating Parameters window, from the menu bar, select Configure | Set Up Recirculating Parameters. The Set Up Recirculating Parameters window shown in Figure 12-21 opens. The top half of this window contains the current recirculating mode parameters. The bottom half of the window contains some fields regarding prediction of success of running in recirculating mode using the currently displayed parameters.

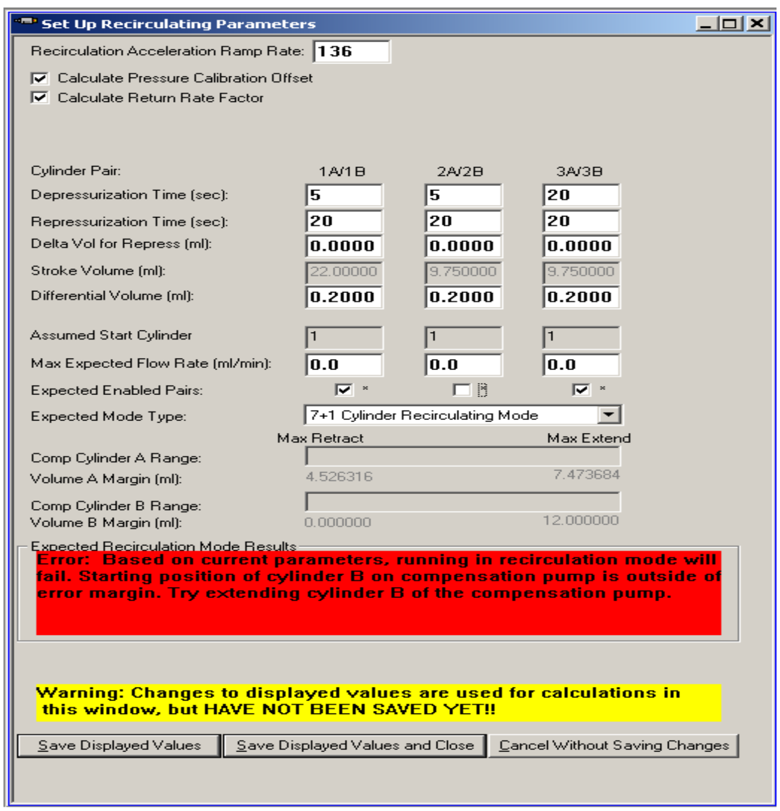


Figure 12-21 Set Up Recirculating Parameters Window

12.5.1 Setting Recirculation Parameters and Assumptions

The top part of the Set Up Recirculating Parameter window contains the fields for the parameters the user can set/save. Changes to these parameters will be displayed and used in the prediction of success of running in recirculation mode, but will not actually be saved and used by PumpWorks in the operation of recirculation mode until one of the save buttons (“Save Displayed Values” or “Save Displayed Values and Close”) at the bottom of the window is clicked. This allows the user to try several “what if” scenarios without actually changing the parameters of the system until they find the desired set of values/states of the parameters.

Each of the parameters/fields in the top part of the window are described in more detail in the sections below.

NOTE: Recirculating parameters may not be changed while updating software to pump controller(s) or front panel(s).

12.5.1.1 Recirculation Acceleration Ramp Rate

The acceleration of the pump cylinder (how fast the flow rate changes between zero and the set rate, or from the set rate to zero) during switchover is determined by the recirculation acceleration ramp rate. The recirculation acceleration ramp rate is a numerical factor that has no physical units. The cylinder acceleration increases as the value of this parameter increases. Acceptable values range from 1 to 255.

12.5.1.2 Calculate Pressure Calibration Offset

When Calculate Pressure Calibration Offset is check-marked, which is the default setting, PumpWorks will automatically match the pressure of the flow pump cylinders to that of the compensation pump cylinder.

12.5.1.3 Calculate Return Rate Factor

When the Calculate Return Rate Factor is check-marked, which is the default setting, PumpWorks will use the Depressurization Time, Repressurization Time, Delta Volume for Repressurization, Stroke Volume, Differential Volume, and current flow rate to calculate a pump cylinder’s optimum return rate.

12.5.1.4 Depressurization Time

The depressurization time is the time it takes (in seconds) for a flow pump to depressurize at switchover from the deliver pressure to the compensation pump’s pressure.

12.5.1.5 Repressurization Time

The repressurization time is the time that it takes for the standby pump cylinder to bring its pressure up to the pressure of the active pump cylinder after the standby pump cylinder has filled with fluid.

12.5.1.6 Deltal Volume for Repressurization

The delta volume for repressurization is the difference in cylinder volume from the start of repressurization to the end of repressurization (just before the cylinder starts delivering fluid). This volume is usually small unless the cylinder is delivering a very compressible fluid.

12.5.1.7 Stroke Volume
The stroke volume is the amount of fluid delivered during one piston stroke, when starting with a competely full cylinder barrel. See Figure 12-5 for the stroke volume of various Quizix pump models. This parameter is displayed for the user to see, but cannot be set by the user.

12.5.1.8 Differential Volume
The different volume is the difference in volume between Cylinder A's actual (measured) stroke volume and Cylinder B's actual (measured) stroke volume for the specified pair.

12.5.1.9 Assumed Start Cylinder
This field indicates which cylinder, for prediction purposes, is assumed to be the cylinder that will deliver fluid first. It is based on the current valve states for the pump and is not directly settable. To influence the assumption, if the pump is not running, you can change the valve states (e.g. to cause cylinder B to be the assumed start cylinder, open the fill valve and close the deliver valve for cylinder A, open the deliver valve and close the fill valve for cylinder B). Make sure the expected flow rate is set to something greater than zero, in order for the valve states to have an effect.

12.5.1.10 Maximum Expected Flow Rate
The maximum expected flow rate fields allow the user to specify an assumption, for prediction purposes, of the maximum expected flow rate of each flow pump while running in recirculation mode.

Set these values to the maximum flow rate that you expect the cylinders to run while in recirculation mode. Note that this setting only impacts the prediction of the compensation cylinder motion. This does not limit the flow rate you can actually set while in recirculation mode.

12.5.1.11 Expected Enabled Pairs
The Expected Enabled Pairs check boxes allow the user to specify an assumption, for prediction purposes, of which cylinder pairs will be enabled for recirculation mode. For example, you could be in a 7 cylinder recirculation mode, but only use the cylinders from the first pump for recirculation flow cylinders by disabling the pairs from pumps 2 and 3. Note that enabling or disabling pumps in this window only impacts the current prediction. The user actually controls which pumps will be enabled or disabled for recirculation mode when they actually select recirculation mode. Please refer to Recirculating Mode Using 3, 5 or 7 Cylinders, Chapter 5, Section 5.14 for details on setting recirculation mode.

For prediction purposes, check each pump that you plan to enable when you run in recirculation mode.

12.5.1.12 Expected Mode Type
The expected mode type determines which cylinder pairs will be acting as flow pumps, and which one(s) will be acting as the compensation cylinder(s). Please see Chapter 5, Section 5.14 for more details.

12.5.1.13 Saving Parameters and/or Closing the Window

Changes made in the Set Up Recirculating Parameters window will be used to update the prediction of success of running in recirculation mode, but they will not actually be saved until the user explicitly saves them using one of the save buttons (“Save Displayed Values” or “Save Displayed Values and Close”) at the bottom of the window. If unsaved changes have been made to the window while actually running in recirculation mode, a warning will flash at the bottom of the window until the changes are saved, or the window is closed without saving the changes.

To close the window without saving the changes, simply click on the “Cancel Without Saving Changes” button at the bottom of the window.

12.5.2 Predicting Success of Running in Recirculation Mode

PumpWorks can predict the range of motion that the compensation cylinder will go through while running in recirculation mode, based on current positions of the applicable cylinders, and the currently displayed recirculating parameters BEFORE actually running in recirculation mode. This predicted range of motion shows a worst case scenario for the compensation cylinder, and is important to look at if you are running a long term experiment that you don’t want to have to abort due to the compensation cylinder(s) running out of stroke.

The user can change the position of the cylinders, and/or change the parameters in the fields of the Set Up Recirculating Parameters window (shown in Figure 12-21) to see the effect on the prediction of success. The changes to parameters will not actually be saved until one of the save buttons (“Save Displayed Values” or “Save Displayed Values and Close”) at the bottom of the window are clicked. This allows the user to try several “what if” scenarios without actually changing the parameters of the system until they find the desired set of values/states of the parameters.

Each of the fields related to prediction of success are described in more detail in the sections below.

12.5.2.1 Compensation Cylinder A Range

The range of compensation cylinder motion for cylinder A is shown in black. The volume margin (or the part of the stroke that will not be used) is shown in gray on each end of the black bar. If there is no gray area to the right or to the left of the black bar, this indicates that this compensation cylinder will probably run out of stroke at some point.

12.5.2.2 Volume A Margin

Just below the range of compensation cylinder motion bar for cylinder A, there are numeric values, in current volume units, that indicate the amount of unused volume at the point when this compensation cylinder has extended as far as it will while in recirculation mode, and the amount of unused volume at the point when this compensation cylinder has retracted as far as it will retract. Both of these values should be positive numbers. A negative number indicates this compensation cylinder will run out of stroke volume.

12.5.2.3 Compensation Cylinder B Range

The range of compensation cylinder motion for cylinder B is shown in black. The volume margin (or the part of the stroke that will not be used) is shown in gray on each end of the black bar. If there is no gray area to the right or to the left of the black bar, this indicates that this compensation cylinder will probably run out of stroke at some point.

12.5.2.4 Volume B Margin

Just below the range of compensation cylinder motion bar for cylinder B, there are numeric values, in current volume units, that indicate the amount of unused volume at the point when this compensation cylinder has extended as far as it will while in recirculation mode, and the amount of unused volume at the point when this compensation cylinder has retracted as far as it will retract. Both of these values should be positive numbers. A negative number indicates this compensation cylinder will run out of stroke volume.

12.5.2.5 Expected Recirculation Mode Results

This text field indicates whether there is enough stroke volume in the compensation cylinders, based on the specified parameteres and the starting positions of all associated cylinders to run recirculation mode successsfully, If the color of this field is red, it indicates that there will probably be a problem while running in recirculation mode. The text will specify the error, and will usually suggest a course of action that will improve the likelihood of success. If the color of this filed is yellow, it indicates that the compensation cylinder(s). barely have enough stroke volume to ensure success. However, if there is any leakage over time, the compensation cylinders may eventually run out of stroke. Again, the text will usually suggest a course of action to improve the results.

The Set Up Recirculation Parameters window allows the user to “test” theoretical parameter values to see how changing them will impact the predicted motion of the compensation cylinder(s). The prediction algorithm uses the values displayed in this window. The user can change these theorectical values withouth saving them, to try to optimize the predicted results. However, to actually use these values when running in recirculation mode, the user must save them using one of the two “save” buttons at the bottom of the window. Closing the window without saving the values will result in the parameters retaining the values that were last saved.

12.6 Set Up Default System

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to change any of the default values. Please refer to Chapter 6, Section 6.8 for details on the password protection feature.

Set Up Default System allows a user to choose default settings for basic pump operations. The user can set a default operating mode, safety pressure, flow rate and set pressure for the pumps in their system.The user can then restore all default values, or just the default safety pressures, whenever they choose. This feature is especially useful when a pump is turned off at regular intervals. (Some, but not all, pump controllers may retain some of this data, even when they are turned off.)

To initially set up default values:

- From the menu bar, select Configure | Set Up Default System. The Set Up Default System window appears as shown in Figure 12-22.
- Set or Select the desired default values (see following sections for details).
- Click on the "Save Values and Exit" button to save selected values as default values for future use. This will **NOT** send values to the pump controllers. It will merely save those values so they automatically appear next time this window is opened.
- Selecting the "Close" button will "undo" any changes made to this window since the last time the window was opened. The values will neither be stored nor sent to the pump controllers.

To send default values to the pump controllers:

- From the menu bar, select Configure | Set Up Default System. The Set Up Default System window appears as shown in Figure 12-22.
- Check to make sure values shown are the ones to be sent to the pump controllers. Make any necessary changes.
- Select the "Send Default Safety Pressures" button to send **ONLY** the safety pressures to the pump controllers.
- Select the "Send All Default Values" button to send **ALL** default values to the pump controllers.
- **NOTE:** Selecting either the "Send Default Safety Pressures" or the "Send All Default Values" button will NOT save any changes made. To save changes, first select the "Save Values and Exit" button, then re-open window and select the appropriate button to send the desired values to the pump controllers.

NOTE: Values may not be sent while updating software to a pump controller or front panel.

.

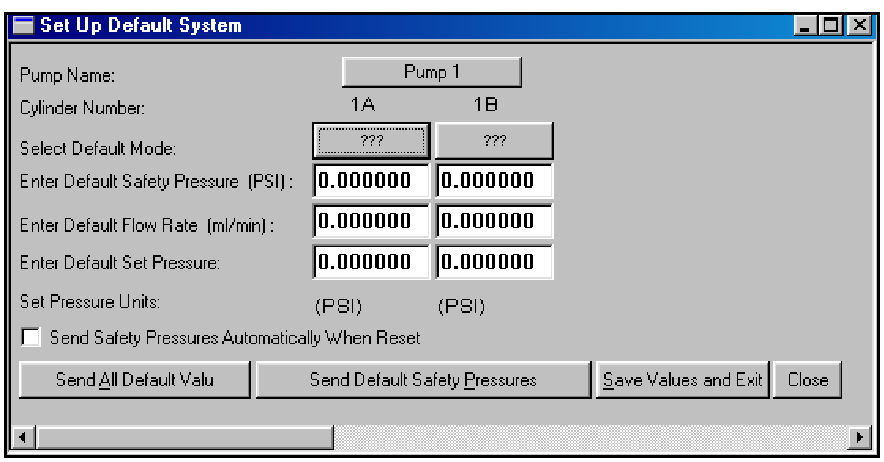


Figure 12-22 Set Up Default System Window

12.6.1 Select Default Mode

Select Default Mode allows a user to set a default operating mode for the pump(s) in their system by doing the following:

- In the Set Up Default System window, click on the Select Default Mode button for the appropriate pump cylinder. The window shown in Figure 12-23 appears.

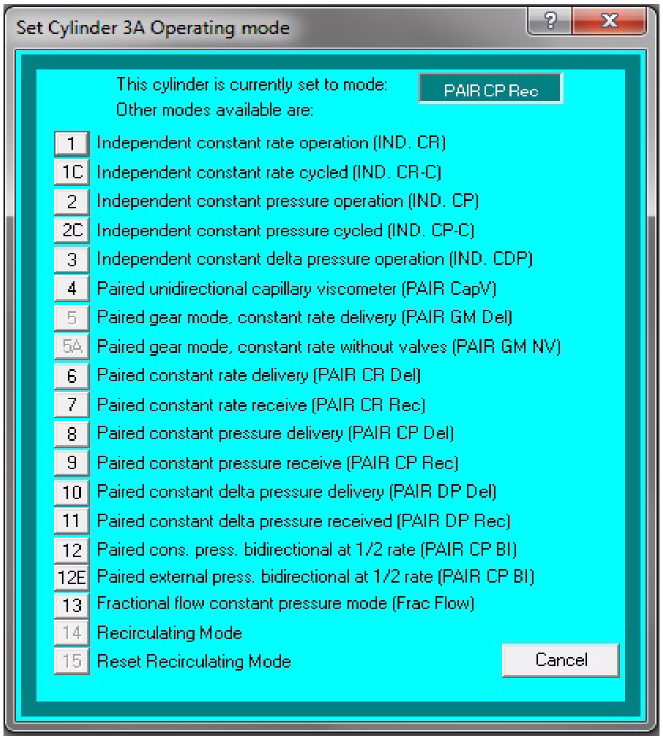


Figure 12-23 Default Mode for Cylinder # Window

To change the default operating mode, do the following:

- From the Default Mode for Cylinder # window, click on the desired default operating mode. Click on the number located to the left of the operating mode description.
- This window will automatically close when a default operating mode is chosen. The new default operating mode will appear in the Set Up Default System window. At this point, the selected mode has not yet been saved or sent to the pump controller.

12.6.2 Enter Default Safety Pressure

Enter Default Safety Pressure allows a user to set a default safety pressure for the pump(s) in their system.

- From the menu bar, select Configure | Set Up Default System.
- In the Set Up Default System window, click in the Enter Default Safety Pressure text box for the appropriate pump cylinder.

- Enter a default safety pressure. At this point, the entered safety pressure has not yet been saved or sent to the pump controller.

12.6.3 Enter Default Flow Rate

Enter Default Flow Rate allows a user to set a default flow rate for the pump(s) in their system.

- From the menu bar, select Configure | Set Up Default System.
- In the Set Up Default System window, click in the Enter Default Flow Rate text box for the appropriate pump cylinder.
- Enter a default flow rate. At this point, the entered rate has not yet been saved or sent to the pump controller.

12.6.4 Enter Default Set Pressure

Enter Default Set Pressure allows a user to set a default set pressure for the pump(s) in their system.

- From the menu bar, select Configure | Set Up Default System.
- In the Set Up Default System window, click in the Enter Default Set Pressure text box for the appropriate pump cylinder.
- Enter a default set pressure. At this point, the entered pressure has not yet been saved or sent to the pump controller.

12.6.5 Send Safety Pressures Automatically when Reset

The Send Safety Pressures Automatically When Reset feature allows PumpWorks to automatically send the saved default safety pressure whenever an illegal safety pressure is detected from a pump controller.

- If the box is checked, the default safety pressure will automatically be sent when an illegal safety pressure is detected.
- If the box is not checked, the user will simply get a warning when an illegal safety pressure is detected.

To set or reset this feature:

- From the menu bar, select Configure | Set Up Default System.
- In the Set Up Default System window, click on the Send Safety Pressures Automatically When Reset box to toggle the status. At this point, the new status has not yet been saved.

12.7 Set Up Error Masking

With error masking, PumpWorks is told to ignore, or mask, certain errors when they occur. In other words, when PumpWorks determines an error occurred, no error message is triggered if that error has been masked. The errors that can be masked are divided into two categories; errors associated with cylinders, and errors associated with pumps.

12.7.1 Set Up Error Masking for Cylinders

To set up error masking for cylinders, do the following:

- From the menu bar, select Configure | Set Up Error Masking | Cylinder #.
- The Set Up Cylinder # Error Masking window appears, as shown in Figure 12-24.

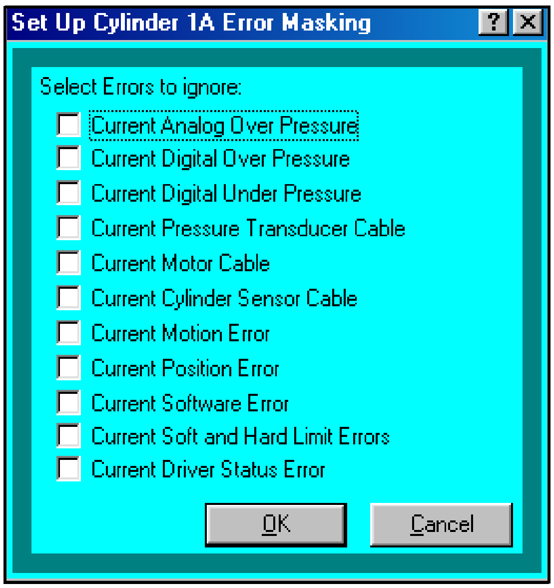


Figure 12-24 Set Up Cylinder # Error Masking Window

- In the Set Up Cylinder # Error Masking window, click in the box(es) to the left of the error(s) you wish to change. Click on the box(es) to toggle the masked status of the error. (Checked errors will be masked.)
- When finished, click on OK.

NOTE: The controller will not allow safety features to be disabled. Masking errors will not make a pump operate if the controller finds a problem.

12.7.2 Set Up Error Masking for Pumps

To set up error masking for pump, do the following:

- From the menu bar, select Configure | Set Up Error Masking | Pump #.

The Set Up Pump # Error Masking window appears, as shown in Figure 12-25.

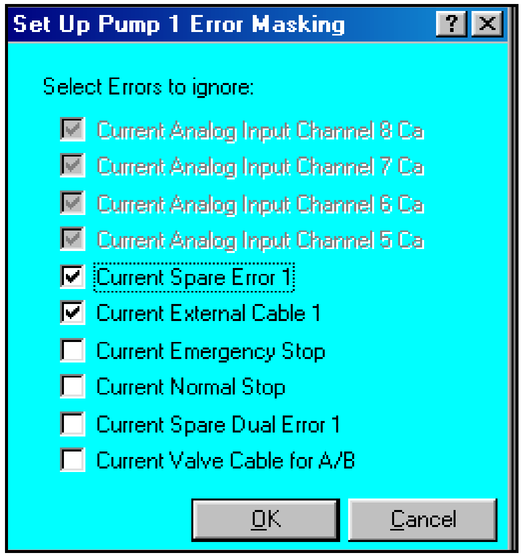


Figure 12-25 Set Up Pump # Error Masking

- In the Set Up Pump # Error Masking window, click in the box(es) to the left of the error(s) you wish to change. Click on the box(es) to toggle the masked status of the error. (Checked errors will be masked.)
- When finished, click on OK.

NOTE: The controller will not allow safety features to be disabled. Masking errors will not make a pump operate if the controller finds a problem.

12.8 Set Up Resource Mapping

Auxiliary devices, including analog voltage inputs, digital inputs, digital outputs, auxiliary valve outputs, and auxiliary transducers, can be connected to Quizix pumps and be monitored and controlled through PumpWorks. Set Up Resource Mapping allows a user to specify how an auxiliary device is identified in the PumpWorks application (windows, equations, sequences, data logging, and so on). Specific details of mapping resources are discussed in Chapter 10, Section 10.2 - Chapter 10, Section 10.5.

12.9 Set Up Data Averaging

Data Averaging is useful for “smoothing” data, and filtering out occasional spikes. This option is available to the user for averaging current rates, pressures, output rates and pressures, auxiliary analog input signals, and equation results. Each data item can be configured separately by specifying the sampling frequency, the number of samples to be averaged, and whether the averaged value should be used for data logging, displaying in PumpWorks windows, posting value to DDE, or any combination of those. The data is then collected at the specified sampling period. Each time a new piece of data is collected, the most recent samples (number of samples specified) are averaged together, and the result is stored and used for display, datalogging and/or DDE, as specified in the configuration. The default configuration for each data item is set up for no data averaging.

12.9.1 Setting Up Data Averaging for a Data Item

To set up data averaging for a data item, do the following.

- From the menu bar, select Configure | Set Up Data Averaging. The window shown in Figure 12-26 appears.

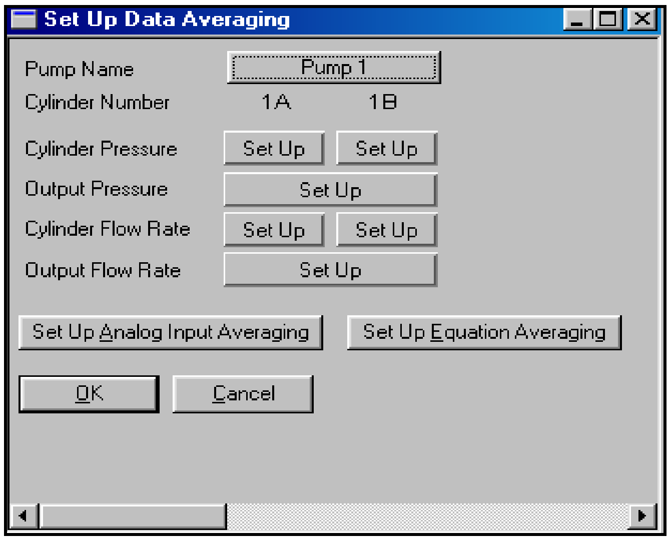


Figure 12-26 Set Up Data Averaging

- Click on the Set Up button for the data item to be configured and the dialog box shown in Figure 12-27 opens.

.

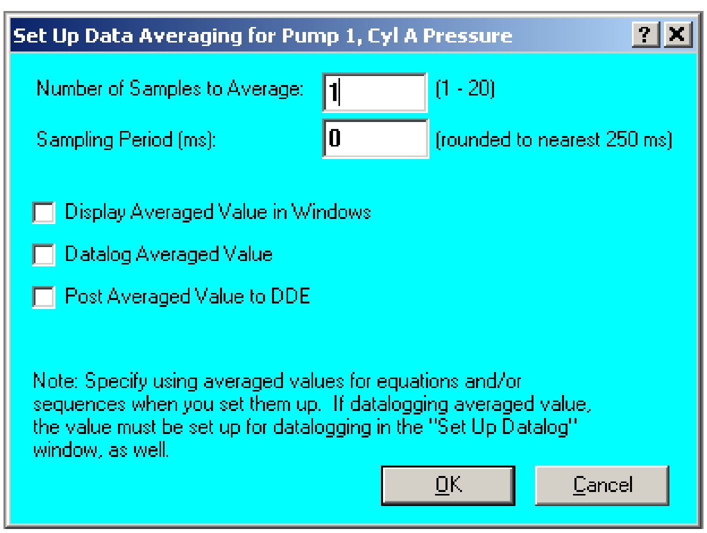


Figure 12-27 Set Up Data Averaging for Pump #

- Enter the number of samples to be averaged.

- Enter the sampling period (in milliseconds to the nearest 250 ms). This value is the time period BETWEEN data samples.

- Click on the appropriate check boxes for data logging, display, or posting to DDE to toggle the status. If the box is checked, the averaged value will be displayed/logged/posted to DDE. If the box is not checked, the current value will be used.

- When finished, click on OK.

12.9.2 Setting Up Data Averaging for an Auxiliary Analog Input Signal

To set up data averaging for an auxiliary analog input signal, do the following.

- From the menu bar, select Configure | Set Up Data Averaging and the window shown in Figure 12-26 opens.
- Click on the Set Up Analog Input Averaging button. The window shown in Figure 12-28 opens.

Figure 12-28 Set Up Analog Input Data Averaging

- Click on the Set Up button for analog input to be configured and the dialog box shown in Figure 12-29 opens.

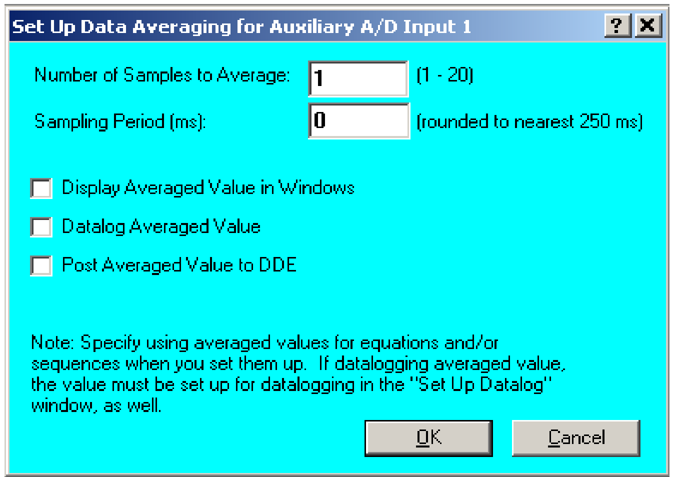


Figure 12-29 Set Up Data Averaging for Auxiliary A/D Input #

- Enter the number of samples to be averaged.
- Enter the sampling period (in milliseconds, to the nearest 250 ms).
- Click on the appropriate check boxes for data logging, display, or posting to DDE to toggle the status. If the box is checked, the averaged value will be displayed/logged/posted to DDE. If the box is not checked, the current value will be used.
- When finished, click on OK.

12.9.3 Setting Up Data Averaging for an Equation Result

To set up data averaging for an equation result, do the following.

- From the menu bar, select Configure | Set Up Data Averaging. The window shown in Figure 12-26 opens.
- Click on the Set Up Equation Averaging button. The window shown in Figure 12-30 opens.

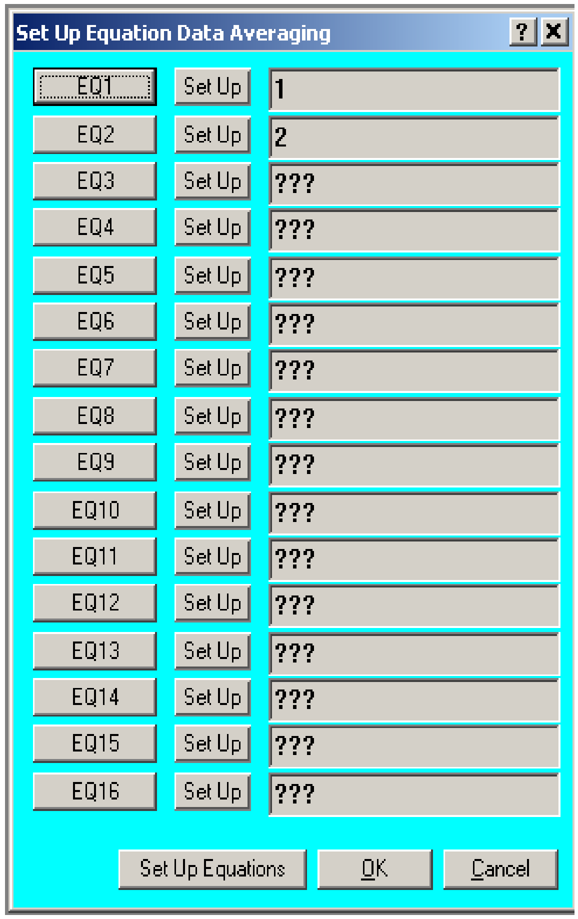


Figure 12-30 Set Up Equation Data Averaging

- Click on the Set Up button for the equation to be configured. The dialog box shown in Figure 12-31 opens.

