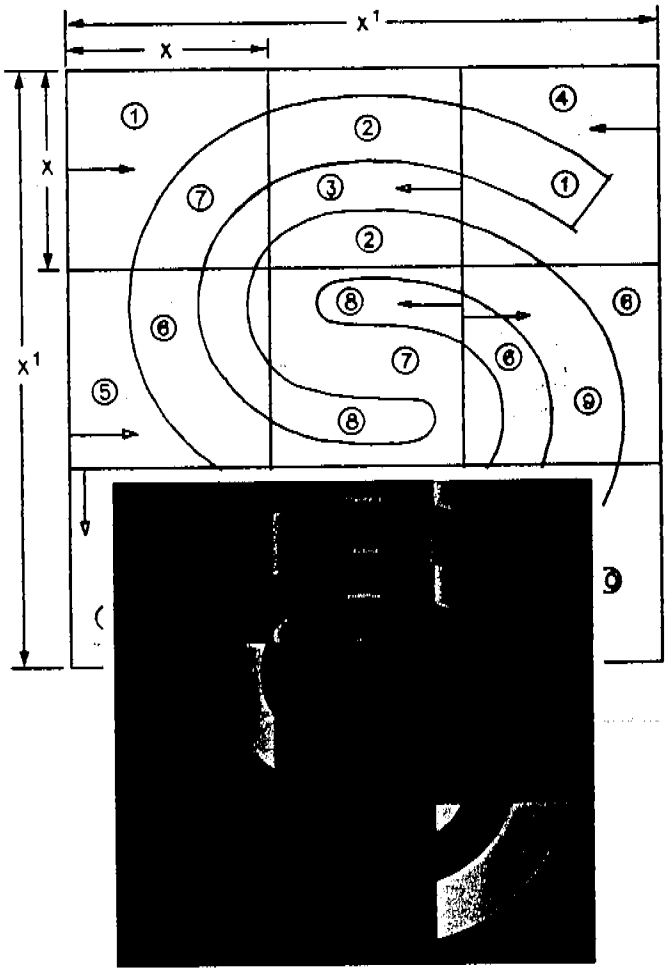
SpectraSYSTEM
ISOCRATIC PUMPS



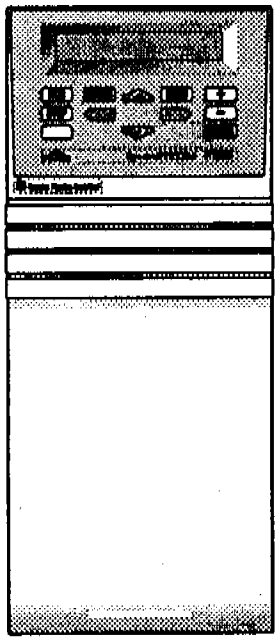
Spectra-Physics

Discover the Quality

REFERENCE MANUAL

SpectraSYSTEM™
Isocratic Pumps

Reference Manual



Spectra-Physics Analytical, Inc.
10/91
part number A0099-500

This manual and the instrument(s) to which it applies have satisfied the requirements for, and have received certification from, TÜV/GS, CSA, VDE, and the FCC.

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Safety Information

INSTRUMENT CERTIFICATION

In accordance with Spectra-Physics Analytical's commitment to customer service and safety, this pump and its accompanying documentation have satisfied the requirements for, and have received certification from TÜV/GS, CSA, FCC (Class A), and VDE (Class B)†. This product complies with the following CSA Standard 022.2 regulations:

- 0-M1982 - General Requirements (Canadian Electrical Code, Part II)
- 0.4-M1982 - Bonding and Grounding of Electrical Equipment (Protective Grounding)
- 151-M1986 - Laboratory Equipment

Designed and tested according to DIN 57411 Pt. 1/VDE 0411 Pt. 1, Safety Requirements for Electronic Measuring Apparatus, this pump has been shipped to you from our manufacturing facility in a safe condition.

IDENTIFYING SAFETY INFORMATION

This reference manual contains warnings and precautionary statements that can prevent personal injury, instrument damage, and loss of data if properly followed. All statements of this nature are called to your attention through the use of bold type and the following icons:

CAUTION!

WARNING!

HIGH VOLTAGE!

SPECIFIC HAZARDS

Every instrument has specific hazards, so be sure to read and comply with the following precautions. They will help ensure the safe, long-term use of your pump.

1. Before plugging the pump in or turning the power on, always make sure that the voltage and fuses are set appropriately for your local power supply. *Never* run the pump at less than 90 VAC when configured for 115 VAC, or less than 180 VAC when configured for 230 VAC. Refer to Appendix A for configuration details.
2. Only use fuses of the type and current rating specified. Do not use repaired fuses and do not short-circuit the fuse holder.
3. The supplied power cord must be inserted into a power outlet with a protective earth contact (ground). When using an extension cord, make sure that the cord also has an earth contact.

4. Do not change the external or internal grounding connections. Tampering with or disconnecting these connections could endanger you and/or damage the pump.

NOTE: The instrument is properly grounded in accordance with these regulations when shipped. You do not need to make any changes to the electrical connections or to the instrument's chassis to ensure safe operation.

5. Never run the pump without the top cover on. Permanent damage can occur.
6. Do not turn the instrument on if you suspect that it has incurred any kind of electrical damage. Instead, disconnect the power cord and contact a Spectra-Physics Analytical Service Representative for a product evaluation. Do not attempt to use the instrument until it has been evaluated. (Electrical damage may have occurred if the pump shows visible signs of damage, or has been transported under severe stress.)
7. Damage can also result if the instrument is stored for prolonged periods under unfavorable conditions (*e.g.*, subjected to heat, water, etc.).
8. Always disconnect the power cord before attempting any type of maintenance.
9. Capacitors inside the instrument may still be charged even if the instrument is turned off.
10. Never try to repair or replace any component of the instrument that is not described in this manual without the assistance of Spectra-Physics Analytical.
11. The pump is shipped with an aqueous methanol solution in the liquid ends. Be sure to prime the pump with a miscible solvent as described in Appendix A prior to use.

GOOD LABORATORY PRACTICES

Always follow good laboratory practices whenever you operate any high-performance liquid chromatograph.

Keep Good Records

To help identify and isolate problems with either your equipment or your chromatography, we recommend that you keep good records of all system conditions (*e.g.*, %RSDs on retention times and peak areas, peak shape and resolution, column pressure, and pump sensitivity). At a minimum, keep a chromatogram of a typical sample and standard mixture, well-documented with system conditions, for future reference. Careful comparison of retention times, peak shapes, column pressure, peak sensitivity, and baseline noise can provide valuable clues to identifying and *solving* future problems.

Chemical Toxicity

Although the large volume of toxic and flammable solvents used and stored in laboratories can be quite dangerous, don't ignore the potential hazards posed by your samples. Take special care to read and follow all precautions that ensure proper ventilation, storage, handling, and disposal of both solvents and samples. Become familiar with the toxicity data and potential hazards associated with all chemicals by referring to the manufacturers' Material Safety Data Sheets (MSDS).

Sample Preparation

Always consider the solubility of your sample in the mobile phase. Sample precipitation can plug the system by obstructing the flow through the injector and/or the column. This obstruction may result in irreparable damage to parts of the system. Particulate matter can be avoided by filtering the samples through 0.45- or 0.2-micron (or less) filters (see above).

Solvent Requirements

Many chemical manufacturers provide a line of high-purity or spectro-quality reagents that are free of chemical impurities. Routine filtration of all solvents or eluants through a 0.45- or 0.2-micron (or less) fluorocarbon filter before placing them in the solvent reservoir will significantly prolong the life and effectiveness of the inlet filters, check valves and seals, injector, and column. Typically, HPLC-grade solvents do not require filtration, although we recommend filtering all solvents.

Choose a mobile phase that is compatible with the sample and column you have selected for your separation. Remember that some solvents are corrosive to stainless steel. Inert/biocompatible instrument versions are also available from Spectra-Physics Analytical.

Degas the Eluants

Degas your LC system eluants using either the vacuum degassing or the helium sparging technique. Complete information for using Spectra-Physics Analytical equipment to perform either of these techniques is found in separate documentation provided with degas accessories.

Solvent Disposal

Make sure you have a solvent waste container or other kind of drain system available at or below the benchtop level. Most solvents have special disposal requirements and should not be disposed of directly down a drain. Follow all governmental regulations when disposing of any chemical.

High-pressure Systems and Leaks

LC systems operate at high pressures, but since liquids are not highly compressible, they do not store much energy. Thus, little immediate danger arises from the high pressure in an LC system. However, if a leak occurs, it should be corrected as soon as possible. Finally, we recommend that you always wear eye and skin protection when working on an LC system and that you always shut down the system and return it to atmospheric pressure before attempting any maintenance.

† TÜV: Technischer Überwachungs-Verein Rheinland
CSA: Canadian Standards Association
VDE: Verband Deutscher Elektrotechniker
FCC: Federal Communications Commission

Start-up Checklist

This list is a brief summary of tasks that should be completed to install your pump. Complete installation information is contained in Appendix A.

- ❑ Inspect your instrument
- ❑ Check for parts shortages
- ❑ Set the voltage
- ❑ Place the pump
- ❑ Connect the power cord
- ❑ Check initial response to power-on
- ❑ Hardwire to eight-pin port, using external function connector, making electrical connection to other SpectraSYSTEM instruments
- ❑ Install kits or accessories
- ❑ Prepare and connect solvent(s)
- ❑ Connect inlet line(s)
- ❑ Prime with solvent
- ❑ Purge solvent line(s)
- ❑ Connect to system

This pump was installed by:

_____ _____

(Name) *(Date)*

List of Spare Parts, Consumables, Kits

Shown below is a list of spare parts, consumables, and kits available from Spectra-Physics Analytical for use with your SpectraSYSTEM™ pump.

Pump Options and Accessories

A4054-010	**Bracket Kit** (Kit contains mounting hardware for the manual injector valve and columns.)
A4052-010	**Rheodyne 7125 Standard Bracket Kit** (Kit contains a 7125NS Rheodyne valve and switch, and the Bracket Kit.)
A4053-010	**Rheodyne 9125 Inert/Biocompatible Bracket Kit** (Kit contains a 9125 Rheodyne valve and switch, and the Bracket Kit.)
A4051-010	**Standard Fittings Kit** (Kit includes stainless steel fittings and tubing used in a SpectraSYSTEM LC system.)
A4061-010	**Inert/Biocompatible Fittings Kit** (Kit includes PEEK fittings and tubing used in an inert/biocompatible SpectraSYSTEM LC system.)
A4114-010	**Piston Flush Seal Kit** (Kit contains parts needed to install the piston flush feature in 10 mL pumps.)
A3930-010S	Inlet Liquid End, standard analytical, 10 mL/min (includes check valve)
A3931-010S	Outlet Liquid End, standard analytical, 10 mL/min
A3895-010S	Inlet Liquid End, inert/biocompatible, 30 mL/min (does not include check valve)
A3896-010S	Outlet Liquid End, inert/biocompatible, 30 mL/min
A3126-010	Flow Restrictor (350 psi at 0.3 mL/min water)
A3126-020	Flow Restrictor (800 psi at 0.3 mL/min water)
A3126-030	Flow Restrictor (1500 psi at 0.3 mL/min water)

Pump Upgrade Kits

Upgrade kits are available for SpectraSYSTEM pumps. Contact your local Spectra-Physics Analytical Representative for details.

Pump Maintenance Kits and Commonly Replaced Parts

10 mL/min Standard

A4050-010	**Standard Maintenance Kit** (Kit includes everything necessary to maintain the instrument for one year: four inlet filters, an inlet check valve, a transducer check valve, two sapphire pistons, a piston flush tube, a syringe, and seals.)
A4051-010	**Standard Fittings Kit** (Kit includes stainless steel fittings and tubing used in a SpectraSYSTEM LC system.)
A3102-010	Sapphire Piston
A3070-010	Piston Seals (pkg. of 10)
A3495-010	Inlet Check Valve
A3990-010	Transducer Check Valve
A3897-010	Bypass Valve
A4094-010	Solvent Inlet Filter Cartridge (pkg. of 4)
A2963-010	Piston Flush Seal (1)

List of Spare Parts, Consumables, Kits, con't.

30 mL/min Inert/Biocompatible

A4060-010	**Inert/Biocompatible Maintenance Kit** (Kit includes the inert/biocompatible versions of everything in the Standard Maintenance Kit.)
A4061-010	**Inert/Biocompatible Fittings Kit** (Kit includes PEEK fittings and tubing used in an inert/biocompatible SpectraSYSTEM LC system.)
A4084-010	**Piston Seal Kit** (Kit includes all the parts and tools necessary to perform seal maintenance on both liquid ends.)
A4083-010	Sapphire Piston
A3893-010	Inlet Check Valve
A3894-010	Transducer Check Valve
A3897-020	Bypass Valve
A4094-010	Solvent Inlet Filter Cartridge (pkg. of 4)

Pump Manuals

A0099-500	Isocratic Pumps Reference Manual (English)
A0099-501	Isocratic Pumps Reference Manual (French)
A0099-502	Isocratic Pumps Reference Manual (German)
A0099-510	Gradient Pumps Reference Manual (English)
A0099-511	Gradient Pumps Reference Manual (French)
A0099-512	Gradient Pumps Reference Manual (German)

Solvent Modules and Other Accessories

A4074-010	**Solvent Inlet Tube Kit** (Kit contains one bottle cap assembly, which includes an inlet filter, bottle cap, vent line, and one 5-foot tube with fitting and union.)
A4117-010	**Solvent Tube Extension Kit** (Kit contains four 5-foot tubes with fittings and unions.)
A4040-010	**Solvent Conditioning Module** (A four-solvent, vacuum- and helium-degassing module with bottles, tubes, and fittings.)
A4122-010	**Two-solvent Helium Degassing Kit with Solvent Bottle Holder** (Kit includes lines, spargers, manifold, connections, tubing, fittings, and the Bracket Kit.)
A4144-010	**Four-solvent Helium Degassing Kit with Solvent Bottle Holder** (Kit includes lines, spargers, manifolds, connections, tubing, fittings, and the Bracket Kit.)
A4125-010	**Two-solvent Helium Degassing Kit** (Kit includes manifold, connections, tubing, fittings, and the Bracket Kit.)
A0369-010	Sparger, 10-micron, for helium degassing
1413-0430	Wheaton Solvent Bottle, 1-liter
A4119-010	Solvent Bottle Holder (This item does not contain the vacuum degassing mechanism or any bottles, tubing, or other accessories.)

Solvent Module Manual

A0099-504	Solvent Conditioning Module Reference Manual (English, French, and German bound together. Manual covers both vacuum and helium degassing.)

Contact your Spectra-Physics Analytical representative for current local prices.

Contents

1 Getting Started

Introduction

This chapter provides you with the three basic rules you'll need for using your pump. It also introduces you to the instrument's command center and describes the conventions we'll use in this manual.

If you haven't installed your pump, be sure that you read the Safety Information at the front of this manual and follow the procedure in Appendix A.

Throughout our explanations, we encourage you to explore the general architecture of the instrument's menus and screens. Use the Menu Tree in Appendix B as your guide if you wish.

Learning Your Way Around

AS EASY AS 1-2-3!

It's easy to learn your way around a SpectraSYSTEM™ pump. Just remember these three easy rules:

1. The arrow keys ([∧], [∨], [<], [>]) move the cursor in the direction printed on the key.

   HINT: Press [MENU] to jump quickly to the top of the menu structure.

2. The shape of the cursor determines how you make a selection:
   - If a triangular cursor appears, press [ENTER]
   - If a blinking square cursor (▮) appears, press the [+] or [-] keys to scroll up or down through preset choices, or to increase or decrease alphanumeric entries.
3. There are four ways to accept (and automatically save) an entry. Just move the cursor out of the field by any of the following methods:
   - Pressing [ENTER]
   - Using the arrow keys
   - Pressing [MENU]
   - Pressing [STATUS]

   NOTE: If you can't leave a menu either errors are present or you haven't filled in all the necessary entries.

VISUAL CLUES

Several visual clues help you move through the pump's menus and enter values.

1. Top-level menu choices are displayed in all-capital letters; lower-level menu choices are displayed in upper- and lower-case letters.
2. A field's square cursor changes to an underscore cursor when you're scrolling through preset choices or entering numerical values and characters.
3. A solid down-arrow (▼) on the right side of some displays indicates that the current menu continues on additional screens. To access additional menu lines, press the down-arrow key, [v].
4. The last line of a longer menu is frequently a blank line (without a solid down-arrow).

Instrument Control

Take a look at the keypad and two-line display located on the front panel (Fig. 1.1). This is the command center from which you'll access menus and control the instrument's operations. A brief explanation of the keys and the main menus and screens follows.

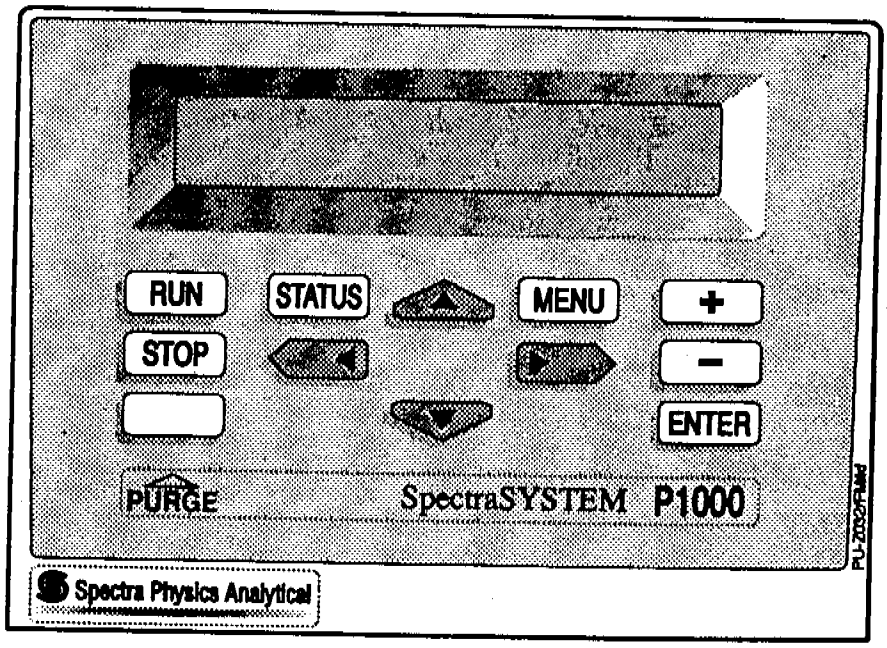


Figure 1.1 The P1000 pump's front panel. The keypad of the P1500 pump is identical.

The keypad of each SpectraSYSTEM instrument consists of twelve keys. Four keys directly control the instrument's operation: [RUN], [STOP], [STATUS], and, on the pump, a blank key called [PURGE]. The remaining keys ([MENU], [ENTER], [∧], [∨], [<], [>], [+], [-]) either access commands or are used to set parameters and move around the display. The function of each is explained below.

[RUN]

Generally, pressing [RUN] starts a run or sets up the conditions specified for the beginning of a run.

The specific [RUN] operation depends on the instrument's state:

1. If the pump's state is STOP, pressing [RUN] automatically prepares the last file loaded (the P1000 has only one file) to be run and sets the pump to the conditions specified for the start of the run (t_0 conditions).
2. If the pump's state is READY, (that is, the initial conditions already exist), pressing [RUN] starts the run. (P1500 only)

[STOP]

Pressing stop halts an operation in progress. (Specifically, the [STOP] key aborts a run in progress by stopping solvent flow through the pump.)

[STATUS]

Pressing [STATUS] displays the Status Screen (Fig. 1.3). From the status screen you can monitor the run in progress. You can also access the Status Menu. See page 5 for more information.

[PURGE]

The unlabeled key is the only variable key in the whole SpectraSYSTEM family. On the pump, the blank key is the [PURGE] key. The key's name appears on the nameplate below the key.

The [PURGE] key brings the PURGE Screen to the display. Purge parameters can be changed, and the purge operation started from this display. Refer to *Purging Solvent Lines* in Chapter 3 and to *Priming and Purging the Pump* in Appendix A for complete information.

[MENU]

Pressing [MENU] displays the Main Menu (Fig. 1.2). Each main menu item is explained in detail in the rest of this manual. For FILE(S) and COMMANDS see Chapter 3, for QUEUE and OPTIONS see Chapter 4, and for TESTS refer to Appendix C.

NOTE: The P1000 pump's Main Menu choices are FILE, OPTIONS, and TESTS.

[ENTER]

Pressing [ENTER] accepts a selected choice or menu entry. The [ENTER] key also advances the cursor to a new field, either on the same line of the display or in the line below.

[^], [v], [<], and [>]

Pressing any arrow key (up, down, left, or right) moves the cursor in the direction indicated on the key. If the cursor is on the first or the last line of a menu, the up- and down-arrow keys move you "up" or "down" in the menu structure.

[+] and [-]

Pressing the [+] and [-] keys scrolls you through a field's available choices or changes the value of alphanumeric entries. Holding down either key will continuously scroll the list of choices forward or backward until you release the key.

In fields that require numeric entries, the value of the selected digit is increased or decreased by one unit each time you press the [+] or [-] key. In fields that accept *either* numeric or alphabetic entries, such as the File Name field, the [+] and [-] key scroll through the alphabet from A to Z, then through the numbers 0 to 9, and finally to a slash, hyphen and blank space.

In other fields, the [+] key advances you through a preset list of choices while the [-] key takes you back through the list.

MENUS AND SCREENS

Your pump has two kinds of displays: menus and screens. Menus require you to make selections or enter specific values. Screens display information that cannot be edited. The Menu Tree in Appendix B illustrates the structure and content of the pump's menus and screens.

Main Menu

The Main Menu [Fig. 1.2 (a) for the P1500, and Fig. 1.2 (b) for the P1000] is the top level of the menu structure. It gives you access to several other menus. In the P1500, there are five menus: FILES, QUEUE, TESTS, COMMANDS, and OPTIONS. In the P1000, there are three menus: FILE, TESTS, and OPTIONS. To see the Main Menu, press the [MENU] key at any time.

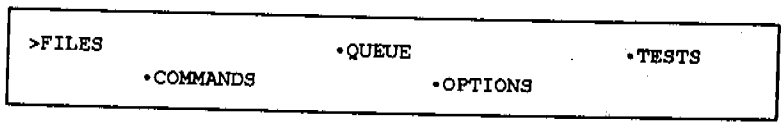


Figure 1.2 (a) Main Menu P1500

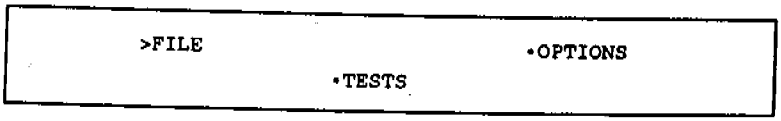


Figure 1.2 (b) Main Menu P1000

From the File(s) Menu you can edit, load, copy (P1500 only), or delete a file. In the Options Menu, you can set up or change your instrument's configuration. The Tests Menu provides access to performance-related diagnostic tests and maintenance-related menus. Two menus are present only in the P1500: Commands and Queue. The Commands Menu lets you hold, continue, or reset the pump. From the Queue Menu you can edit or change the order and number of files in the queue. Refer to Chapters 3 and 4, and Appendices B and C for more information on any of the instrument's menus.

Status Screen

The Status Screen automatically appears whenever you turn on the instrument or press the [STATUS] key. The P1500's Status Screen [Fig. 1.3 (a)] displays the pump's state (or time), flow, selected solvent, and the pressure. The P1000's Status Screen [Fig. 1.3 (b)] shows the pump's state (or purge time), flow, and pressure. Below either Status Screen is the Status Menu, described next.

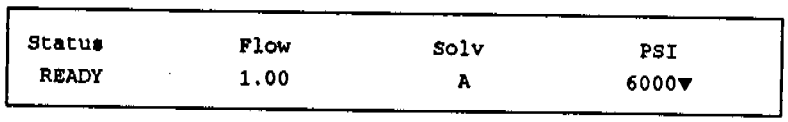


Figure 1.3 (a) The P1500's Status Screen

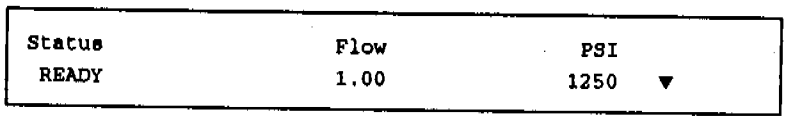


Figure 1.3 (b) The P1000's Status Screen

Status Menu

Just below the Status Screen is the Status Menu. To access the Status Menu, press the down-arrow key from the Status Screen. The Status Menu lets you review and edit run parameters *during* a run. Chapter 3 and Appendix B discuss the Status Menu in more detail.

MESSAGES

There are three different kinds of messages that can appear on the pump's display: user messages, confirmation messages, and error messages.

User messages

User messages (Fig. 1.4) tell you about an existing instrument condition or ask for further action. Some of these will only appear on the display for three seconds. An example of a message requiring further action is shown in Figure 1.4.

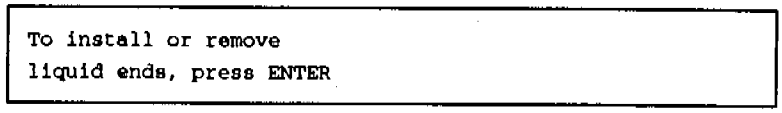


Figure 1.4 An example of a user message

Confirmation messages

Confirmation messages (Fig. 1.5) indicated on the display by asterisks, appear for one second after an operation has been carried out successfully.

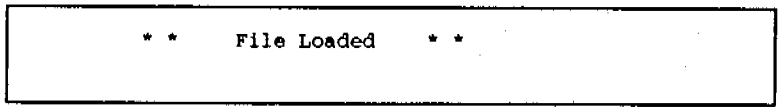


Figure 1.5 An example of a confirmation message

Error messages

Error messages (Fig. 1.6), indicated on the display by exclamation points, are displayed whenever an undesirable condition exists that prevents the instrument from carrying out an operation. Error messages remain on the display until you press a key.

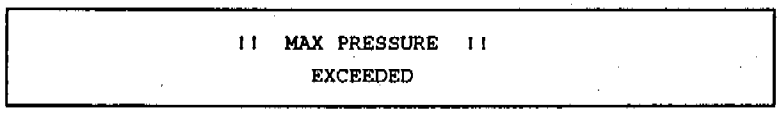


Figure 1.6 An example of an error message

Manual Conventions

This manual uses several conventions. Among them are menu displays, text conventions (brackets, slashes, etc.), standard words, and several different icons.

DISPLAYS

Figure 1.7 shows how we will depict the two-line display. Note that in menu illustrations, the triangular cursor location is indicated by a caret (>).

```
>FILES          •QUEUE                    •TESTS
        •COMMANDS              •OPTIONS
```

Figure 1.7 A two-line menu display

Frequently the two lines shown on the display are only part of a longer menu which you would see by pressing the down-arrow key. In this manual, menus having more than two lines are represented as in Figure 1.8.

```
Edit File                                  1
File Name
------------------------------------------------------------
>Solvent Program
•Options
•Timed Events
```

Figure 1.8 A menu longer than two lines

TEXT

Three typographic conventions are used to differentiate between keys, menus and fields.

Brackets

Brackets, [ ], indicate instrument keys. For example: Press the [MENU] key.

Slashes

Slashes, / /, are used around menu choices. For example: From the Main Menu, select /FILES/, /Edit/.

Capitalization

Capitalization is used to make field and menu names appear just as they do on the display. Generally the first letters of field names are capitalized. For example: In /Solvent Program/ go to the Flow field.

STANDARD WORDS

We have also standardized the meanings of two words: "select" and "enter".

select

The word "select" is used when you need to choose from among available options. For example, to select a particular menu choice, you would move the cursor to the appropriate choice and press [ENTER]. To "select" a field entry, move the cursor to the appropriate field and use the [+] and [-] keys to scroll to the desired choice.

enter

The word "enter" is used when you need to specify individual alphanumeric digits. To "enter" a particular value, move the cursor to the field and use the [+] and [-] keys to increment or decrement each digit in the field until the desired value or letter appears.

ICONS

This manual uses the following five icons to alert you to various situations. Each is called out by an icon in the left margin.

High Voltage!

This warning alerts you to the presence of high voltage and to the potential injury that could occur from electrical shock were you to come in contact with a specific instrument area or component. It also tells you how to avoid contact with the high-voltage areas in your instrument.

Warning

A warning alerts you to other situations that could result in personal injury. It also tells you how to avoid them.

Caution

Cautions alert you to the correct operating or maintenance procedures needed to prevent equipment or data damage.

Hint

Hints call out general rules or shortcuts. They specify ways to obtain the best performance and results from your instrument.

Note

Notes alert you to important exceptions, side effects, or unexpected occurrences that may result from certain action(s).

What's Next

Now you're ready to try the practice example in Chapter 2, *A Quick Example*.

2 A Quick Example

Introduction

This chapter gives you the chance to become familiar with your pump's screens and menus. In this chapter you will set up a few typical options, purge your solvent lines, and run a flow stability test. Once you know your way around the pump's interface, you'll probably only need to refer to this manual for less common operations, or to refresh your memory as to the menu location of some operations.

If you already feel comfortable with how to move through menus and displays, just scan this chapter and proceed to Chapter 3. If you want more practice with the pump, follow the instructions in this chapter closely. Since the object is to become familiar with the keypad and menus, we won't provide detailed explanations of the examples shown. More information can be found in one of the succeeding chapters.

First though, is a description of many of the features and benefits of your pump.

About the SpectraSYSTEM Pumps

The SpectraSYSTEM™ pumps have been designed for ease of use and unsurpassed performance. Any one of them can be used as a stand-alone pump or as a module in a totally automated LC system.

The P1500 pump is a two-solvent pump suited for isocratic applications and solvent switching applications. The P1500 pump contains a total of fifty time lines in as many as five method files (ten lines per file maximum).

The P1000 pump is a single-solvent isocratic pump. Rugged, reliable, and easy to use, it features a Shutdown option and Maintenance Log.

All SpectraSYSTEM pumps are engineered for reliability and ease of maintenance. Easy maintenance helps to ensure that your chromatography results are accurate and remain accurate. A built-in, patented Maintenance Log (refer to Chapter 6) allows you to follow the life span and use of seals, pistons, and check valves. If service is ever required, the resident diagnostics and modular design of the pump will keep downtime to a minimum. The simplicity and durability of the pump means that a minimum of spare parts need to be kept on hand.

Hands-on Examples

This section will take you step-by-step through four operations:

1. Setting a display option.
2. Creating a file
3. Purging a solvent line
4. Running a flow stability test.

These examples assume that the pump is properly installed and that the bypass valve's outlet is routed to a solvent waste container.

SETTING A DISPLAY OPTION - CHANGING PRESSURE UNITS

The default display of your pump can be changed to suit your own needs. The units that pressure is shown in are a good example:

1. Press [MENU]. Use [>] to move the cursor to /Options/, then press [ENTER] to access the Options Menu.
2. Use the down-arrow key [v] until you see the /More/ selection. With the cursor next to /More/, press [ENTER] to access the More Menu.
3. The display now looks similar to Figure 2.1:

```
Pressure Units                    PSI
Purge Mode                        Flow
```

Figure 2.1 The More Menu

4. The cursor should be in the Pressure Units field. Press [+] until the field shows MPa.

   You have just changed the display so that all pressures will be shown in megapascals. If you prefer other units, press [+] until you see another preset choice that suits you.

5. Move the cursor down to the Purge Mode field. Use [+] to see the Pressure selection (pressure). Press [+] once more, to change the purge mode selection back to Flow.
6. You may exit the More Menu in several ways. This time, press [STATUS] to exit the menu.
7. Use [v] to look at the Status Menu, which shows the run file.

EDITING A FILE

Editing a simple file is a good way to become familiar with entering values and moving the cursor between menus.

1. Press [MENU].
2. With the caret (>) next to /FILE(S)/, press [ENTER] to access the File(s) Menu.
3. The cursor should be on the /Edit/ selection. Press [ENTER] to access the Edit Menu.
4. The cursor is either in the File field (P1500), or in the Flow Rate field (P1000).
5. If you have a P1000 (Fig. 2.2), use the [+] key to enter a flow rate of 1.50 ml/min in the Flow Rate field.

```
Flow Rate                                          1.50
Maximum Pressure                                   6000
-------------------------------------------------------
Minimum Pressure                                      0
```

Figure 2.2 The P1000 Edit Menu

If you have a P1500 (Fig. 2.3):

a) Use the [+] key to select a file number. (Ignore the File Name field for now.)

b) Press [v] until you reach /Solvent Program/. Press [ENTER] to access the Solvent Program Menu.

c) The cursor should be in the Solv field. Use [+] to select solvent B, then use [>] to move the cursor into the Flow field. Enter a flow of 1.50, again using the [+] and [-] keys.

```
Time                    Solv                    Flow
 0.0                      B                     1.50
```

Figure 2.3 The P1500 Edit Menu

6. Press [^] until you return to the File(s) Menu.

PURGING A SOLVENT LINE

You may already be familiar with the purge operation from Appendix A. If so, skip this example and go on to *Running a Flow Stability Test.*

In this example you will purge a solvent line.

1. Open the bypass valve on the pump. Make sure that the bypass valve outlet is routed to a solvent waste container.
2. Press [STATUS]. The Status Screen should show that the pump is stopped (Figs. 2.4 and 2.5).

```
Status                Flow                MPa
  STOP                1.50                 1
-------------------------------------------------
Flow                  MaxP                MinP
1.50                    21                   0
```

Figure 2.4 The Status Screen and Status Menu (P1000)

```
Status          Flow          Solv          MPa
  STOP          1.50            B             1
-------------------------------------------------
File 1:
  Time                        Solv          Flow
   0.0                          B           1.50

Maximum Pressure                            21
Minimum Pressure                             0
Equilibration Time                         0.0
(The pressure units displayed may be different depending on your selection in the
example above.)
```

Figure 2.5 The Status Screen and Status Menu (P1500)

3. Leave the Status Screen and go to the Purge Menu by pressing [PURGE] (the blank key).

4. The cursor should be in the Purge field. See Figure 2.6 for the P1000 and Figure 2.7 for the P1500.

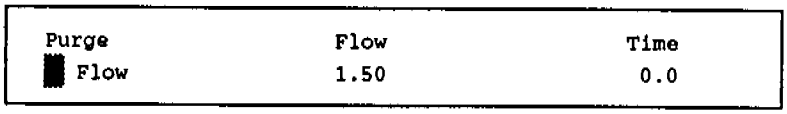


Figure 2.6 The Purge Menu (P1000)

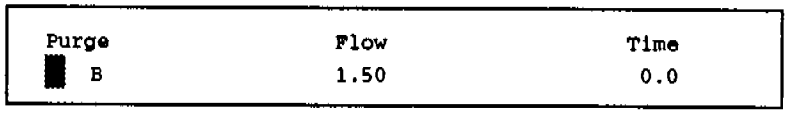


Figure 2.7 The Purge Menu (P1500)

5. If you have a P1500 pump, use [+] to select solvent B in the Purge field. If you have a P1000 pump continue with step 6 below.

