Waters

Alliance GPC 2000 Series System Installation and Maintenance Guide

Waters Alliance GPC 2000 Series System

Installation and Maintenance Guide

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NOTICE

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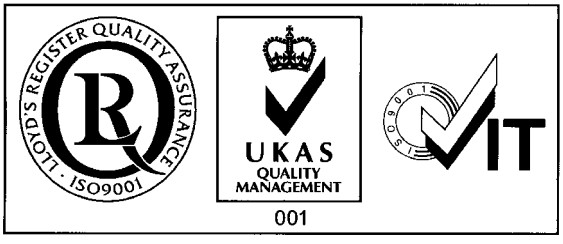


Note: *When you use the instrument, follow generally accepted procedures for quality control and methods development.*

If you observe a change in the retention of a particular compound, in the resolution between two compounds, or in peak shape, immediately determine the reason for the changes. Until you determine the cause of a change, do not rely on the separation results.

Note: *The Installation Category (Overvoltage Category) for this instrument is Level II. The Level II Category pertains to equipment that receives its electrical power from a local level, such as an electrical wall outlet.*

Attention: *Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.*

Important : *Toute modification sur cette unité n'ayant pas été expressément approuvée par l'autorité responsable de la conformité à la réglementation peut annuler le droit de l'utilisateur à exploiter l'équipement.*

Achtung: *Jedwede Änderungen oder Modifikationen an dem Gerät ohne die ausdrückliche Genehmigung der für die ordnungsgemäße Funktionstüchtigkeit verantwortlichen Personen kann zum Entzug der Bedienungsbefugnis des Systems führen.*

Avvertenza: *eventuali modifiche o alterazioni apportate a questa unità e non espressamente approvate da un ente responsabile per la conformità annulleranno l'autorità dell'utente ad operare l'apparecchiatura.*

Atención: *cualquier cambio o modificación efectuado en esta unidad que no haya sido expresamente aprobado por la parte responsable del cumplimiento puede anular la autorización del usuario para utilizar el equipo.*

注意：未經有關法規認證部門允許對本設備進行的改變或修改，可能會使使用者喪失操作該設備的權利。

注意：未经有关法规认证部门明确允许对本设备进行的改变或改装，可能会使使用者丧失操作该设备的合法性。

주의 : 기기 검교정 담당자의 승인 없이 무단으로 기기를 변경 또는 수정하는 경우에는, 그 기기 운영에 대한 허가가 취소될 수 있습니다.

注意：規制機関から明確な承認を受けずに本装置の変更や改造を行うと、本装置のユーザとしての承認が無効になる可能性があります。

Caution: *Use caution when working with any polymer tubing under pressure:*

- *Always wear eye protection when near pressurized polymer tubing.*
- *Extinguish all nearby flames.*
- *Do not use tubing that has been severely stressed or kinked.*
- *Do not use nonmetallic tubing with tetrahydrofuran (THF) or concentrated nitric or sulfuric acids.*
- *Be aware that methylene chloride and dimethyl sulfoxide cause nonmetallic tubing to swell, which greatly reduces the rupture pressure of the tubing.*

Attention : *Manipulez les tubes en polymère sous pression avec precaution:*

- *Portez systématiquement des lunettes de protection lorsque vous vous trouvez à proximité de tubes en polymère pressurisés.*
- *Eteignez toute flamme se trouvant à proximité de l'instrument.*
- *Evitez d'utiliser des tubes sévèrement déformés ou endommagés.*
- *Evitez d'utiliser des tubes non métalliques avec du tétrahydrofurane (THF) ou de l'acide sulfurique ou nitrique concentré.*
- *Sachez que le chlorure de méthylène et le diméthylesulfoxyde entraînent le gonflement des tuyaux non métalliques, ce qui réduit considérablement leur pression de rupture.*

Vorsicht: *Bei der Arbeit mit Polymerschläuchen unter Druck ist besondere Vorsicht angebracht:*

- *In der Nähe von unter Druck stehenden Polymerschläuchen stets Schutzbrille tragen.*
- *Alle offenen Flammen in der Nähe löschen.*
- *Keine Schläuche verwenden, die stark geknickt oder überbeansprucht sind.*
- *Nichtmetallische Schläuche nicht für Tetrahydrofuran (THF) oder konzentrierte Salpeter- oder Schwefelsäure verwenden.*
- *Durch Methylenchlorid und Dimethylsulfoxid können nichtmetallische Schläuche quellen; dadurch wird der Berstdruck des Schlauches erheblich reduziert.*

Attenzione: *prestare attenzione durante l'utilizzo dei tubi di polimero pressurizzati:*

- *Indossare sempre occhiali da lavoro protettivi nei pressi di tubi di polimero pressurizzati.*
- *Estinguere ogni fonte di ignizione circostante.*
- *Non utilizzare tubi soggetti che hanno subito sollecitazioni eccessive o son stati incurvati.*
- *Non utilizzare tubi non metallici con tetraidrofurano (THF) o acido solforico o nitrico concentrato.*
- *Tenere presente che il cloruro di metilene e il dimetilsolfossido provocano rigonfiamento nei tubi non metallici, riducendo notevolmente la resistenza alla rottura dei tubi stessi.*

Advertencia: *se recomienda precaución cuando se trabaje con tubos de polímero sometidos a presión:*

- *El usuario deberá protegerse siempre los ojos cuando trabaje cerca de tubos de polímero sometidos a presión.*
- *Si hubiera alguna llama las proximidades.*
- *No se debe trabajar con tubos que se hayan doblado o sometido a altas presiones.*
- *Es necesario utilizar tubos de metal cuando se trabaje con tetrahidrofurano (THF) o ácidos nítrico o sulfúrico concentrados.*
- *Hay que tener en cuenta que el cloruro de metileno y el sulfóxido de dimetilo dilatan los tubos no metálicos, lo que reduce la presión de ruptura de los tubos.*

警告：當在有壓力的情況下使用聚合物管線時，小心注意以下幾點：

- 當接近有壓力的聚合物管線時一定要戴防護眼鏡。
- 熄滅附近所有的火焰。
- 不要使用已經被壓癟或嚴重彎曲管線。
- 不要在非金屬管線中使用四氫呋喃或濃硝酸或濃硫酸。
- 要了解使用二氯甲烷及二甲基亞楓會導致非金屬管線膨脹，大大降低管線的耐壓能力。

警告：当在有压力的情况下使用管线时，小心注意以下几点：

- 当接近有压力的聚合物管线时一定要戴防护眼镜。
- 熄灭附近所有的火焰。
- 不要使用已经被压瘪或严重弯曲的管线。
- 不要在非金属管线中使用四氢呋喃或浓硝酸或浓硫酸。
- 要了解使用二氯甲烷及二甲基亚枫会导致非金属管线膨胀，大大降低管线的耐压能力。

경고: 폴리머재질의 튜빙을 압력하에서 사용할 때는 다음 사항에 유의하십시오.

- 압력을 받은 폴리머 튜빙 부근에서는 반드시 보호안경을 착용할 것
- 모든 화기의 접근을 금함
- 늘리거나 뒤틀린 튜빙은 사용하지 말 것
- 비금속 튜빙을 테트라히드로퓨란(THF)이나 염산 및 황산과 함께 사용하지 말 것
- 디글로로메탄(methylene chloride)와 디메틸설폭시드(dimethyl sulfoxide)는 비금속 튜빙을 팽창시켜 쉽게 파열되므로 주의할 것

警告：ポリマーチューブに圧力をかけて取り扱う場合は、次のように注意してください。

- 加圧したポリマーチューブの付近では、常に保護めがねを着用してください。
- 付近の火はすべて消してください。
- 激しい応力やねじれを受けたチューブは使用しないでください。
- テトラヒドロフラン（THF）、濃硝酸、あるいは濃硫酸には、非金属製のチューブを使用しないでください。
- ジクロロメタンやジメチルスルホキシドは非金属製のチューブを膨張させ、チューブの破断圧力を大幅に低下させますので、注意してください。

Caution: *The user shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.*

Attention : *L'utilisateur doit être informé que si le matériel est utilisé d'une façon non spécifiée par le fabricant, la protection assurée par le matériel risque d'être défectueuses.*

Vorsicht: *Der Benutzer wird darauf aufmerksam gemacht, dass bei unsachgemäßer Verwenddung des Gerätes unter Umständen nicht ordnungsgemäß funktionieren.*

Attenzione: *l'utente deve essere al corrente del fatto che, se l'apparecchiatura viene usta in un modo specificato dal produttore, la protezione fornita dall'apparecchiatura potrà essere invalidata.*

Advertencia: *el usuario deberá saber que si el equipo se utiliza de forma distinta a la especificada por el fabricante, las medidas de protección del equipo podrían ser insuficientes.*

警告：使用者必須非常清楚如果設備不是按照制造廠商指定的方式使用，那么該設備所提供的保護將被消弱。

警告：**使用者必须非常清楚如果设备不是按照制造厂商指定的方式使用，那么该设备所提供的保护将被消弱**

경고 : 제조사가 지정한 것 이외의 방법으로 기기를 사용하는 경우에는, 사용자가 위험으로부터 보호될 수 없는 경우가 발생할 수 있음에 유념하십시오.

警告 : ユーザは製造業者が指定していない方法で装置を使用した場合は装置が提供する保護が損なわれることがあるということを承知しているものとします。

Caution: *To protect against fire hazard, replace fuses with those of the same type and rating.*

Attention : *Remplacez toujours les fusibles par d'autres du même type et de la même puissance afin d'éviter tout risque d'incendie.*

Vorsicht: *Zum Schutz gegen Feuergefahr die Sicherungen nur mit Sicherungen des gleichen Typs und Nennwertes ersetzen.*

Attenzione: *per una buona protezione contro i rischi di incendio, sostituire i fusibili con altri dello stesso tipo e amperaggio.*

Advertencia: *sustituya los fusibles por otros del mismo tipo y características para evitar el riesgo de incendio.*

警告：為了避免火災的危險，應更換同种類型及規格的保險絲。

警告: **为了避免火灾的危险, 应更换同种类型及规格的保险丝**。

경고 : 화재를 방지하기 위해서는 퓨즈 교체 시 같은 종류, 같은 등급의 것을 사용하십시오.

警告 : 火災の危険防止のために、ヒューズの交換は同一タイプおよび定格のもので行なってください。

Caution: *To avoid possible electrical shock, disconnect the power cord before servicing the instrument.*

Attention : *Afin d'éviter toute possibilité de commotion électrique, débranchez le cordon d'alimentation de la prise avant d'effectuer la maintenance de l'instrument.*

Vorsicht: *Zur Vermeidung von Stromschlägen sollte das Gerät vor der Wartung vom Netz getrennt werden.*

Attenzione: *per evitare il rischio di scossa elettrica, scollegare il cavo di alimentazione prima di svolgere la manutenzione dello strumento.*

Precaución: *para evitar descargas eléctricas, desenchufe el cable de alimentación del instrumento antes de realizar cualquier reparación.*

警告：要避免觸電，請在修理或保養器材前把電源線拔出。

警告：为避免可能引起得触电危险，在修理前请切断电源连接。

경고: 전기 충격의 가능성을 피하기 위해서는, 기기를 수리하기 이전에 전원 코드를 차단하십시오.

警告：感電の危険性を避けるために、装置の保守を行う前には装置の電源コードを引き抜いてください。

Commonly Used Symbols

⎓	Direct current Courant continu Gleichstrom Corrente continua Corriente continua 直流電 直流电 직류 直流
~	Alternating current Courant alternatif Wechselstrom Corrente alternata Corriente alterna 交流電 交流电 교류 交流
⏚	Protective conductor terminal Borne du conducteur de protection Schutzleiteranschluss Terminale di conduttore con protezione Borne del conductor de tierra 保護的導線端子 保护性的接地端 보호 도체 단자 接地

Commonly Used Symbols (Continued)

	Frame or chassis terminal Borne du cadre ou du châssis Rahmen- oder Chassisanschluss Terminale di struttura o telaio Borne de la estructura o del chasis 結構或底盤端子 机架或底盘接地端 프레임 또는 틀 단자 フレームまたはシャーシアース
	Caution or refer to manual Attention ou reportez-vous au guide Vorsicht, oder lesen Sie das Handbuch Prestare attenzione o fare riferimento alla guida Actúe con precaución o consulte la guía 小心或查閱手冊 小心或查阅手册 경고 또는 사용설명서 참조 警告またはマニュアルを参照
	Caution, hot surface or high temperature Attention, surface chaude ou température élevée Vorsicht, heiße Oberfläche oder hohe Temperatur Attenzione, superficie calda o elevata temperatura Precaución, superficie caliente o temperatura elevada 警告，熱表面或高溫 警告,热表面或高温 경고, 뜨거운 표면 또는 고온 警告、熱くなっている面、あるいは高温

Commonly Used Symbols (Continued)

	Caution, risk of electric shock (high voltage) Attention, risque de commotion électrique (haute tension) Vorsicht, Elektroschockgefahr (Hochspannung) Attenzione, rischio di scossa elettrica (alta tensione) Precaución, peligro de descarga eléctrica (alta tensión) 警告，小心触電（高壓電） 警告,小心触电（高压电） 경고, 전기충격의 위험 (고압) 警告、電気ショックの危険性（高電圧）
	Caution, risk of needle-stick puncture Attention, risques de perforation de la taille d’une aiguille Vorsicht, Gefahr einer Spritzenpunktierung Attenzione, rischio di puntura con ago Precaución, riesgo de punción con aguja 警告，小心尖狀物刺傷 警告,小心尖状物刺伤 경고, 뾰족한 것으로부터의 상해 위험 警告、ニードルで穴をあける危険性
	Caution, ultraviolet light Attention, rayonnement ultrviolet Vorsicht, Ultraviolettes Licht Attenzione, luce ultravioletta Precaución, emisiones de luz ultravioleta 警告，紫外光 警告,紫外光 경고, 자외선 警告、紫外線

Commonly Used Symbols (Continued)

	Fuse Fusible Sicherung Fusibile Fusible 保險絲 保险丝 퓨즈 ヒューズ
1	Electrical power on Sous tension Netzschalter ein Alimentazione elettrica attivata Alimentación eléctrica conectada 開啓電源 接通电源 전원 켜기 電源オン
0	Electrical power off Hors tension Netzschalter aus Alimentazione elettrica disattivata Alimentación eléctrica desconectada 關閉電源 切断电源 전원 끄기 電源オフ

United States – FCC Emissions Notes

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: *This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

Shielded cables must be used with this unit to ensure compliance with the Class A FCC limits.

Canada – Spectrum Management Emissions Notes

Cet appareil numérique de la classe A est conforme à la norme NMB-003.

This Class A digital apparatus complies with Canadian ICES-003.

Waters Alliance GPC 2000 Information

Intended Use

The Waters® Alliance® GPC 2000 Series systems are a fully integrated series of instruments that offers new levels of safety and performance in molecular weight characterization for the polymer technologist. They are designed for gel permeation chromatography (GPC) for use by polymer chemists who are working in R&D, QA/QC, technical or manufacturing support, and/or applications and methods development, and need to characterize the molecular weights and molecular weight distribution of polymers.

Calibration

Follow acceptable methods of calibration with pure standards to calibrate methods. Use a minimum of five standards to generate a standard curve. The concentration range should cover the entire range of quality-control samples, typical specimens, and atypical specimens.

Quality Control

Routinely run three quality-control samples. Quality-control samples should represent subnormal, normal, and above-normal levels of a compound. Ensure that quality-control sample results are within an acceptable range, and evaluate precision from day to day and run to run. Data collected when quality-control samples are out of range may not be valid. Do not report this data until you ensure that chromatographic system performance is acceptable.

Table of Contents

Preface

This guide provides procedures for unpacking, installing, preparing, maintaining, and troubleshooting the Waters® Alliance® GPC 2000 Series system. Its appendixes address specifications, spare parts, and solvent considerations.

This guide is for those who must install, operate, maintain, and/or troubleshoot the Alliance GPC 2000 Series system.

Organization

Chapter 1 describes the system, including its features, theory of system operation, and options.

Chapter 2 describes how to unpack and install the system and how to make tubing, signal, and electrical connections.

Chapter 3 describes how to start the system, prepare it for operation, prepare and run samples, and shut it down.

Chapter 4 describes routine and as-needed maintenance procedures for hardware and software components.

Chapter 5 describes troubleshooting methods and diagnostic tests, and includes troubleshooting tables.

Appendix A lists system specifications.

Appendix B lists required and optional spare parts that are recommended for replacement by the customer.

Appendix C provides solvent information.

Appendix D provides related documentation and reference material, and includes a procedure to contact Waters corporation.

Documentation Conventions

The following conventions might appear in this guide:

Convention	Usage
Italic	Italic indicates information that you supply such as variables. It also indicates emphasis and document titles. For example, “Replace *file_name* with the actual name of your file.”
`Courier`	Courier indicates examples of source code and system output. For example, “The `SVRMGR>` prompt appears.”
`Courier Bold`	Courier bold indicates characters that you type or keys you press in examples of source code. For example, “At the `LSNRCTL>` prompt, enter **`set password oracle`** to access Oracle.”
Keys	The word *key* refers to a computer key on the keypad or keyboard. *Screen keys* refer to the keys on the instrument located immediately below the screen. For example, “The A/B screen key on the 2414 Detector displays the selected channel.”
…	Three periods indicate that more of the same type of item can optionally follow. For example, “You can store *filename1, filename2,* … in each folder.”
>	A right arrow between menu options indicates you should choose each option in sequence. For example, “Select File > Exit” means you should select File from the menu bar, then select Exit from the File menu.

Notes

Notes call out information that is helpful to the operator. For example:

Note: *Record your result before you proceed to the next step.*

Attentions

Attentions provide information about preventing damage to the system or equipment. For example:

Attention: *To avoid damaging the detector flow cell, do not touch the flow cell window.*

Cautions

Cautions provide information essential to the safety of the operator. For example:

Caution: *To avoid burns, turn off the lamp at least 30 minutes before removing it for replacement or adjustment.*

Caution: *To avoid electrical shock and injury, turn off the detector and unplug the power cord before performing maintenance procedures.*

Caution: *To avoid chemical or electrical hazards, observe safe laboratory practices when operating the system.*

Chapter 1
Introduction

The Waters® Alliance® GPC 2000 Series system is a fully integrated liquid chromatography system. Designed for use with many gel permeation chromatography (GPC) applications, the system incorporates an advanced differential refractive index (RI) detector, or refractometer. As the Alliance GPCV 2000 system, it also incorporates a multicapillary viscometry detector, or viscometer. Finally, the Alliance GPC 2000 Series software (version 2.0 and later) permits light scattering analysis and supports the PD2040-series Light Scattering Detectors of Precision Detectors, Inc.

The Alliance GPC 2000 Series system separates polymers that are detected through refractive index and viscometry measurements. The refractometer uses optical refraction to monitor the concentrations of sample components after column separation. In an Alliance GPCV 2000 system, the viscometer provides molecular structure information in addition to molecular weight values. That system also applies universal calibration techniques to determine branching index and frequency information as well as molecular weights. Light scattering data provide molecular weight values, the sample's rayleigh ratio and, if you acquire more than one channel of LS data, the radius of gyration – all of which determine the size and shape of macromolecules. Empower™ GPC, GPCV, and LS software processes the data, which yield the polymers' molecular weight distribution, in a single report.

The systems' sample and analysis compartments share an integrated, temperature-controlled and insulated environment. Three levels of independent thermal monitoring ensure the system maintains a programmed temperature and initiates shut-down routines should malfunctions occur.

The system operates with typical GPC solvents like tetrahydrofuran (THF), toluene, 1,2,4-trichlorobenzene (TCB), and dimethylformamide (DMF). It can also accommodate stronger solvents like hexafluoroisopropanol (HFIP).

Note: *Vapor sensors alert the operator to a potentially problematic increase in vapor levels within the analysis and sample compartments.*

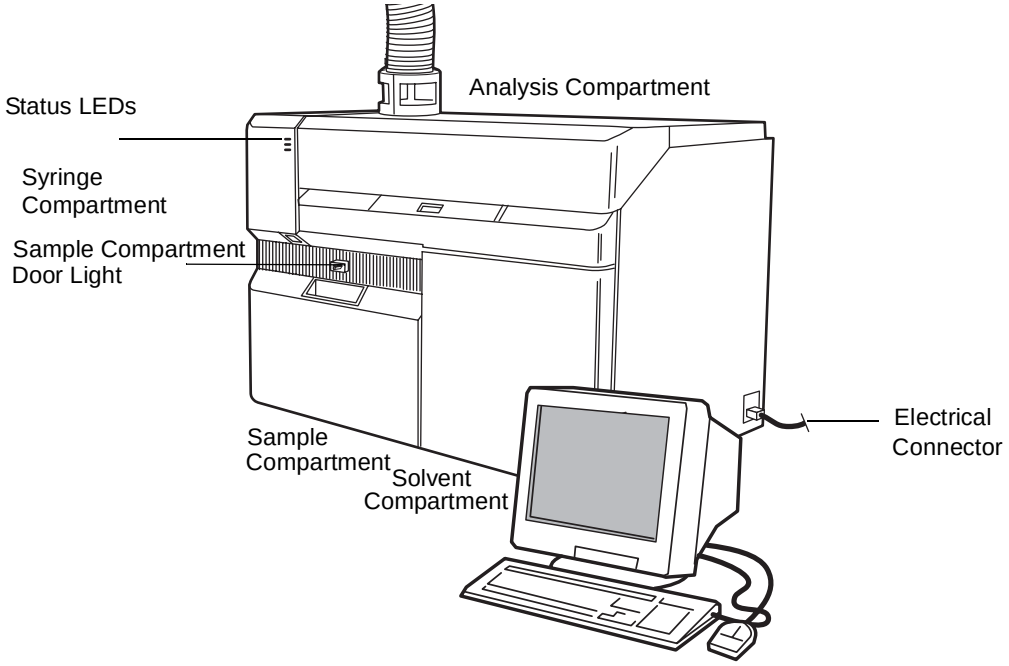


Figure 1-1 Alliance GPC 2000 Series System (Front View)

Figure 1-1 shows a full-face view of an Alliance GPC 2000 Series system.

Table 1-1 describes the system's major components.

Table 1-1 Major System Components

Component	Description
Solvent management system	Degasses, selects, and filters solvent. The system manages solvents isocratically.
Sample management system	Preheats, mix/spins, and filter/injects samples. An internal wash station washes the needle, eliminating sample carryover.
Columns	A diverse selection of Styragel® (polystyrene divinylbenzene) columns for organic-soluble polymers, HSPgel columns for high-speed GPC analysis, or water and Ultrahydrogel™ (hydroxylated methacrylate) columns for aqueous-soluble polymers can be installed. Column lengths range from 150 mm up to 500 mm; widths range from 4.6 mm-ID (narrow bore) to 6.0 mm (high speed) to 7.8 mm-ID (regular bore).

Table 1-1 Major System Components (Continued)

Component	Description
Detectors	The systems each incorporate a differential refractometer. The GPCV 2000 system in addition includes the patented multicapillary viscometer.
System software	• The Microsoft® Windows® 2000 operating system allows networking capabilities. • The system software controls all system components, runs sample sets, and acquires data. • Empower software with GPC, GPC/V, or GPCV-LS processing options allow data processing and report generation.

1.1 Solvent Management System

The solvent management system includes all components that degas and pump solvent (Figure 1-2).

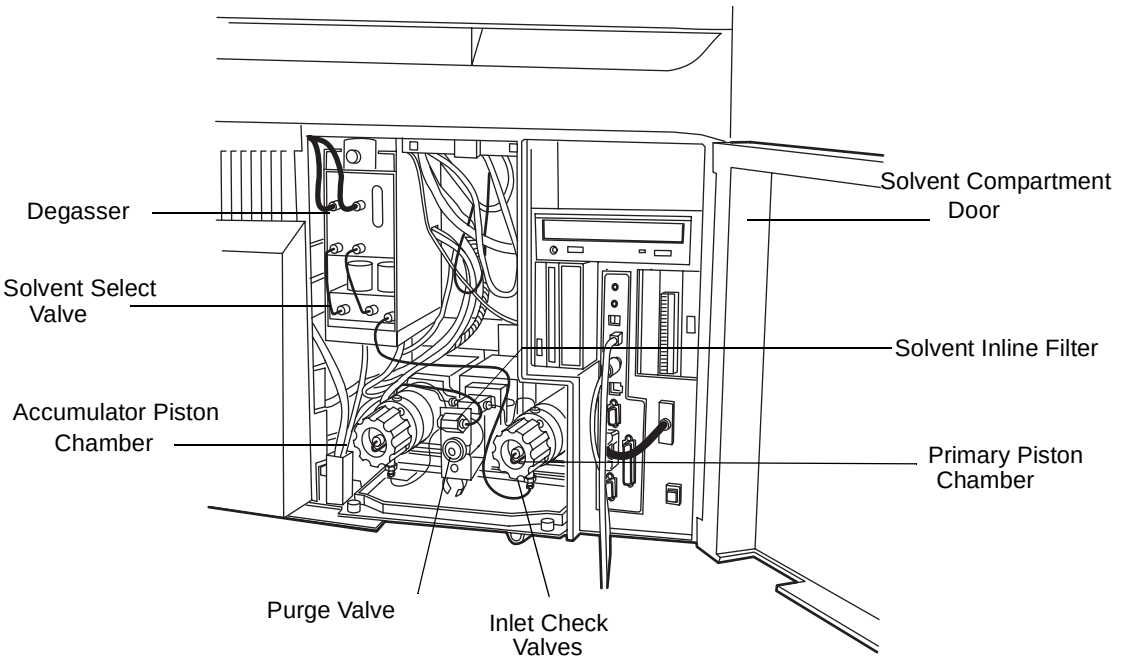


Figure 1-2 Components of the Solvent Manager in the Solvent Compartment

Components

Table 1-2 describes functions of the solvent management system's major components.

Table 1-2 Solvent Management System Components

Component	Function
Primary piston chamber	Draws solvent, transferring it to the accumulator piston as part of the serial flow design.
Accumulator piston chamber	Draws solvent from the primary piston and delivers it to the solvent inline filter.
Purge valve	Allows purging, priming, and venting of the solvent management system via a priming syringe.
Solvent inline filter	Filters the solvent that flows from the solvent management system to the analysis compartment.
Solvent select valve	Selects the choice of solvent specifying it in the Instrument Method Editor's Solvent Manager page from reservoir A or B. Available choices are based on the solvents listed in the Instrument Configuration Editor's Mobile Phase A and Mobile Phase B pages.
Inline vacuum degasser	Removes dissolved gasses from the solvents and exhausts them and any condensates through waste tubing. Selection of solvent degassing is user programmable.
Primary inlet check valve	Maintains flow direction into the primary piston chamber by opening in one direction only (opens on the piston intake stroke; closes on the delivery stroke).
Accumulator inlet check valve	Maintains flow direction into the accumulator piston chamber by opening in one direction only (opens on the piston intake stroke; closes on the delivery stroke).
Primary transducer	Detects and produces a signal proportional to the backpressure developed by resistance to solvent flow in the primary piston chamber.
System transducer	Detects and produces a signal proportional to the backpressure developed by resistance to solvent flow in the system.

Piston Seal-Wash System (Optional)

The seal-wash system lubricates and washes the seals of the primary and accumulator pistons. It flushes away solvents or precipitated salts that slip by the piston seal from the high-pressure side of each piston chamber. As the solvent management system delivers mobile phase, the seal-wash pump intermittently delivers seal-wash solvent according to a programmable time interval.

The seal-wash solvent flows from the wash reservoir to the wash pump, which forces it to a cavity behind the piston seal in the primary piston chamber. From there it flows to the cavity behind the piston seal in the accumulator piston chamber and, finally, to a waste container.

The piston seal wash system, installed by a Waters field engineer, includes a reservoir, pump, seal-wash body, and tubing. To connect the reservoir and tubing, see Section 2.3.4. To activate the wash, see Section 3.2.1. For details, see “Mobile Phase A Tab” or “Mobile Phase B Tab” in the *Alliance GPC 2000 Series System Help.*

Solvent Flow Path

Figure 1-3 shows solvent flow through the system.

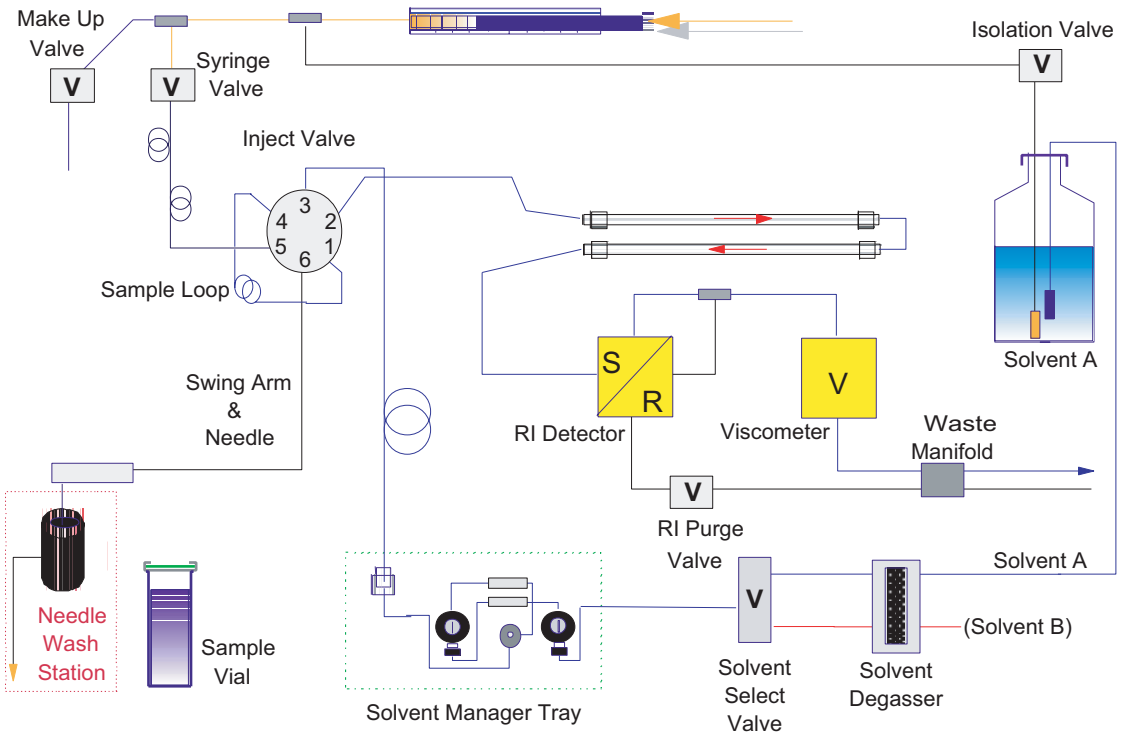


Figure 1-3 Solvent Flow Path

The following sequence references Figure 1-3:

1. The programmable inline solvent degasser applies a vacuum to Solvents A and B.
2. Solvent flows through an inlet check valve and then to the solvent manager's primary piston chamber. Simultaneously, the accumulator piston forces solvent to the system pressure transducer (Figure 1-4).

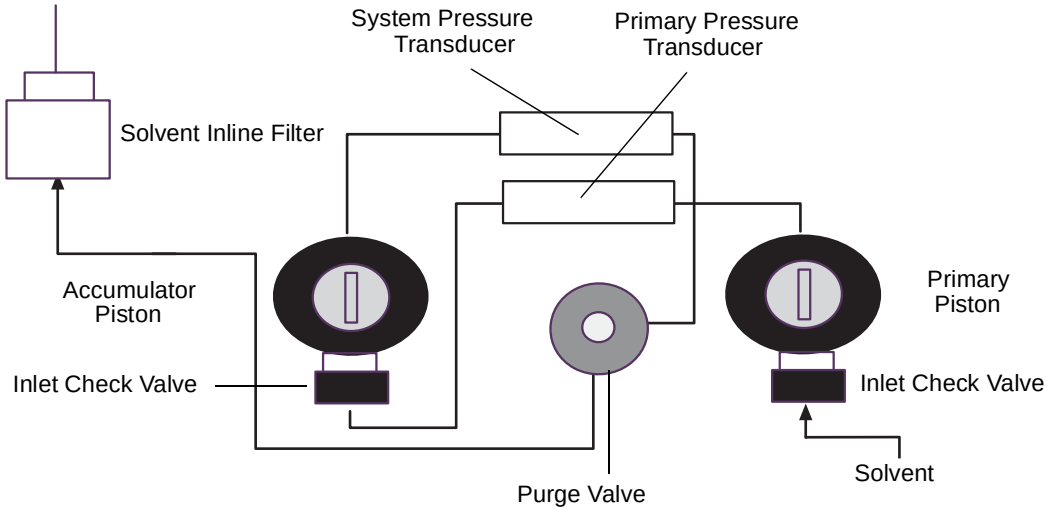


Figure 1-4 Solvent Flow Path Through the Solvent Manager

3. Seconds before the accumulator piston chamber empties, the primary piston compresses solvent to the pressure sensed by the pressure transducer.
4. When the accumulator piston chamber empties, the primary piston forces solvent to the primary pressure transducer. From there it flows through the check valve and into the accumulator piston chamber. The cycle then repeats, beginning at step 2.
5. The system pressure transducer measures the system pressure, comparing it with the primary pressure. It then adjusts the primary pressure to equal the system pressure.
6. Solvent continues from the system pressure transducer through the purge valve and solvent inline filter.

1.2 Sample Management System

The sample management system includes a removable sample carousel housed in a thermally controlled compartment and components that control sample, mixing, heating, filtering, and injection.

Components

Table 1-3 lists and describes the function of the sample management system's major components.

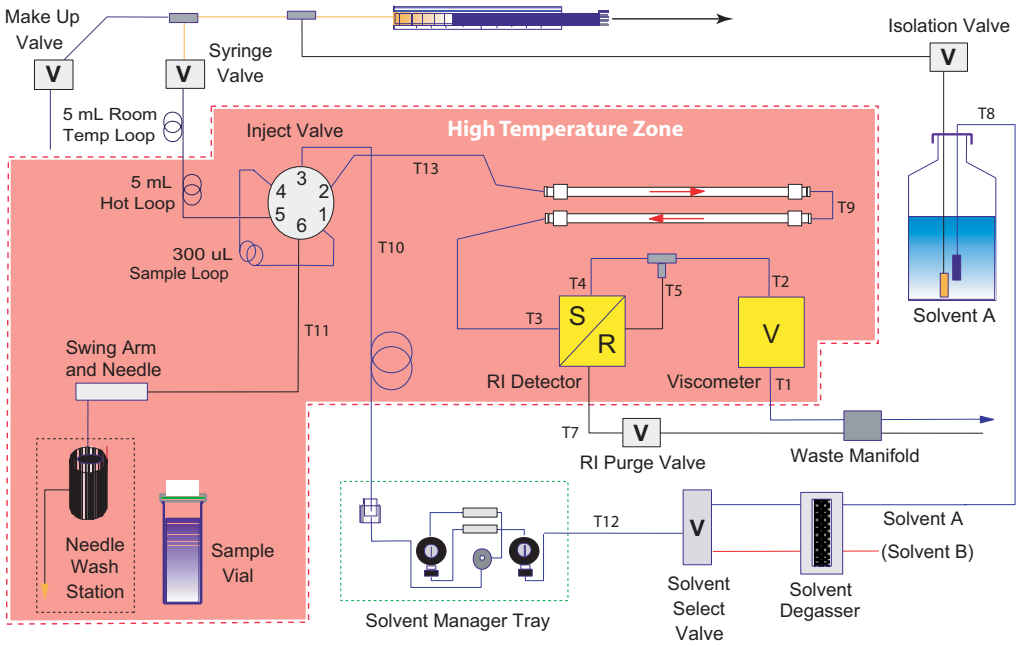
Table 1-3 Sample Management System Components

Component	Function
Carousel	Holds and advances sample vials clockwise, toward the mix/spin and filter/inject stations.
Sample needle and filter ram	Lowers the needle into the sample vial, the filter ram pushing on the sample filter vial to filter the sample. The needle pierces the cap seal and draws sample from the vial.
Wash station	Washes the needle by forcing solvent through and around it.
Syringe	Draws solvent from a reservoir or sample from a vial. When it draws from a reservoir, the sample loop is offline. The syringe then dispenses solvent to the needle (during a wash cycle) or to the solvent dispenser. When the syringe draws sample from a vial, the loop is inline and receives the sample.
Vent Needle	Allows air to replace solvent.
Injection valve	Holds the sample and introduces it to the columns.
Sample loop	Holds a fixed volume of sample to inject into the flow path.
Bypass valve (optional)	Depends on plumbing connections. Typically used to bypass the light scattering detector.

Sample Flow Path

The following sequence describes the route the sample follows through the system:

1. Sample loading and preparation – Sample vials are loaded into the carousel's sample compartment. The carousel rotates clockwise as the system surveys its contents. Each vial moves, in turn, to the mix/spin station and then to the filter/inject station. The instrument method controls the mixing and filtering operation (Figure 1-5).
2. Sample withdrawal and aspiration – The injection valve switches to the load position. With the vial at the filter/inject station, the needle poises above it, pierces its septum, and lowers inside it. The syringe plunger retracts, drawing sample into the loop and the storing extra sample in the overfill loop so that the sample overfills the sample loop without entering the syringe. The system can make multiple injections per vial, depending on the sample loop and vial sizes (Figure 1-5).



Tubing	Description	Specifications
T1	Waste manifold to viscometer	0.8 clear tubing
T2	Viscometer to RI detector	0.009 (green* from RI) and 0.040 (yellow* to viscometer)
T3	Sample Inject	0.012 (black) and 0.009 (green*)
T4	Sample out	0.012 (yellow*)
T5	Reference in	0.02 (blue*)
T6	Reference out	0.04 (red*)
T7	RI purge valve to waste manifold	0.04 (red*)
T8	Solvent inlet	0.125 Tefzel
T9	Intercolumn	0.014 (blue*) teflon
T10	Preheater sample loop to injection	0.009 (green*)
T11	From port 6 inject to needle wash	0.02 (yellow*)
T12	Solvent select valve	0.04 (red*)
T13	Column to injection valve	0.2 (green*) teflon

*Indicates that tubing is sleeved with a color coded covering.
Note: To replace the T3, T9, and T13 tubing, use the GPC high molecular weight tubing kit (700002468).

Figure 1-5 Filling the Sample Loop

3. Sample injection – The injection valve switches to the inject position. Solvent from the injector preheater loop flows into injection valve port 3 and out port 4, picking up sample and depositing it onto the column. After the final injection, excess sample returns to the vial or the wash station (Figure 1-6) depending what you specify in the Instrument Method.

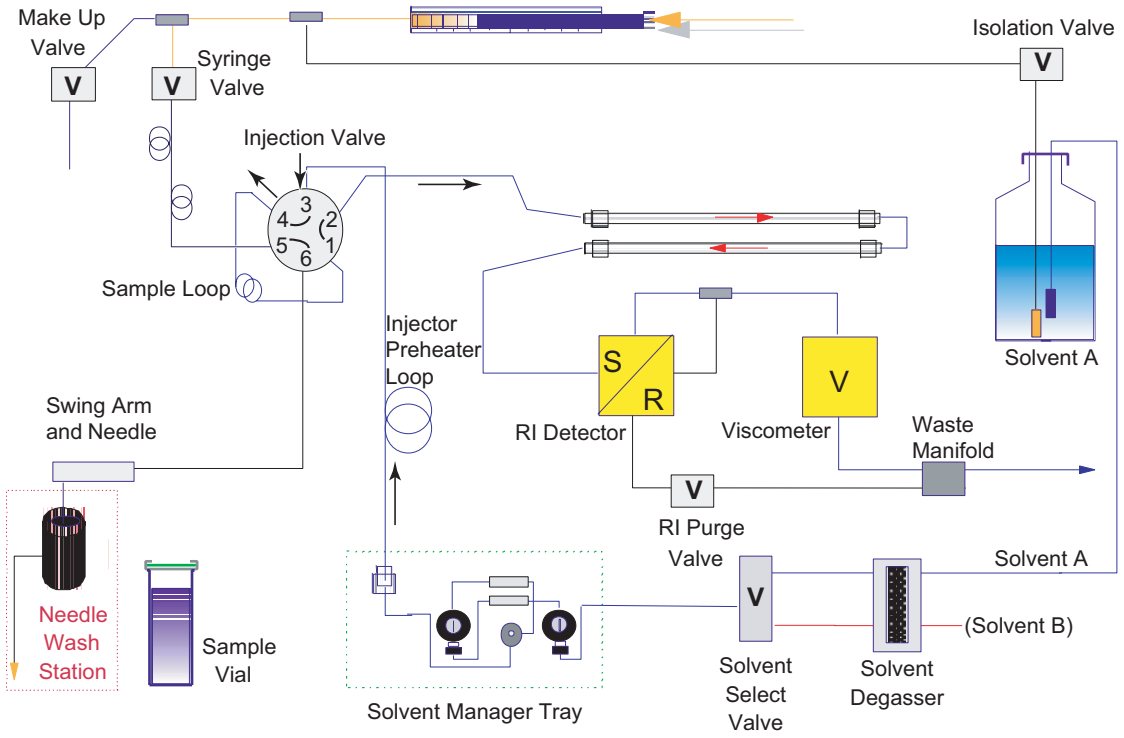


Figure 1-6 Injecting the Sample

4. Separation – The sample flows from the injection valve through the column set, directly to the detectors.
5. Detection – The sample flows through the refractometer and the viscometer (Alliance GPCV 2000 system only). From there it passes through the waste manifold, exiting the system.
6. Needle wash – When the run time for the final injection from a vial has elapsed, the needle returns to the wash station. While there, solvent washes its internal and external surfaces and then flows to a waste container. The syringe returns to the home position when the wash sequence ends.