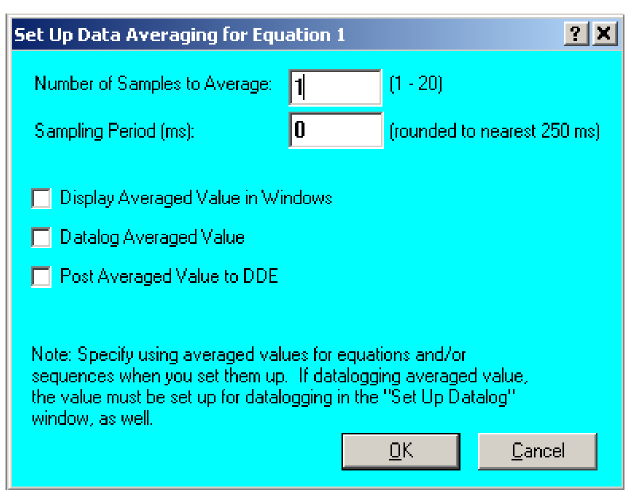


Figure 12-31 Set Up Data Averaging for Equation #

- Enter the number of samples to be averaged.
- Enter the sampling period (in milliseconds, to the nearest 250 ms).
- Click on the appropriate check boxes for data logging, display, or posting to DDE to toggle the status. If the box is checked, the averaged value will be displayed/logged/posted to DDE. If the box is not checked, the current value will be used.
- When finished, click on OK.

12.10 Set Up Sequences

After a sequence program has been written and saved in Notepad, the sequence needs to be configured in the PumpWorks program. To configure a sequence, do the following.

- From the menu bar, select Configure | Set Up Sequences. The Set Up Sequences window shown in Figure 12-32 opens.

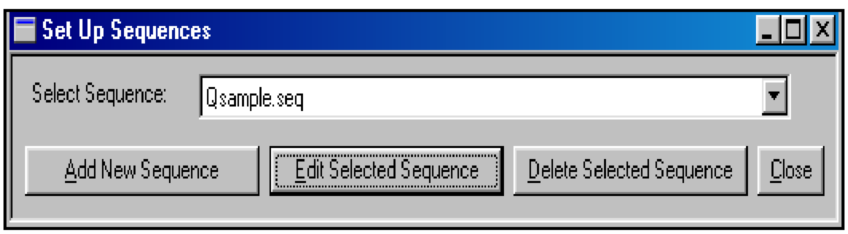


Figure 12-32 Set Up Sequences

- Click on the Add New Sequence button.The window shown in Figure 12-33 opens.

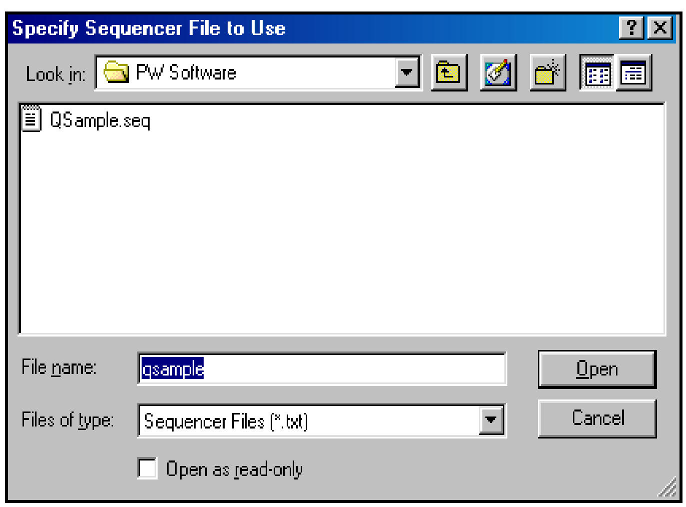


Figure 12-33 Specify Sequencer File to Use Window

- Browse and click on the desired sequence file name, then click on the Open button. (Please refer to the boxed note in Chapter 2, Section 2.2 for an explanation about the shared documents directory and a warning about locating files outside of this directory tree.) The Set Up Sequence window shown in Figure 12-34 opens.

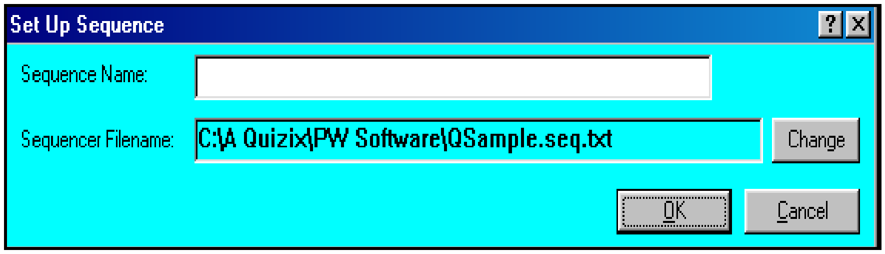


Figure 12-34 Set Up Sequence Dialog Box

- Enter a user defined sequence name associated with the sequence file in the Sequence Name field. Then click on OK. This sequence name will be added to the list of sequence names configured in PumpWorks.

12.10.1 Deleting a Configured Sequence Name

- From the menu bar, select Configure | Set Up Sequences. The Set Up Sequences window shown in Figure 12-32 appears.
- From the Set Up Sequences window, select the sequence name to be changed or deleted by clicking on the arrow to the right of the sequence names text box and highlighting the sequence to be deleted.
- Click on the delete button. This does NOT delete the actual sequence file. It only removes it from the PumpWorks sequence configuration. (PumpWorks will not allow the user to delete ALL the sequences. If there are less than two sequences configured, the delete button will be grayed out.

12.10.2 Editing a Configured Sequence

To edit a configured sequence name, or to change it's associated sequence file, do the following.

- From the menu bar, select Configure | Set Up Sequences. The Set Up Sequences window shown in Figure 12-32 appears.
- From the Set Up Sequences window, select the sequence name to be changed by clicking on the arrow to the right of the sequence names.
- Click on the Edit Selected Sequence button. The Set Up Sequence window shown in Figure 12-34 appears.
- To change the user-defined sequence name, highlight the sequence name and enter the new name.
- To change the sequence file name, click on the change button. The window shown in Figure 12-33 appears.

- Browse and click on the desired sequence file name, then click on the Open button.
- When changes have been completed, click on OK.

12.11 View Pump Information

This window allows a user to view basic pump information such as pump name, cylinder types, controller type, controller I.D., COM port number, expander port letter, pump's user-given name and communication status. A user can view basic pump information about every pump in their system from this window. To view pump information, do the following:

- From the menu bar, select Configure | View Pump Information. The window shown in Figure 12-35 opens.

.

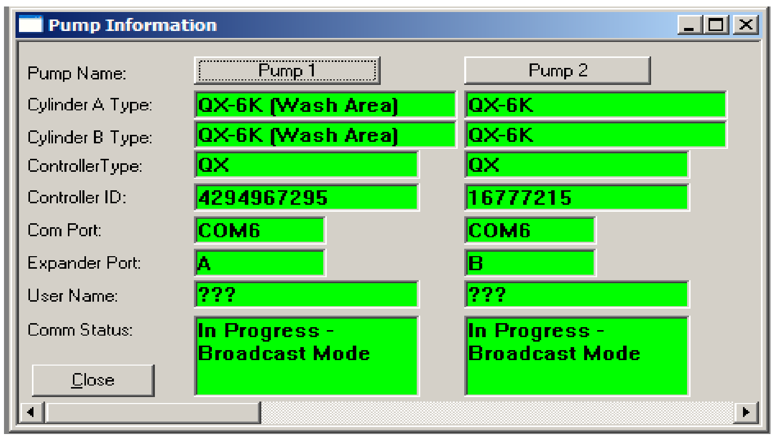


Figure 12-35 Pump Information Window

Another way to view pump information is from the main window by clicking on a pump title bar. The resulting window displays one pump's information, but does not display the pump's communication status.

12.12 Reassign Pump Number

A pump's number (Pump 1, Pump 2, and so on) is both its screen location and the number the pump recognizes itself as. A pump may be reassigned. For example, after reassignment Pump 1 would be recognized by PumpWorks as Pump 4, and its screen position would be Pump 4.

When a pump is installed onto PumpWorks, a user is given the option of specifying the number assigned to the pump when it is installed. If the user makes no choice, by default the pump is placed into the first available pump number or pump location. In other words, if no pumps have been installed onto PumpWorks, the first pump installed would default to Pump 1. The next pump installed would default to Pump 2 position. As pumps are added to a system, a user may wish to position all pumps of the same type together, or all pumps used for a certain purpose together. To reassign a pump, do the following:

- From the menu bar, select Configure | Reassign Pumps. The window shown in Figure 12-36 appears.

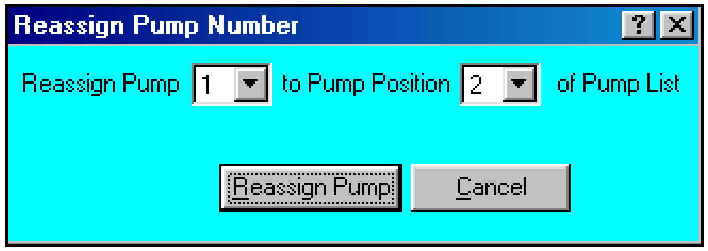


Figure 12-36 Reassign Pump Number Window

- In the Reassign Pump Number window, click on the down arrow located to the right of the Reassign Pump label.
- Click on the pump number you wish to move. Only pumps available to be moved will appear in this box. A pump may not be reassigned if data logging is active, if the pump is in recirculating or fractional flow mode, if currently sensor logging for that pump, or if updating software to pump controller(s) or front panel(s).
- Click on the down arrow to the right of “to Pump Position”.
- Click on the pump number indicating the desired re-assignment. Only available pump positions will be displayed. To reassign a pump to a position that is occupied, first reassign or uninstall the pump in the occupied position.
- When finished, click on Reassign Number, located at the bottom of the window.

The pump’s data is immediately displayed in its new screen location and the two digit display on the control panel of the QX Series, QL-700, CMD-5000 or CN-6000 pump controller will display its new pump number.

12.13 Uninstall Pump

The Uninstall Pump option is useful when a user wishes to remove a pump from their pump system. To uninstall a pump, do the following:

- From the menu bar, select Configure | Uninstall Pump. The window shown in Figure 12-37 appears.

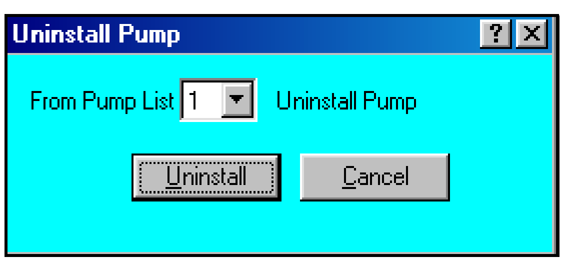


Figure 12-37 Uninstall Pump Window

- In the Uninstall Pump window, click on the down arrow located to the left of "Uninstall Pump".
- Click on the pump number you wish to remove. Only pumps available to uninstall will appear. Pumps cannot be un-installed if data logging is active, if the pump is in recirculating or fractional flow mode, if currently sensor logging for that pump, or if updating software to pump controller(s) or front panel(s).
- Click on Uninstall located on the bottom of the window.

PumpWorks immediately uninstalls the specified pump. You can reinstall the pump by selecting Communications | Search for Pumps from the menu bar. For more information about installing a pump, please refer to Chapter 13, Section 13.1.

NOTE: PumpWorks also allows a pump to be disabled, rather than un-installing it. If a pump is just disabled, communication with the pump will cease, and data for that pump will not be displayed in PumpWorks, but a place will be held for that pump number, so that it can be re-enabled later as the same pump number. See Chapter 13, Section 13.3, for details on enabling/disabling pumps.

12.14 Error State Capture Settings

In the Error State Capture Settings window, a user can set how many seconds before and after an error or event occurs pump operating information will be recorded. The maximum file size where this information will be stored can also be set here.

- From the menu bar, select Configure | Error State Capture Settings. The window shown in Figure 12-38 appears.

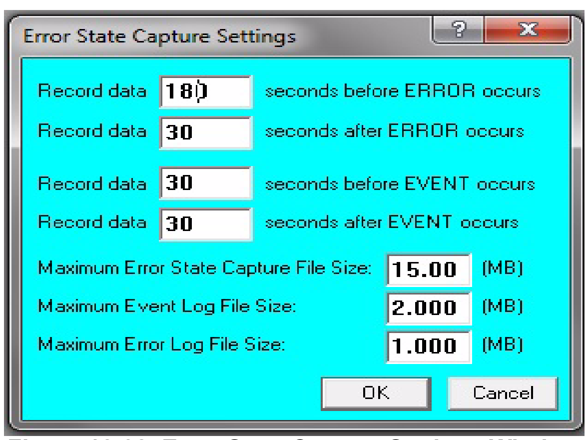


Figure 12-38 Error State Capture Settings Window

12.14.1 Record Data Before Error Occurs

Record Data Before Error Occurs refers to how many seconds before an error condition occurs that PumpWorks will record all operating parameters. The default is 180 seconds before an error occurs.

To change how many seconds before an error occurs data will be recorded, do the following:

- In the Error State Capture Settings window, highlight the current number in the text box labeled Record Data Before Error Occurs.
- Enter a new number.
- When finished with this window, click on OK.

12.14.2 Record Data After Error Occurs

Record Data After Error Occurs refers to how many seconds after an error condition occurs that PumpWorks will record all operating parameters. The default is 30 seconds after an error occurs.

To change how many seconds after an error occurs data will be recorded, do the following:

- In the Error State Capture Settings window, highlight the current number in the text box labeled Record Data After Error Occurs.
- Enter a new number.
- When finished with this window, click on OK.

12.14.3 Record Data Before Event Occurs

Record Data Before Event Occurs refers to how many seconds before an event occurs that PumpWorks will record all operating parameters. The default is 5 seconds before an event occurs.

To change how many seconds before an event occurs data will be recorded, do the following:

- In the Error State Capture Settings window, highlight the current number in the text box labeled Record Data Before Event Occurs.
- Enter a new number.
- When finished with this window, click on OK.

12.14.4 Record Data After Event Occurs

Record Data After Event Occurs refers to how many seconds after an event occurs that PumpWorks will record all operating parameters. The default is 2 seconds after an event occurs.

To change how many seconds after an event occurs data will be recorded, do the following:

- In the Error State Capture Settings window, highlight the current number in the text box labeled Record Data After Event Occurs.
- Enter a new number.
- When finished with this window, click on OK.

12.14.5 Maximum Error State Capture File Size

The size of the error state capture file will be limited to the figure entered in the Maximum Error State Capture File Size box. When the file reaches the user-specified size, any new information will be kept and the oldest information will be deleted. The default size is 8.0 MB.

To change the maximum size of the error state capture file, do the following:

- Highlight the current file size number.
- Enter the new number.
- When finished with this window, click on OK.

12.14.6 Maximum Event Log File Size

The size of the event log file will be limited to the size entered in the Maximum Event Log File Size box. When the file reaches the user-specified size, any new information will be kept and the oldest information will be deleted. The default size is 2.0 MB.

To change the maximum size of the event log file, do the following:

- Highlight the current file size number.
- Enter the new number.
- When finished with this window, click on OK.

12.14.7 Maximum Error Log File Size

The size of the error log file will be limited to the size entered in the Maximum Error Log File Size box. When the file reaches the user-specified size, any new information will be kept and the oldest information will be deleted. The default size is 1.0 MB.

To change the maximum size of the error log file, do the following:

- Highlight the current file size number.
- Enter the new number.
- When finished with this window, click on OK.

12.15 Extended Analog Input Settings

Users may add supported analog input boards to their computer system. The National Instruments NI USB 6251 analog input board has been tested by Chandler Engineering for use with PumpWorks. However, any National Instruments analog input board compatible with the NIDAQmx driver should be usable with PumpWorks. The NIDAQmx driver for the board must be installed and configured properly before applying PumpWorks settings. The Extended Analog Input Settings window is where a user configures communication parameters for an installed analog input board which will be operated with PumpWorks.

NOTE: After completing the extended analog input set up, the user must "map" the extended analog input channels as described in How to Map an Extended Analog Input Signal, Section 10.2.3, in order to access the values.

- From the Menu Bar, select Configure | Extended Analog Input Settings. The Extended Analog Input Settings window appears as shown in Figure 12-39.

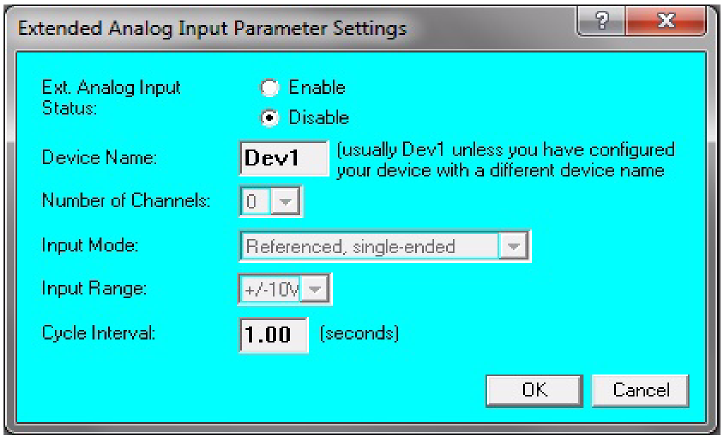


Figure 12-39 Extended Analog Input Parameter Settings

12.15.1 Analog Input Boards Supported by PumpWorks

The following analog input boards are supported by PumpWorks:

<u>NI USB 6251 and PCI-60-40-E</u>
National Instruments Corporation
11500 N Mopac Expwy
Austin, TX 78759-3504
Telephone: 512-794-0100

NOTE: The above boards have been tested by Chandler Engineering for use with Pumpworks. However, any National Instruments board with analog input functionality, that is compatible with National Instruments NIDAQmx driver, should be usable with PumpWorks.

12.15.2 Extended Analog Input Status

Extended Analog Input Status is where a user can enable or disable an analog input board.

- To enable or disable an analog input board, click in either the enable or the disable button.

12.15.3 Device Name

When PumpWorks tries to communicate with the extended a/d device, it identifies the correct device by name. The name of the actual device is usually "Dev1" unless the user has explicitly reconfigured it (with the manufacturer's configuration software). To specify the name of the device that PumpWorks will look for:

- In the Extended Analog Input Settings window, click in the “Device Name” box, and type in the desired name.

12.15.4 Number of Channels

Select the number of channels that the analog input board has by doing the following:

- In the Extended Analog Input Settings window, click on the arrow to the right of the “Number of Channels” box.
- Click on the number of channels the analog input board has.

12.15.5 Input Mode

There are three supported ways signals are cabled to an analog input board, referenced single-ended, differential, and non-referenced single-ended. Below is a brief description of each.

12.15.5.1 Referenced, Single Ended Inputs

For referenced, single ended inputs, there is one signal line for each input and a common ground line for all inputs coming into the analog input board. The analog input board reads the voltage difference between the signal line and the common ground line.

12.15.5.2 Differential Inputs

For differential inputs, there are two voltage lines coming into the analog input board. The analog input board reads the voltage difference between the two lines coming in. Each ground has a separate voltage line.

12.15.5.3 Non-Referenced, Single Ended

Please refer to the manual produced by National Instruments.

12.15.6 Input Range

The Input Range refers to the voltage level the A/D board is expecting.

12.15.7 Cycle Interval

The Cycle Interval refers to how often PumpWorks will acquire signals. The default is 1 second.

12.16 System Settings

The System Settings window allows a user to choose the following settings:

- Close windows automatically after sending a command.
- Start /stop pump cylinders with function keys.
- List pump cylinders individually or in pairs on PumpWorks main window.
- Set the pressure that will trigger a valve warning message.
- Set the minimum disk space necessary for data logging to occur.

- Set the sequencer operator level.
- Set up audible alarms.

From the menu bar, select Configure | System Settings. The window shown in Figure 12-40 appears.

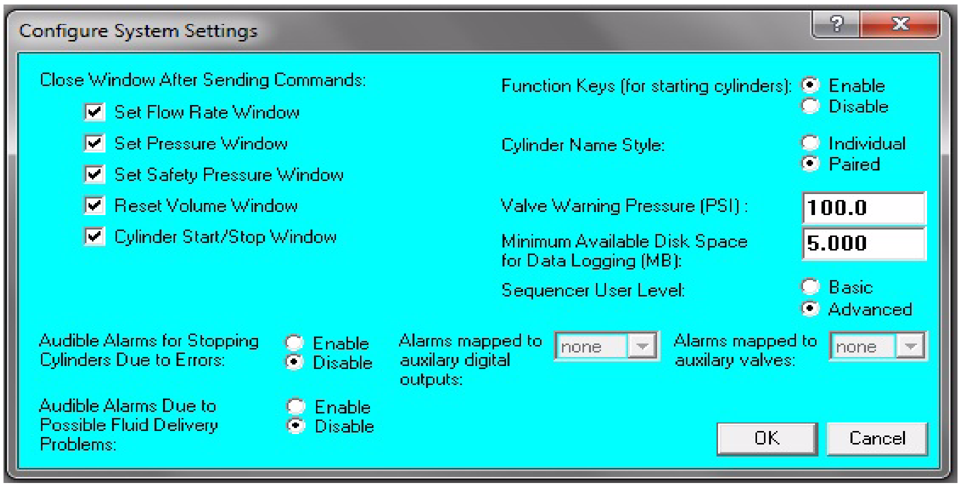


Figure 12-40 System Settings Window

12.16.1 Close Windows After Sending Commands

The Configure Systems Settings window allows a user to decide which of five windows will automatically close after sending a command. Checked window(s) will close automatically after a command has been sent and unchecked window(s) will remain open after a command has been sent. The default setting is for all windows listed to close automatically after a command has been sent.

- In the Configure System Settings window, click in the appropriate box until the check-mark appears if you wish the window to close automatically.
- Click in the appropriate box until the check-mark disappears if you wish the window to remain open after a command has been sent.

12.16.2 Function Keys (for starting cylinders)

Function Keys (for starting pump cylinders) allows a user to set whether the pump cylinders can be started and stopped using function keys. Using the function keys to start or stop a pump cylinder has the advantage of starting or stopping the pump cylinder quickly--even if the Pump Data & Controls window is not open. If the function keys button “enable” is checked, a user can start and stop pump cylinders using the appropriate function key. If the function keys button “disable” is checked, a user cannot start or stop pump cylinders using function keys. The default setting is enable. (See Methods of Starting and Stopping Pump Cylinders, Section 4.6.2, for more details.)

12.16.3 Cylinder Name Style

There are two choices of cylinder name styles. If the pump cylinders are named individually, they are titled Pump Cylinder 1, Pump Cylinder 2, Pump Cylinder 3, Pump Cylinder 4, and so on. If the pump cylinders are named in a paired style, they are titled Pump Cylinder 1A, Pump Cylinder 1B, Pump Cylinder 2A, Pump Cylinder 2B and so on. The default setting is paired (Pump Cylinder 1A and 1B).

- In the Configure System Settings window, click on either the individual or the paired button.
- When finished with this window click on OK.

12.16.4 Valve Warning Pressure

PumpWorks can be set to give a warning if the user tries to open a valve when the pressure inside the pump cylinder is above a user-set level. In such a case, a warning message would appear giving the user a chance to continue or cancel before opening the fill or deliver valve. The maximum valve warning pressure that can be set is the valve's maximum pressure. The default valve warning pressure is 100 psi. To change the warning pressure setting, highlight the text in this field and enter the new warning pressure (in current pressure unit of measure: bar, kPa, psi, and so on).

12.16.5 Minimum Available Disk Space for Data Logging (MB)

When data logging begins, PumpWorks checks how much disk space remains. If the disk space remaining is below the amount set in this window, PumpWorks will issue a warning. If the disk space remaining is less than 1MB, PumpWorks will not log data. The default for this setting is 5 MB.

12.16.6 Set Up Audible Alarms

The audible alarm feature provides the user with the ability to cause PumpWorks to sound an alarm if one or more pump cylinders are automatically shut down due to an error condition, or if a possible fluid delivery problem (for example, a re-pressurization error) is detected. There are four ways to use this feature. If one or both of the audible alarm options is enabled, PumpWorks will pop up an error window, along with an audible "beep" whenever an applicable error occurs. (Since the possible command responses only range from 000 - 300, users can still decipher any other error information contained in the response.) Optionally, the user can also provide an actual alarm device (such as a horn, bell, whistle, and so on.) that can be connected to one of the auxiliary digital outputs or auxiliary valves supported by PumpWorks (Refer to Appendices A-D for hardware information, and Auxiliary Valves, Section 10.4 and Auxiliary Digital Output Signals, Section 10.5 for mapping instructions.) The audible alarm can then be mapped to the specific digital output or valve so that the user's device will be sounded when the error condition occurs. In all cases, the alarm is turned off by the user clicking OK on the error window, and no alarm will be generated if both of the audible alarm options are disabled.

12.16.6.1 Enabling/Disabling Audible Alarms
To enable or disable the audible alarm options, click on the enable or disable button for each option.

12.16.6.2 Mapping Audible Alarms to an Auxiliary Digital Output
To cause the audible alarms to activate an auxiliary digital output, click on the arrow to the right of the box labeled “Alarms mapped to auxiliary digital outputs”, and select the output number that the audible device is mapped to. To undo any previous mapping, select the “none” option at the top of the list (above #1).

12.16.6.3 Mapping Audible Alarms to an Auxiliary Valve
To cause the audible alarms to activate an auxiliary valve, click on the arrow to the right of the box labeled “Alarms mapped to auxiliary valves”, and select the valve number that the audible device is mapped to. To undo any previous mapping, select the “none” option at the top of the list (above #1).

12.17 Controller Setup

WARNING
Controller Setup is an advanced feature for advanced pump users only.

IMPORTANT
If password protection has been enabled for this window, and the user is not logged in as administrator, the user will not be able to open the Controller Set Up window. Please refer to Chapter 6, Section 6.8 for details on the password protection feature.

Controller Setup allows a user to change the type of pump that is installed. This is useful when a user has upgraded or changed their pump and must now communicate that change to PumpWorks. The pump must be communicating with PumpWorks, but the pump cylinders must **not** be running. Also, the Controller Setup option may not be selected while updating software to the pump controller or front panel. For pump controller versions earlier than 56.0, many fields will be disabled, as these fields cannot be changed with the earlier versions of controller software.

From the menu bar, select Configure | Controller Setup | Pump #. A Controller Setup Warning explains this is an advanced feature, then the Set Up Controller window in Figure 12-41 opens.

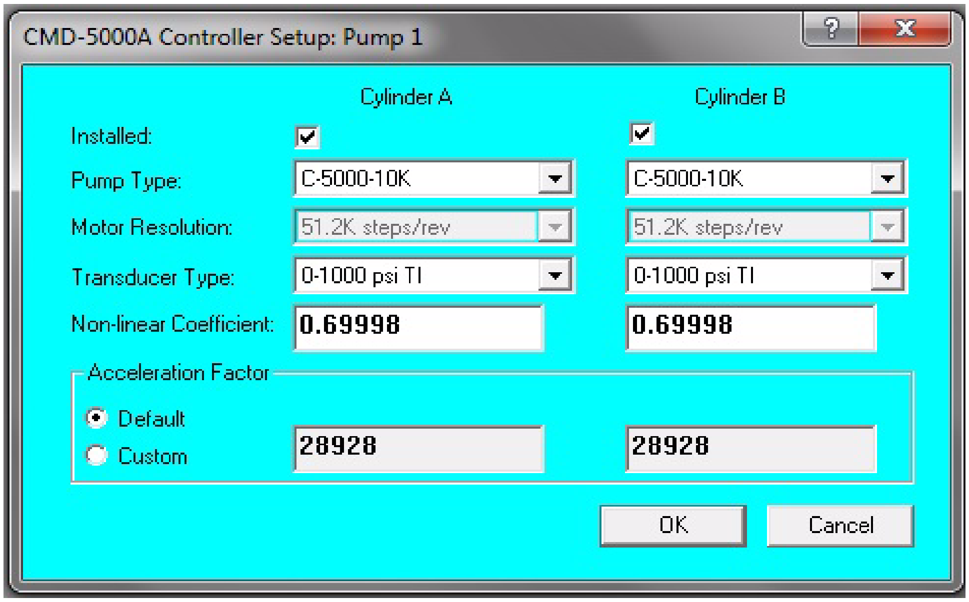


Figure 12-41 Set Up Controller Window

12.17.1 Cylinder A / B Installed

In the Cylinder A Installed, Cylinder B Installed area of the Set Up Controller window, the user chooses whether to install pump cylinder A, B, or both, depending on which needs to be re-installed due the user changes.