Now you will actually begin the purge cycle.

6. Move the cursor to the Time field either by pressing [ENTER] or [>]. The pump motor will start. Enter 2.00 minutes in the Time field, then press [ENTER].

The pump will purge solvent for two minutes at the flow rate shown in the Flow field. You can stop the purge operation at any time by pressing [STOP]. After the purge is complete, the pump will automatically initialize the run file.

Remember to close the bypass valve immediately following the purge so that solvent flow returns to the LC.

RUNNING A FLOW STABILITY TEST

The flow stability test is a common test of the pump's performance. The pump must be running, purging or be in a READY, EQUIL, or INIT state for this test to be initiated, and the flow rate must be greater than 0 ml/min. If you need to change the flow rate, edit the flow setting from the Status Menu, then proceed with the steps below.

NOTE: The Flow Stability test can be completed only when the pump is in a READY state although it may be initiated while the pump is in any of the states mentioned above.

1. When the Status Screen shows READY, press [MENU] and select /TESTS/.
2. Select /Diagnostics/ from the Tests Menu.
3. The cursor should be on /Flow Stability/. Press [ENTER].

After a short time, the flow stability rating followed by a numerical value will appear. STABLE flow corresponds to a reading between 0 and 25, ACCEPTABLE is between 26 and 90, and UNSTABLE is a value greater than 90.

NOTE: The Flow Stability test may show unstable flow during solvent switching in the P1500, or during column equilibration.

Review

In just a few minutes you have become familiar with the [MENU], [STATUS], [ENTER], and [PURGE] keys. You've also used the [+] and [-] keys to enter numerical values and to make selections from among preset choices. In addition, you've learned to use the [∧] and [∨] keys to move between menus.

Using the keys and menus is simple. Remember that if you ever become "lost" you can retrace your steps, moving toward the Main Menu by using [∧], or you can start over at the Main Menu by pressing [MENU].

3 Basic Operations

Introduction

The type of chromatographic analyses you do will determine how you choose to use your pump. The flow rate is a typical parameter to set when using the Spectra-Physics Analytical P1500, P1000, or any other manufacturer's pump. This chapter describes pump basics, some recommended LC pump practices, and how the pump is used to perform basic operations: editing, loading and running a file, purging the pump, and viewing the pump's status.

Pump Basics

The pump is typically the second of six components in an LC system (solvent is the first). A pump delivers a steady flow of one or more solvents to a sample-injection instrument (generally an autosampler). This solvent flow continues through the column and on to a detector. From the detector, a signal is passed to an integrator, a recorder or another kind of data system capable of collecting the data and allowing the data of the injected sample to be analyzed.

The P1500 and P1000 isocratic pumps precisely and accurately deliver a mobile phase to the LC. The P1500 pump has the added capability of allowing the user to choose between two different mobile phases, and switch before, during, or after a run.

Solvent flow rate is specified in the run file. The solvent travels to the pump head where a piston meters the flow of the mixture to an outlet tube. The pump's outlet tubing then connects the solvent stream to an automatic or manual injector.

GOOD PUMP AND LABORATORY PRACTICES

Several of the most important reminders to ensure safe and trouble-free operation of your pump are discussed below and on the Safety Information Card at the front of this manual.

Safety

Good laboratory practices should be kept in mind at all times while operating any high performance liquid chromatograph. The large volume of toxic and flammable solvents used and stored in the laboratory is probably your greatest source of danger. Take special care to read and follow all precautions that ensure proper ventilation, storage, handling, and disposal of solvents and samples. Become familiar with the toxicity data and potential hazards associated with all chemicals by referring to the manufacturers' Material Safety Data Sheets (MSDS). Don't exclude the potential hazards of your samples.

While LC systems operate at high pressures, liquids are not highly compressible and therefore do not store much energy. Little immediate danger arises from the high pressure in an LC system. If a leak occurs however, it should be corrected as soon as possible, particularly if flammable solvents are used. Whenever you are working on an LC system ***wear eye and skin protection***. And last, always shut down the LC system and return it to atmospheric pressure before attempting any maintenance.

Solvent Wastes

Make sure you have a solvent waste container or some other kind of solvent waste drain system available either at or below the bench top level. Most solvents have special disposal requirements and should not be disposed of directly down a drain. Follow all governmental regulations when disposing of any chemical.

Solvent Requirements

Many chemical manufacturers provide a line of high-purity or spectro-quality reagents that are free of chemical impurities. Routine filtration of all solvents or eluants through a 0.45- or 0.2- micron (or less) fluorocarbon filter before placing them in the solvent reservoir will significantly prolong the life and effectiveness of the inlet filters, check valves and seals, injector, and column. Typically, HPLC-grade solvents do not require filtration, although we recommend filtering all solvents.

Choose a mobile phase that is compatible with the sample and column you have selected for your separation. Remember that some solvents are corrosive to stainless steel.

Spectra-Physics Analytical offers inert/biocompatible versions of each pump. For more information, contact your local representative.

CAUTION! Unless your pump is fitted with inert/biocompatible liquid ends, check valves, and tubing, never use hydrochloric acid solutions. In general, halides tend to corrode unpassivated stainless steel at any concentration. In mixing chemicals or buffer solutions, take care to avoid high concentrations of organic acids and salts. Also, since aqueous solutions containing metal ions found in stainless steel can produce electrochemical reactions that facilitate corrosion, salt solutions of the following metals should be avoided: manganese, chromium, nickel, copper, iron, and molybdenum. A method for the passivation of stainless steel components can be found in Chapter 6.

When changing the solvent for any one inlet line, make sure the current solvent is miscible with the new solvent you wish to use. Use intermediary solvents whenever necessary.

Good Sample Preparation

Always consider the solubility of your sample in the mobile phase. Precipitation of the sample can plug the system by obstructing the flow through the injector and/or the column. This obstruction may result in irreparable damage to parts of the system. Particulate matter can be avoided by filtering the samples through 0.45- or 0.2-micron (or less) filters.

Degas the Eluants

Degas your eluants using either the vacuum degassing or the helium sparging technique. Complete information for using Spectra-Physics Analytical equipment to perform either of these techniques is found in separate documentation provided with degassing accessories.

Keep Good Records

To help identify and isolate problems with either your equipment or your chromatography, we recommend that you keep good records of all system conditions (*e.g.*, %RSDs on retention times and peak areas, peak shape and resolution, column pressure, and detector sensitivity). At a minimum, keep a chromatogram of a typical sample and standard mixture, well documented with system conditions, for future reference. Careful comparison of retention times, peak shapes, column pressure, sensitivity, and baseline noise can provide valuable clues to identifying and *solving* future problems.

Turning the Pump On

Be sure someone has installed the pump according to Appendix A and completed the Start-up Checklist.

When you turn the pump on, it automatically loads a file. This enables the pump to have parameters to run by if the [RUN] key were to be pressed. *This "startup" file is the same file the pump last had in its memory just before it was turned off.* (If the last file loaded was changed via the editing capability of the Status Menu, a Save File command must have been issued for the changed parameters for that file to be in effect upon startup.)

At power-up there are no messages to alert you that a file is being loaded, but you can check the file number and name by pressing the [STATUS] key, and then using the down-arrow key to scroll to the file listing. (Both the [STATUS] key and the creation of files are discussed later in this chapter.)

Some Routine Operations

Ordinarily, you will probably perform these operations with your pump every day:

- Edit a file (or create a new file) and/or load a file to run
- Run your samples
- Purge the solvent lines
- Check the pump's status
- Monitor pump performance
- Shut down the pump at the end of the day

The rest of this chapter is devoted to explaining these basic operations. If you need to, refer to the keypad "rules" and manual conventions in Chapter 1. You may also want to refer to the basic menu structure, presented briefly in Chapter 2, or in greater detail in the Menu Reference (Appendix B). Most of the fields described in this chapter have preset (allowed) or default values. Allowed and default values for each field are listed, alphabetically, in Appendix B.

The File(s) Menu

In this section we describe how to set up the files that control solvents, pressures, flow rates, and run times. Each of the file operations accessed from the File(s) Menu is briefly defined, then described in detail.

To access the File(s) Menu, press [MENU] and select /FILES/ in the P1500 or /FILE/ in the P1000. The File(s) Menu for the P1500 is shown in Figure 3.1 (a); for the P1000 in Figure 3.1 (b).

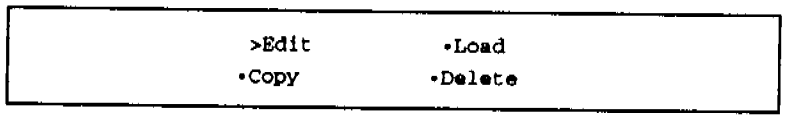


Figure 3.1 (a) The P1500's Files Menu

Figure 3.1 (b) The P1000's File Menu

Edit

Select /Edit/ if you want to change the parameters in an existing file, or create a new file. In the P1500, select the file by file number or letter (file S is the Shutdown file).

Load

Select /Load/ to load the file you want the pump to use when in operation. In the P1500 make a file selection by file number. We refer to a loaded file as the "run file."

Copy (P1500 only)

Select /Copy/ to copy the contents of one file into another. Select both files by file number.

Delete

Select /Delete/ to delete the contents of a file and return all file parameters to their default values. In the P1500 select the file by file number. An information message allows you to cancel the delete operation before the file is deleted. Once deleted, the file cannot be retrieved.

EDITING A FILE

File editing in the P1000 and P1500 are described separately below.

P1000

The P1000 contains only one file and its Edit Menu (Fig. 3.2) consists of three fields.

```
Flow Rate                                          1.00
Maximum Pressure                                   6000
-------------------------------------------------------
Minimum Pressure                                      0
```

Figure 3.2 The Edit Menu (P1000)

Flow Rate

Enter a flow rate in ml/min. The maximum flow rate is determined by the liquid ends installed on the pump. The flow range of your liquid ends was preset by Spectra-Physics Analytical.

NOTE: If you change the liquid ends, refer to the Maintenance Log description in Chapter 6 for complete information on resetting the flow range.

Maximum, Minimum Pressures

Change the pressure levels as desired. The maximum value is 6000 psi, the minimum is 0 psi. (The allowed values depend on the pressure units.) The maximum pressure value must be greater than the minimum pressure. The pump will not allow you to set maximum and minimum pressures to values that are inconsistent. If you are unable to edit one value, try to edit the other.

NOTE: Pressure units (psi, bar, or MPa) are selected from the Main Menu, /OPTIONS/, /More/, as described in Chapter 4.

Creating the Run File - A P1000 Example

Enter run parameters in the P1000 by first selecting /FILE/, /Edit/. The Edit Menu is shown in Figure 3.3.

```
Flow Rate                                          2.50
Maximum Pressure                                   4000
-------------------------------------------------------
Minimum Pressure                                      0
```

Figure 3.3 Example P1000 Edit Menu

Simply enter a flow rate, and the maximum and minimum acceptable operating pressures.

NOTE: Parameters are also easily changed from the Status Menu. Press [STATUS], then [∨] to access active fields.

P1500

A P1500's file consists of four parts: File Name, Solvent Program, Options, and Timed Events. Selecting /Edit/ gives you access to these areas (Fig. 3.4).

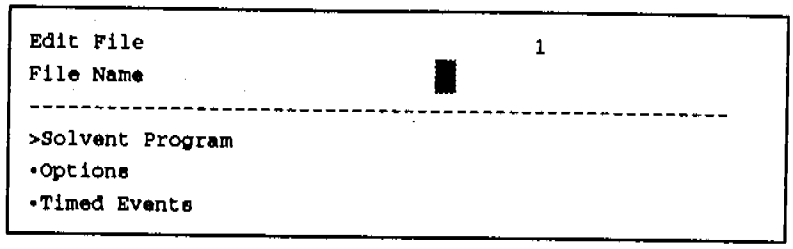


Figure 3.4 The Edit Menu (P1500)

To use the Edit Menu, select the file number in the Edit File field using the [+]/[-] keys. The P1500 pump has file numbers 1 through 4, and S. File S is described on page 25.

If a particular file cannot be accessed, the File Protect feature for that file has been turned on, preventing changes or deletions. When the File Protect feature has been turned on, a message appears on the display, indicating that the file cannot be edited. (File Protection is discussed in OPTIONS, More Menu in Chapter 4.)

File Name

You can enter or change the File Name using the [+]/[-] keys. The File Name field is eight characters long. Any name you enter is automatically remembered by the pump, so you do not need to formally "save" the name. All of the parameters discussed below are automatically remembered by the pump when you edit a file from the Files Menu.

NOTE: When changing the parameters of a run file from the Status Menu, you must select /Save File/ in order for the pump to remember your changes for future runs. The pump will, however, use your changes until the next time the file is initialized (either by pressing [RUN] if the pump is stopped, or by selecting /FILES/, /Load/), regardless of whether the file has been saved. Editing a run file from the Status Menu is discussed in more detail later.

The Solvent Program Menu

The Solvent Program Menu contains time lines used to switch between two solvents. Each time line consists of a time (in minutes), a solvent, and a flow rate (in ml/min). When /Solvent Program/ is selected, the display shows (Fig. 3.5):

Time	Solv	Flow
0.0	A	1.00

Figure 3.5 A P1500 Solvent Program

General Rules for Entering Time Lines

The solvent and flow for the zero (0.0) time line are always editable. The Time field 0.0 itself is not editable; it remains as time zero. To add new times you must create new time lines.

To create a new time line, use the down-arrow key to go to a blank line, or press [ENTER] until a blank line appears, then press the [+] key. The new line, automatically incremented one minute past the previous line, will be displayed. The cursor will appear in the Time field of the new line. The Time field in any new line is editable.

HINT: Don't add all your time lines to the file at once. Enter flow in the first time line, then add a new time line. The solvent selected and flow rate will be copied to the new line automatically. In fact, a new line is always identical to the one just before it, with the exception of the Time field as discussed earlier.

You can enter times in any order you choose. The pump will automatically rearrange the time lines on the display so that they are in chronological order as soon as you move the cursor off the Time field.

The P1500 has a total of 50 time lines available for all files, combined, including the Shutdown file (10 lines per file).

Changing Solvents - A P1500 Example

Figure 3.6 shows an example of a file entered into the P1500.

Time	Solv	Flow
0.0	A	1.00
1.0	B	1.00
2.0	A	1.00
3.0	A	1.00

Figure 3.6 Example P1500 Solvent Program

In this example the pump delivers solvent A until 1.00 minute into the run. After one minute the pump switches solvents so that solvent B is pumped until 2.00 minutes into the run. Then the pump resumes pumping solvent A until the end of the run at 3.00 minutes.

NOTE: Parameters are also easily changed from the Status Menu. Press [STATUS], then [v] to access active fields.

The Options Menu

The Options Menu consists of maximum and minimum pressure levels, and an equilibration time. You are not required to set any values in this menu, although you should always set a maximum pressure level, since the pump will warn you whenever operating pressures exceed this level.

You can access the Options Menu from /FILES/, /Edit/ (see Fig. 3.4) or by pressing [ENTER] or [v] on the blank line at the bottom of the Solvent Program, then selecting /Options/. The Options Menu is shown in Figure 3.7.

```
Maximum Pressure                          3000
Minimum Pressure                             0
-------------------------------------------------
Equilibration Time                         0.0
```

Figure 3.7 The Files, Options Menu

Maximum, Minimum Pressures

Change the pressure levels as desired. The maximum value is 6000 psi, the minimum is 0 psi. (The allowed values depend on the pressure units, selected in /OPTIONS/, /More/, Pressure Units.) The maximum pressure value must be greater than the minimum pressure. The pump will not allow you to set maximum and minimum pressures to values that are inconsistent. If you are unable to edit one value, try to edit the other.

NOTE: Pressure units (psi, bar, or MPa) are selected from the Main Menu, /OPTIONS/, /More/, described in Chapter 4.

During operation, the pump continuously monitors the actual operating pressure and displays this on the Status Screen. If the actual pressure ever exceeds the maximum pressure level, or falls below the minimum pressure level set here, an error message will alert you to this circumstance. For more information about using this error feature, refer to Chapter 4, Options, Error Recovery.

Equilibration Time

If desired, enter a value for the equilibration time. The equilibration time is the time that the pump will maintain the conditions (solvent and flow) specified on the first line of a run file (the zero time line), before showing READY on the Status Screen.

Timed Events Menu

You can access the Timed Events Menu from /FILES/, /Edit/, or by pressing [ENTER] or [v] on the bottom line of the Options Menu, then selecting /Timed Events/. The Timed Events Menu is shown in Figure 3.8.

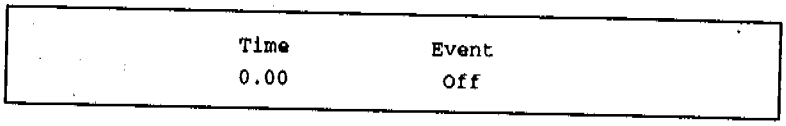


Figure 3.8 The Timed Events Menu

A timed events output is available at the external events port. This output can be used to control an external device such as a column switching valve. The output can be turned on or off up to six times per run.

The time on the first line of the menu remains 0.0. Additional timed events are added much like time lines in the Solvent Program. Use the down-arrow key to reach a blank line, then press [+]. As many as five additional lines can be added. The Time field in any added line is editable. Enter times and turn the output Off or On in any of the six Event fields using the [+] / [-] keys.

For example, Figure 3.9 shows a Timed Events Menu.

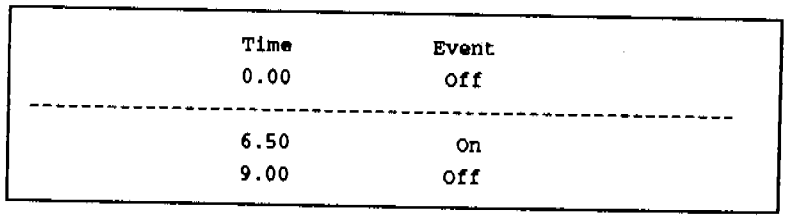


Figure 3.9 Timed events example

In this example, a timed event output (signal) would be sent (turn on) at 6.5 minutes into the pump's run and become inactive (turn off) two and a half minutes later, at 9.00 minutes.

To delete a line, move the cursor to the time field, then press and hold [-]. The time field will eventually become blank, and the line will disappear. If the time has more than one non-zero digit (*e.g.* 6.50), then decrement each digit, starting with the left-most digit. Release the [-] key after each field becomes blank and decrement the next digit.

A SPECIAL FILE: SHUTDOWN

Both pumps also have a Shutdown file. The Shutdown file is file number S in the P1500. The Shutdown file in the P1000 is accessed from /OPTIONS/, /Shutdown/.

Making use of the Shutdown file is an easy way to assist you with the proper maintenance of the pump. Since your pump and column should never be allowed to sit idle with salts or corrosive materials in them (including water), the Shutdown file lets you automatically flush the pump and the column at the completion of a series of samples.

Whenever the pump detects that it has been in a READY state, without a run being initiated, for a specified period of time, it automatically loads, initializes, and runs the Shutdown file.

NOTE: The pump's clock is reset anytime the [RUN] or [STOP] key is pressed, or anytime the /Reset/ command (P1500) is issued.

Some instances when you might want to use a shutdown file are:

- to keep solvent at a very low flow rate flowing through the LC
- to clean the column and keep the pump running
- to clean the column, then stop solvent flow through the LC

CAUTION! If the pump will be operated unattended for an extended period of time, ensure that the solvent reservoir and waste containers have sufficient capacity.

If you use an autosampler, specify the time interval to be longer than the cycle time on the autosampler (*e.g.*, [1.5 x cycle time], or [cycle time + 20 minutes]). If you perform manual injections, set the time interval to the maximum time likely between injections. Depending on your own circumstances, you may wish to turn the Time from Ready to "Off".

P1000 Shutdown Menu

The P1000's Shutdown Menu is shown in Figure 3.10 (a). The Flow field contains the flow rate parameter. The Time field contains 11 preset choices: Off, and ten time values, ranging from 5 to 480 minutes. The value selected in the Time field is the length of time the pump will remain in a READY state before it automatically loads and runs a shutdown file. So, for example, if you select 60 minutes, then whenever the pump senses that it has been READY for 60 minutes without a run being started, it will load and run the Shutdown parameters.

Figure 3.10 (a) The P1000's Shutdown Menu (File), accessed from /OPTIONS/, /Shutdown/

P1500 Shutdown File

The P1500's Shutdown file's Solvent Program, Options, and Timed Events Menus are exactly the same as those for other files with one exception: in the last line of the Options Menu, the display shows a Time from Ready field instead of the Equilibration Time field [Fig. 3.10 (b)].

Minimum Pressure	0
Time from Ready	Off

Figure 3.10 (b) Last lines of the Options Menu of the P1500's Shutdown file

The Shutdown file will be automatically loaded and run if the current run file has not been started, either manually or remotely, in the time specified in the Time from Ready field. There are ten preset times (in minutes) that can be selected in this field: 5, 10, 20, 30, 45, 60, 90, 120, 240, or 480. The Shutdown feature can be turned off completely by selecting "Off." The Time from Ready timer starts as soon as the Status Screen shows READY.

When the Shutdown File Loads Automatically

If the Shutdown file is loaded automatically, the pump will do one of the following when it reaches the last time line of the Shutdown file:

a. (P1000 and P1500) If the flow rate is greater than zero (> 0.0) the pump will maintain (Hold) the last time line's flow rate indefinitely.

b. (P1500) If the flow rate is zero (= 0.0) then the pump stops, and STOP is shown on the Status Screen. In addition, the pump remembers the run file that had been used just before the Shutdown file was automatically invoked, and restores that file to the run file position.

If the Shutdown file is loaded manually (P1500 only, via /FILES/, /Load/), it begins to run immediately. The previously used file is restored to the run file position when the Shutdown file stops.

LOADING A FILE

When you select /Load/ the display shown in Figure 3.11 appears.

```
>Load File   1:(filename)
```

Figure 3.11 The P1500's Load display

Select a file by number (P1500 only), then press [ENTER]. A message will confirm that the file was loaded. A loaded file is referred to as the "run file."

As soon as a file is loaded, the pump will initialize the file, *i.e.*, bring the pump to the conditions specified on the zero (0.0) time line of the file. The Status Screen shows INIT until these conditions are achieved. If an equilibration has been specified, the pump will then show EQUIL until the equilibration time has been reached.

After initialization and equilibration, the Status Screen then shows that the pump is READY. The pump's clock will not start unless a run is triggered either manually by pressing [RUN] or from a properly connected (hardwired) autosampler.

COPYING A FILE (P1500 ONLY)

When you select /Copy/ the display shows (Fig. 3.12):

```
Copy File 1:(filename)
  To File 2:(filename)
```

Figure 3.12 The Copy display

Select both files by number. Press [ENTER] after both files are specified only if you are sure you want to copy the parameters from the top file into the other file. The Copy command overwrites the selected file. Once overwritten, previous values cannot be retrieved. If you do not want to copy a file, leave the display by pressing [MENU] or [STATUS], or the up-arrow key. Press [ENTER] to proceed with the copy operation, and a message confirms its completion.

If you try to copy to a protected file, a message will appear indicating that the file is protected. You will then be returned to the Copy display.

DELETING A FILE

When you select /DELETE/ the display shows (Fig. 3.13):

```
>Delete File 1: (filename)
```

Figure 3.13 The P1500's Delete display

Select a file by number (P1500 only), then press [ENTER]. A message is displayed, asking you to confirm the selection. Press [ENTER] only if you are sure you want to delete the file. Once deleted, a file cannot be retrieved. If you do not want to delete the file, leave the display by pressing [MENU] or [STATUS], or the up-arrow key. A confirmation message concludes a successful file deletion.

When you delete a file you are actually returning all parameters in the file to their default values.

If you try to delete a protected file (P1500 only), a message will appear indicating that the file is protected. You will then be returned to the Delete display.

Purging Solvent Lines

If none of the solvent lines has solvent in it, refer to *Priming the Pump* in Appendix A.

Air will slowly diffuse through the thin-wall Teflon inlet tubing, and into the solvent. If the pump flow has been turned off or if any of the solvent lines from the solvent reservoirs to the switching valve (P1500) have not been used in the past several hours, those lines should be purged with degassed solvent before use.

The purge operation can be activated when the pump is in any state.

CAUTION! Open the bypass valve prior to purging, or else ensure that your chromatographic column can withstand the purge parameters you set before performing any purge.

THE PURGE MENU

Pressing the [PURGE] key brings the Purge Menu to the display (Fig. 3.14 for the P1000, Fig. 3.15 for the P1500).

CAUTION! The Purge Menu is the only menu that can initiate a pump operation simply by moving the cursor between fields in the display! DO NOT move the cursor into the Flow or Time field either using the [ENTER] key or the right-arrow key until your LC is ready to start a purge.

Purge	Flow	Time
FLOW	1.00	0.0

Figure 3.14 The P1000's Purge Menu

Purge	Flow	Time
A	1.00	0.0

Figure 3.15 The P1500's Purge Menu

Purging can be accomplished in either one of two purge modes, flow or pressure. In flow mode, purging is regulated by the flow rate from the pump. In pressure mode purging is accomplished at a specific fluid pressure. Internal limits are designed to protect your LC system: in flow mode, the pump will accept rates of 0.01 to 10.0 ml/min. The maximum pressure the pump allows in flow mode is the maximum pressure value from the current run file; in pressure mode, the maximum flow the pump will reach in attaining the set pressure is 6 ml/min.

NOTE: Purging in pressure mode with the bypass valve open may not allow sufficient pressure to be generated in the system. The pump will operate at maximum flow, but the target purge pressure may not be achieved. Ensure that your analytical column can withstand the purge pressure (or use a flow restrictor or old column), and do not open the bypass valve.

In the P1000 the purge mode is selected from the Purge Menu, in the Purge field.

In the P1500 the purge mode is changed from /OPTIONS/, /More/, Purge Mode, described in Chapter 4.

The top line of the Purge Menu will show either Flow or pressure units (PSI, BAR, MPa), depending on the purge mode you select.

Purge (field)

There are two choices available in the Purge field for the P1500, A, and B. The two choices in the P1000 are FLOW and PRES.

Flow or pressure (PSI, BAR, or MPa)

The flow rate is taken from the last time line of the run file. Use this field to select a flow rate. If the purge mode is pressure, the pressure is automatically set to one-half (50%) of the maximum pressure level set in the run file.

NOTE: To change the purge mode in the P1500 you must go to /OPTIONS/, /More/, Purge Mode. Refer to Chapter 4 for complete information.

Time

The Time field is used to set the length of time you want the pump to purge. If the field remains 0.0, purging, once started, will continue until stopped manually via the [STOP] key.

NOTE: When you check the purge operation from the Status Screen, the time remaining to complete the purge is shown below the word Status.

Starting a Purge

To initiate a purge cycle, move the cursor to the Flow/pressure or Time field by using the [ENTER] key.

The pump will begin to purge solvent as soon as the cursor enters the Flow/pressure or Time field. If the time stays set to 0.0, purging will continue until you press [STOP], or a file is initialized. If a time is entered, the pump will purge until the time set. After completing a purge, the pump automatically initializes the run file.

When running in a timed purge mode, the Status Screen will indicate the time *remaining* to purge (*i.e.*, counts backwards toward 0.0). If the [PURGE] key is pressed once more, the Purge Menu is again displayed and the time countdown continues, uninterrupted, unless the cursor is moved to the Flow/pressure field, at which point the timer will be reset and purging will restart as soon as the cursor leaves the Flow/pressure field.

The pump will retain the selections made in the PURGE display as long as the power to the pump is on.

Stopping a Purge

There are three ways to stop a purge cycle:

- Press the [STOP] key
- Load (initialize) a file by selecting a file using /FILE(S)/, /Load/
- Allow the pump to complete the purge (if a time has been specified), at which point the pump will automatically initialize the last run file.

Running the Pump

To perform a run:

- purge the solvent lines if necessary
- establish a READY state (may require the pump to INIT, and/or EQUIL)
- inject the sample, and
- press [RUN].

If you are performing a manual injection, fill the injection loop, check that the Status Screen shows READY, inject the sample, and press [RUN] in succession. If an autosampler is hardwired to the pump, simply initiate the autosampler run sequence.

NOTE: Generally, when operated manually, if the pump is stopped (i.e., the Status Screen shows STOP), the run file can be initialized by pressing [RUN], and then started by pressing [RUN] again when the Status Screen shows READY.

ESTABLISHING READY

The READY state means that the pump has reached the conditions specified on the first line of the solvent program and is ready to start a run.

Initializing a file

To achieve the READY state, initialize a run file, by any of the following methods:

- Load a file by selecting /FILE(S)/, /Load/, a file number, then pressing [ENTER]. This simultaneously loads the run file and initializes it.
- If the pump is stopped (Status Screen shows STOP), press [RUN]. This initializes the run file, without starting the run.
- If the pump is stopped or in run, reset the run file by selecting /COMMANDS/, /Reset/. This initializes the run file without starting the run. (P1500 only)

Wait for the pump to reach zero time line conditions. If an equilibration time was specified in the file, the Status Screen will show EQUIL for this period of time.

PRESSING [RUN]

As soon as the pump shows READY, begin the run by pressing the [RUN] key. This starts the pump's clock.

CAUTION! Even though the pump may be ready, your column and the rest of your LC system may not be! Take into account your own LC application and ensure that your column is at chemical equilibrium and that the other instruments in your system are ready before your proceed with any injection.

As soon as the [RUN] key is pressed, the pump begins to operate based on the time lines in the Solvent Program of the run file, and the Status Screen is displayed. The Status field shows the time into the run. Status is fully described on page 34.

STOPPING THE PUMP

There are a number of ways to stop the pump, depending on what you wish to do next. More information regarding the Commands Menu (P1500 only), referred to below, is found on page 33.

Using a Hold Command

If you want to stop the pump's clock momentarily (but not stop solvent flow), and plan to resume the run where it was stopped, press [MENU], and select /COMMANDS/, /Hold/. To resume, select /COMMANDS/, /Continue/.

By Resetting the Pump's Clock

If you want to restart the current run, press [MENU] and select /COMMANDS/, /Reset/. This stops the pump's clock and returns to the zero time line, automatically initializing the file. Restart the run by pressing [RUN] after the pump shows READY.

By Pressing [STOP]

If you want to completely stop the pump, press [STOP]. This aborts the run and stops solvent flow through the pump. If you want to resume with the same file, you must initialize the run file by pressing [RUN], waiting for the pump to show [READY], then pressing [RUN] again.

WHILE THE PUMP IS RUNNING

There are several messages which can appear in the Status field. These are discussed in detail in the *Status* section below.

While the pump is running you may do several things without disturbing pump operation:

- edit files (/FILE(S)/, /Edit/).
- check some pump performance parameters.
- edit the run file from the Status Menu. (This has an effect on the current run - see page 36 for more information.)

The Commands Menu (P1500 only)

The Commands Menu (P1500) is reached by pressing [MENU] and selecting /COMMANDS/.

When /COMMANDS/ is selected the display shows (Fig. 3.16):

```
>Reset
•Hold
```

Figure 3.16 The Commands Menu

RESET

Reset is used when the pump is in RUN and you want to abort the run without stopping the pump's flow. Reset reinitializes the file (*i.e.*, resets the timer to zero). The result is that the pump reestablishes the conditions of the zero time line, and returns the pump to a READY state. Pressing [RUN] restarts the run.

HOLD/CONTINUE

Hold is used to stop and hold the pump's clock. It causes the pump to maintain the operating conditions used at the moment the Hold command was issued, including flow rate. These conditions are maintained indefinitely unless:

- A Continue command is used from the Commands Menu, at which point the timer continues from the point at which it was held.
- The [STOP] key is pressed.
- The Reset command is selected.

Whenever a Hold command is issued, the word Continue will replace the word Hold in the Commands Menu.

To select any of the commands on the Commands Menu, move the cursor to the desired line, and press [ENTER] to issue the command. The display returns to the Status Screen.

Status

The Status Screen appears whenever the pump is powered on, a file is initialized, or the [STATUS] key is pressed. The Status Screen, consisting of two lines, shows the pump's current operating values. Below the Status Screen is the Status Menu, where you can view and, if necessary, edit parameters of the run file.

STATUS MESSAGES

The P1000's and P1500's Status field of the Status Screen can show any of the following messages:

(time)	The time into the run (or time remaining if a timed purge).
EQUIL	The pump is equilibrating the LC by maintaining the conditions on the first line of the run file for the equilibration time specified in the file. *(P1500 only)*
HOLD	/COMMANDS/, /Hold/ has been selected. The pump is maintaining the conditions that existed when the Hold command was issued, including the flow rate. To continue, select /COMMANDS/, /Continue/.
INIT	The pump is initializing a file.
Q *(time)*	The file listed in Order 1 of the queue is running. The time into the current run is shown. *(P1500 only)*
QEQUIL	The pump is equilibrating the LC based on a file listed in the queue. *(P1500 only)*
QINIT	The pump is initializing a file in the queue.
QREADY	A queue has been loaded and the run specified in Order 1 can be started. *(P1500 only)*
Q RUN	Appears briefly when a queue is run. *(P1500 only)*
QSTOP	A run listed in the queue has been stopped. *(P1500 only)*
READY	The pump has achieved the conditions on the first line of the run file, and the equilibration time has elapsed (if set). A run can be started.
RUN	Appears briefly when the pump begins a run.
STOP	All mobile-phase flow through the pump is stopped.

SYNC	This is a remote communications message that appears briefly whenever a run is started.
U RDY	The pump is READY, but flow is unstable.
U RUN	The pump is in RUN, but flow is unstable.

STATUS EXAMPLES

Shown below are two examples of an entire Status Screen and Status Menu; one for the P1000 and one for the P1500.

P1000

```
Status                  Flow                    PSI
 READY                  1.00                   1250 ▼
-------------------------------------------------------
Flow                    MaxP                    MinP
1.00                    6000                       0
```

Figure 3.17 Example P1000 Status Screen and Status Menu

The first and second lines of the display show the state, flow, and pressure.

P1500

```
Status          Flow          Solv    PSI
  STOP          1.00             A     0▼
-------------------------------------------------------

File 1:EXAMPLE
Time            Solv                  Flow
 0.0              A                    1.00
 1.0              B                    1.00
 2.0              A                    1.00

Maximum Pressure                      6000
Minimum Pressure                         0
Equilibration Time                     0.0
>Save File
(appears only if the run file is changed)
```

Figure 3.18 Example P1500 Status Screen and Status Menu

The first and second lines of the P1500's Status Screen show the state, flow, selected solvent, and pressure.

EDITING A RUN FILE

The remaining lines, which comprise the Status Menu, show the parameters and options of the run file. If the run file and options do not appear, the Status Lock feature has been turned on. (Status Lock is described in Chapter 4, under the OPTIONS, More Menu.)