1.3 Columns

Column types are Styragel, for organic-soluble polymers, Ultrahydrogel for aqueous-soluble polymers, and HSPgel for high-speed GPC analysis of organic- or aqueous-soluble polymers.

The column rack, in the analysis compartment, can accommodate up to six 300-mm columns or three 500-mm columns of up to 7.8-mm ID. The compartment's high efficacy heaters maintain stable temperatures. You can program a limit for the rate of temperature increase in the compartment to ensure column integrity.

Styragel Columns

For organic GPC separations, three types of Styragel columns are available (see Table B-3):

- Styragel HMW (20-µm particle size) – Use with shear-sensitive, ultra-high molecular weight polymer samples at temperatures between ambient and 180 °C. High-porosity, 10-µm frits accompany these columns.
- Styragel HT (10-µm particle size) – Use with mid-molecular to high-molecular weight samples at temperatures between ambient and 180 °C.
- Styragel HR (5-µm particle size) – Use with low-molecular to mid-molecular weight samples. These columns afford high resolution at temperatures between ambient and 80 °C.

Attention: *Use LS-compatible or preconditioned column(s) for optimal results in LS or viscometry. This minimizes detector contamination by particulates that manifest themselves as signal noise.*

Ultrahydrogel Columns

Use 300 mm × 7.8 mm ID columns for aqueous GPC separations. These include Ultrahydrogel 120, 250, 500, 1000, 2000, linear, and DP columns, which perform with up to 20% organic solvent. Use them with a pH range from 2 through 12 and at temperatures between ambient and 80 °C (Table B-4).

HSPgel Columns

Use HSPgel columns for high-speed GPC analysis (see Table B-5). They are 150 mm × 6.0 mm ID (Table B-5) and are packed in THF, ODCB, or water. Table B-5. The HT series

columns may be used for temperatures up to 180 °C and can withstand multiple solvent switches.

1.4 Differential Refractometer

The differential refractive index (RI) detector, or refractometer, uses optical refraction to detect sample components in the post-column solvent flow. The Alliance GPC control software collects the RI data, and the Empower software performs molecular weight analyses.

The refractometer, set in the analysis compartment, comprises these components:

- A 10–µL flow cell with sample side and reference side
- Long-life, pulsed, light-emitting diode (LED) light source
- Collimating lens
- Mirror
- Dual-element photodiode
- Purge valve, which protects the flow cell by opening when pressure exceeds 35 psi (2.4 bar)
- User-programmable autozero and purge capabilities

1.4.1 Optical Refraction and RI Measurement

The extent to which a solution refracts light is its refractive index (RI), the ratio of light velocity in a vacuum to light velocity in a solution. A physical property of the solution, the RI is expressed by the dimensionless value *n*.

Light passes through the refractometer as follows (Figure 1-7):

1. The aperture and collimating lens focus light from the LED, forming a beam.
2. The beam passes through the sample and reference sides of the flow cell to the mirror.
3. The mirror reflects the light beam through both sides of the flow cell, through the collimating lens and, finally, onto the dual-element photodiode. The difference in the amount of light striking each element of the photodiode (because of sample refraction) results in a deflection from the chromatogram’s baseline.

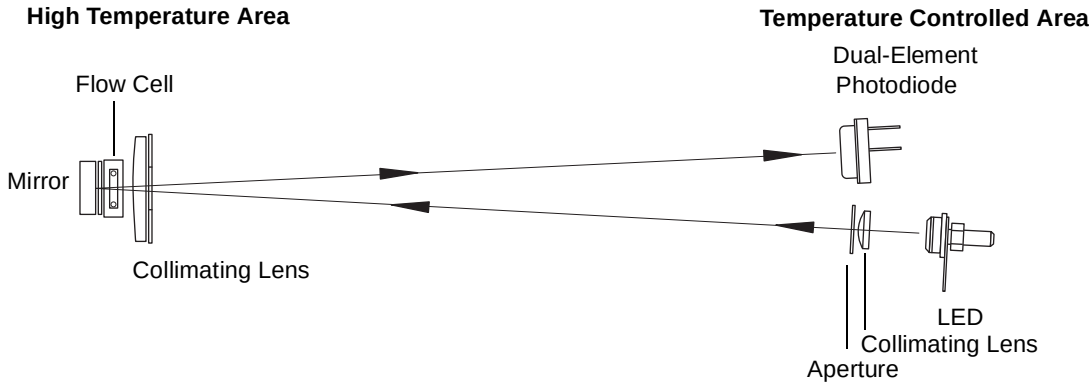


Figure 1-7 Light Path Through the Refractometer

The RI depends on how fast light travels through a solution, a constant rate at a specific temperature and pressure. Density also affects RI, and the density-RI relation is not necessarily linear at a given wavelength, temperature, and pressure. The refractometer exploits the solution's physical characteristics by maintaining a constant wavelength, temperature, and pressure so that only changes in density can cause changes in RI. Thus the higher the concentration of sample in a solution, the greater the change in the its RI. The refractometer detects even slight changes in RI by comparing a sample solution with a reference solution. It then expresses the difference in RI (Δn) as refractive index units (RIU).

1.4.2 Flow Path During Normal Operation

Two fused, hollow, quartz prisms, each with an inlet and outlet, compose the refractometer's flow cell. During an analysis, solvent flows through the cell's sample side. The reference side, which holds pure solvent supplied during the purge operation, remains sealed during normal operation. Thus the reference solvent is stationary.

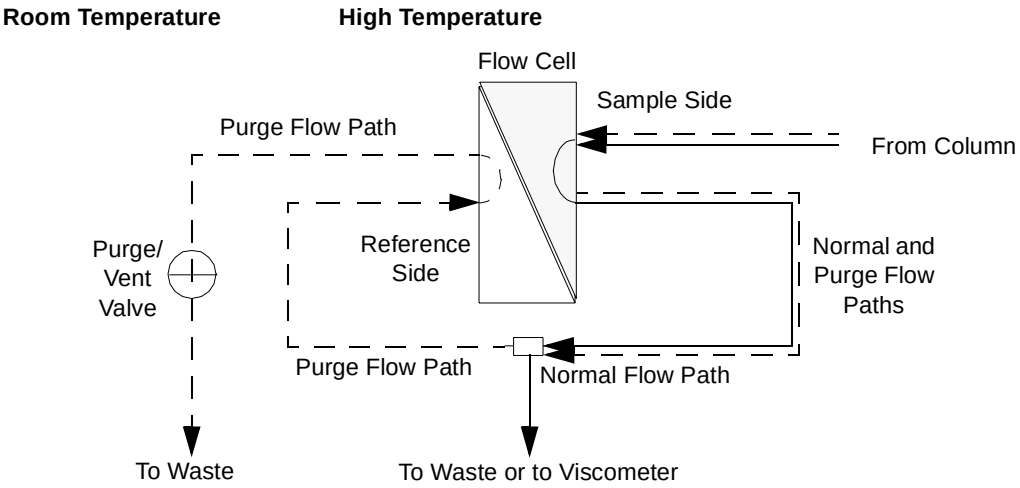


Figure 1-8 Flow Paths Through Refractometer Flow Cell

The following sequence refers to Figure 1-8:

1. Solvent flows through the sample side of the flow cell.

   Note: *In Alliance GPCV 2000 systems, solvent flows from the flow cell to the viscometer. In Alliance GPC 2000 systems, solvent flows from the flow cells to waste.*

2. Refraction of light in the flow cell's sample solution alters the proportion of light that strikes each of the two photodiodes. This causes the photodiode signal to differ from the reference signal, which results from refraction in pure solvent.
3. The photodiode signal creates an output voltage that shows *n* as a deflection from the chromatogram's baseline.

   Note: *Deflections, or peaks, can be positive or negative.*

1.4.3 Flow Path During Purging

When the refractometer is purged, the purge/vent valve opens, allowing solvent to flow from the sample side of the flow cell to the reference side and then to waste (Figure 1-8).

The purge/vent valve opens automatically when the pressure exceeds 35 psi (2.4 bar). This protects the refractometer flow cell and viscometer from pressure damage.

See Table A-8 for detailed refractometer specifications.

1.5 Multicapillary Viscometer

The multicapillary viscometry detector, or viscometer, provides viscometry data for calculating molecular weight distributions, viscosity law plots, and branching information (index and frequency). See Table A-9 for viscometer specifications.

The viscometer comprises these elements:

- Three capillaries
- Two differential pressure transducers
- Two delay volumes

Viscometer types are named for their flow paths: sense-line and flow-through.

1.5.1 Sense Line Viscometer Flow Paths

In the sense-line type, flow from the refractometer enters the viscometer and splits into two paths (Figure 1-9):

- In one path, solution flows through the first capillary to the first delay volume. It then flows through the third capillary and, finally, to waste.
- In the other path, solution flows through a second delay volume to the second capillary and then to a waste vessel.

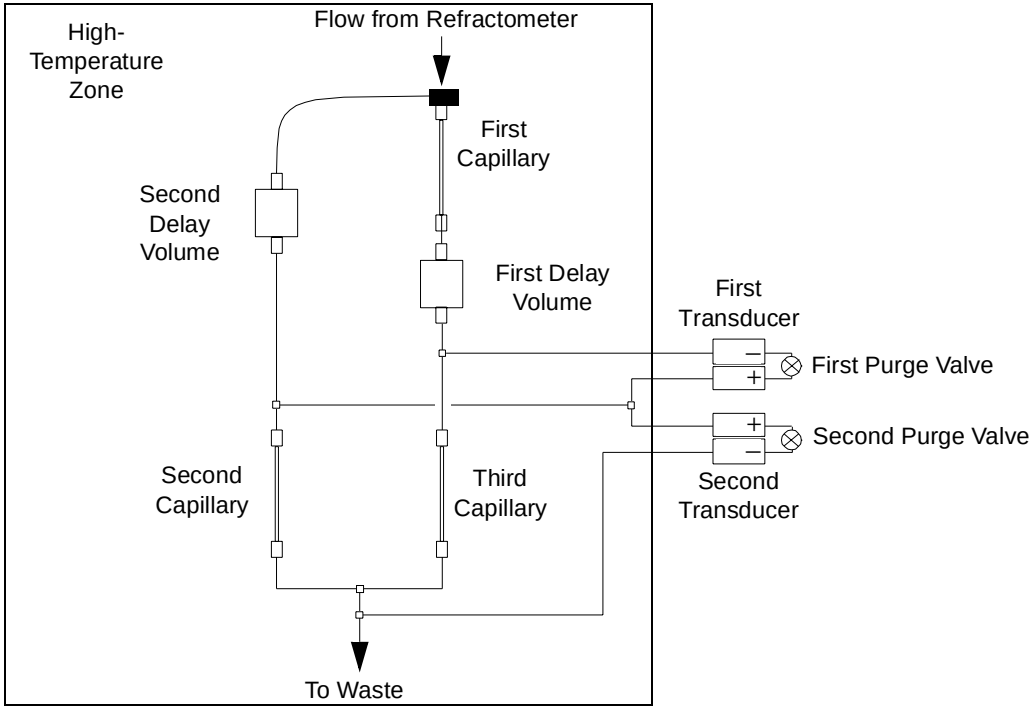


Figure 1-9 Viscometer Flow Path, Sense Line Type

The first and second transducers measure pressures in the first and second capillaries and other fluidic elements. The first and second purge valves (normally closed) allow purging of their associated transducers.

For each capillary, the drop in pressure is proportional to the solution's flow rate and viscosity. Poiseuille's law states pressure (P) is the product of a constant (R), the viscosity (η), and the flow rate (Q) thus

$$P = R \times \eta \times Q$$

where R = capillary length (L), pressure (P), and radius (r) according to the equation

$$R = (8 \times L) / (P \times r^4)$$

Pressure signals from the viscometer are sent to the Alliance GPCV 2000 Series system software, which calculates the relative viscosity and relative flow of the solution.

1.5.2 Flow-Through Viscometer Flow Paths

Flow enters the flow-through viscometer (Figure 1-10) and splits into two paths:

- In one path, the solvent flows through the first capillary, through the first transducer, to the first delay volume, through the third capillary, and finally to waste.
- In the other path, solvent flows from the first transducer to the second delay volume. It then goes to the second transducer, second capillary, and back to the second transducer before exiting to a waste vessel.

The first transducer measures pressure in the first capillary and in its associated plumbing. The second tranducer measures pressure in the second capillary. The flow-through design requires no purge valves.

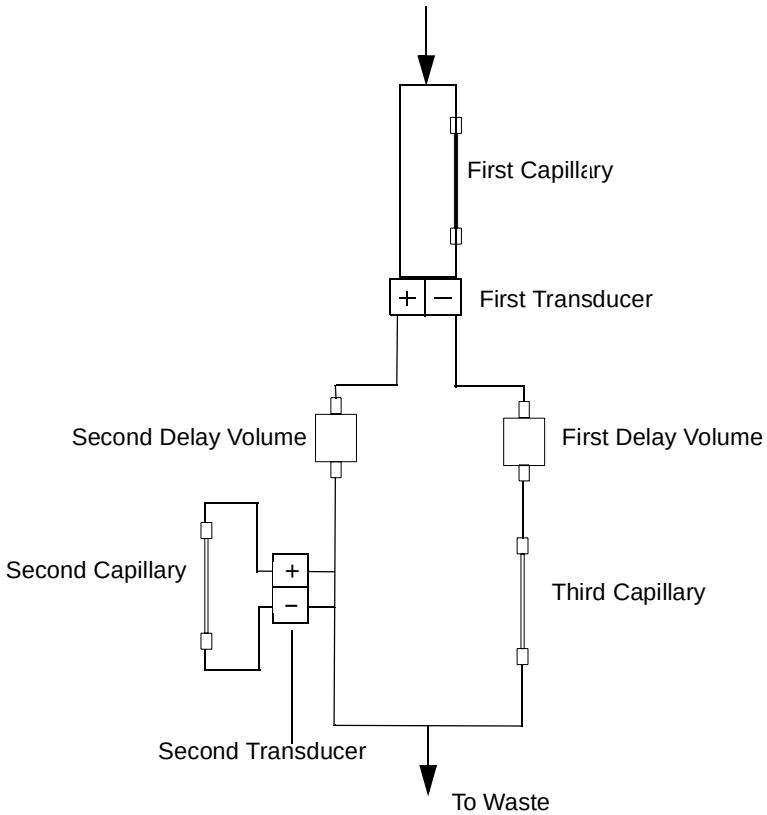


Figure 1-10 Viscometer Flow Path, Flow-Through Type

1.6 Alliance GPC 2000 Software

The system software controls all system hardware components, runs sample sets, and acquires data. Empower software with the GPC and/or GPCV options process the data and report results.

The system software runs on the following hardware:

- Onboard, PC-based central processor; color monitor, keyboard, and mouse
- Built-in disk drive for 3.5-in. disks
- Built-in CD R/W drive
- Onboard I/O card for configuring electrical inputs and outputs
- Onboard USB port
- Onboard Ethernet connection
- Onboard video and audio drivers
- Onboard serial card for controlling external PD2040 Series light scattering detector.

For details about the system software, see “Alliance GPC 2000 Series System Overview” in the *Alliance GPC 2000 Series System Help*.

1.6.1 User Interface

Specify information in the Main, Editor, and Status windows to control the system, configure and troubleshoot it, and monitor its operation.

Main Windows

The Alliance GPC 2000 Series window appears in four modes: Interactive, Sample Set, Carousel, and Diagnostic, which allow access to functions and system information.

Table 1-4 describes the functions of buttons in the button bar of the four main windows.

Table 1-4 Interactive Mode Buttons in the Button Bar

Button	Name	Function
	Interactive Mode	Prepares the system and shows dual plots. (Figure 1-11).
	Sample Set Mode	Runs sample sets, showing dual plots (Figure 1-12).

Table 1-4 Interactive Mode Buttons in the Button Bar (Continued)

Button	Name	Function
	Carousel Mode	Runs sample sets, graphically showing run progress (Figure 1-13).
	Diagnostics Mode	Displays a fluidic schematic and lets you monitor the operating status of system components (Figure 1-14).
	Viewer	Displays Analytical Instruments Association (AIA) files as graphs in a separate window (Figure 1-21).
	Sample Set Method Editor	Defines and edits sample set methods.
	Instrument Configuration Editor	Defines and edits instrument configuration.
	Sample Set Mover	Moves sample sets from local control software to the Empower database.
	Message Board	Opens the Message Board to display a list of system messages (Figure 1-19).
	Log Book	Tells you accumulated run time and shows maintenance and repair entries.
	Help	Activates context-sensitive Help.
	(Emergency)	Stops all solvent flow.

Interactive Mode Window

This window lets you define instrument setup, configuration, and equilibration. It also allows access to other modes in which you define, run, and view sample sets, monitor carousel operation, and monitor instrument diagnostics (Figure 1-11).

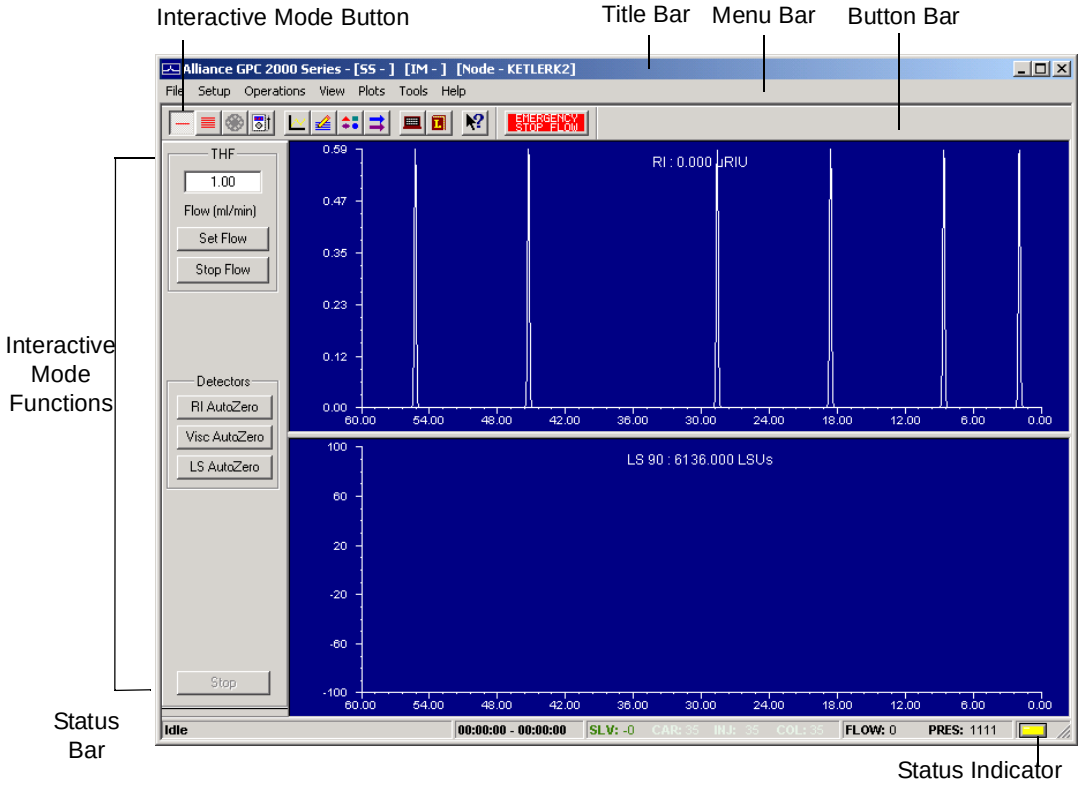


Figure 1-11 Interactive Mode Window (new screen shot)

For Interactive mode details, see “Alliance GPC 2000 Series Window” in the *Alliance GPC 2000 Series System Help*. Also see these subtopics:

- “Procedures and Reference in Setting Up the Alliance GPC 2000 Series System”
- “Running the System in Interactive Mode”

Sample Set Mode Window

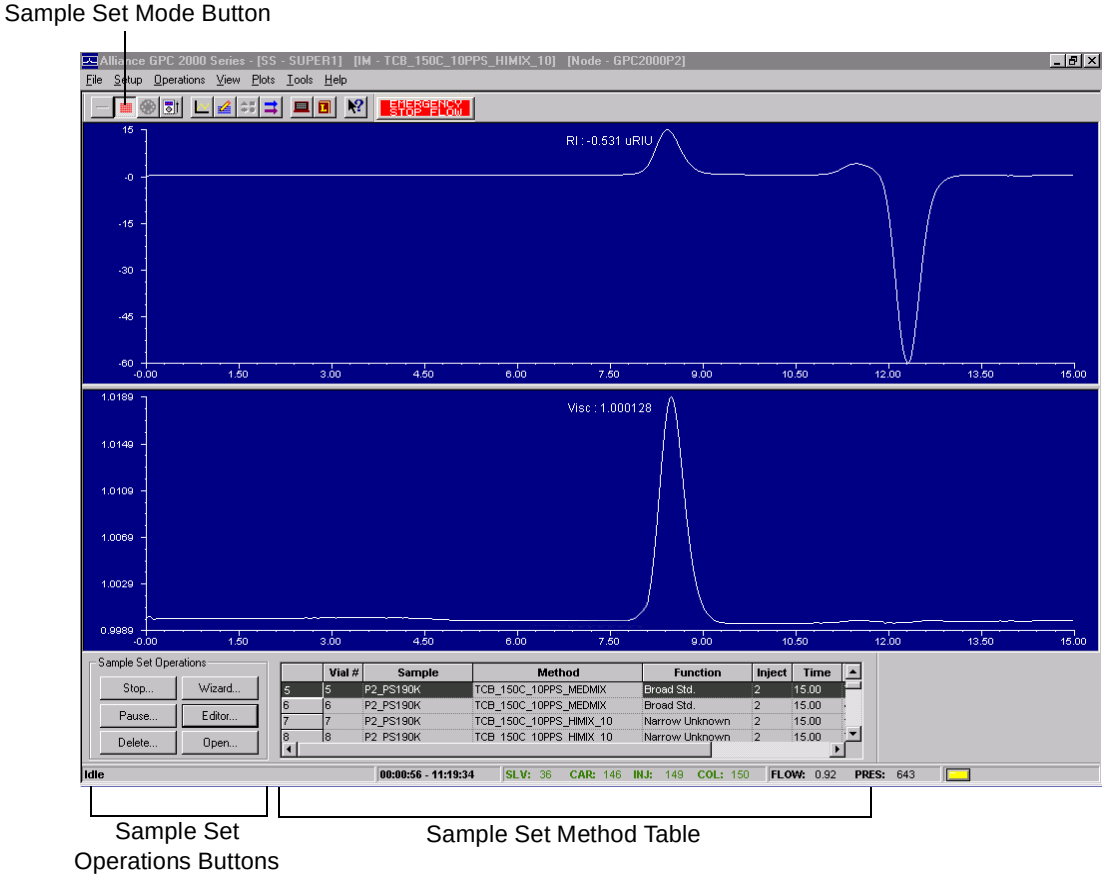


Figure 1-12 Sample Set Mode Window

This window lets you to define, run, and view sample sets (Figure 1-12). For details, see these topics in the *Alliance GPC 2000 Series System Help*:

- "Sample Set Method and Sample Set Overview"
- "Sample Set"
- "Sample Set Mode"

Also see "Procedures" and "Reference," which appear as subtopics under "Acquiring a Sample Set."

Carousel Mode Window

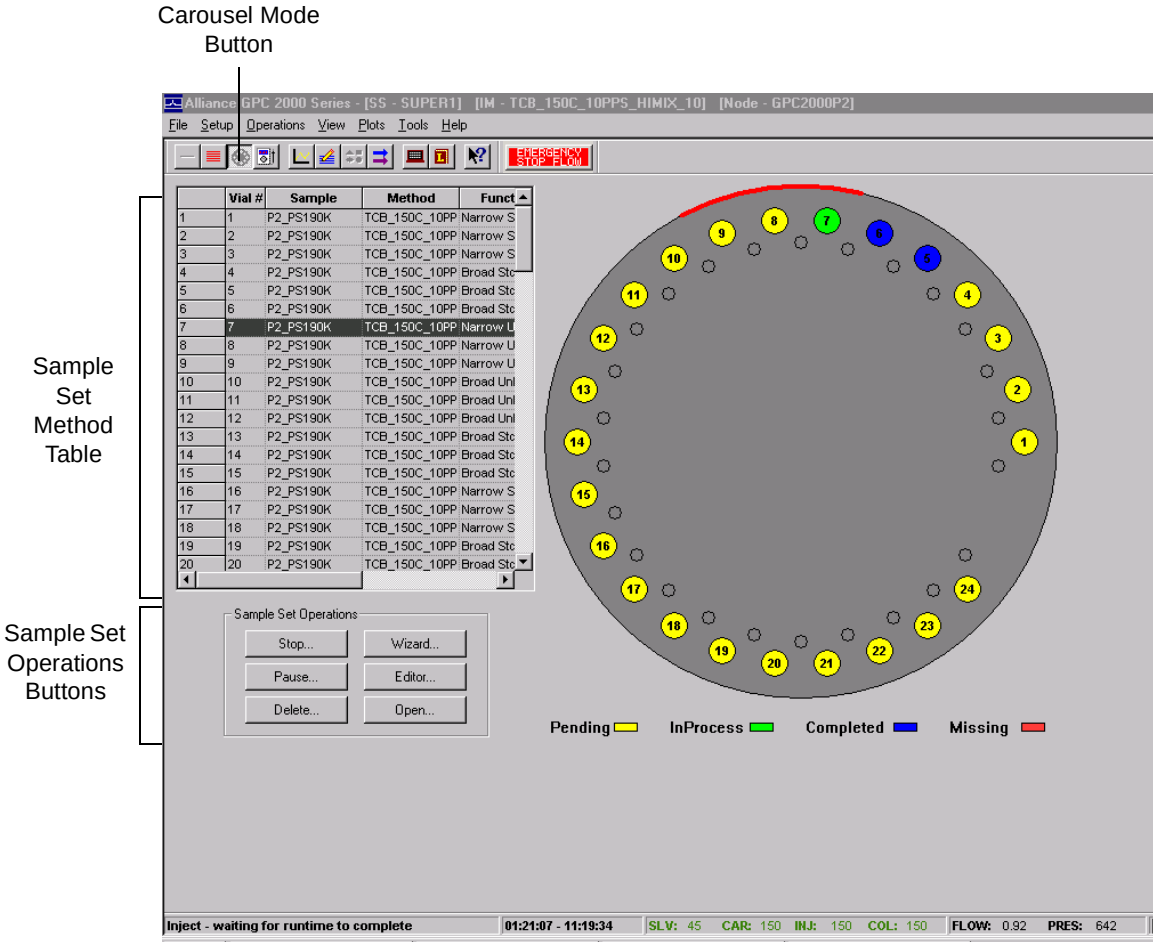


Figure 1-13 Carousel Mode Window

This window lets you define, run, verify, and monitor sample set status for samples on the carousel (Figure 1-13). Sample positions are color-coded.

Color	Sample Set Status
Yellow	Pending
Green	In-process
Blue	Completed
Red	Vial missing

For details, see “Carousel View” in the *Alliance GPC 2000 Series System Help*.

Diagnostics Mode Window

This window lets you determine the current status of system components, monitor diagnostics, and access maintenance wizards (Figure 1-14). For details, see “Alliance GPC 2000 Series System Diagnostics Mode” in the *Alliance GPC 2000 Series System Help*.

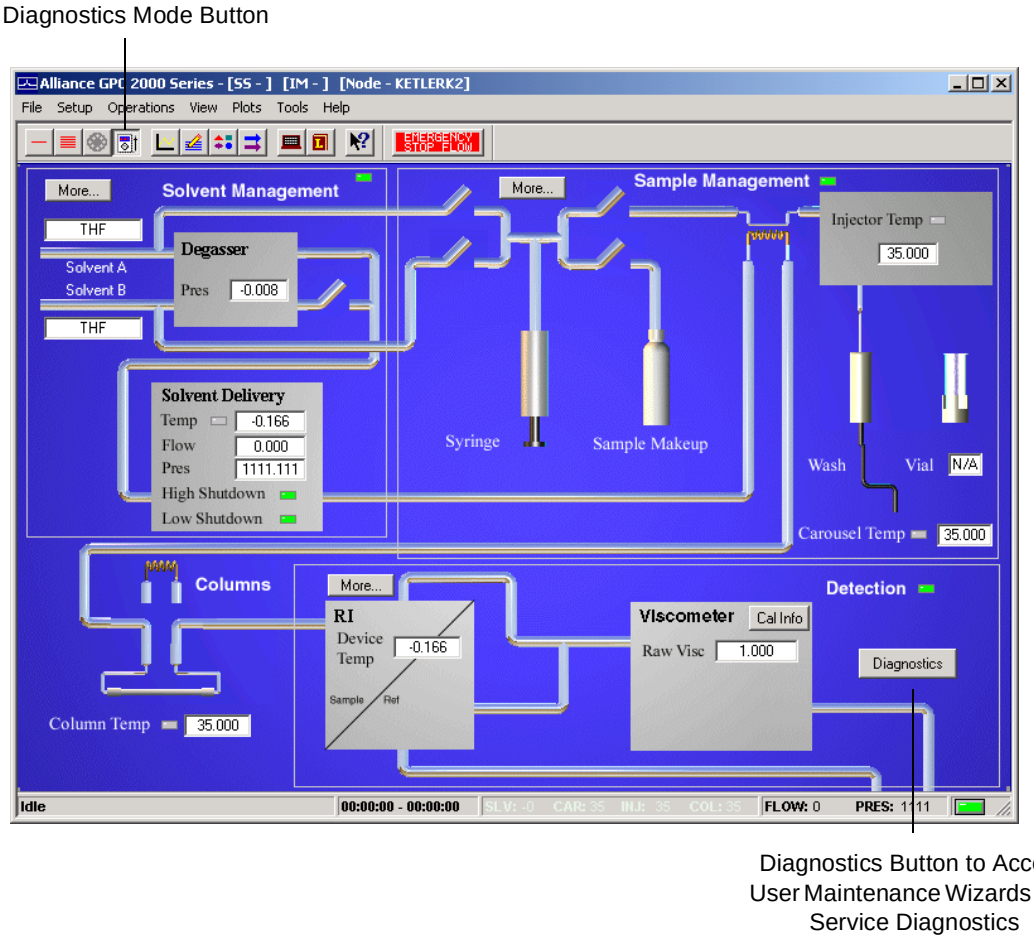


Figure 1-14 Diagnostics Mode Window

The major system components appear in the Diagnostics Mode window as four areas (clockwise from upper left): Solvent Management, Sample Management, Detection, and Columns.

Most areas contain a warning LED, status text, and one or more real-time numeric displays. The More button in each area allows access to diagnostic LEDs for the section components.

The Diagnostics button opens the User Maintenance and Service Diagnostics dialog box (Figure 1-15), which allows access to three maintenance wizards and a diagnostic test. Waters field service engineers also access Service Diagnostics from this dialog box.

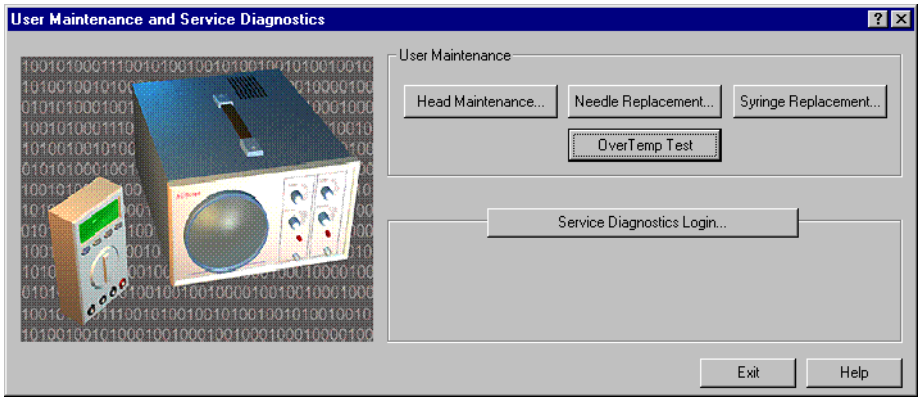


Figure 1-15 User Maintenance and Service Diagnostics Dialog Box

Editor Windows

The Instrument Configuration Editor window, the Instrument Method Editor window, and the Sample Set Method Editor window let you define and edit system parameters.

Instrument Configuration Editor Window

This window lets you define and edit the instrument configuration. It includes the seven tabs (Figure 1-16) described in Section 3.2. For details, see “Defining Instrument Configuration Parameters” in the *Alliance GPC 2000 Series System Help*.

Figure 1-16 Instrument Configuration Editor Tabs

Instrument Method Editor Window

This window lets you define and edit instrument methods. It includes five tabs (Figure 1-17), which are described in Section 3.3. For details, see these topics in the *Alliance GPC 2000 Series System Help*:

- "Creating/Modifying an Instrument Method for Interactive Mode Operation"
- "Creating/Modifying an Instrument Method for Sample Set Mode"

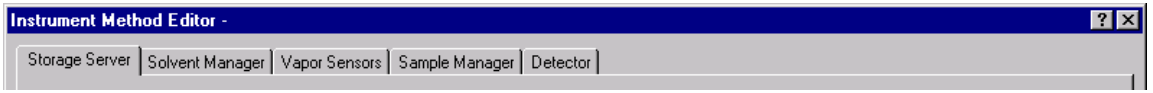
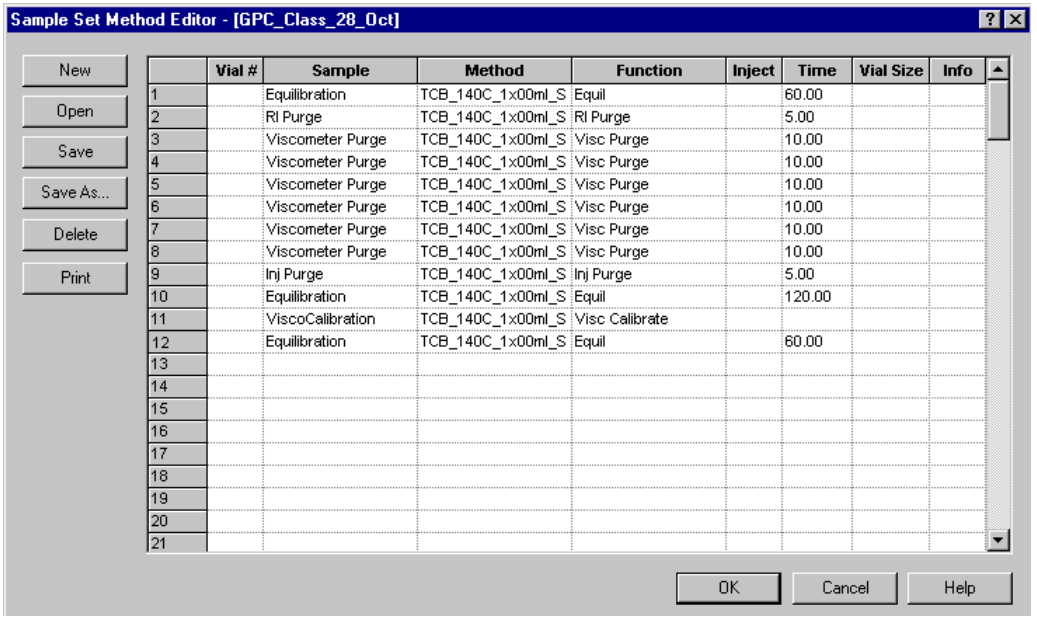


Figure 1-17 Instrument Method Editor Tabs

Sample Set Method Editor Window

This window (Figure 1-18) lets you edit the sample set methods explained in Section 3.7. For details, see "Sample Set Method Editor" in the *Alliance GPC 2000 Series System Help*.



	Vial #	Sample	Method	Function	Inject	Time	Vial Size	Info
1		Equilibration	TCB_140C_1x00ml_S	Equil		60.00		
2		RI Purge	TCB_140C_1x00ml_S	RI Purge		5.00		
3		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		10.00		
4		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		10.00		
5		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		10.00		
6		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		10.00		
7		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		10.00		
8		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		10.00		
9		Inj Purge	TCB_140C_1x00ml_S	Inj Purge		5.00		
10		Equilibration	TCB_140C_1x00ml_S	Equil		120.00		
11		ViscoCalibration	TCB_140C_1x00ml_S	Visc Calibrate				
12		Equilibration	TCB_140C_1x00ml_S	Equil		60.00		
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Figure 1-18 Sample Set Method Editor Window

Status Windows

The Message Board, Status, and Viewer windows provide status information.

Message Board Window

This window displays messages describing significant system events (Figure 1-19). The messages, which constitute information, warning, and error alerts, appear in chronological order. For details, see “GPC 2000 Message Board” in the *Alliance GPC 2000 Series System Help*.

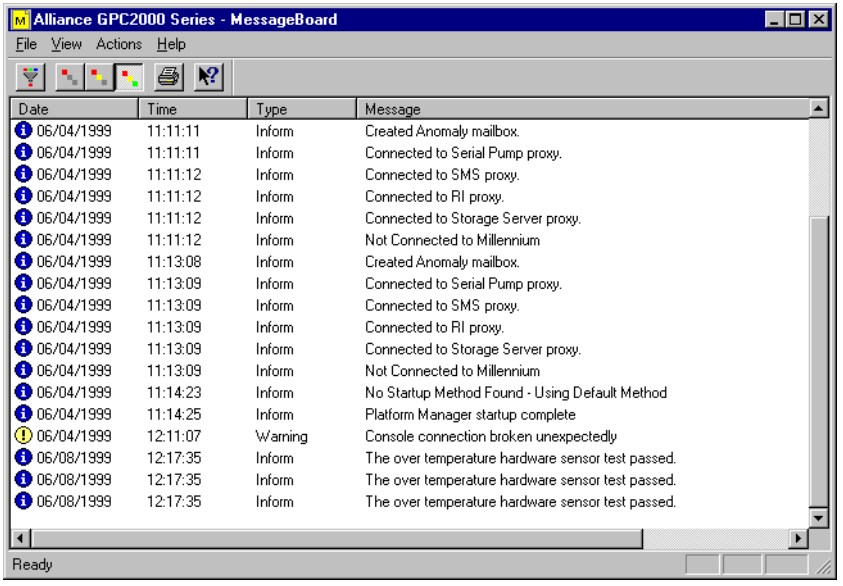


Figure 1-19 Message Board Window

Status Window

This window lets you monitor the current system and injection status (Figure 1-20). To open it, select View > Status Window from one of the four main window modes.

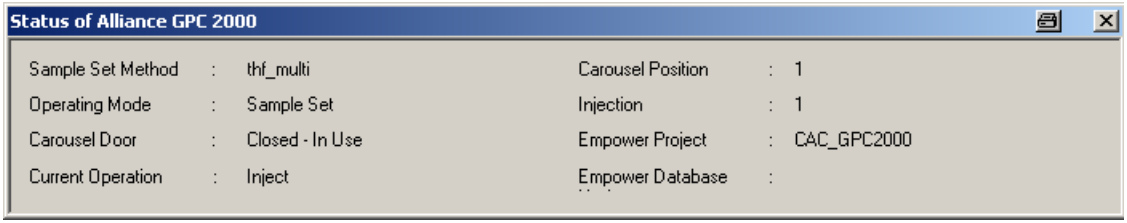


Figure 1-20 Status Window

Viewer Window

Use the Viewer to display and compare acquired channels of data for one or more previous injections (AIA files). For details on using the Viewer, see “Viewer,” “Viewer Menus,” “Viewer Toolbar,” and “Alliance GPC 2000 Series Data File Extensions” in the *Alliance GPC 2000 Series System Help*.

To display chromatograms and data channels

1. Select Tools > Viewer to open the Viewer window (Figure 1-21).

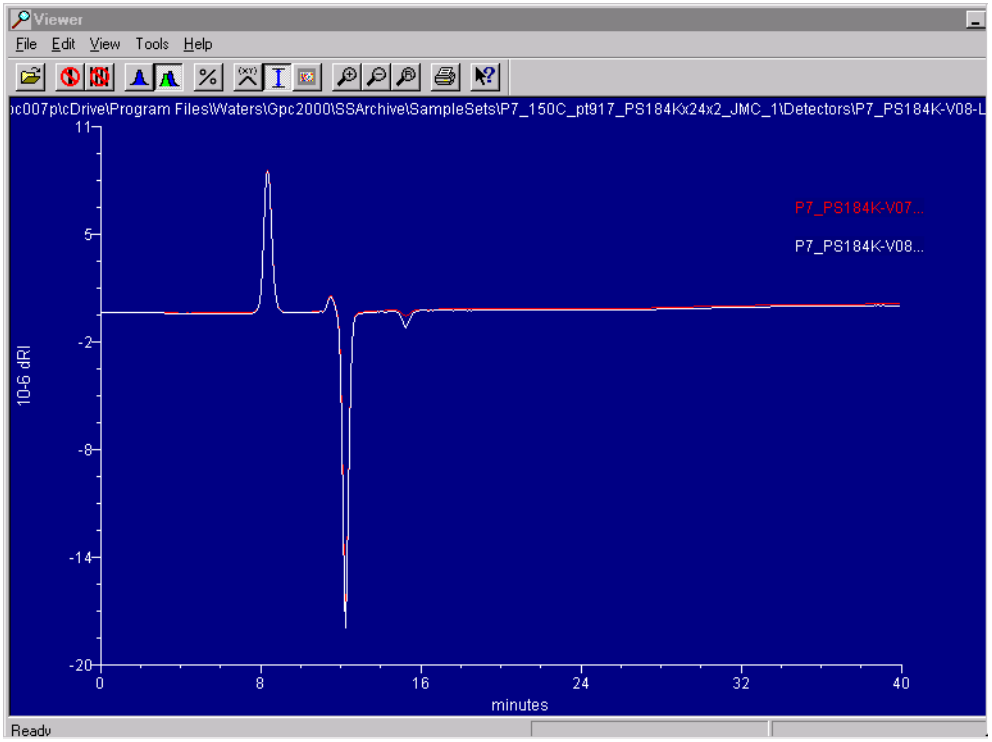


Figure 1-21 Viewer Window with Two Data Channels

2. Click (Overlay Mode) if you want to display up to eight data channels or chromatograms at one time, each in a different color.