To change the install status:

- From the Controller Set Up Window, click on the box next to pump cylinder A and/or pump cylinder B.
- When finished with this window, click on OK.

NOTE: These fields are disabled for pumps whose cylinders can not be uninstalled or for controllers with code version less than 57.0.

12.17.2 Pump Type

The Set Up Controller Window will contain the controller type in the title bar. The Pump Type field specifies the current pump type. (SC2400 pump controllers specify pump type via DIP switches. Users cannot alter the pump type for these controllers with this window.)

To change the pump type:

- From the Controller Set-Up window, click on the arrow on the right side of the Pump Type field. A list of available pump types will be displayed.
- Click on the desired pump type listed.
- When finished with this window, click on OK.

NOTE: For the CN-6000 Controller, Pump Type will list Q5000 Series Pumps and Q6000 Series Pumps.

12.17.3 Motor Resolution

The motor resolution refers to the number of steps per revolution in the pump's digital stepper motor. The Motor Resolution field specifies the current motor resolution for the pump. For the SC2400, QX Series, QL-700 and CMD-5000 pump controllers, the motor resolution is provided and cannot be altered by the user.

To change the motor resolution:

- From the Controller Set-Up window, click on the arrow on the right side of the Motor Resolution field. A list of available motor resolutions will be displayed.
- Click on the desired motor resolution listed.
- When finished with this window, click on OK.

12.17.4 Transducer Type

The Transducer Type text box specifies the current transducer type for the pump. For the SC2400, and QL-700 pump controllers, the transducer type is provided and cannot be altered by the user.

To change the transducer type:

- From the Controller Set-Up window, click on the arrow on the right side of the transducer type field.
- A list of available transducer types will be displayed.
- Click on the desired transducer type listed.
- When finished with this window, click on OK.

12.17.5 Non-Linear Coefficient

The Non-Linear Coefficient text box specifies the current non-linear coefficients for the pump cylinders. This parameter is not applicable to the Lucas transducer types. The coefficient text boxes will be grayed out if one of these transducer types have been selected. To change the non-linear coefficients, simply enter the new coefficients (acceptable range is from -8.0 to 8.0).

12.17.6 Acceleration Factor

The acceleration factor controls how fast a cylinder changes from one rate to another. The higher this number, the faster the rate of change. The default values depend on the pump controller type. This value may only be changed for pump controller versions 51.0 or greater.

To change the acceleration factor:

- From the Controller Set Up window, click on the Custom button.
- Enter the new acceleration factors.
- To change back to the default acceleration values, click on the Default button.
- When finished with this window, click on OK.

12.18 Cylinder Stop Action Settings

The Select Cylinder Stop Action window allows users to specify how PumpWorks should automatically control the valves on a pump when the specified cylinder stop condition (emergency stop, automatically stopped due to an error condition, or any other stop condition) occurs for that pump. When the specified stop condition occurs, regardless of which cylinder of the pump it occurs on, the valves for both cylinders of that pump will be acted upon by the specified action.

To specify the stop condition and actions:

- From the menu bar, select Configure | Cylinder Stop Action Settings. The window shown in Figure 12-42 appears.

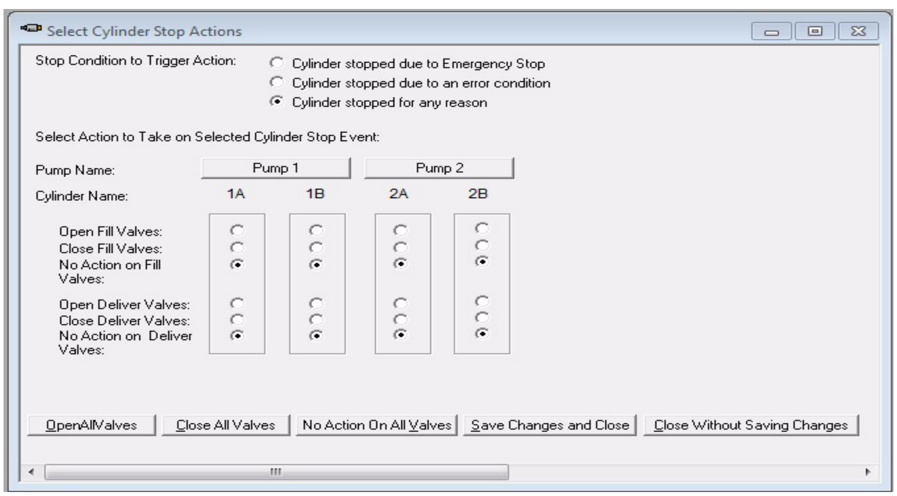


Figure 12-42 Cylinder Stop Action Window

- Select one of three cylinder stop conditions (“Cylinder stopped due to Emergency Stop,” “Cylinder stopped due to an error condition,” or “Cylinder stopped for any reason”) by clicking on the button next to the desired option.
- For each pump cylinder, choose one of three actions (open valve, close valve, or take no action) for the deliver valves and the fill valves.
- Altenatively, the valve action check boxes can be set to the same settings for all pumps by clicking on the Open All Valves button, the Close All Valves button, or the No Action on All Valves button at the bottom of the window. Note that although clicking on one

of these buttons will change the status of the valve actions on the check boxes for all pumps in this window, PumpWorks will only take the actions on the valves of the pump that has the error or stop condition, if/when that event occurs.

- To save the new settings, click on the Save Changes and Close button. The new settings will be saved, and the window will close.
- To ignore any new changes and revert back to the settings before the window was opened, click on the Close Without Saving Changes button. The new settings will be ignored, and the window will close.

NOTE: Any changes to the settings will not be applied until the Save Changes and Close button has been clicked.

12.19 Overpressure/Underpressure Action Settings

PumpWorks allows users to specify a set of actions to be automatically taken on a pump when the pressure exceeds a specified maximum pressure, or goes below a specified minimum pressure. These actions include controlling valves and /or stopping pumps. There are two windows that are used to specify the thresholds and actions for this feature; one to select the thresholds/actions for pumps 1-4, and the other to select the thresholds/actions for pumps 5-8. To specify the thresholds/actions PumpWorks should take:

- From the menu bar, select Configure | Overpressure/Underpressure Action Settings | Pumps 1-4. Figure 12-43 appears. (An analogous window appears for pumps 5-8 if you select Configure | Overpressure/Underpressure Action Settings | Pumps 5-8.)

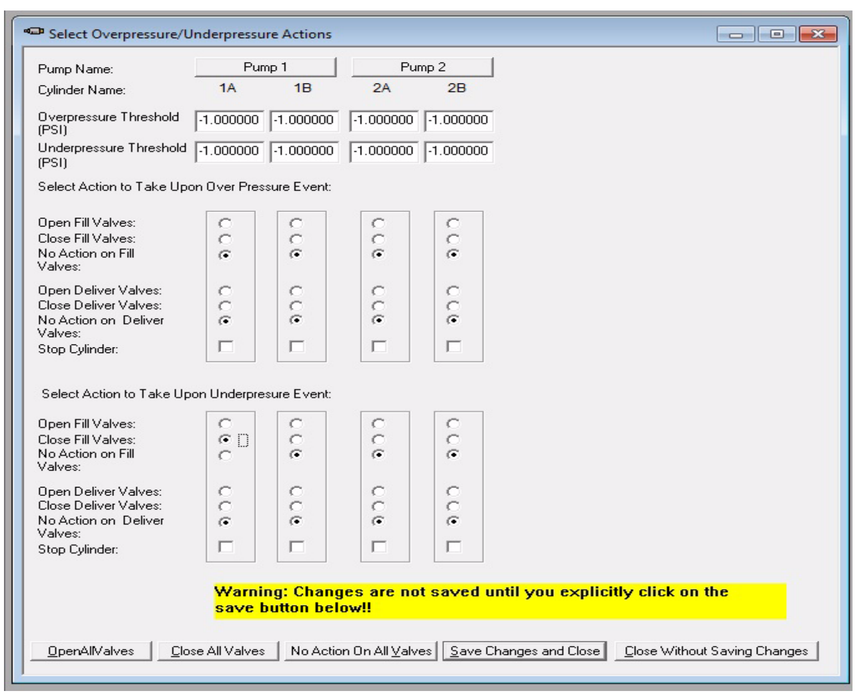


Figure 12-43 Select Overpress/Underpressure Actions

- For each cylinder of each pump, enter the minimum and maximum pressure thresholds.
- For each cylinder of each pump, choose one of three actions (open valve, close valve, or take no action) to be taken in the event that the current pressure exceeds the specified maximum pressure.
- For each cylinder of each pump, choose one of three actions (open valve, close valve, or take no action) to be taken in the event that the current pressure falls below the specified minimum pressure.
- Altenatively, the valve action check boxes can be set to the same settings for all pumps by clicking on the Open All Valves button, the Close All Valves button, or the No Action on All Valves button at the bottom of the window. Note that although clicking on one of these buttons will change the status of the valve actions on the check boxes for all pumps in this window, PumpWorks will only take the actions on the valves of the pump that has the overpressure or underpressure status, if/when that event occurs.
- For each cylinder of each pump, specify whether the pump should be stopped if the pressure exceeds the specified maximum pressure, and whether the pump should be stopped if the pressure drops below the specified minimum pressure. To toggle the status of the Stop Pump check boxes, click the box. If the box is checked, the pump will be stopped if the “error” event occurs. If the box is not checked, the pump will not be stopped if the event occurs.
- To save the new settings, click on the Save Changes and Close button. The new settings will be saved, and the window will close.
- To ignore any new changes and revert back to the settings before the window was opened, click on the Close Without Saving Changes button. The new settings will be ignored, and the window will close.

NOTE: Any changes to the settings will not be applied until the Save Changes and Close button has been clicked.

12.20 Cylinder Error Groups

The Cylinder Error Group feature allows PumpWorks to associate multiple pump cylinders in a system. Specifying cylinder error groups causes PumpWorks to stop all cylinders in a group when one stops due to an error. The user can specify up to 4 cylinder error groups.

To specify the cylinder error groups:

- From the menu bar, select Configure | Set Up Cylinder Error Groups. The Set Up Cylinder Error Groups window shown in Figure 12-44 opens.

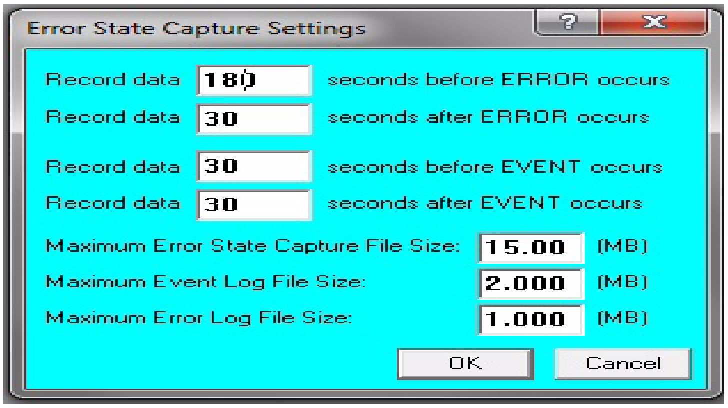


Figure 12-44 Set up Cylinder Error Groups Window

- For each desired group, click on the appropriate pump cylinder check boxes to select which cylinders will be stopped when any cylinder in the group is stopped. For unused cylinder error groups, ensure that all cylinder check boxes are unchecked.
- Click OK to save the groups.

THIS PAGE INTENTIONALLY LEFT BLANK.

13 COMMUNICATIONS MENU

The Communications menu is used to set up or change the link between PumpWorks and the user's pump system. Please note that searching for pumps while updating the controller or front panel software is not allowed. Click on Communications and the following options are displayed.

- Search for Pumps, Section 13.1
- Search Options, Section 13.2
- Pump Communications, Section 13.3
- Separator Communications, Section 13.4
- Back Pressure Regulator Communications, Section 13.5
- Host Mode Communications, Section 13.6
- Auxiliary Transducer Communication, Section 13.7
- View Communication Status, Section 13.8
- Baud Rate Options, Section 13.9
- Update Front Panel Software, Section 13.10
- Update Pump Controller Software, Section 13.11

13.1 Search for Pumps

Search for Pumps is an easy way to install a pump onto PumpWorks. After connecting communications cables to pump controller(s), and powering them up, just follow the instructions below.

- From the menu bar, select Communications | Search for Pumps.

PumpWorks will search all user-specified COM ports and all expander ports for an un-installed Quizix pump. When found, a New Pump Found window opens, as shown in Figure 13-1.

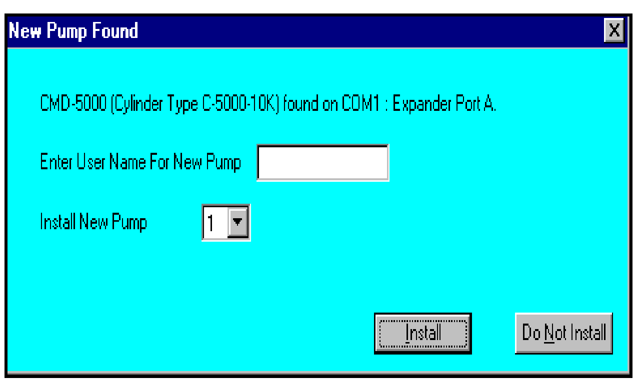


Figure 13-1 New Pump Found Window

The New Pump Found window displays the type of pump found, along with the COM port and the serial expander/isolator port. (For SC-2400 controllers, no serial expander/isolator port is shown.)

13.1.1 Enter User Name for New Pump

The default names for pumps are Pump 1, Pump 2, and so on. A user may choose to give a pump a different name, for example, “Oil Pump”. If a user changes a pump’s name, the user-assigned name will be appended to the default name for that pump. For example, if the user chooses to give pump 1 the name “Oil Pump”, the pump will then be titled “Pump 1 - Oil Pump”. You can also rename the pump at any time from the Pump Data & Controls window by clicking on the “Pump” title bar.

13.1.2 Install New Pump

Install New Pump refers to the number that the pump will be assigned. This is both the screen location and the pump number displayed in PumpWorks, as well as the number displayed on the pump controller’s two digit display. For example, the pump can be assigned as Pump 1, Pump 2, and so on. The user has a choice of eight screen numbers. The default assignment is the lowest available pump number. Once installed, the user can always change a pump’s number assignment by selecting Configure | Reassign Pump Number from PumpWorks menu bar. To assign a different number, do the following:

- In the New Pump Found window, click on the down arrow to the right of the Install New Pump text box.
- Highlight the number that correlates to the screen position where you want your pump to be located.
- When finished with the New Pump Found window, click on install.

PumpWorks will install the pump and search for additional new pumps. If additional new pumps are found, another New Pump Found window will appear. If no additional new pumps are found, the main window, called the Pump Data & Controls window, will automatically open.

13.1.3 Abort Search Option

If the option to "search all com ports" has been selected (please refer to Chapter 13, Section 13.2.3), an option will be given, after finding pumps on a com port, to abort the search. The window shown in Figure 13-2 will appear.

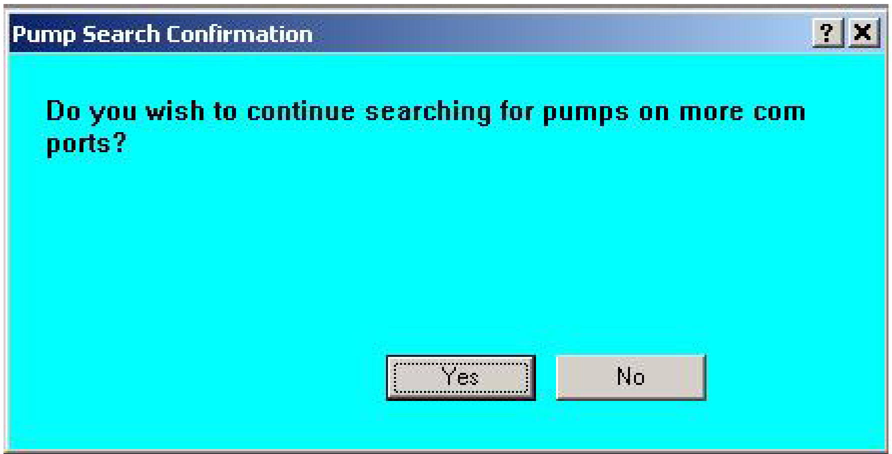


Figure 13-2 Pump Search Confirmation Window

This option may be useful if the user knows there are pumps only connected to a specific number of com ports, and all of them have already been searched. Serveral minutes may be saved by PumpWorks not having to search through the remaining com ports (255 in total!). To abort the search, answer "No" to the confirmation window, indicating that you do not wish to continue the search. The pumps that were found/installed will remain installed, regardless of whether you contine or not.

13.2 Search Options

The Search Options window allows the user to decide how and when PumpWorks will search for new pumps in a user's system. The user can decide if PumpWorks will perform an automatic search for pumps every time it is initialized. The user can also specify whether PumpWorks should search all available COM ports, or they can specify up to 4 specific COM ports for PumpWorks to search for pumps on.

The user can also specify whether or not to search for the old style Quizix SC-2400 series pumps, and if so, which baud rate at which to search. De-selecting the search option for the SC-2400 pumps will significantly speed up the time it takes to search for pumps. Chandler Engineering recommends that this option be turned off unless the user has SC2400 pumps attached, which is the default setting.

- From the menu bar, select Communications | Search Options. The Configure Search Options window opens as shown in Figure 13-3.

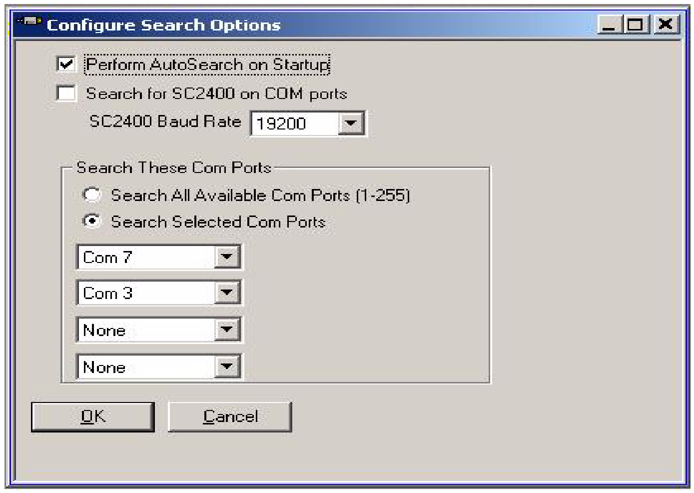


Figure 13-3 Configure Search Options Window

13.2.1 Perform AutoSearch on Start-up

If Perform AutoSearch on Start-up is check-marked, PumpWorks will search all the user-specified COM ports for uninstalled Quizix pumps every time it is initialized. A check-mark in this box is the default setting. If Perform AutoSearch on Start-up is not check-marked, PumpWorks will initialize and not search for uninstalled Quizix pumps. PumpWorks will initialize quicker if autosearch is not being performed.

13.2.2 Search for SC-2400 on COM Ports

If the Search for SC2400 on Com Ports check box is checked, PumpWorks will search for Quizix SC-2400 pump controllers. If the user knows that they do not have any Quizix SC-2400 pump controllers, they can reduce the search time considerably by unchecking this field. To configure this option:

- From the menu bar, select Communications | Search Options.
- In the Configure Search Options window, click on the arrow to the right of Search for SC2400 on COM Ports to check or uncheck the check box.
- When finished with this window, click on OK.

If the user configures PumpWorks to search for SC-2400 pumps, the baud rate at which to search for them must be selected. This baud rate setting does not affect pump controllers other than SC-2400s. The default setting is 19200 and normally will not need to be changed. Older pump equipment may require a slower baud rate setting. To change the search baud rate:

- From the menu bar, select Communications | Search Options.
- In the Configure Search Options window, click on the arrow to the right of “SC2400 Baud Rate”, and click on the desired baud rate.
- When finished with this window, click on OK.

13.2.3 Search These COM Ports

PumpWorks can search all available COM ports to find an uninstalled Quizix pump, or just search up to 4 specified COM ports. The search for pumps can be quicker by only selecting COM ports that have attached pumps. However, if it is unclear which COM ports have attached pumps, searching all available COM ports can be a useful thing to do. Once the appropriate COM ports have been established, it's best to go back and specify to search on only those COM ports, to save time in future searches. It's also useful to specific COM ports if the user has equipment attached to a COM port that could be disturbed by search queries from PumpWorks.

To specify searching all COM ports:

- Click on the Search All Available Com Ports button.

Otherwise, to specify the COM ports to be searched:

- Click on the Search Selected Com Ports button.
- In the selection boxes below that button, choose the COM ports PumpWorks should search for pumps on. If less than 4 COM ports should be searched, ensure that the unused selection boxes have "None" selected.
- When finished with this window, click on the OK button.

13.3 Pump Communications

The Pump Communications window displays the following basic pump information:

- Cylinder types
- Controller type
- Controller I.D.
- COM port
- Expander port
- Baud rate
- User name for pump
- Cycle interval
- Time out interval
- Communication lost interval
- Auxiliary request period.
- Parity
- Checksum

The pump name and the communication intervals are user-specified and can be changed in this window. For pumps that are not currently installed, or not currently communicating (disabled), the user can also select the controller type, Com port, expander port, and baud rate. The parity and checksum parameters can only be changed for SC-2400 pumps.

- From the menu bar, select Communications | Pump Communications
- Click on the appropriate pump number to open the Configure Communications for Pump # window shown in Figure 13-4.

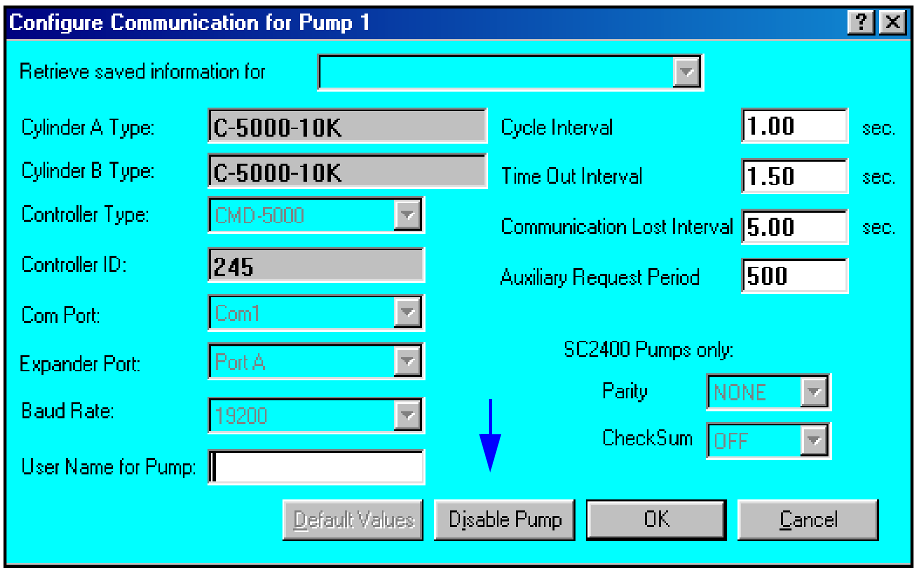


Figure 13-4 Configure Pump Communications Window for a Communicating (Enabled) Pump

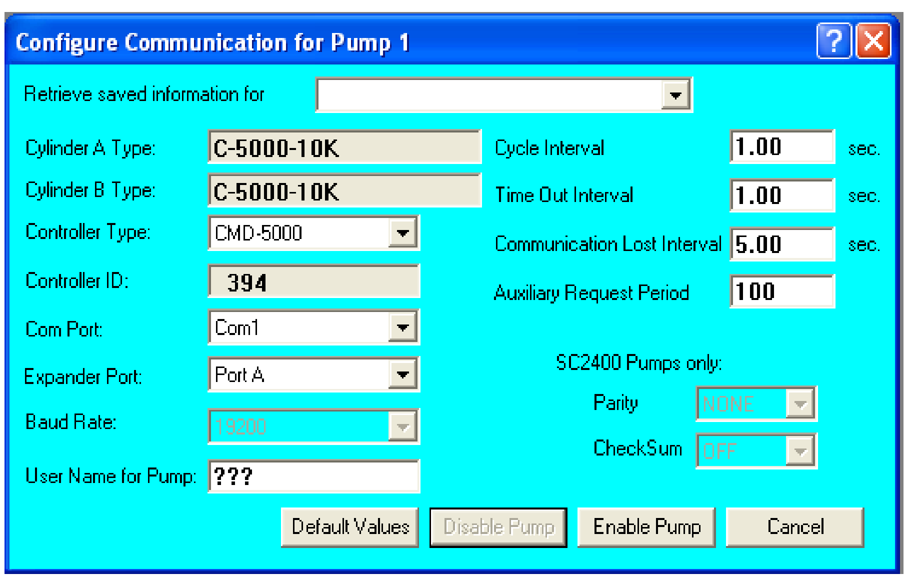


Figure 13-5 Configure Pump Communications Window for a Non-communicating (Disabled) Pump

Figure 13-4 shows the communication parameters (shown in white) that are available to be set on a pump that is communicating (enabled). Figure 13-5 shows the communication parameters that are available to be set on a pump that is not communicating (disabled), is uninstalled, or has not been previously configured.

- **Retrieve saved information for Pump** allows the user to select previously entered communication parameters. When communication is established, the communication parameters are saved and can be retrieved by selecting their identification number here.
- **Cylinder A Type** text box identifies which type of Quizix pump cylinder A is.
- **Cylinder B Type** text box identifies which type of Quizix pump cylinder B is.
- **Controller Type** identifies the type of controller.
- **Controller I.D.** shows the factory-assigned pump controller identification number for the QX Series Pump, QL-700 Pump, the CMD-5000 Dual Controller Driver, or the CN-6000 Controller. In the case of the SC-2400 Pump Controller, the controller I.D. is assigned via dip switches which are set by the user.
- **COM Port** displays the COM port number to which the pump is attached.
- **Expander Port** displays the serial expander/isolator port to which the pump cylinder is attached. (This field is not applicable for SC-2400 controllers.)
- **Baud Rate** is a read only field. It displays the current communication baud rate with the pump controller. The default setting is 19200.
- **User Name for Pump** displays the user-given name for the pump cylinder, but only if the user has chosen to name the pump. If the text box is either blank or has three questions marks in it, then the user has not given the pump a name. The user may enter a pump name if desired.
- **Cycle Interval** is how often PumpWorks sends a request to a pump for information or status. The default interval is 1 second. If a front panel is connected to the pump controller, the cycle interval is limited to a minimum of 3 seconds.
- **Time Out Interval** is the maximum time that PumpWorks waits for a response from a pump before trying again to communicate. The default setting is 1 second.
- **Communication Lost Interval** is how long PumpWorks will keep trying to re-establish communication with a Quizix pump that was previously active but is not responding, before issuing a Communication Lost Message. The default setting is 5 seconds.
- **Auxiliary Request Period** specifies the number of cycle intervals between requests for data that does not change frequently. For example, modes, set pressure, set rate, calibration data, and so on. PumpWorks will also automatically request this data anytime it sends a command to a pump controller that would have an impact on these values. The default setting is 100.
- **Parity** shows the type of parity used for error checking.
- **Checksum** shows whether a checksum is being used as part of error checking.

- **Disable Pump** terminates communication with the pump but preserves the pump number/screen location. This button appears only if the pump is active. It becomes "Enable" when a pump is disabled.
- **Enable Pump** activates communication with the pump again. This button appears only if a pump has been disabled.
- **Cancel** closes the window and discards any changes.
- **OK** updates any changes that were made in the communications parameters and closes the window.

NOTE: Communication intervals can be changed while a pump is operating.

13.4 Separator Communications

A separator is a device that can be attached to a pump system. A separator is able to separate two liquids which have different density properties, such as water and oil, in order to determine the volume of each fluid. PumpWorks can interact with a properly installed separator. Configure Separator Communications is where a user can configure the user-installed separator.

- From the menu bar, select Communications | Separator Communications.
- Select the separator # you wish to configure. (1 or 2 for two phase separators, 3 for three phase separator.)
- The Set Up Separator window appears as shown in Figure 13-6.

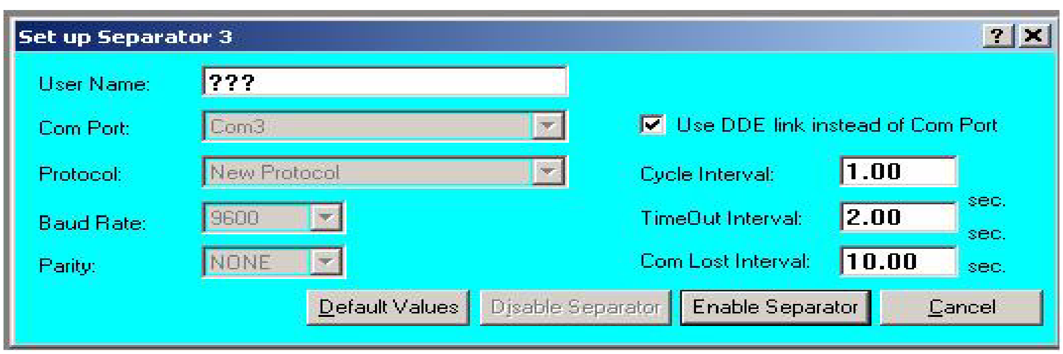


Figure 13-6 Set Up Separator # Window

The Set Up Separator # window allows the user to set up a separator's communication intervals. Included in this window are the following:

- **User Name** displays the user-given name for the separator, but only if the user has chosen to name the separator. If the text box is either blank or has three questions marks in it, then the user has not given the separator a name. The user can enter a separator name, if desired.