All time lines of the run file's solvent program may be edited while the pump is running, as may the maximum and minimum pressures, and the equilibration time. Any changes take effect as soon as the cursor leaves each field. However, the changes are saved only when the /Save File/ command is selected from the Status Menu. (Below Equilibration Time, P1500 only.)

If you change the parameters of a P1500's run file from the Status Menu, you must select /Save File/ in order for the pump to remember your changes. The pump will, however, use your changes until the next time the file is initialized either via a /FILE(S)/, /Load/, via a remote run command, or via the queue.

HINT: (P1500 only) Any time the parameters of the Run File are changed, the /Save File/ command will appear at the bottom of the Status Menu. Note that you cannot save changes using the /Save File/ command if file protection for that file has been turned "On."

Use the same methods described on page 22 and on page 23 to edit the parameters of a run file. In the P1500 new lines may be added to the run file. Timed events may only be edited via /FILES/, /Edit/, /Timed Events/, and will not take effect until the file is reloaded.

Monitoring Pump Performance

You may ask, "How do I know my pump is performing properly?"

The pump has the capability to automatically monitor its own performance and warn you if a flow problem exists. How the pump responds to conditions such as unstable flow are set in the Error Recovery menu of OPTIONS, selected from the Main Menu. These options (not to be confused with File Options), are described in detail in Chapter 4.

Certain flow conditions are monitored continuously. If unstable flow conditions exist (or if the pump runs out of solvent), the pump responds with the appropriate error message:

```
! !  UNSTABLE FLOW  ! !
```

or,

```
! !  OUT OF SOLVENT  ! !
```

Figure 3.19 Two error messages

The out of solvent condition causes the pump to shut off immediately. However, as mentioned earlier, you can select the pump's response to Unstable Flow (Chapter 4, Options section).

The pump can also initiate a Flow Stability Test. This test is run by selecting /TESTS/, /Diagnostics/, /Flow Stability/. The results are continuously displayed until another key is pressed. The results consist of two parts. The first is a summary of the performance evaluation (STABLE, ACCEPTABLE, or UNSTABLE) and the second is a number that indicates a position in each range. Further explanation of this test can be found in Appendix C.

Shutting Down at the End of the Day

Some shut down suggestions when you conclude your work with the pump for the day:

- Do not leave buffers in the pump or in your LC; purge the pump (H_2O is a good solvent) if it has just concluded a run using buffered solutions. (Don't leave H_2O in your LC.)
- Leave the column full of a solvent recommended by the column manufacturer.
- Open the column bypass valve and purge using the same solvent as in the column so that the liquid ends are filled with that solvent.
- Make use of the Shutdown file. The pump will automatically maintain the conditions specified on the last line of the file. This is particularly useful if you prefer to have a small but continuous flow of solvent through your LC system while it is idle.

4 Advanced Operations

Introduction

This chapter focuses on two menu items: Options, used to set important, yet seldom-changed features, and Queue, used to build a list of files to run. Queue is found only in the P1500 pump.

The Options Menu

The Options Menu (accessed from the Main Menu, not from /FILES/), contains seldom-changed features such as the pump's response to certain electrical and flow conditions it detects, user-selected display and operational preferences, and file protection.

```
FILES                    QUEUE                    TESTS
        COMMANDS                          >OPTIONS
```

Figure 4.1 The P1500's Main Menu with /OPTIONS/ selected

The P1500's Options Menu is shown in Figure 4.2.; the P1000's Options Menu is shown in Figure 4.3.

```
>Error Recovery
•More
```

Figure 4.2 The P1500's Options Menu

```
>Shutdown
•Error Recovery
------------------------------------------------
•More
```

Figure 4.3 The P1000's Options Menu

The Error Recovery and More Menus are common to both the P1000 and P1500 pumps. The Shutdown feature is similar to the P1500's Shutdown file.

ERROR RECOVERY MENU

The pump continuously checks flow stability and pressure so that problems can be indicated on the display immediately. The pump can also sense a power failure or power interruption. The Error Recovery Menu (Fig. 4.4) is used to preset the pump's response to detecting error conditions in any of these three operating parameters.

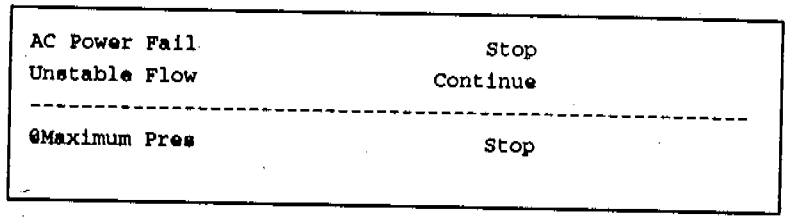


Figure 4.4 The Error Recovery Menu

Each field in the Error Recovery Menu can be set to one of three selections:

Selection	Pump's Response
Stop	The pump stops immediately if the condition is encountered.
Continue	The pump continues as if the condition had not occurred.
Shutdown	The pump immediately stops, then loads and runs the Shutdown file.

AC Power Fail

The pump may sense a power interruption at any time. Select Stop, Continue, or Shutdown in the AC Power Fail field to stop, continue, or shut down the pump as soon as power is restored.

NOTE: If the power switch is turned off while the motor is running, the pump considers this a power failure and will respond accordingly as soon as power is restored.

Unstable Flow

The pump continuously monitors the solvent flow. There are three specific flow conditions that the pump can sense: stable flow, which corresponds to a reading of 0 - 25 (unit-less), acceptable flow (26 - 90), and unstable flow (> 90). If the pump senses that the flow is unstable, it will respond according to your selection. Select Stop, Continue, or Shutdown in the Unstable Flow field to set the pump's response if it senses unstable flow.

@Maximum Pres

In a file's Options Menu, you can change the maximum pressure level (the default is 6000 psi). If the pump's operating pressure ever exceeds this value, the pump will operate based on your selection in the @Maximum Pres field. Select Stop, Continue, or Shutdown to set the pump's response to sensing operation at maximum pressure.

MORE MENU

To access other options, select /More/ (Fig. 4.5).

```
•Error Recovery
>More
```

Figure 4.5 Selecting /More/

The More Menu (Fig. 4.6) contains additional, miscellaneous, user preferences, such as the units the pressure is displayed in and how quickly field choices scroll when the [+] and [-] keys are pressed and held.

Pressure Units	PSI
Purge Mode	Flow
Cursor Speed	Medium
Status Lock	Off
Ready Output Active	Hi
File Name	Protect
1: *(filename)*	Off
2: *(filename)*	Off
3: *(filename)*	Off
4: *(filename)*	Off

(The P1000's More Menu does not contain the File Protect fields shown in the last 5 lines above)

Figure 4.6 The P1500's More Menu

Pressure Units

Select either PSI, BAR, or MPa as your preferred units. All menus and screens that show pressure units will reflect the selection.

Purge Mode

Select either Flow or Pressure in the Purge Mode field. Your selection is reflected on the Purge Menu and is used as the primary purge parameter. Select Flow if you wish to purge based on a flow rate, or Pressure if you want to purge based on an operating pressure.

Purging in pressure mode requires a certain amount of back pressure in the system. Ensure that your analytical column can withstand the purge pressure (or use a flow restrictor or old column), and do not open the bypass valve.

NOTE: The P1000's purge mode may be selected directly from the Purge Menu.

Cursor Speed

Cursor Speed is used to change how quickly choices scroll on the display when the [+] and [-] keys are pressed and held, and how quickly a menu scrolls (up and down) when the arrow keys are pressed and held. Select Fast, Medium, or Slow.

Status Lock

Status Lock prevents a run file from being edited from the Status Menu. When Status Lock is On in the P1500, the Status Menu only shows the run file name (and number). The rest of the run file cannot be accessed.

NOTE: (for P1500 users) Status Lock is different from File Protection (below). A protected file cannot be saved from the Status Menu (using the /Save File/ command), although it can be viewed (from the Status Menu), nor can it be edited from /FILE(S)/. Status Lock, on the other hand, prevents a run file from being seen (and hence edited) from the Status Menu. The file remains editable from /FILE(S)/.

The Status Screen is unaffected by Status Lock; it can always be viewed.

Ready Output Active

The Ready output, located on the back of the pump, continuously sends an electrical signal to any device hardwired to it. Use the Ready Output Active field to choose whether the signal is either a 5V signal (Hi) or a 0V signal (Lo) whenever the pump is in a READY state. If the pump is not READY, the other signal is output. Whenever the pump's Ready Output is hardwired to a SpectraSYSTEM autosampler to coordinate injections, it should be set to provide "Hi" voltage in the READY state.

File Protection (P1500 only)

Each numbered file can be safeguarded against accidental or unauthorized changes by turning on the file protection feature. When File Protection for a specific file is turned On, that file cannot be edited, deleted, or copied to. Initially, all files are editable (file protection is Off.) Use the [+] or [-] key to select Off or On in the Protect field.

SHUTDOWN MENU (P1000 ONLY)

The Shutdown Menu (Fig. 4.7) contains the parameters the pump uses after it has been in a READY state, without a run being started, for a specified length of time. More information about the Shutdown Menu is found in Chapter 3, page 25.

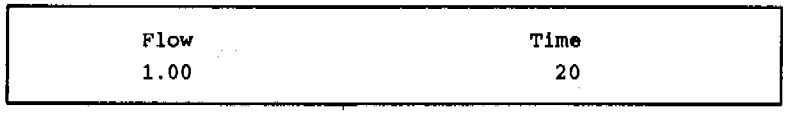


Figure 4.7 The Shutdown Menu

The Queue Menu (P1500 only)

The Queue Menu (P1500 only) is used to edit, load or delete a chronological list of files the pump will run, and the number of times each file is run. By linking several files together by means of a queue you can match specific pump files with injections in your sequence. Any regular file (numbers 1 - 4) can be put into the queue. (The Shutdown file is not queue-able.)

You can create a queue with as many as ten lines. Access the Queue Menu by pressing [MENU] and selecting /QUEUE/ (Fig. 4.8).

Figure 4.8 The Main Menu, showing /QUEUE/ selected

When you select /QUEUE/ the display shown in Figure 4.9 appears.

Figure 4.9 The Queue Menu

This section describes how the queue works, and how to edit, load, delete, and run a queue. It also explains how a running queue can be paused, stopped, or edited.

HOW THE QUEUE WORKS

The pump looks at the first line of the queue to determine which file to run. It then runs that file as many times as specified, with each run being initiated by a manual or remote RUN command.

To use the queue:

1. Edit the Queue.
2. Load the Queue.
3. Initiate the [RUN] (manually or remotely), each time a new injection/run needs to be started.

The pump will run based on the files listed in the queue. For the example queue shown in Figure 4.10, the pump would run File #4 ten times, then File #2 five times, and then File #1 twenty times, for a total of 35 runs. Note that the file number is not the same as the file's Order (chronological position) in the queue.

Order	File:Name	#Runs
1	4:*(filename)*	10
2	2:*(filename)*	5
3	1:*(filename)*	20

Figure 4.10 An Example Queue

Editing, loading, and deleting a queue are explained on the following pages.

EDITING THE QUEUE

To view, build, or change the queue, select /Edit/. A display similar to Figure 4.11 appears.

```
Order          File:Name                          #Runs
1              #:(filename)                       (1-999)
-------------------------------------------------------
```

Figure 4.11 The Queue's Edit Menu

Order

The Order field is not editable. As you add more lines to the queue, this field automatically displays the numerical order of lines in the queue.

File:Name

The File:Name field is used to select the name of each file to be run. Use the [+] / [-] keys to select one file for each line.

#Runs

The #Runs field is used to enter the number of times you want a particular file to be run before the next file (Order 2) is loaded.

Adding Lines to the Queue

Once the File:Name and #Runs fields for Order 1 are filled in, you can add an additional line to the queue by pressing the down-arrow key or [ENTER]. The cursor will move to the Order 2 line. For each line that you add, select a file name and enter a value for the number of times you want the file to run. You may add as many as nine lines (for a total of 10 lines).

```
Order          File:Name                          #Runs
1              #:(filename)                       (1-999)
-------------------------------------------------------
2              2:EXAMPLE                          5
```

Figure 4.12 Adding lines to the queue

HINT: You may repeat a file name several times in the queue, if you wish.

Deleting Lines from the Queue

To delete lines from the queue, put the cursor in the File:Name field, and press [-] until the File:Name field is blank. The remaining entries will be re-sorted as soon as the cursor is moved off the line.

LOADING THE QUEUE

The Queue Menu's Load command simultaneously loads the queue into the pump and begins running the queue by initializing the file in Order 1. When /Load/ is selected, the display prompts you to confirm the operation (Fig. 4.13). Press [ENTER] if you wish to proceed. (If you do not want to load the queue, exit the display by pressing [MENU], or [STATUS], or the up-arrow key.) A confirmation message will appear, completing the load operation.

Figure 4.13 Loading the queue

If you load a queue while another file is running, the queue will immediately take over the pump's operation. The Order 1 file becomes the run file and is initialized.

Once the queue is loaded, you are returned to the Status Screen. The Status Screen will show QREADY, as soon as the pump is ready to begin a run using the file specified in Order 1.

DELETING THE QUEUE

The Queue Menu's Delete command is used to erase the *entire* queue. When /Delete/ is selected, the display prompts you to confirm the operation (Fig. 4.14). Press [ENTER] only if you wish to delete the *entire* queue. A confirmation message completes the operation.

If you do not want to delete the queue, press the up-arrow key, or [STATUS] or [MENU].

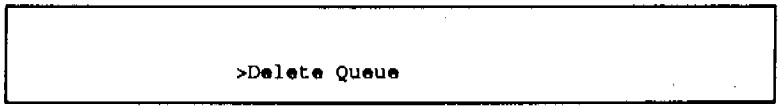


Figure 4.14 Deleting the queue

If you only want to delete certain *lines* of the queue, use the Edit Menu. Refer to the paragraph *Deleting Lines from the Queue* on page 45 for more information.

You can delete the queue at any time, regardless of whether or not it is running. If you delete a running queue, the current run is completed. The file that had been in Order 1 remains as the run file.

NOTE: Deleting a queue has no effect on the files themselves; it simply erases the list of files.

The contents of the queue is lost whenever the pump is switched off or a power failure occurs. The file that had been in Order 1 will be the run file when power is restored.

RUNNING A QUEUE

To run a queue, simply load it by selecting /QUEUE/, /Load/. When the pump's Status Screen shows QREADY, you can begin running the first file in the queue by pressing [RUN] or by having another LC instrument trigger the run. The pump will continue to run the file in Order 1 each time a new run is started, until it has been run the number of times specified in the #Runs field. The pump then loads the file designated in Order 2 and uses that file the number of times specified in that line, and so on, until the entire queue has been run.

CHECKING A QUEUE'S PROGRESS

You can track the progress of a running queue from the Queue Menu. To view the progress of a running queue:

1. Press [MENU].
2. Select /QUEUE/. Notice that when a Queue is loaded, the Queue Menu (Fig. 4.15) changes. The /Load/ selection is replaced by /Pause/.

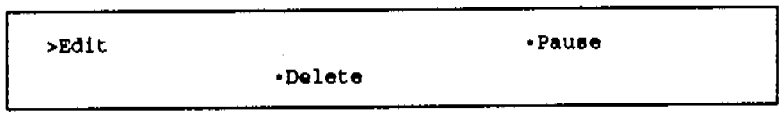


Figure 4.15 The Queue Menu when a queue is loaded (running)

3. Select /Edit/ to view the running queue. The display will look similar to Figure 4.10.

While the queue is running, you can see the #Runs field automatically decrease by one with each run (injection). When the last run is made for a file, the queue is automatically re-sorted. The information for Order 2 is moved up to Order 1, and the information for Order 3 is moved up to Order 2. This process continues until the queue becomes empty, is paused, or is deleted.

You can also see the progress of the current run in the queue from Status. When a queue is running, a Status Screen similar to Figure 4.16 will be displayed. Note that the Status Screen shows the letter Q, followed by the time into the run.

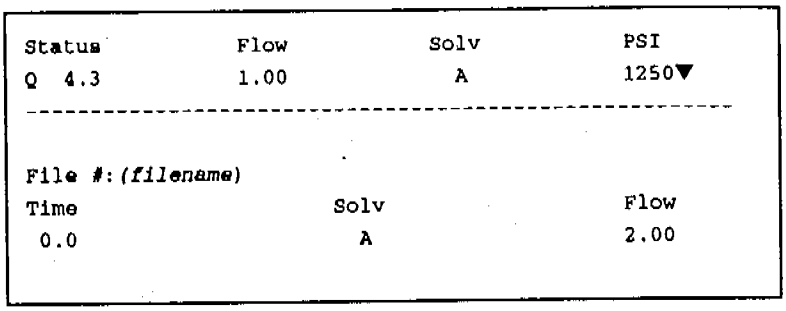


Figure 4.16 A P1500 Status Screen when a queue is running

As always, the Status Menu shows the run file. The run file can be edited from the Status Menu (if Status Lock is Off), as normal.

EDITING A RUNNING QUEUE

You can edit a running queue in order to add, delete, or edit lines (File, #Runs). All lines of a running queue except the Order 1 line are editable. Refer to the procedure outlined in the Edit section on page 45 to edit the queue. If you need to make a change to the Order 1 line of a running queue, you must first pause the queue as described in *Using a Pause Command* on page 49. Note that the pump will always finish the current run before pausing.

EDITING A FILE IN THE QUEUE

You can edit any file in the queue that has not yet been run by selecting /FILES/, /Edit/. Since the pump only loads the file in Order 1 once, any changes made to the file specified in Order 1 do not take effect while the queue is running. If the same file is specified later in the queue, then the changes will be recognized, since the edited file is loaded at a later time. To edit the file shown in Order 1, you can either edit the run file from the Status Menu, or pause the queue (see page 49) then edit the file. If you pause the queue (and the #Runs for Order 1 is greater than 1), the edited file will be loaded as soon as the queue is re-loaded.

LOADING OTHER FILES

When a queue is running, you may not load any other file from the Files Menu without first pausing or deleting the queue. If you try to load a file while a queue is running, the information message shown in Figure 4.17 appears. You are then returned to the Files Menu. As described on page 49 you can load another file *into the pump* by first pausing the queue. You can load another file *into the queue* by editing the queue.

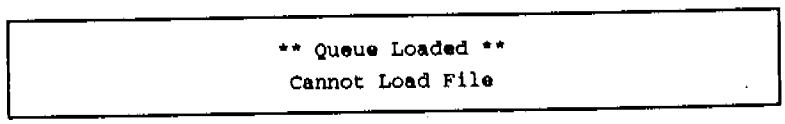


Figure 4.17 File load error message when the queue is loaded

STOPPING A QUEUE

There are several ways to stop a queue, depending on what you wish to do next.

NOTE: You do not need to stop the queue in order to edit it.

Using a Hold Command

If you want to stop the pump's clock momentarily and plan to resume the run in the queue, press [MENU], and select /COMMANDS/, /Hold/, to hold the pump at the current parameters. The pump will hold until a Continue command is issued.

To resume, select /COMMANDS/, /Continue/.

Using a Pause Command

If you want to finish the current run, but then pause the queue so that the pump can run another file, or so that you can edit the Order 1 line of the queue, press [MENU] and select /QUEUE/, /Pause/. The /Pause/ selection is only present if the queue is running. Remember, you can always edit the queue itself to move a particular file into the queue, but you cannot edit the first line of the queue if the queue is running. Whenever the queue is paused, the letter Q will disappear from the Status Screen.

Use /Pause/ if you need to interrupt the running of a queue for the purpose of relegating the pump to another task.

To resume running the queue, re-load the queue by selecting /QUEUE/, /Load/. When the Status Screen shows QREADY, press [RUN] to start the queue.

By Pressing [STOP]

You can stop the current run in the queue by pressing the [STOP] key. The pump will immediately stop, and the clock will be reset to zero. You may restart the same run by initializing the run file by pressing [RUN]. (The run file will be the last file in Order 1 - remember, the queue automatically re-sorts the queue after all the runs of a file have been performed.) When the pump shows QREADY, restart the run as you normally would. The pump continues its operation based on the queue.

By Resetting the Pump's Clock

Another way to reset the pump's clock and to restart the current run is to press [MENU] and select /COMMANDS/, /Reset/. When the Status Screen shows QREADY, restart the run by pressing [RUN].

By Aborting a Queue

You may abort the queue by deleting it. To do this select /QUEUE/, /Delete/. The current run of a deleted queue will be completed and the file in Order 1 will remain the run file.

5 Purchased Kits and Accessories

Introduction

This chapter contains unpacking lists and information for several kits and accessories available from Spectra-Physics Analytical for use with your SpectraSYSTEM pump. Described in this chapter are:

- Manual Injection Valve Bracket Kit (also included with A4052-010, the Rheodyne 7125 Standard Bracket Kit, and A4053-010, the Rheodyne 9125 Inert/Biocompatible Bracket Kit, both of which include an injection valve) p/n A4054-010
- Standard LC Fittings Kit p/n A4051-010
- Inert/Biocompatible LC Fittings Kit p/n A4061-010
- Piston Flush Seal Kit (10 ml) p/n A4114-010
- Solvent Inlet Tube Kit p/n A4074-010
- Solvent Tube Extension Kit p/n A4117-010

Complete information for installing and using the SCM400 vacuum degasser and the SHM helium manifold is found in the *Solvent Degassers Reference Manual*, included with those products.

Maintenance kits are described in Chapter 6, *Required Maintenance*, except the Piston Flush Seal Kit, which is described here.

Manual Injection Valve Bracket Kit

UNPACKING

Your kit consists of:

1	11-3/16 inch steel mounting rod
2	rod brackets
2	short column brackets
2	long column brackets
1	manual injector valve mount
4	short set screws (6-32 x 1/4-inch)
2	flat-head screws (8-32 x 3/8-inch)
2	screws (6-32 x 7/16-inch)
2	long set screws (6-32 x 5/8-inch)
1	Allen wrench (1/16-inch)

If you purchased a Rheodyne valve (standard or inert/biocompatible), you also received the valve, accompanied by Rheodyne's documentation.

Installing the Holder onto the Valve

Refer to Figure 5.1. To install the valve onto the bracket:

1. Move the injector valve handle to the "LOAD" position. Using the Allen wrench supplied with your Rheodyne valve, loosen the two set screws and remove the injection valve handle.
2. Hold the valve mounting bracket so that the two set screw holes are on the left. Place the injector valve into the bracket from the rear. If your injector valve has a remote start cable attached to it, place the cable into the cut-out on the left side of the bracket. When aligned correctly the "V" made by the two flats of the valve shaft will point to the upper left-hand mounting hole.
3. Fasten the valve securely with the two flat-head (Phillips) screws.
4. Attach the handle to the valve by tightening the two set screws, making sure that each screw is positioned over a flat edge of the valve shaft.
5. Install a long (5/8-inch) set screw into each of the valve bracket's mounting holes.
6. Install the rod through the valve bracket so that the notched portion of the rod faces you, as you look at the front of the injection valve.

7. Slide the valve bracket so that it is within the top quarter of the rod. Tighten the two set screws, securing the valve bracket to the rod.
8. Brackets for long (22 cm - 25 cm) and short (3 cm - 10 cm) columns are provided. Choose the bracket size that matches the type of column you use. Both brackets can be mounted, if desired.
9. Install a short (1/4-inch) set screw into each column bracket you wish to use. Slide the brackets onto the rod. Refer to Figure 5.1 for positions. Temporarily tighten the set screws to hold the brackets in place.
10. Remove the two top cover screws from the right side of your SpectraSYSTEM pump or detector. Install a rod bracket into the lower hole, using a 7/16-inch Phillips-head screw.
11. Rest the rod in the lower rod bracket (with the injector valve facing toward the front) and place the upper rod bracket on top of the rod. Attach the upper rod bracket to the pump or detector, using the other 7/16-inch screw.
12. Re-position the column brackets or manual injector valve as needed, and tighten the set screws.

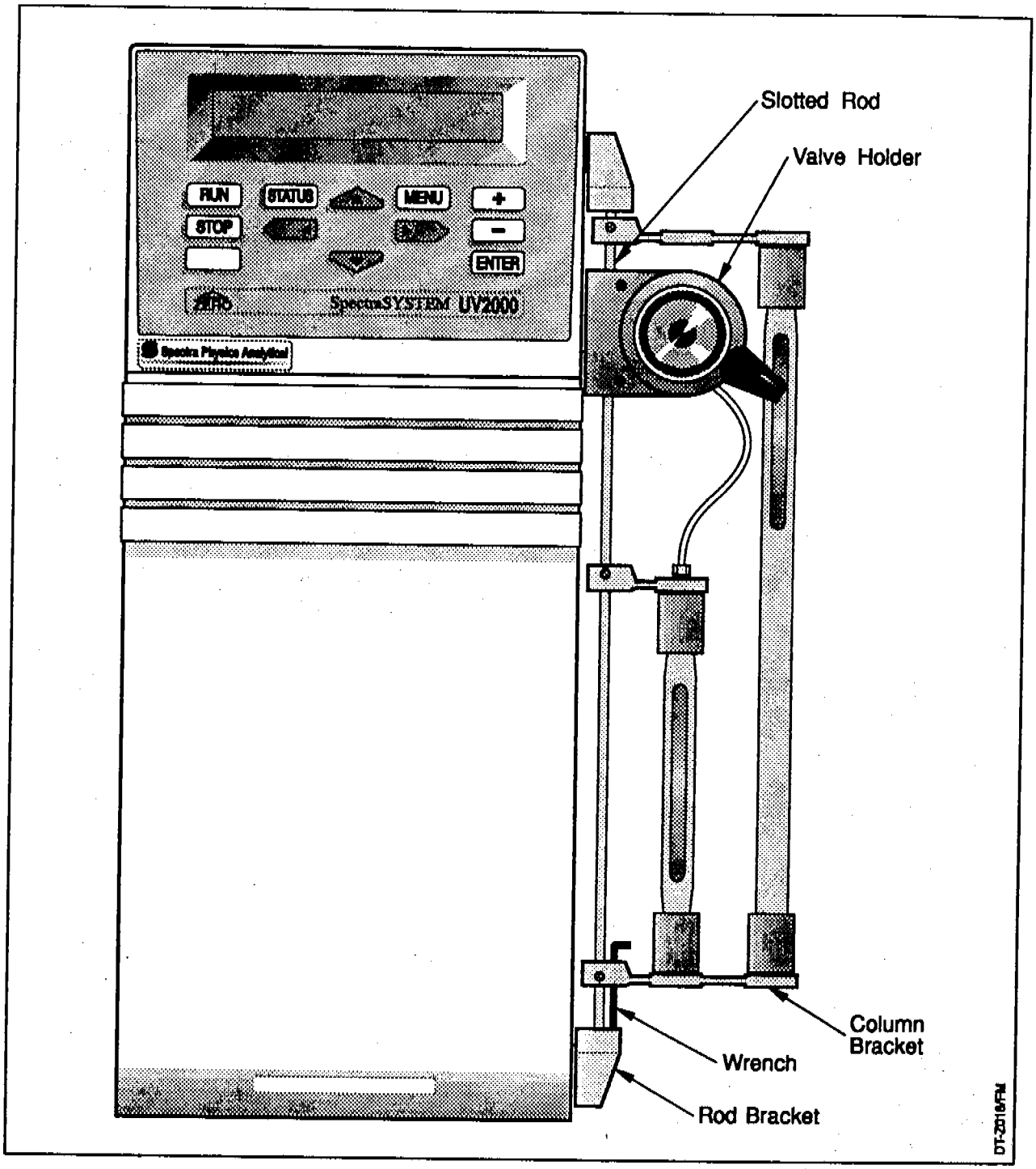


Figure 5.1 Manual Injection Valve/Column Bracket mounted to a SpectraSYSTEM instrument

Standard LC Fittings Kit

UNPACKING

Your kit consists of:

1 storage/carrying case
1 120-inch piece Teflon tubing (0.063-inch ID) (305 cm length)
2 adapter fittings (10-32M)
4 Rheodyne nuts/ferrules
4 Parker type nuts/ferrules
3 wrenches (sizes: 1/4" - 5/16", 3/8" - 7/16", 1/2" - 9/16")
1 1/8-inch tube adapter for gas regulator
assorted tubing: stainless steel 0.020-inch ID
stainless steel 0.010-inch ID

Fittings kits contain tubing and fittings commonly needed for LC systems. These fittings can be used for several different instruments. If you change your LC configuration or damage connections, the fittings provided in this kit should allow you to make changes or replacements quickly and easily. All fittings can be kept in the compartmentalized storage box.

Inert/Biocompatible LC Fittings Kit

UNPACKING

Your kit consists of:

1 storage/carrying case
1 120-inch piece Teflon tubing (0.063-inch ID)
6 finger-tight nuts/ferrules, PEEK
2 nuts/ferrules; steel nut, PEEK ferrule, high pressure
1 1/8-inch tube adapter for gas regulator
1 PEEK tubing, 0.020ID x 60-inch (152 cm length)
1 PEEK tubing, 0.010ID x 60-inch (152 cm length)
3 wrenches (sizes: 1/4" - 5/16", 3/8" - 7/16", 1/2" - 9/16")
1 tubing cutter
3 PEEK tubing, 0.010ID x 4-inch (10 cm length)
1 PEEK tube, 0.010ID x 24-inch (61 cm length)

Piston Flush Seal Kit (10 ml)

UNPACKING

The 10 ml/min Piston Flush Seal Kit is a maintenance kit. Piston flush seals are installed in the low-pressure side of the seal holder (the side facing the piston holder housing), inside the liquid ends. (Refer to Figure 6.17 on page 75) The piston flush seals typically do not need to be replaced as frequently as piston seals. The maintenance interval for the piston flush seal is not related to the volume of mobile phase pumped. We recommend replacing this seal once a year.

Your kit consists of:

1	piece tubing, 30-inch, Tygon® (76 cm length)
1	barbed fitting (nylon)
2	piston flush seals
1	seal removal tool
1	seal insertion tool

The replacement procedure below assumes that the pump head(s) have already been removed. For a description of pump head removal refer to *Quick Piston Seal Maintenance* in Chapter 6, page 67. Skip the steps that describe *piston seal* replacement. (You need to replace the *piston flush seal.*) If necessary, refer to the figures in Chapter 6 as you replace the piston flush seal.

To replace the piston flush seal:

1. Remove the seal holder on each pump head by grasping its exposed top and pulling gently.
2. Use the seal removal tool to remove the piston flush seal from the seal holder. (The seal holder can remain inside the pump head.)
3. Insert a new piston flush seal into the seal holder (spring side down). The piston flush seal is thicker than a piston seal. The seal holder's cavity on the piston flush seal side is deeper to accommodate the larger size.
4. Ensure that the piston flush seal is flush with the edge of the seal holder. Use the large end of the seal removal tool to push the seal into the holder.

5. Place the holder/pump head combination carefully onto the piston and into position.
6. Install the 9/64-inch cap screws and tighten evenly and firmly. (Forty inch-pounds is recommended.)
7. Purge the pump at 3000 - 4000 psi with methanol for five minutes to condition the seals and cleanse the pump.

NOTE: We suggest you use an old column or flow restrictor for seal conditioning, or purge with the bypass valve open to avoid damage to your analytical columns.

Solvent Inlet Tube Kit

UNPACKING

Your kit consists of:

1	bottle cap assembly, with Cheminert® fittings, solvent filter, vent line and inlet tube.

Solvent Tube Extension Kit

UNPACKING

Your kit consists of:

4	60-inch extension tubing, with washer and union (152 cm length)

6 Required Maintenance

Introduction

When properly maintained, your SpectraSYSTEM pump will provide years of trouble-free operation. It is important that your pump receive routine preventive maintenance to ensure reliability and optimum performance. Properly performed routine, preventive maintenance also helps keep your warranty valid. Your pump is designed to encourage proper maintenance by making maintenance parts easy to access, replace and record.

This chapter describes the Maintenance Log Menu and how to use it. Some hints to help you extend the maintenance period of your pump are also included. Easy-to-follow, step-by-step required maintenance procedures are also contained in this chapter so that you can keep your pump in optimum working condition. A few maintenance tips for parts of the pump not directly involved with solvent flow follow the maintenance procedures. The last section contains replacement procedures for two user-serviceable parts: fuses and the solvent switching valve.

NOTE: Maintenance of the pump is the responsibility of the user. Routine maintenance is not provided under warranty. However, planned maintenance contracts are generally available. Please contact your local representative if you are interested in purchasing a planned maintenance contract.

THE BENEFITS OF PROPER MAINTENANCE

As with most things, there is tremendous benefit in doing things right the first time. For example, an unusually fast seal failure may indicate either incorrect installation or a scratched piston. A scratched piston may be caused by improper installation of the seal or piston, by allowing the pump to sit idle with a buffered eluant in it, or by failing to filter your eluants. The recommendations in this manual are based on many years of experience and should provide you with valuable guidance in the use of your equipment.

Maintenance Log

The Maintenance Log provides a convenient way for you to record maintenance performed on the liquid ends and set intervals for periodic maintenance. When a maintenance interval has been exceeded the pump will automatically display a message indicating that maintenance may need to be performed.

MAINTENANCE LOG MENU

The Maintenance Log is accessed by selecting /TESTS/ from the Main Menu, then selecting /Maintenance Log/ (Fig. 6.1 and Fig. 6.2).

```
•FILES          •QUEUE          >TESTS
      •COMMANDS          •OPTIONS
```

Figure 6.1 Main Menu with TESTS selected

```
•Software Version
•Diagnostics
-------------------------------------------------
>Maintenance Log
•Calibration
•Service
```

Figure 6.2 Tests Menu with Maintenance Log selected

The Maintenance Log Menu (Fig. 6.3) consists of a table, used to record dates and volumes, followed by one field used to enter a value relating to flow, and two additional menu items. All of these are described in this section.

```
ITEM        DATE        DUE         VOL
Seal1     8 AUG91       200         201
-------------------------------------------------------
Seal2     8 AUG91       200         201
Piston1   18AUG91       600         400
Piston2   18AUG91       600         400
Inlet     8 AUG91       600         201
X-ducer   8 AUG91       600         201
•Maintenance Position
•Liquid End Type
```

Figure 6.3 Maintenance Log Menu

The Maintenance Table

The top half of the Maintenance Log Menu is constructed in the form of a table. (See Figure 6.3.)

ITEM, DATE, DUE, and VOL

The ITEM field remains fixed. "Seal 1" and "Seal 2" should be paired with "Piston 1" and "Piston 2", respectively, to identify the inlet and outlet liquid ends. "Inlet" refers to the inlet check valve, while "X-ducer" refers to the transducer check valve.

Enter the date (day/month/year) in the DATE field for the last time maintenance was performed on each item.

The pump keeps "liters pumped" counters, in the VOL (volume) field, for each major maintenance item (the pump seals, pistons, and check valves). You may set a DUE volume in liters for each item. When the DUE volume is exceeded by the volume of liters pumped (VOL), the reminder "MAINTENANCE DUE - SEE PUMP LOG" is displayed. This message will appear each time a file is initialized. You may choose to use this feature to set regular intervals for maintenance, such as seal changes, pump/column cleaning, or simply to serve as a reminder to verify that the system is operating properly. The interval remains set until either the date has been updated or the DUE value has been increased.