   Note: *You can also overlay AIA data channels in Empower.*

3. Click (Percent Full Scale) if you want to display different types of data on one vertical axis with values from 0 to 100%.
4. Select File > Open.
5. Select a chromatogram or data channel to display in the Viewer.
6. Repeat steps 2 through 5 for each chromatogram and data channel you want to display.
7. Compare the plots and look for unexpected changes and/or differences.
8. If you need to gather more information, see Section 5.1.2, Checking the Message Board and Logs.

9. Depending on your findings, you can perform diagnostics tests for noise and drift (Section 5.2.1) and/or temperature control (Section 5.2.2), investigate baselines (see Section 5.3) or peaks (Section 5.4), and/or consult troubleshooting tables to solve hardware-based problems (Section 5.5 to Section 5.8).

1.6.2 Data Management Options

The Alliance GPC control software collects data from the detector(s). You can send the data to these places:

- Empower GPC, GPCV, or GPC/V-LS (for processing and reporting)
- To a third-party data system (for processing and reporting) via the I/O card

You can use the Viewer button to display a sample set's chromatograms after it is complete.

Using Empower GPC or GPCV Software

Waters Empower GPC, GPCV, and GPCV-LS software options add GPC, GPCV, and GPCV-LS acquisition and processing capabilities to the base liquid chromatography software.

GPC software includes these capabilities:

- Sample Loading – Lets you define narrow standards, broad standards, and unknowns.
- Component Loading – Lets you specify these items:
  - Molecular weight.
  - Molecular weight averages.
  - Cumulative percent-molecular weight pairs.
  - Mark-Houwink (k and alpha) values for standards and unknowns.
  - Named distributions for standards.
  - Component names for system suitability.
- Calibration Options – Lets you specify narrow standards, broad standards, or combined narrow/broad standards.
- Calibration Techniques – Lets you specify relative or universal (Benoit's protocol) calibration.
- Calibration Curve Fit Types – Lets you specify 1st-, 2nd-, 3rd-, 4th-, or 5th-order, bounded, cubic-spline, and point-to-point curve-fitting techniques.

- Review and Compare Tools – Lets you specify these actions:
  - Display calibration curves and molecular weight distributions.
  - Compare calibration curves from multiple runs.
  - Compare molecular weight distributions from multiple runs.
- Axial Dispersion Correction – Corrects for band-broadening during separations. This is especially helpful with large-particle (20-µm) columns.

GPCV software offers all the capabilites of GPC software plus these:

- Channel Set – Lets you combine the refractometer and viscometer data channels into a one-channel set that yields a single result.
- Sample Loading – Lets you define these parameters for each sample vial:
  - Concentrations (for standards and unknowns)
  - RI sensitivity
- Component Loading – Lets you define concentrations and dn/dc values for standards and unknowns.
- GPCV Calibration Technique – Lets you apply Benoit's protocol to perform a universal calibration.
- GPCV Processing Options – Lets you specify an intrinsic viscosity curve fit for the observed viscosity data. Zimm-Stockmayer fit types calculate the branching frequency of branched polymers. You can also calculate the viscosity law plot (log(n) vs. log MW) and the branching index (g') curve.
- Viscosity law plot – Lets you display these as plots:
  - Theoretical linear viscosity law (extrapolated or manually entered k and alpha).
  - Observed viscosity.
  - Fitted viscosity (polynominal or modified Zimm-Stockmeyer fit).
  - Branching index (g').
  - Molecular weight distribution.
  - Cumulative area percent.
- Branching Index (g') – Lets you perform these functions:
  - Calculate a sample's long- and short-chain branching index (g'LCB and g'SCB).
  - Display the g' value at each slice in the distribution and for each molecular weight average.
  - Display the overall g' value of the polymer.

  - Plot the theoretical linear viscosity (extrapolated or manually entered K and alpha) used to calculate g'.
- Branching Frequency and Probabilities – Lets you calculate the branching probability (λ) for long-chain branching and the number of branches per 1000 carbon atoms in the polymer chain (B).
- Compare – Lets you overlay the calibration curves of multiple runs with their corresponding viscosity plots and molecular weight distributions with Viscosity Law plots.
- Reporting – Lets you overlay the two channels of data, plot the viscosity law plot, and overlay the viscosity plots with a distribution for an unknown sample.

Use the Empower Light Scattering software option in addition to either Empower GPC or Empower GPCV software to process GPC-LS or GPCV-LS (triple detection) data into a single result:

- Light Scattering – Lets you display these plots:
  - Conformation plot.
  - Calibration plot.
  - LS data plot.
- Branching Index (g) – Lets you perform these functions:
  - Calculate a sample's long-chain and short-chain branching index (gLCB and gSCB).
  - Display the g value at each point in the distribution and for each average molecular weight.
  - Display the overall g value of the polymer.
  - Plot the theoretical linear conformation plot (extrapolated or manually entered k and alpha) and fitted Rg used to calculate g.

Empower software allows scale-up from an Empower Personal system to corporate-wide, large-scale, multi-user client/server systems. Empower Enterprise systems use distributed acquisition and processing technologies to distribute the workload to all computers in the client/server system. For details, see these topics in the *Alliance GPC 2000 Series System Help:*

- "Empower Software Overview"
- "Empower GPC, GPCV, and LS Overview"

Using the I/O Card

The I/O card provides these signal input and output connections to data systems and equipment that Empower does not control:

- Two user-programmable event inputs.
- Two user-programmable event outputs.
- Four analog outputs (channels 1 through 4) with voltages proportional to a variety of internally measured parameters.

Consult Section 2.4.5 when connecting other devices and Section 3.3 to configure the I/O card. See “I/O Card” in the *Alliance GPC 2000 Series System Help* for details.

1.7 Temperature Control

Caution: *To avoid burn injuries, allow enough time for the system to cool before you perform maintenance or troubleshooting procedures. Also, wear protective clothing whenever you open the sample or analysis compartment.*

The system maintains each of these areas at different temperatures (Figure 1-22):

- Analysis compartment (contains columns, detectors, and injection valve) – Ambient plus 5 °C (up to 180 °C).
- Sample compartment (contains the carousel, injection valve, sample preheat station, mix/spin station, and filter/inject station) – Ambient plus 5 °C (up to 180 °C).

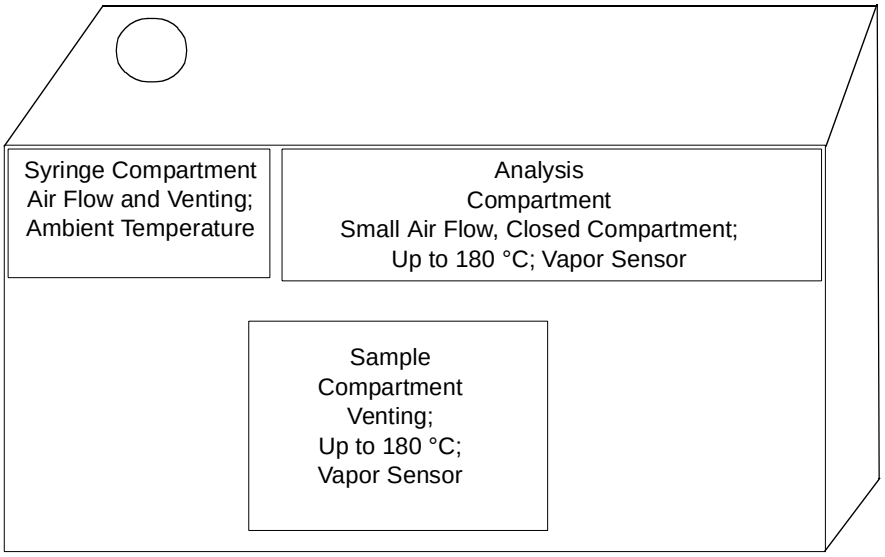


Figure 1-22 System Control in Each Compartment

For details, see these topics in the *Alliance GPC 2000 Series System Help*:

- "Temperature Control"
- "Temperature Shutdown Limit"

These things affect temperature control:

- Compartment and system insulation to keep external surfaces safe to touch.
- Temperature limits that solvent characteristics influence.
- Automatic shutdown protocol: When a compartment's temperature exceeds the high-temperature limit, the system software does the following:
  - Shuts down the compartment
  - Ramps down the solvent management system
  - Activates the red status indicator
- A ventilation system that draws air from vents on the front and right sides, and exhausts the air out the top and rear ports.

The system embodies three levels of overheat protection based on temperature limits that you set in the software and fixed limit thermal fuses:

- Level 1 – The software uses these limits to discern whether temperatures exceed the allowed settings.
- Level 2 – An independent hardware system monitors these limits during initial setup, normal operation, and system failures.
- Level 3 – Fixed-limit thermal fuses (for example, a thermal fuse in the column area or a thermal fuse in the SMS area) that open at temperatures above approximately 250 °C and shut down the heaters.

For additional ventilation control, you can place the system in a fume hood. The monitor, keyboard, and mouse can be located up to 5 feet (1.5 meters) from the system with the cables provided in the startup kit. You can use longer cables to install the workstation farther from the system.

1.8 Safety Features

Vapor Detection and Venting

Vapor sensors monitor vapor levels in three areas:

- Detector compartment
- Sample management (carousel) compartment
- Ambient air space in the lab

The sensors compare vapor levels to those at startup or initialization. Vapor detection is programmable. If vapor levels inside the system exceed the programmed shutdown limit, the red LED lights, and the system shuts down. (You can program the system to alert you during these events.) For details, see “Vapor Sensors” in the *Alliance GPC 2000 Series System Help*.

You should determine shutdown limits experimentally at each installation by introducing small amounts of the solvent to generate a signal that indicates acceptable limits. Too low a limit can induce false triggering; too high a limit can defeat leak detection. Test vapor sensors regularly to ensure limits are working properly and replace them when necessary.

Spill Control and Waste Fluids

Waste fluids drain to a waste container placed below the level of the system.

- Drip trays provide spill control for all compartments. Fluid drains through a waste port on the left side of the system to a waste container (Chapter 5, Troubleshooting the System).
- Waste solvents from detectors exit the system through a waste port on the upper-left side.
- Waste solvents from the needle wash apparatus exit the system through a waste port on the lower-left side.

Chapter 2
Installing the System

2.1 Installation Site Requirements

Choose a location for your system that meets the specifications in Table 2-1.

Table 2-1 Installation Site Requirements

Factor	Requirement
Ambient temperature	10 to 32 °C (50 to 90 °F)
Room temperature variation	Less than 1.5 °C/hr. (long term) or 0.25 °C/min (short term) for best results.
Relative humidity	20 to 80%, noncondensing
Bench space:	
Main system without monitor and keyboard	Width – 37 in. (94 cm) Depth – 22 in. (56 cm) Height – 24 in. (61 cm)
User interface (monitor, keyboard, and mouse)	Width – 24 in. (61 cm)
Clearances for ventilation, cable connections, opening doors, and service	Rear – approximately 0.5 in. (1 cm) Front – approximately 16 in. (41 cm) Left side – approximately 16 in. (41 cm) Right side – approximately 6 in. (15 cm) Top – at least 9 in. (23 cm)
Ventilation	Access to a large fume hood or to a 4-in. (10-cm) exhaust vent with 4 to 8 m/sec air flow (70 to 140 $feet^3$ per minute or 2 to 4 $meters^3$ per minute); no exposure to direct sunlight, other sources of heating, or air conditioning vents. If needed, an optional hookup kit, part number 200000120, comprising a 10-foot length of 4-inch diameter exhaust hose with a sliding, adjustable flow dampener and clamps is available.

Table 2-1 Installation Site Requirements (Continued)

Factor	Requirement
Block instrument support	Five round instrument support blocks 3 (height) x 3 in. (diameter).
Bench top	Stable, flat, clean surface; level or slightly tilted (up to 2°) toward the front and left (for proper drainage of the drip trays); capable of supporting 400 lb. (181 kg); with wheels if possible.
Aluminum feet	The startup kit contains five aluminum feet (3 in. in diameter and height) to position underneath the Alliance GPC 2000. Place the feet on the bench top in an X pattern.
Power requirements	Two grounded power outlets on separate circuits: one for the main system, the other for the monitor. A dedicated electrical circuit is recommended for this instrument. The monitor and any additional devices such as printers or light scattering detectors should draws current from another circuit (or circuits that all share a common ground). The main system outlet must provide 10 A at 240 VAC and 50/60 Hz. The monitor outlet must provide 120 or 240 VAC and 50/60 Hz. The light scattering detector requires 120 VAC and a grounded power outlet.
Electromagnetic fields	No nearby source of electromagnetic noise such as arcing relays or electric motors
Static electricity	Negligible
Vibration	Negligible

2.2 Unpacking, Inspecting, and Setting Up

The major components and their associated parts arrive in three cartons: one for the monitor, one for a GPC column, and one for the following items:

- Alliance GPC 2000 system or Alliance GPCV 2000 system with pre-installed software

- Startup Kit
  - Mouse
  - Keyboard
  - Power cord
  - Windows 2000 software and documentation
  - Empower software and documentation
  - Alliance GPC 2000 Series system software and documentation

Attention: *To prevent damage and preserve access, do not place any items on top of the system.*

Required Materials

- Phillips screwdriver, medium
- Slotted screwdriver
- Open-end wrench, 5/16-in.
- Scissors or knife
- Tubing cutter (for stainless steel tubing)
- Heat-protective gloves and safety goggles
- Spirit level
- Small container for fluids
- Flashlight (optional)
- Flowmeter (when installed on a bench top)

Procedure

1. Inspect the shipping containers for damage or evidence of mishandling. If you observe damage, see the accompanying document, *Waters Licenses, Warranties, and Support,* for instructions on reporting it.
2. Remove the outer container:
   a. Cut and remove the straps.
   b. Open the top of the carton, and remove the Startup and Accessories Kits from the inner box.

c. Remove the inner box and foam packing, and then lift the corrugated outer shell from the system.

d. Remove the four pieces of wood (with two bolts each) that surround the bottom of the system.

e. Use a pallet jack to move the system to the installation site. The system, which is less than 28 in. (70 cm) deep, fits through most doorways.

Note: *Be careful not to damage the recessed waste ports on the left side.*

f. Remove the plastic wrap.

3. Verify that the serial number matches that on the Certificate of Validation in the Startup Kit. Find the serial number in one of two places:

   - Near the power switch, on the right panel
   - Inside the sample compartment, at the lower-left rear corner

   Note: *Retain the Certificate of Validation for future reference.*

Caution: *To avoid solvent vapors exposure, install the system inside a suitable fume hood, or vent it mechanically, ensuring a draw rate of 4 - 8 meters per second (70 to 140 feet^3 per minute or 2 to 4 meters^3 per minute). If needed, an optional hookup kit, part number 200000120, comprising a 10-foot length of 4-inch diameter exhaust hose with a sliding, adjustable flow dampener and clamps is available.*

Ascertain the requirements for venting solvent vapors in your local building and health codes.

4. Prepare to install the system at either well-ventilated location:

   - In a fume hood – The five aluminum blocks that accompany the system raise its height by 3 in.
   - On a bench top with access to an external exhaust vent – See step 6. You will need the Ventilation Option Kit (see Table B-7).

Caution: *To avoid personal injury and system damage, at least four people should lift the system from the pallet using the four, slide-out, lift bars stored beneath it. The empty system weighs about 365 lb. (166 kg).*

5. Remove the five aluminum feet from the startup kit. Arrange four of them on the bench top so that they each receive one of the system's four corners. Set the fifth foot precisely in the center of the rectangle formed by the other feet.

   Note: *The system is 22 in. (56 cm) deep and 37 in. (94 cm) wide.*

6. With four people on the four lift bars (two in front and two at the rear), lift the system from the upper skid, and carefully set it in its final location.

Attention: *To provide for proper drainage of solvents and waste, the system must be level or inclined to the front and left (however, no greater than 2°).*

7. If the system is on a bench top, connect it to an exhaust vent (Figure 2-1):
   a. If available, connect the vent gate (from the Ventilation Option Kit) to a 4-in. (10-cm) diameter exhaust vent (see Table B-7).

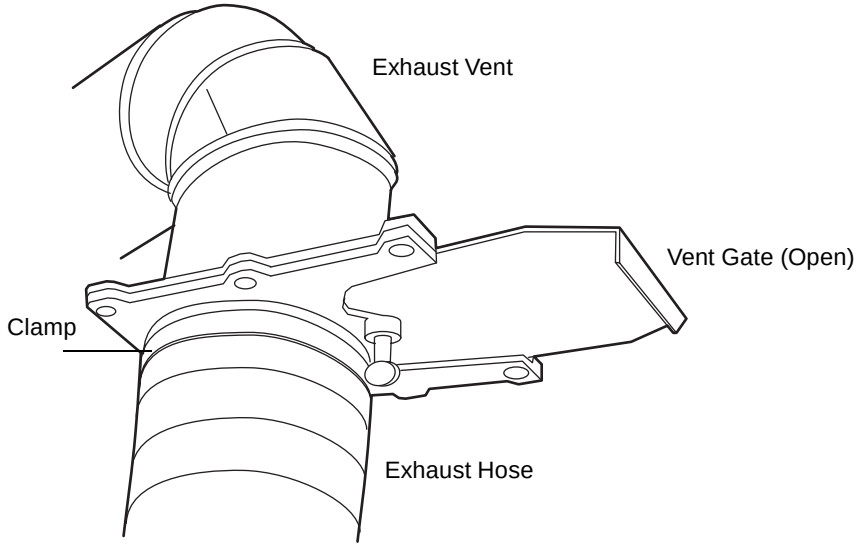


Figure 2-1 Connecting the Vent Gate

   b. Connect one end of the exhaust hose to the vent gate. Secure it with a clamp.
   c. Connect the other end of the exhaust hose to the vent adapter (top-left rear corner of the system). Secure it with a clamp (Figure 2-2).

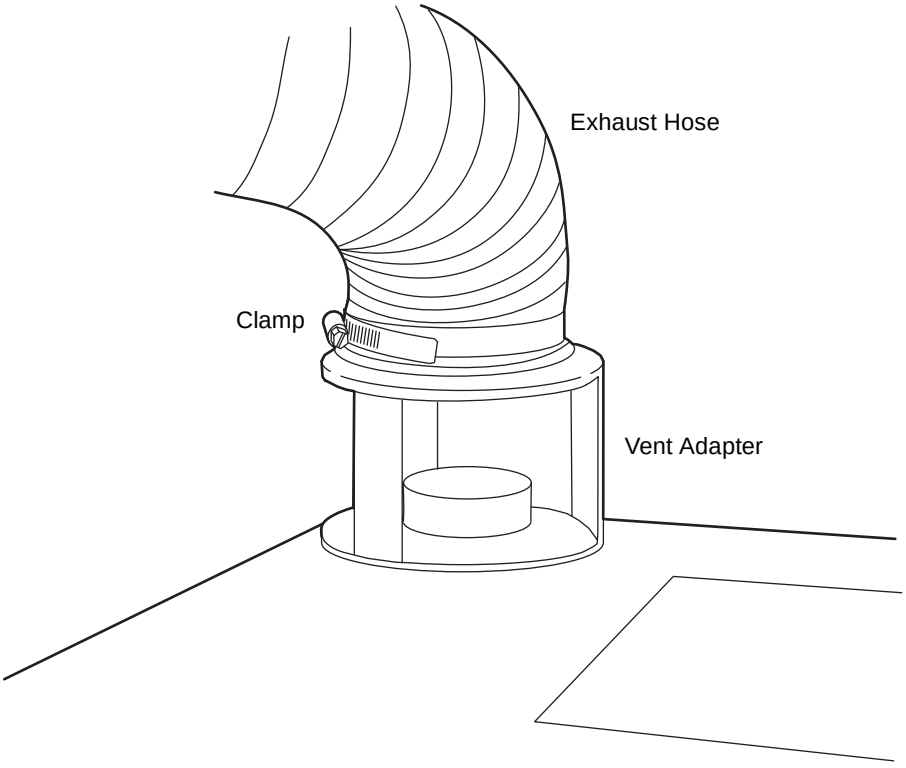


Figure 2-2 Connecting to an Exhaust Vent

8. If the system is in a fume hood, ensure the hood's air flow is sufficient to draw any vapors the system's operation might produce.
9. Contact a Waters field service engineer to perform the required service installation tasks.

2.3 Connecting Flow System Components

Installing the system involves connecting these flow system components:

- Solvent reservoir (see Section 2.3.1)
- Waste container (see Section 2.3.2)
- Columns (see Section 2.3.3)
- Piston seal wash (optional; see Section 2.3.4)

- Syringe (see Section 4.5.3)
- Sample loop (see Section 4.5.4)

2.3.1 Connecting the Solvent Reservoir

Required Materials

- Solvent tubing with filters (startup kit):
- Solvent reservoir and its cap
- HPLC-grade solvents, prefiltered through a 0.5-µm filter membrane
- 0.5-µm filters and filtration apparatus
- Phillips screwdriver, medium
- Magnetic stirbar and stir plate (optional)
- Reserve solvent bottle (optional)
- Solvent safety trays

Attention: *To prevent damaging the system, as well as permit physical access to it, do not place any items on the system components.*

Procedure

1. Connect tubing from the left side of the system to the reservoir as follows (Figure 2-3):
   - Solvent A tubing (yellow) and solvent C tubing (red) to solvent reservoir A.
   - Solvent B tubing (blue) and solvent D tubing (green) to solvent reservoir B.

   Note: *The tubing that enters the top-left side connects internally to the isolation valves, and that which enters the lower left connects internally to the degasser. The colors refer to identification sleeves at the end of the tubing.*

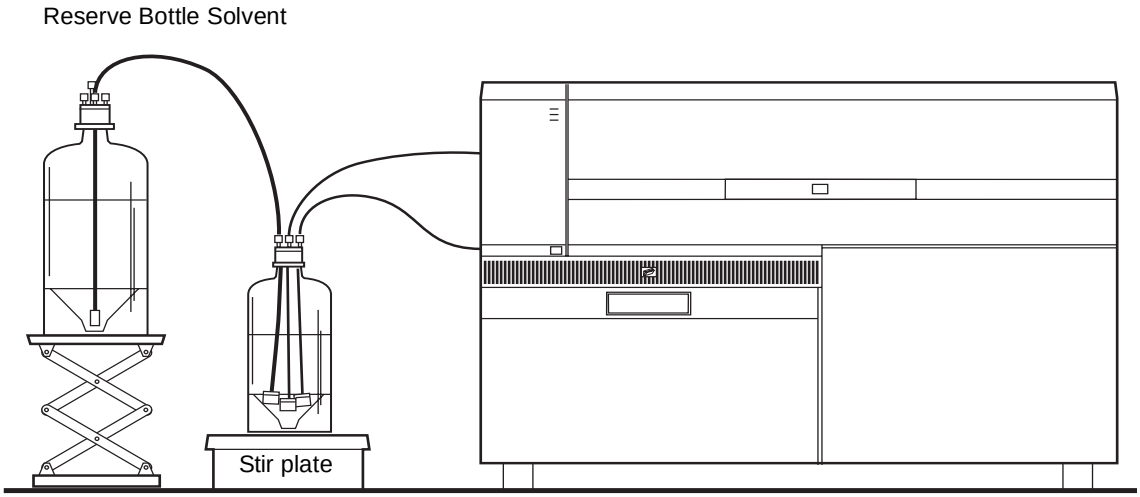


Figure 2-3 Connecting Solvent Reservoirs to the System

Note: *Be sure to filter solvents and cover them afterward (see Appendix C).*

Note: *The solvents must be higher than the solvent management system (pump). For THF and less viscous solvents (chloroform, methylene chloride), set the bottles on top of the instrument or on a jack 18 inches higher than the solvent management system. Place aqueous buffers on a jack 12 to 18 inches higher than the solvent management system; the height depends upon the solvent used. Waters recommends the use of solvent safety trays which are not depicted in Figure 2-3.*

2. Fill solvent reservoirs with prefiltered HPLC-grade solvents.
3. Insert the free end of each solvent inlet line through a hole in the reservoir cap. Connect the solvent filter to the end of each solvent line. The filters should descend to the reservoir bottoms
4. Install reservoir caps on the reservoirs.
5. When a solvent serves many samples, you can continually replenish its reservoir by connecting a reserve bottle to it (Figure 2-3). When you add fresh solvent to the reserve bottle, the solvent is slowly siphoned into the solvent supply bottle. This allows any differences in solvent composition to be gradually introduced into the solvent supply, ensuring a stable RI baseline.

   a. Install solvent tubing from the bottom of a large reserve solvent bottle to the solvent reservoir.

b. Use a priming syringe to remove all air bubbles from the tubing and thus start a free solvent flow from the reserve bottle to the solvent reservoir.

c. Ensure all connections are airtight.

d. Set the solvent reservoir on a stir plate. With a magnetic stirrer and stirring bar, gently and continuously mix the solvent.

e. Place all solvents in safety trays.

6. After installing all parts, configure the mobile phase (see Section 3.4.6). For details, see "Mobile Phase A or B" in the *Alliance GPC 2000 Series System Help*.

2.3.2 Installing a Waste Container

Required Materials

- Startup kit:
  - Waste tubing, 0.25 in. ID × 60 in. (3)
  - Hose clamps (6)
- Waste container (6L to 8L) with solvent-compatible and sample-compatible covers
- Phillips screwdriver, medium
- Tape measure
- Small pliers

Caution: *Ensure electrical power is off, and avoid touching electronic components.*

Procedure

1. Place the waste container below the system, in a well-vented space (Figure 2-4).

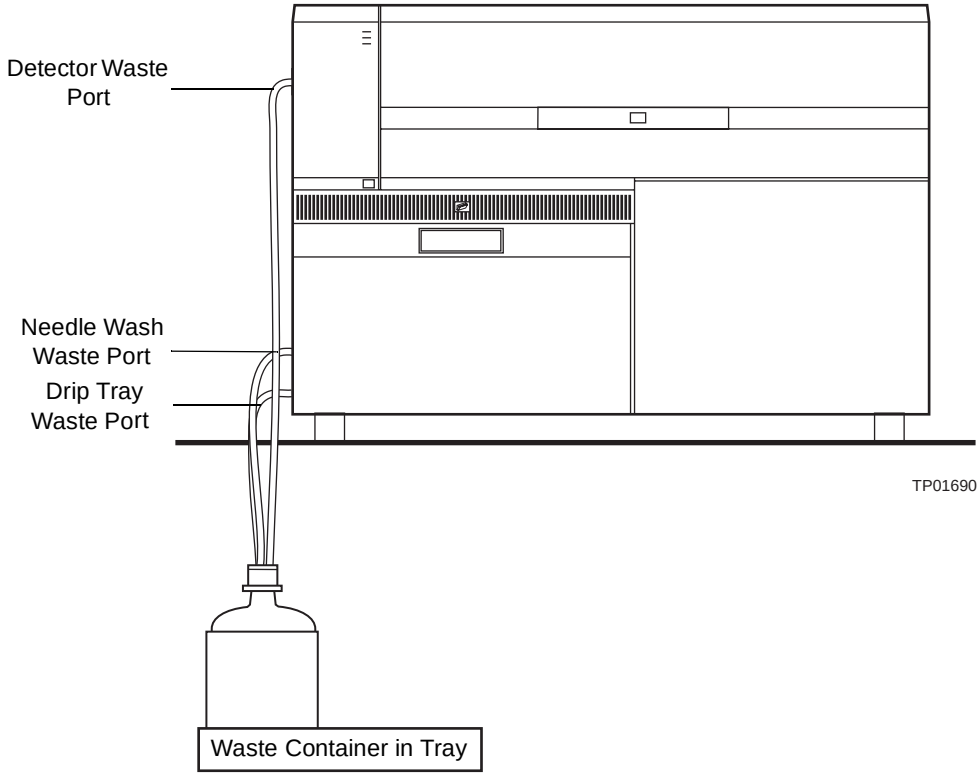


Figure 2-4 Installing the Waste Container

2. Remove the six screws from the left panel, and then remove the panel (Figure 2-5).

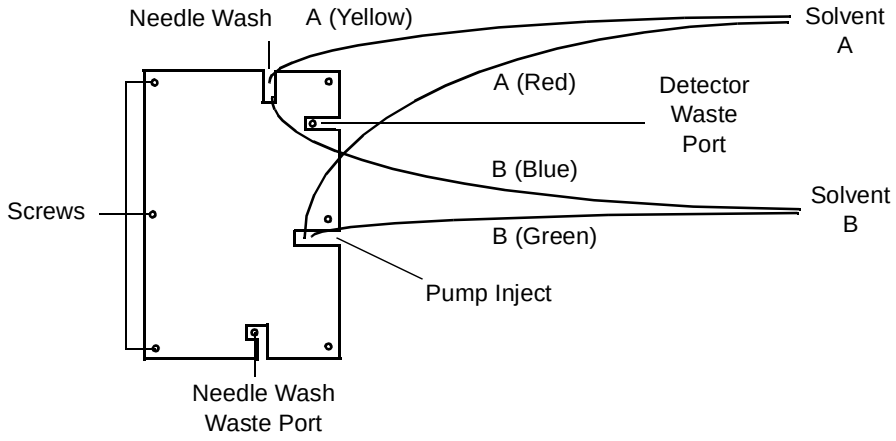


Figure 2-5 Removing the Left Panel

3. Place a spring clamp on the straight end of each length of tubing. Use a small pair of pliers to open the clamps.
4. Remove the protective cap from each waste port.
5. Connect a piece of tubing to each waste port, and secure it with a clamp. Insert the free ends of the tubing through the waste container cap.
6. If the waste container is not in a fume hood, connect a piece of tubing from the waste container cap to an exhaust vent.
7. Reinstall the left panel without pinching tubing or cables. Place the waste tubing through the slots in the left panel.
8. Fit the top edge of the side panel under the top panel. Secure it with the six screws.
9. Tighten the waste container cap.
10. Arrange the ends of the tubing against the inside wall of the waste container to facilitate drainage and eliminate dripping.

2.3.3 Installing Columns

Note: *One column is shipped with the system; however, you can install as many as six.*

For information on the kinds of columns available for the system, see Section 1.3 and Table B-3 and Table B-4. Refer to the *Styragel Column Care and Use Manual* for details on Styragel columns. Refer to the *Ultrahydrogel Column Care and Use Manual* for details on Ultrahydrogel columns. Refer to the *HSPgel Columns for High Speed GPC Analysis Column Care and Use* manual for details on the HSPgel columns.

Attention: *To prevent column damage, use extreme care whenever you change any system parameter, including temperature, pressure, flow rate, solvent type, and/or solvent concentration.*

Caution: *To avoid injury from burns, allow the system enough time to cool before you perform maintenance or troubleshooting procedures. Wear protective clothing whenever you open the sample or analysis compartment.*

Required Materials

- Columns for your applications (see Appendix B)

  Note: *One column, Styragel HT6E packed in toluene (part number WAT044218), and a stainless steel intercolumn tube are shipped with the system.*

- Startup kit (includes ferrules, compression screws, and stainless intercolumn steel tubing, 0.009 in. ID × 10 ft. (3.0 m)
- Open-end wrenches, 5/16-in. and 5/8-in.

Procedure

Attention: *If the analysis compartment is warmed, allow it to cool before you install or replace a column unless your applications require high temperatures.*

If the system is fitted with columns, see Section 4.6 for details on how to prepare it.

1. Arrange the column(s) on a bench top so that directional arrows point in the direction of solvent flow.
2. When assembling two or more types of columns, arrange them in order of decreasing pore size.

   Note: *Remove and save the column end-plugs for future use.*

3. Connect the columns with the U-shaped intercolumn tubing, ferrules, and compression screws (see Figure 1-5, the T9 connection.)
4. Open the analysis compartment door by sliding the latch to the left, and then lift the door from its bottom edge with gloved hands (Figure 2-6).

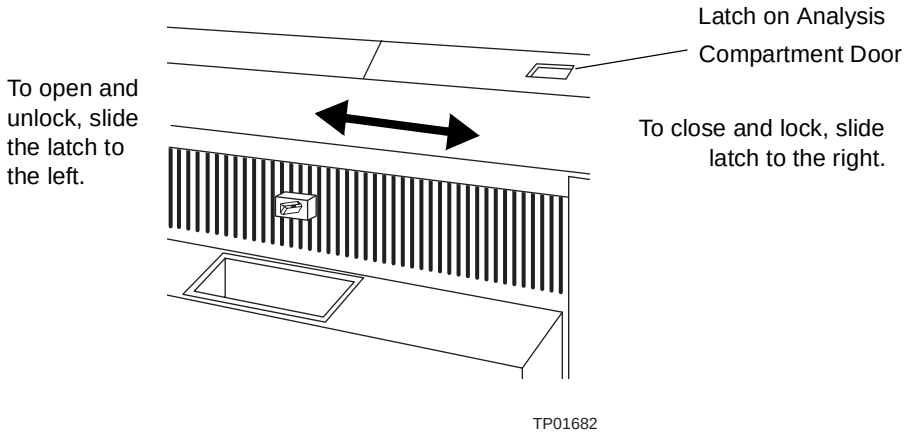


Figure 2-6 Opening the Analysis Compartment Door

5. Place the bank of columns on the left and right column holders (Figure 2-7).

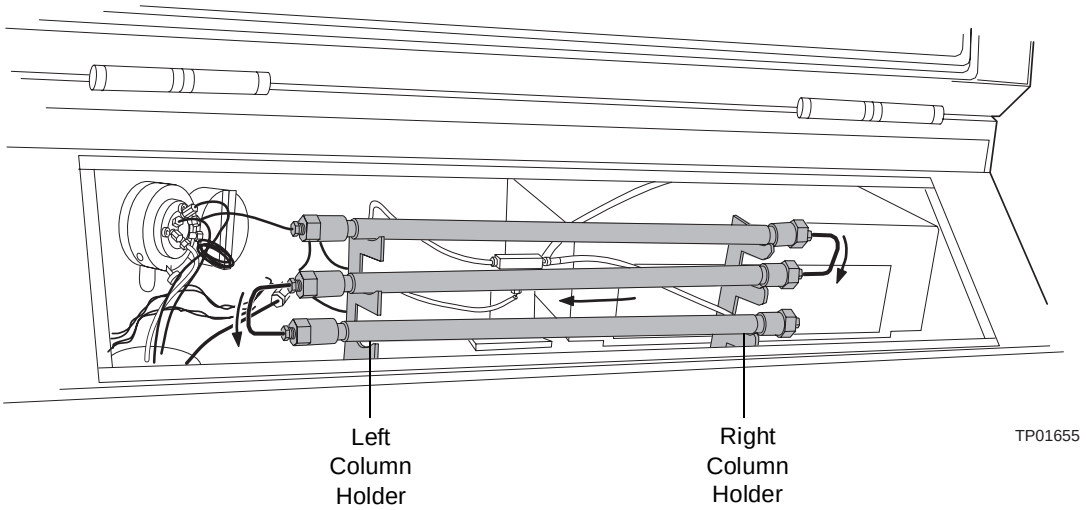


Figure 2-7 Installing the Columns in the Analysis Compartment

6. Connect the tubing from port 2 of the injection valve to the inlet of the first column (Figure 2-8).

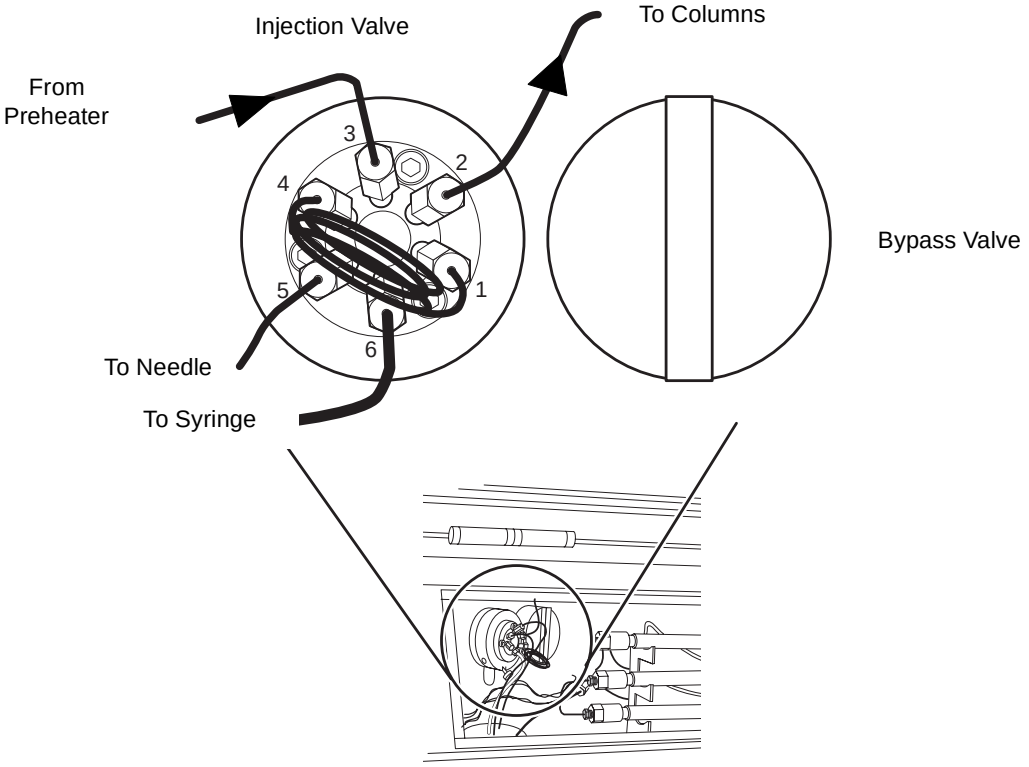


Figure 2-8 Connecting the Columns to the Injection Valve

7. Connect the tubing from the refractometer inlet to last column in the series' outlet (Figure 2-8).
8. Close and lock the analysis compartment door, pushing the latch to the right.
9. After installing the hardware, identify the columns by labeling them in the software (see Section 3.2.4). For details, see "Columns" in the *Alliance GPC 2000 Series System Help*.
10. Equilibrate the system until the baseline stabilizes (see Section 3.6.1). Choose the maximum ramp rate, 0.2 mL/min/min.

STOP ***Attention:*** *To prevent column damage, start the system carefully. Maintain a solvent flow rate of 0.2 mL/min or less until the specified operating temperature is reached.*

2.3.4 Connecting the Piston Seal Wash (Optional)

If you use strong organic solvents like DMF with salts, or buffered aqueous ones at ambient temperature, Waters suggests you also use the piston seal wash. The seal wash extends the life of the piston seal by lubricating the piston and flushing away solvent or precipitated salts.

To connect the piston seal wash, follow the instructions in the Seal Wash Option Kit (see Appendix B). Figure 2-9 shows the seal-wash flow path.

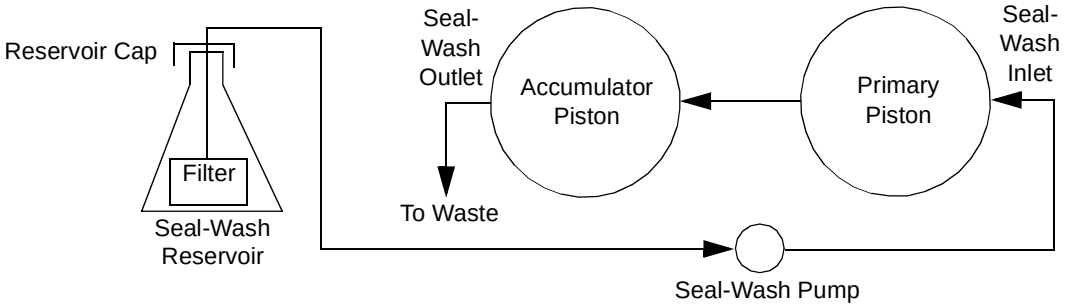


Figure 2-9 Flow of the Piston Seal Wash

After you install the hardware, configure the seal wash (see Section 3.2.1). For details, see "Mobile Phase A or B" in the *Alliance GPC 2000 Series System Help*.

STOP

Attention: *To avoid damaging the system, use a seal-wash solvent that mixes with your mobile phase, one that is also compatible with the seal-wash seals (see Table C-2).*

To prevent immiscibility and/or precipitation when switching between mobile phases, use an intermediate solvent that mixes with both mobile phases (see Appendix C).

2.4 Connecting Signal Wires to External Devices

The system requires digital signal connections to a monitor, keyboard, and mouse. Optional connections include these:

- A printer (Section 2.4.2)
- A serial card (Section 2.4.3)
- A network (via an Ethernet network cable) (Section 2.4.4)
- An I/O card in the communication panel (Section 2.4.5)

Figure 2-10 outlines the steps that making signal connections to the system can involve.