- **COM Port** allows the user to specify which COM port the separator is attached to. Only those COM ports that are available will be included in the list.
- **Protocol** refers to which version of communication protocol (“New Protocol” or “Old Protocol” or "Expanded Data Range Protocol") a separator may require to function properly. Currently, most manufactured devices operate with the protocol setting of "New Protocol". However, these devices do not handle large values properly. There is yet a newer version of separator that uses the "Expanded Data Range Protocol", that handles these large values properly. These new separator devices should be clearly marked indicating which protocol they use. If it’s not clear, they probably use the "New Protocol". Selecting the wrong protocol will result in PumpWorks not communicating properly with the device. If PumpWorks is having trouble communicating with the separator, try selecting a different protocol.

NOTE: Known separators that use the extended data protocol are the later models of New England Research models ALDM 2-Phase and ALDM 3-Phase separators (version 3.7 and later).

- **Baud Rate** displays the baud rate that is appropriate for a separator. The default setting is 9600. The baud rate setting made here must agree with the setting made on the actual separator.
- **Parity** is a communication parameter which checks the integrity of a communication transmission. The parity setting made here must agree with the setting made on the actual separator.
- **Use DDE link instead of Com Port** allows the user to specify using the DDE link to obtain separator data instead of using the com port. (Clicking on the check box will toggle the state.)
- **Cycle Interval** is how often PumpWorks sends a request to a separator for information or status. The default interval is 1 second.
- **Time Out Interval** is the maximum time that PumpWorks waits for a response from a separator before trying again to communicate. The default time out interval is 1.5 seconds.
- **Com Lost Interval (Communication Lost Interval)** is how long PumpWorks will keep trying to make a connection with a separator that was previously installed but is not responding, before issuing a Communication Lost Message. The default setting is 5 seconds.
- **Default Values** allows the user to return the cycle interval, time out interval, com lost interval, baud rate and parity to their default values.

13.4.1 Enable or Disable Separators

To disable a separator means a user is not operating it and does not want PumpWorks to acknowledge it. Disabling a separator completely removes all record of the separator from

PumpWorks. When a user is ready to return the separator into operation, simply enable the separator and PumpWorks again acknowledges it.

- From the menu bar, select Communications | Configure Separator Communications | Separator #.
- In the Set Up Separator # window, either the disable or the enable button will be available at the bottom of the window. Clicking on the button will cause the action to occur (either disable the separator or enable the separator).

13.4.2 Separators Supported by PumpWorks

The following 2-phase separator models are supported by PumpWorks:

AMS-780 and the AMS-900
Core Laboratories Instruments
2105 McKenzie, Suite 106
Carrollton, TX, 75006 USA
Phone:972-484-3431

NISEP-200
Christian Michaelson Research AS
P.O. Box 6031, Postterminalen
N-5892 Bergen, NORWAY
Phone:47 55574040

The following 2-phase separator models from New England Research are supported by PumpWorks, but because they use the same communication protocol used by 3-phase separators, they must be configured as separator number 3:

NERAS-2000 2-Phase and ALDM 2-Phase
New England Research
331 Olcott Drive, Suite L1
White River Jct., VT 05001
Phone: 802-296-2401

The following 3-phase separators are supported by PumpWorks:

NERAS-2000 3Phase and ALDM 3-Phase
New Englands Research
See address above.

NISEP-300
Christian Michaelson Research AS
See address above.

13.4.3 Viewing and Logging Separator Data

To view the separator data, please refer to Chapter 10, Section 10.6. To record data from a separator into a data log, please refer to Chapter 7, Section 7.2.6.

13.5 Back Pressure Regulator Communications

A back pressure regulator is another device that can be added to a pump system by the user. A back pressure regulator maintains a specific pressure level, or can vent a pressure, but cannot build pressure to a higher level.

- From the menu bar, select Communications | Configure Back Pressure Communications. The window shown in Figure 13-7 appears.

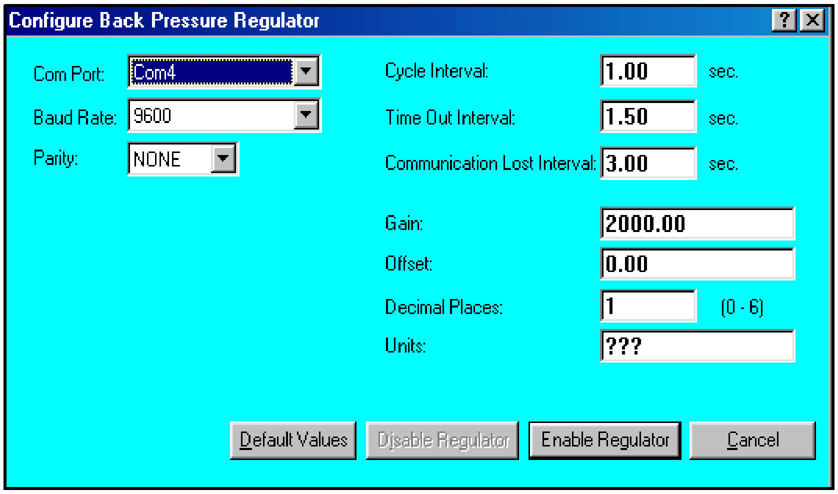


Figure 13-7 Configure Communication for Back Pressure Regulator Window

- **COM Port** allows the user to specify which COM port the back pressure regulator is attached to. Only those COM ports that are available will be included in the list.
- **Baud Rate** displays the baud rate that is appropriate for the back pressure regulator. The default setting is 9600. The baud rate setting made here must agree with the setting made on the actual back pressure regulator.
- **Parity** is a communication parameter which checks the integrity of a communication transmission. The parity setting made here must agree with the setting made on the actual back pressure regulator.
- **Cycle Interval** is how often PumpWorks sends a request to a back pressure regulator for information or status. The default interval is 1 second.
- **Time Out Interval** is the maximum time that PumpWorks waits for a response from a back pressure regulator before trying again to communicate. The default time out interval is 1.5 seconds.
- **Communication Lost Interval** is how long PumpWorks will keep trying to make a connection with a back pressure regulator that was previously installed but is not responding, before issuing a Communication Lost Message. The default setting is 3 seconds.
- **Gain and Offset** Calibration values for the back pressure regulator.

$$\text{Output Voltage} = \frac{\text{Pressure Setpoint} - \text{(minus) Offset}}{\text{Gain}}$$

- **Decimal Places** are how many numbers to the right of the decimal point are displayed for the pressure.
- **Units** are the user-defined unit of measure for pressure. This field is used strictly for display; there are no automatic unit conversions done for this value.

- **Default Values** allows the user to return the cycle interval, time out interval, com lost interval, baud rate and parity to their default values.
- **Enable or Disable Regulators** Either the disable or the enable button will be available at the bottom of the Configure Communication for Back Pressure Regulator window. Clicking on the button will cause the action to occur (either disable the regulator or enable the regulator).

  Disabling a regulator completely removes all record of the device from PumpWorks. When a user is ready to return the regulator into operation, simply enable the regulator and PumpWorks again acknowledges it.

NOTE: To view or set the back pressure regulator's set pressure, please refer to Chapter 10, Section 10.7.

13.5.1 Back Pressure Regulators Supported by PumpWorks

<u>DBPR-5</u>
Coretest Systems, Inc.
23 Las Colinas Lane, Suite #104
San Jose, CA 95119
Telephone: 408-229-8185

13.6 Host Mode Communications

A program running on a remote computer can interface with PumpWorks in the same way that DDE allows a program on the same computer to interface with PumpWorks. Host Mode Communications is where a user configures the communications with that remote computer.

- From the menu bar, select Communications | Host Mode Communications. The window shown in Figure 13-8 appears.

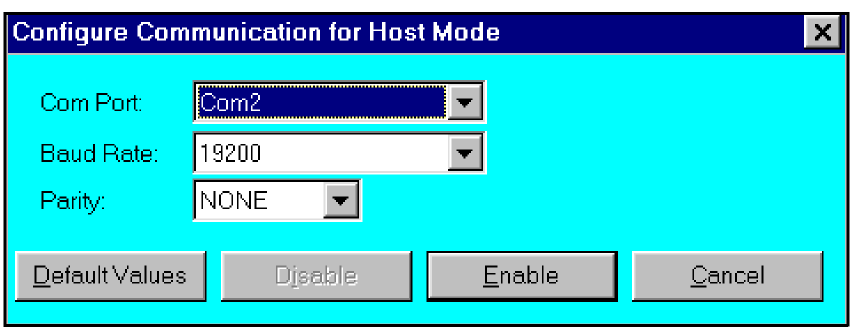


Figure 13-8 Configure Communication for Host Mode

- **COM Port** allows the user to specify which COM port the host mode is attached to. Only those COM ports that are available will be included in the list.
- **Baud Rate** displays the baud rate that is appropriate for the host mode. The default setting is 9600. The baud rate setting made here must agree with the setting made on the actual host mode.

- **Parity** is a communication parameter which checks the integrity of a communication transmission. The parity setting made here must agree with the setting made on the actual host mode.
- **Default Values** allows the user to return the cycle interval, time out interval, com lost interval, baud rate and parity to their default values.
- **Enable or Disable** Either the enable or the disable button will be available at the bottom of the Configure Communication for Host Mode window. Clicking on the button will cause the action to occur (either disable the host mode or enable the host mode).

  To disable the host mode means a user is not communicating with PumpWorks from a remote site.

For more information about host mode communication, please refer to Chapter 15, Setting Up Remote Host Communications, Section 15.4.

13.7 Auxiliary Transducer Communication

PumpWorks supports an interface to Paroscientific Series 9000 transducers via an RS232 port. These transducers measure both pressure and temperature, and these values can be mapped to the Auxiliary Analog Input Signals described in Chapter 10, Section 10.2. These transducers are referred to in PumpWorks as Auxiliary Transducers. Before attempting to configure the transducers in PumpWorks, please consult the Paroscientific documentation for instructions on how to connect one or multiple transducers to your computer's RS232 port. To configure these transducers within PumpWorks:

- From the menu bar, select Communications | Auxiliary Transducer Communication.
- The Set Up Auxiliary Transducer Communication window appears as shown in Figure 13-9.

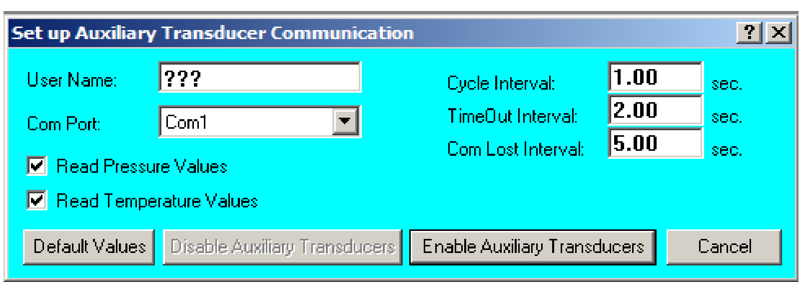


Figure 13-9 Set Up Auxiliary Transducer Communication

The Set Up Auxiliary Transducer Communication window allows the user to set up the transducers' com port and communication intervals, as well as which values are to be read from the transducers. The following is a description of each field in the window:

- **User Name** displays the user-given name for the transducers, but only if the user has chosen to name the pump. If the text box is either blank or has three question marks in it, then the user has not given the transducers a name. The user may enter a custom name, if desired.

- **COM Port** allows the user to specify which COM port the auxiliary transducer is attached to. Only those COM ports that are available will be included in the list.
- **Cycle Interval** is how often PumpWorks sends a request to the transducers for information or status. The default interval is 1 second.
- **Time Out Interval** is the maximum time that PumpWorks waits for a response from the transducers before trying again to communicate. The default setting is 1.5 seconds.
- **Communication Lost Interval** is how long PumpWorks will keep trying to make a connection with transducers that were previously active but are not responding, before issuing a Communication Lost Message. The default setting is 5 seconds.
- **Read Pressure Values -** when the Read Pressure box is check-marked, which is the default setting, PumpWorks will request and display pressure values from the transducers. Click on the check box to toggle the status.
- **Read Temperature Values -** when the Read Temperature box is check-marked, which is the default setting. PumpWorks will request and display temperature values from the transducers. Click on the check box to toggle the status.
- **Default Values** allows the user to return the communication intervals to their default values.
- **Disable Auxiliary Transducers** terminates communication with the transducers. This button is enabled only if the transducers are currently communicating with PumpWorks. The button is disabled if the transducers are not communicating with PumpWorks.
- **Enable Auxiliary Transducers** activates communication with the transducers. This button is enabled only if the transducers are not currently communicating with PumpWorks. The button is disabled if the transducers are already communicating with PumpWorks.
- **Cancel** closes the window and discards any changes.

NOTE: Communication intervals can be changed while the transducers are communicating.

When the enable button is clicked, PumpWorks will attempt to establish communication with the transducers. If communication is not established, an error window, shown in Figure 13-10, will appear.

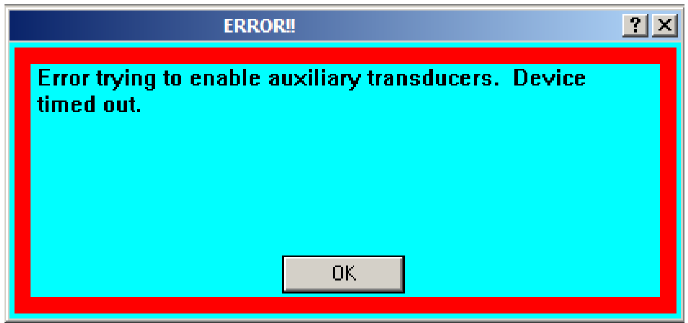


Figure 13-10 Auxiliary Transducer Communication Error Pop Up

If communication is successfully established, the Set Up Auxiliary Transducer Communication window will close. Once communication with the transducers has been established, the transducer values need to be mapped to the desired Auxiliary A/D Input signals, as described in Chapter 10, Section 10.2.4.

13.8 View Communication Status

- From the menu bar, select Communications | View Communication Status. Allow ten seconds for the window to open that is shown in Figure 13-11.

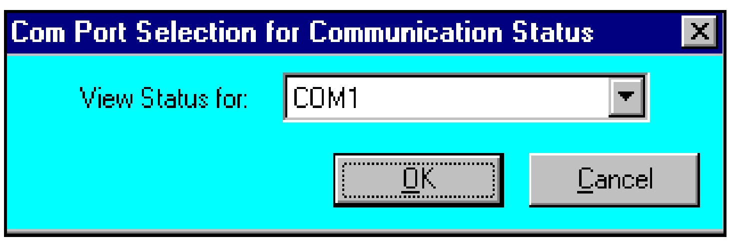


Figure 13-11 Com Port Selection for Communication Status Window

Choose the COM Port by doing the following:

- Click on the arrow to the right of the View Status for text box.
- Click on the COM port desired. Only the currently available COM ports are listed.
- Click on OK and the following window opens.

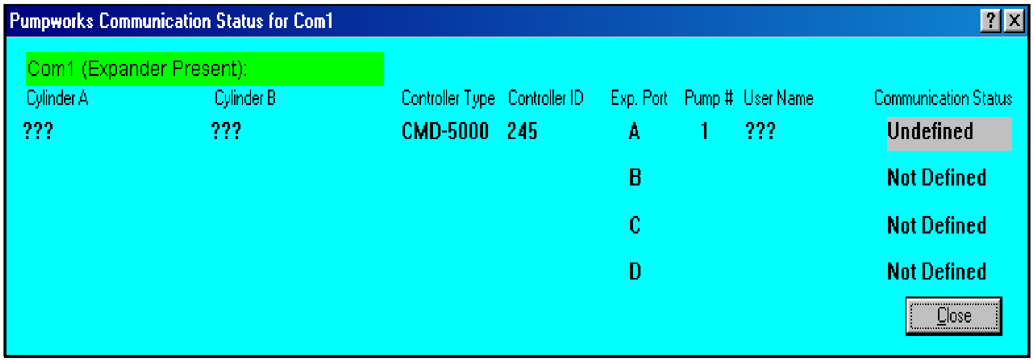


Figure 13-12 PumpWorks Communications Status for COM # Window

The PumpWorks Communication Status for COM # window displays the following basic information about the COM port.

- **Com Port Status** is shown in the upper left corner of the window (above Cylinder Type) and gives the basic status of the Com port. The possible messages follow:
  - No Quizix Controller Present
  - Non-Quizix Device Present
  - Expander Present
  - SC-2400 Controller Defined
  - Expander Not Present
  - Acoustical Separator Present
- **Cylinder Type A** text box identifies the type of pump cylinder A.
- **Cylinder Type B** text box identifies the type of pump cylinder B.
- **Controller Type** identifies the type of controller.
- **Controller I.D.** shows the factory-assigned pump controller identification number for the QX Series Pump, QL-700 Pump, the CMD-5000 Dual Controller Driver, or the CN-6000 Controller. In the case of the SC-2400 Pump Controller, the controller I.D. is assigned via dip switches which are set by the user.
- **COM Port** displays the COM port number to which the pump is attached.
- **Exp Port (Serial Expander/Isolator Port)** displays the serial expander/isolator port to which the pump is attached. (Not applicable for SC-2400 pump controllers.)
- **Pump Number** displays the pump's number which both its screen position and the pump number displayed in PumpWorks, as well as the two digit display on the control panel of the QX Series, QL-700, CMD-5000, and CN-6000 controllers.
- **User Name (for Pump)** displays the user-given name for the pump but only if the user has chosen to name the pump. If the text box is either blank or has three questions marks in it, then the user has not given the pump a name.

- **Communication Status** shows if communication is in progress. Not defined means there is no pump assigned to that expander port.

13.9 Baud Rate Options

For some of the newer Quizix pump controllers, baud rates higher than 19200 are now available. PumpWorks can automatically detect the baud rate capabilities of each pump connected, and optimize the baud selected for each of the pumps. This feature can be enabled or disabled for each COM port. If the feature is disabled, the pumps will be configured to communicate at 19200. To configure this feature:

- From the menu bar, select Communications | Baud Rate Options. The Configure Baud Rate Options window opens as shown in Figure 13-13.

Figure 13-13 Configure Baud Rate Options

- In the Buad Rate Options window, click on the check boxes for each COM port to check or uncheck them. If they are checked, PumpWorks will optimize the baud rate. Note that only the COM ports with pumps attached are displayed.
- Click on the Enabled Broadcast Mode check box to check or uncheck, enabling or disabling the feature. (See the note below descibing Broadcast Mode.)
- When finished with this window, click on OK.

NOTE: If a pump appears to have numerous communication errors on a regular basis, disabling high speed baud for the appropriate COM port may help.

NOTE: Broadcast Mode refers to the practice of sending out commands for a specific pump to all pumps connected to a serial expander, and relying on the non-applicable pumps to ignore the command. Enabling broadcast mode may slightly increase PumpWorks performance. Starting with version 6.15, PumpWorks defaults to disable broadcast mode. If you are experiencing communication errors, please disable broadcast mode to see if this is your problem.

NOTE: Some serial expanders, particularly those distributed in 2010 or later, may not support broadcast mode. If you are experiencing communication errors, please disable broadcast mode to see if this is your problem.

13.10 Update Front Panel Software

The Front Panel is a device for QX Series pump controllers that provides the means for "stand alone" control of the pump (without the need for PumpWorks or a user-provided computer). If the QX controller has a Front Panel, the user has the option of running the pump in this "stand alone" configuration, or running the pump with both the Front Panel and PumpWorks concurrently.

PumpWorks provides the means to download updated code to the Front Panel. To Update the Front Panel software:

- Make sure the pumps/pump controllers you wish to update are powered on and communicating, but pump cylinders are not running, ramping, under auto volume control, or in recirculating mode. In addition, ensure that PumpWorks is not currently sequencing, or in error state capture mode.
- From the menu bar, select Communications | Update front Panel Software. The window shown in Figure 13-14 opens.

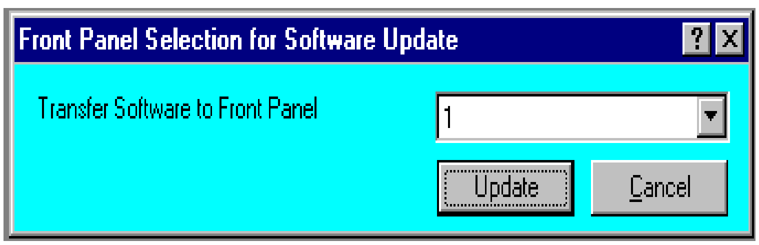


Figure 13-14 Front Panel Selection for Software Update

Choose the pump you wish to update by doing the following:

- Click on the arrow to the right of Transfer Software to Front Panel text box.
- Click on the pump number you wish to update, or click on "All Software Upgradeable Pumps". Only pumps with front panels are available in this menu. (Non QX Series pumps, uninstalled pumps, or pumps running in recirculating mode are examples of pumps that would not be included in this menu.)
- If PumpWorks is in a state that does not allow upgrading of the selected pump (if pump cylinders are currently running, ramping, under auto volume control, in recirculating or fractional flow rate mode, or PumpWorks is running a sequence or schedule, searching for pumps, or in error state capture mode), an error will be given. Otherwise, the Specify Front Panel Program File window opens, as shown in Figure 13-15.

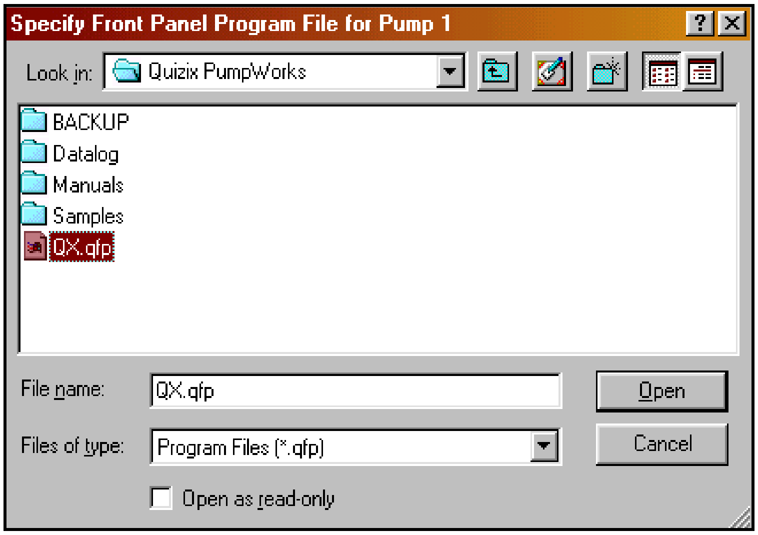


Figure 13-15 Specify Front Panel Program File

- Double click on the file where the software update is located. (These files are available from Chandler Engineering.) Examples of updates for the front panel are shown in the example above. The naming convention for front panel software update files will be "QX", followed by the software version number, followed by the ".qfp" file extension (or .qf2 or .qf3 file extension for newer model front panels). The progress status will initially show "Front Panel Not Ready For Code Update". Up to this point, the user may still cancel the update by clicking on the cancel button. (Once the actual update has started, the user will no longer be able to stop the update before it has completed.) To start the actual software update, the user must now perform the following actions on the front panel.
- From the main front panel window, touch the Quizix logo in the upper left corner to access the main menu.
- Touch the configure button.
- Touch the Update Software button.
- Confirm to software update by touching the Yes button.

The status of the progress will be shown during the update process. When the update has completed, the progress windows will close and Front Panel program will automatically restart itself with the new version of the software.

A window titled "Updating Front Panel Software" will appear showing progress of the update. When the update is completed, the Front Panel will restart itself.

NOTE: During the software update, PumpWorks will continue to function normally, communicating with any other pumps that are not updating software.

13.11 Update Pump Controller Software

In addition to PumpWorks software, all Quizix pump systems include a second software program the user does not see because it is embedded in the pump controller. Users may want to update their pump controller software when new versions become available. (NOTE: The SC-2400 Pump Controller does not support controller software updates.)

VERY IMPORTANT NOTE: It is extremely important that incompatible versions of software are not loaded onto a pump controller. Please read the corresponding note regarding version numbers at the end of this section.

To check which pump controller software version is currently in use in your pump system, do the following:

- From the menu bar, select Help | About PumpWorks. If currently running in error state capture mode, or sequencing, an error will be given. Otherwise, the window shown in Figure 13-16 appears.

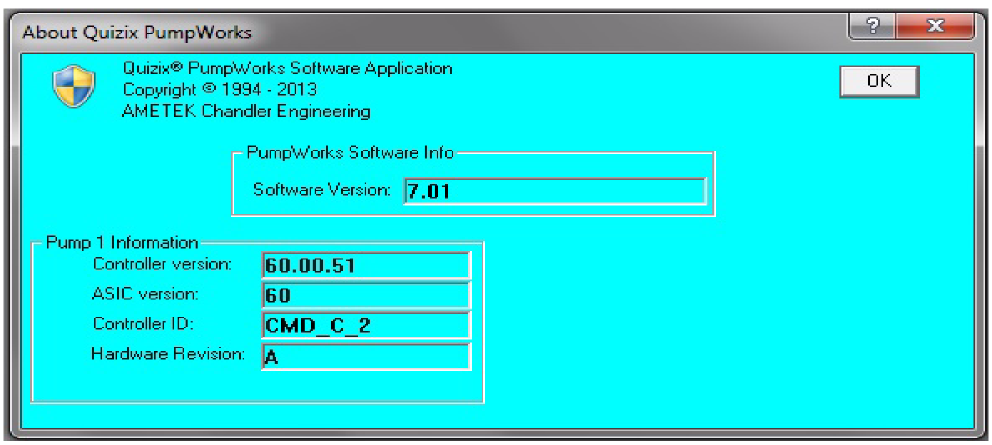


Figure 13-16 About PumpWorks for Windows

Note that in the About Quizix PumpWorks window the “Controller Version” number is displayed for each pump. In the example above, the controller software version is number 60.00.51.

You can now close the above window. To update the pump controller software,

- Make sure the pumps/pump controllers you wish to update are powered on, but not operating, ramping, under auto volume control, or in recirculating mode. In addition, ensure that PumpWorks is not currently sequencing, or in error state capture mode.
- Make sure the pumps you wish to update are depressurized.
- From the menu bar, select Communications | Update Pump Controller Software. The window shown in Figure 13-17 opens.

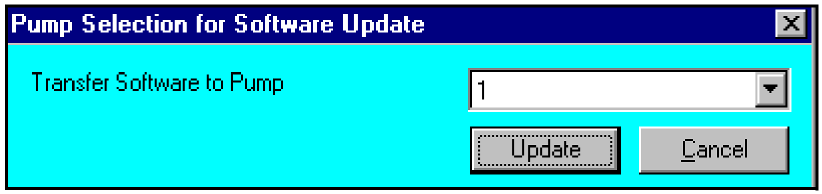


Figure 13-17 Pump Selection for Software Update Window

- Click on the arrow to the right of the Transfer Software to Pump test box.
- Click on the pump number you wish to update, or click on "All Software Upgradeable Pumps". The Specify Pump Controller Program File window opens, as shown in Figure 13-18.
- If PumpWorks is in a state that does not allow upgrading of the selected pump (if pump cylinders are currenlty running, ramping, under auto volume control, in recirculating or fractional flow rate mode, or PumpWorks is running a sequence or schedule, searching for pumps, or in error state capture mode), an error will be given. Otherwise, the Specify Pump Controller Program File window opens, as shown in Figure 13-18.

Choose the pump you wish to update by following the instructions below. Only Upgradeable pumps that are currently communicating are shown.

- Click on the arrow to the right of the Transfer Software to Pump text box.
- Click on the pump number you wish to update, or click on “All Software Upgradeable Pumps”. (This file would normally be located in the Quizix PumpWorks subdirectory of the shared documents directory. For an explanation of the shared documents directory, please refer to the boxed note in Chapter 2, Section 2.2.) If PumpWorks is in a state that does not allow upgrading of the selected pump (if pump cylinders are currently running, ramping, under auto volume control, in recirculating or fractional flow rate mode, or PumpWorks is running a sequence or schedule, seaching for pumps, or in error state capture mode), an error will be given. Otherwise, the Specify Pump Controller Program File window opens, as shown in Figure 13-18.