In the example shown in Figure 6.3, a fairly complete maintenance was done on 8 Aug91, when both seals and check valves were replaced.

Setting Intervals

The volume of mobile phase that you can expect to pump before the pump requires maintenance is very dependent upon the eluant being pumped and your adherence to good chromatographic practices. To obtain the maximum lifetime and best performance from your pump, read *Extending the Maintenance Period* on page 64. Pump pistons and check valves have been known to last for years. Even the seals themselves can last more than a year for some applications.

An initial guideline for setting up your Maintenance Log for the first time is to set both seal DUE counters to 200 liters, and the check valve and piston DUE counters to 600 liters. Setting a value of zero (0) for any DUE interval inactivates the Maintenance Log for that specific item. To inactivate the entire Log, a zero (0) must be entered for all DUE intervals. Your specific maintenance interval can be determined by observing pump performance over time.

When a Maintenance Message Is Displayed

Whenever the interval has been exceeded, and the message "MAINTENANCE DUE - SEE PUMP LOG" is displayed, you should either verify that the pump needs maintenance or that the pump is operating properly. If a maintenance interval is exceeded and you find that the pump does not require maintenance, increase the DUE interval by another 50 liters from the previous setting. Once you have established an expected interval for your system, use that interval for routine preventive care.

If you find that the interval before component failure is either unacceptable or variable, then the source of the problem must be identified. Read this chapter and Appendix C. Poor chromatographic practices are by far the most common source of problems. Specific procedures for inspecting and changing parts begin on page 65.

Maintenance Position

Selecting /Maintenance Position/ prepares the pump for liquid end removal or replacement. The display shown in Figure 6.4 appears:

```
To install or remove
liquid ends press ENTER
```

Figure 6.4 Maintenance position message

The maintenance position puts the pump's cam into a position to facilitate liquid end removal.

Liquid End Type

The Liquid End Type Menu allows you to set the flow range for your pump, based on the type of liquid ends installed. Each pump is set to the correct flow range before it leaves the Factory. Do not change the flow range unless you are installing liquid ends with capacities different from those the pump was purchased with.

```
Liquid End Type              Normal
Flow Range              0 - 10 mL/Min
```

Figure 6.5 Liquid End Type Menu

Selecting Normal, Inert, or Prep

If you select Normal, Prep, or Inert in the Liquid End Type field, the Flow Range field changes automatically to corresponds to the preset ranges for these Spectra-Physics Analytical liquid ends. (Normal = 0 - 10 ml/min, Inert = 0 - 30 ml/min, Prep = 0 - 90 ml/min.)

Selecting Other

If you select Other in the Liquid End Type field, the Flow Range field becomes active, allowing you to enter your own flow range.

After changing the liquid end type on the display, press [ENTER]. A message (Fig. 6.6) will prompt you to write down the old values in the Maintenance Log which correspond to the liquid ends you presumably just removed. It is important to keep records for each set of liquid ends you use. If you reinstall the "old" liquid ends, you will need to reenter the dates and statistics for the "old" ends into the Maintenance Log table. You are also reminded to enter new values into the log's VOL field, which correspond to the newly installed liquid ends. Normally the VOL field is not edited, but when new liquid ends are installed, ensure that the VOL fields for the appropriate maintenance items are reset to 0.

Figure 6.6 Reminder to keep proper records when liquid ends are changed.

Flow Correction

An additional menu appears whenever you press an arrow key, [ENTER], or [+]/ [-] from the display shown in Figure 6.6. This menu (Fig. 6.7) allows you to set a Flow Correction, if desired. OLD and NEW values are displayed. For no Flow Correction, enter 100.00%

NOTE: The Flow Correction menu is the same as the menu displayed when a flow calibration (/TESTS/, /Calibration/, /Flow Calibration/) has been initiated, except that it does not include the Use, Save, or Scrap option.

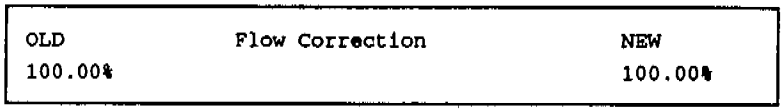


Figure 6.7 Flow Correction menu

Flow correction is a value, in percent, which adjusts the actual volume that the pump delivers. As you use the pump, you may feel that although the pump is set at a specific flow rate, for example 2 ml/min, the pump actually delivers slightly more or less than this volume per minute. This can be due to a variety of maintenance- or LC-related reasons (seals, valves, etc.)

If desired, manually enter a flow correction value. This value can be entered automatically, based on the result of the flow calibration test, initiated from /TESTS/, /Calibration/, /Flow Calibration/. This test [which requires you to enter an accurately measured operation value (time, volume or flow rate)] is fully explained in Appendix C.

If no correction to the flow is desired, enter a value of 100% in this field. Values from 90% to 110% are valid. For example, if you pump for one minute at 1 ml/min and collect 0.95 ml, then the pump is actually delivering 5% less solvent than expected. To compensate, enter 105.26% in the Flow Correction field. The pump's Status Screen will still display a flow rate of 1.0 ml/min, but the pump will actually deliver 105.26% of what it normally delivers at 1.0 ml/min.

Press [ENTER] to save the value, or simply leave the menu by pressing an arrow key.

Extending the Maintenance Period

As mentioned earlier, the volume of mobile phase you can expect to pump before maintenance is due is very much dependent on the way that the pump is being used. Following these guidelines helps you extend the life and improve the performance of your pump.

- Use high quality, spectro-grade or HPLC-grade solvents. These solvents do not usually need to be filtered before use.
- Filter water and prepared solvents through at least a 0.45-micron filter before placing them in the solvent reservoirs to remove particulate matter and organic contamination.
- Avoid pH extremes. Spectra-Physics Analytical offers an inert/biocompatible pump for mobile phases that are outside the pH range of 2.2 to 8.0.
- Verify that the solvents used are miscible in all proportions. This is very important for a buffered mobile phase. Precipitation of salts quickly damages maintenance parts.
- Never leave the pump filled with buffered solvent when not pumping. Either lower the flow to 0.1 ml/min. or thoroughly flush the pump. Flush with at least 25 ml of pure filtered water.
- The pump should be filled with methanol if it is to be left idle for more than two days. This avoids the possible growth of organisms in aqueous solvent systems.
- Never use hydrochloric acids solutions.
- Avoid metal ions that can cause corrosion due to electrochemical processes. Typical metal ions to avoid: manganese, chromium, nickel, copper, iron, molybdenum.

NOTE: The inert/biocompatible version of the P1500 can pump metal ions and other corrosive solvent systems. Contact your Spectra-Physics Analytical sales representative for more information.

Maintenance Procedures

SAFETY PRECAUTIONS

Observe the following safety precautions whenever performing periodic maintenance.

HIGH VOLTAGE! To avoid electrical shock do not open covers or remove parts beyond the descriptions in the operation portions of this manual or in this maintenance section.

WARNING! Disconnect the power cord before changing the voltage setting on the back of the pump, or before replacing fuses.

HIGH VOLTAGE! If, after any maintenance or repair, the pump requires adjustment with the top cover off and the power on, such service should be performed by a trained Service Representative who is aware of the hazards involved.

WARNING! Whenever working on an LC system wear eye and skin protection.

CAUTION! Prevent contamination of pump parts! Wear finger protection and perform disassembly of pump parts on uncontaminated surfaces.

Once the pump has indicated that maintenance is due, or you suspect poor performance based on the liquid ends or valve operation, use the simple procedures described in this section to inspect, and, if necessary, replace parts. This section includes a list of parts found in the standard maintenance kit available from Spectra-Physics Analytical, and procedures for:

- quickly replacing the piston seals
- complete liquid end maintenance (includes disassembly and assembly)
- check valve replacement
- passivating stainless steel parts (not purchased from Spectra-Physics Analytical)

Also included are maintenance tips for pump parts that are not involved with pump flow.

MAINTENANCE KIT UNPACKING

The standard Maintenance Kit (p/n A4050-010) contains the following:

- 4 inlet filter cartridges
- 1 inlet check valve
- 1 transducer check valve
- 2 sapphire pistons (0.125 inch-diameter)
- 1 barbed fitting (nylon)
- 1 piece (30-inch) tubing, 0.0655 ID (76 cm length)
- 1 piston flush tube (Tygon®)
- 1 syringe (20 cc)
- 6 piston seals
- 2 piston flush seals
- 6 Kel-F® seals
- 1 seal removal tool

TOOLS

The following tools are useful to have on-hand as you perform maintenance procedures.

- tweezers
- open-end wrenches (1/4-inch, 5/16-inch, 1/2-inch)
- loupe or magnifying glass
- Allen wrench (Hex head) 9/64-inch

PREPARATION

Prepare the pump for maintenance before performing any maintenance procedure.

To prepare the pump for maintenance, flush the pump with 25 ml of methanol. If an incompatible solvent is resident in the pump, flush with appropriate intermediate solvents before flushing with methanol. For example, if chloroform is being used as the mobile phase solvent, an intermediate flush of 25 ml methylene chloride would be appropriate before flushing with methanol.

QUICK PISTON SEAL MAINTENANCE

The pump piston seals can be replaced quickly without removing the complete liquid end assemblies. The following procedure will save you time if the only parts that require replacement are the piston seals. Quick piston seal maintenance includes procedures for seal removal, inspection, replacement, and installation.

1. After flushing the pump with methanol as described in *Preparation* on page 66, stop the pump flow.
2. Remove the front cover to expose the liquid ends (Fig. 6.8).

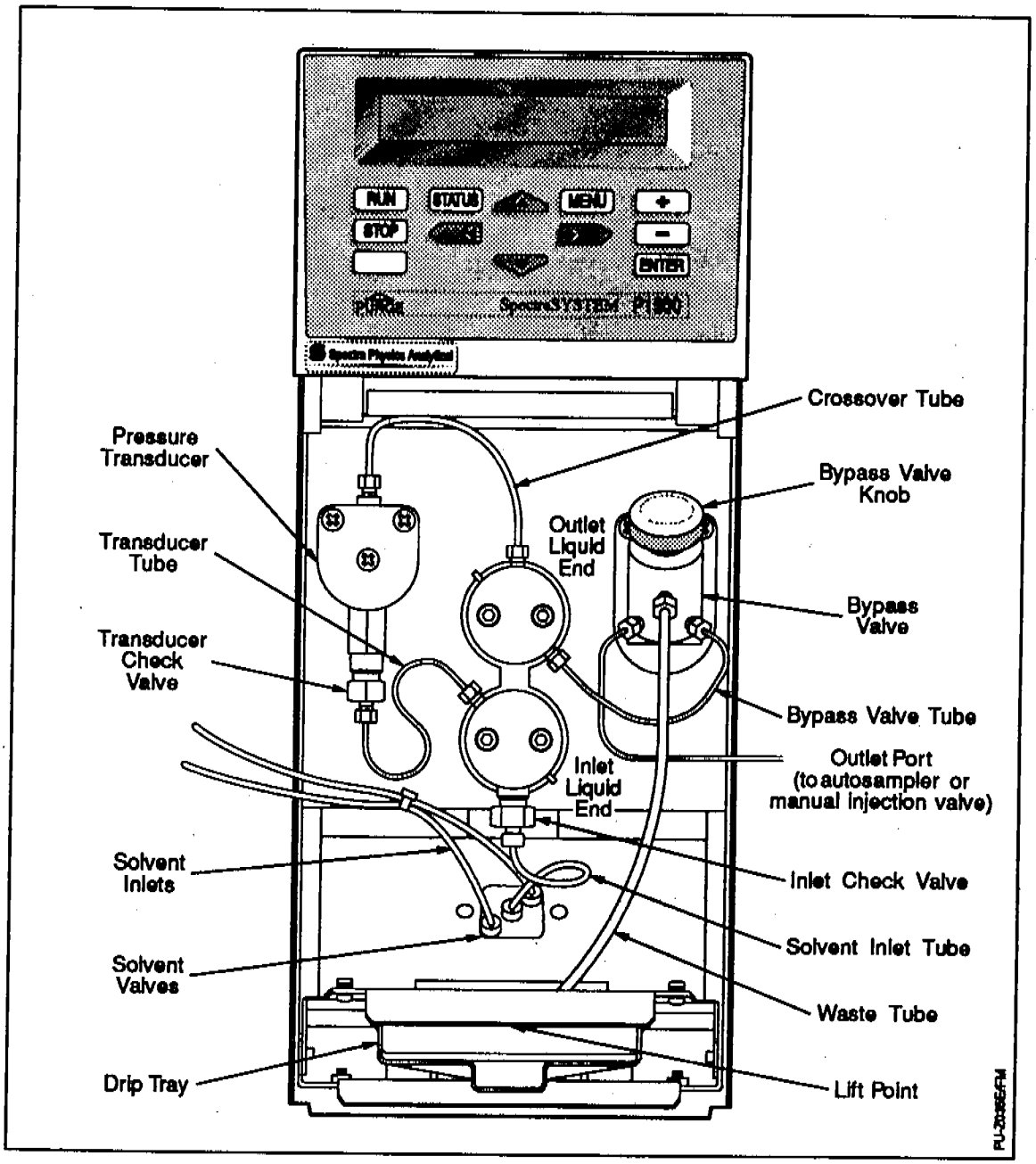


Figure 6.8 Pump with front cover removed

3. Remove the following three tubes (refer to Figures 6.8 and 6.9):
   - top crossover tube
   - transducer tube
   - bypass valve tube
   - solvent inlet tube

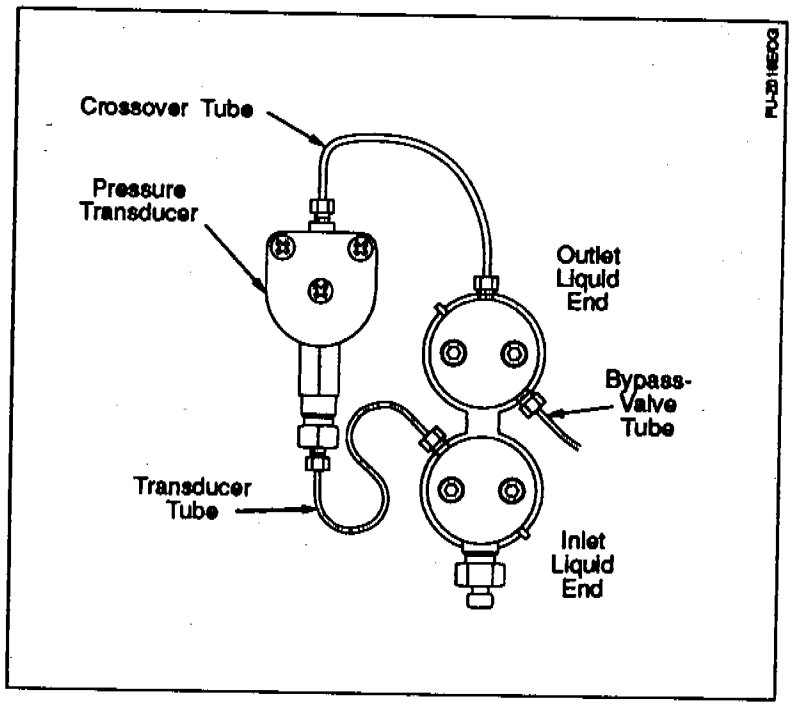


Figure 6.9 Liquid ends and tubing

At this point, only the inlet check valve should be connected to the inlet pump head. No tubes should be connected to either pump head.

4. Remove the two cap screws from each liquid end pump head (turn counter-clockwise), using a 9/64-inch Allen/hex wrench.
5. Remove the two pump heads. Lay the heads on the bench near the pump. Examine the inner cylinders of the pump heads. If they show evidence of contamination, proceed to *Liquid End Maintenance* on page 72 for thorough cleaning. If not, continue with step 6 to replace the seals.

6. Remove the seal holder (Fig. 6.11) on each pump head by grasping its exposed tube's top and bottom and pulling gently.
7. Examine the two pistons for ridges or scratches (Fig. 6.10). A magnifying glass or loupe is helpful. Proceed to *Liquid End Maintenance* if damaged.

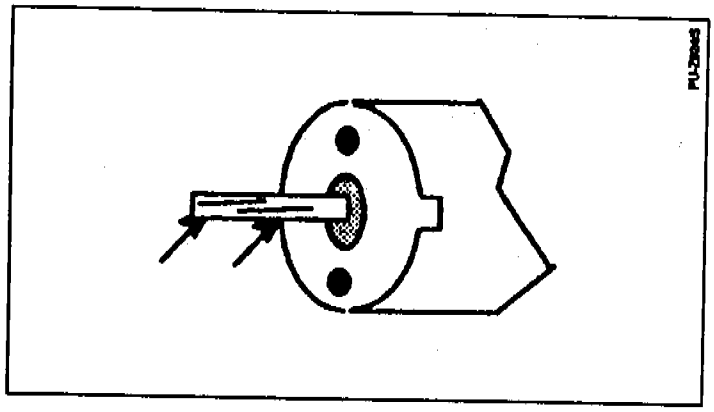


Figure 6.10 Piston scratches

8. Carefully remove the piston seals from the seal holders using the seal removal tool supplied in the accessory kit. Insert the tool and wiggle it in a circular manner to remove the seal (Fig. 6.11). Flush the holders with methanol if contamination is present.

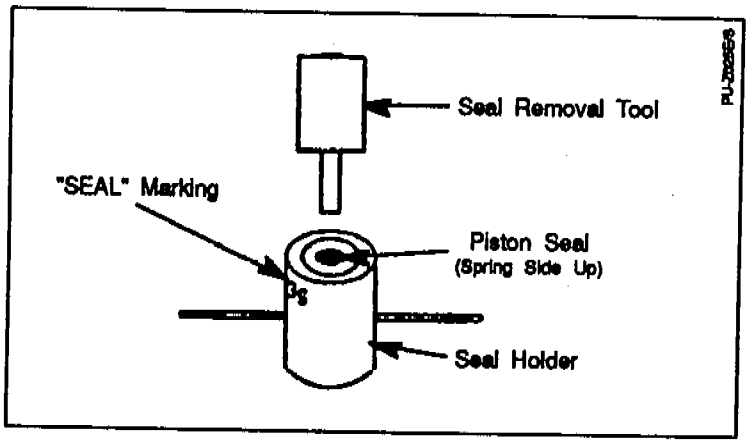


Figure 6.11 Removing seals from holders

9. Orient the seal holder so the end marked "SEAL" is up.

10. The Kel-F seal should remain firmly implanted inside the pump head. If it has been dislodged, a new seal must be installed. Replace the pump seal (described in step 11), then place the Kel-F seal over the seal holder and continue with step 12.

NOTE: A clear Kel-F seal is difficult to see. Closely examine the seals in the pump head cavity. A new seal must be installed if damaged (missing, warped, torn, or scratched).

11. Install new piston seals by setting them in position on the seal holder (spring side up) and gently pressing them into place using the pump head (Fig. 6.12).

NOTE: It is possible to install the seal in the wrong end of the seal holder. If installed in the wrong end, the seal will not be flush with the top of the holder. The opposite end of the seal holder is deeper, to accommodate the piston flush seal. Install the piston seal only in the end marked "SEAL."

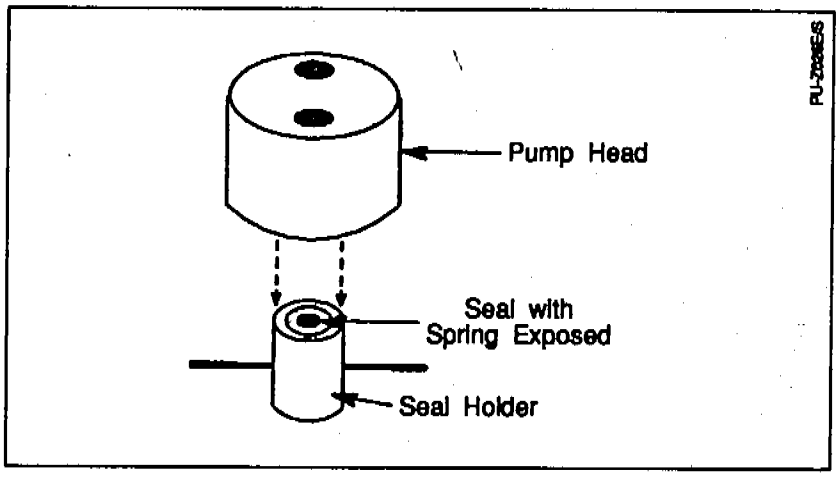


Figure 6.12 Installing seals in holders

12. A piston flush seal (part of a Piston Flush Seal Kit and normally used with buffers), may be located at the opposite end of the seal holder. If you use a piston flush seal it should be replaced once a year. The piston flush seal is not subject to the higher pressures seen by the piston seal, so maintenance of this part is only occasionally necessary. To replace the piston flush seal:

    a. Use the seal removal tool to remove the piston flush seal.

    b. Insert a new piston flush seal into the seal holder (spring side down). The piston flush seal is thicker than a piston seal. The seal holder's cavity on the piston flush seal side is deeper to accommodate the larger size.

    c. Ensure that the piston flush seal is flush with the edge of the seal holder. Use the large end of the seal removal tool to push the seal into the holder.

13. Place the holder/pump head combination carefully onto the piston and into position. The inlet check valve on the inlet liquid end is oriented in a down position. Refer to Figure 6.9 for correct head orientation.

14. Install the 9/64-inch cap screws and tighten evenly and firmly. Alternate the tightening of each screw to ensure even tightening. (Forty inch-pounds, minimum, is recommended.)

15. Purge the pump at 3000 - 4000 psi with methanol for five minutes to condition the seals and cleanse the pump.

NOTE: We suggest you use an old column or flow restrictor for seal conditioning, or purge with the bypass valve open to avoid damage to your analytical columns.

LIQUID END MAINTENANCE

Complete liquid end maintenance includes procedures for seal and piston maintenance:

- Removal
- Disassembly
  - inspection for contamination
  - cleaning
  - piston inspection
  - cleaning/replacing parts if necessary
- Assembly
- Installation

For thorough cleaning, piston replacement, or total liquid end reconditioning, the liquid ends must be removed.

Having a second set of reconditioned liquid ends on hand for quick replacement will save additional time and allow maintenance to be performed at your convenience. Contact your local Spectra-Physics Analytical representative if you are interested in obtaining spare components. (Part numbers are listed in the front of this manual.)

CAUTION! Keep the liquid end components as clean as possible. Contamination decreases seal life significantly.

Preparation

1. After flushing the pump with methanol as described in *Preparation* on page 66, stop the pump flow.
2. Remove the front cover, exposing the liquid ends (Fig. 6.8).

Liquid End Removal

To remove the liquid ends from the pump:

1. Remove all tubing attached to the pump heads. (See Fig. 6.9.)
2. Position the pump cam to enable the liquid ends to be removed. To do this, press [MENU], and select /TESTS/, /Maintenance Log/ then move the cursor to /Maintenance Position/ and press [ENTER]. The display shown in Figure 6.13 appears.

```
To install or remove
liquid ends, press ENTER
```

Figure 6.13 Maintenance position message

Press [ENTER] to continue. The pump motor rotates for a few seconds and then is electrically locked into position. While the motor rotates the display appears as in Figure 6.14.

```
Install or remove liquid
ends when motor stops
```

Figure 6.14 The display when the motor moves cam to maintenance position

When the motor stops, the display returns to the Maintenance Log. The pump is now in its maintenance position. It will hold this position (if power is maintained) until a file is initialized or a purge is started.

3. Remove the inlet check valve (Fig. 6.15) from the inlet pump head.

NOTE: It is not necessary to remove the check valve to replace a piston, however, it is easier to remove at this time if total liquid end reconditioning is to be performed.

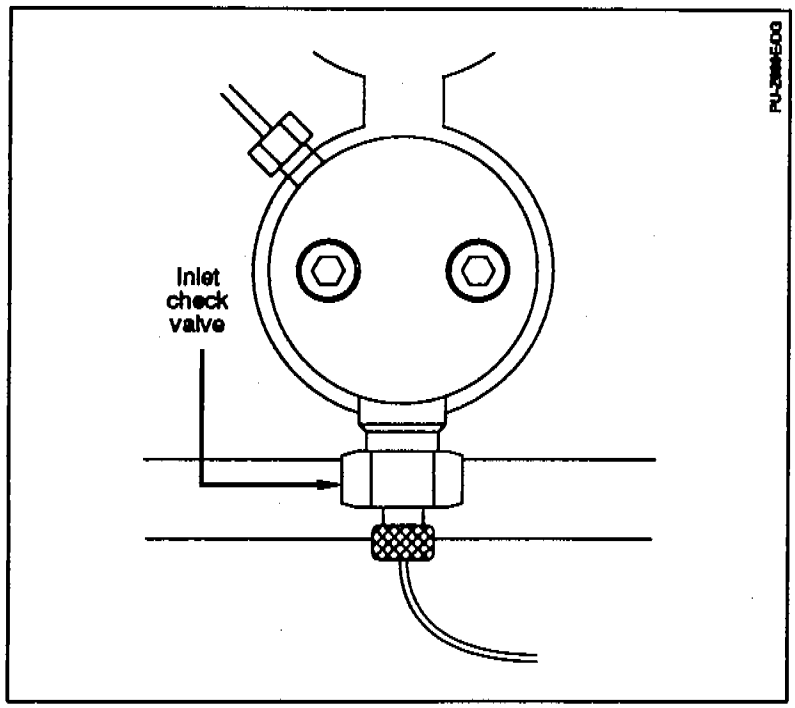


Figure 6.15 Inlet check valve

4. Push in the outlet (upper) liquid end and rotate it (90 degrees) until it releases from the pump module. Remove the liquid end and set it aside.
5. Push in the inlet (lower) liquid end and rotate it (90 degrees) until it releases from the pump module. Remove it and set it aside.

Liquid End Disassembly

To disassemble the liquid ends:

1. Separate the pump head from the piston holder housing (refer to Figure 6.16) by removing the two 9/64-inch hex cap screws.
2. Examine the Kel-F seal in the cylinder bore. If the seal is damaged (scratched, warped or torn) it must be removed. Use tweezers to remove it by pulling gently on the seal's inner circumference. (Be careful not to scratch the cylinder surface!)
3. Examine the pump head for contamination. Flush the pump head with methanol or place it into an ultrasonic bath.
4. While retaining the piston holder, remove the 9/64-inch retaining cap screw. This allows the piston holder to be removed from the piston holder housing. Separate the holder, piston, spring and housing.

CAUTION! The piston components are spring loaded and may shoot out! (See Figure 6.16).

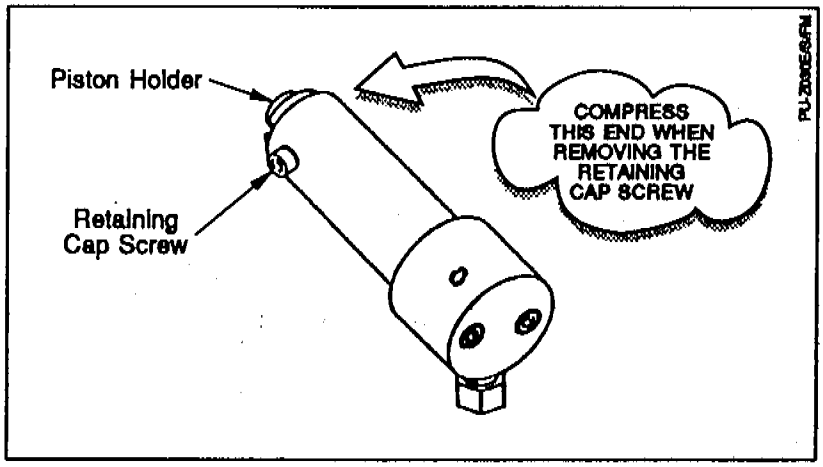


Figure 6.16 Retaining the piston holder

5. Examine all parts for wear, corrosion or contamination. Clean or replace as necessary. Refer to Figure 6.17.

NOTE: It is normal for the piston holder to produce a small amount of wear particles.

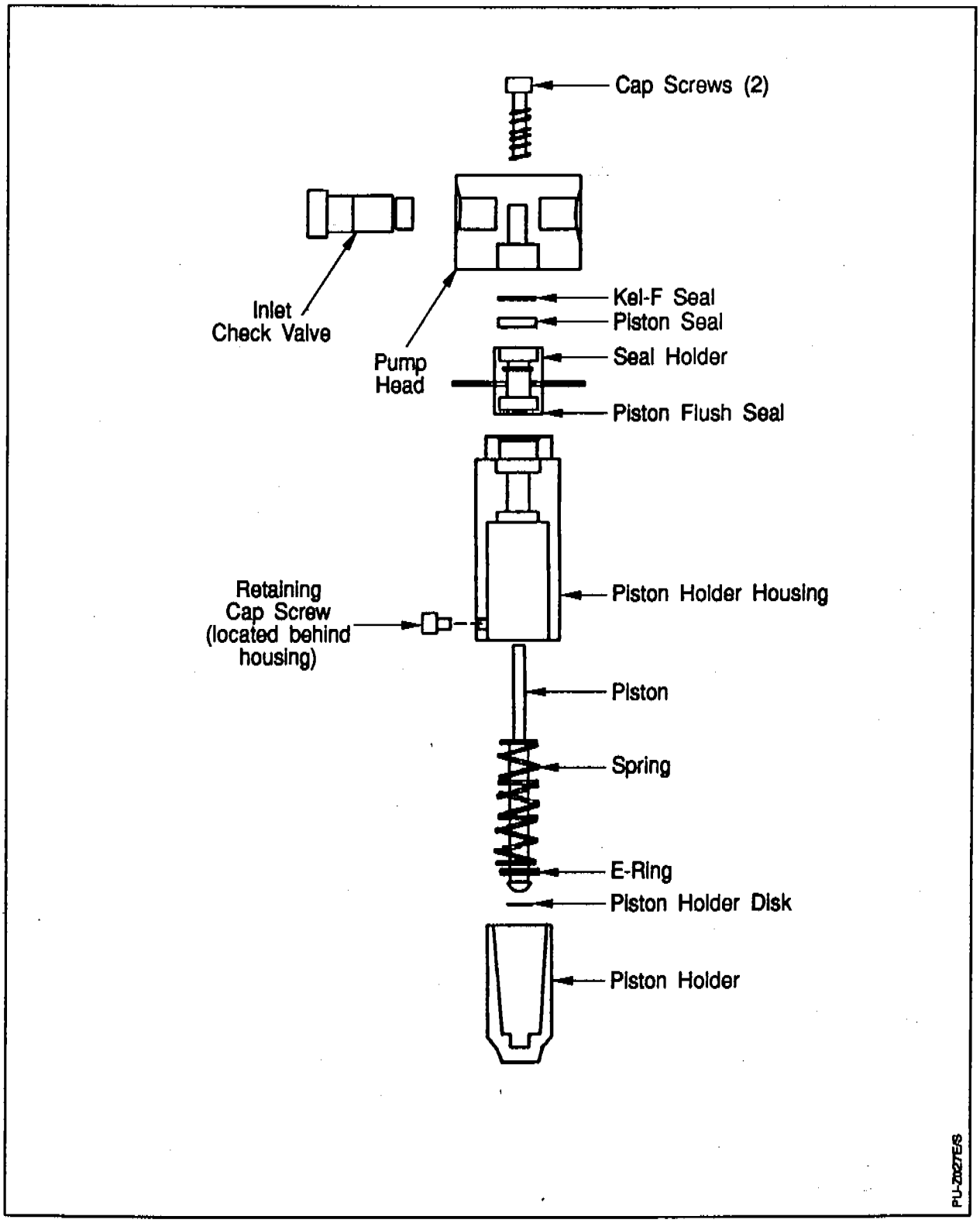


Figure 6.17 Liquid end components

6. Examine the piston carefully for fine scratches, ridges, or scoring (Fig. 6.10) which can reduce seal life. Replace the piston if scratched.
7. Thoroughly flush all components with methanol.

Liquid End Assembly

To replace the piston seal and reassemble the liquid end:

1. Place the seal holder on end on a clean, flat surface with the "SEAL" marking up. Install new piston seals by setting them in position on the seal holder (spring side up) and gently pressing them into place with the pump head (Fig. 6.18).

NOTE: It is possible to install the seal in the wrong end of the seal holder. If installed in the wrong end, the seal will not be flush with the top of the holder. The opposite end of the seal holder is deeper, to accommodate the piston flush seal. Install the piston seal only in the end marked "SEAL".

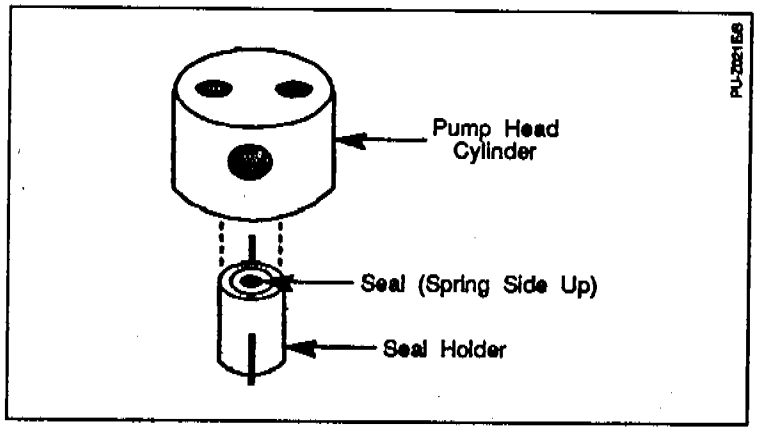


Figure 6.18 Seal installation

2. A piston flush seal (part of a Piston Flush Seal Kit and normally used with buffers), may be located at the opposite end of the seal holder. If you use a piston flush seal it should be replaced once a year. The piston flush seal is not subject to the higher pressures seen by the piston seal, so maintenance of this part is only occasionally necessary. To replace the piston flush seal:
   a. Use the seal removal tool to remove the piston flush seal.
   b. Insert a new piston flush seal into the seal holder (spring side down). The piston flush seal is thicker than a piston seal. The seal holder's cavity on the piston flush seal side is deeper to accommodate the larger size.
   c. Ensure that the piston flush seal is flush with the edge of the seal holder. Use the large end of the seal removal tool to push the seal into the holder.