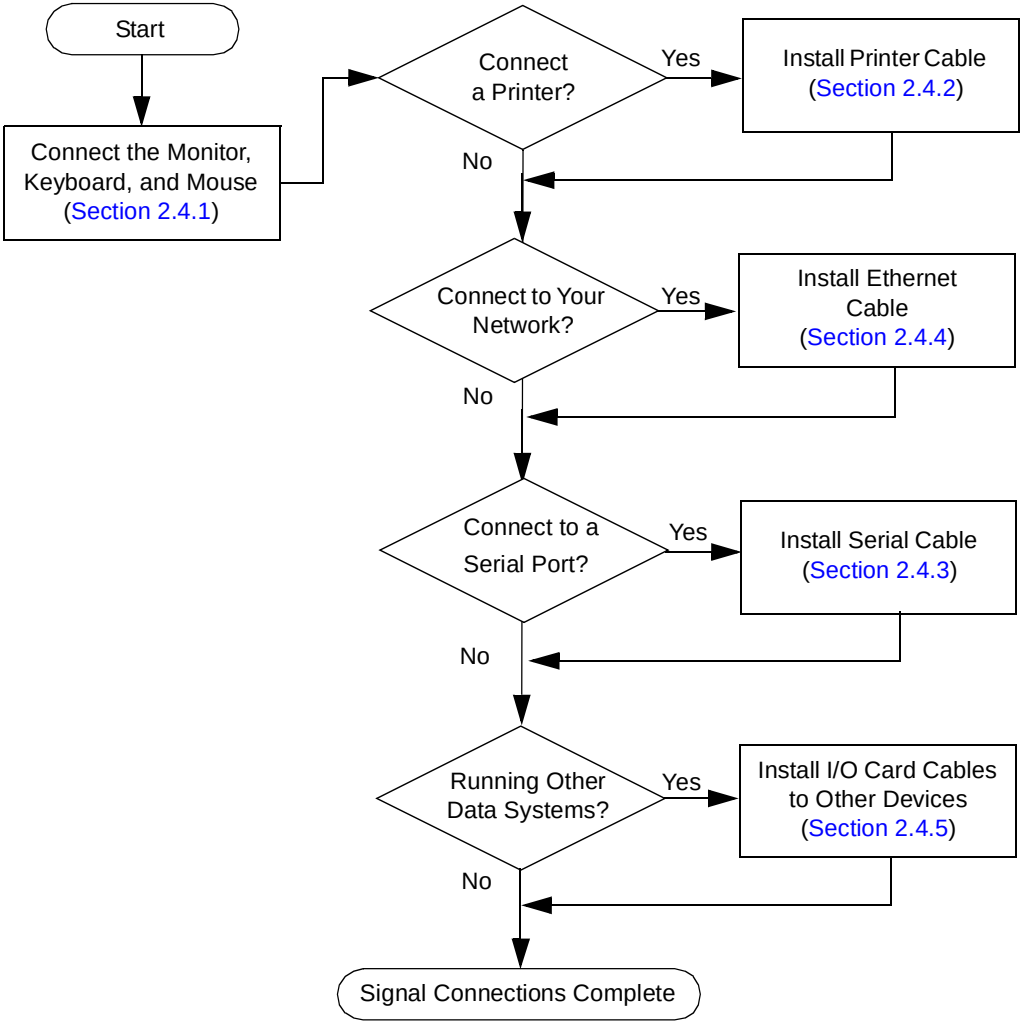


Figure 2-10 Making Signal Connections

STOP ***Attention:*** *Waters recommends you install on the onboard CPU only the software it supplies. Installation of other software can cause your system to operate improperly.*

You can install the monitor, keyboard, and mouse as far as 5 ft. (1.5 m) from the system with the cables in the Startup Kit. Use longer cables for greater distances. The monitor requires a separate AC power outlet.

Attention: *To avoid electrical shock, shut down the system, and disconnect its power cord before you perform the following procedures.*

2.4.1 Connecting the Monitor, Keyboard, and Mouse

1. Unpack the monitor, and place it in its permanent position.
2. Open the solvent compartment door to access the communication panel.
3. Connect the monitor cable to the communication panel's 15-pin connector (Figure 2-11).

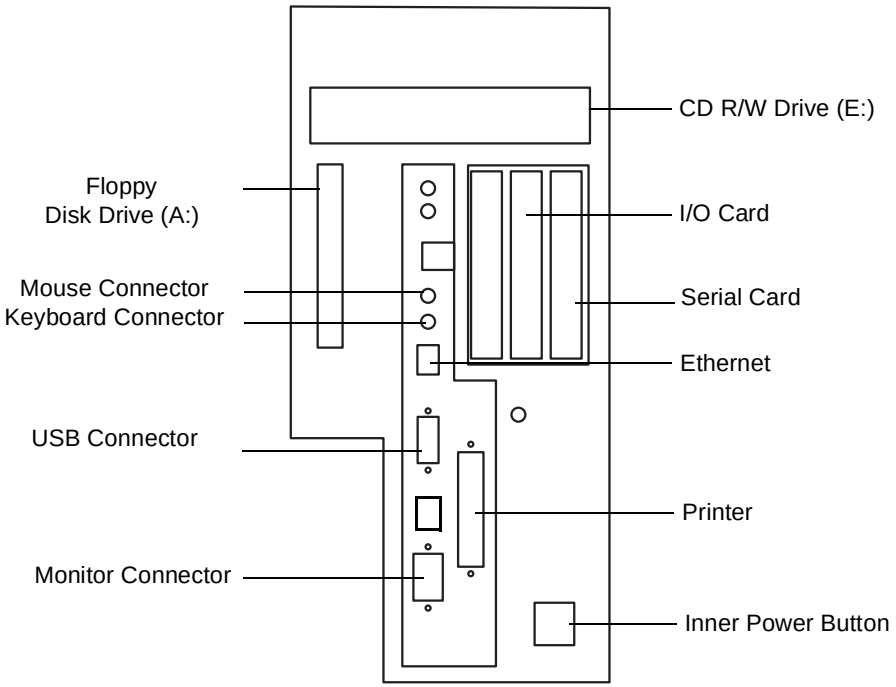


Figure 2-11 Connecting to the Communication Panel

4. Connect the monitor's power cord to an AC outlet.
5. Connect the keyboard cable to the keyboard connector (Figure 2-11).
6. Connect the mouse cable to the mouse connector (Figure 2-11).

2.4.2 Connecting a Printer

Required Materials

- Printer
- Printer cable
- Printer power cord
- Windows 2000 printer driver for the model of the printer

Procedure

1. Connect one end of the printer cable to the printer.
2. Open the solvent compartment door, and connect the other end of the printer cable to the communication panel's printer (Figure 2-11).
3. Connect one end of the power cord to the printer and the other end to a grounded power outlet.
4. To configure the printer, see the *Windows 2000 Help* and the manufacturer's documentation. Configure the printer in the Printer Setup dialog box (open it from the File menu in the Windows 2000 software). You can install the printer icon in the Windows 2000 Control Panel.

2.4.3 Connecting to a Serial Device

To connect to the serial device, use a RS-232 cable to connect the optional Waters-approved device to the serial port on the serial card (Figure 2-11).

2.4.4 Connecting to a Network

Required Material

Ethernet cable

Procedure

1. Open the solvent compartment door.
2. Connect an Ethernet cable from your network to the communication panel's RJ45 network port (Figure 2-11).
3. Close the solvent compartment door. Avoid pinching the cables.

Note: *To configure communication from GPC 2000 to an Empower Enterprise, refer to the GPC 2000 Software Installation Instructions.*

2.4.5 Connecting to the I/O Card

The I/O card contains these signal channels:

- Four for analog output (see Section 2.4.5.1)
- Two for event input (see Section 2.4.5.2)
- Two for event output (see Section 2.4.5.3)

For a description of each I/O card port, see Table A-10.

Required Materials

- Four I/O cables (Startup Kit)
- I/O screwdriver (Startup Kit)

To configure software to recognize the I/O connections, see Section 3.2.6, Configuring the I/O Card.

2.4.5.1 Sending Analog Output Signals

The system can send up to four analog output signals, including refractometer and viscometer data, and LS to another data system or to a chart recorder using I/O card channels 1, 2, 3, and/or 4. It can also send signals that represent these operating parameters:

- Flow rate
- Pressure
- Temperature
- Vapor sensor readings

1. Connect one end of an I/O cable to these pins on the I/O card (Figure 2-12):
   - Analog Out (+)
   - Analog Out (Ground)

   Note: *If you use a shielded cable, connect the shield wire to the grounding clip located on the front of the computer.*

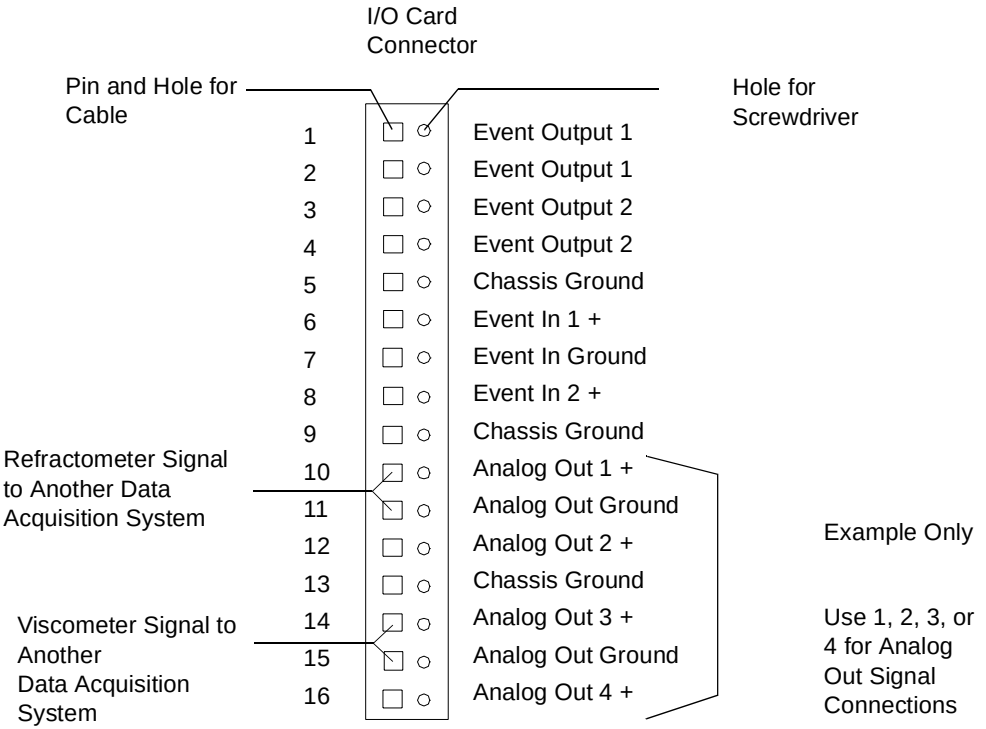


Figure 2-12 Analog Out Signal Connections on the I/O Card

2. Follow the other system manufacturer's instructions to connect the opposite end of the I/O cable to that system's data acquisition board.
3. Repeat steps 1 and 2 for each output signal you send.
4. To configure the signals, see Section 3.2.6. Select the analog channels that correspond to the pin connectors (Analog Out 1 to 4) on the I/O card.

2.4.5.2 Receiving Event Input Signals

The system can receive up to two event input signals through the I/O card, regardless of which data system you connect it to. External events trigger the input signals used for starting events, like an injection sequence or stopping solvent flow.

Note: *You must configure I/O card inputs.*

1. Connect one end of an I/O cable to the I/O card's Event In pin and one of its Event In ground pins (Figure 2-13).

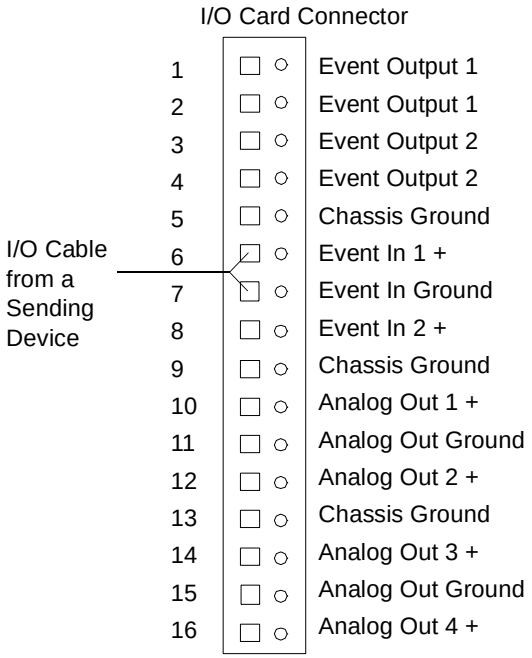


Figure 2-13 Event Input Signal Connections on the I/O Card

2. Connect the output device to the I/O card according to its manufacturer's instructions.
3. Repeat steps 1 and 2 for a second Event In signal, if any.
4. Select the event controls that correspond to the pin connectors (Event In 1 + or 2 +) on I/O card. See Section 3.2.6 to configure the signals.

2.4.5.3 Sending Event Output Signals

The system can send one or two event output signals through the I/O card, regardless of its associated data system.

Note: *You must configure I/O card outputs.*

1. Connect one end of an I/O cable to an event output pin and chassis ground pin on the I/O card (Figure 2-14).

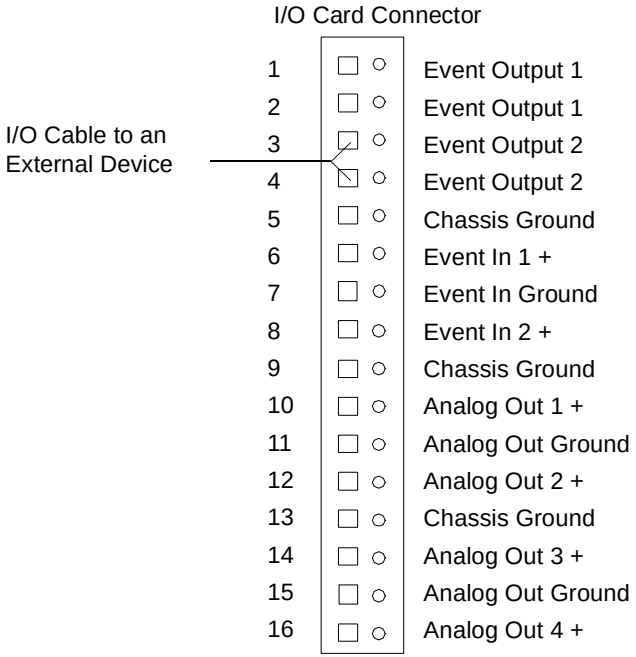


Figure 2-14 Event Output Signal Connections on the I/O Card

2. Connect the I/O cable's other end to the device receiving the signal. Follow the device manufacturer's instructions.
3. Repeat steps 1 and 2 for a second event, if needed.
4. Select the event outputs that correspond to the pin connectors (Event Output 1 or 2) on the I/O card. To configure the signals, see Section 3.2.6.

2.5 Connecting to the Electrical Power Supply

Required Material

Power cord

Note: *The startup kit contains two power supply cables: one rated for north American use, the other for international use, and both can be used with 100–240 VAC. Install the cable prescribed for use in your geographic location. Keep in mind that the instrument is rated up to 20 amps and requires a non fluctuating input voltage of 100–240 VAC. To address this need, Waters recommends a dedicated circuit, receptacle, and line conditioner or uninterruptible power supply (UPS). The cords are not equipped with plugs, because*

receptacle configurations vary. After selecting the correct cable to install, fit it with a plug that matches your receptacle's configuration. (The startup kit does not contain plugs.)

Procedure

Refer to Figure 2-15.

1. Ensure the on/off switch on the right side panel is Off (O).
2. Insert one end of the power cord into the connector on the right panel.
3. Insert the opposite end into a grounded power outlet. The GPCV2000 instrument power input is rated for 100-240 VAC, 50/60 Hz, and 20 A.

STOP

Attention: *A dedicated electrical circuit is recommended for this instrument. The monitor and any additional devices such as printers or light scattering detectors should draws current from another circuit (or circuits that all share a common ground). The GPCV2000 instrument, and any peripheral devices or instruments connected to it, must be connected to a properly grounded power outlet. The ground connection in all these outlets must be the same, and connect to a common point near the service panel and the system. Finally, consider using a line conditioner or an uninterruptible power supply (UPS) for optimum long-term input voltage stability.*

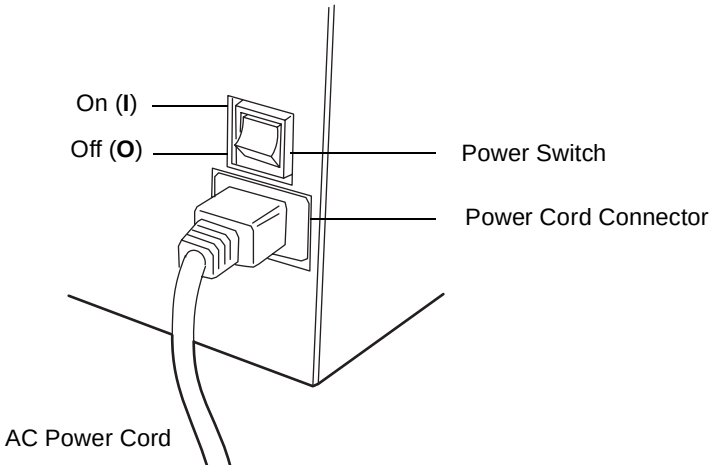


Figure 2-15 Connecting the Power Cord

Chapter 3
Preparing for Operation

This chapter details how to prepare the system for operation, how to run a sample set, and how to shut down the system.

Figure 3-1 summarizes the tasks involved in operating the system.

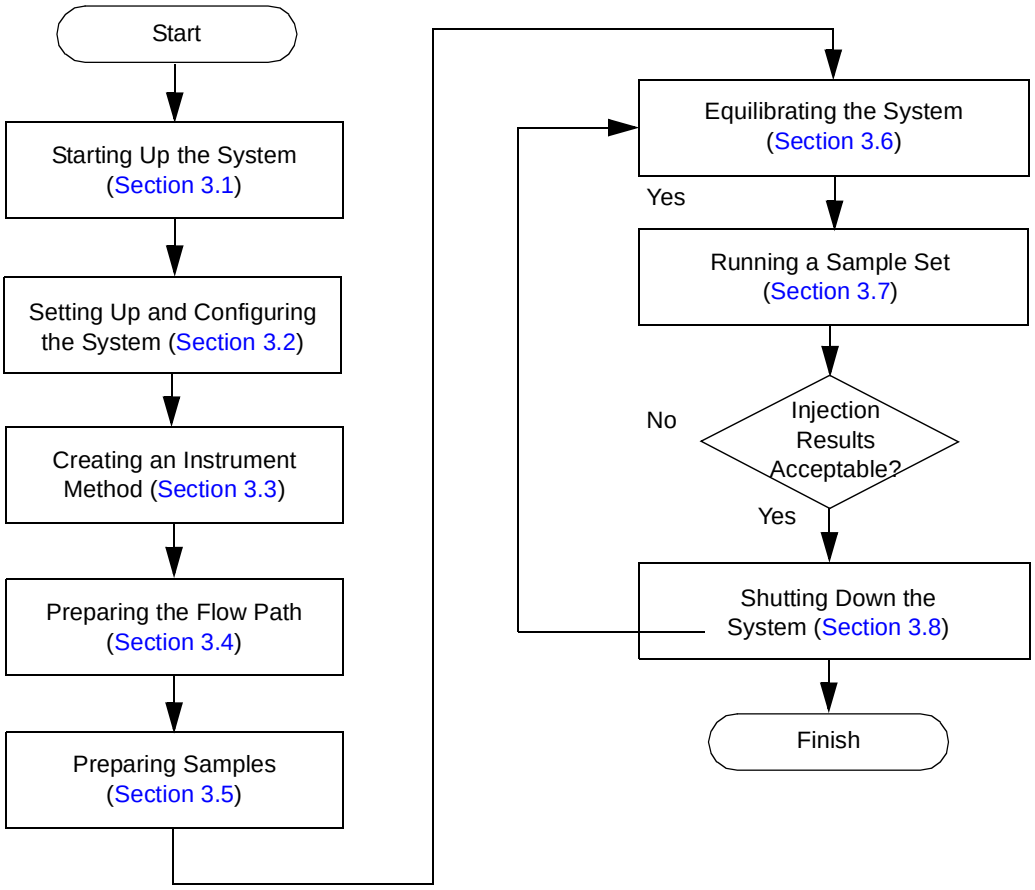


Figure 3-1 Operating the System

Note: *System heating and equilibration requires considerable time. You should therefore complete all preparations such as hardware and solvent changes, software configurations, and maintenance tasks before letting the system warm to desired operational temperatures.*

3.1 Starting the System

1. Start all peripheral devices, including the monitor and the PD Light Scattering detector, if purchased.

   Note: *If the LS detector was on before you powered on the GPC 2000 instrument, power off the LS detector for 30 seconds, and then power it back on to re-initialize the LS detector.*

2. Start the system by setting the power switch to **I** (On).

   Note: *If the computer does not automatically start, open the solvent compartment door, press and release the inner power button on the communication panel, and then close the door.*

   The status LEDs on the front panel flash, showing current system condition (Table 3-1). The instrument requires several minutes to initialize. It signals completion when the LEDs stop flashing.

Table 3-1 Status LEDs

LED Description	System Condition	Action
Top, Red, Flashing	Starting. Or a system-level fault exists and the system is in shut-down mode.	Troubleshoot (Chapter 5).
Middle, Yellow, Steady	Starting. Or has not yet reached specified conditions.	Allow enough time for the system to start. If the condition persists, begin troubleshooting (Chapter 5).
Bottom, Green, Steady	Conditions specified in the startup method reached.	Ready for operation.
All Flashing	Starting.	Wait until one LED lights.
All LEDs Off	Shut down.	Start and wait until one LED lights.

3. When the Log On dialog box appears, simultaneously press the Control, Alt, and Delete keys to log in to the Windows 2000 operating system.
4. Enter your user name and password. The default account name is “Administrator,” and the password is “gpc2000,” these confer administrator privileges, and then click OK.

   Note: *Passwords are case sensitive.*
5. Wait for the status LEDs to stop flashing, indicating that initialization is complete.
6. The user interface starts, and the Alliance GPC 2000 Series Login window appears (Figure 3-2).

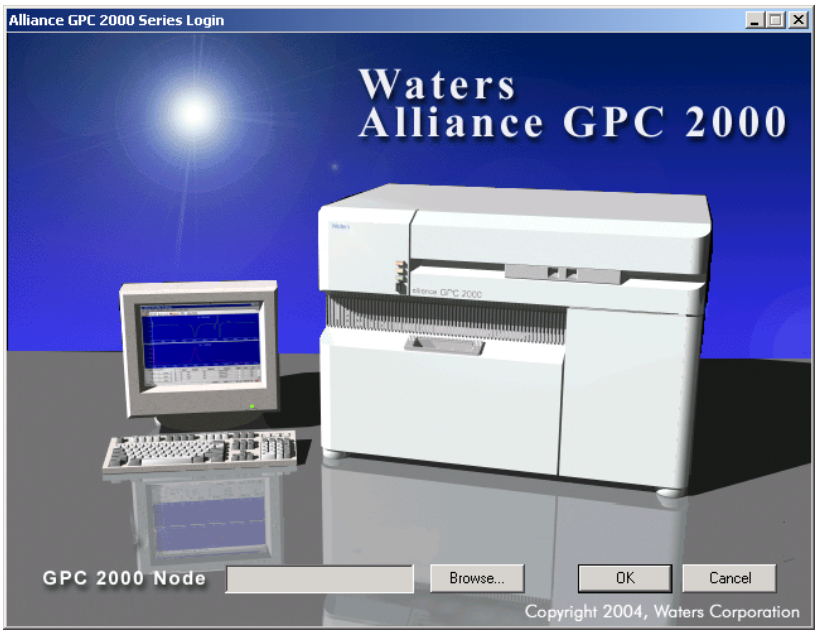


Figure 3-2 Alliance GPC 2000 Series Login Window

If the Alliance GPC 2000 Series Login window fails to appear after a few minutes, select Start > Programs > GPC2000 > Chromatography > GPC2000 Console.

When connecting to a remote Alliance GPC 2000 Series system, enter the name of the GPC 2000 node you want to connect to or Browse to locate a specific system. When operating the system as a standalone system, leave this field blank (normal operation).

Note: *You can create a desktop shortcut to start the Console Login window.*

7. Click OK.

When startup is complete, the Message Board appears and minimizes. Then the Interactive Mode window appears (Figure 3-3). The status indicator (lower right) shows the current system status, reproducing the function of the status LED on the front panel. If a problem occurs, or if the status indicator is red, see Chapter 5.

> For details, see the "Starting Up the Alliance GPC 2000 Series System" in the *Alliance GPC 2000 Series System Help*.

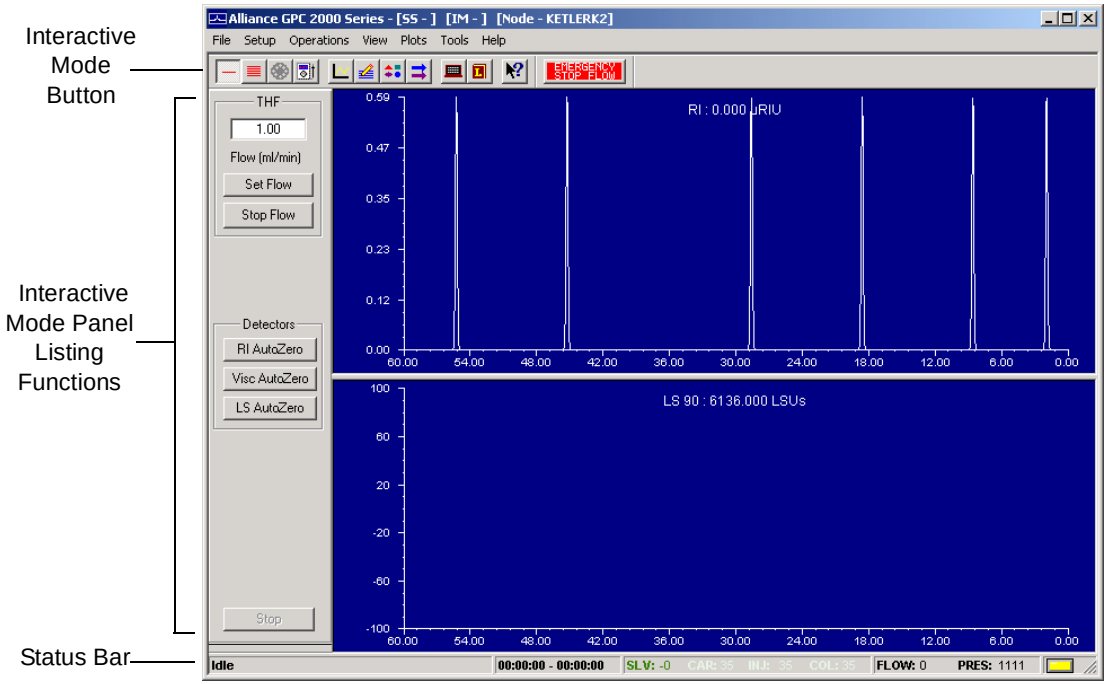


Figure 3-3 Interactive Mode Window

3.2 Setting Up and Configuring the System

Setting up and configuring the system entails specifying parameters for basic operation.

Note: *See Windows 2000 documentation for tasks involving initial setup and configuration settings in Windows 2000 software.*

Specify generic settings. These reflect how you use the system and determine how it operates:

1. If you connected a printer to the system, install its driver. Then refer to the *Windows 2000 Help*, and the printer manufacturer's documentation to configure the printer.
2. If you connected the system to an Ethernet network, set the Ethernet port.
3. Specify these parameters in the Instrument Configuration Editor dialog box. Click OK to close the dialog box.
   - Mobile phase (Section 3.2.1)
   - Temperature ramp rate (Section 3.2.2)
   - Injector (Section 3.2.3)
   - Columns (Section 3.2.4)
   - Detector (Section 3.2.5)
   - I/O card (Section 3.2.6)

3.2.1 Configuring the Mobile Phases

See Section 3.4 to prepare the flow path. See Appendix C and also "Mobile Phase A Tab" in the *Alliance GPC 2000 Series System Help* for solvent information.

Configuring Mobile Phase A

1. Click  (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Select Setup > Instrument Configuration. The Instrument Configuration Editor dialog box appears, displaying the Mobile Phase A page (Figure 3-4).

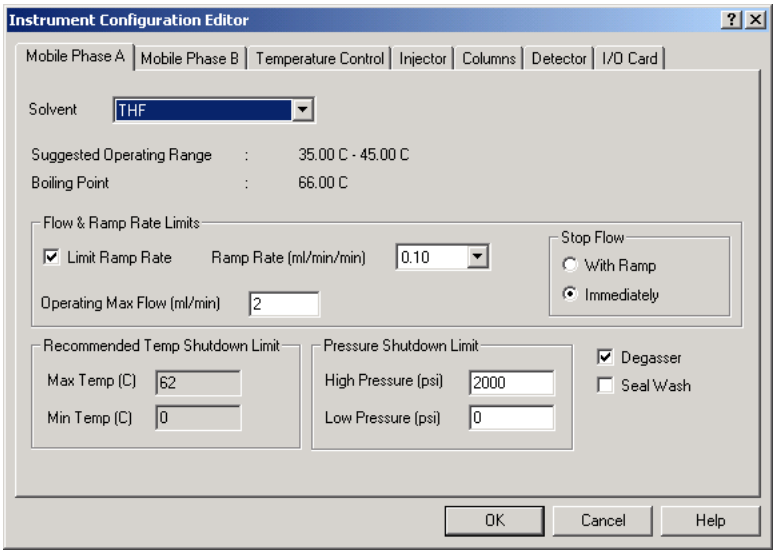


Figure 3-4 Mobile Phase Page

3. Select the Reservoir A's solvent from the Solvent list, noting its suggested operating range, boiling point, and recommended temperature shutdown limits.

Caution: *Whenever you select Other from the Solvent list, record the solvent, its operating range, and its boiling point.*

4. Specify the ramp rate and the maximum operating flow rate:
   a. Select Limit Ramp Rate to control the rate of flow increase.
   b. Select a Ramp Rate value from 0.05 to 1.00 mL/min/min. (default = 1.00 mL/min/min).
   c. Specify the maximum flow rate by entering an Operating Max Flow rate (mL/min).

Note: *Flow should not saturate columns or viscometer pressure transducers. Waters suggests a flow rate value of no greater than 1.5 mL/min (1.0 mL/min is a typical flow rate for most analytical GPC columns). Nevertheless, you may specify a greater flow rate. For viscous solvents with a flow rate of 0.5 mL/min, the pressure relief valve may open earlier. If it does, it will divert part of the flow stream through the reference side of the RI detector.*

Attention: *Excessively high flows can damage columns. The appropriate flow rate depends on solvent viscosity and temperature.*

5. Specify the Stop Flow method:
   a. Select Immediately when you want solvent flow to stop simultaneously with entering the Stop Flow command. This is the default setting.
   b. Select With Ramp when you want solvent flow to decrease at the ramp rate specified when you enter a Stop Flow command.
6. Specify Pressure Shutdown Limits:
   a. Enter the High Pressure, from 100 to 5000 psi. Default = 2000 psi.

Caution: *To avoid damaging columns because the flow pressure exceeds their design limits, specify a shutdown limit when using viscous solvents. If the main oven's temperature decreases, the columns will be protected from the resultant high pressures.*

   b. Enter the Low Pressure, from 0 to 4900 psi. Default = 0 psi. If you specify 0 as the default limit, the system does not monitor for low-pressure occurrence. The recommended value is 50 psi.
7. Select solvent options. See Appendix C for the options that apply to your solvent.
   a. Select Degasser to vacuum-degas the solvent.
   b. If the seal-wash option is installed, select Seal Wash to wash the piston seals.

   Note: *The seal-wash option must be installed and connected to a seal-wash reservoir. See Section 2.3.4.*
8. Continue with Section 3.2.2, or click OK to save the changes.

3.2.2 Limiting the Temperature Ramp Rate

You can limit the rate of temperature increase in the analysis compartment (Temperature Ramp Rate Limit).

1. Click the Temperature Control tab in the Instrument Configuration Editor to open the Temperature Control page.
2. Select Enable Temperature Ramp Rate Limit to limit the rate of temperature increase in the analysis compartment.
3. In the Temperature Ramp Rate list, select a temperature ramp rate limit from 0.25 to 5.00 ^{o}C/min. No default setting.

4. Continue with Section 3.2.3, or click OK to save the changes.

3.2.3 Configuring the Injector

Note: *Perform this procedure when you install different-sized sample loops or syringes.*

To configure the injector, you must specify the exact sample loop volume, syringe size, draw rate, and dispense rate.

1. Click the Injector tab in the Instrument Configuration Editor to open the Injector page (Figure 3-5).

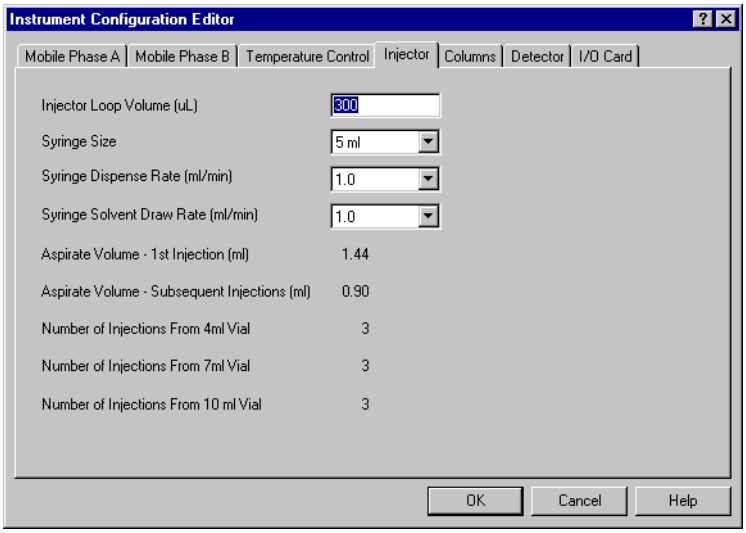


Figure 3-5 Injector Page

2. If you replace the sample loop with one of a different size, enter the loop volume (labeled on the loop) in the Injector Loop Volume field.

   Note: *You may enter an injection volume as low as 5 uL. If you are using 4 mL vials and enter a loop volume greater than 310.0 uL, you can only perform one injection per vial. This restriction does not apply to 10 mL vials or filter vial use.*

3. If you replace the 5-mL syringe the system was shipped with, select the 2.5 mL-syringe size from the Syringe Size list. Default = 5.0 mL.
4. Select from the Syringe Dispense Rate list a dispense rate from 0.1 to 10.0 mL/min. Default = 1.0 mL/min. The dispense rate determines how fast solvent is dispensed to wash the needle.

Note: *Highly viscous samples and solvents require low dispense rates and draw rates.*

5. Select from the Syringe Solvent Draw Rate list a solvent draw rate from 0.1 to 10.0 mL/min. Default = 1.0 mL/min. The draw rate determines how fast fresh solvent is drawn from the solvent reservoir.

   Note: *The the instrument method defines the draw rate for aspirating a sample from its vial (see Section 3.3).*

6. Continue with Section 3.2.4, or click OK to save the changes.

3.2.4 Labeling Columns

The Instrument Configuration Editor dialog box's Columns page lets you identify the columns in the analysis compartment.

1. Click the Columns tab in the Instrument Configuration Editor dialog box (Figure 3-6) to open the Columns page.

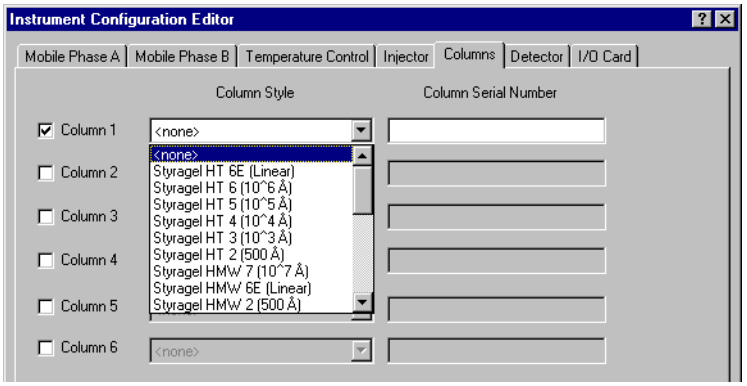


Figure 3-6 Columns Page

2. Select a column position, 1 through 6.
3. Select an appropriate column from the Column Style list.

   Note: *Select no column if the list does not include an appropriate one.*

4. You can enter the column's serial number and description (up to 250 alphanumeric characters) in the Column Serial Number field.
5. Repeat steps 2 through 4 for each column.
6. Continue with Section 3.2.6, or click OK to save the changes.

3.2.5 Configuring the Detector

If you installed a Precision Detector light scattering detector and want to enable the light scattering option, select the Detector tab in the Instrument Configuration Editor dialog box (Figure 3-7), and select the PDI LS Installed? check box.

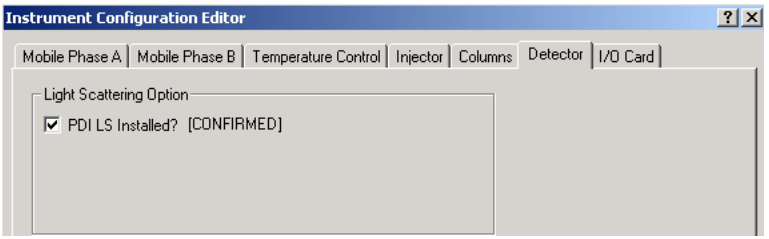


Figure 3-7 Detector Page

3.2.6 Configuring the I/O Card

When you connect external devices through the I/O card, you must configure the software to recognize the card's connections (Section 2.4.5). These connections, and their intended functions, can require configuring these channels:

- Analog output
- Event input
- Event output

Note: *You might also need to create a timed event list.*

Consult these topics in the *Alliance GPC 2000 Series System Help* when configuring channels:

- "I/O Card" for the I/O card and analog output channels
- "Event Input/Output Control Dialog Box" for the event input and output channels

Note: *See Appendix A for electrical specifications of signals transmitted through the I/O card.*

1. Click the I/O Card tab in the Instrument Configuration Editor (Figure 3-8) to open the I/O Card page.

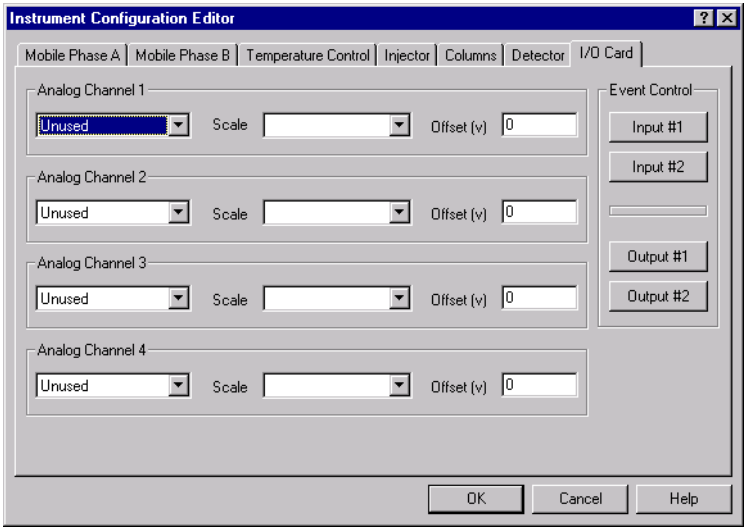


Figure 3-8 I/O Card Page

2. To configure an analog output channel, select these items:
   a. A physical parameter.
   b. Channel scale. See Table 3-2 for the output values and scale for the parameters.
   c. Channel offset. Valid entries are from –2.0 to +2.0 V. Default = 0.0 V.

Table 3-2 Output Scale

Parameter	Output Values (per Volt)
RI	25, 50, 100, 500, 1000, 2500 µRIU/V
Viscometer, Visc. Rel. Flow	1.0 relative viscosity unit/V
Viscometer P1 Viscometer P2	5.5 kPa/V 55 kPa/V
LS 15 Deg. LS 90 Deg.	1000, 10,000, 1,000,000, 10,000,000 LSU/volt
Device and Ambient Temperatures	25 °C/V
Solvent Temperature	25 °C/V
Column, Injector, and Carousel Temperatures	100 °C/V
Pump Pressure Degas Pressure	1000 or 2500 psi/V 10 psi/V

Table 3-2 Output Scale (Continued)

Parameter	Output Values (per Volt)
Pump Flow	1 or 5 mL/min/V
Ambient, Detector, or Carousel Vapor	100, 500, or 1000 relative vapor units/V

3. Repeat step 2 for each additional analog output.
4. Configure an event input channel:
   a. Click Input #1 or Input #2, whichever corresponds to the external device's connection to the I/O card.
   b. Select an event type from the Event Type list (Figure 3-9).

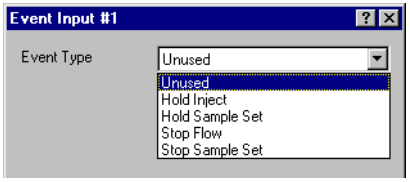


Figure 3-9 Selecting the Event Input Type

   c. Select an activated state, Open or Closed.

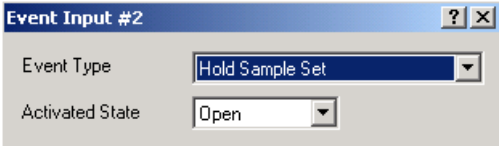


Figure 3-10 Selecting the Event Input Activated State Type

   d. Click OK to close the Event Input dialog box.
5. Repeat step 4, if necessary, for a second event input channel.
6. Configure an event output channel for any event type except a timed list:
   a. Click Output #1 or Output #2, whichever corresponds to the external device's connection to the I/O card.
   b. Select an event type from the Event Type list (Figure 3-11).