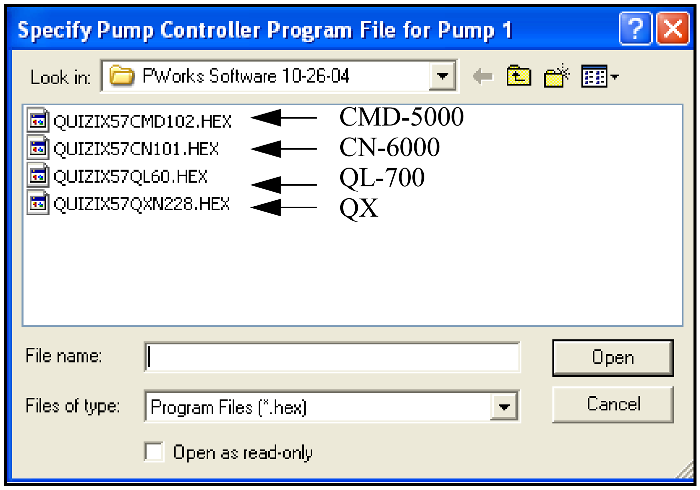


Figure 13-18 Specify Pump Controller Program File Window

- Double-click on the file where the software update is located. (These files are available from Chandler Engineering., and will usually be located either in c:\Documents And Settings\All Users\Application Data\Quizix PumpWorks, or c:\ProgramData\Quizix PumpWorks). Examples of updates for the QX Series Pump, QL-700 Pump, CMD-5000 Controller and CN-6000 Controller are shown in the example above. The naming convention includes the software version number after “Quizix” followed by the controller type, followed by the build number.

- If the loader file (usually named “loader.ihx”) is not in the same directory as the specified software update file, the user will be prompted for the loader file name, using the same type of dialog box. If prompted, browse to the appropriate directory and select the loader file to be used. (This file would normally be located in either c:\Documents And Settings\All Users\Application Data\Quizix PumpWorks, or c:\ProgramData\Quizix PumpWorks.)

- A window titled “Updating Pump Software” will appear showing the progress of the update. When the update is completed, the pump controller will restart itself. The user does not need to do anything to cause this to happen, it will happen automatically.

  If the user wishes to abort the software update (not recommended), clicking on the cancel button will stop the update process. However, the pump controller will be left in a state with no software present, so the software update will have to be restarted and completed before any communication with the pump controller can resume. (If the user clicks the cancel button, a window will pop up stating that a controller has been found with no code. The user can then choose to restart the software update by clicking on the Update Program Code button, or postpone the software update by clicking on the Uninstall Pump button.

NOTE: The pump controller software reboots, not the computer. The computer will remain on during this procedure. During a controller software update, PumpWorks will continue to function normally and other pumps may be controlled or receive controller software updates.

- The operating mode will return to default, which is independent constant rate.

NOTE: It is extremely important that incompatible versions of software are not loaded onto a pump controller. Please make sure that the controller type matches the controller type implied in the file name. In addition, any controller whose last number in the current controller version is 39 or less, should NOT be updated with a file whose version number (the number following “Quizix”) is greater than 57. Likewise, any controller whose last number in the current controller version is 40 or greater should NOT be updated with a file whose version number is less than 58. For example, if the current controller version is 54.20.35, the file used for the update should not be higher than version 57 (for example, Quizix57CMD102.hex would be OK), since the last number in the controller version is 35. Also controller code versions less than 60 should not be updated onto a controller with an ASIC version less than 50, and vice versa. The ASIC version can be found in the About PumpWorks window, shown in Figure 13-16. **Failure to adhere to these instructions may result in permanently disabling communication with the pump.** If a controller with no code is detected, the appropriate part of the current controller version can be found by watching the indicator on the pump controller when it is first powered up. You will first see all of the LEDs light up (looks like “88”) for a brief moment. Next you’ll see a 2 digit number flash for a very brief moment, before the segments of the right LED cycle around. This is followed by the left LED cycling through the numbers 0 - 7. The 2-digit number that flashes just before the right LED starts its cycle indicates the last part of the version number.

THIS PAGE INTENTIONALLY LEFT BLANK.

14 WINDOWS & HELP MENU'S

14.1 Windows

The Windows option allows the user to access multiple screens and either cascade or tile them.

14.1.1 Cascade

The cascade command takes all open windows and lines them up neatly on-screen with their title bars showing, as in Figure 14-1 below.

.

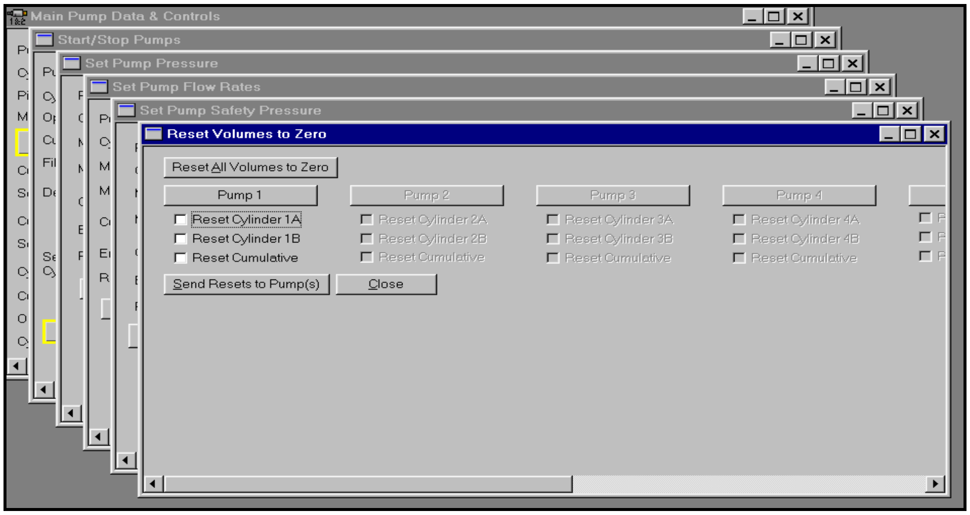


Figure 14-1 Cascaded Windows

To put windows in a cascade arrangement:

- From the menu bar, select Window | Cascade.

14.1.2 Tile

The tile command arranges all open windows across the screen, giving each window the same amount of space, as in Figure 14-2.

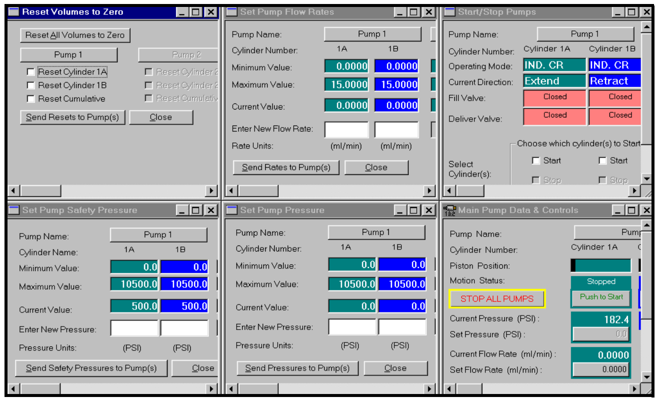


Figure 14-2 Tiled Windows

To put windows in a tile arrangement do the following:

- From the menu bar, select Window | Tile.

14.2 Help

The Help menu offers access to on-line help for the PumpWorks application, access to user's manuals for PumpWorks and the various Quizix pumps, and an "about" box indicating version numbers of a user's pump system and PumpWorks software.

14.2.1 PumpWorks Help

A user can access the PumpWorks on-line user manual with this option. There is also context sensitive help available by pressing the SHIFT key and F1 key. (If function keys have been disabled in the System Settings window, the user may also use the F1 key - please refer to Chapter 12, Function Keys (for starting cylinders), Section 12.16.2.) Context sensitive help will automatically open to the most appropriate section of the on-line help manual, based on the currently active window.

Once a topic is displayed, there may be words or phrases shown in a different color. Click on them to get more information on the subject, if desired. These can sometimes be found in a "See Also" section, or as part of the regular text. If one of these words is clicked on, and another topic displayed, the previous window can be recalled by clicking on the "Back" button at the top of the window.

To get back to the tabbed window with the Table of Contents, Index and Find options:

- Click on the Contents or Index buttons at the top of the window.

14.2.1.1 To access the PumpWorks Help "Table of Contents":

- From the menu bar, select Help | PumpWorks Help. The on-line help manual's Table of Contents appears as shown in Figure 14-3.

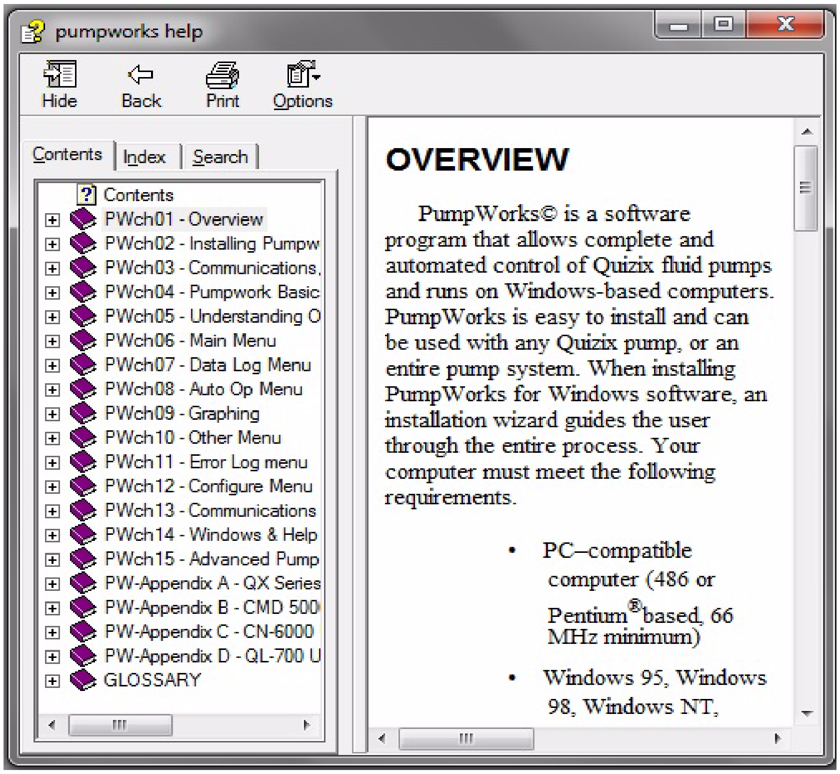


Figure 14-3 Help Topics Window

- If there is a plus sign in front of a chapter, click on the plus sign to "open" the chapter, causing the sub-sections of that chapter to be listed. Clicking on the minus sign in front of the chapter will "close" the chapter, hiding the subsection titles.
- Clicking on a particular section of a chapter will cause the contents of that section to be displayed in the pane to the right of the chapter listings.
- If there are words or phrases shown in a different color, you can click on them to get more information on the subject. These words or phrases can be found in a "See Also" section, or embedded in the regular text.
- Clicking on the "Back" button at the top of the window will take you to the previously viewed window.

14.2.1.2 Index Tab

To access help using the Index tab:

- From the menu bar, select Help | PumpWorks Help.
- Click on the Index tab at the top of the Help Topics window.

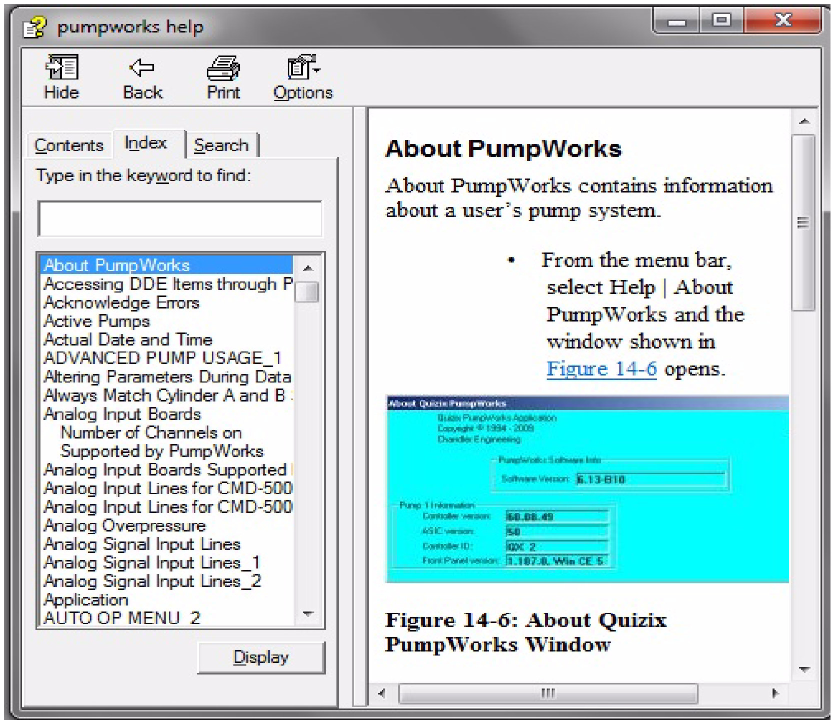


Figure 14-4 Help Topics - Index Window

Either browse through the index topics using the scroll bar, or type in the first few letters of the desired topic.

- Double-click on the desired topic to view more information.

14.2.1.3 Search Tab

The last known status of this feature is that there is a Microsoft bug in HTMLHelp making it non-functional.

14.2.2 QL-700 User's Manual

From the Help Menu, select the QL-700 User's Manual option to open the QL-700 User's Manual (pdf file).

14.2.3 QX Series User's Manual

From the Help Menu, select the QX Series User's Manual option to open the QX Series User's Manual (pdf file).

14.2.4 5000 Pump Series User's Manual

From the Help Menu, select the 5000 Pump Series User's Manual option to open the 5000 Pump Series User's Manual (pdf file).

14.2.5 6000 Pump Series User's Manual

From the Help Menu, select the 6000 Pump Series User's Manual option to open the 6000 Pump Series User's Manual (pdf file).

14.2.6 PumpWorks User's Manual

From the Help Menu, select the PumpWorks User's Manual option to open the PumpWorks User's Manual (pdf file).

14.2.7 About Quizix PumpWorks

About Quizix PumpWorks contains information about a user's pump system.

- From the menu bar, select Help | About Quizix PumpWorks and the window shown in Figure 14-5 opens.

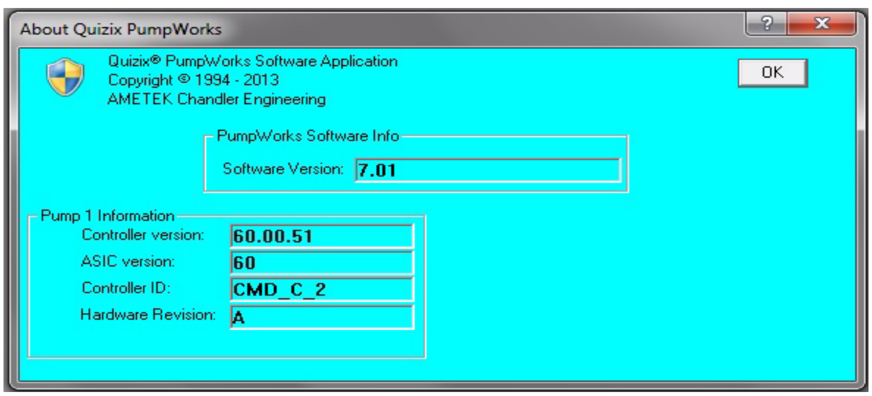


Figure 14-5 About Quizix PumpWorks Window

The About Quizix PumpWorks window displays the following information:

- Pumpworks software version that is installed.
- Number of pumps and type of pumps installed.
- Controller version: This tells the version number of the pump controller software. An "r" will be appended to the controller version for CMD and CN series pumps if recirculating mode is available.
- DSSIP# or ASIC Version: This tells the version number of a piece of hardware inside of the pump.
- Controller ID: Pump controller identification number.
- Front Panel Version: Front Panel software version that is installed, if a front panel is attached to the pump controller, along with the front panel operating system version. If no front panel is present, this field and its label will not be visible.

THIS PAGE INTENTIONALLY LEFT BLANK.

15 ADVANCED PUMP USAGE

Included in this chapter are the following topics:

- Auxiliary Signal Interface (User Interface), Section 15.1
- PumpWorks Dynamic Data Exchange Server, Section 15.2
- PumpWorks Dynamic Data Exchange Client, Section 15.3
- Setting Up Remote Host Communications, Section 15.4

15.1 Auxiliary Signal Interface (User Interface)

The auxiliary signal interface allows the Quizix pump system to connect to various external devices and can be useful to the user for building a complete experimental system. Additional sensors, valves, digitally controlled devices and logic inputs, as well as power, are available on this connector. Each Quizix pump controller (QX Series, QL-700, CMD-5000 and CN-6000) has a user interface connector with these functions. The exact details as to number of channels, signal levels, voltages available, etc. differ from controller to controller and are detailed in Appendices A, B and C. In general, the following capabilities exist:

- 3 each auxiliary analog input channels, which go to an A/D converter.
- 2 each digital input lines for sensing digital status
- 8 each valve control lines to open and close valves
- 2 each digital output lines for digitally controlled devices
- emergency pump stop control line
- DC power +5 to +12

These signals are made available to the user on a DB style connector on the outside of the controller case. The connector is labeled “User Interface”.

NOTE: In addition to the signals connected via the DB connector on the controller, PumpWorks can also access signals from the devices described in Chapter 12, Section 12.15 and Chapter 13, Section 13.7.

15.1.1 Auxiliary Analog Input Lines

Auxiliary analog input lines are available for use with external sensors. These lines are connected to an analog to digital (A/D) converter on the pump controller. A typical application could involve a pressure transducer which has an output voltage that goes from 0 to 5 volts. After wiring this pressure transducer to the pump’s auxiliary signal user interface and setting up the mapping and linear scaling in PumpWorks (Refer to Chapter 10, Auxiliary Analog Input Signals, Section 10.2), the pressure detected by this pressure transducer could then be displayed and recorded by PumpWorks. The A/D converters differ depending on controller type. Please refer to Appendix A, B or C for details.

15.1.2 Auxiliary Digital Input Lines

Two logic level input lines are available. These are CMOS type logic inputs with an 11 kiloohm pull-up resistor to the 5 volt logic supply. These signals can be activated by an external microswitch or a digital output from another digital logic system. The input voltage range for a logic low signal is 0 to 1.4 volts and a logic high is a signal from 3.6 to 5 volts. Signal levels should not go above the 5 volt logic power supply voltage, or below ground. A typical use for this signal would be to detect an oven door opening by placing a microswitch on the door.

15.1.3 Auxiliary Valve Control Lines

The auxiliary valve control lines operate electrically actuated valves. The auxiliary signal interface on the Quizix pump controllers are designed with the expectation that 12 volt pilot solenoids would be used, so 12 volt power is available on the connector. The 12 volt power supply is connected to the positive lead of the pilot solenoids. The ground side of the valve is connected to the desired valve control line. The valve control lines are low side drivers (they sink current) and are capable of sinking 200 milliamperes on each line. The maximum number of auxiliary valves is limited by the current drawn from each valve, up to 8 valves per controller. For example, the pilot solenoids that are used by Chandler Engineering on the QL-700 Pump only draw about 20 milliamperes each, so eight pilot solenoids can easily be operated from the controller.

If other types of valves are to be used, then the electrical requirements for these valves must be checked. The valve control lines can also be used to sink current from a 5 volt supply. An external power supply can be used with these sink type drivers, however, voltages greater than 12 volts are not permitted. Devices other than pilot solenoids can also be controlled, such as indicator lamps, relays and other actuators.

15.1.4 Auxiliary Digital Output Lines

Two logic level output lines are available. These are CMOS type logic level signals which, at a logic zero (low level), put out a voltage close to ground (guaranteed to be less than 0.2 volts for a 20 milliamperes maximum current sink). When at a logic one (high level) the signals put out a voltage close to the 5 volt supply (guaranteed to be greater than 4.6 volts while sourcing up to 20 milliamperes). These digital output lines can be used to interface with an external digital system or light an LED type indicator.

15.2 PumpWorks Dynamic Data Exchange Server

PumpWorks is a Microsoft Windows application which acts as a Dynamic Data Exchange (DDE) server and allows other Window applications access to data from up to eight Quizix pumps, as well as data from auxiliary devices, equation results, separators,.a back pressure regulator, and other internal PumpWorks data. The PumpWorks DDE Server may be used by any Microsoft Windows application which is capable of acting as a DDE client.

15.2.1 DDE Overview

DDE stands for Dynamic Data Exchange. DDE is a complete communication protocol designed by Microsoft. DDE allows data or instructions to be sent or received between **two**

Windows applications. DDE implements a client-server relationship between the two concurrently running applications.

- The “server” application provides the data and accepts requests from any other application interested in its data.
- The “client” requests data from the DDE server.

To obtain data from another application, the client program opens a channel to the server application by specifying three things:

- **server application name**
- **topic name**
- **specific item name**.

For the PumpWorks server, the application name is “PumpWorks”. The topic names are “PumpUnit1”, “PumpUnit2” and so on through “PumpUnit8”; “Resources”, “AmsData”, “BprData”, “Equations”, and “PumpWorks”. Each topic has a set of item names that specify data items for that topic. (Refer to Section 15.2.3 and Section 15.2.4 for lists of item names for each topic.)

The two primary methods that a DDE client uses to communicate with a DDE Server are:

- Sending a command to the Server, Section 15.2.1.1
- Requesting data from the server, Section 15.2.1.2

15.2.1.1 Sending a Command to the Server

The client application sends a command to the server by “poking” data. The client sets up a link to a DDE server data item, and subsequently sends or ‘pokes’ data (in the currently specified display units) to the server for this item. This method is useful where it is necessary for the client to send commands to the pump controllers or other devices.

15.2.1.2 Requesting Data from the Server

The client requests data from the server by setting up a link to the DDE server data item, and requesting that the link be automatic or ‘hot’. The server application will then send new data (in the currently specified display units) to the client whenever a specific item’s value changes. These data links will remain active until either the client or server program terminates the link. This is an efficient means of exchanging data, because once the link has been established, no communication occurs until the specified data value changes. See Section 15.2.2.4 regarding receiving averaged data from PumpWorks.

15.2.2 Accessing DDE Items through PumpWorks

The DDE protocol identifies an element of data by using a three-part address. The three parts of a DDE address are the application, topic and item. None of these identifiers are case sensitive.

15.2.2.1 Application

Application refers to the Windows server application which knows how to access the data element. In the case of data coming from or going to the PumpWorks DDE server, the application name is “PumpWorks”.

15.2.2.2 Topic

Topic is an application-specific sub-group of data elements. The PumpWorks DDE Server defines twelve topics, one each for the eight possible pump units, one for available resources such as A/D channels, and auxiliary valves, one for an acoustic separator, one for a back pressure regulator device, and one for PumpWorks equation results. The names of the topics are:

- “**PumpUnit1**”
- “**PumpUnit2**”
- “**PumpUnit3**”
- “**PumpUnit4**”
- “**PumpUnit5**”
- “**PumpUnit6**”
- “**PumpUnit7**”
- “**PumpUnit8**”
- “**Resources**”
- **“AmsData”**
- **“BprData”**
- **“Equations”**
- **“PumpWorks”**

15.2.2.3 Item

Item indicates a specific data element within the specified topic. There are two types of items available in the PumpWorks DDE server:

- PumpWorks DDE Command Items, Section 15.2.3
- PumpWorks DDE Request Items, Section 15.2.4

Some topics have both command and request items, and some have only request items. The specific items for each topic are listed in the sections below.

15.2.2.4 Averaged Data

The DDE client can receive averaged data for any desired data item by setting up data averaging for the item in PumpWorks. Please refer to Chapter 12, Section 12.9 for details.

15.2.3 PumpWorks DDE Command Items

The DDE Client sends commands to PumpWorks by establishing a data link to a command item, then poking data (in the currently specified display units) to that item.

When the PumpWorks DDE Server receives a command from a DDE Client application, the Cmd_response item for that topic is set to “9999” (See PumpWorks DDE Request Items, Section 15.2.4). This serves as a notification that the command has been received and is ‘in progress’. When command processing has been completed, the Cmd_response item is set to either:

- “000” to indicate that the command has been successfully processed, or
- a non-zero 3 digit error code if the command had an error associated with it.

Many (but not all) of the PumpWorks command items have a command value associated with them. For example, the Set_rate1 command requires a set rate value to accompany it, so PumpWorks will know the desired new rate. The sections below list the command items along with a description, and a specified command value “format”. All DDE communication to and from the PumpWorks DDE server occurs as ASCII string transactions. The command value “format” refers the expected form of the string data, not the underlying communication format itself. If ‘xxxxx’ is listed as the command value format, it indicates that PumpWorks will ignore the command value. For example, the command item “Reset1” serves to reset pump cylinder 1 volume to zero. Pump cylinder 1 volume is reset when any data (command value) is ‘poked’ to the “Reset1” item of the PumpWorks DDE server.

15.2.3.1 DDE Command Items for Topics “PumpUnit1” through “PumpUnit8”

The following table lists the DDE command items for topics “PumpUnit1” through “PumpUnit8”. These topics are associated with the Quizix pumps.

NOTE: Unless otherwise stated, and when the command refers to pump cylinders, number 1 = pump cylinder A; number 2 = pump cylinder B.

Table 15-1 DDE Command Items for “PumpUnit1” through “PumpUnit8” Topics

Item	**Command Value Format**	**Description**
Set_rate1 Set_rate2	Float	Sets the flow rate in current scaled units.
Set_dir1 Set_dir2	Integer	Sets the pump cylinder direction. 1=Extend (deliver) 2=Retract (fill)
Set_saf_press1 Set_saf_press2	Float	Sets the safety pressure in current scaled units.
Set_press1 Set_press2	Float	Sets the requested pump cylinder pressure in current scaled units.

Set_frac	Float	Sets the fraction (0.0 - 1.0) of fluid delivery for this pump. Applies only in fractional flow mode. The desired fraction can be sent to either of the two pumps in fractional flow mode - the other pump's fraction will automatically be adjusted.
Reset1 Reset2	xxxxx	Resets the pump cylinder volume.
Reset12	xxxxx	Resets the cumulative volume.
Reset_all	xxxxx	Resets all volumes for the pump.
Set_mult1 Set_mult2	Float	Sets the return rate multiplier. (1.0 - 2.992)
Set_min1 Set_min2	Float	Sets the return rate minimum in current scaled units.
Set_p_s_gain1 Set_p_s_gain2	Integer	Sets the proportional servo gain for open valves. (0 - 65535)
Set_d_s_gain1 Set_d_s_gain2	Integer	Sets the differential servo gain for closed valves. (0 - 65535)
Set_p_s_gain1_cv1 Set_p_s_gain2_cv2	Integer	
Set_d_s_gain1_cv1 Set_d_s_gain2_cv2	Integer	
Set_cali_off1 Set_cali_off2	Float	Sets the pressure calibration offset in current scaled units.
Clr_cali_off1 Clr_cali_off2	xxxxx	Clears the pressure calibration offset.
Set_mode1 Set_mode2	Integer	Sets the operating mode. Range 1 - 22. (Refer to Table 15-2.)
Set_cyl1_on Set_cyl2_on	xxxxx	Starts the pump cylinder.
Set_cyl1_off Set_cyl2_off	xxxxx	Stops the pump cylinder.
Stop_all	xxxxx	Stops both pump cylinders.
Set_valve1_on Set_valve2_on Set_valve3_on Set_valve4_on	xxxxx	Opens pump cylinder 1 fill valve. Opens pump cylinder 1 deliver valve. Opens pump cylinder 2 fill valve. Opens pump cylinder 2 deliver valve.

Set_valve1_off Set_valve2_off Set_valve3_off Set_valve4_off	xxxxx	Closes pump cylinder 1 fill valve. Closes pump cylinder 1 deliver valve. Closes pump cylinder 2 fill valve. Closes pump cylinder 2 deliver valve.
Set_recirc_on Set_recirc_off	Integer xxxxx	Starts up recirculating mode, enabling cylinder pairs based on the command value: 1 - enable pump 1 pair only 2 - enable pump 2 pair only 3 - enable pump 3 pair only 4 - enable pumps 1 & 2 pairs only 5 - enable pumps 1 & 3 pairs only 6 - enable pumps 2 & 3 pairs only 7 - enable pumps 1, 2 & 3 pairs Resets recirculating mode.
Set_deltap1_chan Set_deltap2_chan	Integer	Sets up which auxiliary A/D channel to be used (1-3, specified in the command value) as the delta pressure transducer when in a delta pressure mode.
Send_Debug	Text String	Sends the command value directly to the pump controller as a command.
Set_Smart_Start	Integer	Sets the smart start status, 1 = on, 0 = off.
Set_pressure_max1 Set_pressure_max2	Float	Sets the maximum pressure for rate mode, in current scaled units.
Set_rate_max1 Set_rate_max2	Float	Sets the maximum rate for pressure mode, in current scaled units.
Set_Fill_Valve_Threshold	Float	Sets the maximum pressure at which valves are allowed to be opened.
Set_Remote_Rate_Control	Integer	Sets the Remote Rate Control status (1 = on, 0 = off)
Set_Wash_Area	Integer	Sets the wash area status (1 = on, 0 = off)
Ramp	Text String	Starts or stops ramping for a specified pump cylinder. Value must be in the format **c;a;mt;t;v**, where **c** = cylinder number (1 or 2) **mt** = mode type (1 = constant rate, 2 = constant pressure, 3 = delta pressure) **t** = ramp time (in minutes) **v** = end value (in current units)

Auto_Volume	Text String	Starts or Stops the auto volume operation for a specified cylinder (please refer to Chapter 8, Section 8.2 for an explanation of the auto volume operation). Value must be in the format: c;a;v, where: c: cylinder number (1 or 2) a: action (ON or OFF) v: volume to pump, in current units
Auto_Time	Text String	Starts or Stops the auto time operation for a specified cylinder (please refer to Chapter 8, Section 8.2 for an explanation of the auto time operation). Value must be in the format: c;a;t, where: c: cylinder number (1 or 2) a: action (ON or OFF) t: time to pump, in current minutes
Set_rate_scaleX	Float	Sets the rate scaler for cylinder X (X=1 or 2) - analogous to selecting Configure->Scale Pump Flow Rates and changing a value from PumpWorks.
StartMultiplePumps	Text String	Starts multiple pump cylinders “simultaneously”. Value is in the form “**u:c;u:c;u:c:**...” where each “u:c” pair represents the pump number (u=1-8) and the cylinder number (c=1-2). Any number of pairs may be specified, as long as they represent a valid pump cylinder.