3. Place the seal holder into the piston holder housing so that the seal marking is visible (Fig. 6.19).

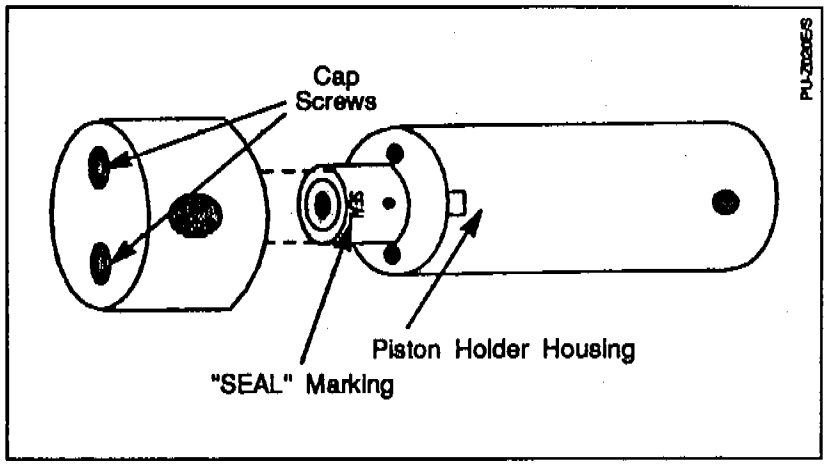


Figure 6.19 Alignment of seal holder

4. If the Kel-F seal is being replaced, put the new seal in the pump head cavity now. Install the pump head onto the housing using the two 9/64-inch Allenhead screws. Evenly tighten the screws to forty inch-pounds (tight).
5. Install the piston into the piston spring and then place into the piston holder housing (Fig. 6.20). Do not press the piston through the seal at this time.

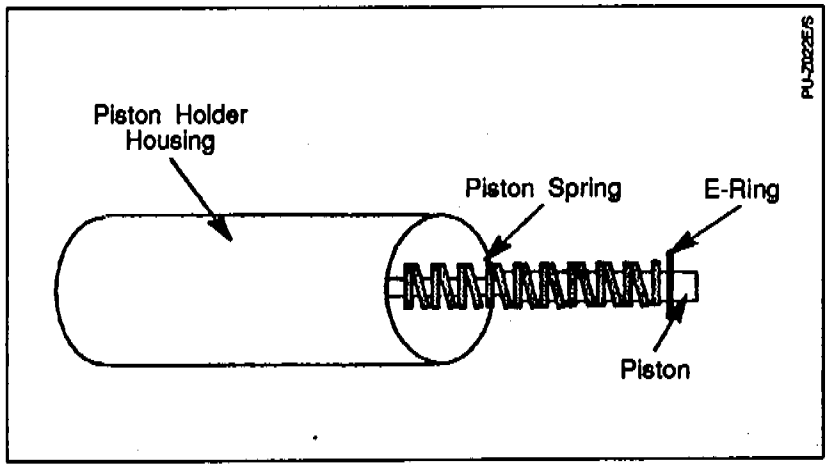


Figure 6.20 Piston installation

6. Compress the piston holder into the holder housing and install the retainer screw as shown in Figure 6.21, so that the screw enters the slot in the piston holder. Tighten the screw until snug.

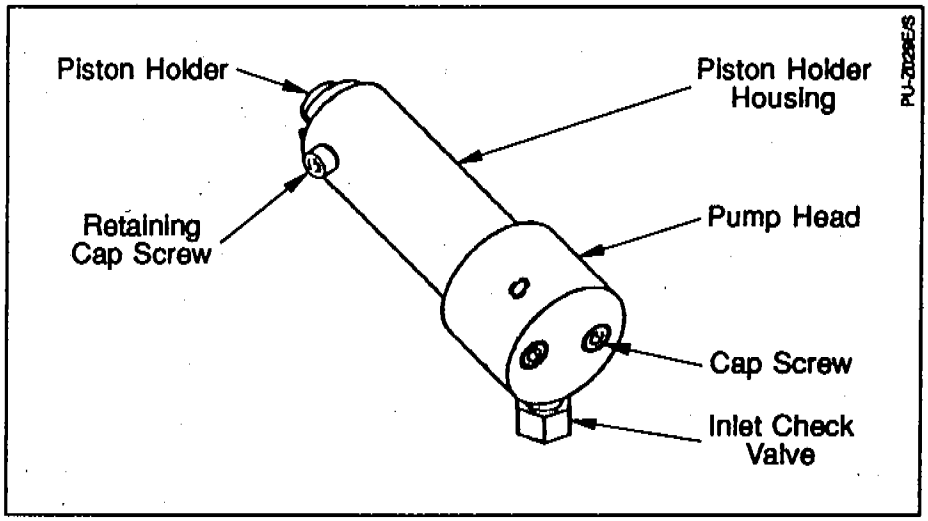


Figure 6.21 Installing the retaining cap screw

Liquid End Installation

To install the liquid end assemblies into the pump, the pump must be in the maintenance position. If the pump has not been switched off since the liquid ends were removed, the pump motor should still be in its maintenance position. If not, press Press [MENU], /TESTS/, /Maintenance Log/ then move the cursor to /Maintenance Position/ and press [ENTER]. The display shows:

```
To install or remove
liquid ends, press ENTER
```

Figure 6.22 Maintenance position message

Press [ENTER] to continue. The pump motor rotates for a few seconds and then is electrically locked into position. While the motor rotates the display shows:

```
Install or remove liquid
ends when motor stops
```

Figure 6.23 Pump rotating cam to maintenance position

As soon as the motor stops, the display returns to the Maintenance Log. The pump is now in its maintenance position. The liquid ends can be installed.

1. Replace the inlet liquid end first. This liquid end contains tapped holes for the inlet check valve and the transducer tube. Install it by pressing in and turning it approximately 90 degrees counter-clockwise, until it locks into position. Be sure that the check valve hole is pointed down, and the transducer tube hole is pointed to the upper left-hand side (10 o'clock). (See Fig. 6.24.)

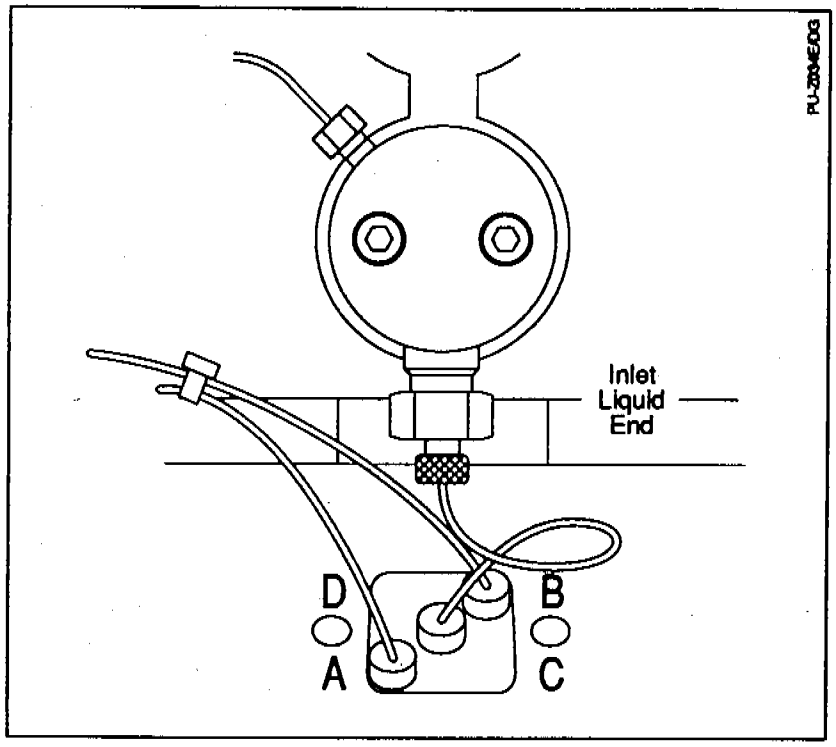


Figure 6.24 Inlet liquid end

2. Replace the outlet (upper) liquid end. This liquid end contains tapped holes for the crossover tube and the bypass valve tube. This liquid end is installed by pressing in and turning it approximately 90 degrees clockwise, until it locks into position. Be sure that the crossover tube hole is pointed up, and the bypass valve tube is pointed to the lower right-hand side (4 o'clock).
3. Replace the check valve and tubing. (Do not over-tighten fittings.) Generally, a 1/16-turn beyond finger-tight is sufficient to make a leak-free connection.

HINT: If the transducer check valve has been removed you can distinguish the two check valves: the inlet check valve has a wider fitting opening than the transducer check valve (connected to the pressure transducer).

NOTE: IF SEALS WERE REPLACED
REFER TO PAGE 71 FOR SEAL CONDITIONING
INSTRUCTIONS

CHECK VALVE MAINTENANCE

If the pump has notified you that it is time to replace check valves or if check valve replacement was recommended in Appendix C, *Troubleshooting*, then follow these steps. Check valve maintenance consists of:

- Inlet check valve removal and installation
- Transducer check valve removal and installation

CAUTION! The Factory-supplied replacement check valves are manufactured in a clean-room environment and capped to protect them from contamination. It is very important to maintain a clean environment when installing them.

Inlet Check Valve (bottom position)

To remove the existing inlet check valve and install a new one:

1. Remove the solvent inlet tube (Fig. 6.8) from the check valve.

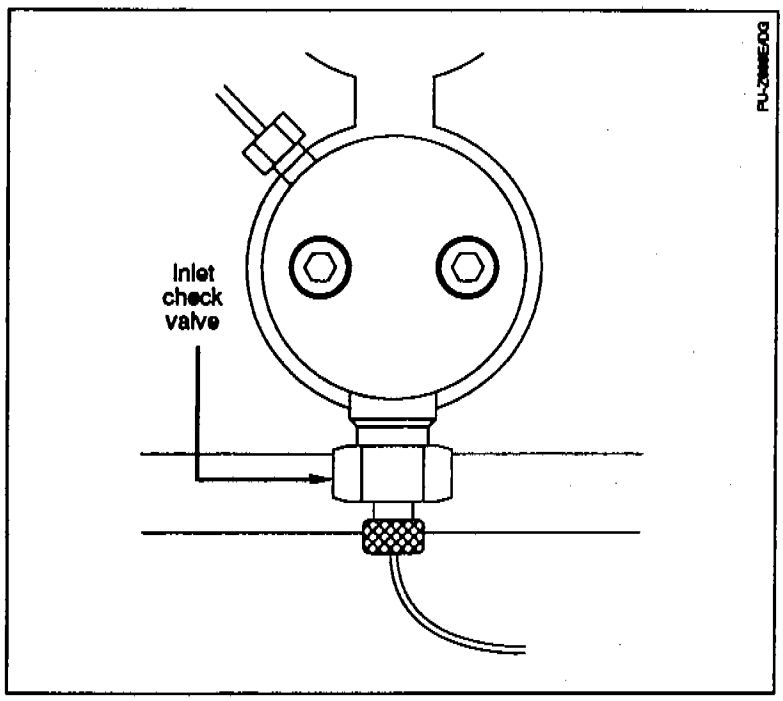


Figure 6.25 Inlet check valve

2. Remove the defective check valve by rotating the valve counter-clockwise with a 1/2-inch open-end wrench.
3. Install the new check valve by rotating clockwise until the valve is snug against the liquid end cylinder. Reconnect the inlet tubing. Tighten to finger-tight.

Transducer Check Valve

To remove the existing transducer check valve (connected to the Pressure Transducer) and install a new one:

1. Remove the transducer tubing from the transducer check valve and the inlet pump head (Fig. 6.26).

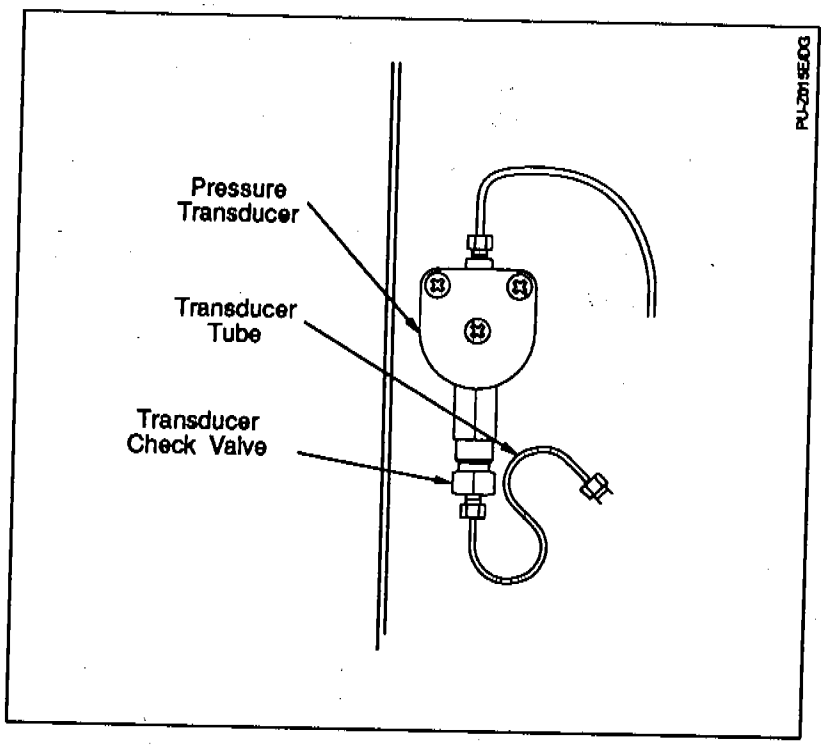


Figure 6.26 Transducer check valve

2. Remove the defective check valve by rotating it counter clockwise with a 1/2-inch open-end wrench.
3. Install the new check valve by rotating it clockwise until snug, and tighten with a 1/2-inch open-end wrench. Replace the connecting tubing. Tighten fittings only enough to stop leaks. Generally, this is 1/16-turn beyond finger-tight.

Maintenance Tips

This section contains useful maintenance tips for pump parts not directly related to solvent flow.

DRIP TRAY

A removable, white plastic solvent drip tray is located underneath the inlet bracket of your pump.

To remove the tray squeeze the top, front-edge of both sides of the tray together and carefully pull the tray out. You may need to wiggle the tray as you pull. If you see solvents in the tray, be particularly careful not to spill them as the tray is removed.

HINT: It may be easiest to use the index finger of each hand to push the sides together.

If necessary, empty and clean the tray before returning it to the pump. Replace the tray by sliding the shallow end into the small space between the bottom of the pump and the inlet block. Squeeze the sides of the front end together and firmly push the tray back into position underneath the solvent inlet bracket (Fig. 6.27).

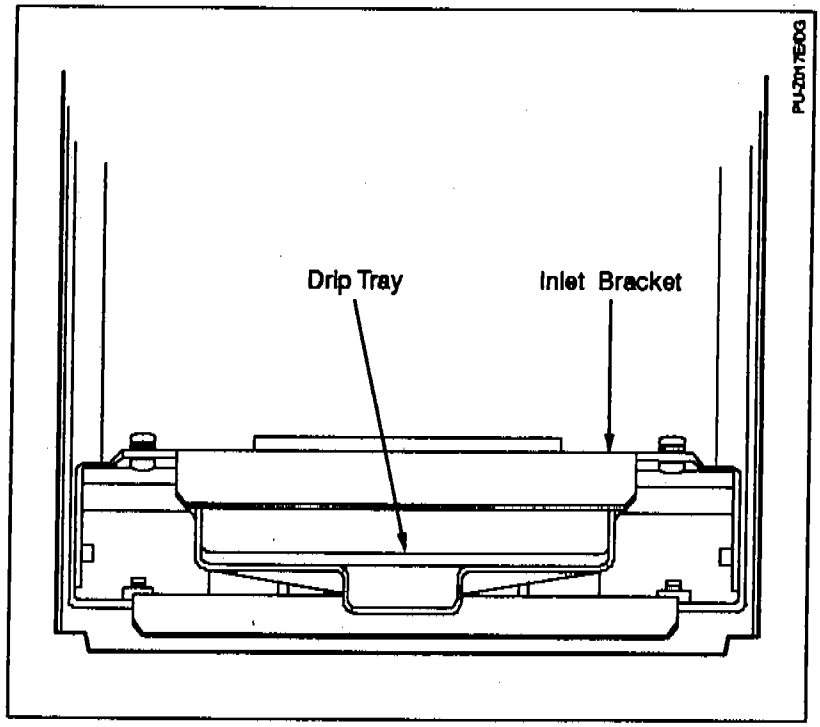


Figure 6.27 Drip tray installed

FAN FILTER

Your pump uses an electric fan to remove the heat generated by the electronic circuitry and pump motor from the instrument housing. A foam filter removes airborne contaminants from the cooling air. With time (depending on the environment), the filter will become clogged, restricting the flow of air. If allowed to continue, the flow of air is eventually cut off which may cause the instrument to overheat. The pump stops pumping automatically if overheating occurs and displays a warning message. To avoid this condition, the filter should be cleaned every six months (more often in dirty environments).

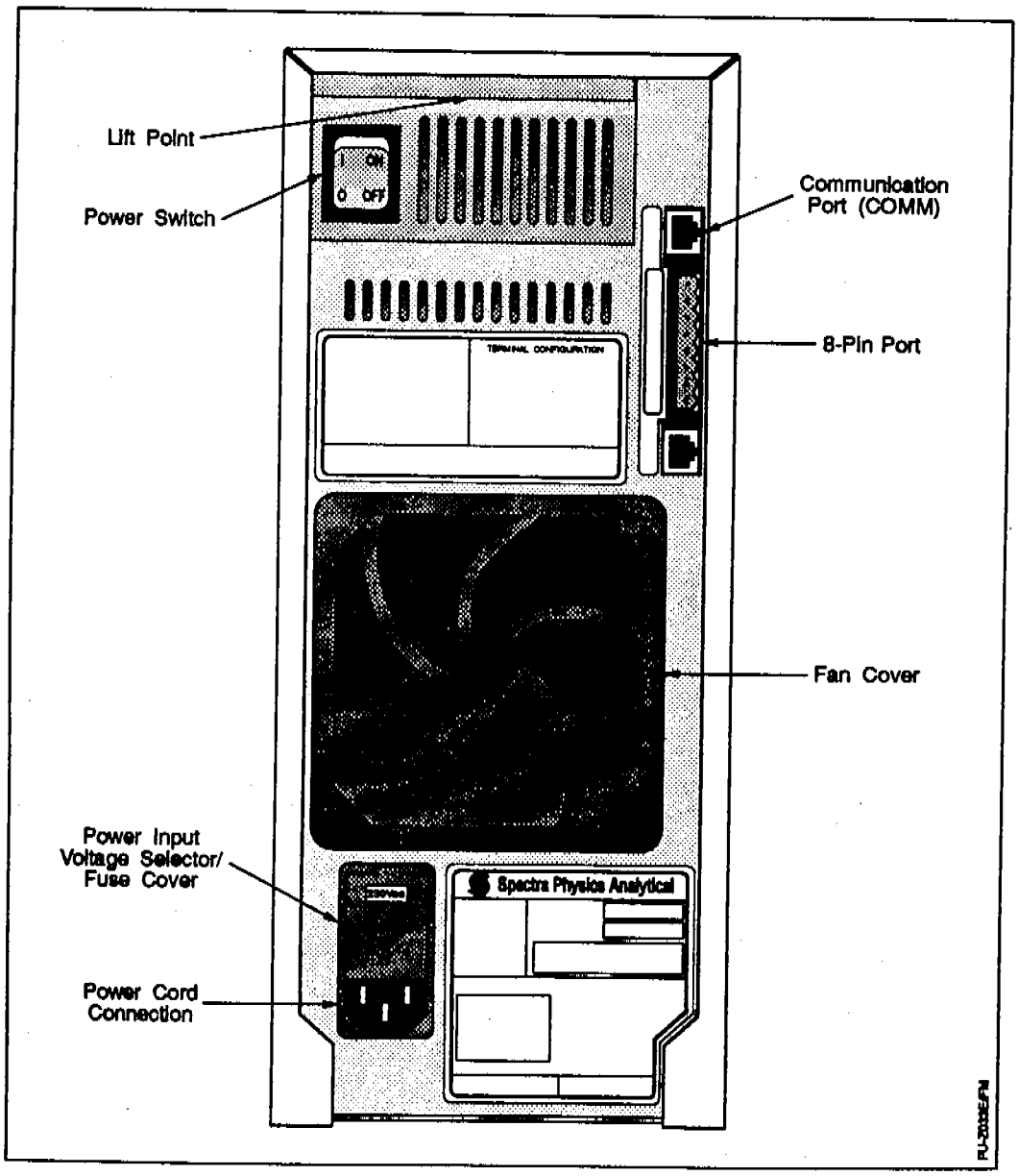


Figure 6.28 Filter located behind fan cover

To clean the fan filter:

1. Remove the fan cover (Fig. 6.28).
2. Remove the filter.
3. Wash the filter in warm soapy water. Rinse, and allow the filter to dry.
4. Replace the filter and push the fan cover back into position. The fan cover has four tabs, one on each edge of the cover. These fit into the slots on the sides of the fan housing.

PASSIVATION OF STAINLESS STEEL COMPONENTS

All the major type 316 stainless steel components used in the SpectraSYSTEM pumps are passivated prior to assembly to ensure the removal of porous particles from the surface and to coat the surface with a layer of chromium oxide, which is highly resistant to corrosion. All stainless steel replacement parts purchased from Spectra-Physics Analytical are also passivated.

However, stainless steel components are subject to corrosion from strong acid solutions (in particular, materials containing halides), organic acids, and sometimes even water. Resistance to corrosion of the stainless steel components can be enhanced by using the following procedures.

NOTE: Before installing any new parts not supplied from the Factory such as stainless steel tubing, the parts should first be passivated using the following methods:

CAUTION! DO NOT expose a column to the passivation mixture. Remove the column before pumping if it is necessary to pump passivation solvents through the pump. It is preferable, however, to remove the components from the pump and then passivate them apart from the system.

1. Parts to be passivated must first be cleaned and degreased using a degreasing solvent by completely immersing the part and drawing the solvent through the tubing.
2. The cleaning solvent must then be removed again by washing the part first with methanol, and then with successive washes of deionized water until the surface area to be passivated is thoroughly clean.
3. When the surface area to be passivated is thoroughly clean, it is passivated by wetting the surface with a 20% nitric acid solution in deionized water for about 10 minutes at room temperature.

4. After passivation, the parts must again be thoroughly cleaned to remove any residual nitric acid. Wash with deionized water until the system is neutral to pH paper. Follow up with another wash using 50-50 water/methanol followed by methanol. When thoroughly clean, blow dry using nitrogen. (Do not use the laboratory air system or air from a compressor that may contain an oily residue.)

If frequent passivation is required to protect your pump from aggressive solvent systems, you may wish to consider using the inert version of SpectraSYSTEM pumps. The inert pump parts do not require passivation.

Other Maintenance Kits

INERT ASSEMBLIES

Inert assemblies commonly resemble stainless steel assemblies, except in the materials of which they are made. Maintaining an inert version of the SpectraSYSTEM pump is similar to the descriptions in the first part of this chapter. However, the inert heads are larger, and do not contain the seal holder, pictured in Figure 6.17. Instead, a series of rings and seals (Fig. 6.29) comprise the connection between the piston holder housing and pump head.

Inert/Biocompatible Maintenance Kit

The Inert/Biocompatible Maintenance Kit (p/n A4060-010) consists of:

- 1 barbed fitting (nylon)
- 4 inlet filter cartridges
- 1 inert inlet check valve
- 1 inert transducer check valve
- 2 sapphire pistons (0.218-inch diameter)
- 1 piston flush tube (Tygon)
- 1 syringe (20 cc) with Luer LOK® tip
- 2 30 ml/min piston seal kits (described on below)
- 1 seal removal tool

30 ml/min Piston Seal Kit

The 30 ml/min Piston Seal Kit (p/n A4084-010) consists of:

- 1 piston seal (w/small O-ring) (high-pressure)
- 3 PEEK wash rings
- 1 large O-ring
- 1 piston flush seal (low-pressure)

Maintenance Procedure

This section describes how to replace the 30 ml/min piston seals in an Inert/Biocompatible (30 ml) liquid end. It assumes that the entire liquid end has already been removed from the pump.

WARNING! Whenever working on an LC system wear eye and skin protection.

CAUTION! Prevent contamination of pump parts! Wear finger protection and perform disassembly of pump parts on uncontaminated surfaces.

1. Carefully remove the two cap screws from the pump head. Hold both the head and piston holder housing as you unscrew the screws.
2. Gently pull pump head and piston holder housing apart, watching carefully for any parts that may fall out.
3. Remove the three PEEK wash rings inside the pump head.
4. Using the seal removal tool, remove the colored piston seal inside the pump head. Rinse the seal and inspect it for contamination, damage, or wear.
5. Place the seal removal tool (notched end up) into the cleaned pump head. Slide a new piston seal onto the seal removal tool, with the O-ring side down.
6. Place the three PEEK wash rings on top of the piston seal.
7. The piston flush seal probably remained on the visible end of the piston, inside the piston holder housing. Remove the piston flush seal.
8. Insert a new piston flush seal onto the removal tool, on top of the PEEK wash rings, O-ring side down.
9. Gently press all seal components into place inside the pump head cavity.

10. Bring the piston holder housing and pump head together. Install the cap screws and tighten evenly and firmly. (Forty inch-pounds is recommended.)
11. Repeat steps 1 - 10 for the other liquid end.
12. Install the liquid ends back into the pump. A general procedure is found on page 79.

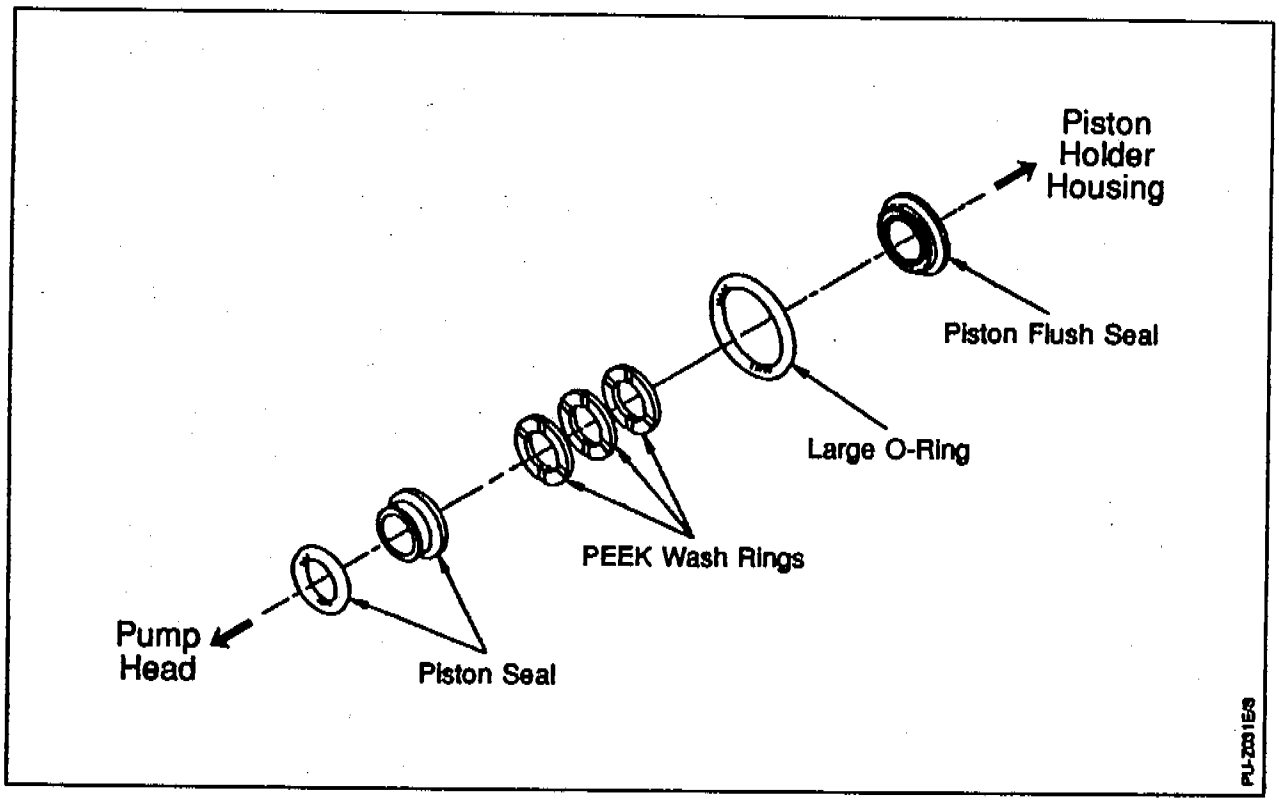


Figure 6.29 Contents of the 30 ml/min piston seal kit

Repair Instructions

If troubleshooting has pointed to a blown fuse in the power entry module, or to the need to replace the solvent switching valve (P1500 only), use the procedures below to make repairs.

POWER ENTRY MODULE FUSE REPLACEMENT

Instrument power is supplied by two 4.0-amp fuses housed in the fuse compartment of the power entry module, above the power cord receptacle.

HINT: The following procedure is easier to perform if you first remove the snap-on fan cover and filter.

To replace the fuses:

1. Ensure that the power cord is not connected to the pump.
2. Use a small, flat blade screwdriver to pry open the power selector/fuse cover. You will probably hear the top edge of the cover snap as it is pried open.
3. Pull out the fuse holder and discard the bad fuse. Place the new fuse into the holder with the metal end visible.
4. Snap the fuse holder back into place.

NOTE: If the power selector barrel accidentally comes out, be sure to replace it so that the correct voltage for your area shows through the voltage window.

5. Firmly snap the housing cover back in place. Be sure that the correct voltage is visible in the voltage window.

HINT: Use two thumbs to push up on the top half of the cover as you push in.

6. If you removed the fan cover and filter, replace them by snapping them back into place.

SOLVENT SWITCHING VALVE REPLACEMENT (P1500 ONLY)

To remove the solvent switching valve:

1. Turn off power.
2. Remove front cover.
3. Remove the solvent inlet tube fitting from the inlet check valve.
4. Loosen the two knurled screws on the front-left and front-right sides of the inlet bracket.
5. Lift and pull the bracket forward 3 - 4 inches.
6. Disconnect the inlet tubes from the solvent switching valves at locations A and B.
7. Remove the solvent inlet line from the center port of the valve.
8. Disconnect the solvent switching valve cable at the rear of the solvent valve cavity, and remove the solvent valve/bracket fully from the pump.

To install a new solvent switching valve:

1. Connect the replacement valve's cable to the connector at the rear of the solvent valve cavity.
2. Connect the solvent inlet line to the center port of the replacement valve. Tighten snugly but only finger-tight.
3. Re-connect the inlet tubes to the valve ports, making sure the identification of each inlet tube matches the identification of each valve port location.
4. Install the valve and bracket into the solvent valve cavity. Tighten the knurled screws.
5. Attach the solvent inlet line to the inlet check valve. Tighten snugly but only finger-tight.
6. Prime the pump using the technique described in Appendix A.

A Installation, Specifications, and Warranty

Introduction

This appendix contains information necessary to install your pump properly. The step-by-step instructions describe how to set the voltage for your area, how to connect tubing, and how to prime and purge the pump. Be sure you read the Safety Information at the front of this manual before proceeding with any installation.

Unpacking

INSPECT YOUR INSTRUMENT

Your pump was shipped in a special container designed to provide excellent protection from routine wear and tear encountered in transit.

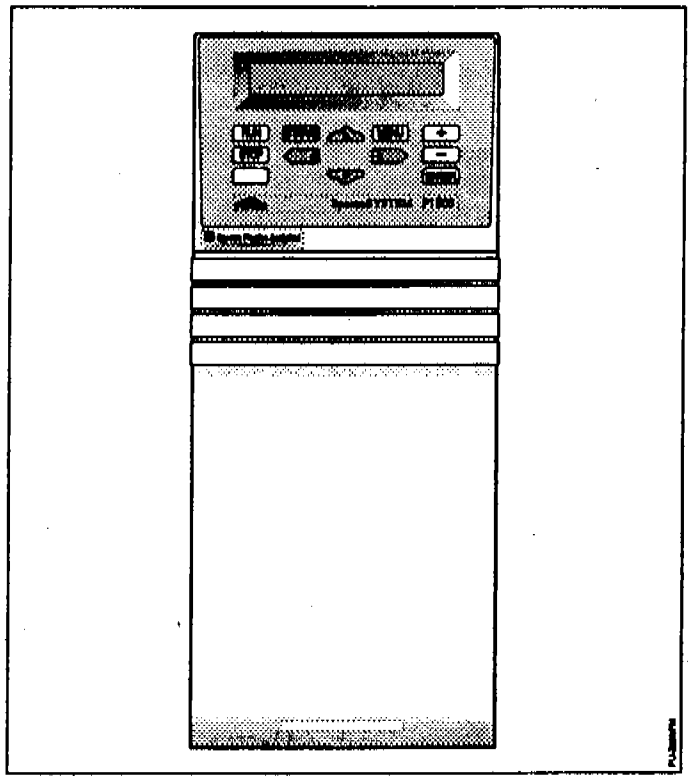


Figure A.1 A SpectraSYSTEM pump

After unpacking, inspect your pump and its accessories for missing parts and/or physical damage. If damage is found, notify both the carrier and your sales representative. Please DO NOT return any goods without prior authorization (either a Returned Goods Authorization number or a Returned Materials Authorization number) from Spectra-Physics Analytical.

ACCESSORY KIT

The contents of your package varies with the model and options purchased. A basic accessory kit is supplied with each pump and includes the following tools and parts.

Quantity	Description
2	4 amp, 250V fuse
1	12-inch piece stainless steel tubing (0.06OD x 0.02ID) (27.5 cm length)
2	nuts
2	ferrules
1	seal removal tool
1	hex/ball wrench
1	4-connection cable
1	external function connector
1	20 ml (cc) priming syringe with Luer LOK® tip
1	luer adapter
1	waste tube kit: 48-inch Teflon® tubing, 0.031 ID (123 cm length) washer and finger-tight fitting

Your package also contains a power cord.

OPTIONS AVAILABLE

A variety of options, kits, and accessories are available for your pump. Refer to Chapter 5, *Purchased Kits and Accessories* for a full description and parts list of each. If you purchased an inert/biocompatible pump, the correct tubing and liquid ends were installed at the factory before shipment.

For a list of all available accessories, upgrades, and kits, see the insert at the front of this manual or contact your Spectra-Physics Analytical sales representative. Note that all upgrades require installation by Spectra-Physics Analytical.

NOTE: The pump features a bypass valve pre-installed as standard equipment.

Installation

LIFTING AND CARRYING THE PUMP

The correct way to carry the pump is to use the two hand holds, one located underneath the front of the pump, and the other at the top of the back, near the power switch. Grasp the pump well underneath the front when lifting and carrying.

SETTING THE VOLTAGE

All pumps are configured at shipment for 230 VAC (50/60 Hz) operation. Depending upon the country of use, you may need to change the voltage setting.

WARNING! Check the position of the voltage select barrel located on the rear of the instrument. If the indicated voltage setting is not consistent with your area, DO NOT CONNECT THE POWER CORD!

Figure A.2 shows the rear panel of the pump.