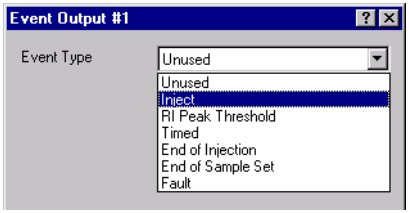


Figure 3-11 Selecting the Event Output Type

c. Select an activated state from the Activated State list (Figure 3-12).

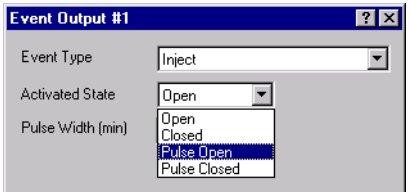


Figure 3-12 Selecting the Activated State of an Event Output

d. If you selected a pulse state from the Activated State list, select a pulse width (Figure 3-13). Available choices are from 0.01 to 10.0 min. Default = 1.0 min.

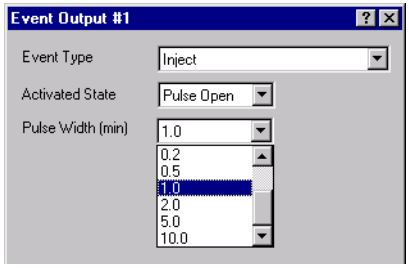


Figure 3-13 Selecting the Pulse Width

e. Click OK to close the Event Output dialog box.

7. To create a timed event list in an event output channel:

   a. Click Output #1 or Output #2, whichever corresponds to the external device's connection to the I/O card.

   b. Select Timed from the Event Type list (Figure 3-14).

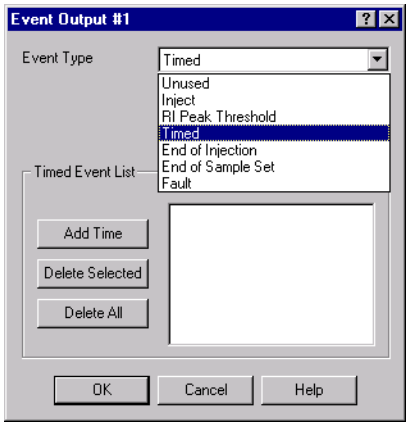


Figure 3-14 Creating a Timed Events List

c. Click Add Time. The Event Time dialog box appears (Figure 3-15).

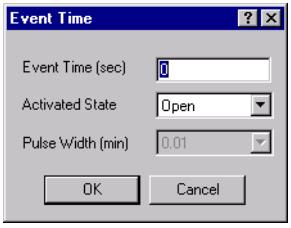


Figure 3-15 Specifying a Timed Event

d. Enter the event time, in seconds.

e. Select an activated state from the Activated State list (Figure 3-16).

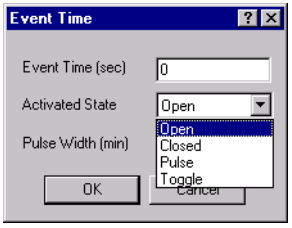


Figure 3-16 Selecting the Activated State of a Timed Event

f. If you select a pulse state from the Activated State list, select a pulse width from the Pulse Width list. Choices range from 0.01 to 10.0 min. Default = 0.01 min.

g. Click OK to close the Event Time dialog box.

8. Click OK to enable the changes and to close the Instrument Configuration Editor.

3.3 Creating the Current Instrument Method

The instrument method specifies operating parameters for the solvent manager, sample manager, vapor sensors, and detectors.

Create a current instrument method by setting parameters in these pages of the Instrument Method Editor dialog box:

- Storage Server (Section 3.3.1)
- Solvent Manager (Section 3.3.3)
- Vapor Sensors (Section 3.3.4)
- Sample Manager (Section 3.3.5)
- Detector (Section 3.3.6)

Note: *Refer to these pages in the Alliance GPC 2000 Series System Help for details.*

3.3.1 Creating a New Instrument Method

1. From the Interactive Mode window (Figure 3-3), select Tools > Instrument Method Editor. The Storage Server page of the Instrument Method Editor dialog box appears (Figure 3-17).

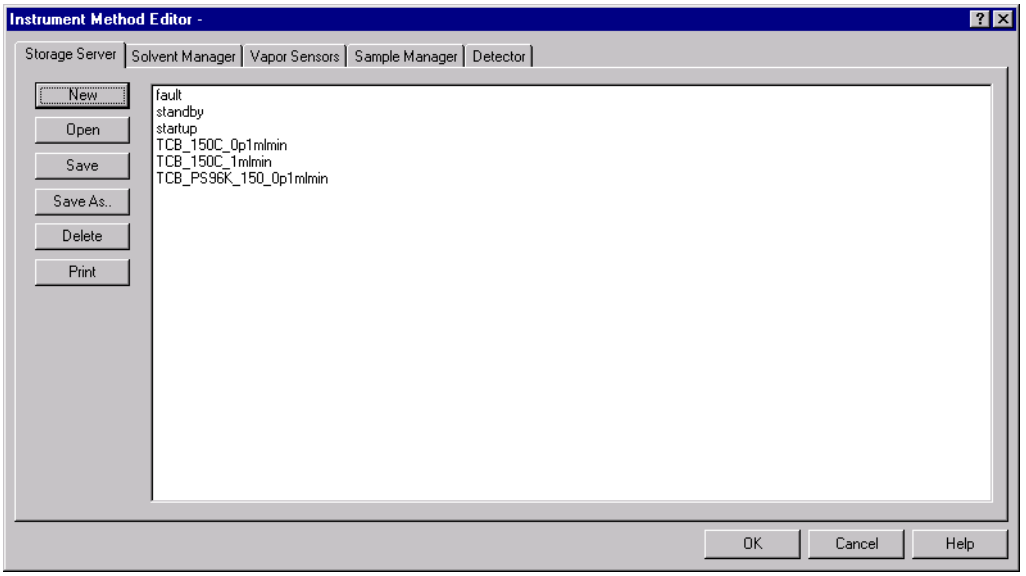


Figure 3-17 Storage Server Page

2. Click New to create a new instrument method modeled on the default instrument method. Modify it, if necessary, by selecting or entering parameter values in each page of the current instrument method (Section 3.3.3 through Section 3.3.6).
3. When you finish creating the instrument method, click Save As. Enter a unique name, and then click OK.
4. Click OK to close the Instrument Method Editor and add the new values to the current instrument method.

3.3.2 Modifying an Instrument Method

1. Select Setup > Current Instrument Method from the Interactive Mode window (Figure 3-3). The Instrument Method Editor dialog box appears (Figure 3-17). Click the Storage Server tab.
2. Select an instrument method from the list.
3. Open each page of the current instrument method to modify it, selecting or entering parameter values as described in Section 3.3.3 through Section 3.3.6.
4. Click Save As. Enter a new name for the method, and then click OK.
5. Click OK to close the Instrument Method Editor and activate the current instrument method.

3.3.3 Specifying Solvent Manager Settings

1. Click the Solvent Manager tab in the Instrument Method Editor dialog box (Figure 3-18).

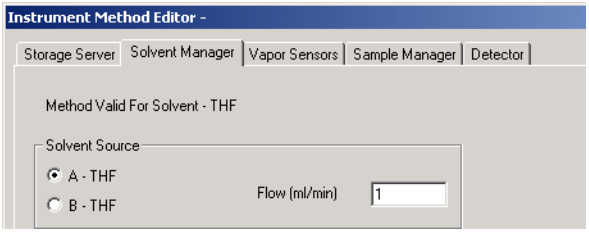


Figure 3-18 Solvent Manager Page

2. Click A or B in the Solvent Source area to select the solvent.
3. Specify a flow rate from 0 to 10.0 mL/min. Default = 0 mL/min.
4. Continue with Section 3.3.4, or click OK to save the changes.

3.3.4 Specifying Vapor Sensor Settings

Vapor sensors monitor vapor levels in three areas:

- Detector compartment
- Sample management (carousel) compartment
- Ambient air space in the lab

The sensors compare the levels to those at startup or initialization. Vapor detection is programmable. If vapor levels inside the system exceed the programmed shutdown limit, the red LED lights, and the system shuts down.

To determine shutdown limits experimentally, at each installation by introducing small amounts of the solvent to generate a signal that indicates suitable limits at each installation. Too low a limit can induce false triggering; too high a limit can defeat leak detection. Check vapor sensors regularly to ensure limits are working properly and replace sensors if needed (Section 4.4.5).

Note: *Vapors in your laboratory will affect the ambient vapor sensor reading.*

Use the Vapor Sensors page to enable or disable the vapor sensors, change the vapor shutdown or warning limit, and monitor current vapor sensor readings.

1. Click the Vapor Sensors tab in the Instrument Method Editor dialog box (Figure 3-19).

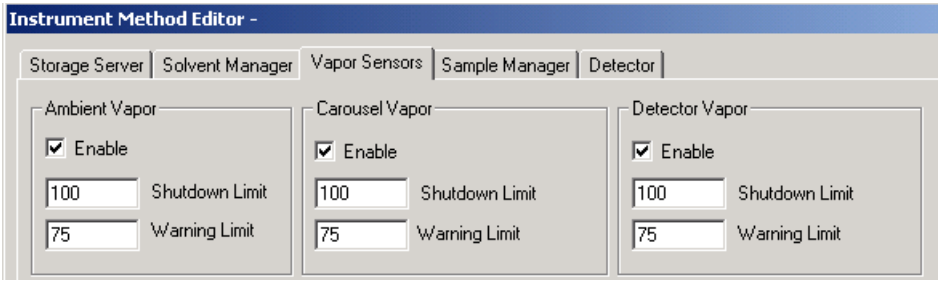


Figure 3-19 Vapor Sensors Page

2. Select Enable in the Ambient Vapor, Carousel Vapor, and/or Detector Vapor area(s).
3. Specify a shutdown or warning limit:
   - Ambient Vapor (near the right side vents).
   - Carousel Vapor (in the sample compartment near the carousel).
   - Detector Vapor (on the back wall of the analysis compartment).
4. Continue with Section 3.3.5, or click OK to save the changes.

Determining a Vapor Sensor Reading

1. Click (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Right-click one of the plots, and select Channel.
3. Select Ambient Vapor, Carousel Vapor, or Detector Vapor. The resultant plot displays the selected sensor's relative reading.

3.3.5 Specifying Sample Manager Settings

The Sample Manager page includes fields for setting these parameters:

- Mixer rate and duration
- Carousel temperature
- Injector needle temperature
- Filtration rate

- Syringe draw rate
- Needle wash volume

Note: *For details about this page, see "Sample Manager Tab (Instrument Method Editor)" in the* Alliance GPC 2000 Series System Help*.*

To open the Sample Manager page, click the Sample Manager tab in the Instrument Method Editor dialog box (Figure 3-20).

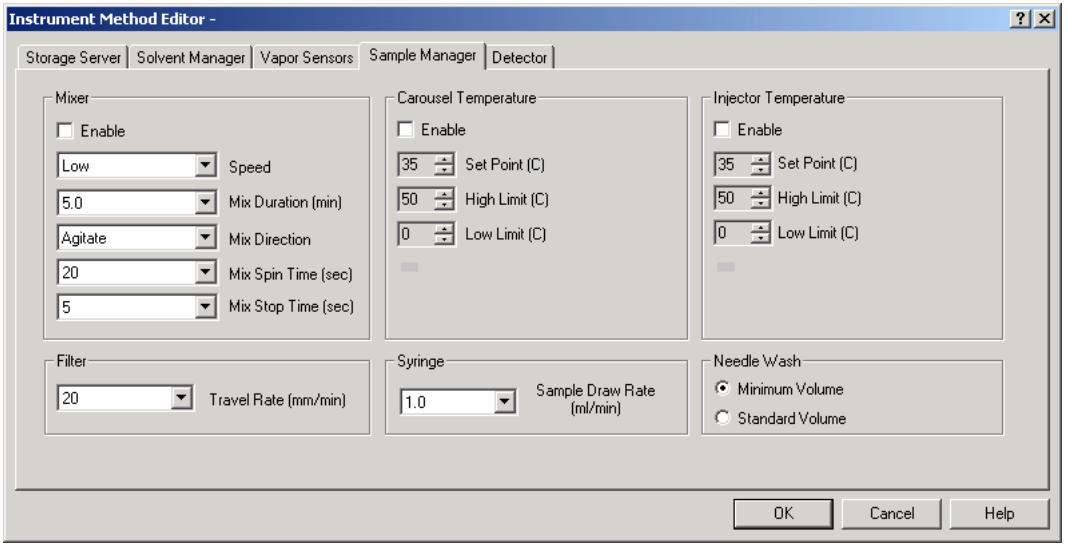


Figure 3-20 Sample Manager Page

Mixer

Select Enable in the Mixer area. Then specify values for these parameters:

- Relative speed: Low, Medium, or High (50, 150, or 300 rpm). Default = High.
- Mix duration, from 0.5 to 60.0 min. Default = 5.0 min.
- Mix direction: Clockwise (CW), Counterclockwise (CCW), or Agitate (alternating between clockwise and counterclockwise).

Note: *If you select Agitate you must specify values for Mix Spin Time and Mix Stop Time, selecting values from 0.5, 1, 2, 3, 4, 5 sec (default = 1 sec).*

Carousel Temperature

Select Enable in the Carousel Temperature area. Then specify values for Set Point, High Limit, and/or Low Limit.

Note: *The carousel and injector temperatures allowed vary with the solvent you choose and under most circumstances should be set to the same value.*

Injector Needle Temperature

Select Enable in the Injector Temperature area. Then specify values for Set Point, High Limit, and/or Low Limit.

Filtration Rate

In the Filter area, specify a filtration rate by selecting it from the Travel Rate list. Select from 10 to 100 mm/min. Default = 20 mm/min.

Note: *For highly filled samples, use 10 mm/min.*

Syringe Sample Draw Rate

In the Syringe area, specify a sample draw rate from the Sample Draw Rate list. Select from 0.1 to 4.0 mL/min. Default = 1.0 mL/min.

Note: *The draw rate specifies how fast the syringe moves when it aspirates sample. For viscous solutions (high MW), use a lower draw rate like 0.5 mL/min or lower.*

Needle Wash Volume

In the Needle Wash area, click Minimum Volume or Standard Volume. This specifies the amount of solvent volume used to clean the needle in the needle wash. If you select standard volume, more solvent is used to wash the needle. To wash the needle for a longer time, select standard volume. The length of time the needle is washed is based on the number of injections. Default = Minimum Volume.

Aspirated Sample Disposition

If the Return to Vial button is selected, most of the unused sample in the inject loop is returned to the vial. If the Send to Waste button is selected, all samples are purged, sent to waste, and not returned to the vial. Default = Return to Vial.

Continue with Section 3.3.6, or click OK to save your specifications.

3.3.6 Specifying RI, Viscometer, and Light Scattering Detector Settings

Specify these parameters in the Detector page.

1. Click the Detector tab in the Instrument Method Editor dialog box (Figure 3-21).

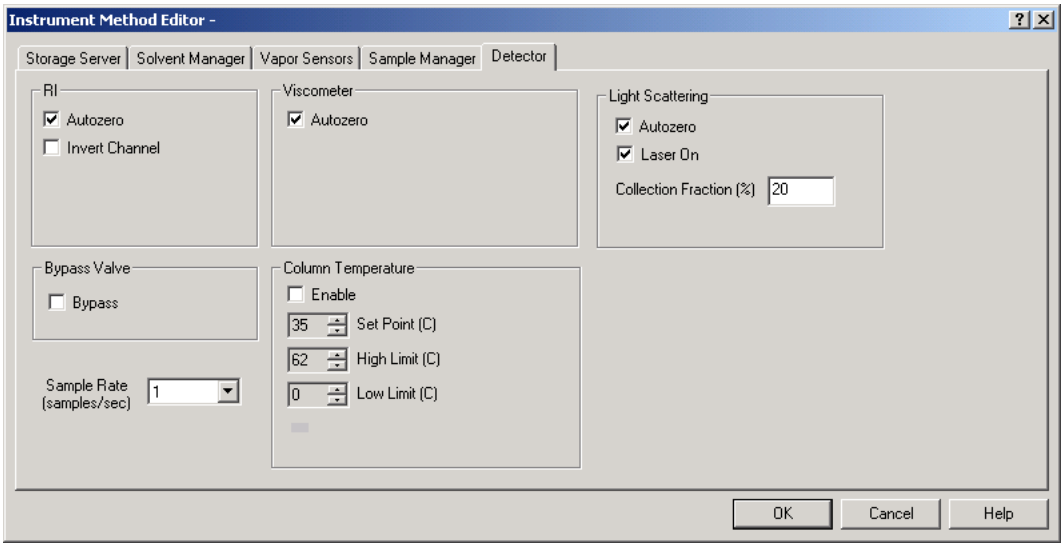


Figure 3-21 Detector Page

2. Optionally select these items in the RI area:
   - Autozero (to automatically zero the refractometer baseline).
   - Invert Channel (to display and save negative peaks as positive ones).
3. Optionally select Autozero in the Viscometer area (Alliance GPCV 2000 system only) to automatically zero the viscometer baseline.
4. Optionally select these parameters in the Light Scattering area:
   - Autozero to adjust the zero offset of the signal output of the LS detector to compensate for changes in baseline position due to drift (moves the signal baseline to 0 light scattering units). Autozeroing allows the system to compensate for any long-term drift that may occur. If you select this check box, the LS detector is always at 0 before to making an injection.
   - Laser On (to enable laser and the LS detector).
   - Collection Fraction % to control filtering of the light scattering detector data. A value of 100% represents no filtering; a value of 1% represents maximum filtering. Suggested starting value: 20 %.
5. Select a sample rate, from 10 to 0.5 samples/sec, from the Sample Rate list. The default, 1 sample/sec, best suits broad standards.

Note: *If you select a rate faster than 1 sample/sec., only the light scattering channels will be processed at 1 sample/sec.; the remainder of the detector channels will be processed at the selected rate.*

6. Optionally select Enable in the Column Temperature area to set an analysis compartment temperature. Then specify values for Set Point, High Limit, and Low Limit. The set point should fall in the range between the high and low limits.

   Note: *The allowed set point values vary with the solvent you choose. Nevertheless, a 50 degrees Celsius difference should exist between the set point and limits.*

7. Click OK to save your specifications and to close the Instrument Method Editor.

3.4 Preparing the Flow Path

Preparing the flow path involves these tasks:

- Priming the system (Section 3.4.1)
- Purging the injector (Section 3.4.2)
- Purging the refractometer (Section 3.4.3)
- Purging the viscometer (sense-tube type, only) (Section 3.4.4)
- Changing a solvent (Section 3.4.6)
- Priming the seal wash (Section 3.4.7)

Caution: *To avoid chemical hazards, always observe safe laboratory practices when you operate the system and handle solvents. Know the chemical and physical characteristics of the solvents you use, referring to their Material Safety Data Sheets.*

Caution: *To prevent solvent overheating, select the correct solvent name when you configure a solvent in the Instrument Configuration Editor.*

Caution: *If you use a solvent that the Instrument Configuration Editor's Mobile Phase page does not list, and you therefore select Other, record the solvent and its physical characteristics elsewhere.*

Attention: *To avoid precipitating salts in the solvent management system, use an appropriate intermediate solvent when you change from buffered solvents to high-organic-content solvents. See to Appendix C, Solvent Considerations, for solvent miscibilities.*

Note: *To maintain solvent manager system efficiency and obtain accurate, reproducible chromatograms, use only filtered HPLC-grade solvents.*

3.4.1 Priming the Solvent Management System

A priming operation incorporates a manual prime and a pump prime.

Prime the system with a low-viscosity solvent when the flow path is dry or when air bubbles persist despite purging.

Attention: *To avoid column damage, ensure the purge valve is open before priming the system. This protects the columns from the effects of sudden pressurization when the Auto Pump Prime feature suddenly pumps solvent at a high flow rate.*

Required Materials

- Priming syringe (startup kit)
- Wide-mouth, solvent-resistant container

Procedure

1. Set up the solvent reservoirs as in Section 2.3.1. Gently shake the filters in the reservoirs to remove trapped bubbles. Ensure all waste tubing drains into the waste container.
2. Click  (Interactive Mode) in the Interactive Mode window (Figure 3-3) and ensure the flow rate is 0.
3. Select Operations > Manual Pump Prime. The Manual Prime wizard appears for solvent A or B.

   Note: *To prime with the alternate solvent, click Exit. Then select Setup > Current Instrument Method and the solvent, A or B, from the Instrument Method Editor dialog box.*

4. Follow the wizard's instructions:

   a. Click Next.

   b. Connect the priming syringe to the purge valve (Figure 3-22).

c. Turn the purge valve counterclockwise, between a half and a full turn.

Note: *Because the priming syringe does not lock onto the purge valve, hold the syringe body in place while you retract the syringe plunger.*

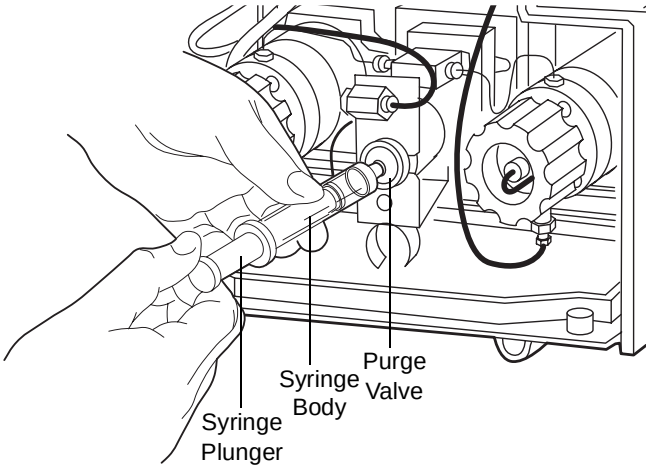


Figure 3-22 Using the Priming Syringe

d. Retract the syringe plunger, drawing solvent from the reservoir and through the tubing. This can require considerable force. Let the syringe fill and repeat the procedure until you remove at least 60 mL of solvent and solvent flows out the purge valve.

e. Click Exit to close the wizard.

5. Continue with these purging functions:
   - Section 3.4.2, Purging the Injector
   - Section 3.4.3, Purging the Refractometer
   - Section 3.4.4, Purging the Sense-Tube Viscometer (sense-tube type, only)

3.4.2 Purging the Injector

Purging flushes fresh solvent through the injector, sample loop, needle, and associated tubing.

Purge to remove any traces of sample from a previous run or to clear bubbles from the flow path or the syringe.

Note: *Always purge the injector after priming with a new solvent.*

You can also purge the injector in Sample Set mode by adding an Inject Purge row to the sample set method. See "Control Functions and Purging the Injector" in the Alliance GPC 2000 Series System Help.

1. Click (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Monitor the solvent flow rate as shown in the status bar. If it is 0 mL/min, enter a flow rate in the Flow field, and click Set Flow.
3. When the solvent reaches the specified flow rate, select Operations > Inj Purge to open the Injector purge dialog box (Figure 3-23).

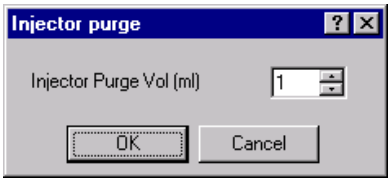


Figure 3-23 Injector Purge Dialog Box

4. At the prompt, select from the list the volume of injector purge solvent. Available choices:
   1 to 60 mL. Default = 1 mL. Suggested = 4 mL.
5. Click OK. The injector purge process starts. When the purge is complete, the system status reads Idle.

3.4.3 Purging the Refractometer

Purge the refractometer whenever you change solvents or observe an increase in noise or drift.

Note: *You can also purge the refractometer in Sample Set mode by adding a row, RI Purge, to the sample set method. See "Interactively Creating a Sample Set Method" in the* GPC 2000 Series System Help.

During the purge, the refractometer purge valve opens, and solvent flows through the reference side of the flow cell.

Note: *If you use the refractometer frequently, purge it weekly.*

1. Click (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Observe the solvent flow rate readout in the status bar. If it is 0 mL/min, enter a flow rate in the Flow field, and click Set Flow.

3. When the solvent flow reaches the specified rate, select Operations > RI Purge to open the RI Purge dialog box (Figure 3-24).

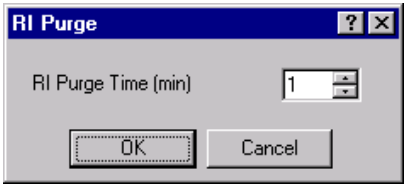


Figure 3-24 RI Purge Dialog Box

4. At the prompt, select from the list, a purge duration, from 1 to 60 min. Default = 1 min.
5. Click OK. The refractometer purge process starts. When the purge ends, "Idle" appears in the Interactive Mode window's status bar (Figure 3-3).

Note: *If refractometer bubbles persist despite purging, prime the system (see Section 3.4.1).*

3.4.4 Purging the Sense-Tube Viscometer

Purge the sense-tube viscometer type whenever you change solvents or observe a noise increase in the Noise and Drift dialog box.

The viscometer purge involves the transducers and associated tubing.

Note: *This process takes solvent from the outlet of the delay volumes, inside the viscometer. Therefore, at least 30 mL of solvent should flow through the viscometer before starting a purge.*

Note: *You can also purge the viscometer in Sample Set mode by adding a row, Visc Purge, to the sample set method. See "Control Functions" and "Purging the Viscometer" in the* Alliance GPC 2000 Series System Help.

1. Click (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Observe the solvent flow rate in the status bar. If it is 0 mL/min, enter a flow rate in the Flow field, and click Set Flow.
3. When the solvent flow reaches the specified rate, select Operations > Visc Purge to open the Viscometer Purge dialog box (Figure 3-25).

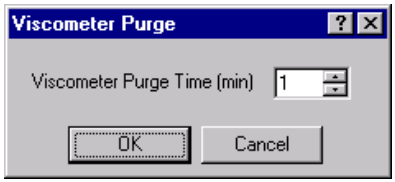


Figure 3-25 Viscometer Purge Dialog Box

4. Select the viscometer purge time (purge duration), from 1 to 60 min. Default = 1 min. Suggested = 6 purges for 5 minutes at 1 mL/min.
5. Click OK. When the purge ends, “Idle” appears in the Interactive Mode window’s status bar (Figure 3-3).

Note: *Multiple purges of short duration (two minutes at 1 mL/min) effectively dislodge bubbles.*

3.4.5 Calibrating the Viscometer

Wait three to four hours after purging the viscometer to calibrate it. Doing so assures more accurate results in the relative viscosity and can be viewed in the viscometer relative flow data channels.

Viscometer calibration prepares the viscometer to operate under a particular set of operating conditions. It is valid only for a particular solvent, detector temperature, and flow rate. Calibrate the viscometer when any of these operating conditions changes, or when viscometer performance degrades.

Before starting a calibration sequence, ensure that these conditions are satisfied:

- The detector’s operating temperature is at the specified temperature for your analysis.
- The viscometer’s internal volume (35 mL) has been flushed with solvent in use, for at least two volumes.
- The viscometer is purged (sense-tube type only).
- The flow rate is the same as that specified for your analysis.

The viscometer calibration sequence requires six minutes or more to finish, depending on the specified flow rate.

There are two ways to calibrate the viscometer, in Interactive Mode or by adding a row to a sample set method.

Calibrating the Viscometer in the Interactive Mode

1. Click  (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Select Operations > Visc. Cal.
3. At the confirmation prompt, click OK.
4. The viscometer calibration sequence starts. Progress is reported at the bottom left corner of the Alliance GPC 2000 Series window.

   Note: *The Stop button is active.*

Calibrating by Sample Set

1. Add a row, Visc Calibrate, to the sample set method that calibrates the viscometer at the specific operating conditions (solvent, flow rate and temperature settings).
2. Add a row, Equilibrate, to the sample set method to equilibrate for at least two hours.

When the viscometer calibration finishes, the status display reads Idle, or the sample set method moves to the next line in the table and Stop button is disabled.

3.4.6 Changing a Solvent

When changing the solvent source from one reservoir to another that contains a different but miscible solvent, you must replace the solvent in the flow path. This involves priming the solvent manager then purging the injector and detector(s). See Section 4.6 for column-related information.

Attention: *To avoid precipitating salts in the solvent management system, use an appropriate intermediate solvent when you change from buffered solvents to strongly organic ones. See to Appendix C for solvent miscibility information.*

1. Click  (Interactive Mode) in the Interactive Mode window (Figure 3-3).
2. Set the flow rate to 0 mL/min, and wait for the flow to stop.
3. Remove the filter and tubing from the current reservoir and immerse them in the new reservoir, gently shaking the filter to remove its infiltrated air.
4. Increase the flow gradually, in 0.1-mL/min increments, to 2.0 mL/min.
5. Prime with 48 mL of solvent, or more, for each 300 mm × 7.8 mm column.

3.4.7 Priming the Optional Seal Wash

Note: *Ensure the seal-wash apparatus is connected to a seal-wash reservoir (see Section 2.3.4). It must also be configured for solvent A or B (see Section 3.2.1 or Section 3.2.2).*

Attention: *To prevent system damage, use a seal-wash solvent that mixes with your solvents and does not react with the material that composes the seal-wash body. See Appendix C for solvent compatibility information.*

Required Materials

- Priming syringe (startup kit)
- Syringe adapter
- Seal-wash solvent

Procedure

1. Attach the syringe adapter to the priming syringe.
2. Fill the syringe with seal-wash solvent.
3. Remove the filter from the reservoir end of the seal-wash inlet tubing, and attach the syringe adapter in its place.
4. Click  (Interactive Mode) in the Interactive Mode window (Figure 3-3).
5. Select Operations > Seal Wash Prime to open the Seal Wash Prime dialog box (Figure 3-26).

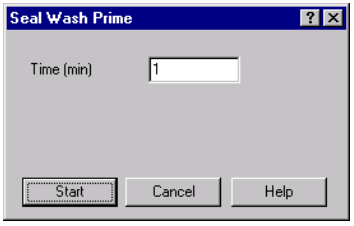


Figure 3-26 Seal Wash Prime Dialog Box

6. Specify duration of the prime and click Start. Default = 1 min. Suggested = 10 min.
7. Push the priming syringe plunger to force seal-wash solvent through the seal-wash system as the pump operates.

8. When solvent flows from the waste tubing, click Stop to stop the seal-wash pump. Click OK and then Cancel.
9. Remove the syringe and adapter from the tubing. Reinstall the filter, and return the tubing to the seal-wash reservoir.
10. Select Setup > Instrument Configuration from the Interactive Mode window to open the Instrument Configuration Editor.
11. Click the Mobile Phase A and/or Mobile Phase B tabs.
12. Select Seal Wash, and then click OK.

3.5 Preparing Samples

The system accommodates two carousel types. One that holds up to 24sample vials of 4-mL, 7-mL, and 10-mL capacity. The other holds up to 40 4-mL vials.

3.5.1 Preparing and Capping Sample Vials

Attention: *To prevent damage to the sample management system, use only Alliance GPC 2000 sample filter vials when filtering samples.*

Required Materials

- 10-mL glass vials (standard)
- Screw caps with PTFE septa
- Large vial holders
- 4-mL glass vials (optional):
  - Screw caps
  - 4-mL vial septa
  - 4-mL vial holders
- 7-mL stainless steel filter vials (optional):
  - Plunger
  - Vial cup
  - Plunger seal
  - Filter (0.5µm or 2.0µm)

Procedure

1. Select vial sizes according to your sample sizes (Table 3-3).

Table 3-3 Vial Types

Vial	Cap	Vial Holder
10-mL glass vial (standard)	20-mm screw cap	Large vial holder
4-mL glass vial (optional)	Screw cap and 4-mL vial septum	4-mL vial holder and large vial holder
7-mL stainless steel filter vial (optional)	20-mm crimp/seal cap	Large vial holder

2. Dissolve polymer samples, ensuring complete solubility at the desired concentration. Highly crystalline polymers may require high temperatures to completely dissolve.

   Note: *Because some solvents can expand as much as 10% when heated, a vial's nominal capacity can prove in certain cases insufficient. You should therefore fill a vial only to the bottom of its shoulder. Alternatively, you can calculate the heated solvent's expected volume, applying its expansion coefficient, and then adjust the vial volume accordingly.*

3. Add a sample aliquot to each vial. See Table A-6 for the minimum volume of sample needed for each vial size and for each sample loop.
4. Seal each 10-mL vial with a screw cap and septum.
5. Seal each 4-mL vial with a 4-mL vial septum and screw cap. Then install the vial in a 4-mL vial holder.
6. Assemble 7-mL sample filter vials (Figure 3-27):

   a. Press a 0.5-µm filter onto the bottom of the plunger. You can use a 2.0-µm filter for shear-sensitive polymer samples.

   b. Install a 20-mm crimp cap on the plunger top.

   c. Crimp the 20-mm crimp cap with the vial crimper (part number 700000847).

   Note: *You can preheat the vial cup and the assembled, crimped plunger before adding heated sample.*

7. Carefully pour about 7 mL of heated, dissolved sample into a stainless steel vial cup.

   Note: *You may dissolve the sample at a higher temperature than the analysis temperature to ensure it remains dissolved during transfer to the vial cup.*

8. Carefully slide the plunger assembly into the vial cup until its alignment mark aligns with the top of the vial cup. Do not push the plunger down below this alignment mark.

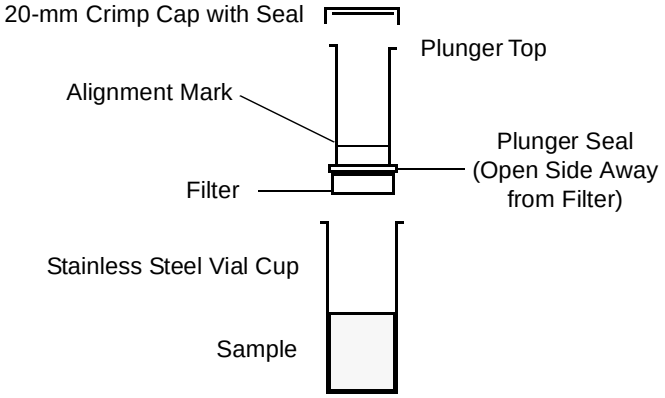


Figure 3-27 Assembling a Filter Vial with Sample

9. Place the assembled filter vial in a large vial holder within the carousel. Ensure its position matches the vial location illustrated in the Carousel Mode window (see Figure 1-13).

3.5.2 Loading the Carousel

When the sample compartment door button  on the front panel is illuminated, you can open the sample compartment door. Do not open the sample compartment door under these conditions:

- The sample compartment door button is not illuminated.
- A sample set is running.
- The injection needle is down inside a vial.

Note: *When the GPC 2000 software is not running and GPC instrument is on, the sample compartment door button may flash intermittently:*

To stop the flashing, either power-off the system and Windows 2000 software, or start the GPC 2000 software. If the compartment door flashes at any other time, phone Waters Technical Service.

Caution: *To avoid injury from burns, allow the system enough time to cool before you perform maintenance or troubleshooting. Wear protective clothing whenever you open the sample or analysis compartment.*

Attention: *Stop the sample set, and wait for idle mode before you add vials to the sample compartment. Ensure the needle is in the home position or wash station. If the needle is inside a vial, initialize the software by selecting Operations > Smart Reinit.*

Loading vials

1. Before opening the sample compartment door, ensure the sample door button is illuminated. Open the sample compartment door by pulling the sample door (Figure 3-28) outward to a 90° angle.

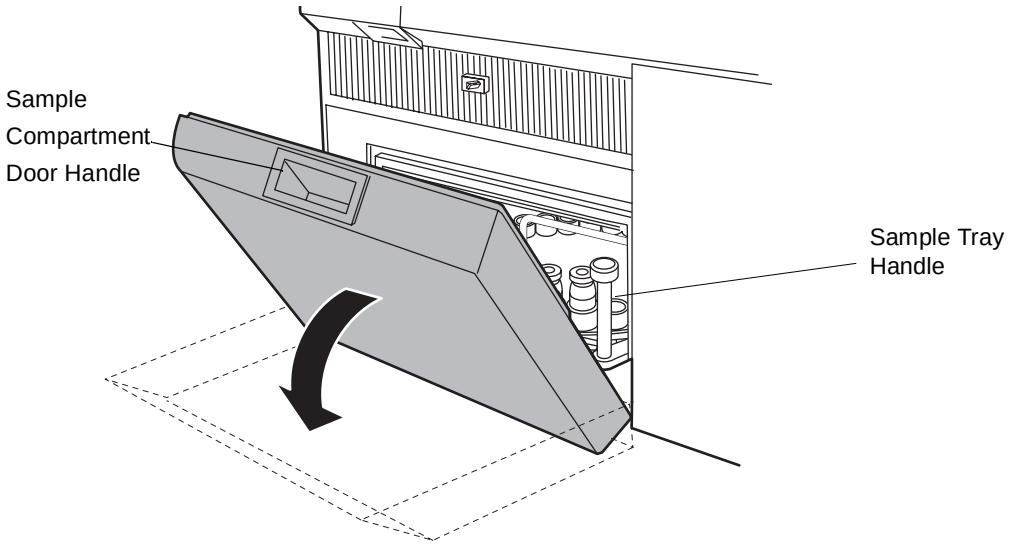


Figure 3-28 Opening the Sample Compartment Door

2. Pull the sample compartment handle downward to an angle of 90° from vertical (Figure 3-29). To access the sample tray, grasp the sample tray handle with a gloved hand, and swing the carousel outward.
3. With a gloved hand, grab the carousel handle and remove the carousel by lifting it out of the sample management system.

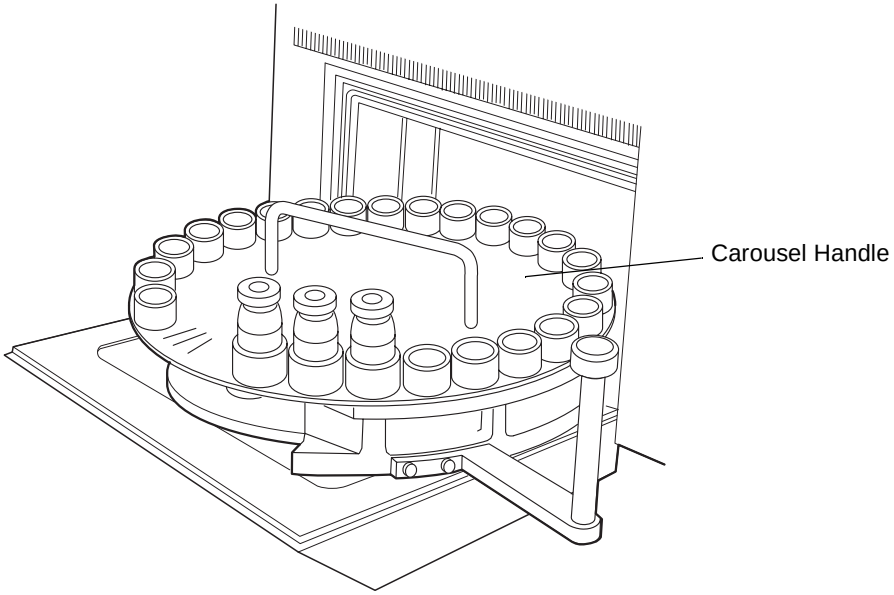


Figure 3-29 Accessing the Carousel

Note: *If a vial is accessible, you can use gloves and/or tongs to load or remove it without removing the carousel (Figure 3-30).*

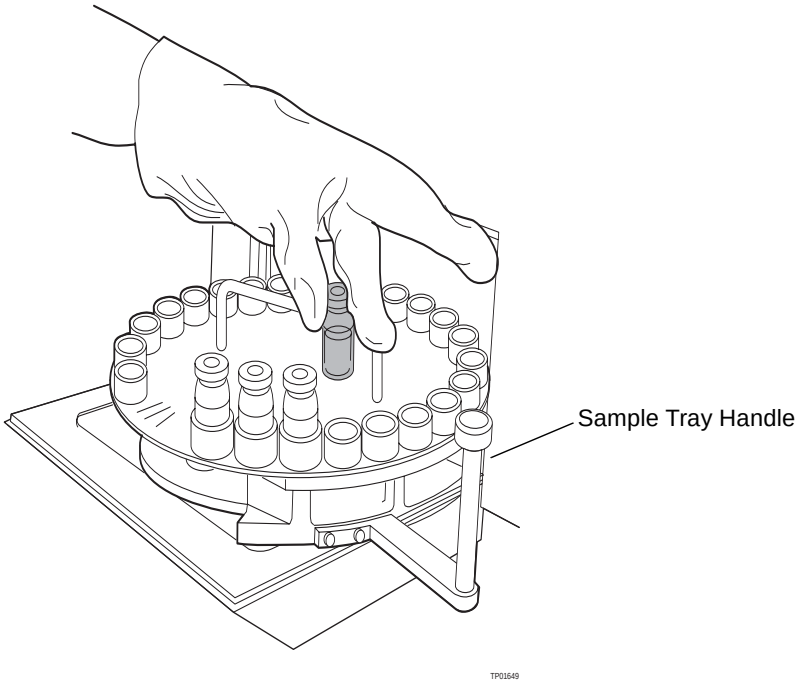


Figure 3-30 Installing or Removing a Vial

4. After you finish loading and/or removing samples, replace the carousel if necessary.
5. Grab the sample tray handle and move the carousel back into the unit.
6. Close the sample compartment door until it reaches its stop within 0.5 in. (1.3 cm) of the cabinet. Ensure the door is vertical. The carousel rotates to its home position so that it will be ready for a run.
7. Equilibrate the system (see Section 3.6.1, Equilibrating the System).