Table 15-2 DDE Mode Numbers for PumpWorks Operating Modes			
Operating Mode	Mode Abbreviation	**Pump-Works Mode**	**DDE Mode Number**
Independent constant rate	(IND. CR)	1	1
Independent constant pressure	(IND. CP)	2	2
Independent constant delta pressure	(IND. CDP)	3	3
Paired unidirectional capillary viscometer	(PAIR CapV)	4	4
Paired gear mode, constant rate delivery	(PAIR GM Del)	5	5
Paired constant rate delivery	(PAIR CR Del)	6	6

Paired constant rate receive	(PAIR CR Rec)	7	7
Paired constant pressure delivery	(PAIR CP Del)	8	8
Paired constant pressure receive	(PAIR CP Rec)	9	9
Paired constant delta pressure delivery	(PAIR DP Del)	10	10
Paired constant delta pressure receive	(PAIR DP Rec)	11	11
Paired constant pressure bidirectional at 1/2 rate	(PAIR CP BI)	12	12
Independent constant rate cycled	(IND. CR-C)	1C	20
Independent constant pressure cycled	(IND. CP-C)	2C	21
Paired gear mode, constant rate without valves	(PAIR GM NV)	5A	22

15.2.3.2 DDE Command Items for "Resources" Topic

The "Resouces" topic allows commands to, and provides access to, data associated with the auxiliary A/D channels and auxiliary valves that are connected to the Quizix pump controllers. The availability of auxiliary resources is dependent on the number and type of devices under PumpWorks control. Use the PumpWorks auxiliary configuration windows to set up available auxiliary resources. (Refer to Chapter 10, Section 10.2 and Chapter 10, Section 10.4)

Table 15-3 DDE Command Items for "Resources" Topic

Item	Format	Description
Set_aux_valve1_on Set_aux_valve2_on ... Set_aux_valve32_on	xxxxx	Activates the specified auxiliary valve.
Set_aux_valve1_off Set_aux_valve2_off ... Set_aux_valve32_off	xxxxx	De-activates the specified auxiliary valve.

15.2.3.3 DDE Command Items for "AmsData" Topic

The "AmsData" topic is associated with the acoustic separators that may optionally be included as part of a pump system. Use the PumpWorks configuration windows to set up the acoustic separator(s). (Refer to Chapter 10, Section 10.6 and Chapter 13, Section 13.4)

Table 15-4 DDE Command Items for “AmsData” Topic		
Item	**Format**	**Description**
Reset1 Reset2 Reset3	xxxxx	Resets the relative volume of AMS Unit 1 to zero. Resets the relative volume of AMS Unit 2 to zero. Resets the relative volumes of the two-phase AMS Unit 3 to zero.

15.2.3.4 DDE Command Items for “BprData” Topic

The “BprData” topic is associated with a back pressure regulator that may optionally be included as part of a pump system. Use the PumpWorks configuration windows to set up the back pressure regulator (Refer to Chapter 10, Section 10.7 and Chapter 13, Section 13.5)

Table 15-5 DDE Command Items for “BprData” Topic		
Item	**Format**	**Description**
Set_bpr_press	Float	Sets the BPR set pressure.

15.2.3.5 DDE Command items for “PumpWorks” Topic

The PumpWorks topic provides access/control to some of PumpWorks internal data not necessairly associated with a particular device.

Table 15-6 DDE Command Items for “PumpWorks” Topic		
Item	**Format**	**Descriptions**
Sequencer	Text String	Starts, pauses, resumes or stops Sequencer 1. If starting the sequencer, starts the specified sequence at the specified starting step number. (Please refer to Chapter 8, Section 8.3 for an explanation of the Sequencers.) Value must be in the format: a;s;f, where: a: action (ON or OFF) s: sequence step number at which to start f: sequence file name
SequencerX	Text String	Starts pauses, resumes or stops Sequencer X, where X is 1-20. If starting the sequencer, starts the specified sequence at the specified starting step number. (Please refer to Chapter 8, Section 8.3 for an explanation of the Sequencers.) Value must be in the format: a;s;f, where: a: action (ON or OFF) s: sequence step number at which to start f: sequence file name

Table 15-6 DDE Command Items for "PumpWorks" Topic		
Item	**Format**	**Descriptions**
Set_VarX	Float	Sets the current value of PumpWorks Variable X (X is 1-16). This command will fail if a currently running sequence controls the specified variable
Set_VarX_Override	Float	Sets the current value of PumpWorks Variable X (X is 1-16), regardless of whether a currently running sequence controls the specified variable

15.2.4 PumpWorks DDE Request Items

The DDE Client requests data by establishing an automatic or 'hot' data link to a PumpWorks DDE server request item. Whenever the data value associated with the item changes, the PumpWorks DDE server sends the new data (in currently specified display units) to the DDE client. The sections below list the request items associated with each topic, along with a description, and a specified data "format". All DDE communication to and from the PumpWorks DDE server occurs as ASCII string transactions. The data "format" refers to the expected form of the string data, not the underlying communication format itself.

15.2.4.1 DDE Request Items for Topics "PumpUnit1" through "PumpUnit8"

The following two tables break down the request items for the pumps into two categories; regular (non-error) data and current error items.

Table 15-7 DDE "Regular" Request Items for "PumpUnit1" through "PumpUnit8" Topics		
Item	**Format**	**Description**
Status	Integer	Current pump communication status. 1 if the server is receiving valid data from the pump, otherwise 0.
Cmd_response	Integer	Current returned result of the last executed command. A "9999" is returned when PumpWorks receives a command. When the command has been processed, either a '0" is returned to indicate no errors, or a positive 3 digit integer is returned, representing the error number.
RR_error	Integer	Current error code as returned from the Quizix pump controller in response to a rate request. 0 means no error.
Rate1 Rate2 Output_rate	Float	Current flow rate in current scaled units.
RP_error	Integer	Current error code as returned from the Quizix pump controller in response to a pressure request. 0 means no error.

Pressure1 Pressure2 Output_press	Float	Current pressure in current scaled units.
RV_error	Integer	Current error code returned from the Quizix pump controller in response to a volume request. 0 means no error.
Volume1 Volume2	Float	Current volume in current scaled units.
Cumul_vol	Float	Current cumulative volume in current scaled units.
RS_error	Integer	Current error code as returned from the Quizix pump controller in response to a status request. 0 means no error.
Cyl1_error Cyl2_error	Integer	Current error condition of the pump cylinder 1 = error present.
Cyl1_direction Cyl2_direction	Integer	Current direction of the pump cylinder 1 = extend. 0 = retract.
Cyl1_running Cyl2_running	Integer	Current “running” status of the pump cylinder. Running means the pump cylinder has been started. 1 = running. 0 = not running.
Cyl1_moving Cyl2_moving	Integer	Current motion status of the pump cylinder 1 = moving. 0 = not moving.
Cyl1_press_mode Cyl2_press_mode	Integer	Indicates whether the pump cylinder is currently pressurizing 1 = pressurizing. 0 = not pressurizing.
Cyl1_servos_on Cyl2_servos_on	Integer	Current servo status 1 = servo on. 0 = servo off.
Cyl1_paired Cyl2_paired	Integer	Indicates whether the pump cylinder is currently in an independent or paired mode. 1 = paired. 0 = not paired.
Cyl1_installed Cyl2_installed	Integer	Current installation status of the pump cylinder. 1 = installed. 0 = not installed.
Cyl1_retract_lim Cyl2_retract_lim	Integer	Current status of the pump cylinder retract limit. 1 = active
Cyl1_retract_trig Cyl2_retract_trig	Integer	Current status of the pump cylinder retract trigger. 1 = active
Cyl1_extend_trig Cyl2_extend_trig	Integer	Current status of the pump cylinder extend trigger. 1 = active
Cyl1_extend_lim Cyl2_extend_lim	Integer	Current status of the pump cylinder extend limit. 1 = active

Cyl1_pos Cyl2_pos	Integer	Current position information for pump cylinders 1 and 2. Data ranges from 0 to 127 to cover full range of pump cylinder travel. The lower the number, the more retracted it is. The value 0 is used when a position cannot be determined.
m_valve1	Integer	Current main valve 1 status (pump cylinder 1 fill). 1 = open
m_valve2	Integer	Current main valve 2 status (pump cylinder 1 deliver). 1 = open
m_valve3	Integer	Current main valve 3 (pump cylinder 2 fill). 1 = open
m_valve4	Integer	Current main valve 4 (pump cylinder 2 deliver). 1 = open
recirc_m_s	Integer	Current recirculating master/slave status. Master = 1. (This data is only valid for SC-2400 pumps.)
cyl12_recirc_state	Integer	Current enabled state for recirculating mode. 1 = Enabled.
recirc_mode_type	Integer	Current recirculating mode type. Values are: 0 - No recirculating allowed for this pump 1 - 3 cylinder recirculating mode 2 - 5 cylinder recirculating mode 3 - 7 cylinder recirculating mode 4 - 3+ cylinder recirculating mode 5 - 5+ cylinder recirculating mode 6 - 7+ cylinder recirculating mode
recirc_mode	Integer	Current recirculating mode status. On = 1.
Cyl1_r_sw7 Cyl1_r_sw6 . . Cyl1_r_sw0 Cyl2_r_sw7 Cyl2_r_sw6 . . Cyl2_r_sw0	Integer	Current reed switch information about the pump cylinder. 1 = reed switch closed.
Servo_Mode1 Servo_Mode2	Integer	Indicates whether the limits for max rate for pressure mode or max pressure for rate mode are currently limiting the rate or pressure. 1 = limiting. 0 = not limiting.

VolStat1 VolStat2	Integer	Current pump cylinder auto-volume status. 1 indicates that the pump cylinder is in auto volume mode. This value refers to the firmware controlled auto volume operation intiated with the sequencer commands (AUTO_VOLUME_STOP, AUTO_VOLUME_PAUSE, and SET_CYL_ONV). This should not be confused with the PumpWorks Auto-Volume feature controlled using the Auto-Volume/ Time window in PumpWorks.
RI_error	Integer	Current error code as returned from the Quizix pump controller in response to a Read Initial request. 0 means no error.
Cyl1_set_rate Cyl2_set_rate	Float	Current pump cylinder set rate. Data in current scaled units.
Cyl1_set_press Cyl2_set_press	Float	Current pump cylinder set pressure. Data in current scaled units.
Cyl1_safe_press Cyl2_safe_press	Float	Current pump cylinder safety pressure. Data in current scaled units.
Cyl1_mode Cyl2_mode	Integer	Current pump cylinder operating mode setting. Range 1-22. (Refer to Table 15-2.)
Grp1_r_p_sw Grp2_r_p_sw Grp3_r_p_sw Grp4_r_p_sw	Integer	Current rear panel switch settings for the group. Applicable to SC2400 pump controllers only.
Pressure_Max1 Pressure_Min1 Safety_Max1 Safety_Min1 Rate_Max1 Rate_Min1 Rate_Max1 Rate_Min1 Pressure_Max2 Pressure_Min2 Safety_Max2 Safety_Min2 Rate_Max2 Rate_Min2	Float	Minimum and maximum values for the pump cylinders in current scaled units.
User_Pressure_Max1 User_Pressure_Max2 User_Rate_Max1 User_Rate_Max2	Float	Current pump cylinder user set maximum values, in current scaled units.
Deltap1_chan Deltap2_chan	Integer	Auxiliary A/D channel currently used as pressure transducer for delta pressure modes.

RQ_error	Integer	Current error code as returned from the Quizix pump controller in response to an RQ request. 0 means no error.
Depress_Time	Integer	Current pump depress time for recirculating mode.(This data is only valid when pump is in recirc mode.)
Cyl_Type1 Cyl_Type2	Integer	Current pump cylinder type. (see Table 15-8)
Tran_Type1 Tran_Type2	Integer	Current pump cylinder transducer type. (see Table 15-10)
Motor_Res1 Motor_Res2	Integer	Current pump cylinder motor resolution. (see Table 15-11)
Contr_Type	Integer	Controller type: 0 x 80: QL model 0 x 60: QX model 0 x 00: CMD model 1 0 x 01: CMD model 2 0 x 100: SC2400 model
Unit_Type	Integer	Current pump unit type: 0 - expander port A 1 - expander port B 2 - expander port C 3 - expander port D 4 - SC2400AB 5 - SC2400CD 6 - place holder
Fill_Valve_Threshold	Float	Current pump fill valve pressure threshold, in current scaled units.
Contr_ver	Integer	Current pump controller software version number.
DSSIP12_ver	Integer	Current DSSIP12 software version number.
DSSIP34_ver	Integer	Current DSSIP34 software version number.
RL_error	Integer	Current error code as returned from the Quizix pump controller in response to a RL request. 0 means no error.
Cyl1_r_mult Cyl2_r_mult	Float	Current pump cylinder return rate multiplier. (1.0 - 2.992)
Cyl1_r_min Cyl2_r_min	Float	Current pump cylinder return rate minimum.
Cyl1_p_s_gain Cyl2_p_s_gain	Integer	Current pump cylinder proportional servo gain ranging from 0 to 65535 for open valve state.
Cyl1_d_s_gain Cyl2_d_s_gain	Integer	Current pump cylinder differential servo gain ranging from 0 to 65535 for open valve state.
Cyl1_p_c_s_gain Cyl2_p_c_s_gain	Integer	Current pump cylinder proportional servo gain ranging from 0 to 65535 for closed valve state.

Cyl1_d_c_s_gain Cyl2_d_c_s_gain	Integer	Current pump cylinder differential servo gain ranging from 0 to 65535 for closed valve state.
Auto_Ret_Rate_Status	Integer	Current pump auto return rate status, 1 indicates on.
Remote_Status	Integer	Current pump remote start status - 1 indicates on.
Max_Ret_Rate1 Max_Ret_Rate2	Float	Current pump cylinder maximum return rate valves, in current scaled units.
Acceleration1 Acceleration2	Float	Current pump cylinder acceleration factors.
Remote_Rate_Status	Integer	Current pump remote rate control status (1 = on, 0 = off)
Wash_Area_Status	Integer	Current pump wash area status (1 = on, 0 = off)
Front_Panel_Status	Integer	Current pump front panel status (1 = present, 0 = not present)
RC_error	Integer	Current error code as returned from the Quizix pump controller in response to a RC request. 0 means no error.
Cyl1_offset Cyl2_offset	Float	Current pump cylinder pressure calibration zero offset.
Cyl1_gain Cyl2_gain	Float	Current pump cylinder pressure calibration gain.
Cyl1_min_offset Cyl2_min_offset	Float	Current pump cylinder pressure calibration offset minimum, in current scaled units.
Cyl1_max_offset Cyl2_max_offset	Float	Current pump cylinder pressure calibration offset maximum, in current scaled units.
Cyl1_min_gain Cyl2_min_gain	Float	Current pump cylinder pressure calibration gain minimum.
Cyl1_max_gain Cyl2_max_gain	Float	Current pump cylinder pressure calibration gain maximum.
Cyl1_coefficient Cyl2_coefficient	Float	Current pump cylinder transducer coefficients (valid only for T1 type transducers).
Frac_flow	Float	Value represents the fraction (“percentage”) of fluid delivered by this pump (vs. the other pump running in fractional flow mode). Applicable only in fractional flow mode. Range of 0.0 to 1.0. A negative integer indicates an error condition.
Text	Integer	Current returned result of the last executed debug command. A “9999” is returned when PumpWorks receives a debug command. When the debug command has been processed, either a ‘0’ is returned to indicate no errors, or a positive 3 digit integer is returned, representing the error number.
Smart_Start_Status	Integer	Current pump smart start status - 1 indicates on.

Pressure_Units	Integer	Currently displayed pressure units: 1 - bars 2 - kPa 3 - mbar 4 - MPA 5 - PSI
Rate_Units	Integer	Currently displayed rate units: 1 - ml/hour 2 - ml/minute 3 - ul/minute
Volume_Units	Integer	Currently displayed volume units: 1 - L 2 - ml 3 - uL

Table 15-8 Cylinder Type Table for PumpWorks Versions 6.01 or Less
0 - QL_700_1K
1 - QL_700_5K
2 - C_5000_2POINTS5K
3 - C_5000_2 POINTS5K_HF
4 - C_5000_5K
5 - C_5000_10K
6 - C_5000_20K
7 - C_5000L_7POINT5K
8 - C_50-00L_10K
9 - C_5000L_20K
10 - C_5000LX_10K
11 - C_5000LX_20K
12 - FDS_210
13 - FDS_HIGH_210
14 - C_6000_5K
15 - C_6000_10K
16 - C_6000_20K
17 - QX_500
18 - QX_1500_HV
19 - QX_1500

20 - QX_6000
21 - QX_20000
22 - QX_W_500
23 - QX_W_1500_HV
24 - QX _W_1500
25 - QX_W_6000
26 - QX_W_20000

Table 15-9 Cylinder Type Table for PumpWorks Versions 6.02 or Greater
0 - QL_700_1K
1 - QL_700_5K
2 - C_5000_2POINTS5K
3 - C_5000_2 POINTS5K_HF
4 - C_5000_5K
5 - C_5000_10K
6 - C_5000_15K
7 - C_5000_20K
8 - C_5000L_7POINT5K
9 - C_50-00L_10K
10 - C_5000L_20K
11 - C_5000LX_10K
12 - C_5000LX_20K
13 - FDS_210
14 - FDS_HIGH_210
15 - C_6000_5K
16 - C_6000_10K
17 - C_6000_15K
18 - C_6000_20K
19 - QX_500
20 - QX_1500_HV
21 - QX_1500
22 - QX_6000
23 - QX_20000

24 - QX_W_500
25 - QX_W_1500_HV
26 - QX _W_1500
27 - QX_W_6000
28 - QX_W_20000

Table 15-10 Transducer Type Table
0 - TRANS_5_SENSO
1 - TRANS_10_SENSO
2 - TRANS_50_SENSO
3 - TRANS_100_SENSO
4 - TRANS_250_SENSO
5 - TRANS_500_SENSO
6 - TRANS_1000_SENSO
7 - TRANS_2500_SENSO
8 - TRANS_5000_SENSO
9 - TRANS_7500_SENSO
10 - TRANS_10000_SENSO
11 - TRANS_15000_SENSO
12 - TRANS_20000_SENSO
13 - TRANS_30000_SENSO
14 - TRANS_5_LUCAS
15 - TRANS_10_LUCAS
16 - TRANS_50_LUCAS
17 - TRANS_100_LUCAS
18 - TRANS_250_LUCAS
19 - TRANS_500_LUCAS
20 - TRANS_1000_LUCAS
21 - TRANS_2500_LUCAS
22 - TRANS_5000_LUCAS
23 - TRANS_7500_LUCAS
24 - TRANS_10000_LUCAS
25 - TRANS_15000_LUCAS
26 - TRANS_20000_LUCAS

27 - TRANS_5_TI
28 - TRANS_10_TI
29 - TRANS_50_TI
30 - TRANS_100_TI
31 - TRANS_250_TI
32 - TRANS_500_TI
33 - TRANS_1000_TI
34 - TRANS_2500_TI
35 - TRANS_5000_TI
36 - TRANS_7500_TI
37 - TRANS_10000_TI
38 - TRANS_15000_TI
39 - TRANS_20000_TI
45 - TRANS_500_CI
46 - TRANS_1500_CI
48 - TRANS_6000_CI
52 - TRANS_20000_CI
58 - TRANS_500_TI
59 - TRANS_1500_T1
61 - TRANS_6000_TI
65 - TRANS_20000_TI
72 - TRANS_1500_IC_GEN_II
74 - TRANS_6000_IC_GEN_II
78 - TRANS_20000_IC_GEN_II

Table 15-11 Motor Resolution Table
0 - MR_51_2K
1 - MR_5000_4K
2 - MR_5000_10K
3 - MR_5000_25K
4 - MR_5000_50K
5 - MR_6000_12_8K
6 - MR_6000_25K
7 - MR_FDS_10K

Table 15-12 Current Error Request Items for “PumpUnit1” through “PumpUnit8” Topics

Item	Format	Description
Cyl1_a_o_press Cyl2_a_o_press	Integer	Current analog overpressure error. 1 = error
Cyl1_d_o_press Cyl2_d_o_press	Integer	Current digital overpressure error. 1 = error
Cyl1_d_u_press Cyl2_d_u_press	Integer	Current digital underpressure error. 1 = error
Cyl1_p_t_cable Cyl2_p_t_cable	Integer	Current pressure transducer cable error. 1 = error.
Cyl1_m_cable Cyl2_m_cable	Integer	Current motor cable error. 1 = error.
Cyl1_c_s_cable Cyl2_c_s_cable	Integer	Current pump cylinder sensor cable error. 1 = error.
Cyl1_m_error Cyl2_m_error	Integer	Current motion error from switches. 1 = error.
Cyl1_pos_error Cyl2_pos_error	Integer	Current position error. 1 = error.
Cyl1_sw_error Cyl2_sw_error	Integer	Current switch error for the pump cylinder. 1 = error.
Cyl1_h_limit Cyl2_h_limit	Integer	Current hard limit error for the pump cylinder. 1 = error.
AD_ch5_cable AD_ch6_cable	Integer	Current AD Channel cable error. 1 = error.
sp_error1	Integer	Current spare error. 1 = error.
ext_cable1	Integer	Current external cable error. 1 = error.
Emy_stop	Integer	Current emergency stop. 1 = error.
norm_stop	Integer	Current normal stop. 1 = errors
spare_d_error1	Integer	Current spare dual error. 1 = error.
v_cable12	Integer	Current valve cable error. 1 = error.
driv1_stat driv2_stat	Integer	Current driver status. 1 = error.
Audible_Alarm	Integer	Audible alarm status. 1 = error.
Cyl1_Start_Error Cyl2_Start_Error	Integer	Current cylinder start error status. 1 = error.

15.2.4.2 DDE Request Items for “Resources” Topic

The “Resources” topic allows commands to, and provides access to data associated with the auxiliary A/D channels and auxiliary valves connected to the Quizix pump controllers. The availability of auxiliary resources is dependent on the number and type of devices under PumpWorks control. Use the PumpWorks auxiliary configuration windows to set up available auxiliary resources. (Refer to Chapter 10, Section 10.2 and Chapter 10, Section 10.4)

Table 15-13 DDE Request Items for "Resources" Topic		
Item	**Format**	**Description**
Cmd_response	Integer	Result of last executed resource command, as described below. 0: No errors 1: Invalid unit specified 2: Unit not enabled 3: Communication not active 4: Unable to decode item 5: Unable to decode value 10: Invalid valve number 11: Invalid valve state 12: No mapping for specified valve
Aux_AD1 Aux_AD2 Aux_AD3 ... Aux_AD32	Float	32 channels of PumpWorks-defined analog data.
Aux_valve1 Aux_valve2 Aux_valve3 ... Aux_valve32	Integer	32 channels of PumpWorks-defined auxiliary valve status. 0 = Valve de-activated. 1 = Valve activated. -1 = Not defined.

15.2.4.3 DDE Request Items for "AmsData" Topic

The "AmsData" topic is associated with the acoustic separators that may optionally be included as part of a pump system. Use the PumpWorks configuration windows to set up the acoustic separator(s) (Refer to Chapter 10, Section 10.6 and Chapter 13, Section 13.4)

Table 15-14 DDE Request Items for "AmsData" Topic		
Item	**Format**	**Description**
Rel_vol1 Rel_vol2	Float	The current relative volume (ml) for AMS Unit 1 or 2.
Abs_vol1 Abs_vol2	Float	The current absolute volume (ml) for AMS Unit 1 or 2. NOTE: If the 3-phase separator is in use (Unit 3) then Abs_vol1 and Abs_vol2 refer to the two absolute volume outputs of Unit 3.
Velocity1 Velocity2	Float	The fluid velocity (ml/sec) for AMS Unit 1 or 2. NOTE: If the 3-phase separator is in use (Unit 3) then Velocity 1 and Velocity2 refer to the two fluid velocity outputs of Unit 3.

Error1 Error2	String	The error string returned for AMS Unit 1 or 2. NOTE**:** If the 3-phase separator is in use (Unit 3) then Error1 and Error2 both contain the error string for the unit.

15.2.4.4 DDE Request Items for "BprData" Topic

The "BprData" topic is associated with a back pressure regulator that may optionally be included as part of a pump system. Use the PumpWorks configuration windows to set up the back pressure regulator (Refer to Chapter 10, Section 10.7 and Chapter 13, Section 13.5.)

Table 15-15 DDE Request Items for "BprData" Topic

Item	Format	Description
Bpr_set_press	Float	BPR set pressure

15.2.4.5 DDE Request Items for "Equations" Topic

Up to sixteen equations may be set up via PumpWorks (Refer to Chapter 10, Section 10.8) The "Equations" topic provides access to the results of these equations.

Table 15-16 DDE Request Items for "Equations" Topic

Item	Format	Description
Equation1	Float	Equation Results
Equation16		

15.2.4.6 DDE Request Items for "PumpWorks:" Topic

The PumpWorks topic provides access to some of PumpWorks' internal data not necessarily associated with a particular device.

Table 15-17 DDE Request Items for "PumpWorks" Topic

Item	Format	Description
Sequencer_Status	Text String	Status of Sequencer 1("Running", {"Paused", or "Not Running")
Sequencer_StatusX	Text String	Status of Sequencer X, where X is 1-20 ("Runing", "Paused", or "Not Running")
VarX	Float	Current value of PumpWorks Vairable X (X is 1-16)
Cmd_response	Integer	0 indicates no error, -1 indicates error
Watchdog Timer	Long	Indicates the number of seconds elapsed since midnight (00:00:00), January 1, 1970, coordinated universal time, according to the computer's system clock.

15.2.5 Changes in DDE Format from PumpWorks Version 3.1

1. PumpWorks Version 4.0 or later is pump-based rather than pump controller-based. Pumps are always composed of two pump cylinders. If an SC2400 pump controller has four pump cylinders, it will be represented in PumpWorks as (2) two-cylinder pumps. The available DDE items reflect this change. For example, for setting flow rate, there are now two items: (“Set_rate1” and “Set_rate2”), rather than four items (“Set_rate1”, “Set_rate2”, “Set_rate3” and “Set_rate4”).
2. The available topics have changed. There are now thirteen topics, “PumpUnit1” through “PumpUnit8”, “Resources”, “AmsData”, “BprData”, “Equation”, and “PumpWorks”. Previously there were only two topics, “Controller1” and “Controller2”.
3. There are new formats and item names for the pressure, rate, and volume request items. The new names are “Rate1”, “Rate2”; “Pressure1”, “Pressure2”; and “Volume1”, “Volume2” and are floating-point values with unit types defined by PumpWorks. In PumpWorks 3.1, pressure data was supplied by items “Raw_press1” through ‘Raw_press4”. Rate data was “Cyl 1_r_data” through “Cyl 4_r_data”. Volume data was “Curr 1” through “Curr_vol 4”. The pressure and rate data were in raw device format and the volume was in ml.