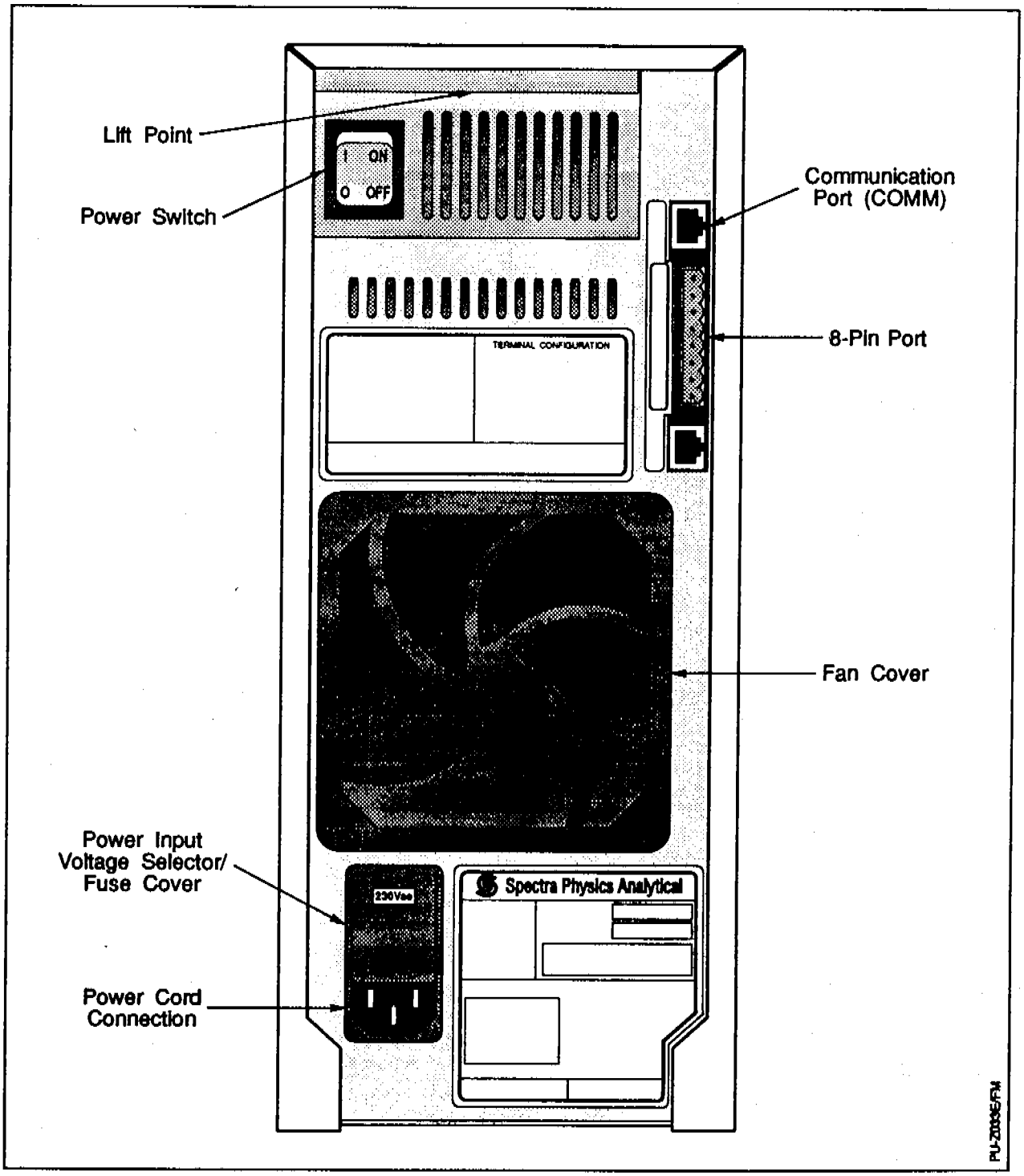


Figure A.2 Rear panel

The voltage setting can be easily modified as follows:

HINT: The following procedure is easier to perform if you first remove the snap-on fan cover and filter.

1. Remove the tape label covering the power entry receptacle.
2. Ensure that the power cord is <u>not</u> connected to the pump.
3. Use a small, flat blade screwdriver to pry open the power selector/fuse cover to expose the voltage selector barrel. You will probably hear the top edge of the cover snap as it is pried open (Fig. A.3).

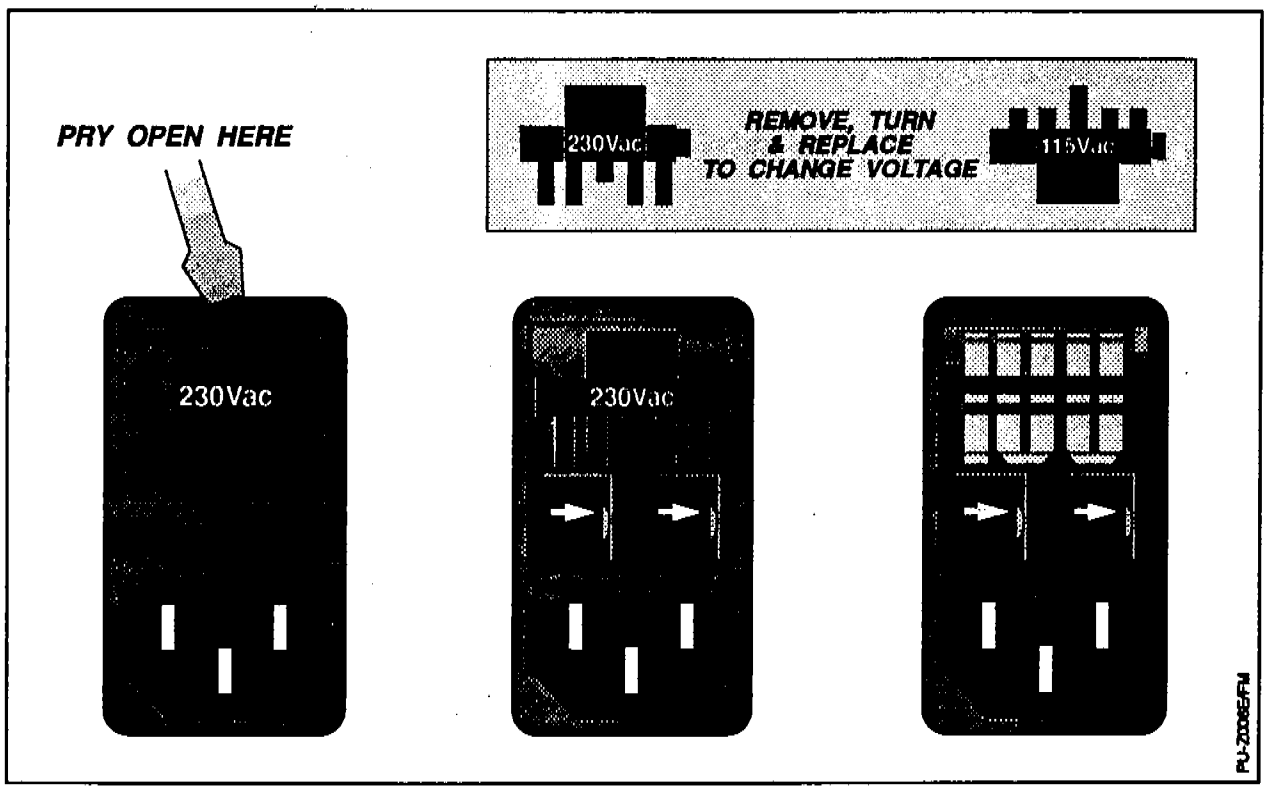


Figure A.3 Power selector/fuse cover, closed, with "voltage window." The opened power selector/fuse cover, with barrel selector removed.

4. Remove the plastic selector barrel by pulling it straight out.
5. Rotate the barrel until you see the desired voltage (either 115 VAC or 230 VAC) and insert the barrel back into the housing with the desired voltage visible.

6. Firmly snap the housing cover back in place. Be sure that the selected voltage is visible in the voltage window.

HINT: Use two thumbs to push up on the top half of the cover as you push in. The voltage selected will be visible through the window.

7. If you removed the fan cover and filter, replace them by snapping them back into place.

PLACING THE PUMP

The pump weighs approximately 38 pounds (18 kg) and requires at least 6 inches (16 cm) of bench width and at least 19 inches (48 cm) of bench depth. If used with a manual injector bracket, the pump requires 9 inches (23 cm) of bench width. The pump needs a space at least 15 inches (38 cm) high.

Place the pump on a level surface. Leave 2 inches (6 - 7 cm) behind the instrument for good air flow and access to electrical connections. Keep the pump away from heating and cooling ducts, and avoid exposing the pump to direct sunlight. The pump should be placed to the far left of your LC system if it is used with the SpectraSYSTEM autosampler or detector.

CONNECTING THE POWER CORD

Attach the AC power cord. (Refer to Fig. A.3.) Plug the power connector into an appropriately grounded power outlet.

WARNING! For safe operation and optimum performance, the pump must be connected to a properly grounded power receptacle.

CHECKING INITIAL RESPONSE TO POWER ON

Turn the power on by pressing the power switch. (Refer to Fig. A.2.) With the pump's front panel facing you, the power switch is located in the back, on the upper right-hand side. The fan starts and a display similar to Figure A.4 appears for one second.

```
Spectra Physics                                P1500
Analytical              (C) 1991               V (number)
```

Figure A.4 Brief power-up message

If this message does not appear, double-check the electrical connections and try turning on the pump once more, watching the screen closely. If the message still does not appear, contact your Spectra-Physics Analytical representative.

Next, the display shows the Status Screen, similar to Figure A.5.

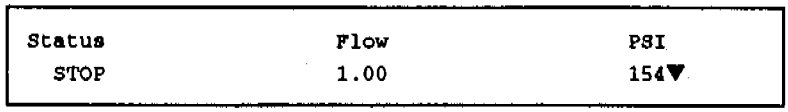


Figure A.5 P1000 Status Screen

NOTE: The P1500's Status Screen differs slightly from the figure above.

HARDWIRING EXTERNAL EVENTS

Pin 6 of the eight-pin port on the back of the pump (see Fig. A.2) allows you to control another device, such as a column switching valve or fraction collector. If you plan to control such a device or instrument via the pump's Timed Events feature, insert the external function connector into the eight-pin port.

The pins are labeled both on the port and on the external function connector. Ensure that the pin numbers match whenever connecting the connector to the port.

Hardwire your device using the 4-connection cable. Loosen pin 6's small screw, insert the wire, then tighten the screw.

You must also insert the external function connector if you use a SpectraSYSTEM autosampler. More information about making hardwire connections to an autosampler is found on page 105, and in the *SpectraSYSTEM Autosamplers Reference Manual.*

Pin assignments for the eight-pin port are shown in Table A.1:

Pin #	Description
1	**READY (Output)**
2	**+5 VDC 100mA MAX**
3	**GROUND**
4	**PRESSURE 0.1 V/1000 PSI**
5	**STOP (Input)**
6	**TIMED EVENT (Output)**
7	**RUN (Input)**
8	**INJ HOLD (Output)**

Table A.1 Eight-pin port pin assignments

All outputs (pin 1, pin 6, and pin 8) are open-collector type, capable of sinking up to 30 mA at a maximum of 30 VDC.

INSTALLING KITS OR ACCESSORIES

Refer to Chapter 5 for complete instructions for installing the Manual Injection Valve Bracket (column holder).

PREPARING AND CONNECTING SOLVENTS

If you did not purchase solvent degassing apparatus or solvent bottles from Spectra-Physics Analytical, skip this section. Continue with *Connecting Inlet Lines* on the next page when your supply of solvent is available.

Solvent Bottles

Prepare your solvent bottle(s) by following the steps below.

1. Rinse the bottle(s) with LC-grade solvent to remove any dust.
2. Fill the bottle(s) with appropriate LC-grade solvent(s).
3. The bottle caps are pre-assembled to include an inlet line and filter. Ensure that each filter is tightly assembled to its fitting, and the filter fitting is firmly attached to the inlet line. Place the solvent filter/inlet line into each bottle, making sure that the inlet filter rests on the bottom of the bottle. Screw the cap on.
4. Attach the appropriate label to each solvent bottle cap to identify it.
5. Run vent lines from each bottle to an appropriate exhaust apparatus.

Degassing

There are two recommended methods for degassing solvents for use with your pump: vacuum degassing and helium degassing.

NOTE: Solvent degassing is recommended for isocratic applications because it results in improved detector performance.

If you purchased an SCM400 vacuum degas module, or helium degas accessory (2-channel SHM2 or 4-channel SHM4) a manual containing installation and operation information was included with these products.

Set up your degas apparatus and continue the pump installation when you have a supply of degassed solvent available.

CONNECTING INLET LINES

The front panel of the pump is shown in Figure A.6.

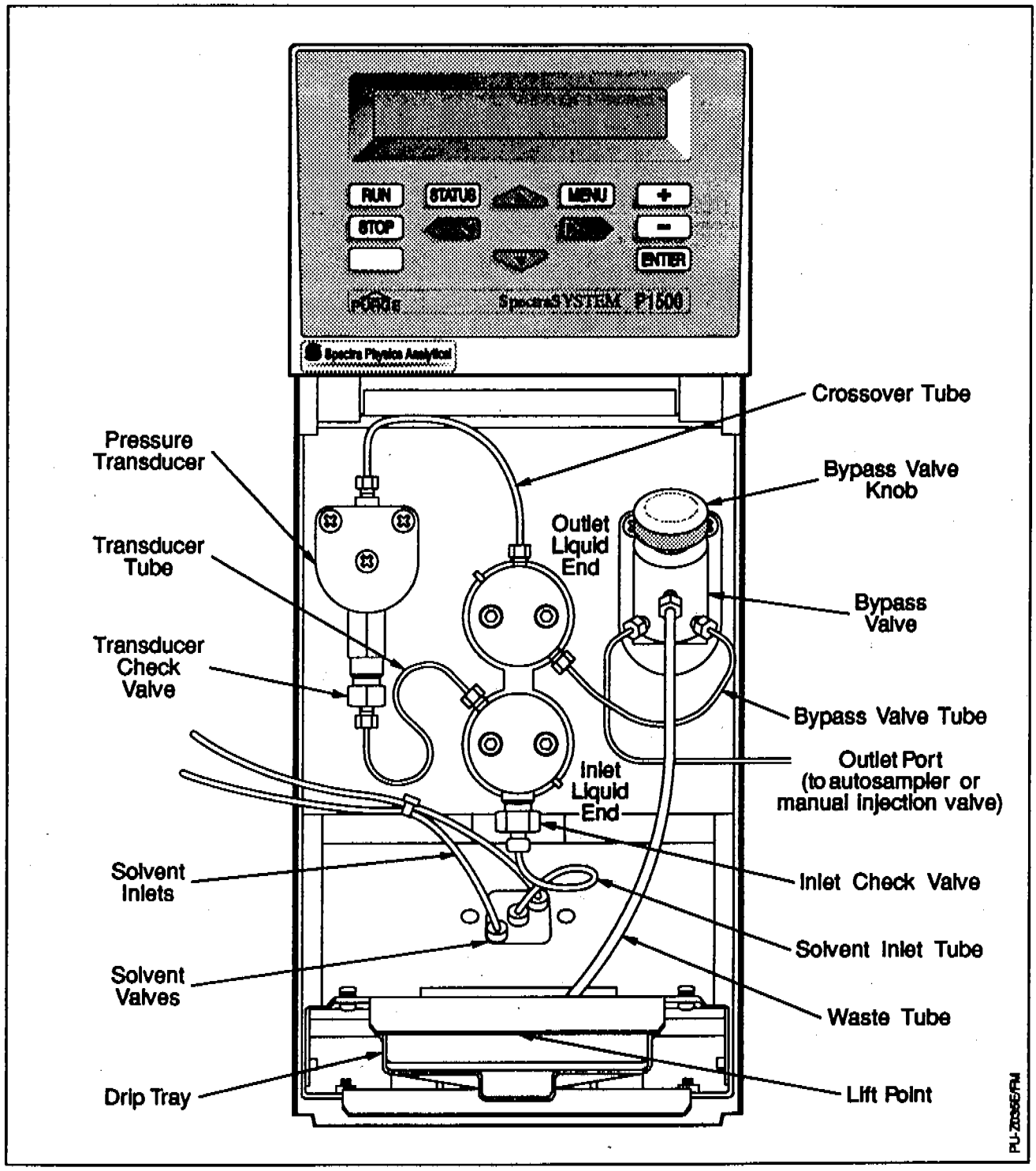


Figure A.6 Front panel, cover removed

The P1000 has only one inlet; the P1500 has two. Make connections between the pump's inlet line(s) and your solvent supply. The pump's solvent valves and inlet lines are shown in Figure A.7.

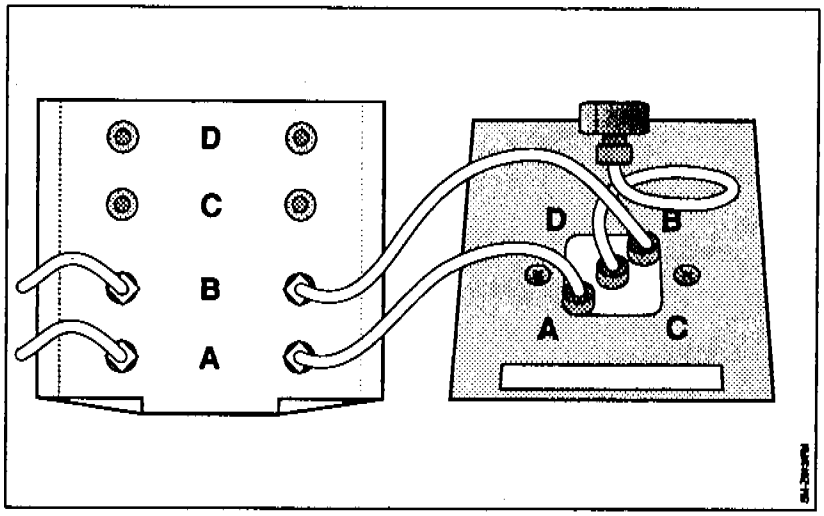


Figure A.7 Connecting solvent lines from an SCM400 to solvent switching valve inlets in the P1500 pump

BYPASS VALVE

The bypass valve is shown in Figure A.8. Do not attach a line to the waste/prime port (the middle port) now, but have the solvent waste tube (provided in the accessory kit) ready. You will attach the tube to the waste/prime port after priming the pump.

PRIMING AND PURGING

Both the P1000 and P1500 pumps are shipped with methanol in the pump heads and connecting tubing. If the first solvent you'll use is not miscible with methanol, the pump must first be primed with an intermediary solvent. Once primed, you should purge the pump to remove any air bubbles.

HINT: It is best to prime the pump initially with methanol to fully wet all internal surfaces. Priming with 100% water can often result in trapped air due to the high surface tension of the water. Trapped air affects flow stability.

Priming the Pump

To prime the pump with your solvent and simultaneously flush the methanol out, you will need the 20 ml priming syringe and luer adapter found in the accessory kit. You will also need a solvent waste container.

1. Remove the waste line from the waste/prime port of the bypass valve, if connected.
2. Install the luer adapter to the waste/prime port (Fig. A.8). Tighten to finger-tight, then use a wrench to tighten approximately 1/4-turn. (This allows the priming syringe to be attached and detached conveniently.)

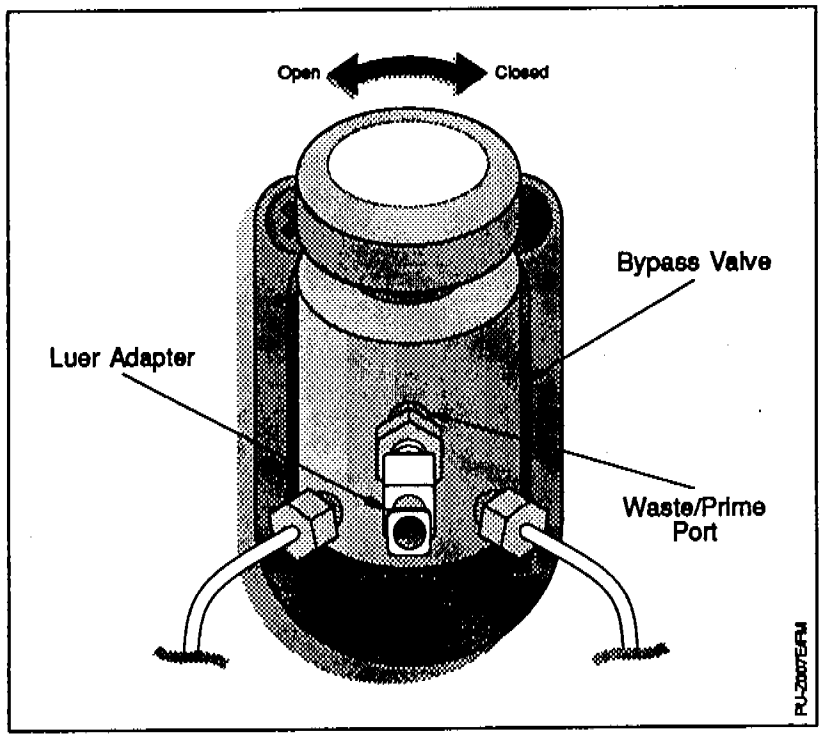


Figure A.8 Bypass valve with luer adapter connected

3. Make sure that the 20 ml luer-tip priming syringe is fully depressed. Connect the syringe to the adapter in the waste/prime port (Fig. A.9), twisting the syringe slightly to make a leak-free connection.

4. Position a solvent waste container nearby to collect the syringe discharge, since two or three syringe volumes may be needed to prime the pump. Make sure that all tube connections are air-tight.

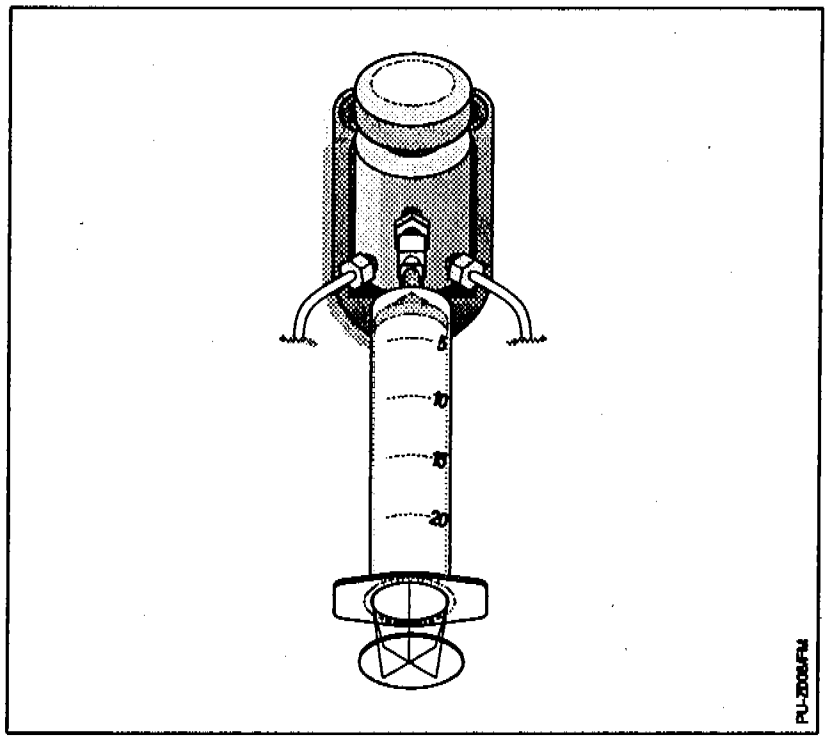


Figure A.9 Bypass valve with syringe attached

5. Open the bypass valve by turning the knob fully counterclockwise.

CAUTION! Solvents flow through the pump when the pump is purging or when a file is initialized (loaded as a run file).

6. Turn on power to the pump (if it not already on) and press [PURGE]. The P1500's Purge Menu (Fig. A.10) differs from the P1000's (Fig. A.11). If you have a P1500, the cursor should appear under the word Purge on the display. Press [+] to select the solvent (A or B).

CAUTION! Purging starts whenever the cursor is moved to the right in the Purge Menu, or whenever [ENTER] is pressed.

Purge	Flow	Time
A	1.00	0.0

Figure A.10 The P1500's Purge Menu

Purge	Flow	Time
FLOW	1.00	0.0

Figure A.11 The P1000's Purge Menu

NOTE: The Flow field may be labeled Pres instead of Flow, depending on the purge mode that is set.

7. Press [ENTER] once. The cursor will move to the Flow field and you will hear purging begin.
8. With the cursor in the Flow field set the flow rate to 10 ml/min. If the purge mode is pressure, set the pressure to 1000 psi (69 bars, 7 MPa).
9. Slowly pull the syringe plunger back, thus creating a small vacuum in the solvent lines and drawing the solvent from the solvent bottles (or the vacuum degasser), into the pump heads. *Do not draw back so far as to remove the plunger from the syringe barrel!*

   If more than one draw is necessary to prime the pump, (*i.e.*, the syringe fills with air before solvent enters the pump heads), press [STOP], close the bypass valve (turn clockwise), remove the syringe, and depress the plunger. Reconnect the syringe, open the bypass valve, press [PURGE], [ENTER], and finish drawing the solvents into the pump as described at the beginning of this step.

   If you notice a leak in one of the fittings, or need to stop the solvent flow, press [STOP]. This will immediately stop flow through the pump.
10. When solvent steadily appears in the syringe and no air bubbles are present, press [STOP], then close the bypass valve.
11. Gently remove the syringe and empty it into the solvent waste container.
12. Remove the luer adapter from the valve port and store it, along with the priming syringe, for later use.
13. Connect the solvent waste line to the waste/prime port of the valve and tighten to finger-tight. Route the waste tubing to an appropriate solvent waste container.

Purging the Pump

With the pump primed, you now must purge the lines containing your chosen solvents.

1. Ensure that the solvent inlet filters inside each solvent bottle are in a vertical position so that air within the filter will not be trapped.
2. Fully open the bypass valve.
3. We suggest that you initially purge the lines with a volume of 10 ml. (Don't use too large a volume of degassed solvent, or you will need to wait a short time for more to be available from the SCM400.)

   If you have a P1000, follow the steps below to begin the purge operation:

   a) Press [PURGE] to reach the Purge Menu (Fig. A.12). If desired, change the purge mode by changing FLOW to PRES in the Purge field. (The word "Flow" in the top line of the display now shows pressure units.)

   b) Press [ENTER]. If the purge mode is Flow, enter a flow of 10.00 ml/min. [If pressure, set to 1000 psi (69 bars, 7 MPa).]

   c) Press [ENTER] and enter a time of 1.00 minutes. Ten milliliters should be enough volume to remove any trapped air and ensure that the pump and tubing are cleansed of any contaminants. The pump will automatically stop purging after one minute.

Purge	Flow	Time
FLOW	1.00	1.00

Figure A.12 The P1000's Purge Menu with flow and time values entered

If you have a P1500, follow the steps below to begin the purge operation:

a) Press [PURGE] to reach the Purge Menu (Fig. A.13).

b) Select the solvent of choice in the Purge field, then press [ENTER]. If the purge mode is Flow, enter a flow of 10.00 ml/min. [If Pres, set to 1000 psi (69 bars, 7 MPa).]

c) Press [ENTER] and enter a time of 1.00 minutes. Ten milliliters should be enough volume to remove any trapped air and ensure that the pump and tubing are cleansed of any contaminants. The pump will automatically stop purging after one minute.

Purge	Flow	Time
A	10.00	1.00

Figure A.13 The P1500's Purge Menu with flow and time values entered

If you choose to purge without setting a time in the Time field, you can stop the purge by pressing [STOP]. This will immediately stop flow through the pump.

4. When you complete the purge and the pump stops, close the bypass valve.

LC System Connections

Once the pump is purged, you can plumb it to the rest of your chromatographic system. Figures A.8 and A.9 illustrate the bypass valve, showing the pump's outlet. Using a pre-cut piece of stainless steel tubing (or PEEK tubing if inert/biocompatible), connect the outlet to your autosampler or manual injection apparatus.

If you are using a manual injector valve from Spectra-Physics Analytical, refer to Chapter 5 for complete information for installing the injector valve bracket.

If you are using a SpectraSYSTEM autosampler, the pump can send a ready signal to the autosampler through pin 1, and can receive a stop signal from the autosampler through pin 5. In addition, the ground contact (pin 3) must also be connected to the autosampler's ground contact. For complete information on how to make these connections, refer to the SpectraSYSTEM Autosampler Reference Manual, Appendix A. The table below summarizes the hardwire connections necessary between a SpectraSYSTEM autosampler and pump.

	PUMP		AUTOSAMPLER	
READY (Output)	Pin 1	to	Pin 5	*PUMP READY*
GROUND	Pin 3	to	Pin 1	*GROUND*
STOP (Input)	Pin 5	to	Pin 3	*PUMP STOP*
RUN (Input)	Pin 7	to	Pin 4	*GRAD START*
INJ HOLD (Output)	Pin 8	to	Pin 7	*INJ HOLD*

Table A.2 Pump connections to SpectraSYSTEM autosampler

Specifications

FEATURE	SPECIFICATION
Pump Design	Dual in-line piston, pulseless design. Micro-stepped motor control. Floating piston bayonet-mounted heads. Patented ceramic check valves.
Flow Accuracy	±0.5% at 1 ml/min with water, after liquid end calibration (ASTM method E-19.09.07)
Flow Precision	<0.2% RSD
Flow Range	0.01 to 10 mL/min standard. Up to 30 mL/min using inert/biocompatible (PEEK) option. Settable in 0.01 mL/min increments. (30 mL/min settable in 0.1 mL/min increments)
Maximum Pressure	6000 psi, 420 bar, 42 MPa with standard heads; 4000 psi, 280 bar, 28 MPa with inert/biocompatible (PEEK**) heads
Wetted Surfaces	Stainless steel or PEEK, titanium, ceramic, sapphire, Teflon®, Tefzel®, and polyethylene
Pressure Pulsation	<2% amplitude; <1% typical at 1 ml/min water or methanol at >500 psi
Compressibility Compensation	Automatic
Method File(s)	Protected in non-volatile memory
Shutdown File	User programmed file initiated automatically at end of sample run to clean out pump and column.
Flow Stability Test	Pump flow diagnostic to verify proper pump performance.
Diagnostics	Diagnostic tests to verify proper electrical and mechanical operation.
Communications	Hardwire external events connector. Run and Stop remote inputs; Ready, Run, Timed Event and Analog Pressure outputs.
Ambient Environment	10 - 40°C, 5 - 95% relative humidity, noncondensing.
Dimensions	H x W x D 37 cm x 15 cm x 47 cm
Weight	18 kg 38.6 pounds

Power Requirements	115/230 VAC nominal; 200 VA; 50/60 Hz
Fuse Size	4.0 Amperes
Product Certification	CSA (safety) TÜV/GS (safety) FCC Class A (EMI) VDE Class B (EMI)

** With aqueous solvents.

Warranty

COVERAGE

Spectra-Physics Analytical (SPA) warrants that products manufactured by Spectra-Physics Analytical shall be free of defects in materials and workmanship for the warranty period which commences at date of shipment. All product warranties provide, for a period of one year, parts (excluding all normal consumable and maintenance items), labor, and travel within a radius of 100 km from an SPA authorized repair center. Products warranted for 5 years have an additional 4-year parts coverage. SPA will, at its option, either repair or replace defective instruments or components. Exceptions to this warranty period are shown in Table 1 below.

TABLE 1:
INSTRUMENTS COVERED BY A ONE-YEAR WARRANTY

SCM400 (Solvent Conditioning Module)
SHM2 (2-Solvent Helium Degassing Kit)
SHM4 (4-Solvent Helium Degassing Kit)
Spectra PHORESIS™ 1000
Spectra PHORESIS™ 500
DataJet™ Integrator
Shodex RI Detector
All Computers Sold with SPA Products
SP8792 (Column Heater)

Instruments, parts, and accessories not manufactured by SPA, may be warranted by SPA for the specific items and periods expressed in writing on SPA warranty statements or published price lists. All such accessory warranties extended by SPA are limited in accordance with all the terms, conditions, and other provisions stated in this warranty. SPA makes no warranty whatsoever concerning products or accessories not of its manufacture, except as noted above.

SPA warrants that software and firmware designed by SPA for use with an SPA analytical instrument will execute their programming instructions when properly installed on that instrument. SPA does not warrant that the operation of the instrument, software, or firmware will be uninterrupted or error-free.

Customers located outside the United States or Canada should contact their local SPA representative for warranty information appropriate to their locale.

CUSTOMER RESPONSIBILITIES

The customer bears the following responsibilities with regard to maintaining the warranty. The customer shall:

1. Perform the routine maintenance and cleaning procedures specified in SPA's operating and service manuals at the specified intervals. Failure to perform specified maintenance will automatically void warranty.
2. Use SPA replacement parts. Failure to use the specified replacement parts will automatically void warranty.
3. Supply consumables such as paper, disks, gases, solvents, columns, syringes, lamps, needles, filters, frits, batteries, vials, etc.
4. Provide access to the products during the specified periods of coverage to perform service.
5. Provide adequate and safe working space around the products for servicing by SPA personnel.
6. Provide access to, and use of, all information and facilities determined necessary by SPA to service and/or maintain the products. (Insofar as these items may contain proprietary or classified information, the customer shall assume full responsibility for safeguarding and protecting them from wrongful use.)

REPAIRS AND REPLACEMENTS

Repair or replacement of products or parts under warranty does not extend the original warranty period.

With the exception of consumable and maintenance items, replacement parts or products used on instruments out of warranty are themselves warranted to be free of defects in materials and workmanship for 90 days.

Any product, part, or assembly returned to SPA for examination or repair shall have SPA's prior approval and be sent prepaid by the customer. Return transportation will be at SPA's expense if the product, part, or assembly was under warranty.

WARRANTY LIMITATIONS

The Warranty does not cover:

a) Parts and accessories which are expendable or consumable in the normal operation of the instrument.
b) Any loss, damage, and/or instrument malfunction resulting from shipping or storage, accident (fire, flood, or similar catastrophes normally covered by insurance), abuse, alteration, misuse, neglect, or breakage or abuse of parts by User.
c) Operation other than in accordance with correct operating procedures, and environmental and electrical specifications.
d) Modification of, or tampering with, the system.
e) Improper or inadequate care, maintenance, adjustment, or calibration by User.
f) User-induced chemical action (such as precipitation of buffers), contamination, or leaks.
g) Any loss, damage, and/or instrument malfunction resulting from use of User-supplied software, hardware, interfaces, or consumables other than those specified by SPA.

WARRANTY EXCLUSIONS

In the course of normal use and maintenance, certain parts have finite lifetimes. For this reason, the consumables and maintenance parts listed in Table 2 carry only a 90-day warranty unless otherwise specified.