3.6 Equilibrating the System

Before running a sample set, make a preliminary injection to ensure the system operates and that parameter values are correctly specified.

Note: *Ensure the system contains sufficient solvent and that it is purged of all air (no bubbles).*

3.6.1 Equilibrating the System

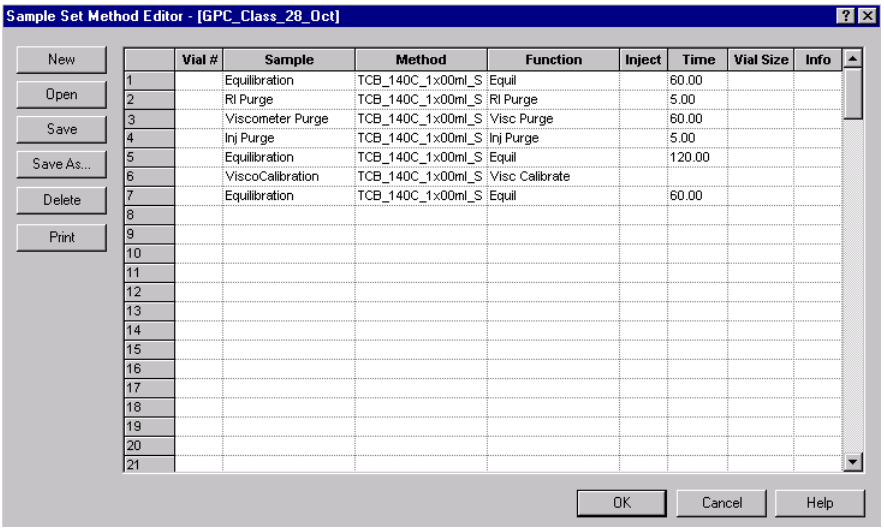
Using Interactive mode, operate the system at initial run conditions until the baseline stabilizes. Alternatively, you can use the sample set mode and an Equilibrate or Verify function (see Section 3.7).

Note: *Minute variations in parameter settings like flow rate, temperature, and solvent viscosity can adversely affect chromatographic results. You should therefore allow four hours or more for equilibration. Bringing the system from ambient to high temperatures may require up to 24 hours for equilibration.*

Interactive Mode Equilibration

1. Click  (Interactive Mode) in the Alliance GPC 2000 Series system window (Figure 3-3).
2. Specify an appropriate set of instrument operating parameters for the current instrument method. For details, consult these topics in the *Alliance GPC 2000 Series System Help:*
   - "Creating an Instrument Method for Interactive Mode Operation"
   - "Modifying an Instrument Method for Interactive Mode Operation"
   - "Temperature Control"

Attention: *To prevent damaging your columns with sudden flow rate changes, use the Limit Ramp Rate function in the Instrument Configuration Editor (for solvent reservoir A and/or B). Increase the flow rate in no more than 0.1-mL/min increments.*



	Vial #	Sample	Method	Function	Inject	Time	Vial Size	Info
1		Equilibration	TCB_140C_1x00ml_S	Equil		60.00		
2		RI Purge	TCB_140C_1x00ml_S	RI Purge		5.00		
3		Viscometer Purge	TCB_140C_1x00ml_S	Visc Purge		60.00		
4		Inj Purge	TCB_140C_1x00ml_S	Inj Purge		5.00		
5		Equilibration	TCB_140C_1x00ml_S	Equil		120.00		
6		ViscoCalibration	TCB_140C_1x00ml_S	Visc Calibrate				
7		Equilibration	TCB_140C_1x00ml_S	Equil		60.00		
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								

Figure 3-31 Sample Set Equilibration Example

3. Let the equilibration continue until the baseline is stable. If the baseline does not stabilize, see Chapter 5, Troubleshooting the System.

Note: *You can also equilibrate your system by inserting an Equilibrate or Verify row into a sample set method.*

Use "viscometer purge" to purge sense-tube viscometers only.

Select Equil or Verify from the Sample Set Method table's Function list, and then select an instrument method from the Method list. When you run the sample set method, equilibration automatically occurs.

Using an Equil function in your sample set method lets you equilibrate for a specified run time. A Verify function monitors parameters and waits until programmed conditions are reached.

3.7 Creating and Running a Sample Set

3.7.1 Creating a Sample Set

To create a new sample set, you can either enter information directly in the Sample Set Method Editor, or you can use the Wizard and follow its instructions.

A sample set can include two types of functions, acquisition and control.

Acquisition functions include

- Prelude operations
- Broad and/or narrow standards
- Broad and/or narrow unknowns

Control functions include

- RI Purge
- Inj Purge
- Visc. Purge (sense-tube only)
- Equil
- Verify
- Visc Calibrate

Using the Sample Set Method Editor to Create a Sample Set

1. Click (Sample Set) in the Alliance GPC 2000 Series system window. The Sample Set Mode window appears with a read-only view of the Sample Set Method table (Figure 3-32).

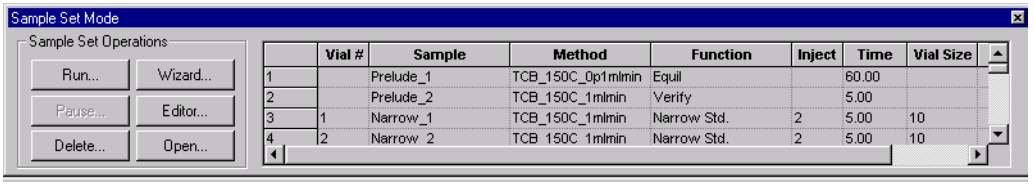


Figure 3-32 Sample Set Method Table

2. Click Editor in the Sample Set Operations area, to open the Sample Set Method Editor.
3. Click New to create a new sample set method.
4. To use a control function prior to acquiring data
   - Click the Function column, and then select the function (such as Equil, Inj Purge, RI Purge, Verify) that you want to perform.
   - Click the Time column, and then enter a suitable run time for the control function (or injection volume in the case of Inj Purge).

   Note: *Do not enter an injector purge volume less than 1 mL. A typical injector purge volume is 5 mL.*

- Click the Method column, and then select a previously created method from the list.

5. Click the next row in the Sample Set Method table. Define the acquisition sample set as follows:
   a. Specify in the Vial# and Sample fields, the vial number and sample name.
   b. Click the Method column, and then select from the list of instrument methods the one for the row.

   Note: *If you do not select an instrument method, the one you specified in the preceding row is adopted by default. You can create a new instrument method or modify an existing one via Instrument Method Editor.*

   c. Click the Function column, and then select from the list the acquisition function you want to use for the row: Narrow Unknown, Broad Unknown, Narrow Std, or Broad Std.
   d. In the Inject field, specify the number of injections from the specified vial.
   e. In the Time field, specify the run time (in minutes) for each injection.
   f. In the Vial Size field, specify the size of the vial in the specified vial position.
   g. If you intend to use Empower to process the acquired sample set data, click More in the Info field. This allows access to the component information dialog box whose parameters reflect the selected acquisition function (narrow standard, broad standard, narrow unknown, or broad unknown). Specify component information for the standard or unknown, and then click OK.
6. Repeat step 5 as required for subsequent standard and unknown sample rows in the table.

   Note: *You can copy and paste rows of data. Select the row number, right-click, select Copy, and then select Paste.*

7. If you want to ramp-down the solvent flow rate after the last injection specified in the table, add a row at the end of the table that includes an instrument method with a progressively diminished flow rate.
8. When you finish, click OK.
9. Click Yes to save changes. The Save Sample Set Method dialog box appears.
10. Enter the name of the sample set method in the File Name field, and then click OK.

    Note: *Sample set method names must be alphanumeric characters with a maximum length of 30 characters; do not use special characters (slashes (/), or an underscore (_), or a blank space).*

11. Click Yes to load the contents of the saved sample set method into the active Sample Set Method table. The contents of the sample set method appear in the Alliance GPC 2000 Series window.

    Note: *If you are sending sample data to Empower, ensure the sample set table contents are left-justified and do not contain spaces in the rows or cells of the table.*

Modifying a Sample Set Method

1. In the Sample Set Mode window, click Editor to open the Sample Set Method Editor.
2. Click Open, select a sample set method, and then click OK.
3. Modify the sample set method in the Sample Set Method Editor.
4. If you want to change the name of the sample set method, click Save As, and enter a new a sample set method name. If you want to save the changes to the sample set method without changing the name, click Save.
5. Click Yes to load the sample set.
6. Click OK to close the Sample Set Method Editor.

3.7.2 Running a Sample Set

Note: *You can run a sample set with or without sending the data to Empower during the run.*

1. In the Sample Set Mode window, click Run to open the Start Sample Set dialog box (Figure 3-33).

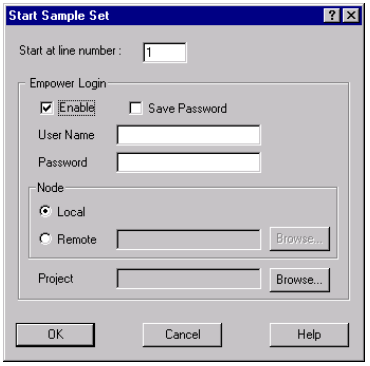


Figure 3-33 Start Sample Set Dialog Box

Note: *If you are not using Empower, go to step 5.*

2. Enter the following information in the Start Sample Set dialog box:
   - Enable – Activates communication with Empower.
   - Save Password – Saves the current password and redisplays it for the next login.

   Note: *Use correct uppercase and lowercase letters. Names and passwords are case-sensitive.*

   - User Name – Your user name (assigned by the Empower system administrator).
   - Password – Your password (assigned by the Empower system administrator).
3. In the Node area, select the node name of the computer that hosts the database you want to connect to.
   a. Click Local to connect to the Empower database on your Alliance GPC 2000 system.
   b. Click Remote and then Browse to connect to a remote Empower database and select the Empower computer whose database you want to access.
4. In the Project area, click Browse. Select from the list of previously created Empower projects that will receive the data you transfer.
5. To start the sample set at row 1 (default), click OK. To start it at a different row, specify a number in the Start At Line Number field, and then click OK.
6. To watch the sample set as it runs, open either the Carousel mode or the Sample Set mode window. The active row is highlighted in the sample set table, depicting the progress of the run (Figure 3-3).

3.7.3 Moving the Sample Set Results into Empower

Note: *If the sample set run is interrupted for any reason, you must manually import the sample set data into Empower and you cannot use the Sample Set Mover.*

To move sample set results into Empower after a run:

1. Click  (Sample Set Mover) to open the Sample Set Mover - Please Login dialog box (Figure 3-34).

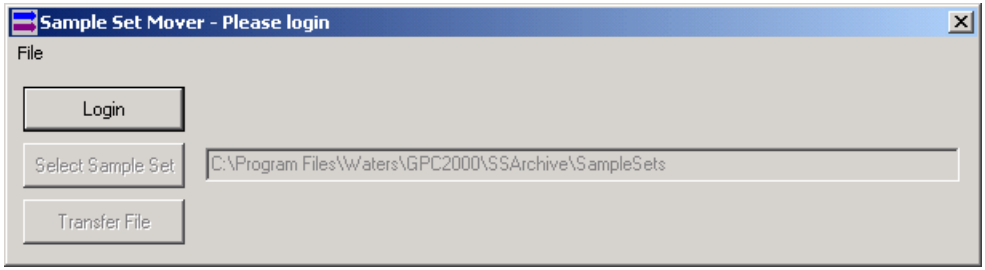


Figure 3-34 Selecting the Sample Set to Transfer

2. Click Login to open the Empower Login dialog box (Figure 3-35).

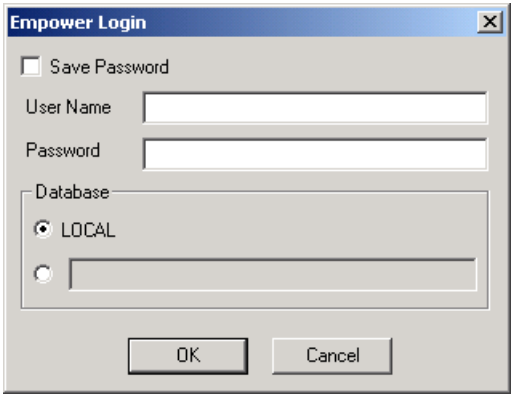


Figure 3-35 Empower Login

3. Select the Save Password check box to save the current password and re-display it the next time you log on.
4. Enter your Empower user name and password in the User Name and Password fields.

   Note: *Your Empower System Administrator defines your user name and password.*

5. Select your Empower database:
   - Local, to connect to the Empower database on your Alliance GPC 2000 system.
   - Node name, identifying where your Empower database resides, to connect to a remote Empower database.
6. Click OK. The Select Project dialog box appears.

7. Select the name of the Empower project that you want to send the results of your sample set to, and click OK.
8. The Sample Set Mover - Please Login dialog box reappears (Figure 3-34). Click Select Sample Set to browse for the sample set results that you want to send to Empower. All sample set results reside in this folder:

   c:\Program Files\Waters\GPC2000\SSArchive\SampleSets

   Note: *You must select an entire sample set folder to send to Empower. You cannot send partial sample set components, for example, channels of data.*
9. Click Transfer File. A dialog box appears verifying the successful transfer of the sample set results. When the transfer is complete, click OK.

3.8 Shutting Down the System

After the system reaches operating temperature and equilibrates, it should hold that temperature for long periods to ensure thermal stability.

You will occasionally need to shut the system down, temporarily or indefinitely.

Temporary Shutdown

If you are shutting down your system for four days or less, do this:

- Ensure all equilibration, acquisition, and purge operations in the sample sets are complete.
- Keep the system at its current temperature and flow rate, or maintain the current temperature but decrease the flow rate.

If you are shutting your system down for more than four days, do this:

- Purge the injector (Section 3.4.2).
- Purge the refractometer (Section 3.4.3).
- Purge the (sense-tube type) viscometer (Section 3.4.4).
- Decrease the flow rate slowly to approximately 0.1 mL/min or higher (depending on the solvent) and decrease the temperature.
- Empty the waste container.

Indefinite Shutdown

Attention: *To prevent the corrosion of metal surfaces, remove buffered solvent before you shut down the system (see Appendix C).*

1. Follow the suggestions for temporarily shutting down the system, but slowly decrease the flow rate to 0.0 mL/min.
2. Ensure all equilibration, acquisition, and purge operations in the sample sets are complete.
3. Select File > Exit from the Interactive Mode window (Figure 3-3).
4. Select Start > Programs > Gpc2000 Chromatography > Shutdown GPC 2000 Platform.

   Note: *If the software does not appear to shutdown after several minutes, select Start > Programs > Gpc2000 Chromatography > Stop All GPC2000 Processes.*
5. Select Start > Shut Down. At the prompt, confirm your decision to shut down the system, and then click Yes to exit application.
6. Set the power switch (on the right side panel) to Off (O).
7. Once the system is off, shut down the monitor and printer.

Chapter 4
Routine Maintenance

This chapter presents routine maintenance procedures, which when followed ensure the system consistently provides accurate and precise results.

4.1 Required Materials

See Appendix B for spare parts information.

In addition to spare parts, you need these items:

- Medium-sized container that is resistant to your solvents
- Squirt bottle with solvent that is compatible with your solvents
- Lint-free tissues
- Heat-resistant gloves
- Torx® T20 driver
- Medium Phillips-head screwdriver
- Medium flat-blade screwdriver
- Open-end wrenches, 1/4-in., 5/16-in., 3/8-in., 1/2-in., and 5/8-in.
- Flashlight
- Pipe cleaners (compatible with solvents)

4.2 Safety and Handling

When you perform maintenance procedures, keep the following safety considerations in mind.

Caution: *To avoid injury from burns, allow the system enough time to cool before you perform maintenance or troubleshooting. Wear protective clothing whenever you open the sample or analysis compartment.*

Caution: *To prevent injury, observe good laboratory practices when you handle solvents, change tubing, or operate the system. Know the physical and chemical properties of the solvents you use. Refer to the Material Safety Data Sheets for the solvents in use.*

Caution: *To avoid electric shock, or damaging the system, do not open the back panel. Removing the back panel does not allow you access to user-serviceable parts.*

Attention: *To avoid damaging electrical parts, never disconnect an electrical assembly while power is applied to the system. Once power is turned off, wait 10 seconds before you disconnect an assembly.*

Attention: *To prevent circuit damage from static charges, do not touch integrated circuit chips or other components that do not specifically require manual adjustment.*

4.3 Contacting Waters Technical Service

Customers in the USA and Canada should report the problems to Waters Technical Service (800 252-4752). Others should phone their local Waters subsidiary or Waters corporate headquarters in Milford, Massachusetts (USA), or they may visit http://www.waters.com, and click Offices.

For complete information on reporting shipping damages and submitting claims, see *Waters Safety Notices, Licenses, Warranties, and Support*.

4.3.1 Maintenance Schedules

Based on 24-hour operation, maintain the system as recommended in Table 4-1.

Table 4-1 Suggested Maintenance Procedures

Procedure	Frequency	Reference
Replace the solvent inline filter	Every 1 to 4 weeks, depending on your application and solvent.	Section 4.5.7

Table 4-1 Suggested Maintenance Procedures (Continued)

Procedure	Frequency	Reference
Replace the solvent reservoir filters	Every 2 to 4 weeks, depending on the solvent.	Section 4.5.8
Replace the vapor sensors	Every 2 months, depending on the solvent	Section 4.4.5
Replace the piston seals	30 days (application dependent)	Section 4.5.9, Section 4.5.10, and Section 4.5.13
Replace the seal-wash seals (optional) Do not use with TCB. For more information about solvents, see Table C-2.	As needed (application dependent)	Section 4.5.9, Section 4.5.10. Section 4.5.11, and Section 4.5.13
Replace the primary and accumulator pistons	Every 12 months	Section 4.5.9 to Section 4.5.13
Replace check valves	Every 3 months	Section 4.5.14
Replace waste tubing or other tubing	As needed	Section 4.5.15
Replace the sample needle	As needed	Section 4.5.2
Replace the syringe and seal	90 days	Section 4.5.3
Change the sample loop	As needed	Section 4.5.4
Replace the filter in a sample filter vial	After use of a sample filter vial	Section 4.5.6
Add, delete, or replace a column	As needed	Section
Replace the pre-detector inline filter	As needed	Section 4.5.7
Clean the system and inspect for leaks	Daily	Section 4.4
Back up and delete chromatographic data	Weekly or as needed	Section 4.7.1

4.4 Maintaining Performance

To keep your system in optimal working order, perform the routine operating tasks in Table 4-2 and the maintenance procedures in this chapter. These maintenance tasks are based on 24-hour system operation.

Table 4-2 Routine Operating Tasks

Task	Frequency
Empty the waste container.	Weekly or as needed
Check and refill the solvent reservoirs with solvent.	As needed
Check and refill the seal-wash reservoir with seal-wash solvent.	As needed
Change the seal-wash solvent (optional).	As needed (optional)
Calibrate using standards appropriate for your samples.	As needed
Purge the injector. See Section 3.4.2.	At the beginning of each sample set
Purge the refractometer. See Section 3.4.3.	As needed weekly
Clean the waste manifold. See Section 4.5.1.	Weekly or as performance dictates
Back up data files and logs (Alliance GPC 2000 Series system). See Section 4.7.	Weekly
Back up sample sets and projects (Empower application).	Weekly

4.4.1 Cleaning the System

If you are using TCB, clean the system every 30 days at 160 °C at a low flow rate. Clean the system regularly if you are processing high MW samples or begin to see extra peaks in your chromatograms.

Required Materials

- Laboratory detergent
- Distilled and deionized water
- Absorbent tissue
- Gloves

Caution: *Dispose of cleaning materials safely, complying with local, state, and federal regulations.*

Caution: *To prevent injury, observe safe laboratory practices when you clean the system and handle solvents. See the Material Safety Data Sheets for the solvents you use.*

Caution: *To avoid burn injuries, allow the system enough time to cool before you perform maintenance or troubleshooting tasks. Wear protective clothing whenever you open the sample or analysis compartment.*

Spill Control and Waste Fluids

Waste fluids drain to a waste container placed below the level of the system.

- Drip trays provide spill control for all compartments. Fluid drains through a waste port on the left side of the system to a waste container (Chapter 5, Troubleshooting the System).
- Waste solvents from detectors exit the system through a waste port on the upper-left side.
- Waste solvents from the needle wash apparatus exit the system through a waste port on the lower-left side.

Procedure

1. Clean the sample compartment:
   a. Open the door, and remove the carousel.
   b. Inspect the sample compartment for leaks, and then wipe surfaces and the drip tray under the carrier with dilute laboratory cleaning agent.
   c. Wash the carousel. Rinse it with water, and dry it thoroughly.
   d. Wash the vial holders. Rinse and dry them thoroughly.
   e. Close the door.
2. Open the analysis compartment door. Inspect the sample compartment for leaks, and wipe its lower surface. Close the door.
3. Open the syringe door. Inspect for leaks, and wipe the grill area. If you can, wipe the drip area under the grill (reach back, and then under). Close the door.

   Note: *The grill is not removable.*

4. Open the solvent compartment door. Inspect the compartment for leaks, and wipe the drip tray, under the solvent management system. Close the door.
5. Disconnect the waste container tubing. Empty the waste container, and clean it. Let it drain, and then reconnect the waste tubing.
6. Purge the injection valve, refractometer, and viscometer, and then equilibrate the system.
7. Consult manufacturers' instructions for cleaning the surfaces of the monitor and computer peripherals.

4.4.2 Monitoring the Inlet Check Valve Performance

Replace the inlet check valve if it leaks or otherwise fails to function properly (see Section 4.5.14). For optimal performance, check for leakage daily.

Determining Whether the Check Valve Leaks

1. Monitor the baseline by
   - using the Viewer ("Viewer Window" on page 27), or
   - viewing the real-time plots in the Interactive mode window, or
   - importing the viscosity relative flow channel into Empower. See "*Manually Importing AIA Raw Data into the Empower Software*" in the Alliance GPC 2000 Series System Help.

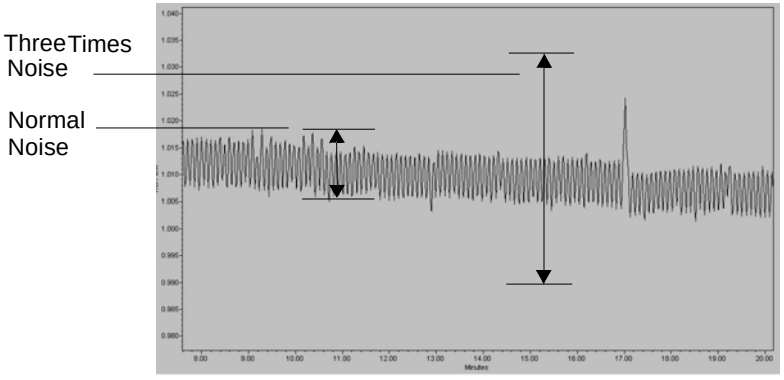


Figure 4-1 Normal Viscosity Relative Flow Channel

Figure 4-1 depicts a normal viscosity flow channel. (Figure 4-2), however, depicts one with three times the normal noise, which indicates a leaking check valve.

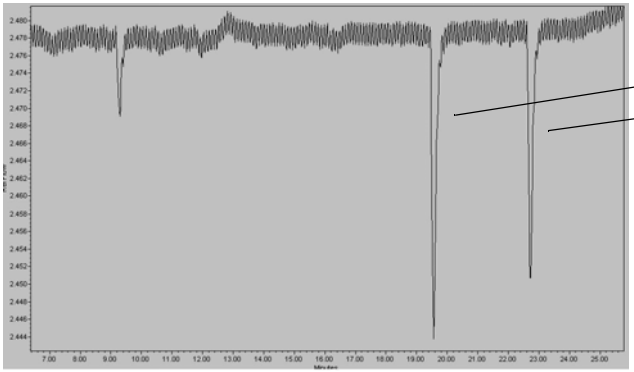


Figure 4-2 Abnormal Viscosity Flow Channel

2. If it is leaking, replace the inlet check valve (see Section 4.5.5).

4.4.3 Determining Whether the System Is Plugged

If the polymer precipitates, there may be a plug in the system.

1. View a plot to ensure that the pump pressure is relatively constant. If there is any fluctuation, look for some sign of a blockage.
2. You can view a plot by using the Viewer ("Viewer Window" on page 27), the Interactive Mode window, or by plotting the P1 or P2 channel in Empower (Figure 4-3) if you have a GPC/V system. See "Manually Importing AIA Raw Data into the Empower Software" in the *Alliance GPC 2000 Series System Help*. The rise and fall of the baseline indicate a blockage within the system (twice the width of the baseline is acceptable).

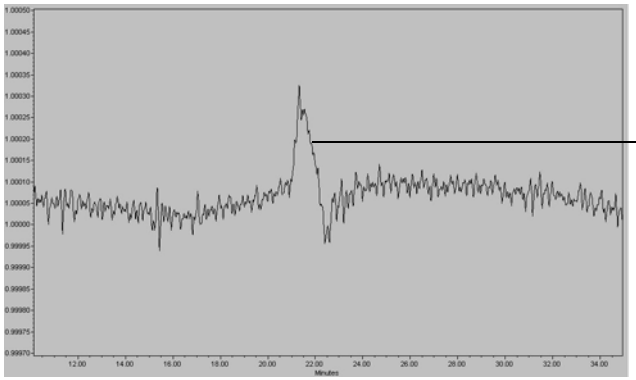


Figure 4-3 Abnormal Baseline

3. Replace any blocked tubing (Section 4.5.15, Replacing Tubing).

4.4.4 Monitoring the Vapor Sensors

Check solvent vapor levels every 90 days for potential leakage by using one of the following methods:

- View plots in the Viewer or the Interactive mode window
- Import the vapor level channel into Empower.

4.4.5 Replacing the Vapor Sensors

If you are using chlorinated solvents, like TCB, vapor sensor performance may degrade over time. To maintain optimal performance when using TCB, replace the vapor sensors every two months, or as needed.

Note: *Before replacing the vapor sensors, ensure that the instrument and ambient room space is free of vapors.*

Required Materials

- Torx T10 screwdriver
- Replacement vapor sensors (3)

Procedure

1. Power-down the GPC 2000 instrument (Section 3.8) and unplug it.
2. Lift and slide the L-shaped vent cover to expose the vapor sensor manifold and mounting blocks.

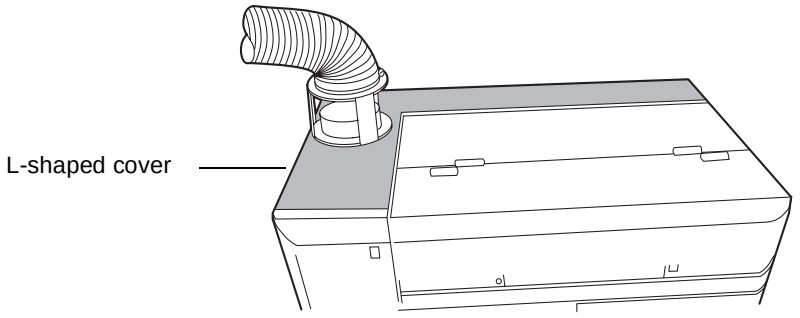


Figure 4-4 Removing the L-shaped Cover

3. Using a Torx T10 wrench, remove the four corner screws from the vapor sensor mounting plate, and then place them in a secure location.

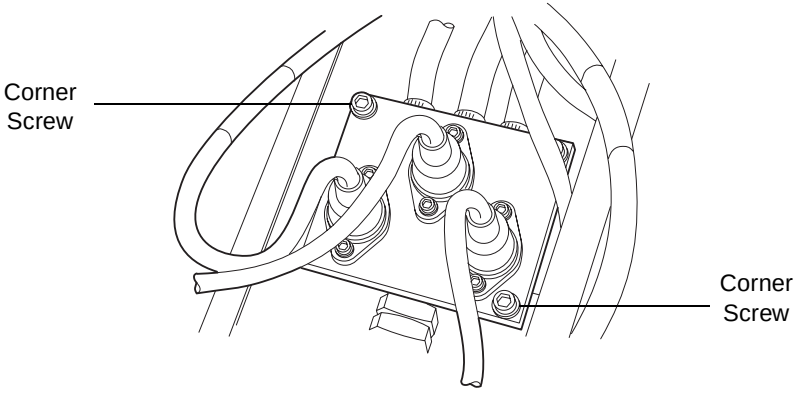


Figure 4-5 Removing the screws from manifold

4. Remove the vapor sensor manifold, and then invert it to access the three vapor sensors.

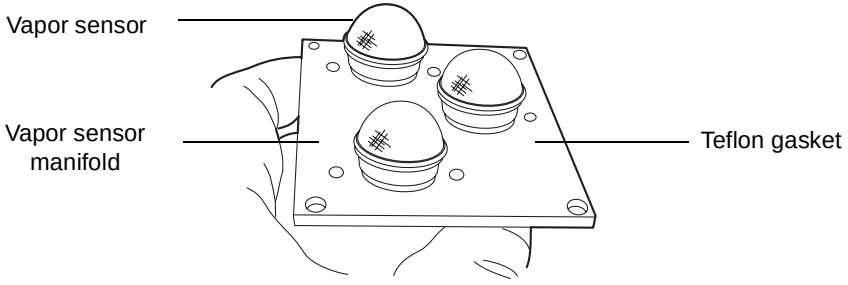


Figure 4-6 Accessing the vapor sensor manifold

5. To replace the vapor sensors, gently pull each from the vapor sensor manifold.
6. Remove and replace teflon gasket if needed.
7. Remove and replace the three vapor sensors.

   Note: *You need not align the pins at the bottom of a vapor sensor when you replace it.*

8. Replace the four screws in the mounting plate, and then gently place the plate on top of the vapor sensor manifold.

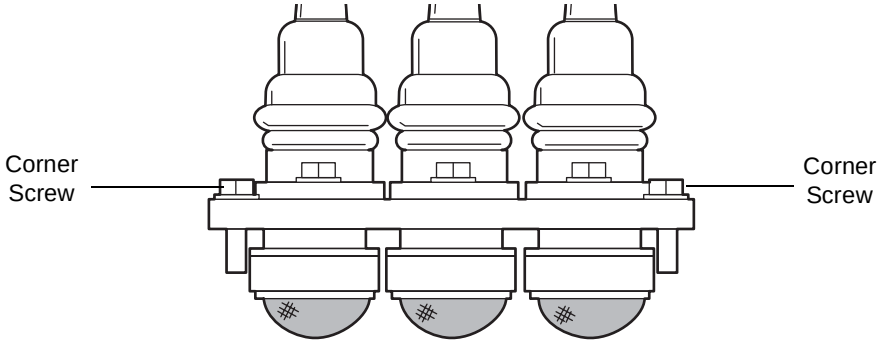


Figure 4-7 Replacing the vapor sensor manifold

9. Using a Torx T10 driver, drive the four screws into the manifold.
10. Replace the L-shaped cover by snapping it back into place.
11. Plug in the power cord into a grounded power outlet, and then start the instrument.

Determining a Vapor Sensor Reading

When you replace the vapor sensors, allow the sensors to stabilize for at least two hours, and then check the vapor levels in the Interactive window.

1. From the Interactive Mode window, right-click any plot, and then select Channel > Ambient Vapor.
2. Repeat step 1 to check the Carousel Vapor and Detector Vapor levels.

   The resultant plot displays the selected sensor's relative reading. If the vapor sensor is below 5.0 level, they are set correctly. If they exceed this level, contact your Service Representative to request that your vapor sensors be calibrated in the Service Diagnostics window.

Verifying that the Replaced Vapor Sensors were Installed Correctly

When you replace the vapor sensors, you can use the procedure outlined below to verify that they are working correctly.

Required Materials

- 10 mL glass vial
- Methanol
- Gloves
- Syringe

Procedure

1. From the Vapor Sensors tab in the Instrument Method Editor, disable the ambient carousel, and detector vapor sensors by clearing the Enable check boxes (Section 3.3.4).
2. From the Detector tab in the Instrument Method Editor, set the column, carousel, and injector temperature to 40 °C for the current instrument method, and save the modified instrument method. Wait until the temperature stabilizes at 40 °C.
3. Using gloves, draw approximately 2 mL of methanol and inject into a 10 mL vial.
4. Place the vial in the front left-hand corner of the detector compartment and close the compartment door.
5. From the Interactive Mode window, right-click any plot, and then select Channel > Detector Vapor.
6. Wait 30 minutes.

   The resultant plot displays the detector's relative reading. A sudden increase in vapor levels confirms that the vapor sensor is working correctly.
7. Remove the vial from the detector compartment and place in position #15 of the carousel.
8. Repeat steps 5 and 6, but monitor the carousel channel by selecting Channel > Carousel Vapor.
9. Remove the vial from the carousel compartment and hold next to ambient vapor sensor tube (Figure 4-8).

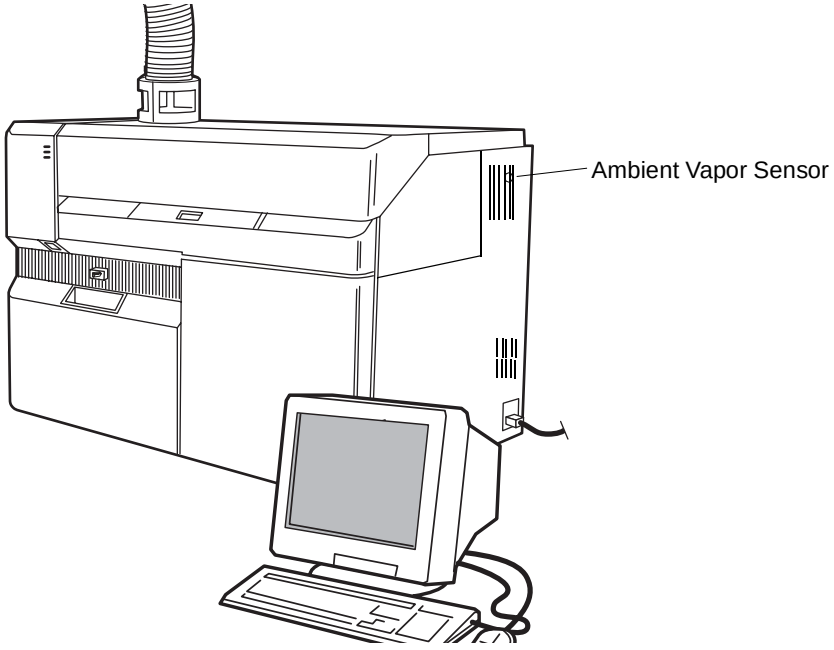


Figure 4-8 Ambient Vapor Sensor Location

10. Repeat steps 5 and 6, but monitor the ambient vapor channel by selecting Channel > Ambient Vapor.
11. Before you enable the vapor sensors in the Instrument Method Editor, allow vapor levels to fall below the warning level.
12. Reset the detector's operating temperature for your analysis.

4.4.6 Routine Solvent Manager Maintenance Tasks

Periodic maintenance involves these procedures:

Table 4-3 Routine Solvent Manager Maintenance Tasks

Task	**Frequency**
Replacing the solvent inline filter.	Every 1 to 4 weeks, depending on the solvents
Replacing a solvent reservoir filter.	Every 2 to 4 weeks, depending on the solvents
Replacing the piston and face seals.	Monthly (application dependent)

Table 4-3 Routine Solvent Manager Maintenance Tasks (Continued)

Task	Frequency
Change the seal-wash solvent (optional).	As needed
Inspect, clean, and replace (if needed) the needle wash line, waste line, and waste manifold.	Every 1 to 3 months
Replacing the seal-wash seals (optional).	As needed (application dependent)
Replacing a piston.	Every 12 months
Replacing a check valve.	Every 90 days

Caution: *Always observe good laboratory practices when you handle solvents, change tubing, or operate the system. Know the physical and chemical properties of the solvents you use by referring to their Material Safety Data Sheets.*

Note: *See Chapter 5 for information about isolating problems in the solvent management system.*

4.5 Maintaining the Sample Manager System (SMS)

Periodic maintenance of the sample management system involves these tasks:

- Maintaining (cleaning) the waste manifold – Weekly
- Replacing the sample needle – As needed
- Replacing the syringe and seal – Every 12 months or as needed
- Replacing the sample loop – As needed
- Replacing the filter in a sample filter vial – As needed

Caution: *To avoid injury from burns, allow the system enough time to cool before you perform maintenance or troubleshooting. Wear protective clothing whenever you open the sample or analysis compartment.*

Attention: *In order to avoid leaks when you maintain and/or replace parts in the sample management system, use Waters fittings and ferrules.*

4.5.1 Maintaining the Waste Manifold

The waste manifold can become contaminated with polymer residue if you do not properly maintain it. When the waste manifold is dirty, extra peaks appear at the beginning of your chromatogram. Waters recommends you clean the waste manifold (Figure 4-9) weekly.

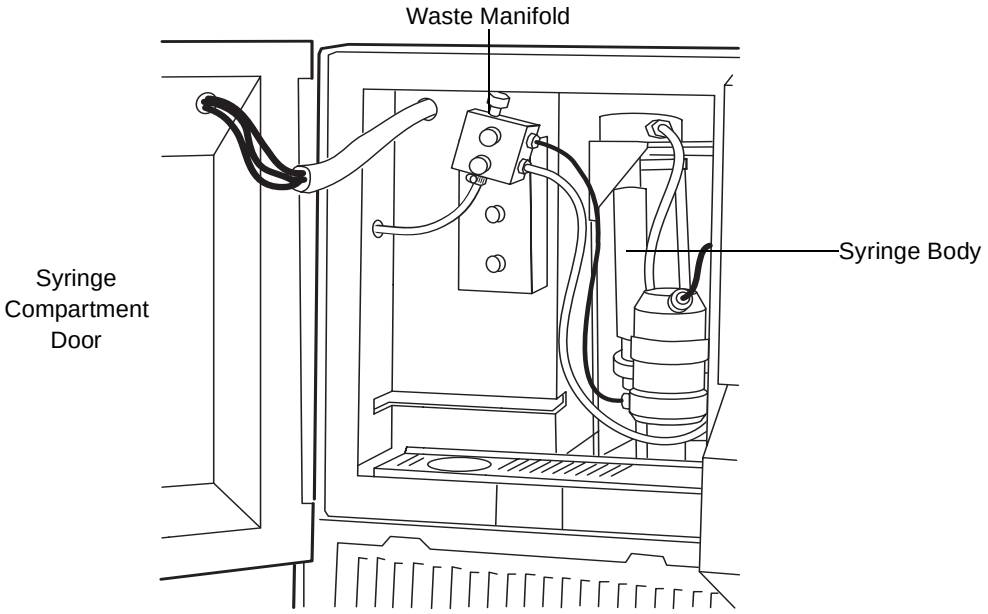


Figure 4-9 Accessing the Waste Manifold

Cleaning the Waste Manifold:

1. Power-down the GPC 2000 system.
2. Open the syringe compartment door.
3. Remove waste drain tubing from the detector (1/4-inch NPT).
4. Remove the RI reference flush tubing, 5/16-inch.
5. Remove the tubing from the rear of the waste manifold (1/4 to 20 in.).
6. Remove the vent tubing, 1/4 inch NPT.
7. Using a Torx T20 driver, remove the two T-20 screws that secure the waste manifold to the GPC 2000 chassis, and remove the waste manifold.
8. Clean the waste manifold using pipe cleaners and/or a solvent bath.

Note: *Do not use nylon pipe cleaners. The accumulation of polymers in the waste manifold will dissolve them.*

9. Dry and reinstall the manifold onto the chassis.
10. Reconnect the flow tubes to the manifold.
11. Restart the system and check for fluid leaks.

4.5.2 Replacing the Sample Needle

Replace the sample needle when it becomes blocked, bent, or otherwise damaged.

Required Materials

- New sample needle
- Open-end wrenches, 5/16-in. and 1/2-in.
- Screwdriver
- Flashlight
- Gloves

Procedure

1. Let the sample compartment cool.
2. Click  (Diagnostics) in the Interactive Mode window (Figure 3-3) to open the Diagnostics Mode window (Figure 4-10).