15.3 PumpWorks Dynamic Data Exchange Client

PumpWorks can also act as a DDE Client. For an explanation/overview of DDE, please see Section 15.2.1

15.3.1 PumpWorks DDE Client Supporting Separator Data

15.3.1.1 Separator DDE Data Interface

PumpWorks can act as a DDE Client to obtain separator data for the separators, with an interface as follows:

- Server Applictiona Name: “AMS”
- Server Topic Name: “SYSTEM”
- Server Item Names:
    - “VolumesString1” - This item contains the actual separator data for Separator 1, in a string of 23 characters, whose format is as follows (Byte 0 being the first character in the string):
        - Bytes 0-7 - Error String
        - Bytes 8-11 - Absolute Volume 1 (with implied decimal point between 3rd & 4th bits)
        - Bytes 12-17 - Relative Volume 1 (with implied decimal point between 4th & 5th bits)
        - Bytes 18-22 - Fluid Velocity 1

- "VolumesString2" - This item contains the actual separator data for Separator 2, in a string of 23 characters, whose format is as follows (Byte 0 being the first character in the string):
    - Bytes 0-7 - Error String
    - Bytes 8-11 - Absolute Volume 2 (with implied decimal point between 3rd & 4th bits)
    - Bytes 12-17 - Relative Volume 2 (with implied decimal point between 4th & 5th bits)
    - Bytes 18-22 - Fluid Velocity 2
- "VolumesString3" - This item contains the actual separator data in a string of 38 characters, whose format is as follows (Byte 0 being the first charaacter in the string):
    - Bytes 0-7 - Error String
    - Bytes 8-12 - Absolute Volume 1
    - Bytes 13-18 - Relative Volume 1
    - Bytes 19-22 - Fluid Velocity 1
    - Bytes 23-27 - Absolute Volume 2
    - Bytes 28-33 - Relative Volume 2
    - Bytes 34-37 - Fluid Velocity 2
- "VolumesString1Updated" - This item acts as a watchdog timer for Separator 1, letting PumpWorks know that it's still connected to the DDE server. PumpWorks will set up an advise link to this data item, so that it sees an update each time the value of this item changes. The server needs to ensure that this item is updated at least as often as the communication lost interval that's set in the Separator Communications window of PumpWorks. If PumpWorks does not receive an update for this item within the communication lost interval time period, it will report that communication has been lost with the separator.
- "VolumesString2Updated" - This item acts as a watchdog timer for Separator 2, letting PumpWorks know that it's still connected to the DDE server. PumpWorks will set up an advise link to this data item, so that it sees an update each time the value of this item changes. The server needs to ensure that this item is updated at least as often as the communication lost interval that's set in the Separator Communications window of PumpWorks. If PumpWorks does not receive an update for this item within the communication lost interval time period, it will report that communication has been lost with the separator.

- "VolumesString3Updated" - This item acts as a watchdog timer for Separator 3, letting PumpWorks know that it's still connected to the DDE server. PumpWorks will set up an advise link to this data item, so that it sees an update each time the value of this item changes. The server needs to ensure that this item is updated at least as often as the communication lost interval that's set in the Separator Communications window of PumpWorks. If PumpWorks does not receive an update for this item within the communication lost interval time period, it will report that communication has been lost with the separator.

15.3.1.2 Setting up the Separator DDE in PumpWorks

To enable the interface between the PumpWorks and the Separator DDE Server, do the following:

- Start the Separator Server Application
- From the main menu, select Communications->Separator Communications->Separator. The Set Up Separator window opens, as shown in Figure 15- 1.

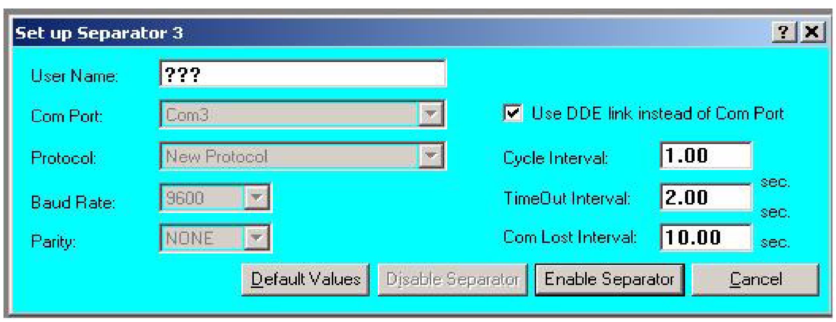


Figure 15-1 Set Up Separator window

- Check the "Use DDE link instead of Com Port" check box (clicking on the check box will toggle the state.)
- Set the cycle interval, timeout interval and com lost interval to the desired values, and click the Enable Separator button.

Unless an error message pops up indicating that the DDE link has failed, the Set Up Separator window will close, and PumpWorks will now be communicating with the Separator DDE Server.

To view the separator data, follow the instructions in Chapter 10, Section 10.6.

To disconnect PumpWorks from the Separator DDE Server, do the following:

- From the main menu, select Communications->Separator Communications->Separator. The Set Up Separator window opens, as shown in Figure 15- 1.
- Click on the Disable Separator button.

15.4 Setting Up Remote Host Communications

The remote serial access feature of PumpWorks allows commands to be sent to PumpWorks and current data retrieved from PumpWorks via an RS-232 connection between a remote computer or terminal, and the computer that is running the PumpWorks application. All transmitted and received data is in standard ASCII protocol and is terminated with a carriage return (ASCII code 13).

For communication with PumpWorks from a Windows application running on the same computer as PumpWorks, please refer to PumpWorks Dynamic Data Exchange Server, Section 15.2.

A query and response protocol forms the basis of remote serial access. The remote application sends a query and PumpWorks sends back a response. PumpWorks only responds to queries. Never is there an unsolicited response from PumpWorks. Queries sent to PumpWorks are of two types:

1. **Requests** for data.
2. **Commands** to change setpoints or perform an action.

Queries sent to PumpWorks are case-insensitive. For example, PumpWorks treats the following queries as identical:

RP1PRV_All

RP1PRV_ALL

rp1prv_all

15.4.1 Requests for PumpWorks Data

Most supported data requests are for pump data. The one exception is the request for PumpWorks system time.

15.4.1.1 Request for PumpWorks Time Data

The request for PumpWorks system time has the following format:

RT[CR]

- R, as character 1, indicates that the query is a Request for data.
- T, as character 2, indicates that the request is for time.
- The final delimiting character, is a carriage return (ASCII code 13).

15.4.1.2 Request for All Other Pump Data

All requests other than the one for PumpWorks system time are for pump data and have the following format:

RPnRequestText[CR]

- R, as character 1, indicates that the query is a Request for data.
- P, as character 2, indicates that the request is for Pump data.
- n, as character 3, is an integer in the range of 1 to 8 that denotes the pump that is being requested for data.
- The request text that indicates the specific data that is being requested, begins at character 4 and continues for the length of the text.
- The final delimiting character, is a carriage return (ASCII code 13). For example:

  RP1PRV_ALL[CR]

  is a request to Pump1 for all current pressure, rate and volume data.

All responses to data requests are in fixed format. The formats are defined by the specific requests and are given below. Floating point data is returned in a 14-character exponential format:

+d.ddddddE+ddd

- Where “+” indicates a “+” or “-” sign,
- d is a numeric character in the range of 0 to 9, and
- “.” and “E” are fixed characters.

In the specification of response format in the tables below, the letter E is used to denote the 14-character exponential field as described above.

Where more than one value is returned, the values are comma-delimited. The terminating character of the response is a carriage return (ASCII code 13).

If an error is encountered, only the three byte error code is sent as a response. If there are no errors, the response is prefixed with “000”.

Valid requests for PumpWorks pump data have been divided into grouped data requests, and individual requests in the following two sections.

15.4.1.3 Requests for Grouped Pump Data Items

In Table 18, the following symbols are used to denote the format of returned values:

- ‘E’ denotes a 14-character exponential format for floating point values as described in Section 15.4.1.2 above.
- d is a numeric character.
- sss is a 3 digit numeric character string that indicates the status (or error) code. All responses to successful commands are prefixed with 000. All responses to unsuccessful commands will contain only the 3 digit error code.
- dd denotes a 2-digit numeric character string.

- [CR] is a carriage return character. (ASCII code 13)

Table 15-18 Requests for Grouped Pump Data Items

Item	Format	Description
PRV_All	sss, E,E,E,E,E,E,E,E,E [CR] 139 characters total	All current pressure, rate, and volume data. Cyl1 Pres, Cyl2 Pres, Output Pres, Cyl 1 Rate, Cyl 2 Rate, Output Rate, Cyl1 Vol, Cyl 2 Vol, Cumulative Vol
Setpoint_All	sss, E,E,E,E,E,E,dd,dd[CR] 100 characters total	All Set Rate, Set Pressure, Set Safety Pressure and Pump Mode data. Cyl1 Set Rate, Cyl2 Set Rate Cyl1 Set Pres, Cyl2 Set Pres, Cyl1 Safety Pres, Cyl2 Safety Pres. Cyl1 Mode, Cyl2 Mode

15.4.1.4 Requests for Individual Pump Data Items

In Table 19, the following symbols are used to denote the format of returned values:

- ‘E’ denotes a 14-character exponential format for floating point values as described in Section 15.4.1.2 above.
- d is a numeric character.
- sss is a 3 digit numeric character string that indicates the status (or error) code. All responses to successful commands are prefixed with 000. All responses to unsuccessful commands will contain only the 3 digit error code.
- [CR] is a carriage return character. (ASCII code 13)

Table 15-19 Requests for Individual Pump Data Items

Item	Format	Description
Rate1 Rate2	sssE[CR]	Current cylinder rate in current scaled units.
Output_rate	sssE[CR]	Current output rate in current scaled units.
Pressure1 Pressure2	sssE[CR]	Current cylinder pressure in current scaled units.
Output_press	sssE[CR]	Current output pressure in current scaled units.
Volume1 Volume2	sssE[CR]	Current volume in current scaled units.
Cumul_vol	sssE[CR]	Current cumulative volume in current scaled units.
Cyl1_direction Cyl2_direction	sssd[CR]	1 = extend. 0 = retract.
Cyl1_running Cyl2_running	sssd[CR]	1 = running. 0 = not running.
Cyl1_set_rate Cyl2_set_rate	sssE[CR]	Cylinder set rate. Data in current scaled units.
Cyl1_set_press Cyl2_set_press	sssE[CR]	Cylinder set pressure. Data in current scaled units.
Cyl1_safe_press Cyl2_safe_press	sssE[CR]	Cylinder safety pressure. Data in current scaled units.
Cyl1_mode Cyl2_mode	sssdd[CR]	Mode setting for cylinder. Range 1-22 (Refer to Table 15-2.)

15.4.2 Command Query Format

A command to a pump has the following format:

CPnCommandText:ValueText[CR]

- C, as character 1, indicates that the query is a command.
- P, as a character 2, indicates that the command is a pump.
- n, as character 3, is an integer in the range of 1 to 8 that denotes the pump that is to receive the command.
- The command text that indicates the specific command to be sent, begins at character 4 and continues until the delimiting colon.
- "**:**" delimits the command text from the value text.
- The value text follows the delimiting colon.
- The final delimiting character is a carriage return (ASCII code 13).

NOTE: For commands that do not have an associated value, a delimiting colon is not required. The terminating carriage return may follow immediately after the command text.

Example of a Command with Associated Value
CP2Set_rate1:3.5[CR]
A command to Pump2 sets cylinder 1 rate to 3.5 in the currently configured rate units.

Example of a Command Without Associated Value
CP1Set_cyl1_on[CR]
A command to Pump1 sets cylinder 1 state to on--(the pump is started).

15.4.2.1 Command Response Format

All responses to pump commands are three numeric characters followed by a terminating carriage return (ASCII code 13). A response of 000 indicates that the command was successfully transmitted to the pump. A non-zero response indicates that an error occurred on sending the command to the pump.

15.4.2.2 Command Value Formats

The value format field on the table below specifies the required format for the value text of the command.

- Float values may be sent in standard floating point notation or in exponential format.
- A delimiting colon (ASCII code 58) always precedes the value text and a carriage return (ASCII code 13) terminates it.
- Integer values are composed of the characters 0 through 9 only.
- N/A means that a value is not required for the command; the terminating carriage return should immediately follow the command text.

15.4.2.3 Commands to the Pump

Table 15-20 Commands to the Pump

Item	Format	Description
Set_rate1 Set_rate2	Float	Sets the cylinder rate in current scaled units.
Set_press1 Set_press2	Float	Sets the requested cylinder pressure in current scaled units.
Set_mode1 Set_mode2	Integer	Sets the operating mode. Range 1 - 22. (Refer to Table 15-2.)
Set_cyl1_on Set_cyl2_on	N/A	Starts the cylinder.
Set_cyl1_off Set_cyl2_off	N/A	Stops the cylinder

15.4.3 Command/Request Response Error Code Summary

All responses to requests for data are prefixed with a 3-digit error code. “000” indicates no errors. If the error was of a type that prevented data being returned, then only the 3-digit error code followed by a carriage return will be returned by PumpWorks.

In the case of commands, only the 3-digit error code followed by a carriage return is returned.

Table 15-21 Error Code Summary

000	Message Correct
001	Incomplete Command - Sent when decoding of command cannot proceed, for example in the case of a carriage return only.
002	Too many characters in message.
003	First character decode error.
004	Second character decode error.
005	Currently transmitting, cannot accept Read command.
006	Not enough tension in the motor driver cable for Cylinder A.
007	Not enough tension in the motor driver cable for Cylinder B.
008	Cannot decode channel number on Halt command.
009	Unused.
010	Cannot decode channel number on Begin command.
011	Error Cylinders A and B Not Installed.
012	Both cylinders extended, cannot start A/B as pair.
013	Both cylinders extended, cannot start A/B as pair.
014	Both cylinders retracted, cannot start A/B as pair.
015	Unused.
016	Cylinder A: Warning maximum extend limit reached.
017	Cylinder B: Warning maximum extend limit reached.
018	Cylinder A: Warning maximum retract limit reached.
019	Cylinder B: Warning maximum retract limit reached.
020	Cylinder A is currently in error and cannot start.
021	Cylinder A is currently running and cannot start.
022	Cylinder A is still moving and cannot start.
023	Cylinder B is currently in error and cannot start.
024	Cylinder B is currently running and cannot start.

025	Cylinder B is still moving and cannot start.
026	Cylinder A is currently in error and cannot start.
027	Cylinder A is currently running and cannot start.
028	Cylinder A is still moving and cannot start.
029	Cylinder B is currently in error and cannot start.
030	Cylinder B is currently running and cannot start.
031	Cylinder B is still moving and cannot start.
032	Both cylinders extended, pair A/B stopped.
033	Both cylinders retracted, pair A/B stopped.
034	Gradient set error on Cylinder A.
035	Gradient set error on Cylinder B.
036	Unused.
037	Cannot set direction while cylinder is moving.
038	Could not decode the direction on the set direction command.
039	Could not decode channel number on the set direction command.
040	No numeric data sent with the set flow rate command.
041	Non numeric data sent with the set flow rate command.
042	Numeric data out of range with the set flow rate command.
043	Could not decode the channel number on the set flow rate command.
044	No numeric data sent with the set pressure command.
045	Non numeric data sent with the set pressure command.
046	Numeric data out of range with the set pressure command.
047	Could not decode channel number on the set pressure command.
048	No numeric data sent with SC command.
049	Non numeric data sent with SC command.
050	Numeric data out of range with SC command.
051	Could not decode channel number on SC command.

052	No numeric data sent with the set safety pressure command.
053	Non numeric data sent with set safety pressure command.
054	Numeric data out of range with the set safety pressure command.
055	Could not decode channel number on set safety pressure command.
056	No numeric data sent with the set return rate multiplier command.
057	Non numeric data sent with the set return rate multiplier command.
058	Numeric data out of range with the set return rate multiplier command.
059	Could not decode channel number on the set return rate multiplier command.
060	No numeric data sent with the recirculating mode set flow rate command.
061	Non numeric data sent with the recirculating mode set flow rate command.
062	Numeric data out of range with the recirculating mode set flow rate command.
063	Could not decode channel number on the recirculating mode set flow rate command.
064	No numeric data sent with the recirculating mode set return rate multiplier command.
065	Non numeric data sent with the recirculating mode set return rate multiplier command.
066	Numeric data out of range with the recirculating mode set return rate multiplier command.
067	Could not decode channel number on the recirculating mode set return rate multiplier.
068	Could not decode channel number on the reset volume command.
069	Could not decode second character on Set command.
070	Main valve command decode error.
071	Auxiliary Valve command decode error.
072	Valve number decode error on close.
073	Valve number decode error on open.
074	Main valves 1 to 4 not installed.
075	Main valves 5 to 8 not installed.

076	Auxiliary valves 1 to 4 not installed.
077	Auxiliary valves 5 to 8 not installed.
078 - 079	Unused.
080	Selected Mode not available in this version.
081	Cannot set Mode, Cylinder not installed.
082	Cannot set Mode, Cylinder running.
083	Cannot set Mode, Cylinder moving.
084	Cannot set Mode, Cylinders A/B not installed.
085	Incorrect configuration for recirculation mode.
086	Channels 3 and 4 not present on F set command.
087	Could not decode byte number on error clear.
088	Incorrect number of bytes sent on error clear.
089	Non hexidecimal data sent on error clear command.
090	No numeric data sent with FF command.
091	Non numeric data sent with FF command.
092	Numeric data out of range with FF command.
093	Could not decode channel number on FF command.
094	No numeric data sent with FT command.
095	Non numeric data sent with FT command.
096	Numeric data out of range with FT command.
097	Could not decode channel number on FT command.
098	No numeric data sent with FG command.
099	Non numeric data sent with FG command.
100	Numeric data out of range with FG command.
101	Could not decode channel number on FG command.
102	No numeric data sent with FI command
103	Non numeric data sent with FI command.

104	Numeric data out of range with FI command.
105	Could not decode channel number on FI command.
106	Could not decode second character on F command.
107 - 119	Unused.
120	No numeric data sent with the set differential servo gain command.
121	Non numeric data sent with the set differential servo gain command.
122	Numeric data out of range with the set differential servo gain command.
123	Could not decode channel number on the set differential servo gain command.
124	No numeric data sent with the set proportional servo gain command.
125	Non numeric data sent with the set proportional servo gain command.
126	Numeric data out of range with the set proportional servo gain command.
127	Could not decode channel number on set proportional servo gain command.
128	No numeric data sent with the set return rate minimum command.
129	Non numeric data sent with the set return rate minimum command.
130	Numeric data out of range with the set return rate minimum command.
131	Could not decode channel number on the set return rate minimum command.
132	No numeric data sent with set pressure calibration offset command.
133	Non numeric data sent with the set pressure calibration offset command.
134	Numeric data out of range with the set pressure calibration offset command.
135	Could not decode channel number on the set pressure calibration offset command.
136	No numeric data sent with FG command.
137	Non numeric data sent with FG command.
138	Numeric data out of range with FG command.
139	Could not decode channel number on FG command.
140	Could not decode channel number on the reset pressure calibration offset command.

141	No numeric data sent with the set ramp factor command.
142	Non numeric data sent with the set ramp factor command.
143	Numeric data out of range with the set ramp factor command.
144	Could not decode channel number on the set ramp factor command.
145	No numeric data sent with the recirculating mode set ramp factor command.
146	Non numeric data sent with the recirculating mode set ramp factor command.
147	Numeric data out of range with the recirculating mode set ramp factor command.
148	Could not decode channel number on the recirculating mode set ramp factor command.
149	No numeric data sent with FD command.
150	Non numeric data sent with FD command.
151	Numeric data out of range with FD command.
152	Could not decode channel number on FD command.
153	No numeric data sent with FR command.
154	Non numeric data sent with FR command.
155	Numeric data out of range with FR command.
156	Could not decode channel number on FR command.
157	Warning, fan not connected.
158	Warning, fan not running.
159	Warning: Valve wire disconnected fill valve A type 114 with valve off.
160	Warning: Valve wire disconnected fill valve A type 114 with valve on.
161	Warning: Valve wire disconnected fill valve A type 124 with valve off.
162	Warning: Valve wire disconnected fill valve A type 124 with valve on.
163	Warning: Valve wire disconnected deliver valve A type 124 with valve off.
164	Warning: Valve wire disconnected deliver valve A type 124 with valve on.
165	Warning: Valve wire disconnected deliver valve A type 114 with valve off.
166	Warning: Valve wire disconnected deliver valve A type 114 with valve on.

167	Warning: Valve wire disconnected fill valve B type 114 with valve off.
168	Warning: Valve wire disconnected fill valve B type 114 with valve on.
169	Warning: Valve wire disconnected fill valve B type 124 with valve off.
170	Warning: Valve wire disconnected fill valve B type 124 with valve on.
171	Warning: Valve wire disconnected deliver valve B type 124 with valve off.
172	Warning: Valve wire disconnected deliver valve B type 124 with valve on.
173	Warning: Valve wire disconnected deliver valve B type 114 with valve off.
174	Warning: Valve wire disconnected deliver valve B type 114 with valve on.
175	Sensor cable not connected.
176	Unused.
177	Optional software not installed unit.
178 - 189	Unused.
190	Delta pressure transducer not installed - Cylinder A.
191	Delta pressure transducer not installed - Cylinder B.
192	Delta pressure transducer not installed - Pair A/B.
193	Delta pressure transducer not installed - Cylinder A.
194	Delta pressure transducer not installed - Cylinder B.
195	Delta pressure transducer not installed - Pair A/B.
196 - 199	Unused.
200	Activate Recirculation Mode before SC command.
201	Activate Recirculation Mode before the recirculation mode set flow rate command.
202	Activate Recirculation Mode before the recirculating mode set return rate multiplier command.
203	Recirculation Mode Error. Cannot start any cylinder.
204 - 209	Unused.
210	Cylinder A fully extended, cannot start extending.
211	Cylinder B fully retracted, cannot start retracting.

212	Cylinder B fully extended, cannot start extending.
213	Cylinder A fully retracted, cannot start retracting.
214	Cylinder A fully extended, cannot start extending.
215	Cylinder B fully retracted, cannot start retracting.
216	Cylinder B fully extended, cannot start extending.
217	Cylinder A fully retracted, cannot start retracting.
218	Cannot start pair with soft limit error.
219	Both trigger switches detected.
220	Cylinder A fully retracted, direction reset to extend.
221	Cylinder A fully extended, direction reset to retract.
222	Cylinder B fully retracted, direction reset to extend.
223	Cylinder B fully extended, direction reset to retract.
224	Cylinder A fully retracted, direction reset to extend.
225	Cylinder A fully extended, direction reset to retract.
226	Cylinder B fully retracted, direction reset to extend.
227	Cylinder B fully extended, direction reset to retract.
228	Pair A/B start, cylinder A already fully extended.
229	Pair A/B start, cylinder A already fully retracted.
230	Pair B/A start, cylinder B already fully extended.
231	Pair B/A start, cylinder B already fully retracted.
232	Pair A/B start, cylinder A already fully extended.
233	Pair A/B start, cylinder A already fully retracted.
234	Pair B/A start, cylinder B already fully extended.
235	PAir B/A start, cylinder B already fully retracted.
236	Cylinder A at extend limit, cannot start in mode 2.
237	Cylinder B at extend limit, cannot start in mode 2.
238	Cylinder A at extend limit, cannot start in mode 2.

239	Cylinder B at extend limit, cannot start in mode 2.
240 - 242	Unused.
243	Pump type selected not defined unit.
244	No pump type selected unit.
245	Main program initialization failure unit.
246	Run time Register failure for DSSIP unit.
247	Run time Register failure for Main unit.
248	Power on initialization failure DSSIP A/B.
249	Power on initialization failure DSSIP A/B.
250	DSSIP A/B RAM failure on start-up.
251	DSSIP A/B RAM failure on start-up.
252	External RAM failure on start-up.
253	Internal RAM failure on start-up.
254	Internal Register failure on start-up unit.
255 - 269	Unused.
270	Command not supported.
271	Previous command in process.
272	Communication error on host link.
273	Command discarded.
274 - 288	Unused.
289	Invalid cylinder number.
290	Invalid mode.
291	Can't set up even cylinder ramping in paired mode.
292	Can't change ramping set up while ramping.
293	Can't start ramping while cylinder is not running.
294	Ramping mode does not match current mode.
295	Ramp value or end value is out of range.

296	Second character command decode error.
297	Invalid pump number.
298	Pump undefined.
299	Pump off-line - no active communication with pump
300	Communications Lost.

15.5 PumpWorks OPC Server Interface

PumpWorks includes an OPC Server interface to provide data from PumpWorks to other applications and to allow other applications to send commands to PumpWorks. In this chapter, it is assumed that the user is familiar with OPC standards and functionality and has an existing OPC Client. This chapter is not intended to be a tutorial on how to create or use an OPC client.

15.5.1 Registering/Connecting to the PumpWorks OPC Server

The name of the PumpWorks OPC Server is “PW.OPCSvr.1”. This server is available in version 7.01 and later of PumpWorks, and is automatically registered when PumpWorks is installed. If for some reason the “PW.OPCSvr.1” does not appear to be registered, start PumpWorks with the command line argument “/REGOPC” to re-register it. PumpWorks must be run “as administrator” when doing this in order to properly register the server. Once the OPC server is registered and PumpWorks is running, any OPC client should be able to browse/connect to the server.

15.5.2 Accessing PumpWorks Data via the OPC Server

To access PumpWorks data via the OPC Server, connect to the PumpWorks OPC Server as described in Chapter 15, Section 15.5.1. Once connected, create an OPC group in the OPC client, add the desired data items to the group and set the desired “read options” (e.g. automatic update rate, etc.)

For convenience to the users, the PumpWorks OPC Server data items were designed to be consistent with the PumpWorks DDE Server. The data is provided as a hierarchical tree, with “PW_Data” as its root, followed by the topic name and item name as described in the DDE Server section (Chapter 15, Section 15.2). Each of these names is separated by a period. For example, to access the set rate of cylinder 1 of Pump 1, the complete data item name would be “PW_Data.PumpUnit1.Cyl1_set_rate”.

To see a list of the available data items, utilize the browsing mechanism supported by the OPC interface. You can also refer to tables 15-7 through 15-17 in Chapter 15, Section 15.2.4 of this manual.

15.5.3 Sending Commands to PumpWorks via the OPC Server

To send commands to PumpWorks via the OPC Server, connect to the PumpWorks OPC Server as described in Chapter 15, Section 15.5.1. Once connected, create an OPC group in the OPC client, and add the desired command items to the group. Then “write” these commands to the PumpWorks OPC Server with the appropriate command values.

For convenience to the users, the PumpWorks OPC Server command items were designed to be consistent with the PumpWorks DDE Server. The commands are provided as a hierarchical tree, with “PW_Commands” as its root, followed by the topic name and item name as described in the DDE Server section (Chapter 15, Section 15.2). Each of these names is separated by a period. For example, to set rate of cylinder 1 of Pump 1, the complete command item name would be “PW_Commands.PumpUnit1.Set_rate1”.

To see a list of the available command items, utilize the browsing mechanism supported by the OPC interface. You can also refer to tables 15-1 through 15-6 in Chapter 15, Section 15.2.3 of this manual.

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix A: QX Series User Interface

The QX Series Pump has a user interface connector that allows the user to control and read data from additional sensors and control devices from PumpWorks. Specifically, the QX Series has the following capabilities available on the 25 pin DB style connector:

- 2 each auxiliary A/D channels
- 8 each valve pilot solenoid controls
- 2 each digital logic input channels
- 2 each digital logic output channels
- 5 volt and 24 volt power

A.1 Valve Control Lines

The valve control lines have been designed to operate the pilot solenoids, which are used to activate air operated On/Off control valves used on the QX Series Pump to control fluid flow. Each On/Off valve requires two pilot solenoids, one to turn the valve On and one to turn the valve Off. These pilot solenoids are available in many different voltages, however, the Quizix
QX Series pumps use 24 volt versions. The user interface was designed with the expectation that 24 volt pilot solenoids would be used, so 24 volt power is available on four nearby pins (numbers 14, 15, 16 and 17). The 24 volt supply is connected to the positive lead of the pilot solenoids and the ground side of the pilot solenoid is connected to the desired control line. The valve control lines are low side drivers (they sink current) and are capable of sinking in excess of 100 milliamperes (ma) each. The 24 volt power supply, however, is only capable of supplying a combined total of 500 milliamperes (150 milliamperes with Front Panel attached). The pilot solenoids used by Chandler Engineering only draw about 20 milliamperes each, so eight pilot solenoids can easily be operated from the QX Series user interface. If other types of pilot solenoids are to be used, then their current requirements must be checked. The valve control lines can also be used to sink current from the 5 volt supply. An external supply can be used with these sink type drivers, however, voltages of greater than 24 volts are not permitted. Devices other than pilot solenoids can also be controlled such as indicator lamps, relays and other actuators.

NOTE: Since these lines pull only to ground, you cannot use a volt meter directly connected to these lines to check their operation. To check these lines with a volt meter, use a resistor (greater than 1 kiloohm) to tie the line to a power supply line (either +5 or +24 volts).

A.2 Digital Input Lines

Two logic level input lines are available on pins 20 and 21. These are CMOS type logic inputs with a 47 kiloohm pullup resistor to the 5 volt logic supply. These inputs are ESD protected.These signals can be activated by an external microswitch or a digital output from another digital logic system. The input voltage range for a logic low signal is 0 to 1.4 volts and a logic high is a signal from 3.6 to 5 volts. Signal levels should not go above the 5 volt logic power supply voltage or below ground. A typical use for this signal would be to detect an oven door opening with a microswitch on the door.

A.3 Digital Output Lines

Two logic level output lines are available on pins 18 and 19. These are CMOS type logic level signals which, when at a logic zero (low level), put out a voltage close to ground (guaranteed to be less than 0.2 volts for a 2 milliamperes maximum current sink) and when at a logic one (high level) put out a voltage close to the 5 volt supply (guaranteed to be greater than 4.6 volts while sourcing up to 20 milliamperes). These signals will either source or sink current but are limited to a maximum of 20 milliamperes. These digital output lines can be used to interface with an external digital system or light an LED type indicator.