TABLE 2:
CONSUMABLES AND MAINTENANCE PARTS

UV/Vis Detectors	FL2000 Detectors
Flowcells	Flowcells
Tungsten Lamps	Xenon Lamps (1 year)
Deuterium Lamps (500 hours)	
Autosamplers	**Pumps/SCM**
Needles	Pistons and Seals
Filters	Inlet Filters and Spargers
Sample Injection Valves	Check Valves
Syringes	Bypass Valves
Flush Valves	Sample Injection Valves

LIABILITY LIMITATIONS

THIS WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES, INCLUDING (BUT NOT LIMITED TO) WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES WILL SPECTRA-PHYSICS ANALYTICAL BE LIABLE FOR CONSEQUENTIAL DAMAGES OR LOSS OF ANY KIND. THE LIMITS OF SPECTRA-PHYSICS ANALYTICAL'S LIABILITY IN ANY DISPUTE SHALL BE THE PRICE RECEIVED FROM THE PURCHASER FOR THE SPECIFIC EQUIPMENT AT ISSUE.

B Menu Reference

Introduction

This appendix contains an alphabetical list of all fields and menu items shown in the pump's display. A brief description of the field or menu item is given. For fields, allowed values are listed. The default value for each field is shown in parentheses at the end of each description.

Also contained in this appendix is a Menu Tree. If you become "lost" within the pump's menus, you many find the Menu Tree a valuable resource. The Menu Tree is also useful when learning about the pump without having a pump in front of you.

Editable Fields and Menu Selections

Field/Menu Name	Allowed entries (Default entry)
@Maximum Pres	Used to determine the pump's response to reaching the maximum pressure setting during operation. Stop, Continue, Shutdown (**Stop**)
AC Power Fail	Used to determine the pump's response to recovering from a power disruption during operation. Continue, Stop, Shutdown (**Continue**)
Calculated Time	*TESTS, Calibration, Flow Calibration (Fixed Volume mode)* Values are not typically entered in this field. The pump inserts a time (in minutes). See Measured Time. Initiate Calibration "test" by pressing [RUN].
Calculated Vol	*TESTS, Calibration, Flow Calibration (Fixed Time mode)* Values are not typically entered in this field. The pump inserts a calculated volume (in milliliters). See Measured Vol.
Calibration	*TESTS* This menu contains two calibration tests.
Check Valve Test	*TESTS, Diagnostics* A diagnostic test which evaluates check valve performance.
COMMANDS	*(P1500) Main Menu* This menu contains the commands Hold (or Continue) and Reset.
Continue	*(P1500) COMMANDS* Continue replaces Hold whenever the pump's state is HOLD. Resumes pump operation according to the run file.
Copy	*(P1500) FILES* Copy the contents of one file to another.
Copy File: **To File:**	*(P1500)* Select two files by number.
Current History	*TESTS, Service* Contains a chronological list of operating state changes. Number on the far left indicates time (in minutes) since the state change occurred.
Cursor Speed	Set the speed at which selectable choices scroll: Fast, Medium, or Slow (**Medium**)
DATE	Set the date that service was performed on the items listed in the Maintenance Log.
Dead Volume Ratio	*TESTS, Maintenance Log, Liquid End Type (appears only when OTHER is selected for Liquid End Type)* Used to enter several values which refine the pump's operation whenever non-standard liquid ends are installed on the pump. The dead volume ratio is the ratio of the dead volume (contained in the inlet liquid ends, check valves and transducer tube) to the stroke (piston) volume.

Delete *FILES* Deletes the contents of a file (returns all file values to their defaults).

Delete *(P1500) QUEUE* Deletes the contents of the Queue.

Delete File *(P1500)* Select a file by number to delete.

Diagnostics *TESTS* This menu contains four diagnostic tests.

DUE Enter a volume (in liters) 0 - 999 that the pump will pump before displaying a Maintenance Due message. **(0)**

Edit *FILE(S) menu* In the P1000 this menu contains fields for acquisition parameters. In the P1500 the menu shows the file name and other menus containing acquisition parameters.

Edit *(P1500) QUEUE menu* Menu contains an ordered list of files and the number of runs per file.

Edit File *(P1500)* Select a file by number 1 - 4, or name Shutdown, *(P1500)* **(1)**

Equilibration Time *(P1500)* Enter a value for the number of minutes that the conditions on the first line of a run file will be maintained and held, before the pump shows ready. 0.0 - 99.9 **(0.0)**

Error Recovery *OPTIONS* This menu contains three fields whose values determine the pump's response to certain operational conditions.

Event *(P1500)* Timed event operation. Off, On **(Off)**

FILES *(P1500) Main Menu* This menu contains Edit, Load, Copy, and Delete.

FILE *(P1000) Main Menu* This menu contains Edit, Load, and Delete.

File Name *(P1500)* in FILES, enter a name; in QUEUE, select a file by number.

Fixed Time *TESTS, Calibration, Flow Calibration* Allows calibration of flow based on a known, measured volume.

Fixed Volume *TESTS, Calibration, Flow Calibration* Allows calibration of flow based on a known, measured time.

Flow *FILES, Edit, Solvent Program (P1500) or FILE, Edit (P1000)* Used to set a flow rate (in ml/min) 0.00 - 9.99, or 10.0 - 90.0 with optional heads.

Flow *[PURGE]* Enter a flow rate.

Flow Calibration *TESTS, Calibration* Select a flow calibration mode. Fixed Time, Meter or Fixed Volume (Fixed Time). For Meter see also Selected Flow and Measured Flow. For Fixed Volume see also Elapsed Time and Desired Time. For Fixed Time see also Calculated Vol and Measured Vol.

Flow Correction

(appears if Liquid End Type is changed or after a flow calibration test) View OLD and NEW Flow Correction values (in percent of flow). Select Use, Save or Scrap the New value (default is Use, not saved to NOVRAM when pump is powered-down). A NEW value is entered automatically after the pump obtains results of a flow calibration test (meter mode), however the NEW value can be edited manually. Allowed values are 90.00 to 110.00 percent. For uncorrected flow enter 100.00%.

Flow Range

Normally, a pre-set flow range is displayed, based on the Liquid End Type selection. This field is only active if "Other" has been selected for the Liquid End Type. The maximum flow range accepted is 100 mL/min. **(0 - 10 mL/min)**

Flow Stability

TESTS, Diagnostics Test used to evaluate the stability of solvent flow.

Hold

(P1500) COMMANDS Maintains flow and solvent parameters until a Continue command is issued.

ITEM

(not editable) This field shows several pump parts that can be replaced during routine maintenance.

Lifetime History

TESTS, Service Displays a log of five measured items: top line shows the total time that the pump's motor has been running and the total number of strokes (in thousands) taken by the cam; the bottom line shows the number of times the pump has been powered-on, the number of times the pump has been powered-down, and the number of times an error occurred when NOVRAM was written to upon power-down.

Liquid End Type

TESTS, Maintenance Log The Liquid End Type menu contains information and settings that pertain to the type of liquid ends installed in the pump.

Liquid End Type

This field is used to select a type of liquid end, all but one of which correspond to preset flow ranges. Normal (0 - 10 ml/min), Inert (0 - 30 ml/min), Prep (0 - 90 ml/min), and Other. When Other is selected, the user may enter his own flow range values in the Flow Range field. **(Normal)**

Load

FILE(S) Load and initializes a file (it becomes the run file).

Load

(P1500) QUEUE Loads the queue. The first file listed in the queue is loaded and initialized. This menu item is replaced by Pause when a queue has been loaded.

Load File

(P1500) Select a file by number to load.

Maintenance Log

Contains the Maintenance Log and two additional menu selections.

Maintenance Position

TESTS, Maintenance Log Puts the pump's cam in the proper position for liquid end maintenance.

Maximum Pressure

0 - 6000 PSI, 0 - 414 BAR, or 0 - 41 MPa **(6000 PSI, 414 BAR, 41 MPa)**

Measured Flow

TESTS, Calibration, Flow (Meter mode) Used to enter a the actual volume the pump has pumped after exactly 1 minute. The pump uses the two values shown in the Flow Menu to calibrate the flow. See Selected Flow. Initiate this calibration by pressing [RUN]. Old and new Flow Correction values (in percents up to 110% of set values) are displayed during the calibration. You may choose to Use, Scrap, or Save the values obtained by the flow calibration test.

Measured Parameters

Displays two values: current operating flow rate and solvent compressibility.

Measured Time

TESTS, Calibration, Flow Calibration (Fixed Volume mode) Enter the time (in minutes) the pump takes to pump a fixed volume. See also Calculated Time. Initiate calibration by pressing [RUN].

Measured Vol

TESTS, Calibration, Flow Calibration (Fixed Time mode) Enter the actual volume output (in milliliters) by the pump in a fixed time. Initiate calibration by pressing [RUN].

Meter

TESTS, Calibration, Flow Calibration Allows calibration of flow based on a known, measured flow rate.

Minimum Pressure

Used to set a minimum operating pressure value. 0 - 6000 PSI, 0 - 414 BAR, or 0 - 41 MPa **(0)**

More

OPTIONS This menu contains several options fields and File Protection fields.

NEW

A value is entered automatically after the pump obtains results of a flow calibration test (meter mode), however the NEW value can be edited manually. Allowed values are 90.00 to 110.00 percent. For uncorrected flow enter 100.00%.

#Runs

Enter the number of times each file will be run. The number of runs for a file contained in a queue cannot exceed 999. **(1)**

OPTIONS

Main Menu Contains two (P1500) or three (P1000) selections whose menus contain operational options.

Options

(P1500) FILES, Edit Contains fields for optional file parameters, including equilibration time, maximum/minimum pressure.

Order

(P1500) Not editable. This field shows the queue's sequence.

Pause

(P1500) QUEUE Pause replaces Load in this menu whenever a queue has been loaded.

Pressure Units

Units pressure is displayed/set in. PSI, BAR, MPa **(PSI)**

Protect

(P1500) Set On or Off for each file. Off prevents the file from being edited, saved to, deleted or copied to. **(Off)**

PSI, BAR or MPa

(P1500) [Purge] Set a purge pressure. Maximum values depend on pressure units selected. The default value is one-half the maximum pressure set in the run file.

Purge

[PURGE] This menu contains purge parameters: flow rate or pressure, and length of time to purge. In the P1500, also select a solvent; in the P1000 select a purge mode.

Purge

In the P1500, select a solvent to purge: A or B (A); in the P1000 select a mode: FLOW or PRES (FLOW)

Purge Mode

Purge mode can be based on a flow rate or a pressure setting. Flow, Pressure (Flow)

QUEUE

(P1500) Main Menu The Queue Menu contains Edit, Load, and Delete.

Ready Output Active

Sets the signal at the READY output on the back of the pump. Hi, Lo (Hi)

Reset

(P1500) COMMANDS A command used to reset the file; stops the current run and re-initializes the run file, resetting the pump's clock to zero.

Selected Flow

TESTS, Calibration, Flow Calibration (Meter mode) Displays the flow rate last used in a file. Typically this field is not entered. See Measured Flow. Initiate Calibration "test" by pressing [RUN]. Old and new Flow Correction values (in percents up to 110% of set values) are displayed during the calibration. You may choose to Use, Scrap, or Save the values obtained by the flow calibration test.

Service

TESTS This menu contains seven service tests and two other menu items (Current History, Lifetime History).

Shutdown

(P1000) OPTIONS This menu contains the Shutdown file consisting of Flow and Time from Ready fields. The Shutdown File is automatically loaded and run whenever the set time has elapsed, with the pump showing READY, without a run being initiated.

SHUTDOWN

(P1500) File selected for editing. If Time from Ready field in /Options/ contains a non-zero value, the Shutdown File is automatically loaded and run whenever the set time has elapsed, with the pump showing READY, without a run being initiated.

Software Version

Menu item used to display the version of software residing in the pump.

Solvent Program

(P1500) FILES, Edit This menu contains time lines used to set time, solvent, and flow.

Status Lock

Select a user's ability to see the Run File from Status. Selections are On or Off. (Off)

Status Menu

[STATUS], below Status Screen View or edit the run file as desired.

TESTS

Main Menu The Tests Menu contains five selections (Software Version, Diagnostics, Maintenance Log, Calibration, Service).

Time

File editing, and Timed Events: enter a time (to tenths of a minute) 0.0 - 99.9, 100 - 650 (minutes) **(0.0)**.

Time

OPTIONS, Shutdown (P1000) Amount of time the pump continuously shows READY, before the Shutdown file is automatically loaded and run. Off, 5, 10, 20, 30, 45, 60, 90, 120, 240, 480 **(Off)**

Timed Events

(P1500) FILES, Edit This menu contains lines used to turn on and off a signal to the external events pin (pin 6).

Time From Ready

(Shutdown File only) Amount of time the pump continuously shows READY, before the Shutdown file is automatically loaded and run. Off, 5, 10, 20, 30, 45, 60, 90, 120, 240, 480 **(Off)**

Transducer Range

Enter the calibration value for a newly installed pressure transducer. This value is marked on the transducer cable near the connector.

Unstable Flow

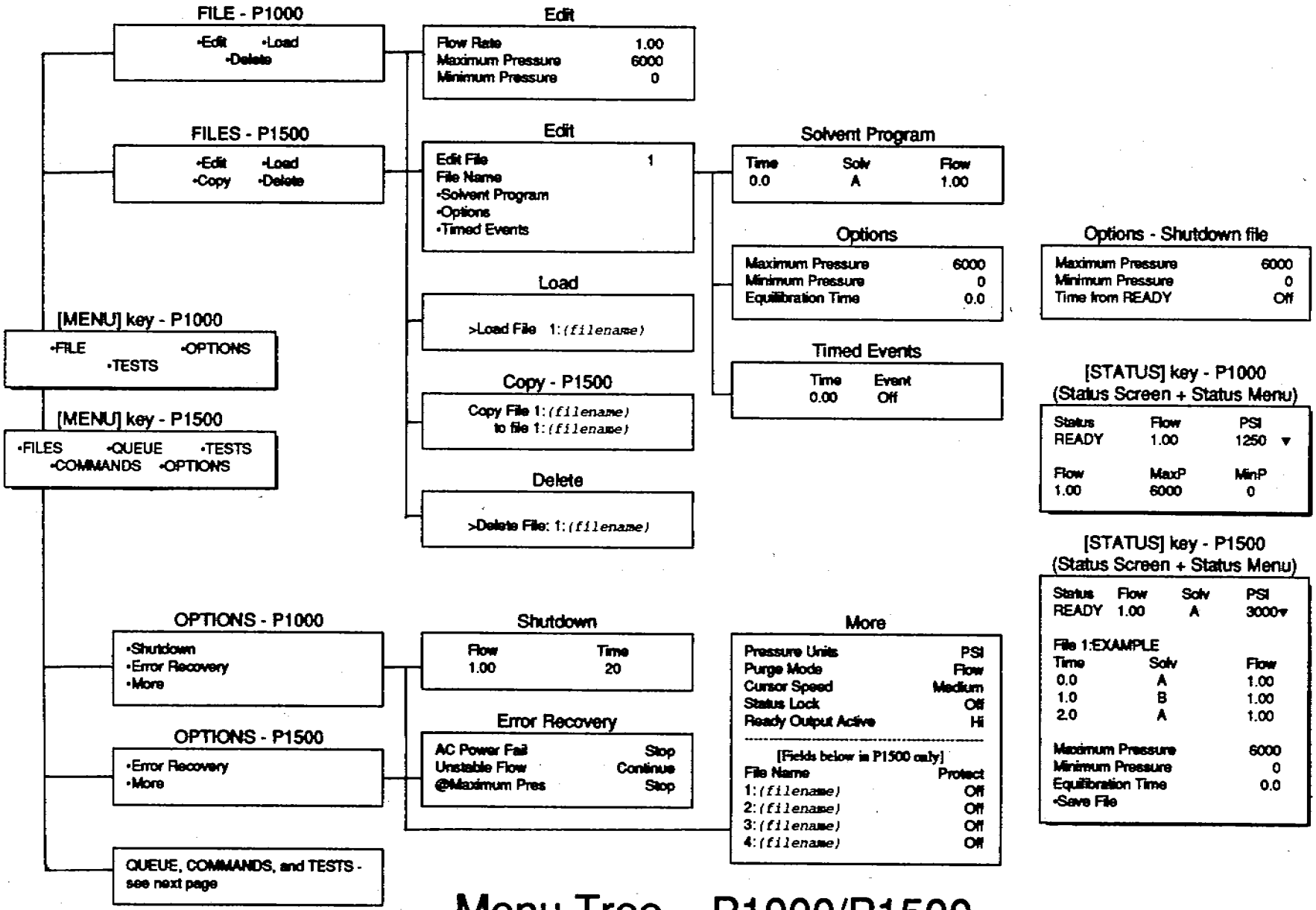
Used to determine the pump's response to sensing an unstable flow during operation. Continue, Stop, Shutdown **(Continue)**

VOL

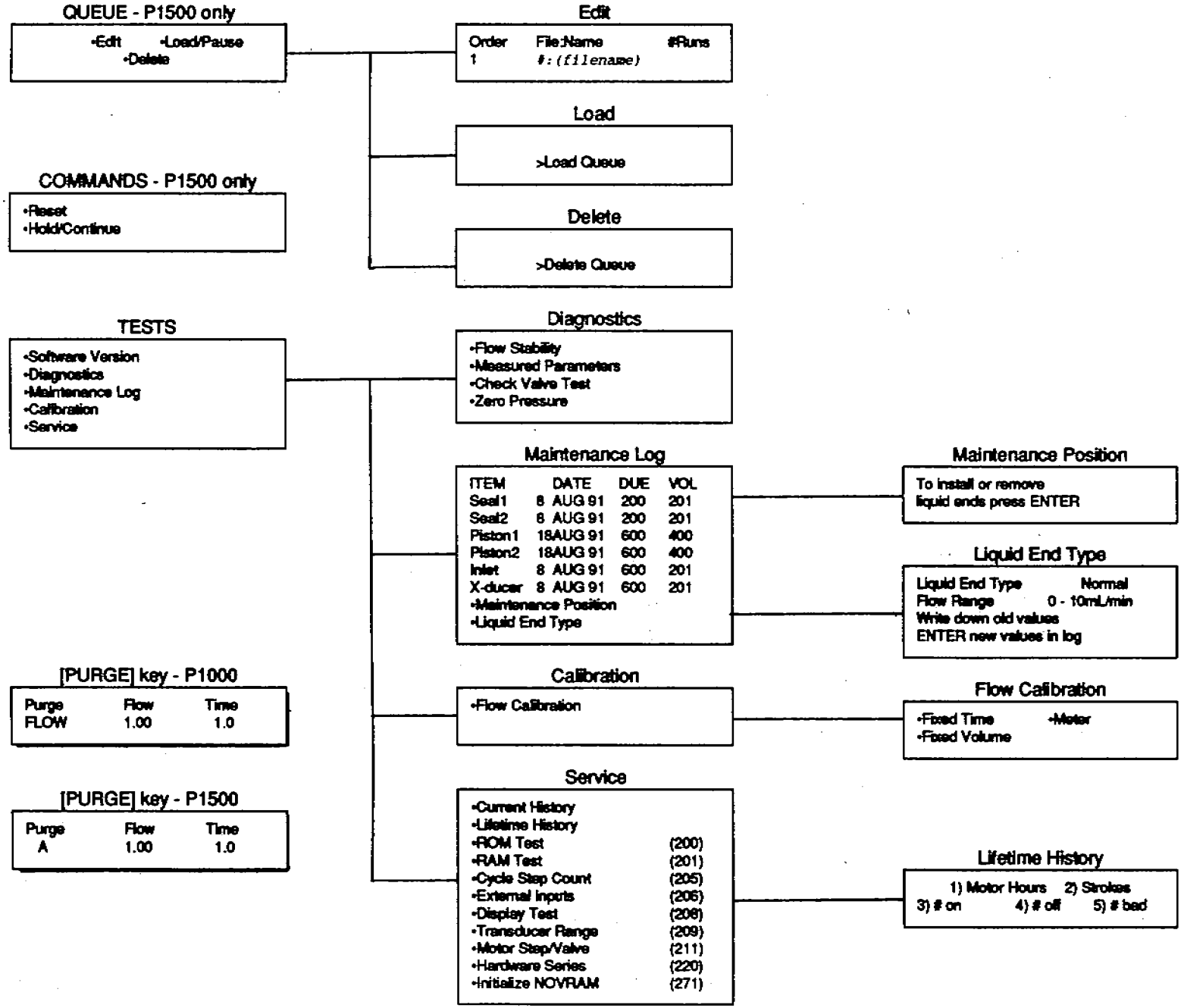
A cumulative count of the volume (in liters) pumped.

Zero Pressure

A command/test which zeros the pressure transducer's setting. Must be performed with no pressure in the LC system (*i.e.*, remove the column and/or open the bypass valve).



Menu Tree - P1000/P1500


QUEUE - P1500 only
•Edit •Load/Pause
•Delete
COMMANDS - P1500 only
•Reset
•Hold/Continue
TESTS
•Software Version
•Diagnostics
•Maintenance Log
•Calibration
•Service
[PURGE] key - P1000
Purge Flow Time
FLOW 1.00 1.0
[PURGE] key - P1500
Purge Flow Time
A 1.00 1.0
Edit
Order File:Name #Runs
1 #:(filename)
Load
>Load Queue
Delete
>Delete Queue
Diagnostics
•Flow Stability
•Measured Parameters
•Check Valve Test
•Zero Pressure
Maintenance Log
ITEM DATE DUE VOL
Seal1 8 AUG 91 200 201
Seal2 8 AUG 91 200 201
Piston1 18AUG 91 600 400
Piston2 18AUG 91 600 400
Inlet 8 AUG 91 600 201
X-ducer 8 AUG 91 600 201
•Maintenance Position
•Liquid End Type
Calibration
•Flow Calibration
Service
•Current History
•Lifetime History
•ROM Test (200)
•RAM Test (201)
•Cycle Step Count (205)
•External Inputs (206)
•Display Test (208)
•Transducer Range (209)
•Motor Step/Valve (211)
•Hardware Series (220)
•Initialize NOVRAM (271)
Maintenance Position
To install or remove
liquid ends press ENTER
Liquid End Type
Liquid End Type Normal
Flow Range 0 - 10mL/min
Write down old values
ENTER new values in log
Flow Calibration
•Fixed Time •Meter
•Fixed Volume
Lifetime History
1) Motor Hours 2) Strokes
3) # on 4) # off 5) # bad

C Troubleshooting

Introduction

Your SpectraSYSTEM pump is designed to operate trouble-free for many years when properly maintained. Most pump problems can be avoided by simple, periodic maintenance, as described in Chapter 6. However, in the event that an error message is displayed or if a mechanical or electrical failure is suspected, the problem can be easily diagnosed. Further, if the diagnosis indicates that a problem exists with non user-serviceable parts inside the pump, a qualified Spectra-Physics Analytical service representative can quickly and easily replace most malfunctioning parts.

This appendix contains information on:

- Theory of operation
- Displayed messages (error messages, other messages)
- The Tests Menu (where all self-tests are accessed)
- General LC system troubleshooting

A quick-reference hardware troubleshooting guide is included at the end of this appendix that includes tips for diagnosing and remedying hardware problems. This guide can save you time in diagnosing problems when the symptoms are known.

Theory of Operation

An isocratic pump works by first pulling a solvent into a valve. In the P1500 pump there are two valves; only one valve is used during operation, as specified in the run file. Solvent travels to the pump head, where a piston regulates the flow of the mixture to an outlet tube. The solvent is routed through the pressure transducer, into a second pump head, then through a bypass valve (closed during normal operation), and finally out to the LC system. The pump's outlet tubing is then generally connected to an automatic injector, such as an autosampler.

Troubleshooting Your Pump

SAFETY PRECAUTIONS

Observe the following safety precautions whenever troubleshooting hardware difficulties.

HIGH VOLTAGE! To avoid electrical shock do not open covers or remove parts beyond the descriptions in the operation portions of this manual or in this troubleshooting section.

WARNING! Disconnect the power cord before changing the voltage setting on the back of the pump, or before replacing fuses.

HIGH VOLTAGE! Capacitors inside the pump may still be charged even if the pump has been turned off and disconnected from power.

HIGH VOLTAGE! If, after any maintenance or repair, the pump requires adjustment with the top cover off and the power on, such service should be performed by a trained Service Representative who is aware of the hazards involved.

WARNING! Whenever working on an LC system wear eye and skin protection.

CAUTION! Prevent contamination of pump parts! Wear finger protection and perform disassembly of pump parts on uncontaminated surfaces.

ELIMINATE ALL OTHER POSSIBLE SOURCES OF TROUBLE

Before you spend any time trying to diagnose a suspected pump problem you should verify that the pump is the only source of difficulty. Systematically eliminate all other instruments in your LC system as the source of trouble. If you are not sure which component of your chromatography system is responsible for poor system performance the *General LC System Troubleshooting* section beginning on page 142 of this appendix provides useful suggestions.

WHEN YOU'RE SURE ITS THE PUMP

Once you have isolated the pump as the only remaining source of difficulty, a variety of self-tests are built into the pump to help you determine if your pump is operating correctly.

The next section describes the tests found in the /TESTS/ menu item. Instructions for the built-in hardware and electronics diagnostics are contained within the description of the Test Menu.

Types of Messages That Indicate Pump Problems

Error Messages

Error messages are indicated on the display by exclamation points and are displayed whenever an undesirable condition exists that prevents the pump from carrying out an operation. These types of messages remain on the display until you press a key.

When certain real time performance faults are encountered, your pump displays a message informing you of the problem. A list of error messages and their meaning begins below.

Test Messages

Test messages are only displayed as a result of a test being initiated and/or completed. These messages may be instructions for running a test, or the results of the test itself. These messages often will point directly to a source of trouble. Specific test messages are explained in conjunction with each test in the Test Menu section.

Error Messages

The following messages may occur while operating your pump.

BELOW MINIMUM PRESSURE	The column pressure has fallen below the file's Minimum Pressure setting. Check for mobile phase leaks.
CHECKSUM ERROR BAD PROGRAM	The program memory may have been corrupted. Make a note of the circumstances which preceded the message and contact Spectra-Physics Analytical.
CODE ERROR PROGRAM LOST	The program code has errors. Make a note of the software version and the circumstances which preceded the message. Contact Spectra-Physics Analytical.
CODE ERROR STACK UNDERFLOW	The program code has errors. Make a note of the software version and the circumstances which preceded the message. Contact Spectra-Physics Analytical.
CODE ERROR STACK OVERFLOW	The program code has errors. Make a note of the software version and the circumstances which preceded the message. Contact Spectra-Physics Analytical.
CODE ERROR FALSE POWER FAIL	You may have experience low line voltage ("brown-out") or there may be hardware problems. Note the circumstances which preceded the message and contact Spectra-Physics Analytical.
EXCEEDS FLOW RANGE	A flow rate was entered in the pump file which exceeded the flow rate capabilities of the pump. The maximum flow rate for standard SpectraSYSTEM pumps is 10 ml/min. If higher flow rates are needed, inert/biocompatible liquid ends are available to extend the flow rate to 30 ml/min. Contact your local sales representative for information.

MAX PRESSURE EXCEEDED	The column pressure of the system has exceeded the MaxP (maximum pressure) value entered into the pump file. The file's Maximum Pressure value may need to be increased. The default value is 3000 psi for 10 ml/min liquid ends (the maximum is 6000 psi). If your operating column pressure is increasing, check for column plugging.
MOTOR STALLED	The motor is unable to maintain the combination of requested flow rate and needed pressure for operation. Reduce flow rate or check for flow restriction or plugged column frit.
OUT OF SOLVENT	The pump has detected that no solvent is available. Check reservoir levels and prime the pump. See Appendix A for priming technique.
OVER MAXIMUM TEMPERATURE	The pump has overheated. This may be due to blocked ventilation slots or to a hardware malfunction.
POWER FAILURE CONTINUE	A power failure has occurred or the pump was switched off with the motor running. The pump has automatically resumed operation. ("Continue" was selected in /OPTIONS/, /Error Recovery/, AC Power Fail.)
POWER FAILURE STOP	A power failure has occurred or the pump was switched off with the motor running. The pump has automatically stopped. ("Stop" was selected in /OPTIONS/, /Error Recovery/, AC Power Fail.)
POWER FAILURE SHUTDOWN	A power failure has occurred or the pump was switched off with the motor running. The pump has automatically loaded and run the shutdown file. ("Shutdown" was selected in /OPTIONS/, /Error Recovery/, AC Power Fail.)
UNSTABLE FLOW	The flow is not stable. This can be caused by bubbles or a rapidly changing flow rate. Depending on the selection made under Unstable Flow in the error recovery options, the pump will either continue, stop, or shutdown when unstable flow is detected. See Chapter 4 for more information about the pump's response to unstable flow. No error message is displayed if the pump is set to "Continue."
VACUUM DEGAS PROBLEM	The SCM400's vacuum pump has been operating more frequently or for a longer period than is considered normal. Check for leaks. Check the SCM400's vacuum pump exhaust tube for liquid. Suspend operation immediately if liquid is seen flowing from the exhaust tube. (A small amount of condensation inside the exhaust tube is normal.) This message causes the pump to hold operation for five minutes. After that time, pump operation automatically resumes.
ZERO FLOW RATE	A time line (other than Time = 0.0 min) with a zero flow rate was encountered. To remedy, enter a valid flow rate in the first line of the pump file. Rates between .01 and 10 ml/min are valid for standard SpectraSYSTEM Pumps. The optional inert/biocompatible liquid ends extend the maximum flow rate to 30 ml/min.

Table C.1 Error messages

The Tests Menu

This section assumes that the source of the problem is known to be the SpectraSYSTEM pump. If you are not certain that the pump is the source of trouble, refer to *General LC System Troubleshooting*, on page 142.

To access the Tests Menu, select /TESTS/ from the Main Menu (Fig. C.1).

```
•FILES          •QUEUE          >TESTS
      •COMMANDS          •OPTIONS
```

Figure C.1 Main Menu with /TESTS/ selected

The Tests Menu (Fig. C.2) consists of five items. Tests are divided into three specific menus, for convenience: diagnostic tests, calibration tests, and service tests. The Maintenance Log is described fully in Chapter 6.

```
>Software Version
•Diagnostics
-------------------------------------------------------
•Maintenance Log
•Calibration
•Service
```

Figure C.2 The Tests Menu

ABOUT RUNNING TESTS

Tests are internal computer programs that exercise the pump's hardware and circuitry and verify operation. If any abnormal behavior is found it is reported as a message or an electronic circuit board failure code. In most cases the test isolates the problem to the failed module or component.

"Active" and "Passive" Tests

There are active and passive tests. Passive tests can be initiated at any time as they do not affect either file memory or pump performance. Passive tests are usually initiated by pressing [ENTER]. Active tests require that the pump be idle before being initiated, since the pump's valves and motor maybe engaged during the test. Usually, active tests are initiated by pressing [RUN], and are stopped by pressing [STOP]. Some tests stop by themselves. An active test should not be performed while the pump is in operation, as it will interfere with pump operation.

CAUTION! Pressing [STOP] during a "passive" test can interrupt pump operation.

Initiating Tests

To initiate a test, move the cursor to the test's name and press [ENTER]. Always follow the instructions displayed on the pump when you initiate a test. In some cases the message, "Pump must be stopped to run test" may be displayed if you attempt to run an active test while the pump is in RUN. Alternately, if the pump is stopped when you initiate a test you may see the message, "The Pump Must Be Running to Perform This Test" In most cases, the pump will initiate an active test if the pump is in INIT, EQUIL, or READY.

Usually you will press [ENTER] to initiate a passive test, or [RUN] to initiate an active test. Some tests display instructions. In these cases, follow the instructions in the message to proceed.

Test Results

After each test is run a message appears advising you of the results of the test. In most cases, if trouble is found, the message indicates the failure or failed component.

Specific test menu descriptions begin on page 127.

Flow Stability and Hardware Series Test Routines

Under most circumstances the Flow Stability and Hardware Series tests will provide a thorough evaluation of the condition of your pump. We recommended that these two tests be used first if the performance of the pump is in question. The Flow Stability test is described on page 127 and the Hardware Series Tests is described on page 137.

SOFTWARE VERSION (PASSIVE)

Selecting /Software Version/ displays the version of software contained in the pump. The particular version of software resident in your pump will vary depending upon the date of manufacture or upon the date of software upgrade.

THE DIAGNOSTICS MENU

The Diagnostics Menu (Fig. C.3) contains three items commonly used to evaluate the pump and an additional selection to allow the pressure transducer's output to be zeroed.

```
>Flow Stability
•Measured Parameters
------------------------------------------------------------
•Check Valve Test
•Zero Pressure
```

Figure C.3 The Diagnostics Menu

Flow Stability

Your pump is constantly monitoring its flow stability while pumping. An internal software program allows the pump to determine when flow stability has been adversely affected by leaking check valves, out-gassing solvents, or other abnormal conditions.

The Flow Stability test (a passive test) evaluates how even the solvent flow is through the pump. The pump must be pumping solvent for this test to be run. The test can be initiated when the Status Screen shows any one of these states: EQUIL, INIT, or READY (all pumps). In addition, *time*, QEQUIL, QINIT, or QREADY can be displayed on the P1500 pump. Completion of the test however, is dependent on the pump being in a READY state. When the pump is not in a ready state the Flow Stability screen will read, "Not Ready". When flow stability is being evaluated, the screen will read, "Test in Progress. Please Wait."

The pump's cam must go through at least 10 pump cycles (cam revolutions) to accurately assess stability. The value displayed is affected by the compressibility of the solvent being pumped and the compliancy of the hardware (tubings, column, etc.). Therefore, the results are reported in two ways: a) an overall judgement of the pump performance which appears in the upper left-hand corner of the display and b) a number indicating where, within the range, the result lies. This number is shown in the upper right-hand corner of the display. Three flow stability readings are possible:

Stable	(0- 25)
Acceptable	(25 - 90)
Unstable	(> 90)

Unless a very volatile or compressible solvent is being pumped, for example hexane, a number near the higher end of the range (60-90) probably indicates that the system is not ideal, and the results of further troubleshooting might improve the flow stability.

NOTE: The Flow Stability test will show unstable flow during column equilibration.

If the results of the flow stability test are abnormal for your LC application, follow these steps to locate the problem:

1. Test the integrity of the inlet and transducer check valves by running a Check Valve test. (See page 129.)
2. Verify that the mobile phase solvents are adequately degassed.
3. Refer to the recommendations of *General LC System Troubleshooting Techniques.*

The flow stability assessment will remain displayed until you stop the test by pressing any one of the following keys: [ENTER], [^], [MENU], or [STATUS].

Measured Parameters

Measured Parameters (a passive test) consist of two flow-related measurements. The first line of the Measured Parameters Menu (Fig. C.4) shows the measured flow rate. The number in parentheses indicates the flow rate setting in the run file. The second line shows the compressibility of the solvent(s) inside the pump. This value is calculated by the pump, based on its reading of current operation.

```
Flow Rate              (2.00)        1.95
Compressibility                      20.63
```

Figure C.4 An example of the Measured Parameters Menu

The measured parameters will remain on the display until the test is stopped by pressing any one of the following keys: [ENTER], [^], [MENU], or [STATUS].

Check Valve Test

The Check Valve test (an active test) can help you further diagnose the source of flow stability problems. If the results indicate a defective check valve, the test should be repeated to ensure the results were not due to an isolated transient condition, such as a single air bubble.