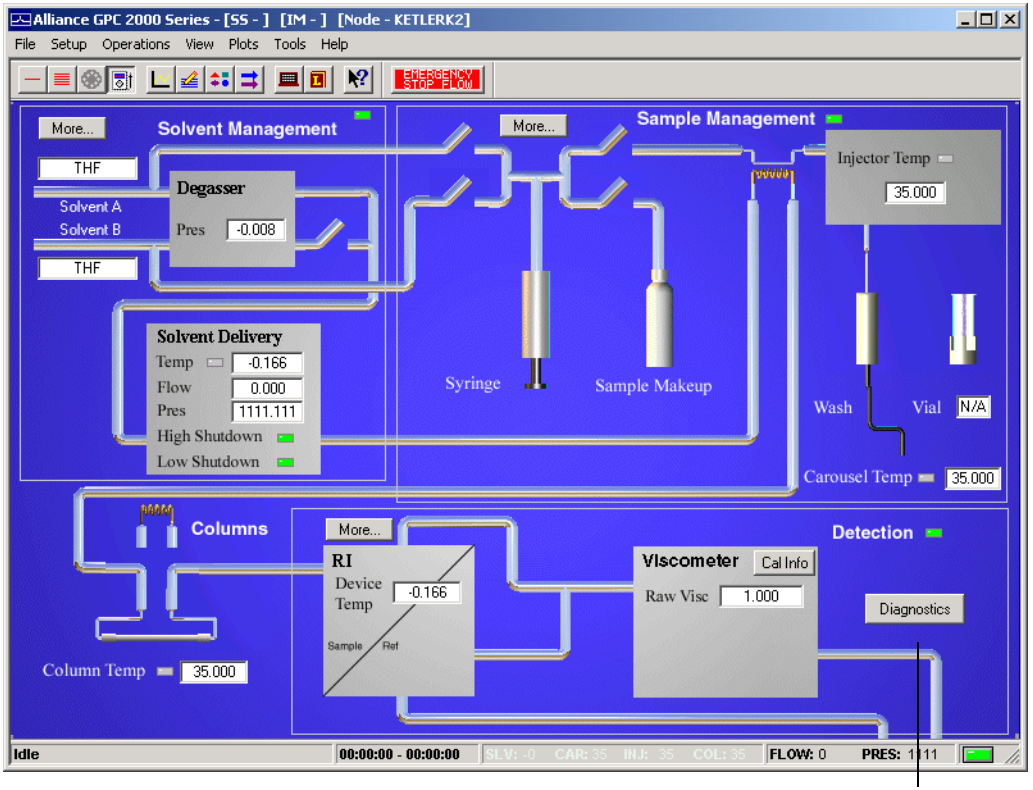


Figure 4-10 Diagnostics Mode Window

3. Click Diagnostics, in the lower-right corner, to open the User Maintenance and Service Diagnostics dialog box (Figure 4-11).

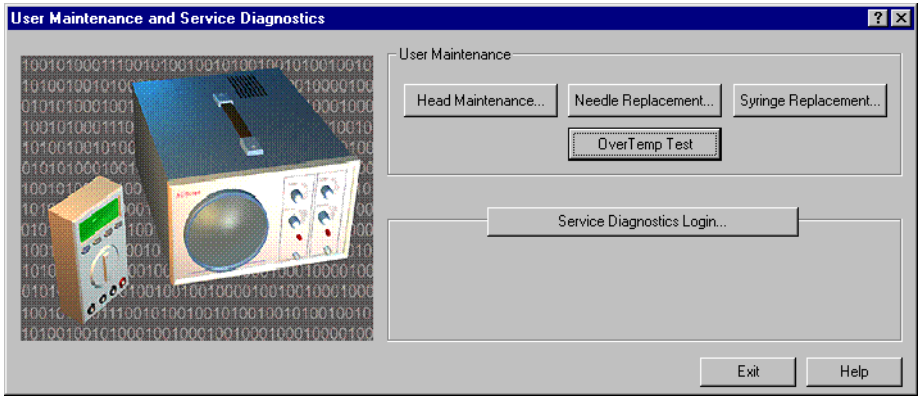


Figure 4-11 User Maintenance and Service Diagnostics Dialog Box

4. Click Needle Replacement.
5. Follow the steps in the Needle Maintenance wizard to remove the sample needle:
   a. Ensure the sample compartment door is closed, and then click Next.
   b. Fully open the sample compartment door.
   c. Remove the sample carousel.
   d. Click Next to lower the needle.
   e. Find the ram nut and sample needle inside the sample compartment, to the left of the tray (Figure 4-12). Use the flashlight to monitor the needle movement.

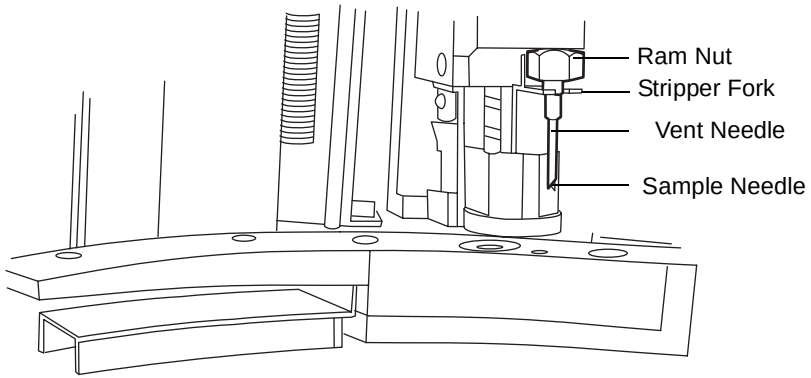


Figure 4-12 Viewing the Sample Needle

   f. Remove the left panel (Figure 2-5).

g. Find the needle-moving knob on the left side of the system (Figure 4-13). When the wizard needle no longer moves, turn the knob clockwise to lower it or counterclockwise to raise it. It should remain approximately half-way between its highest and lowest positions.

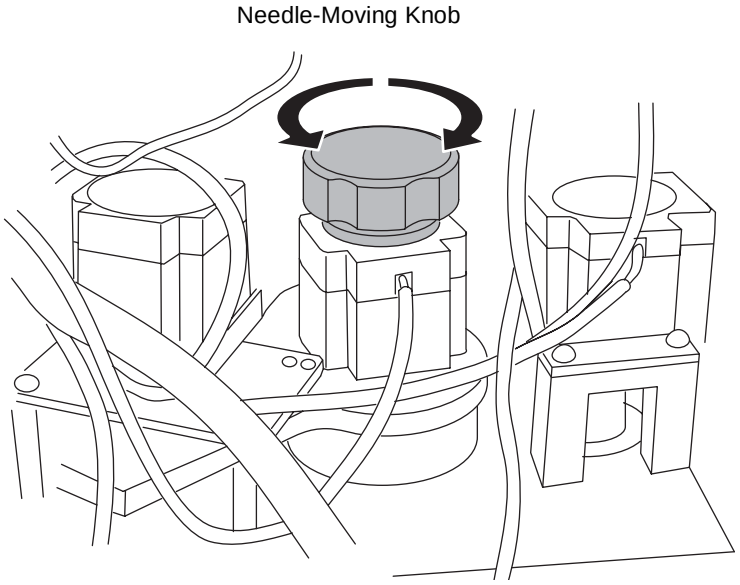


Figure 4-13 Manually Moving the Needle

h. Use the 1/2-inch wrench to remove the ram nut (see Figure 4-12).

i. Use the 5/16-inch wrench to remove the needle.

6. Install the new sample needle:

a. Set the ferrule first (Figure 4-14), cinching it onto the replacement needle while both are outside the sample compartment. If the replacement needle comes with a pre-installed ferrule, go to step 6e.

b. Slide the compression screw and ferrule onto the needle's blunt end.

c. Thread the compression screw into a standard 1/16-inch compression union. This forces the ferrule into place at the bottom of the compression union. Use the two open-end wrenches to tighten the compression screw 1/4-to-1/2 turn into the union, permanently crimping the ferrule to the needle.

d. Remove the compression union, and ensure the ferrule crimps properly to the needle.

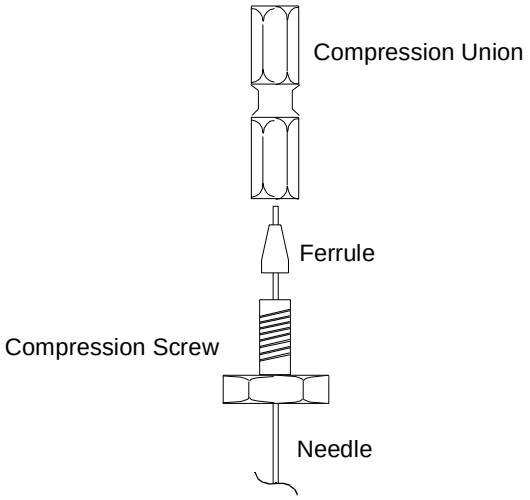


Figure 4-14 Setting the Ferrule

e. Assemble the needle, ferrule, and compression screw onto the ram nut/needle assembly in the sample compartment.

f. Place the ram nut/needle assembly on top of the stripper fork in the sample compartment.

g. Use the 5/16-inch wrench to install the compression screw.

h. Install the ram nut.

Note: *Reinstall the ram nut in its original position.*

7. Click Next in the Needle Maintenance wizard to reposition the needle.
8. Click Close to close the Needle Maintenance wizard.
9. Reinstall the left side panel.
10. Click Exit to close the User Maintenance and Service Diagnostics dialog box.
11. Install the carousel, and close the sample door.
12. Select Operations > Inj Purge from the Interactive Mode window (Figure 3-3) to purge the injector (Section 3.4.2).
13. Let the sample compartment reach the operating temperature and the system equilibrate (Section 3.6.1).

4.5.3 Replacing the Syringe and Seal

Replace the syringe and seal when you need a different volume or if the syringe leaks or draws air.

The current instrument method specifies the syringe speed during its downstroke (filling) and upstroke (emptying). You can create an instrument method to increase syringe speed (Section 3.3.1).

Note: *You should specify a relatively slow speed on completing syringe maintenance.*

Required Materials

- New syringe, 5.0-mL
- Absorbent tissue
- Gloves

Procedure

1. Open the syringe compartment door (Figure 4-9).
2. Click  (Diagnostics) in the Interactive Mode window (Figure 3-3), and then click Diagnostics to open the User Maintenance and Service Diagnostics dialog box (Figure 4-11).
3. Click Syringe Replacement to open the Syringe Replacement wizard.
4. Unscrew the knurled nut at the bottom of the syringe (Figure 4-15).

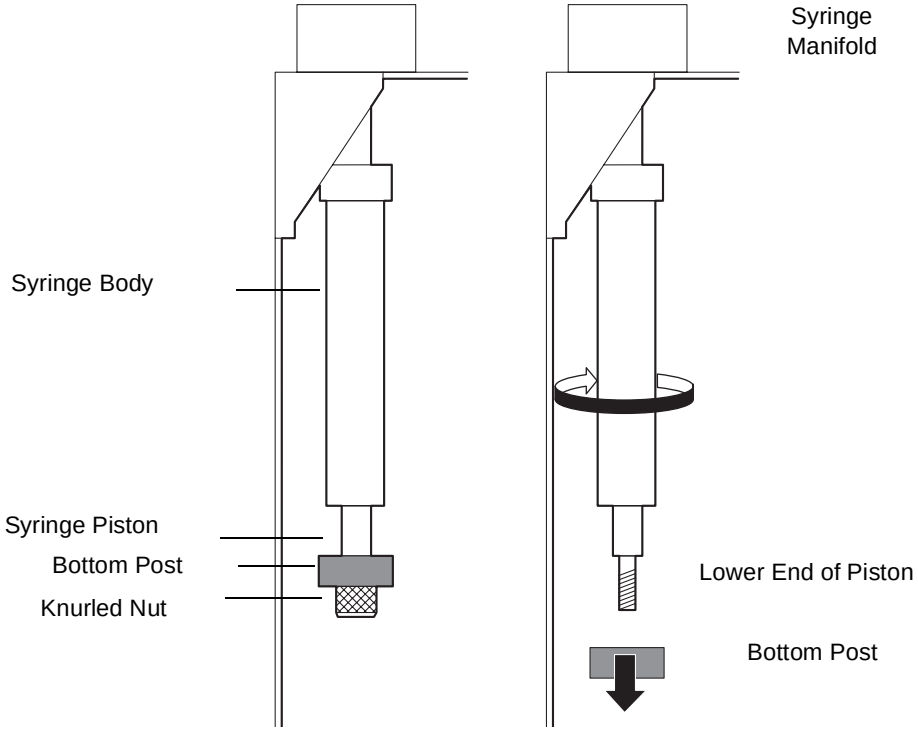


Figure 4-15 Removing the Syringe

5. Click Next. The bottom post drops to a point below the syringe bottom, releasing the lower end of the piston.
6. Turn the top of the syringe *counterclockwise* to remove it from its manifold. Hold the syringe by its middle or higher, and pull it down and away from you.

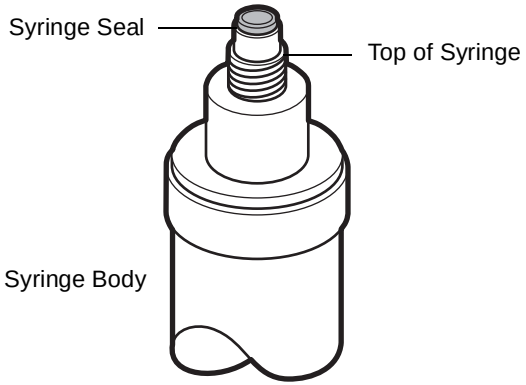


Figure 4-16 Syringe Seal

7. Screw the top of the new syringe *clockwise* into the manifold, finger tightening it (Figure 4-16). Then turn it another 1/8- to-1/4 turn.

   Note: *You might need to guide the syringe bottom into the hole in the lower post.*

8. Click Next. The lower post rises until it connects to the syringe bottom and engages the end of the piston.
9. After the syringe stops moving, install and tighten the knurled nut at the syringe bottom.
10. Click Close to close the Syringe Replacement wizard.
11. Inspect the syringe and tubing to ensure no bubbles remain. If you see bubbles, purge the injector (Section 3.4.2).
12. Close the syringe compartment door, and click Exit to close the User Maintenance and Service Diagnostics dialog box.

4.5.4 Replacing the Sample Loop

Replace the sample loop when you want to use one with a different volume or if the current one leaks or otherwise fails to function properly. The system is shipped with a 200-µL calibrated sample loop.

Required Materials

- Open-end wrench, 1/4-inch
- New sample loop
- Absorbent tissue
- Gloves

Procedure

1. Allow the analysis compartment and the columns to cool (Section 3.4).
2. Open the analysis compartment door.
3. Use the wrench to loosen the two compression screws that connect the sample loop to ports 1 and 4 of the injection valve, then remove the sample loop (Figure 4-17).

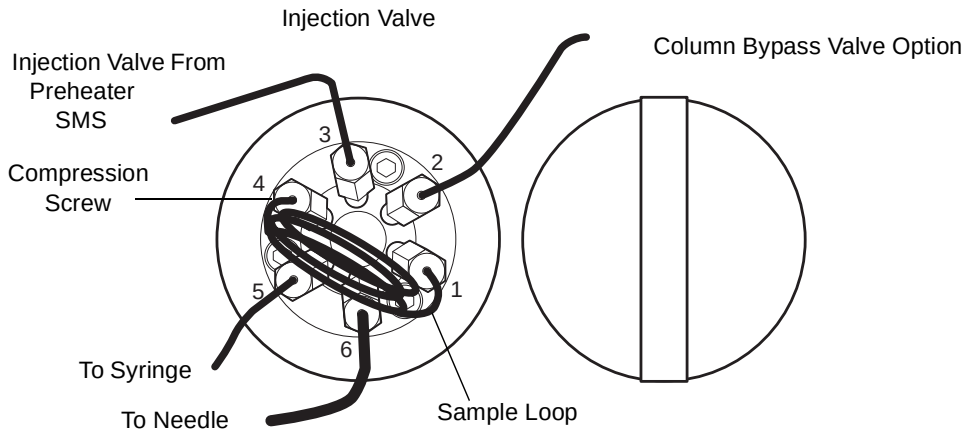


Figure 4-17 Changing the Sample Loop

4. Install the new sample loop on ports 1 and 4, and tighten the two compression screws.
5. Record the exact loop volume, in µL, as labeled on the loop tag.
6. Close and lock the analysis compartment door.
7. Configure the sample loop for the volume labeled on its tag (Section 3.2.3).
8. Select Operations > Inj Purge from the Interactive Mode window (Figure 3-3).
9. Equilibrate the system (Section 3.6.1).

4.5.5 Replacing the Injection Valve

Replace the injection valve if it leaks or otherwise fails to function properly. The system is shipped with a 200-µL calibrated sample loop.

Required Materials

- Open-end wrench, 1/4-inch

- Injection valve cartridge
- Absorbent tissue
- Gloves
- New injection valve

Procedure

1. Allow the analysis compartment and the columns to cool (Section 3.4).
2. Open the analysis compartment door.
3. Use the wrench to loosen the two compression screws that connect the sample loops to ports of the injection valve, then remove all the sample loops (Figure 4-17).

   Note: *Label the tubing as you remove it.*

4. Loosen the thumb screw at the bottom of the valve and remove it.
5. Install the new injection valve, making sure to align Port 3 in the 12 o'clock position. If you do not replace the valve correctly, it will not be flush with the valve holder body.
6. Install the sample loop in the correct ports as labeled, and tighten the two compression screws.
7. Close and lock the analysis compartment door.
8. Select Operations > Inj Purge from the Interactive Mode window (Figure 3-3).
9. Equilibrate the system (Section 3.6.1).

4.5.6 Replacing the Filter in a Sample Filter Vial

You can reuse the sample filter vials by cleaning them with solvent, or you can replace the filter after each use.

Attention: *To prevent damage to the sample management system, use only Alliance GPC 2000 sample filter vials to filter samples in the Alliance GPC 2000 Series system.*

Required Materials

- New sample filter, 0.5-µm, or 2.0-µm for shear-sensitive samples
- Filter removal tool for 7-mL stainless steel vials
- Seal for vial plunger
- Absorbent tissue

- Gloves

Procedure

1. Remove and discard the crimp/seal cap, using the 10-mL decapping pliers (Figure 4-18).
2. Discard the remaining filtered sample.
3. Remove the plunger assembly.
4. Discard any sample residue from the vial cup, and clean the vial cup with solvent.
5. Remove the filter from the plunger assembly, using the filter removal tool, and then clean the plunger and the seal. Replace the plunger seal if it is damaged.
6. Install a new filter in the plunger.
7. To add sample to the vial, see Section 3.5.1.

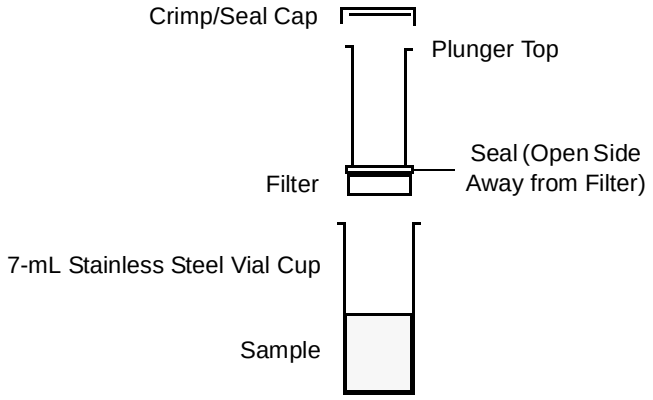


Figure 4-18 Changing the Filter in a Sample Filter Vial

4.5.7 Replacing the Solvent Inline Filter

The solvent inline filter filters solvent as it flows from the solvent management system to the sample management system. Replace this filter when it leaks, shows contamination, or elevates backpressure.

Required Materials

- Open-end wrenches, 5/8-inch (2) and 5/16-inch
- Squirt bottle containing a solvent compatible with the one you are using
- New solvent inline filter, 2-µm

- Absorbent tissue
- Gloves

Procedure

1. Use a 5/8-inch wrench and the 5/16-inch wrench to separate the compression screw on the left side of the solvent inline filter from the inlet filter housing. Use a tissue to absorb the small amount of solvent that may leak.
2. Hold the outlet housing with a 5/8-inch wrench while you loosen the inlet housing with a second 5/8-inch wrench (Figure 4-19).

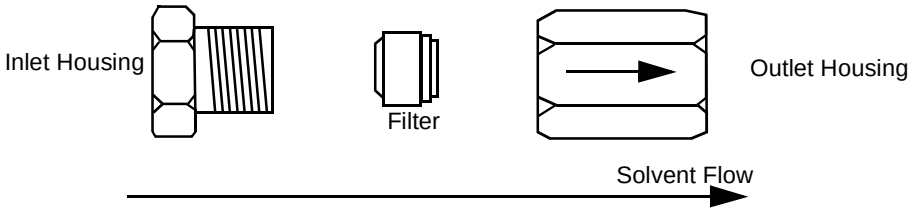


Figure 4-19 Replacing the Solvent Inline Filter

3. Tip the inlet housing upside down to remove the filter.
4. Wet the new filter with solvent.
5. Insert the new filter into the inlet housing.
6. Reconnect the inlet and outlet housings.
7. Tighten the compression screw in the inlet housing.
8. Purge the system:
   - Select Operations > RI Purge from the Interactive Mode window (Figure 3-3). See Section 3.4.3 for details.
   - Select Operations > Visc Purge (for sense-tube type GPCV viscometers only). See Section 3.4.4 for details.
9. Inspect the filter housing for leaks, and if necessary tighten it.

4.5.8 Replacing the Solvent Reservoir Filter

Replace the solvent reservoir filters when they show contamination.

Required Materials

- New solvent reservoir filter, 5-µm or 10-µm
- Absorbent tissue
- Gloves

Procedure

1. Remove the solvent reservoir cap from the solvent reservoir.
2. Remove the solvent reservoir filter from the solvent tubing.
3. Install the new solvent reservoir filter on the solvent tubing.
4. Reinstall the solvent reservoir cap on the solvent reservoir.

4.5.9 Removing the Head Nut and Head Piston Assembly

Remove the head nut and head piston assembly when you replace any of these parts:

- Piston seal and face seals
- Seal-wash seals (optional)
- Pistons

Required Materials

- Absorbent tissue
- Gloves

Procedure

1. Click Stop Flow in the Interactive Mode window (Figure 3-3) to stop solvent flow.
2. Click  (Diagnostics) to open the Diagnostics Mode window (Figure 4-10).
3. Click Diagnostics in the lower-right corner, to open the User Maintenance and Service Diagnostics dialog box (Figure 4-11).
4. Click Head Maintenance. When the Head Maintenance wizard appears, click Next.
5. Open the solvent compartment door. Place absorbent tissue under the purge valve, and then turn the purge valve one turn, counterclockwise, to open it (Figure 4-20).

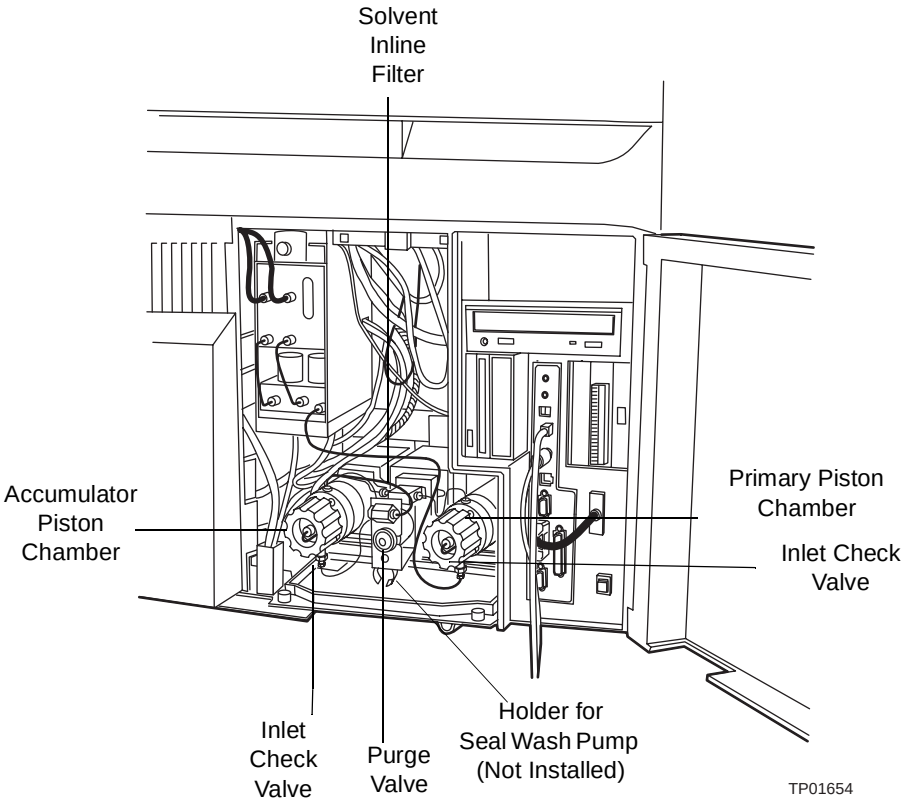


Figure 4-20 Solvent Management System Components

6. Select Primary or Accumulator. Click Next.
7. If seal-wash tubing is connected to ports on the piston chamber manifold, disconnect it.
8. Push in, and turn counterclockwise the piston chamber's release ring. Click Next to release the piston and push it forward.

   Figure 4-21 shows the head nut, head piston assembly, and check-valve components of a piston chamber.

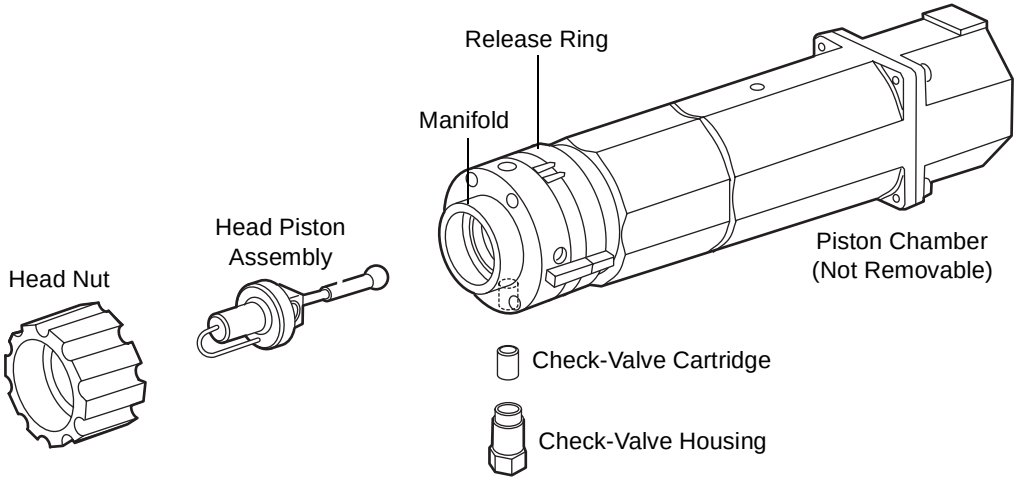


Figure 4-21 Piston Chamber Components

9. Rotate the head nut counterclockwise, and remove it.
10. Remove these head piston assembly components from the piston chamber (Figure 4-22):
    - Piston head with the J tube
    - Seal-wash assembly (if fitted)
    - Seal-wash housing washer (if fitted)
    - Piston

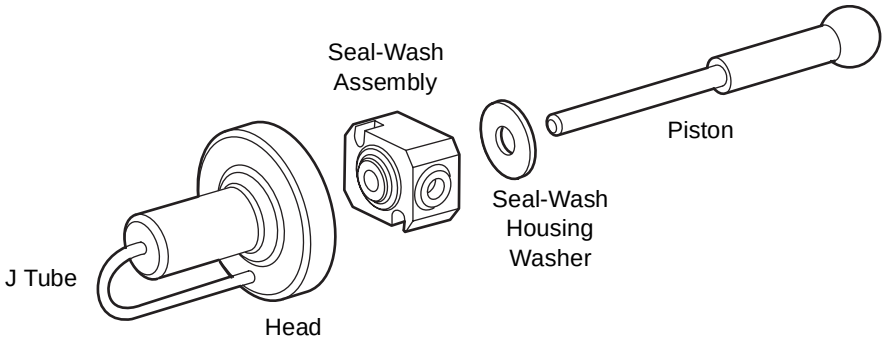


Figure 4-22 Head Piston Assembly

11. Continue with the maintenance procedures in the following sections:

- Section 4.5.10, Replacing the Piston Seal and Face Seals
- Section 4.5.11, Replacing the Seal-Wash Seals (Optional) (if fitted)
- Section 4.5.12, Replacing the Piston
- Section 4.5.13, Completing Piston Head Maintenance

4.5.10 Replacing the Piston Seal and Face Seals

Replace the piston seal when you perform piston head maintenance (application dependent). Replace the inlet and outlet face seals after every two or three replacements of the piston seal. Before you begin, remove the head nut and head piston assembly (Section 4.5.9).

Required Materials

- Startup Kit:
  - Seal insertion and removal tool
  - Priming syringe
- New seals
- Squirt bottle containing a solvent compatible with the one you are using
- Absorbent tissue
- Gloves
- Clean, flat object for applying pressure to seals
- Plastic tweezers

Procedure

Attention: *To avoid scoring the sealing surfaces, do not use a sharp or metallic tool to remove or install seals.*

1. Use the plastic end of the seal insertion and removal tool to remove the piston seal from the head (Figure 4-23).

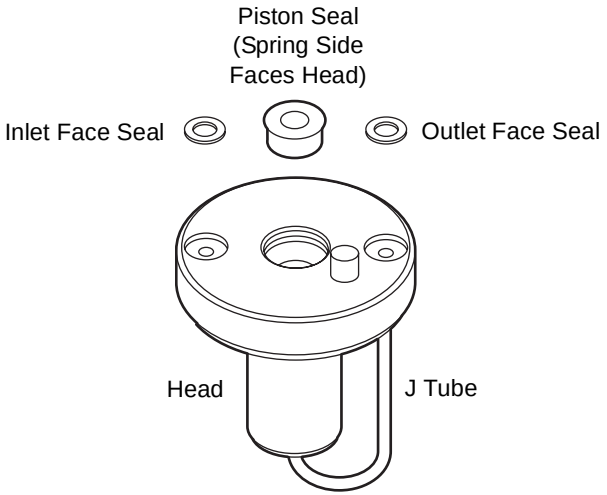


Figure 4-23 Piston and Face Seal Placement

2. Clean the seal opening with tissues if you see residue, and wet the insertion and removal tool, seal opening, and new piston seal with solvent.
3. Place the new piston seal on the seal insertion and removal tool with the spring side facing the tip of the tool.
4. Insert the tip of the tool into the piston seal opening, then remove the tool.
5. Use plastic tweezers to remove the face seals from the seal openings in the head (Figure 4-23).
6. Clean the seal opening with tissue if you see residue, and wet the new seals and seal openings with solvent.
7. Place the new face seals in the face seal openings in the head.
8. Use a solvent-cleaned, flat object to firmly press the face seals into the openings on the pump head.

4.5.11 Replacing the Seal-Wash Seals (Optional)

Replacing the seal-wash seals involves replacing the seal-wash face seal, two tube seals, and the piston-wash seal (Figure 4-24).

Before you begin, remove the head nut and head piston assembly (Section 4.5.9).

Note: *See Chapter 5 when isolating seal-wash problems.*

Attention: *To prevent system damage, use a seal-wash solvent that is miscible with the solvent in the system and also compatible with the seal-wash seals.*

Consult Appendix C for solvent compatibility information.

Required Materials

- Startup Kit:
  - Seal insertion and removal tool
  - Priming syringe
- New seal-wash face seal, tube seals, and piston-wash seal
- Squirt bottle containing a solvent compatible with your solvents
- Absorbent tissue
- Gloves
- Plastic tweezers

Procedure

1. Use the plastic end of the seal insertion and removal tool to remove the piston-wash seal from its seat. Repeat this procedure for each tube seal (Figure 4-24).

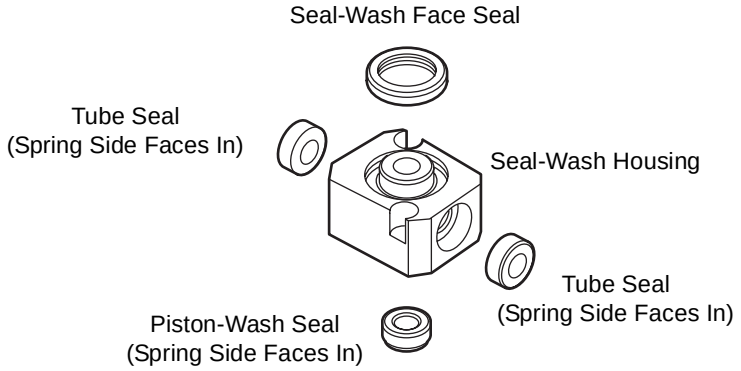


Figure 4-24 Seal-Wash Assembly Seals

2. Use the plastic tweezers to remove the seal-wash face seal.
3. Clean the seal openings with tissues if you see residue, and wet each new seal, seal opening, and the seal insertion and removal tool with solvent.

4. Place the new piston seal on the seal insertion and removal tool with the spring side facing the tool tip.
5. Insert the tool tip into the seal opening, and remove the tool. Repeat this procedure for each tube seal.
6. Press the new seal-wash face seal into the opening with your thumb.
7. Install the seal-wash housing washer (Figure 4-22).
8. If you intend to replace the piston, proceed with Section 4.5.12; otherwise, proceed with Section 4.5.13.

4.5.12 Replacing the Piston

Replace the primary and accumulator piston at the same time. Before you begin, remove the head nut and head piston assembly (Section 4.5.9).

Required Materials

- New pistons
- Absorbent tissue
- Gloves

Procedure

1. Inspect the piston for damage, excessive wear, or residue.
2. If the piston or seal shows signs of damage, excessive wear, or residue, replace it (Section 4.5.10).

4.5.13 Completing Piston Head Maintenance

1. Click Next at Head Maintenance, Part 3, of the Head Maintenance Wizard (Section 4.5.9).
2. Reinstall the piston, washer, seal-wash housing, and head. The head alignment pin should be correctly positioned, and the J-tube should face downward (Figure 4-22).
3. Replace the head nut, and tighten it.
4. Turn the release ring clockwise. Withdraw it (Figure 4-21), and click Next.
5. If the seal-wash option is installed, connect the seal-wash tubing to ports on the piston chamber manifolds. Click Next.
6. Click Exit to close the Head Maintenance wizard.
7. Repeat Section 4.5.9, through Section 4.5.13 for the other piston.

8. Turn the purge valve counterclockwise to close it, and close the solvent compartment door.
9. Prime and purge the solvent management and seal wash systems to draw solvent into the piston cavities and through the seal wash before you start pumping them (Section 3.4).

4.5.14 Replacing a Check Valve

Replace both check valves during the same service interval.

Note: *See Chapter 5 for details for how to identify check valve malfunctions.*

Required Materials

- Open-end wrenches, 1/2-inch and 5/16-inch
- New inlet check-valve cartridge, 2
- Squirt bottle containing a solvent compatible with your solvents
- Priming syringe (Startup Kit)
- Absorbent tissue
- Gloves

Procedure

1. Open the solvent compartment door.
2. Hold the check-valve housing with the 1/2-inch wrench as you disconnect the compression screw with the 5/16-inch wrench (Figure 4-25).

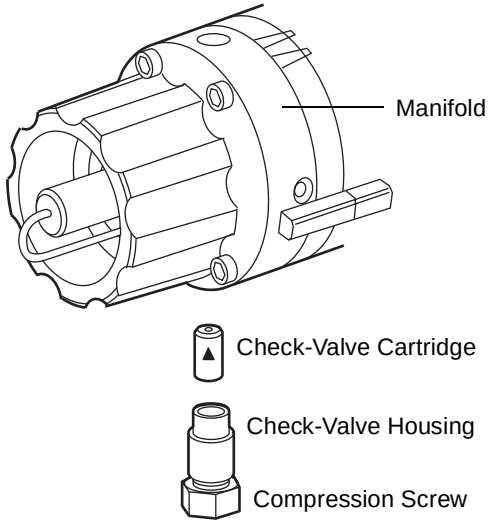


Figure 4-25 Inlet Check Valve

3. Use the 1/2-in. wrench to disconnect the check-valve housing from the piston chamber inlet port.
4. Invert the check-valve housing, removing the old check-valve cartridge.
5. Wet the new cartridge with solvent.
6. Insert the cartridge into the check-valve housing.

STOP ***Attention:*** *The arrow on the check-valve cartridge must point toward the piston chamber.*

7. Insert the check-valve housing into the piston chamber housing.
8. Finger-tighten the housing, afterward using the 1/2-in. wrench to tighten it 1/8-turn.
9. Hold the check-valve housing with the 1/2-in. wrench as you reinstall and tighten the compression screw inside it with the 5/16-in. wrench.
10. Close the solvent compartment door.
11. Prime the solvent management system (Section 3.4.1). See “Priming the Pump, Manual Prime Wizard” in the *Alliance GPC 2000 Series System Help*.

4.5.15 Replacing Tubing

Replace the following tubing when leaks, clogs, kinks, deterioration, or contamination affect fluid flow:

- Solvent reservoir
- Drip tray:
  - Syringe waste
  - Refractometer waste
- Intercolumn
- Tubing between the injection valve and columns
- Degasser
- Interdetector (Alliance GPCV 2000 system only)

Figure 1-5 illustrates the solvent flow path and provides tubing descriptions and part information.

4.6 Replacing, Adding, or Removing Columns

Column life span is reduced by contamination from samples and solvents, frequent solvent changeover, improper handling and storage, and excess temperature or pressure. For best results, see the manufacturer's instructions for the columns. Use HPLC-grade solvents and filter all solvents through a 0.5-µm filter.

General Guidelines for Styragel Columns

- Use solvents compatible with the columns to prevent gel shrinkage and irreversible channeling.
- Allow a maximum flow rate of 2.0 mL/min and a maximum backpressure of 500 psi (30 bars) per column.
- Protect the columns from vibration and mechanical shock.
- Protect the columns from rapid changes in pressure, this can result from rapid composition changes of the solvent during solvent changeover and from temperature or flow rate changes.
- When changing to a solvent of different viscosity, use a flow rate of 0.1 mL/min to prevent excess backpressure.

- Dissolve samples in the solvent to avoid precipitation.
- Dedicate each column, or column set, to a specific application. Frequent switching of samples and solvents accelerates column deterioration and loss of resolution.
- Maintain a solvent flow of 0.1 mL/min or greater at all times. Keep columns filled with solvent.

Attention: *Use LS-compatible or preconditioned column(s) for optimal results in LS or viscometry. This minimizes detector contamination by particulates that manifest themselves as signal noise.*

If the column set performance deteriorates, you can replace the entire column set, or isolate the problematic column and replace it. To isolate a problematic column, remove one column at a time, and install it in a well-performing column bank. Run a known standard, and then compare results.

Caution: *To avoid burn injuries, always allow adequate time to cool the system before you perform maintenance or troubleshooting. Wear protective clothing whenever you open the sample or analysis compartment.*

Attention: *To prevent column damage, use extreme care whenever you change any system parameter, including temperature, pressure, flow rate, solvent type, and/or solvent concentration.*

Required Materials

- Styragel HMW, HT, or HR columns (Table B-3), Ultrahydrogel columns (Table B-4), or HSP gel columns (Table B-5)
- Open-end wrenches, 5/16-inch and 5/8-inch
- Small waste container for solvent
- Absorbent tissue
- Gloves

Procedure

If you are using Styragel columns for high-temperature chromatography in solvents such as TCB or ODCB, switch the column to the selected solvent at an elevated temperature. Refer to the *Styragel Column Care and Use Manual* for details about Styragel columns.

1. Allow the analysis compartment to cool, and maintain a solvent flow of 0.1 mL/min.
2. Open the analysis compartment door.

3. If columns are installed in the analysis compartment, use the 5/16-in. and 5/8-in. wrenches to disconnect the column tubing (that connects to ports 1 and 2 of the column bypass valve) and remove the column set.
4. If the new columns will use a solvent different from the one old columns used, follow these steps:
   a. Install a zero-dead-volume union in place of the columns.
   b. Convert the system to the solvent the new columns will use.
   c. Purge the system to remove any micro particulates and old solvent (Section 3.4.6, Changing a Solvent).
   d. Remove the zero-dead-volume union.
5. To install a column, see Section 2.3.3, Installing Columns.
6. Close and lock the analysis compartment door.
7. Equilibrate the system (Section 3.6.1, Equilibrating the System).

Attention: *Waters recommends that you purge new columns individually to remove any micro particulates.*

4.7 Maintaining Data Storage

Periodically storing, backing up, and archiving data files and log files frees disk space and helps prevent loss of data if the hard drive fails. You can store data on CDs using the CD R/W drive or on a networked server if the system is connected to one.

Use Windows 2000-compatible software to check for viruses.

Ensure that the latest Microsoft Windows critical updates and service packs are installed.

Attention: *Waters recommends that you install only Waters-supplied software on the Alliance GPC 2000 Series system onboard CPU. Installation of other software may cause improper operation and/or poor performance of your GPC 2000 system.*

The drives of the onboard CPU consist of:

- Floppy disk drive
- Hard drive
- CD R/W drive

4.7.1 Backing Up Data

Each injection during a sample set run, generates a sample set containing multiple sets of AIA (Analytical Instruments Association) data files, such as refractometer, viscometer, vapor sensor, light scattering detector, and temperature sensor responses. If you connect to the Empower database, detector data files are also sent there via the Empower storage server. The refractometer, viscometer, light scattering files and other data files remain in the Waters\GPC2000\SSArchive\Sample Sets folder until you delete them. The data channels also remain available for display in Interactive Mode for 72 hours. For troubleshooting purposes, you can view a running recording of the data channels so that you can compare injections before and after a problem arises.

You can manually transfer all AIA files of a sample set run into any Empower database after the injection, using the Sample Set Mover (Section 3.7.3).

To back up data using a CD R/W, select files for replication, and drag them to the CD drive.

4.7.2 Restoring Data

To restore data from a CD, selected files can be dragged and dropped to the appropriate drive, resulting in file replication. A Windows wizard provides a dialog decision box that requires you to overwrite the original file, or create a new file via a Save As command.

Data files are located in *C:\Program Files\Waters\GPC2000\SSArchive\SampleSets*.

4.7.3 Updating the Software

Note: *Remove all Empower options before updating the software.*

To update the Alliance GPC 2000 software or the Empower software from a CD

1. Open the solvent compartment door.
2. Install the CD in the CD drive.
3. From the Windows desktop, access My Computer.
4. Double-click the CD-Drive to view all the files on the CD.
5. Open the file labeled Install Instructions.Txt, and follow the installation instructions.
6. Remove the CD from the CD drive once the installation is completed.
7. Store the CD in a safe location for future reference.