A.4 Analog Signal Input Lines

Two analog input channels are available for use with external sensors. These lines are connected with a 14 bit analog to digital (A/D) converter on the QX Series controller printed circuit board.The input range for the A/D used for this conversion is 0 to +5 volts. An analog voltage that is within the 0 - +5 range is supplied to the appropriate channel. The A/D converter digitizes the signal, then the 14 bit result is displayed by PumpWorks. PumpWorks allows for linear scaling of the data so that convenient units can be obtained for the signal. The electrical characteristics of the input allow for signals up to +10 volts and as low as -1 volt without damage. The input resistance is about 20 kiloohms. Signals are referenced to the ground of the QX Series (pin numbers 9, 10 and 11 of the user interface).

A typical application could involve a pressure transducer which is supplied by the 24 volt supply and has an output voltage which goes from 0 to 5 volts. After wiring this transducer to the QX Series user interface and setting up the linear scaling in PumpWorks, the pressure detected by this pressure transducer could then be displayed and recorded by PumpWorks.

NOTE: If you wish to interface a current loop-type sensor, you will need a current to voltage converter. Contact Chandler Engineering regarding the availability of this item.

A.5 Emergency Stop Signal

Pin 22 of the user interface connector is tied to the emergency stop signal of the pump controller. This signal is a pull to ground to activate the emergency stop function. It can be pulled to ground using a switch that connects it to any of the digital ground pins.

A.6 Power Lines

The user interface has +5 and +24 volt power available on various pins. This is to make it easy to hook up external sensors and devices. However, the amount of current available is limited. The +5 volt power can supply 500 milliamperes total current and the +24 volt power can supply 500 milliamperes of current (150 milliamperes with Front Panel attached.). Do not exceed these amounts. If more current is needed to operate a device, use an external power supply.

A.7 Remote Control Interface

The following remote control capabilities are available via the user interface connector. The remote control features can be enabled/disabled via PumpWorks.

- Start/Stop - Available on Pin 21. Logic level high (5 volts) stops pump. Logic level low (ground) starts pump.
- Setpoint - A 0-5V voltage level at Pin 23 referenced to ground at pins 9, 10, and 11. A zero voltage level corresponds to a setting of 0.0 ml/min (rate mode) or 0.0 psi (pressure mode). A 5 volt level corresponds to the maximum rate or pressure setpoint available for the pump. There is a linear mapping of voltage to rate or pressure setpoint.

A.8 Connector Pinouts

The user interface connector is a standard 25 pin DB-type female connector. Wiring of the user interface connector is as follows:

PIN NUMBER	FUNCTION
1	Valve control line 1 for external valves, sink current to ground
2	Valve control line 2 for external valves, sink current to ground
3	Valve control line 3 for external valves, sink current to ground
4	Valve control line 4 for external valves, sink current to ground
5	Valve control line 5 for external valves, sink current to ground
6	Valve control line 6 for external valves, sink current to ground
7	Valve control line 7 for external valves, sink current to ground
8	Valve control line 8 for external valves, sink current to ground
9	Ground for +5 volt and +24 volt supplies
10	Ground for +5 volt and +24 volt supplies
11	Ground for +5 volt and +24 volt supplies
12	+5 volt power for logic signals or sensors
13	+5 volt power for logic signals or sensors
14	+24 volt power for valves or sensors
15	+24 volt power for valves or sensors
16	+24 volt power for valves or sensors
17	+24 volt power for valves or sensors
18	Digital logic output line 1 for logic control
19	Digital logic output line 2 for logic control

20	Digital logic input line 1 for logic sensing
21	Digital logic input line 2 for logic sensing
22	Input for emergency pump stop
23	Analog input to A/D converter channel 1
24	Analog input to A/D converter channel 2
25	+5 volt power for logic signals or sensors

Appendix B: CMD-5000A/5000B User Interface

The CMD-5000A/5000B pump controller and motor driver has a user interface connector that allows the user to read additional sensors and control external devices from PumpWorks. There are slight differences in the same signals between the CMD-5000A and the CMD-5000B controllers. These differences are detailed below in Analog Signal Input Lines, Section B.4, and Emergency Stop Signal, Section B.5. Specifically, the CMD-5000 has the following capabilities available on the 37 pin DB style user interface connector, which are described in the following sections.

- 3 each auxiliary A/D channels
- 8 each valve pilot solenoid controls
- 2 each digital logic input channels
- 2 each digital logic output channels
- An emergency stop control line
- +5, +12, +24 volt power and power supply ground connections

B.1 Valve Control Lines

The valve control lines have been designed to operate pilot solenoids which are used to activate air actuated On/Off control valves like the valves used on the CMD-5000 to control fluid flow. Each on/off valve requires one pilot solenoid. Usually the valve is connected so that when the pilot solenoid is On the valve opens and when the pilot solenoid is Off the valve closes. The standard valve used on a Quizix pump cylinder consists of <u>two</u> On/Off valves and needs <u>two</u> pilot solenoids to control it. These pilot solenoids are available in many different voltages, however, the Quizix pumps use 12 volt versions. The user interface was designed with the expectation that 12 volt pilot solenoids would be used and 12 volt power is available on 8 nearby pins (20, 21, 22, 23, 24, 25, 26, and 27). For ease of wiring there is one 12 volt pin for each valve control line. The 12 volt supply is connected to the positive lead of the pilot solenoid. The ground side of the pilot solenoid is connected to the desired control line. The valve control lines are low side drivers (they sink current) and are capable of sinking in excess of 100 milliamperes (ma.) each. The 12 volt power supply, however, is capable of supplying a combined total of 800 ma. The pilot solenoids used by Chandler Engineering only draw about 80 milliamperes each, so 8 pilot solenoids can easily be operated from the CMD-5000 user interface. If other types of pilot solenoids are to be used, then the current (ma) requirements of these pilot solenoids must be checked. The valve control lines can also be used to sink current from the 5 volt supply. An external supply can be used with these sink type drivers, however, voltages of greater than 12 volts are not permitted. Devices other than pilot solenoids can also be controlled, such as indicator lamps, relays and other actuators.

NOTE: Since these lines pull only to ground, you cannot use a volt meter directly connected to these lines to check their operation. To check these lines with a volt meter, use a resistor (greater than 1 kiloohm) to tie the line to a power supply line (either +5 or +12 volts).

B.2 Digital Output Lines

Two logic level output lines are available on pins 10 and 29. These are CMOS type logic level signals which, when at a logic zero (low level), put out a voltage close to ground (guaranteed to be less than 0.2 volts for a 20 milliamperes maximum current sink). When the signals are at a logic one (high level) they put out a voltage close to the 5 volt supply (guaranteed to be greater than 4.6 volts when sourcing up to 20 milliamperes). These signals will either source or sink current but are limited to a maximum of 20 milliamperes. These digital output lines can be used to interface with an external digital system or light an LED type indicator. Do not short these lines to +5 volts or ground as they are not short circuit protected.

B.3 Digital Input Lines

Two logic level input lines are available on pins 9 and 28. These are CMOS type logic inputs with a 10 kiloohm pullup resistor to the 5 volt logic supply. These signals can be activated by an external microswitch or a digital output from another digital logic system. The input voltage range for a logic low signal is from 0 to 1.4 volts and a logic high is a signal from 3.6 to 5 volts. Signal levels should not go above the 5 volt logic power supply voltage or below ground. A typical use for this signal would be to detect an oven door opening with a microswitch on the door.

B.4 Analog Signal Input Lines

A typical application could involve a pressure transducer which is supplied by the 12 volt supply and has an output voltage which goes from 0 to 10 volts. After wiring this transducer to the CMD-5000 user interface and setting up the linear scaling in PumpWorks, the pressure detected by this transducer could then be displayed and recorded by the PumpWorks software.

B.4.1 Analog Input Lines for CMD-5000A

Three analog input channels are available for use with external sensors. These lines are connected with a 12 bit analog to digital (A/D) converter on the CMD-5000A controller printed circuit board. The A/D used for this conversion can be programmed for input ranges to four different values 0 to +5 volts, 0 to +10 volts, -5 to +5 volts and -10 to +10 volts. These input voltage ranges are selectable from PumpWorks. The default voltage input range is 0 to +5 volts. An analog voltage, that is within the voltage range selected, is supplied to the appropriate channel. The A/D converter digitizes the signal and the 12 bit result is displayed by PumpWorks. PumpWorks allows for linear scaling of the data so that convenient units can be obtained for the signal. The electrical characteristics of the input allow for signals up to +15 volts and as low as -15 volts without damage. The input resistance is about 20 kiloohms. Signals are referenced to the analog ground of the CMD-5000A (pins 33, 35 and 37 of the user interface).

B.4.2 Analog Input Lines for CMD-5000B

Three analog input channels are available for use with external sensors. These lines are connected with a 16 bit analog to digital (A/D) converter on the CMD-5000B controller printed circuit board. The A/D used for this conversion is preset to an analog input range of -10 to +10 volts. This input voltage range will cover most user applications. If the user's signal does not cover the entire range, then the full resolution of the A/D will not be available. However, the signal will still be converted and work for most applications. PumpWorks displays the 16 bit result and allows for linear scaling of the data so that convenient units can be obtained for the signal. The electrical characteristics of the input allow for signals up to +12 volts and as low as -12 volts without damage to the converter. The input resistance is about 45 kiloohms. Signals are referenced to the analog ground of the CMD-5000B (pins 33, 35 and 37 of the user interface).

NOTE: If you wish to interface a current loop-type sensor, you will need a current to voltage converter. Contact Chandler Engineering regarding the availability of this item.

B.5 Emergency Stop Signal

B.5.1 CMD-5000A

Pin 19 of the user interface connector is tied to the emergency stop signal of the pump controller. This signal is a pull to ground to activate the emergency stop function. It can be pulled to ground using a switch that connects it to any of the digital ground pins.

B.5.2 CMD-5000B

Pin 19 of the user interface connector is tied to the emergency stop signal of the pump controller. By setting a jumper inside the controller, this line can be made to be: 1) a pull to ground for emergency stop, or 2) a loop signal which, if it is interrupted, causes an emergency stop. For the loop signal, a +5 volt source is needed and this has been supplied on pin 12. This is a +5 volt signal sourced through 500 ohms.

B.6 Power Lines

The user interface has +5, +12 and +24 volt power available on various pins. This is to make it easy to hook up external sensors and devices. However, the amount of current available is limited. The +5 volt power can supply 500 milliamperes total current and the +12 volt power can supply 800 milliamperes of current. The +2 is an unregulated supply and can vary from 22 to 30 volts. Current should be limited to 1 ampere. Do not exceed these amounts. If more current is needed to operate a device, use an external power supply.

B.7 Connector Pinouts

The user interface connector is a standard 37 pin DB type female connector. Wiring of the user interface connector is as follows, first listed by function and then by pin number.

User Interface Connector Listed by Function	
Pin Number User Interface Connector	**Function**
20	+12 volt power normally used for pilot solenoids.
21	+12 volt power normally used for pilot solenoids.
22	+12 volt power normally used for pilot solenoids.
23	+12 volt power normally used for pilot solenoids.
24	+12 volt power normally used for pilot solenoids.
25	+12 volt power normally used for pilot solenoids.
26	+12 volt power normally used for pilot solenoids.
27	+12 volt power normally used for pilot solenoids.
13	+24 volt power supply.
15	+24 volt power supply.
17	+24 volt power supply.
11	+5 volt power for logic signals or sensors
30	+5 volt power for logic signals or sensors.
14	Analog input to A/D converter channel 1.
16	Analog input to A/D converter channel 2.
18	Analog input to A/D converter channel 3.
33	Analog signal ground.
35	Analog signal ground.
37	Analog signal ground.
12	CMD-5000A This is a digital ground connection.
12	CMD-5000B This is a +5 volt via 500 ohms for emergency stop loop power.
9	Digital logic input line 1 for logic sensing.
28	Digital logic input line 2 for logic sensing.
10	Digital logic output line 1 for logic control.
29	Digital logic output line 2 for logic control.
19	Emergency stop, pull to ground for stop.
31	Power and signal ground for all power supplies.
32	Power and signal ground for all power supplies.
34	Power and signal ground for all power supplies.

36	Power and signal ground for all power supplies.
1	Valve control line 1 for external valves, sink current to ground.
2	Valve control line 2 for external valves, sink current to ground.
3	Valve control line 3 for external valves, sink current to ground.
4	Valve control line 4 for external valves, sink current to ground.
5	Valve control line 5 for external valves, sink current to ground.
6	Valve control line 6 for external valves, sink current to ground.
7	Valve control line 7 for external valves, sink current to ground.
8	Valve control line 8 for external valves, sink current to ground.

User Interface Connector listed by Pin Number	
Pin Number User Interface Connector	**Function**
1	External valve control line 1 [DB 4]
2	External valve control line 2 [DB 5]
3	External valve control line 3 [DC 0]
4	External valve control line 4 [DC 1]
5	External valve control line 5 [DC 2]
6	External valve control line 6 [DC 3]
7	External valve control line 7 [DC 4]
8	External valve control line 8 [DC 5]
9	Digital input signal 1 [DI 16].
10	Digital output signal 1 [DO 6].
11	+5 volt power
12	CMD-5000A:This is a digital ground connection CMD-5000B: This is a +5 volt via 500 ohms for emergency stop loop power.
13	+24 volt power
14	External analog input 1 [Vin 5]
15	+24 volt power
16	External analog input 2 [Vin 6]
17	+24 volt power
18	External analog input 3 [Vin 7].
19	Emergency stop, pull to ground for stop.

20	+12 volt power
21	+12 volt power
22	+12 volt power
23	+12 volt power
24	+12 volt power
25	+12 volt power
26	+12 volt power
27	+12 volt power
28	Digital input signal 2 [DI 17].
29	Digital output signal 2 [DO 7]
30	+5 volt power
31	Power and signal ground
32	Power and signal ground
33	Analog signal ground.
34	Power and signal ground
35	Analog signal ground.
36	Power and signal ground
37	Analog signal ground.

Appendix C: CN-6000 User Interface

The CN-6000 pump controller has a user interface connector that allows the user to read additional sensors and control external devices from PumpWorks. Specifically, the CN-6000 has the following capabilities available on the 37-pin DB style user interface connector.

- 3 each   auxiliary A/D channels
- 8 each   valve pilot solenoid controls
- 2 each   digital logic input channels
- 2 each   digital logic output channels
- An emergency stop control line
- +5, +12, +24 volt power and power supply ground connections

C.1   Valve Control Lines

The valve control lines have been designed to operate pilot solenoids which are used to activate air actuated On/Off control valves like the valves used on the CN-6000 to control fluid flow. Each on/off valve requires one pilot solenoid. Usually the valve is connected so that when the pilot solenoid is On the valve opens and when the pilot solenoid is Off the valve closes. The standard valve used on a Quizix pump cylinder consists of two On/Off valves and needs two pilot solenoids to control it. These pilot solenoids are available in many different voltages, however, the Quizix pumps use 12 volt versions. The user interface was designed with the expectation that 12 volt pilot solenoids would be used and 12 volt power is available on 8 nearby pins (20, 21, 22, 23, 24, 25, 26, and 27). For ease of wiring there is one 12 volt pin for each valve control line. The 12 volt supply is connected to the positive lead of the pilot solenoid. The ground side of the pilot solenoid is connected to the desired control line. The valve control lines are low side drivers (they sink current) and are capable of sinking in excess of 100 milliamperes (ma.) each. The 12 volt power supply, however, is capable of supplying a combined total of 800 ma. The pilot solenoids used by Chandler Engineering only draw about 80 milliamperes each, so 8 pilot solenoids can easily be operated from the CN-6000 user interface. If other types of pilot solenoids are to be used, then the current (ma) requirements of these pilot solenoids must be checked. The valve control lines can also be used to sink current from the 5 volt supply. An external supply can be used with these sink type drivers, however, voltages of greater than 12 volts are not permitted. Devices other than pilot solenoids can also be controlled, such as indicator lamps, relays and other actuators.

NOTE: Since these lines pull only to ground, you cannot use a volt meter directly connected to these lines to check their operation. To check these lines with a volt meter, use a resistor (greater than 1 kiloohm) to tie the line to a power supply line (either +5 or +12 volts).

C.2   Digital Output Lines

Two logic level output lines are available on pins 10 and 29. These are CMOS type logic level signals which, when at a logic zero (low level), put out a voltage close to ground (guaranteed to be less than 0.2 volts for a 20 milliamperes maximum current sink). When the signals are at a logic one (high level) they put out a voltage close to the 5 volt supply (guaranteed to be greater than 4.6 volts when sourcing up to 20 milliamperes). These signals will either source or sink current but are limited to a maximum of 20 milliamperes. These digital output lines can be used to interface with an external digital system or light an LED type indicator. Do not short these lines to +5 volts or ground as they are not short circuit protected.

C.3 Digital Input Lines

Two logic level input lines are available on pins 9 and 28. These are CMOS type logic inputs with a 10 kiloohm pullup resistor to the 5 volt logic supply. These signals can be activated by an external microswitch or a digital output from another digital logic system. The input voltage range for a logic low signal is from 0 to 1.4 volts and a logic high is a signal from 3.6 to 5 volts. Signal levels should not go above the 5 volt logic power supply voltage or below ground. A typical use for this signal would be to detect an oven door opening with a microswitch on the door.

C.4 Analog Signal Input Lines

A typical application could involve a pressure transducer which is supplied by the 12 volt supply and has an output voltage which goes from 0 to 10 volts. After wiring this transducer to the CN-6000 user interface and setting up the linear scaling in PumpWorks, the pressure detected by this transducer could then be displayed and recorded by the PumpWorks software.

Three analog input channels are available for use with external sensors. These lines are connected with a 16 bit analog to digital (A/D) converter on the CN-6000 controller printed circuit board. The A/D used for this conversion is preset to an analog input range of -10 to +10 volts. This input voltage range will cover most user applications. If the user’s signal does not cover the entire range, then the full resolution of the A/D will not be available. However, the signal will still be converted and work for most applications. PumpWorks displays the 16 bit result and allows for linear scaling of the data so that convenient units can be obtained for the signal. The electrical characteristics of the input allow for signals up to +12 volts and as low as -12 volts without damage to the converter. The input resistance is about 45 kiloohms. Signals are referenced to the analog ground of the CN-6000 (pins 33, 35 and 37 of the user interface).

NOTE: If you wish to interface a current loop-type sensor, you will need a current to voltage converter. Contact Chandler Engineering regarding the availability of this item.

C.5 Emergency Stop Signal

Pin 19 of the user interface connector is tied to the emergency stop signal of the pump controller. By setting a jumper inside the controller, this line can be made to be: 1) a pull to ground for emergency stop, or 2) a loop signal which, if it is interrupted, causes an emergency stop. For the loop signal, a +5 volt source is needed and this has been supplied on pin 12. This is a +5 volt signal sourced through 500 ohms.

C.6 Power Lines

The user interface has +5, +12 and +24 volt power available on various pins. This is to make it easy to hook up external sensors and devices. However, the amount of current available is limited. The +5 volt power can supply 500 milliamperes total current and the +12 volt power can supply 800 milliamperes of current. Do not exceed these amounts. If more current is needed to operate a device, use an external power supply.

C.7 Connector Pinouts

The user interface connector is a standard 37 pin DB type female connector. Wiring of the user interface connector is as follows, first listed by function and then by pin number.

User Interface Connector Listed by Function	
Pin Number User Interface Connector	**Function**
1	Valve control line 1 for external valves, sink current to ground
2	Valve control line 2 for external valves, sink current to ground
3	Valve control line 3 for external valves, sink current to ground
4	Valve control line 4 for external valves, sink current to ground
5	Valve control line 5 for external valves, sink current to ground
6	Valve control line 6 for external valves, sink current to ground
7	Valve control line 7 for external valves, sink current to ground
8	Valve control line 8 for external valves, sink current to ground
9	Digital logic input line 1 for logic sensing
28	Digital logic input line 2 for logic sensing
10	Digital logic output line 1 for logic control
29	Digital logic output line 2 for logic control
14	Analog input to A/D converter channel 1
16	Analog input to A/D converter channel 2
18	Analog input to A/D converter channel 3
12	Emergency stop loop power (+5 volts through 500 ohms)
19	Emergency stop, pull to ground for stop
11	+5 volt power for logic signals or sensors
30	+5 volt power for logic signals or sensors

13	+12 volt power normally used for transducers
15	+12 volt power normally used for transducers
17	+12 volt power normally used for transducers
20	+12 volt power normally used for pilot solenoids
21	+12 volt power normally used for pilot solenoids
22	+12 volt power normally used for pilot solenoids
23	+12 volt power normally used for pilot solenoids
24	+12 volt power normally used for pilot solenoids
25	+12 volt power normally used for pilot solenoids
26	+12 volt power normally used for pilot solenoids
27	+12 volt power normally used for pilot solenoids
33	Analog signal ground
35	Analog signal ground
37	Analog signal ground
31	Power and signal ground for all power supplies
32	Power and signal ground for all power supplies
34	Power and signal ground for all power supplies
36	Power and signal ground for all power supplies

User Interface Connector listed by Pin Number	
Pin Number User Interface Connector	**Function**
1	External valve control line 1 [DB 4]
2	External valve control line 2 [DB 5]
3	External valve control line 3 [DC 0]
4	External valve control line 4 [DC 1]
5	External valve control line 5 [DC 2]
6	External valve control line 6 [DC 3]
7	External valve control line 7 [DC 4]
8	External valve control line 8 [DC 5]
9	Digital input signal 1 [DI 16]
10	Digital output signal 1 [DO 6]
11	+5 volt power

12	Emergency stop loop supply signal
13	+12 volt power
14	External analog input 1 [Vin 5]
15	+12 volt power
16	External analog input 2 [Vin 6]
17	+12 volt power
18	External analog input 3 [Vin 7]
19	Emergency stop, pull to ground for stop
20	+12 volt power
21	+12 volt power
22	+12 volt power
23	+12 volt power
24	+12 volt power
25	+12 volt power
26	+12 volt power
27	+12 volt power
28	Digital input signal 2 [DI 17]
29	Digital output signal 2 [DO 7]
30	+5 volt power
31	Power and signal ground
32	Power and signal ground
33	Analog signal ground
34	Power and signal ground
35	Analog signal ground
36	Power and signal ground
37	Analog signal ground

This page intentionally left blank.

Appendix D: QL-700 User Interface

The QL-700 Pump has a user interface connector that allows the user to control and read data from additional sensors and control devices from PumpWorks. Specifically, the QL-700 has the following capabilities available on the 25 pin DB style connector:

- 3 each auxiliary A/D channels
- 8 each valve pilot solenoid controls
- 2 each digital logic input channels
- 2 each digital logic output channels
- 5 volt and 12 volt power

D.1 Valve Control Lines

The valve control lines have been designed to operate the pilot solenoids, which are used to activate air operated On/Off control valves used on the QL-700 Pump to control fluid flow. Each On/Off valve requires two pilot solenoids, one to turn the valve On and one to turn the valve Off. These pilot solenoids are available in many different voltages, however, the Quizix QL-700 pumps use 12 volt versions. The user interface was designed with the expectation that 12 volt pilot solenoids would be used, so 12 volt power is available on four nearby pins (numbers 14, 15, 16 and 17). The 12 volt supply is connected to the positive lead of the pilot solenoids and the ground side of the pilot solenoid is connected to the desired control line. The valve control lines are low side drivers (they sink current) and are capable of sinking in excess of 100 milliamperes (ma) each. The 12 volt power supply, however, is only capable of supplying a combined total of 400 ma. The pilot solenoids used by Chandler Engineering only draw about 20 milliamperes each, so eight pilot solenoids can easily be operated from the QL-700 user interface. If other types of pilot solenoids are to be used, then their current requirements must be checked. The valve control lines can also be used to sink current from the 5 volt supply. An external supply can be used with these sink type drivers, however, voltages of greater than 12 volts are not permitted. Devices other than pilot solenoids can also be controlled such as indicator lamps, relays and other actuators.

NOTE: Since these lines pull only to ground, you cannot use a volt meter directly connected to these lines to check their operation. To check these lines with a volt meter, use a resistor (greater than 1 kiloohm) to tie the line to a power supply line (either +5 or +12 volts).

D.2 Digital Input Lines

Two logic level input lines are available on pins 20 and 21. These are CMOS type logic inputs with an 11 kiloohm pullup resistor to the 5 volt logic supply. These signals can be activated by an external microswitch or a digital output from another digital logic system. The input voltage range for a logic low signal is 0 to 1.4 volts and a logic high is a signal from 3.6 to 5 volts. Signal levels should not go above the 5 volt logic power supply voltage or below ground. A typical use for this signal would be to detect an oven door opening with a microswitch on the door.

D.3 Digital Output Lines

Two logic level output lines are available on pins 18 and 19. These are CMOS type logic level signals which, when at a logic zero (low level), put out a voltage close to ground (guaranteed to be less than 0.2 volts for a 20 milliamperes maximum current sink) and when at a logic one (high level) put out a voltage close to the 5 volt supply (guaranteed to be greater than 4.6 volts while sourcing up to 20 milliamperes). These signals will either source or sink current but are limited to a maximum of 20 milliamperes. These digital output lines can be used to interface with an external digital system or light an LED type indicator. Do not short these lines to +5 volts or ground as they are not short circuit protected.

D.4 Analog Signal Input Lines

Three analog input channels are available for use with external sensors. These lines are connected with a 12 bit analog to digital (A/D) converter on the QL-700 controller printed circuit board. The A/D used for this conversion can be programmed for input range to the following different values: 0 to +5 volts, 0 to +10 volts, -5 to +5 volts and -10 to +10 volts. These input voltage ranges are selectable from PumpWorks. The default voltage range is 0 to +5 volt range. An analog voltage that is within the voltage range selected is supplied to the appropriate channel. The A/D converter digitizes the signal, then the 12 bit result is displayed by PumpWorks. PumpWorks allows for linear scaling of the data so that convenient units can be obtained for the signal. The electrical characteristics of the input allow for signals up to +15 volts and as low as -15 volts without damage. The input resistance is about 20 kiloohms. Signals are referenced to the ground of the QL-700 (pin numbers 9, 10 and 11 of the user interface).

A typical application could involve a pressure transducer which is supplied by the 12 volt supply and has an output voltage which goes from 0 to 5 volts. After wiring this transducer to the QL-700 user interface and setting up the linear scaling in PumpWorks, the pressure detected by this pressure transducer could then be displayed and recorded by PumpWorks.

NOTE: If you wish to interface a current loop-type sensor, you will need a current to voltage converter. Contact Chandler Engineering regarding the availability of this item.

D.5 Emergency Stop Signal

Pin 19 of the user interface connector is tied to the emergency stop signal of the pump controller. This signal is a pull to ground to activate the emergency stop function. It can be pulled to ground using a switch that connects it to any of the digital ground pins.

D.6 Power Lines

The user interface has +5 and +12 volt power available on various pins. This is to make it easy to hook up external sensors and devices. However, the amount of current available is limited. The +5 volt power can supply 500 milliamperes total current and the +12 volt power can supply 400 milliamperes of current. Do not exceed these amounts. If more current is needed to operate a device, use an external power supply.

D.7 Remote Control Interface

The following remote control capabilities are available via the user interface connector. The remote control features can be enabled/disabled via PumpWorks.

- Start/Stop - Available on Pin 21. Logic level high (5 volts) stops pump. Logic level low (ground) starts pump.
- Setpoint - A 0-5V voltage level at Pin 23 referenced to ground at pins 9, 10, and 11. A zero voltage level corresponds to a setting of 0.0 ml/min (rate mode) or 0.0 psi (pressure mode). A 5 volt level corresponds to the maximum rate or pressure setpoint available for the pump. There is a linear mapping of voltage to rate or pressure setpoint.

D.8 Connector Pinouts

The user interface connector is a standard 25 pin DB-type female connector. Wiring of the user interface connector is as follows:

PIN NUMBER	FUNCTION
1	Valve control line 1 for external valves, sink current to ground
2	Valve control line 2 for external valves, sink current to ground
3	Valve control line 3 for external valves, sink current to ground
4	Valve control line 4 for external valves, sink current to ground
5	Valve control line 5 for external valves, sink current to ground
6	Valve control line 6 for external valves, sink current to ground
7	Valve control line 7 for external valves, sink current to ground
8	Valve control line 8 for external valves, sink current to ground
9	Ground for +5 volt and +12 volt supplies
10	Ground for +5 volt and +12 volt supplies
11	Ground for +5 volt and +12 volt supplies
12	+5 volt power for logic signals or sensors
13	+5 volt power for logic signals or sensors
14	+12 volt power for valves or sensors
15	+12 volt power for valves or sensors
16	+12 volt power for valves or sensors
17	+12 volt power for valves or sensors
18	Digital logic output line 1 for logic control
19	Digital logic output line 2 for logic control

20	Digital logic input line 1 for logic sensing
21	Digital logic input line 2 for logic sensing
22	Input for emergency pump stop
23	Analog input to A/D converter channel 1
24	Analog input to A/D converter channel 2
25	Analog input to A/D converter channel 3

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

CONVENTIONS

The # sign is used in this manual to represent an unknown number. For example, pump cylinder # could be pump cylinder 1A, 1B, 2A and so on.

This page intentionally left blank.