This test affects flow accuracy while the test is running. Do not run the test during an analysis. The pump can be in INIT, EQUIL, or READY and the flow rate must be 2.5 ml/min or less (for standard liquid ends). If the test is activated and the current flow rate is greater than 2.5 ml/min, a message will be displayed, prompting you to reset the flow rate. In general, the flow rate must be set to one-quarter or less of the maximum flow rate of the liquid ends.

HINT: Defective check valves tend to perform better at higher column pressures. Lowering the column pressure by decreasing the flow rate increases the test's sensitivity of marginally operating check valves.

To activate the test select /Check Valve Test/. Follow the displayed instructions. A message will inform you of the 8 - 10 pump cycle delay before test completion. During this time, the condition of the inlet and transducer check valves of the pump are monitored. When the monitoring period is complete, pumping returns to normal constant flow control and a message is displayed, showing the results. Messages are listed in Table C.2.

Pressing [RUN] after the results are displayed will rerun the test. Stop the test by pressing [ENTER] or [^].

NOTE: The inlet check valve is located at the base of the inlet liquid end. The transducer check valve is located at the base of the pressure transducer.

Both check valves good	Both check valves are performing well.
Transducer check valve is defective	The transducer check valve should be replaced. See Chapter 6, *Required Maintenance* for instructions.
Inlet check valve may be defective	The inlet check valve may be defective. An air bubble lodged in the check valve or piston seal or a slight leak in an inlet fitting may cause this message to be displayed. Verify that solvents are adequately degassed and that fittings are tight. Purge the pump and rerun the test to verify the message. If this same message is displayed, replace the inlet check valve. See Chapter 6, *Required Maintenance* for instructions.
Bubbles or leaks likely. Check degas	The check valves are not the cause of flow problems. Verify that solvents are adequately degassed and that fittings are tight. Observe the inlet tubing while purging the pump. If air bubbles are seen, increase the helium flow rate (if helium degassing), or tighten the leaking fitting. Tighten bottle caps. Ensure solvent supply is vented. NOTE: Pulse dampeners should not be used with SpectraSYSTEM pumps. The flow is dynamically controlled and will be adversely affected by compliant loads.
Test aborted, Pump not referenced in 10 Cycles	The pump is not able to establish a reference column pressure within 10 pump cycles. The pump has serious flow problems. Verify that the solvents used are miscible in all concentrations encountered. If possible for your column, increase the column pressure by raising the flow rate. The check valves require more than 100 psi column pressure to operate properly. Defective check valves will usually operate well enough at higher pressures to allow the test to run.
Test aborted By Operator	The test was stopped before the pump could count 8 cycles.

Table C.2 Check Valve Test Results

Zero Pressure

The pump allows the pressure transducer's output to be zeroed automatically without the need for adjustment of potentiometers. The pump should be stopped before selecting /Zero Pressure/. The display will show:

```
Release system pressure,
then press ENTER key.
```

Figure C.5 Release system pressure prior to zeroing the pressure transducer's output

Release the system pressure by opening the bypass valve or removing the column from the system to ensure that the transducer is actually sensing zero system pressure. Otherwise, a message showing "Unable to Zero" will appear. Follow the instructions to complete zeroing the pressure. To abort the test, press [ENTER], or [^], or [STOP]. This will return the zero setting to its previous value.

THE MAINTENANCE LOG

The Maintenance Log is fully described in Chapter 6, *Required Maintenance.*

THE CALIBRATION MENU

The Calibration Menu (Fig. C.6) contains a Flow Calibration "test". The flow Calibration can be run in one of three modes.

```
•Flow Calibration
```

Figure C.6 The Calibration Menu

Flow Calibration

The Flow Calibration asks the pump to perform some internal calculations based on user-measured values. This is a passive test but it uses the [RUN] key. Unless run incorrectly, this test will not interfere with pump operation. Select /Flow Calibration/ to access the flow calibration menus.

The test is run in one of three modes. Select either Meter, Fixed Volume or Fixed Time from the Flow Calibration Menu (Fig. C.7). Depending on your selection, the display will allow you to enter values that enable the test to be completed. These are described in Table C.3 below:

```
•Fixed Time                    •Meter
•Fixed Volume
```

Figure C.7 Flow Calibration Menu

Calibration Mode	*Value to Enter*
/Meter/	**Measured Flow** (ml/min). This calibration mode assumes that you have externally measured the precise flow rate that the pump is operating at while set at a specific flow rate. Keep the pump set at that flow rate while you run this test. (It is automatically entered in the Selected Flow field.) Press [RUN]. The display will show old and new flow correction values, as percents. (This is the same value that appears in the Flow Correction Menu accessed whenever the Liquid End Type is changed from the Liquid End Type Menu (/TESTS/, /Maintenance Log/)) You must determine whether to Use, Scrap, or Save the new value. Make this selection in the field in the middle of the bottom line of the display. Enter values in the Flow Correction Menu as desired, then press [RUN] to complete the test.
/Fixed Volume/	**Measured Time** (min). This calibration mode assumes that you have externally timed the period in which a specific volume has been pumped. Enter values as desired then press [RUN] to initiate the test. The Flow Correction Menu is displayed. Enter values as desired. Press [RUN] to complete the test.
/Fixed Time/	**Measured Vol** (ml). This calibration mode assumes that you have collected and measured a specific volume pumped during a fixed time period. Enter values as desired, then press [RUN] to initiate the test. The Flow Correction Menu is displayed. Enter values as desired. Press [RUN] to complete the test.

Table C.3 Flow calibration modes

To exit the flow calibration menus without entering any values, press [^] until you return to the Calibration Menu. To stop the calibration after entering a new value, press [STOP].

CAUTION! Do not press [STOP] unless you have already entered a new value in one of the flow calibration menus. If the pump is in RUN, doing so will interfere with your analysis. Use [^] to exit the flow calibration menus instead.

THE SERVICE MENU

The Service Menu (Fig. C.8) contains several service-related tests, including the Hardware Series test.

```
>Current History
•Lifetime History
-------------------------------------------------------
•ROM Test                                    (200)
•RAM Test                                    (201)
•Cycle Step Count                            (205)
•External Inputs                             (206)
•Display Test                                (208)
•Transducer Range                            (209)
•Motor Step/Valve                            (211)
•Hardware Series                             (220)
•Initialize NOVRAM                           (271)
```

Figure C.8 The Service Menu

The numbers in parentheses refer to similar test found in earlier Spectra-Physics pumps. They are included for the convenience of users and service personnel familiar with this previously-used numbering scheme.

Current History

By selecting /Current History/ you access a chronological list of operating state changes. The negative number on the far left indicates the time (in minutes) between the time the Current History Menu was accessed and the state change occurred. More specific information about reading the Current History Menu is found in the SpectraSYSTEM Pumps Field Repair Manual.

To exit the Current History, press [ENTER].

Lifetime History

By selecting /Lifetime History/ you access a log of five measured items relating to the entire time the pump has been in operation. An example Lifetime History Menu is shown in Figure C.9.

The top line shows 1) the total time that the pump's motor has been running in hours (Hr) and 2) the total number of strokes in thousands (kSt) taken by the cam; the bottom line shows 3) the number of times the pump has been powered-on (on), 4) the number of times the pump has been powered-down (off), and 5) the number of times an error occurred when NOVRAM was written to upon power-down (bad).

Press any one of the following keys to exit the Lifetime History screen: [ENTER], [^], [MENU], or [STATUS].

```
          1.2 Hr          2.3kSt
24on              23off           0bad
```

Figure C.9 The Lifetime History Menu

ROM Test (Passive)

The ROM test (200) verifies the integrity of the ROM (Read Only Memory) in your pump. The ROM is where all of the built-in programs for the pump operation are stored. If faults are found in any part of ROM, a message indicating that the test has failed will be displayed. Press [STOP] to stop this test. Do not to press [STOP] more than once or else pump operation will be interfered with.

If a failure is indicated, contact Spectra-Physics Analytical.

RAM Test (Active)

The RAM test (201) verifies the integrity of the RAM (Random Access Memory) in your pump. The RAM is where your pump files are stored and where temporary calculations are performed. The pump must be stopped (STOP) for this test to be implemented. If any faults are found with RAM, the message shown in Figure C.10 is displayed:

```
RAM TEST failed
```

Figure C.10 RAM Test failure message

Contact Spectra-Physics Analytical if this test indicates a failure.

Cycle Step Count (Passive)

Normally, 12,800 motor drive pulses are required for one revolution of the pump motor, as detected by the cam sensor. The Cycle Step Count test (205) displays a count of the number of pulses required for the last complete motor revolution.

The Cycle Step Count test is a dynamic measurement of the number of steps counted, the lag amount (the number of steps the count has shifted since the last revolution), and the number of seconds required for the last revolution.

Generally, the number of steps should be 12,800 ± 64. The lag value varies due to the load on the pump. This number should be steady, or fluctuate no more than ±120 steps.

Start the test by selecting /Cycle Step Count/. To stop the test, press any one of the following keys: [ENTER], [^], [MENU], or [STATUS].

NOTE: The Cycle Step Count test requires that a full cam revolution has occurred.

External Inputs (Passive)

The External Inputs test (206) allows you to conveniently monitor the status of two of the external input lines, STOP and RUN. The STOP line causes the pump to stop pumping when momentarily grounded. A momentary ground at the RUN input line causes the run time clock to begin. Use this test if you are having difficulty interfacing your pump to a controlling device, such as a SpectraSYSTEM autosampler.

To run the test, select /External Inputs/. The display continuously shows the current state of the STOP and RUN inputs (updates every 0.5 second). "Lo" means the input is grounded (active) and "Hi" means the input is "high" (inactive).

In addition, this test displays the state of the SCM400 (if DEGAS cable is properly connected): READY, NOT READY, GROUNDED, or ABSENT.

To stop the test, press either [ENTER], [^], [MENU], or [STATUS].

Display Test (Passive)

The Display test (208) exercises the pump's display. When initiated, the display shows staggered alphanumeric characters that scroll from left to right. Pressing [STOP] freezes the display; pressing [RUN] resumes movement.

This test is also a keyboard test. Pressing the cursor keys will cause the alphanumeric display to scroll in that direction.

Other keys can be tested by first pressing [ENTER] to access the key test. The display will verify other keys such as [STATUS] or [MENU], as soon as each is pressed.

To return to the scrolling alphanumeric characters, press [RUN], [RUN]. To stop the test, and return to the Service Test Menu, press [STOP], [STOP].

Contact your representative if the display appears unusual.

Transducer Range (Active)

Transducer Range is not truly a test. It contains a field where you may enter the calibration value for a replaced pressure transducer. Your pump features advanced circuit designs which allow the pressure transducer range adjustment to be set by entering a value from the keyboard. No adjustment of potentiometers is necessary. Your pump comes from the factory preset to the proper range. The value is stored in a NOVRAM. Do not change the transducer calibration setting unless the pressure transducer or System PCB are replaced. The calibration number is recorded on a tag attached to the transducer cable. The System PCB and pressure transducer are not user-serviceable parts. A qualified service representative must perform any repair or replacement.

Motor Step/Valve (Active)

The Motor Step/Valve test (211) exercises the pump motor and the switching valve on the P1500. When activated, the pump motor is continuously stepped and each switching valve is sequentially opened and closed at a rate of 1 valve per 0.512 seconds. This test is useful for detecting an intermittently failing switching valve or pump motor.

Select /Motor StepValve/ to initiate the test. Follow the instructions. Each open valve is shown dynamically on the display. The test will continue until one of the following keys is pressed: [ENTER], [^], [STOP], [MENU], or [STATUS].

Hardware Series (Active)

The Hardware Series test (220) is an extensive evaluation of the System Printed Circuit Board (PCB), switching valve, pump motor, and pressure transducer. The System PCB contains all of the circuitry for the operation of the pump, except for the display functions. Once activated, the test exercises and diagnoses the condition of various circuits. The pump must be idle (not pumping) before activating the test. This test will not affect pump files.

NOTE: The external events connector (if present) must be removed from the rear of the pump before initiating the Hardware Series test. Otherwise, "Board Failure: Code 8" may occur.

To activate the test, select /Hardware Series/. Follow the instructions given on the display. Typically, the display will show:

```
Release system pressure
Then press ENTER.
```

Figure C.11 Initial Hardware Series test message

Open the column bypass valve or otherwise remove column pressure from the transducer since the pump will operate during the test and an excessively high column pressure might be generated if not bypassed. Press [ENTER] to continue the test.

Once the test is activated the display will appear as in Figure C.12.

```
        Test in Progress
```

Figure C.12 Hardware Series test message, after pressing [ENTER]

The pump's components are tested in the following order.

1) Pressure transducer and circuitry
2) Input/output ports
3) Solvent switching valve and circuitry (P1500 only)
4) Motor drive circuitry
5) Cam marker and circuitry
6) Motor revolution and sine/cosine circuitry

As each portion of the test is completed a message is displayed. If all components and circuitry are within specifications, the messages shown in Figure C.13 are displayed during the test.

If a failure is detected during the test, the failure message is displayed. It remains displayed until [ENTER] is pressed (the test resumes).

To stop the test, press [STOP], or press [^] to return to the Service Menu.

```
TRANSDUCER TEST PASSED
-------------------------------------------------------
PORT TEST PASSED
-------------------------------------------------------
VALVE TEST PASSED          (P1500 only)
-------------------------------------------------------
MOTOR DRIVE TEST PASSED
-------------------------------------------------------
CAM MARKER TEST PASSED
-------------------------------------------------------
REVOLUTION TEST PASSED
-------------------------------------------------------
Hardware series tests completed - PASSED
```

Figure C.13 No problems found during the Hardware Series test

If problems are found during the test, a message suggesting the most likely failure is displayed, although in some cases other failures are possible. The messages shown in Table C.4 indicate a possible System PCB failure.

Table C.4

BOARD FAILURE: CODE XXX	If the failure is identified as a component on the system printed circuit board or if the test cannot determine the failed component, a message is reported where XXX is a 1-, 2- or 3- digit number.
8	Remove the external events connector from the rear of the pump. This test exercises the input lines and may be affected by attached cabling.
1-100	Pertains to failures of the system printed circuit board. Contact your service representative.
101, 102, 103	Indicates the switching valve's electrical system (P1500 only) has failed. Refer to Chapter 6, under *Solvent Switching Valve Replacement.*
104, 105	Possible broken or loose pump motor cable wire.

124	Too many motor steps were needed to complete a cam revolution. You may have a loose motor coupler or faulty System PCB. Contact your local sales/service representative for service information.
125	Too few motor steps were needed to complete a cam revolution. You may have a faulty cam sensor or System PCB. Contact your local sales/service representative for service information.
TRANSDUCER UNPLUGGED	The pressure transducer was not detected. The connector going to the pressure transducer should be checked. Access to this connector requires the removal of the pump's outer protective cover. Because there are safety issues involved in its removal, this should only be performed by a qualified service technician. The location of this connector as well as the proper procedure for removing the outer cover are outlined in the Field Repair Manual.
CANNOT ZERO TRANSDUCER	The transducer circuitry is not able to compensate for the zero offset of the transducer. Make sure that the system is at zero column pressure (column bypassed) before starting the test. If so, replace the transducer. Contact your local sales/service representative for assistance.
CHECK FUSE F1	(P1500 only.) Fuse F1 is used to protect the valve drive circuitry from internally shorted valves which may short internal circuitry on the system PCB. Checking the status of F1 requires the removal of the outer cover of the pump. Because of safety issues involved in the removal of this cover a trained service technician should perform this evaluation. Contact your local sales/service representative for assistance.
CAM MARKER NOT FOUND	This message indicates that the sensor that detects cam revolutions is not operational. Either the motor coupling is loose or the cam sensor is defective. This requires tightening of the motor-to cam coupler if loose, or replacement of the cam sensor. Both of these actions require the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform this evaluation.
VALVE CABLE UNPLUGGED	(P1500 only.) The test has detected that the solvent switching valve cable is disconnected from the System PCB. There are two locations where the valve is connected. The first location is underneath the switching valve assembly. To access this location the switching valve must first be removed. This is achieved by unscrewing the finger-tight captive fasteners which hold the assembly in place. Once this is accomplished the cable connector is visible. Press together the connector attached to the cable coming from the switching valve assembly to the mating connector located nearby in the chassis of the pump. If this fails to remedy the problem then the second cable connection location should be checked. Correction of the problem at this second location requires the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform corrective action.

CAM SENSOR FAILURE	The cam sensor cable is disconnected or defective and needs to be replaced. Correction of this problem requires the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform corrective action. Contact your local sales/service representative for service information.
NO CURRENT TO MOTOR	The test has detected no current flow through the pump motor. Either the motor cable is unplugged on the System PCB or the entire drive circuitry is defective. Correction of this problem requires the removal of the top cover. Because of safety issues involved in the removal of this cover a trained service technician should perform corrective action. Contact your local sales/service representative for information on obtaining a replacement.

Table C.4 (cont.) Hardware Series test messages that indicate problems

Initialize NOVRAM (Active)

The pump must be stopped for /Initialize NOVRAM/ to be completed.

CAUTION! Initialize NOVRAM (271) has a profound effect upon the pump's non-volatile RAM. Do not initialize the NOVRAM unless you fully understand all consequences associated with this action.

By initializing the NOVRAM all files are reset to their default values, with the exception of the run file. All user-preferences set in /OPTIONS/ are also returned to their default values. In addition, any changes that had been made to the Liquid End Type and Flow Calibration parameters are erased, and these selections are returned to their default values. The pressure transducer's range setting, entered by the factory, is also reset. See the note below.

NOTE: Record the value of the pressure transducer's range before initializing the NOVRAM. This value must be re-entered into the pump's memory after NOVRAM has been initialized. To obtain the pressure transducer's range select /TESTS/, /Service/, /Transducer Range/. On a separate paper record the value displayed. After initializing NOVRAM, again select /TESTS/, /Service/, /Transducer Range/ and re-enter this value. Zero the transducer after entering the range value by selecting /TESTS/, /Diagnostics/, /Zero Pressure/. Follow the instructions and zero the pressure transducer.

In general, any field value or selection that is normally retained when the pump is turned off and then on will be reset to its default value when the NOVRAM is initialized.

HINT: To retain a single file while initializing the NOVRAM: load it (so that it becomes the run file), stop the pump, initialize NOVRAM, make a change to a value within the run file from Status, then select /Save File/ at the bottom of the Status Menu.

Other Messages

Table C.5 lists other messages which can be displayed.

`Maintenance Due` `See Log`	A volume milestone has been reached. Consult the Maintenance Log for component by pressing the [MENU] key and selecting /TESTS/, /Maintenance Log/. For more information, refer to Chapter 6.
`Memory Full` `File Not Copied`	There is not enough memory available to copy the parameters of one file into another. Free memory by deleting an old or unused file, or by reducing the number of time lines in a file. Try to copy the file again.
`Memory Nearly Full` `Data May Not Be Saved`	There may not be enough memory available. Double-check the file to ensure that no parameters or settings were lost. Free memory by deleting an old or unused file, or by reducing the number of time lines in a file. Try to save the file again.
`No Queue Available`	You cannot load a queue if none has been set up first.
`Not Enough Room` `File Not Saved`	The run file changes cannot be saved to the file. Free memory by deleting an old or unused file, or by reducing the number of time lines in a file. Try to save the run file once more from the Status Menu.
`Protected File` `Cannot Be Copied To`	You cannot modify a protected file.
`Protected File` `Cannot Be Deleted`	You cannot modify a protected file.
`Protected File` `Cannot Be Edited`	You cannot modify a protected file.
`Queue Loaded` `Cannot Load File`	When a queue is loaded you cannot load any other file without first pausing the queue.
`Run In Progress` `No Testing Allowed`	The test cannot be initiated because the pump is in RUN or is in HOLD.

Table C.5 Other messages

General LC System Troubleshooting Techniques

The following is a helpful guide when troubleshooting a liquid chromatographic system.

- Study the effects of changing flow rate or solvent on the chromatogram and then change only one variable at a time while observing the result.
- Define not only the symptoms, but provide quantitative information of their magnitude. Record all parameter settings.
- Make sure that the problem can be repeated. If the problem is of a random nature, note the following: the time and date of each occurrence, and the sequence of events prior to the occurrence of the problem.
- Eliminate chemical and operating contributing factors. Check and/or replace the column. Clean the column, dilute the sample, and check the mobile phase for purity. Run solvents on a scanning UV spectrometer over a range of ± 50 nm of working wavelength.
- Check the pump for flow rate accuracy.
- Beware of changes made to the chromatographic system (e.g., new solvents, columns, or samples). If a problem develops after a change has been made, revert to the conditions existing before the problem appeared.
- Check the date when the last periodic maintenance procedures were performed on the system and when the pump seals and filters were replaced.
- Make sure that the solvents are degassed and that air is excluded from all fluid lines. If bubbles are still present, check the condition of the inlet filters and adjust the seal of the fittings without over-tightening them. Check for leaks on all fluid lines.
- Run a test sample. Most column manufacturers provide a sample, a chromatogram, and a set of conditions that you can use. Compare the new chromatogram with the one supplied by the manufacturer and with your own chromatograms obtained prior to the problem.
- Replace the column with a flow restrictor (a column filled with glass beads) that provides a minimum of 1000 psi (69 bars) pressure drop at normal analytical flow rates. Note the pressure drop and compare with the values obtained earlier. Observe how consistent the pressure is under isocratic conditions.

The following information lists the most common chromatography system problems that may occur. An explanation of possible remedies is provided along with each symptom.

Drifting, Noisy or Unusual Baseline

As a first step, stop the pump flow and monitor the detector baseline. If the noise and drift are still present after ten minutes, the fault is likely to be in the detector. Refer to your detector operators manual for further information on diagnosing detector problems.

Equilibration - Allow adequate time for the total system to fully equilibrate. The system must be at temperature and at equilibrium to avoid baseline drift.

Solvent UV Cutoff - A detector wavelength too close to the mobile phase UV cutoff causes excessive flow-related noise on the baseline and a baseline shift. As an example, the UV cutoff of LC grade methanol is 205 nm. This is the point of 1.0 absorbance unit.

However, even at 220 nm, methanol absorbs more than 0.2 absorbance unit. To reduce this sensitivity of the detector to the mobile phase, either raise the detector wavelength or change to a solvent with a lower UV cutoff. In this case, UV-grade acetonitrile (cutoff 190 nm) may be a better solvent to use.

Mobile Phase Degassing - Use thoroughly degassed solvents to avoid noise and spikes attributed to dissolved gases in the mobile phase. Your SpectraSYSTEM pump provides for continuous vacuum or helium degas of solvents. If helium is used, maintain sufficient helium flow to ensure positive flow from the vent line. Caps must seal tightly and vent lines must be in place.

Column - Replace or condition the column to avoid drift due to column aging or degradation.

Solvent Contamination - Change the solvents used for the mobile phase. "Ghost" peaks are often related to impurities in the mobile phase solvents. Run a blank analysis to spot solvent impurities.

Retention Time Reproducibility

Composition - Inconsistent pre-mixed solvent composition is likely if the peak retention times are variable, yet the unretained peak is consistent in retention time from run to run.

Flow Rate - Pump-flow induced retention time inconsistencies will also affect the unretained peak. Measure the pump flow with the column in the system to detect flow irregularities due to column obstructions.

Column - As the column ages or starts to degrade, long term (day-to-day) retention time variances are more likely than short term (run-to-run).

Equilibration - Allow the system to fully equilibrate before starting analysis. The pump file (P1500) can be programmed to return to initial conditions prior to the end of the run to help speed equilibration after analysis.

Changes in Detector Sensitivity

Manually inject a standard sample and compare the results to sample results previously achieved to help determine if the detector has lost sensitivity or if the chromatography system is at fault. If the detector is suspected, refer to your detector's operators manual.

Column - Verify that the column has not degraded and is the proper column for the analysis. Replace the column with a new one.

Injections - If using an autosampler, verify the volume of sample injected by manually reproducing the injections. If manually injecting, verify the sample loop and the condition of the sample valve.

Sample - Is the sample analysis well known? If not, use a known test sample to verify detector response. The sample may not be stable in its present environment. Verify the sample concentration.

Baseline Spikes

Stop pump flow to determine if baseline spikes are due to electrical disturbances or from bubbles in the mobile phase passing through the detector flow cell. If the spikes do not stop when the pump flow is stopped, the problem is likely electronic in nature. Refer to your detector's operators manual.

Bubbles - Thoroughly degas mobile phase solvents. Check all fittings for tightness. Clean or replace plugged solvent inlet filters which may cause pump piston cavitation. Attach a coil of small bore tubing to the sample exit line of the detector to provide a slight back pressure on the flow cell.

Hardware Troubleshooting Guide

Symptom	Possible Cause	Diagnostic/Remedy
1. No response when power is switched on.	a) Power cord not firmly installed.	a) Re-seat cord.
	b) Power cord defective.	b) None/Replace cord.
	c) Power Entry Module Fuse blown.	c) None/Refer to page 89 for fuse replacement.
2. No display. Fan and pump run OK.	a) Display contrast needs adjustment.	a) Press [STATUS]. Press and hold the right-arrow key. Press the [+] or [-] key to adjust the display contrast.
	b) Internal fuse blown.	b) None/Contact Spectra-Physics Analytical representative for service.
3. No display.	a) System PCB defective.	a) None/Contact Spectra-Physics Analytical representative for service.
4. Only fan runs with power on.	a) Internal fuse blown.	a) None/Contact Spectra-Physics Analytical representative for service.
	b) Display cable loose/unplugged.	b) None/Contact Spectra-Physics Analytical representative for service.
5. No response to keypad entry. Display OK.	a) Keypad defective or System PCB defective.	a) None/Contact Spectra-Physics Analytical representative for service.
6. Random display.	a) Display defective.	a) Display Test/Contact Spectra-Physics Analytical representative for service.

Symptom	Possible Cause	Diagnostic/Remedy
7. Pump motor will not run.	a) Max pressure set to zero.	a) Press [STATUS]/Set Maximum Pressure to a value > 100 psi.
	b) Motor defective.	b) Hardware series test/Contact Spectra-Physics Analytical representative for service.
	c) Motor cable unplugged.	c) Hardware series test/Contact Spectra-Physics Analytical representative for service.
	d) Drive circuit.	d) Hardware series test/Contact Spectra-Physics Analytical representative for service.
	e) Internal fuse blown.	e) Hardware series test/Contact Spectra-Physics Analytical representative for service.
	f) Target pressure low.	f) None/Press [PURGE] and then reinitialize file.
8. Oil found on inlet bracket.	a) Main bearing over-lubricated.	a) None/Small amount of oil is normal.
9. Solvent not switching.	a) Switching valve cable loose.	a) Hardware series test/reconnect cable.
	b) Switching valve defective.	b) Hardware series test/replace solvent switching valve.
	c) Switching valve drive defective.	c) Hardware series test/Contact Spectra-Physics Analytical representative for service.
	d) Cam marker failure.	d) Hardware series test/Contact Spectra-Physics Analytical representative for service.
10. Switching valve does not click open.	a) Internal fuse defective.	a) Hardware series test/Contact Spectra-Physics Analytical representative for service.
	b) Switching valve drive failure.	b) Hardware series test/Contact Spectra-Physics Analytical representative for service.

Symptom	Possible Cause	Diagnostic/Remedy
11. Flow unstable (will not go READY).	a) Check valve failure.	a) Flow Stability Test, Check Valve Test/replace check valve - see Appendix C.
	b) Immiscible solvents.	b) Flow Stability Test, Check Valve Test/change solvent system.
	c) Unstable load (column).	c) Flow Stability Test, Check Valve Test/Pump must see stable, non-compressible load.
	d) Insufficient degas.	d) Flow Stability Test, Check Valve Test/Increase helium rate (if helium degas) or decrease flow rate (if vacuum degas). Use vent line and good bottle cap seal.
	e) Circuitry failure.	e) Hardware series Test/Contact Spectra-Physics Analytical representative for service.
	f) Partially clogged frit or filter on high pressure side of pump.	f) Hardware Series Test/Replace filter or frit.
12. Sudden shift in pressure display with no flow.	a) Pressure transducer failure.	a) None/Contact Spectra-Physics Analytical representative for service.
	b) Circuitry failure.	b) Hardware series Test/Contact Spectra-Physics Analytical representative for service.
13. Pump goes from RUN immediately to READY (will not maintain RUN state).	a) Run file has only one time line.	a) View run file/add time line and reload file.
14. Pump will not start or stop remotely.	a) Incorrect wiring.	a) External Inputs Test/Correct wiring.
	b) SCM400 not ready.	b) Press [STATUS]. If Status shows DEGAS, wait for SCM400 to show green light. Or, disconnect DEGAS cable.

D Glossary

A

autosampler — an instrument designed to automatically inject samples into the sample flow path with a high degree of precision and reproducibility; sometimes called an injector

B

baseline — the reference line at the bottom of a chromatogram from which measurements are made; a baseline represents the chromatogram that would be drawn if only the mobile phase (with no sample) were run through the column

binary — capable of mixing or switching between two solvents

biocompatible — describes components that are inert when used with biological samples; biocompatible components are usually made from titanium, Teflon®, PEEK, quartz, or sapphire

buffer — a medium the resists changes in acidity and alkalinity

C

channel — the path along which something (solvent or information) flows

chromatogram — a plot depicting the separated components in a sample (absorbance units versus time); each component is shown as a separate peak whose concentration can be determined by studying the area under the peak

chromatograph — the basic set of instruments needed to perform chromatography: a pump, injector (manual or automatic), a column, and a detector; various recording and data handling instruments are common additions

chromatography — a means of separating and analyzing mixtures of chemical substances

column — the packed tube through which a sample is passed for separation; the sample separates according to the way in which it adheres to the column's packing material

component — an "ingredient" in a chemical mixture, also the individual parts of a liquid end assembly

conditioning — the process of preparing the surface of the column wall and introducing the buffer pH conditions into the column before a run

configuration — the way instruments are interconnected to form a system

cursor — a moving or blinking symbol on the display which indicates where information is entered

D

default — a value or choice built into a system; if no specific choice is made, instruments will run (or data analyzed) using the default settings

degassing — removal of dissolved gas (*i.e.*, oxygen) from the solvent to prevent bubbles from forming in the pump; degassing can be done by vacuum or by sparging

detector — the instrument used to detect the presence of a chemical compound

diagnostics — ways of detecting and isolating instrument or software problems

digit — an editable space within a field

display — the backlit LCD screen on all SpectraSYSTEM™ instruments

E

elution time — the length of time needed to pass a particular sample through a packed LC column

equilibration — the process used to bring a system (solvent, column, etc.) to a point of equilibrium, where all thermal and chemical reactions occur at equal rates; a stable baseline is a good sign of a well-equilibrated system

error message — a printed or displayed message that notifies the user of an error condition

error recovery — user-selectable responses to error conditions detected by the instrument, such as a power interruption or over-pressure

external event — an action performed by an external device that is under the control of the current instrument (see also timed event)

F

field — an area in a display, screen, or menu where an entry is required or a choice must be made

file protect — a P1500 setting which allows files to be edited when "off" and protects files from being changed by editing when "on"

flow parameters — flow rate, solvent, and run time

flow rate — the rate at which solvent flows through a system

G

ground terminal — a terminal used to connect the ground or earth lead of a signal or contact closure cable; generally green and/or black

H

helium manifold — a pneumatic assembly containing valves and switches for regulating helium sparging

helium sparging — see sparging

I

inert — see biocompatible

injection — the manual or automatic introduction of a sample into a chromatography system

integrator — the instrument used to analyze data and produce a chromatogram

isocratic — constant solvent composition

K

Kel-F™ seal — the translucent seal, made of Kel-F material, inside the pump head which faces the piston seal

keypad — all of the keys by which you can communicate with an instrument or computer

L

LC — Liquid Chromatography

linear — a gradient curve that follows a straight line

liquid end — the inlet or outlet assemblies of the pump consisting of the head, piston, seals, and sometimes a check valve

M

maintenance log — a place to record dates, service, and cumulative solvent volume pumped

menu — a list of choices

method — the set of parameters that define how one or more analyses will be accomplished

method development — the process of specifying the parameters under which an instrument will perform a particular function

N

NOVRAM — Non-volatile RAM (random access memory). Computer memory into which the user can enter information and instructions and from which the user can recall information. Data in NOVRAM are saved even when the instrument is switched off.

P

parameter — a value or set of values used to define the characteristics or behavior of an instrument or system

PEEK — polyetheretherketone; a material frequently used in fabricating inert/biocompatible components

piston — the short cylinder piece that moves inside the sealed cylindrical opening and is used to pressurize fluid

piston holder housing — the shaft into which the piston and its holder are housed

piston flush seal — the low-pressure spring seal inside the liquid ends, facing the piston assembly

piston seal — also called pump seal, a high-pressure spring seal located inside the pump head

plot — the presentation of analytical data in a graphical manner; typical plots include chromatogram traces and calibration curves

prime — to flush the solvents contained in a new pump in order to prepare the pump for solvents chosen by the user

pump — the instrument used to push a liquid solvent through a chromatography system

purge — to flush the system with fresh, degassed solvent

Q

queue — a set of files in a prearranged order

R

RAM — Random Access Memory (computer)

real-time — the current, actual time

reproducibility — the precision with which a piece of data can be repeated; a good measure of a system's overall performance

retaining screw — also retaining cap screw; the screw which holds the piston assembly into the piston holder housing

run — a complete analytical operation cycle of the chromatographic system

run file — the file that has been loaded and that the pump is currently operating by

run time — the duration of a sample run, from injection to separation

S

sample — a known or unknown substance in a small quantity

seal holder — a metal part used for pumps fitted with standard parts which contains two seals, (piston seal and piston flush seal) and allows the pump head and piston holder housing to be joined

shutdown file — a special file used by the pump after the pump has been in a READY state for a period of time set by the user

solvent — a substance that can completely dissolve another; the mobile phase of an LC system

solvent filter — a small cylindrical attachment for inlet tubing used to filter a solvent prior to the solvent entering a pump

solvent program — a set of time lines indicating a time, selected solvent, and flow rate

sparging — a degassing technique in which solvent gases are replaced with an inert gas such as helium or nitrogen

status — the current condition

status lock — a feature used to prevent a run file from being changed from the Status Menu

stroke one complete revolution of the pump's cam which displaces both pistons

system a set of chromatography instruments that operate together in a concerted manner to produce an analytical result

T

timed event an instrument action triggered to occur at a specific, preset time during a run or analysis

trace a chromatogram

transducer check valve the valve which attached to the inlet of the pressure transducer

V

vacuum chamber the housing surrounding the tubing pairs, inside an SCM400. Gases flow out of the solvent, through the tubing and into the vacuum chamber, which is vented to the atmosphere.

vacuum degassing the technique of removing dissolved gasses from solvents by passing the solvent through tubing made of gas-permeable membrane, and creating a vacuum around the tubing, thus allowing gasses to be evacuated out of the solvent and into the surrounding chamber

viscosity the degree to which a fluid resists flow

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