8. Close the solvent compartment door.

Chapter 5
Troubleshooting the System

This chapter describes methods for diagnosing problems with an Alliance GPC 2000 Series system. Two assumptions apply to the troubleshooting information in this chapter:

- System performance has degraded compared with previous performance.
- All preventive maintenance tasks have been performed correctly and on time.

For detailed troubleshooting information, see to the Error Messages, General System Troubleshooting, Instrument Operation Troubleshooting, and Instrument Performance Troubleshooting topics in the *Alliance GPC 2000 Series System Help*. If the suggestions in this chapter do not solve the problem, call Waters Technical Service (see Appendix D).

Caution: *To avoid injury from burns, allow the system enough time to cool before you perform maintenance or troubleshooting. Wear protective clothing whenever you open the sample or analysis compartment.*

5.1 Analyzing the Problem

Perform a preliminary inspection:

- Inspect your system for leaks, tubing blockages and connections, cable connections, temperature problems, and other areas that you can quickly check.
- Check the values specified in the Instrument Configuration Editor and the current instrument method to ensure that operating parameters such as temperature and flow rate are set correctly.

You can take several approaches to analyzing and diagnosing problems with an Alliance GPC 2000 Series system.

To locate the problem's source,

- use the status LEDs in the Diagnostics mode window and in the Diagnostics dialog boxes for Solvent Management, Sample Management, and Detectors (see Section 5.1.1).
- read the Message Board for recent error, warning, and information messages that may be related to the problem (see Section 5.1.2).

Depending on your findings from these initial approaches, you may perform these diagnostic tests:

- Noise and drift (see Section 5.2.1)
- Temperature control (see Section 5.2.2)
- Baseline investigation (see Section 5.3)
- Peak investigation (see Section 5.4)

You may also use the appropriate troubleshooting tables to help you resolve hardware-based problems (see Section 5.5 to Section 5.8).

5.1.1 Using the Onboard Diagnostics

Use the LEDs to obtain specific diagnostic information about the solvent management system, sample management system, columns, and detectors.

Gathering Diagnostic Information from LEDs:

1. Check the status LED on the front of the Alliance GPC 2000 Series system:
   - If the LED is red, an error exists; proceed to step 2.
   - If the LED is yellow, there is a warning; allow sufficient equilibration, and then proceed to step 2 if the LED remains yellow.
   - If the LED is green, proceed to Section 5.1.2, Checking the Message Board and Logs.
2. Click  (Diagnostics) in the Alliance GPC 2000 Series system window. The Diagnostics Mode appears (Figure 5-1).

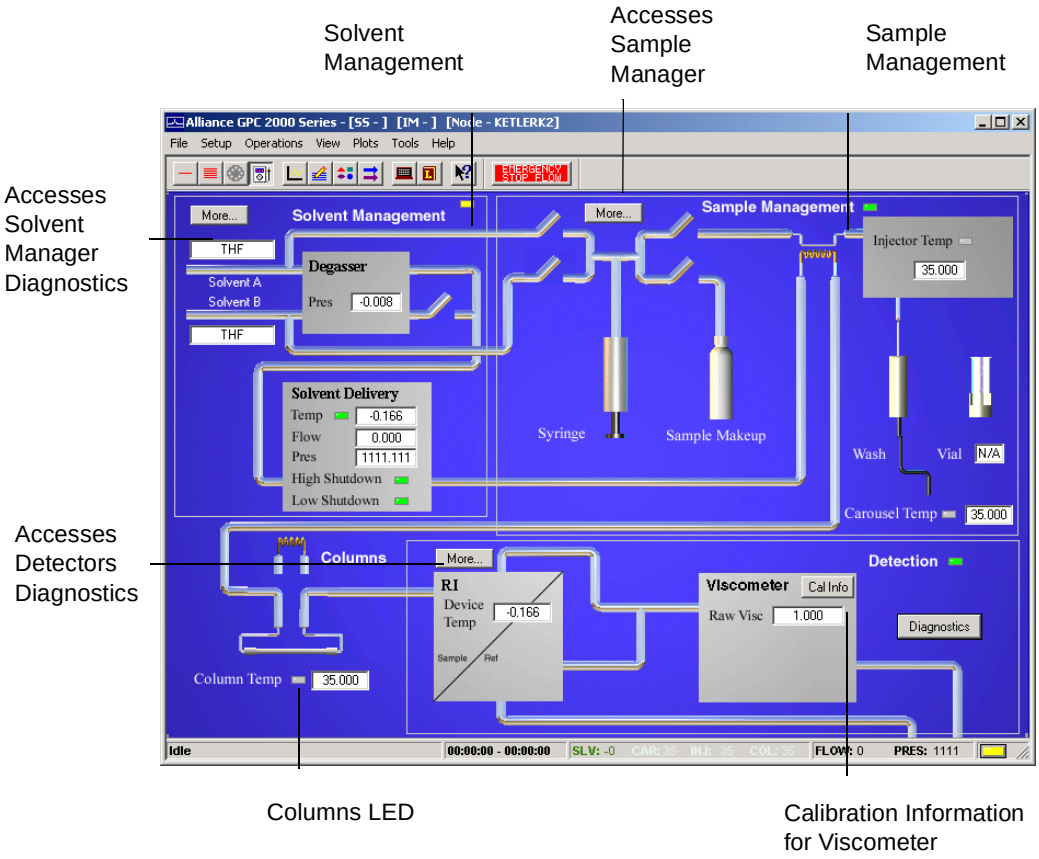


Figure 5-1 Checking the Onboard Diagnostics

3. To check the component diagnostics, click the More button near an LED. When you do so, these dialog boxes appear:

   - Solvent Management Status Indicators (Figure 5-2).
   - Sample Management Status Indicators (Figure 5-3).
   - Detection Status Indicators (Figure 5-4).

   For information about the yellow or red status LEDs that may appear in the diagnostic dialog boxes, see “Solvent Management Diagnostics Dialog Box,” “Sample Management Diagnostics Dialog Box,” and “Detection Diagnostics Dialog Box” in the *Alliance GPC 2000 Series System Help*.

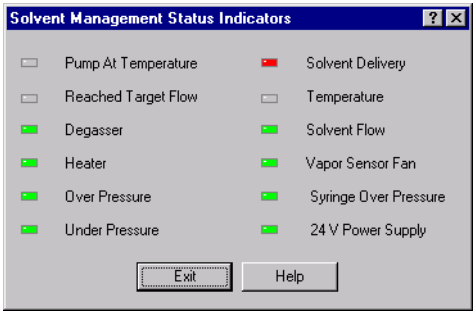


Figure 5-2 Solvent Management Status Indicators Dialog Box

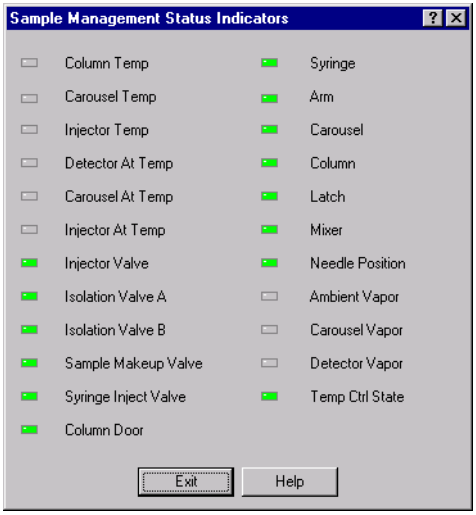


Figure 5-3 Sample Management Status Indicators Dialog Box

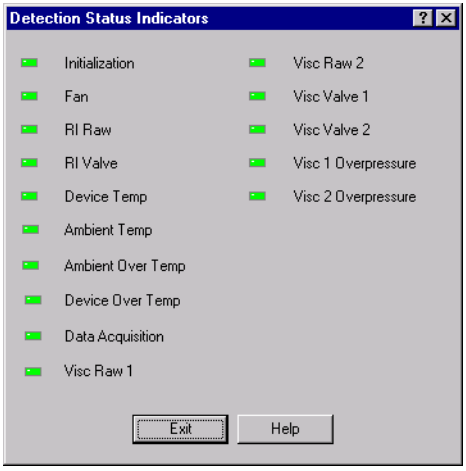


Figure 5-4 Detection Status Indicators Dialog Box

4. Determine the components that contribute to, or that are affected by, the symptoms. Based on your findings, use the appropriate troubleshooting tables to help you solve hardware-based problems:
   - Section 5.5, Correcting Solvent Manager Problems
   - Section 5.6, Correcting Sample Manager Problems
   - Section 5.7, Correcting Detector Problems
   - Section 5.8, Correcting Miscellaneous Problems
5. If the Detection LED in Diagnostics Mode (see Figure 5-1) is yellow or red, or if one of the viscometer LEDs in the Detection Diagnostics dialog box (see Figure 5-4) is yellow or red, click Cal Info in the Diagnostics mode (see Figure 5-1) for details about viscometer calibration.
6. To return to normal operations, select Operations > Smart Reinit.

5.1.2 Checking the Message Board and Logs

Use the Message Board to obtain chronologically ordered information, warning, and error messages about the system. Also review the Log Book for the service records. Likewise, review your maintenance records for previously documented information about the problem.

Using the Message Board:

1. Click  (Message Board).

2. Review recent error, warning, and information messages.
3. Click  (Log Book).
4. Review the service records.
5. Review your own maintenance records.

5.2 Performing Diagnostic Tests

You can test for these behaviors:

- Noise and drift of the baseline (Section 5.2.1, Testing Noise and Drift)
- Ability of the system to detect temperature overheating (Section 5.2.2, Testing Temperature Control)

5.2.1 Testing Noise and Drift

For more detail about testing baseline noise and drift, see “Calculating Noise and Drift of Channel Data” and “Noise and Drift Dialog Box” in the *Alliance GPC 2000 Series System Help*.

Testing the Noise and Drift of an Injection

1. Purge the injector, refractometer, and (possibly) the sense-tube viscometer, and then allow the system to equilibrate.
2. Inject a standard using Sample Set mode (see Section 3.7.2, Running a Sample Set).
3. Review the results.
4. Calculate the noise and drift of a channel (Figure 5-5):
   a. Right-click the pane displaying the chromatogram or trace, and then select a channel.
   b. Right-click the pane, and then select Noise and Drift.
   c. Select a time interval.
   d. Click Calculate.
5. Record the noise and drift values that appear in the Results area.

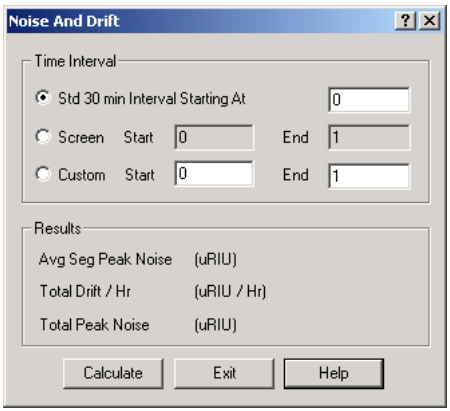


Figure 5-5 Noise And Drift Dialog Box

6. Click Exit to close the Noise And Drift dialog box.

You can test the noise and drift for any of the AIA channels- in a sample set.

5.2.2 Testing Temperature Control

The OverTemp test sets the hardware overtemperature setting 5 °C below the current reading for the analysis (detector) compartment and both areas of the sample compartment (sample needle or injector and carousel). If system hardware temperature circuits are functioning correctly, the system detects the simulated overtemperature condition in each compartment and displays messages on the monitor screen.

For more detail about testing temperature control, see “User Maintenance and Service Diagnostics Dialog Box” and “Performing User Maintenance Procedures” in the *Alliance GPC 2000 Series System Help*.

Performing the overtemp test

1. Click  (Diagnostics). The Diagnostics Mode appears in the Alliance GPC 2000 Series window (see Figure 5-1).
2. Click Diagnostics. The User Maintenance and Service Diagnostics dialog box appears (Figure 5-6).

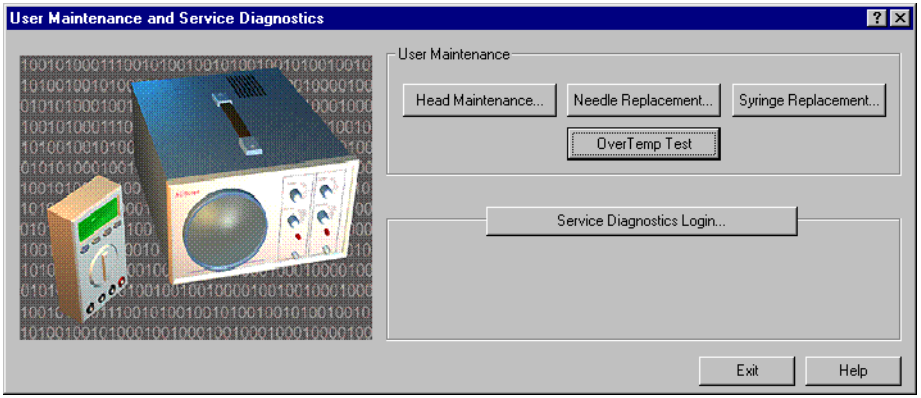


Figure 5-6 User Maintenance and Service Diagnostics Dialog Box

3. Click OverTemp Test.
4. If the overtemperature circuits test OK, message boxes appear, verifying that the compartments pass the overtemperature hardware sensor test.
5. Click OK to close each message box.

5.3 Optimizing the Baseline

Noisy Refractometer

1. Purge the refractometer (see Section 3.4.3, Purging the Refractometer).
2. Allow adequate time for equilibration (see Section 3.6.1, Equilibrating the System).

Noisy Viscometer

Note: *You must measure viscometer noise at a flow rate ensuring that the transducer P1 pressure is above 3 kPa and the transducer P2 pressure is above 30 kPa. The system must be properly and equilibrated.*

1. Let the viscometer temperature stabilize.
2. Purge the viscometer (see Section 3.4.4).
3. Set the flow rate as indicated in the note above.
4. Calibrate the viscometer (in Interactive mode, select Operations > Visc. Cal, or see Section 3.4.5).
5. Allow adequate time for equilibration (see Section 3.6.1, Equilibrating the System).

This section describes symptoms, causes, and corrective actions for baseline-related problems:

- Noncyclic or erratic noise (Table 5-1)
- Short-term cyclic noise (Table 5-2)
- Long-term cyclic noise (Table 5-3)
- Drift (Table 5-4)
- Noise spikes (Table 5-5)

5.3.1 Noncyclic Baseline Noise

Use Table 5-1 to troubleshoot noncyclic (erratic) baseline noise.

Table 5-1 Noncyclic Baseline Noise

Possible Cause	Corrective Action
Large air bubble trapped in the refractometer flow cell	• Purge the refractometer (see Section 3.4.3). • Ensure the solvent is properly degassed (see Section 3.3.3).
Small air bubbles traveling through the flow path	• Ensure the solvent is properly degassed (see Section 3.3.3).
System not stabilized or equilibrated	Allow sufficient time for the baseline to stabilize (see Section 3.6.1). Note the operating conditions of your application (such as solvent type).
Solvent contaminated	• Discard the contaminated solvent. • Clean the solvent reservoirs. • Replace the solvent inline filter element (see Section 4.5.7). • Prepare and filter fresh solvent using only high-quality reagents and HPLC-grade solvents. • Purge the injector (see Section 3.4.2) and equilibrate the system (see Section 3.6.1).
Detector flow cell leaking	Call Waters Technical Service (see Appendix D).
Refractometer and/or viscometer not stabilized	Allow sufficient time for the baseline to stabilize (see Section 3.6.1).
Refractometer flow cell contaminated	Purge the refractometer (see Section 3.4.3).
Detector electronics problem	Call Waters Technical Service (see Appendix D).

Table 5-1 Noncyclic Baseline Noise (Continued)

Possible Cause	Corrective Action
Column(s) contaminated	Replace all columns with a union or a known good column of the same type (see Section , Procedure and Section 2.3.3, Installing Columns). Equilibrate (see Section 3.6.1) and monitor the baseline. If the problem stops, discard the old column and install a new one. If the problem continues, consider the following: • Solvent properties such as miscibility (see Appendix C, Solvent Considerations). • Contaminated solvent (see the Solvent Contaminated Possible Cause listed above). • Contaminated solvent inline filter or solvent reservoir filter (see Section 4.5.7 or Section 4.5.8). • Improperly connected reserve bottle (see Section 2.3.1).
Cable loose or improperly connected to the external data-handling system	• Ensure the correct output signal is properly connected to the data-handling device (see Section 2.4.5). • Ensure that output signal switch settings are in the proper positions (see Section 3.2.6).
Cycling equipment or radio frequency (RF) interference	• Isolate the system from other nearby equipment, especially devices with large electric motors. • Ensure proper circuit grounding and determine line voltage quality. • If necessary, relocate the system to an area where RF is not a problem.

5.3.2 Short-Term Cyclic Baseline Noise

Use Table 5-2 to troubleshoot short-term (seconds to minutes) cyclic baseline noise.

Table 5-2 Short-Term Cyclic Baseline Noise

Possible Cause	Corrective Action
Erratic solvent manager pressure or pulsations	Determine and correct the source of erratic pressure. If erratic pressure continues, see Section 4.4.3, to check solvent manager components.

Table 5-2 Short-Term Cyclic Baseline Noise (Continued)

Possible Cause	Corrective Action
Solvent manager tubing loose, bent, or blocked	Inspect the tubing. If loose, tighten it. If bent, straighten it. If blocked, replace (see Section 4.5.15).
Solvent miscibility problems during solvent changeover	Verify the miscibility of solvents and/or change to more miscible solvents (see Appendix C, Solvent Considerations).
Large air bubble in the refractometer flow cell	• Purge the refractometer (see Section 3.4.3). • Ensure the solvent is properly degassed (see Section 3.2.1).
Dirty or malfunctioning inlet check valve	Replace the inlet check valve (see Section 4.5.14).
Worn piston seal(s)	Replace the piston seals (see Section 4.5.10).
Cycling equipment or radio frequency (RF) interference	• Isolate the system from other nearby equipment, especially devices with large electric motors. • Ensure prompt circuit grounding and determine line voltage quality. • If necessary, relocate the system to an area where RF is not a problem.

5.3.3 Long-Term Cyclic Baseline Noise

Use Table 5-3 to troubleshoot long-term (minutes to hours) cyclic baseline noise.

Table 5-3 Long-Term Cyclic Baseline Noise

Possible Cause	Corrective Action
Ambient temperature fluctuations	• Stabilize the operating environment temperature to allow full equilibration (see Section 3.6.1). • Ensure the analysis compartment set point is at least 5 °C above ambient temperature. • Relocate the system to a thermally stable, draft-free environment. • Avoid placing the system in direct sunlight or near heating/cooling vents.
Solvent being recycled from waste outlet back through the system	Use only fresh, filtered, HPLC-grade solvents for your application. Unless necessary, do not recycle solvent through the system.
Cycling equipment or radio frequency (RF) interference	• Isolate the system from other nearby equipment, especially devices with large electric motors. • Ensure prompt circuit grounding and determine line voltage quality. • If necessary, relocate the system to an area where RF is not a problem.

5.3.4 Baseline Drift

Use Table 5-4 to troubleshoot baseline drift.

Table 5-4 Baseline Drift

Possible Cause	Corrective Action
System not stabilized or equilibrated	Allow sufficient time for the baseline to stabilize (see Section 3.6.1). Note the operating conditions of your application, such as solvent type.

Table 5-4 Baseline Drift (Continued)

Possible Cause	Corrective Action
Ambient temperature fluctuations	• Stabilize the operating environment temperature to allow full equilibration (see Section 3.6.1). • Ensure the analysis compartment set point is at least 5 °C above ambient. • Relocate the system to a thermally stable, draft-free environment. • Avoid placing the system in direct sunlight or near heating/cooling vents.
Solvent contaminated or degraded	• Discard the contaminated solvent. • Clean the solvent reservoirs. • Replace the solvent inline filter element (see Section 4.5.7). • Prepare and filter fresh solvent using only high-quality reagents and HPLC-grade solvents. • Purge the injector (see Section 3.4.2) and equilibrate the system (see Section 3.6.1).
Solvent improperly degassed	• Degas the solvents (see Section 3.2.1). • Equilibrate the system (see Section 3.6.1).
Detector flow cell leaking	Call Waters Technical Service (see Appendix D).
Column(s) contaminated	Replace all columns with a union or with a known good column of the same type (see Section 2.3.3). Equilibrate (see Section 3.6.1) and monitor the baseline. If the problem stops, discard the old column and install a new column. If the problem continues, consider these possible causes: • Solvent properties such as miscibility (see Appendix C, Solvent Considerations). • Contaminated solvent (see the Solvent Contaminated Possible Cause listed above). • Contaminated solvent inline filter or solvent reservoir filter (see Section 4.5.7 or Section 4.5.8). • Improperly connected reserve bottle (see Section 2.3.1)

Table 5-4 Baseline Drift (Continued)

Possible Cause	Corrective Action
Solvent being recycled from waste outlet back through the system	Use only fresh, filtered, HPLC-grade solvents for your application. Unless necessary, do not recycle solvent through the system.
Leak(s) in system	• Inspect all fittings for leaks. Tighten (do *not* overtighten) leaky fittings. • If the leak continues, replace the fitting and ferrule.
Solvent contains a stabilizer that is degraded or changed	Use a different stabilizer. Separations may require adjustment if changing the stabilizer.
Refractometer and/or viscometer not stabilized	Allow sufficient time for the baseline to stabilize (see Section 3.6.1).
Change in ambient temperature	• Stabilize operating environment temperature. • Ensure the analysis compartment set point is at least 5 °C above ambient temperature. • Relocate the system to a thermally stable, draft-free environment. • Avoid placing the system in direct sunlight or near heating/cooling vents.
Contaminated refractometer flow cell	Purge the refractometer (see Section 3.4.3).

5.3.5 Noise Spikes

Use Table 5-5 to troubleshoot noise spikes.

Table 5-5 Noise Spikes

Possible Cause	Corrective Action
Small air bubbles traveling through the flow path	Ensure the solvent is properly degassed (see Section 3.3.3).
Pump head cavitation	Decrease the flow rate (see Section 3.3.3).

Table 5-5 Noise Spikes (Continued)

Possible Cause	Corrective Action
Particles in refracto-meter or viscometer	Purge the refractometer (see Section 3.4.3) and the viscometer (see Section 3.4.4).
Improper grounding of system electrical connections	• Use a shielded signal cable and attach the shield to one device *only*. • Plug the system into another outlet on a different electrical circuit. If a separate outlet is unavailable, use a power line conditioner.
Cycling equipment or radio frequency (RF) interference	• Isolate the system from other nearby equipment, especially devices with large electric motors. • Ensure proper circuit grounding and determining line voltage quality. • If necessary, relocate the system to an area where RF is not a problem.
Detector electronics problem	Call Waters Technical Service (see Appendix D).

5.4 Optimizing Chromatographic Peaks

This section explains how to optimize chromatographic peaks and correct problems such as these:

- No peaks – see Table 5-6
- Smaller-than-expected peaks – see Table 5-7
- Broad peaks – see Table 5-8
- Other types of abnormal peaks, including double, shoulder, fronting, tailing, flat-topped, and negative peaks – see Table 5-9

See the “Acquisition Troubleshooting” in the *Alliance GPC 2000 Series System Help*.

5.4.1 No Peaks

Consult Table 5-6 when troubleshooting chromatograms when peaks are expected but absent.

Table 5-6 Troubleshooting – No Peaks

Possible Cause	Corrective Action
Injector problem • Wrong vial • No vial • Insufficient sample volume • Incorrect injection • Blocked needle • Leaking syringe seal	• Ensure samples are prepared and installed in the carousel correctly (see Section 3.5). • Check the vial number for the injection in the sample set method or the carousel view. • Replace the needle if it is blocked or damaged (see Section 4.5.2). • Inspect the syringe to ensure is no air is in it and no solvent leaks past the seal.
No flow or low flow • Pump power not on or not delivering solvent • Reservoir low or out of solvent • Blocked inlet lines • Blocked solvent reservoir inlet filter	• Observe whether solvent is flowing from the detector waste outlet. Ensure pump is on and is delivering solvent. • Refill the reservoir with filtered solvent. • Inspect tubing for blockages and replace if necessary. • Replace the solvent inlet filter.
Incorrect detector settings	Verify the detector settings (see Section 3.3.6).
Detector output not zeroed	Zero the detector baselines by selecting RI Autozero and/or Visc. Autozero from the Operations menu. See the “Autozeroing the Refractometer” and “Autozeroing the Viscometer” in the *Alliance GPC 2000 Series System Help*.
Other detector problem (flow cell, power supply, electronics)	Call Waters Technical Service (see Appendix D).

Table 5-6 Troubleshooting – No Peaks (Continued)

Possible Cause	Corrective Action
Cable improperly connected to external data-handling system	Ensure that the correct output signal is connected to the data-handling device and that related output signal switch settings are in the proper positions (see Section 2.4.5, and Section 3.2.6).
Incorrect solvent	• Prepare new solvent (see Section 3.4.6). • If the system backpressure is also high, check for sample precipitation.
Degraded sample	• Verify sample integrity and review the sample preparation process. • Replace with a fresh sample. • Reduce the total incubation time in the sample carousel at elevated temperature, if possible.

5.4.2 Smaller-Than-Expected Peaks

Consult Table 5-7 when troubleshooting peaks that are smaller than expected (indicating a loss of sensitivity).

Table 5-7 Troubleshooting Smaller Than Expected Peaks

Possible Cause	Corrective Action
Wrong injection volume	Select an appropriate injection volume. See the “Making a Single Injection in Interactive Mode” in the *Alliance GPC 2000 Series System Help*.
Incorrect size of sample loop	Verify the size of the sample loop in use (see Section 3.2.3). If necessary, replace with a sample loop of another size (see Section 4.5.4).
Incorrect detector settings	Verify the detector settings in the Instrument Method Editor (see Section 3.3.6).
Detector output not zeroed	Zero the detector baselines by selecting Operations > RI Autozero and/or Visc. Autozero. See the “Autozeroing the Refractometer” and “Autozeroing the Viscometer” in the *Alliance GPC 2000 Series System Help*.

Table 5-7 Troubleshooting Smaller Than Expected Peaks (Continued)

Possible Cause	Corrective Action
Incorrect output signal to external data-handling system	Ensure the correct output signal is connected to the data-handling device and that related output signal switch settings are in the proper positions. See Section 2.4.5, and Section 3.2.6.
Contaminated refracto-meter flow cell	Purge the refractometer (see Section 3.4.3).
Injector problem: • Wrong vial • No vial • Insufficient sample volume • Incorrect injection • Blocked needle • Leaking syringe seal	• Ensure samples are prepared and installed in the carousel correctly (see Section 3.5). • Determine the correct vial number for the injection in the sample set method or the carousel view. • Replace the needle if it is blocked or damaged (see Section 4.5.2). • Inspect the syringe to ensure no air is in the syringe or no solvent leaks past the seal.
Sample too viscous	Dilute the sample or decrease the syringe draw rate (see Section 3.3.3).

5.4.3 Broad Peaks

Use Table 5-8 to troubleshoot broad peaks.

Table 5-8 Troubleshooting Broad Peaks

Symptom	Possible Cause	Corrective Action
Early-eluting peaks are broad	Inline filter, column inlet, or connecting tubing partially blocked	• If the inline filter has particle buildup, replace it (see Section 4.5.7). • If the column inlet has particle buildup, replace it. • Replace any blocked tubing (see Section 4.5.15).
	Injector problem: • Sticking or leaking injection valve • Blocked or damaged needle • Plugged injection port	• Ensure samples are prepared and installed in the carousel correctly (see Section 3.5). • Replace the needle if it is blocked or damaged (see Section 4.5.2). • Call Waters Technical Service to repair an injection port (see Appendix D).
	Incorrect size of sample loop in injector	Replace the sample loop with one of proper size (see Section 4.5.4).
Bandspreading	Flow path problems	Look for injector problems, tubing/fittings problems, leaking refractometer flow cell, or column deterioration.
	Large particle size (20-µm columns) for high-molecular-weight polymers	Use axial dispersion correction in Empower GPC/GPCV software.

Table 5-8 Troubleshooting Broad Peaks (Continued)

Symptom	Possible Cause	Corrective Action
All peaks are broad	Incorrect column size or type	Verify the source or type of the column (see Section 2.3.3). Use a column identical to that used during methods development.
	Ambient temperature change	• Stabilize the operating environment temperature. • Ensure the analysis compartments set point is at least 5 °C above ambient. • Move system to a thermally stable, draft-free environment. • Avoid placing the system in direct sunlight or near heating/cooling vents.
	System not stabilized or equilibrated	Allow sufficient time for the baseline to stabilize (see Section 3.6.1). Note the operating conditions of your application (such as solvent and temperature set points).
	Column contaminated or damaged	Determine the plate count. If the plate count is low, replace the column (see Section 2.3.3).

5.4.4 Other Abnormal Peaks

Consult Table 5-9 when troubleshooting other types of abnormal peaks, including double, shoulder, fronting, tailing, flat-topped, and negative peaks.

Table 5-9 Troubleshooting Other Abnormal Peaks

Symptom	Possible Cause	Corrective Action
Double peaks/shoulder peaks	Column inlet partially blocked	Inspect for particle buildup: • If the inline filter has particle buildup, replace it (see Section 4.5.7). • If the column inlet has particle buildup, replace it (see Section 4.5.7). • Replace any blocked tubing (see Section 4.5.15).
	Column contaminated or degraded (due to voiding)	Determine the column plate count. If it is low, replace the column (see Section 2.3.3).

Table 5-9 Troubleshooting Other Abnormal Peaks (Continued)

Symptom	Possible Cause	Corrective Action
Fronting peaks	Column contaminated or degraded (due to voiding)	Determine the column plate count. If it is low, replace the column (see Section 2.3.3, Installing Columns).
Tailing peaks	Column contaminated or degraded (due to voiding)	Determine the column plate count. If it is low, replace the column (see Section 2.3.3, Installing Columns).
	Injector problem • Wrong vial • No vial • Insufficient sample volume • Incorrect injection • Blocked needle • Leaking syringe seal	• Ensure samples are prepared and installed in the carousel correctly (see Section 3.5). • Determine the correct vial number for the injection in the sample set method or the carousel view. • Replace the needle if it is blocked or damaged (see Section 4.5.2). • Inspect the syringe to ensure that no air is in it and or solvent leaks past the seal.
Flat-topped peaks	Incorrect detector settings	Adjust the detector settings, then autozero the detector baselines by selecting Operations > RI Autozero and/or Visc. Autozero. See "Autozeroing the Refractometer" and "Autozeroing the Viscometer" in the *Alliance GPC 2000 Series System Help*.
	Injection volume or sample concentration too high	Decrease the injection volume or use a diluted sample. To select an appropriate injection volume, see the "Making a Single Injection in Interactive Mode" in the *Alliance GPC 2000 Series System Help*.
Negative peaks (all peaks)	Signal cables to external data-handling device reversed	Connect the cables correctly (see Section 2.4.5, and Section 3.2.6).

Table 5-9 Troubleshooting Other Abnormal Peaks (Continued)

Symptom	Possible Cause	Corrective Action
Negative peaks (one or more peaks)	Sample has a component with an RI lower than that of the solvent (refractometer only)	Determine whether the negative peak is due to sample or solvent impurities, and then • Right-click, and select Invert Channel to invert the peak. • If the peak interferes with your analysis, modify the method. • If the peak is due to solvent impurities, use fresh, filtered solvent (see Appendix C, Solvent Considerations).
	Injection of air instead of sample (due to wrong vial, no vial, insufficient sample volume, incorrect injection, blocked needle, leaking syringe seal)	• Ensure samples are prepared and installed in the carousel correctly (see Section 3.5). • Replace the needle if it is blocked or damaged (see Section 4.5.2). • Inspect the syringe to ensure no air is in the syringe and no solvent leaks past the seal.

5.5 Correcting Solvent Manager Problems

Use Table 5-10 when you suspect that the problem is caused by a component of the solvent management system.

Table 5-10 Solvent Manager Troubleshooting

Symptom	Possible Cause	Corrective Action
Overpressure error or shutdown	Solvent viscosity too high for the specified flow rate	Lower the flow rate (see Section 3.3.3).
	Solvent not heated to correct temperature, so viscosity too high	Wait until the system is equilibrated and has reached the set point. Allow sufficient time for the baseline to stabilize (see Section 3.6.1).
	Blocked tubing, filter, or column frit	• If the inline filter or sample vial filter has particle buildup, replace it (see Section 4.5.7 or Section 4.5.6). • If the column inlet or frit has particle buildup, replace the column. • If any tubing is blocked, replace it (see Section 4.5.15).
	Blocked solvent inline filter	Replace the solvent inline filter (see Section 4.5.7).
	Blocked waste tubing	Clean or replace tubing (see Section 4.5.15).
	Restriction between solvent and sample management systems	Inspect tubing and remove restriction (see Section 4.5.15).
	Solvent select valve not in correct position	Ensure the correct solvent (A or B) is selected (see Section 3.3.3).

Table 5-10 Solvent Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Underpressure error or shutdown	Leaky injection valve or valve fittings	Investigate the analysis compartment for an elevated vapor level (by selecting Detector Vapor in Plots). If elevated, inspect the injection valve and the valve fittings for leaks.
	Leaky column fitting	Investigate the analysis compartment for an elevated vapor level (by selecting Detector Vapor in Plots). If elevated, inspect the column fittings for leaks (see Section 4.6, Replacing, Adding, or Removing Columns).
	Leaky preheat loop	Investigate the sample compartment for an elevated vapor level (by selecting Carousel Vapor in Plots). If elevated, inspect the drip trays to find the fluid leaks.
	Disconnected or damaged tubing	Investigate the tubing connections for leaks. Replace tubing (see Section 4.5.15, Replacing Tubing).
	Empty solvent reservoir	Refill the solvent reservoir.
	Purge valve open or leaking	Close the purge valve (see Section 3.4.1).
	Piston seal leaking	Replace the piston seals (see Section 4.5.10).
	Loose head nut, or piston ring not locked (in back or removal position).	Hand-tighten the head nut and ensure the piston ring is in the forward, locked position (see Section 4.5.13).
Cannot manually draw solvent from the purge valve into the priming syringe	Blocked reservoir filter	Replace the solvent reservoir filters (see Section 4.5.8).
	Blocked or restricted tubing	Replace any blocked tubing (see Section 4.5.15).
	Purge valve not open wide enough	Rotate the purge valve one turn counterclockwise to open it wider (see Section 3.4.1).

Table 5-10 Solvent Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Backpressure during equilibration exceeds 100 psi	Blocked solvent inline filter	Replace the solvent inline filter (see Section 4.5.7).
	Precipitated sample	• Use sample filter vial (see Section 3.5.1). • Filter the sample before adding it to a vial. • Warm sample up using mixing (see Section 3.7.2). • Ensure correct solvent is used.
Piston head leaks	Worn piston seals	Replace the piston seals (see Section 4.5.10).
	Worn seal-wash seals (if fitted, optional)	Replace the seal-wash seals (see Section 4.5.11).
	Loose head nut, or piston ring not locked (in back or removal position).	Hand-tighten the head nut and ensure the piston ring is in the forward, locked position (see Section 4.5.13).
	Loose inlet check valve	Tighten or replace the check valve (see Section 4.5.14).
	Defective or worn face seals	Replace the face seals (see Section 4.5.10).
	Seal-wash tubing not installed correctly	Connect seal-wash tubing correctly (see Section 2.3.4).
Solvent select valve not opening	Solvent reservoir is empty	Add filtered solvent to the reservoir, then use priming syringe to wet the tubing (see Section 3.4.1).
Syringe not drawing solvent from reservoir A or B and appears to be drawing air	Loose fittings	Inspect the fittings for leaks. Tighten fittings as needed.
	Solenoid valve failure error message; valve not heard	Call Waters Technical Service (see Appendix D).
	Worn syringe seal	Examine syringe for leaks around seal. If seal is leaking, replace syringe using Syringe Replacement wizard (see Section 4.5.3).

Table 5-10 Solvent Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Erratic flow or pressure pulsations	Gas dissolved in solvent	Degas the solvent (see Section 3.2.1).
	Air bubble in piston head	• Open the purge valve, attach a priming syringe, and pull solvent into the syringe to remove the bubble (see Section 3.4.1). • Increase degassing time before making a run.
	Dirty inlet check valves	Clean or replace inlet check valves (see Section 4.5.14).
	Purge valve open or leaking	Close the purge valve (see Section 3.4.1).
	Blocked solvent reservoir filter	Clean or replace the solvent reservoir filter (see Section 4.5.8).
	Piston seal leaking	Replace the piston seals (see Section 4.5.10).
	Loose head nut, or piston ring not locked (in back or removal position).	Hand-tighten the head nut and ensure the piston ring is in the forward, locked position (see Section 4.5.13).

5.6 Correcting Sample Manager Problems

Use Table 5-11 when you suspect that the problem is caused by a component of the sample management system.

Table 5-11 Sample Manager Troubleshooting

Symptom	Possible Cause	Corrective Action
Vials do not fit in holders or holders do not fit in carousel	Wrong vials	Use only Alliance GPC 2000 vials (see Appendix B, Spare Parts and Accessories).
	Obstructions or bent holders or damaged carousel	Clear obstructions; replace damaged holders or carousel.

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Vial holder does not fit into carousel	The holder is damaged	Use a different vial holder.
	The lower bearing is damaged	Inspect the bearing. If damaged, call Waters Technical Service (see Appendix D).
The carousel does not fit or lie flat on the tray, preventing the door from closing	The carousel is not positioned correctly due to debris on the tray	Remove the carousel, and then remove any obstructions or debris on the carousel and the tray. Install the carousel, matching the locating pins in the tray to the holes in the carousel.
	Holes on the bottom of the carousel are blocked	Remove debris from holes or replace the carousel.
	A locating pin on the tray is damaged	Inspect the locating pins. If damaged, call Waters Technical Service (see Appendix D).
Sample compartment door fails to shut completely; the carousel does not try to rotate.	Obstruction or contamination of the tray or carousel	Look for obstructions and debris in the sample compartment and on the door. Clear obstructions and clean the carousel and the tray.
	The door close switch or lever is out of adjustment or failed; defective carousel sensor	Call Waters Technical Service (see Appendix D).

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Carousel fails to register (but rotates up to three times); Missed Sawtooth Error or No Rumble Strips Present error message displayed	Obstruction or contamination of the tray or carousel	Check for obstructions and debris in the sample compartment. Clear obstructions and clean the carousel and the tray.
	Rumble strips on carousel dirty or blocked	Ensure that the rumble strips on the lower plate of the carousel (see Figure 3-29) are clean and allow light to pass through them.
	Carousel tray out of alignment or fiber optics dirty, failed, or degraded	Call Waters Technical Service (see Appendix D).
Needle fails to travel down into wash station or to return up; no audible movement and/or Did Not Reach Switch error message displayed	An obstruction blocking movement of the needle arm	Open the sample compartment door, and examine the lower part of the needle travel range. Carefully remove any obstructions or debris. If you suspect debris above this area, call Waters Technical Service.
	Failed switch, faulty motor, or faulty motor driver	Call Waters Technical Service (see Appendix D).

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Needle arm fails to swing between wash station and inject station; no audible movement and/or Did Not Reach Switch error message displayed	An obstruction blocking movement of the needle arm	Open the sample compartment door, and examine the lower part of the needle travel range. Carefully remove any obstructions or debris. If you suspect debris above the lower part of the travel range, or around the motor, call Waters Technical Service (see Appendix D).
	Failed switch, faulty motor, or faulty motor driver	Call Waters Technical Service (see Appendix D).
Needle fails to reach bottom switch in wash position	An obstruction blocking movement of the needle arm	Open the sample compartment door and examine the lower part of the needle travel range. Then carefully remove any obstructions or debris. If you suspect debris above this area, call Waters Technical Service (see Appendix D).
	Failed switch, faulty motor, or faulty motor driver	Call Waters Technical Service (see Appendix D).
Needle fails to reach bottom switch in wash position	Bent needle preventing entry into wash station	Use the Needle Maintenance wizard to examine the needle and change the needle if bent (see Section 4.5.2).

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Needle fails to reach bottom switch in inject position	An obstruction blocks movement of the needle arm	Open the sample compartment door and examine the lower part of the needle travel range, and then carefully remove any obstructions or debris. If you suspect debris above this area, call Waters Technical Service (see Appendix D).
	Failed switch, faulty motor, or faulty motor driver	Call Waters Technical Service (see Appendix D).
	Blocked filter in sample filter vial (if filtering)	Inspect filter in sample filter vial and change it if blocked (see Section 4.5.6). Examine the sample for excessive particulate; remove particulates matter (for example, by external filtration or low-speed centrifugation) before adding sample to sample filter vial.
	Sample vial too high in vial holder	Inspect the bottom of the vial holder for debris, and then insert the vial and press it completely into the holder.
No fluid flowing down the needle wash waste tubing, even after a needle wash or injector purge	During normal startup process, air in the flow path is displaced by solvent, so no fluid initially flows at first	Wait for startup to finish.

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
No fluid flowing down the needle wash waste tubing and high vapor levels (vapor sensor LEDs are red)	If vapor levels remain high after needle wash has finished, the wash station or waste tubing may be blocked	Call Waters Technical Service (see Appendix D).
No fluid flowing down the needle wash waste tubing and high syringe pressure readings	Blockage between the needle and the syringe.	Call Waters Technical Service (see Appendix D).
Needle misses vial: injection requested but the vial septum has no puncture hole, or hole is in the cap instead of septum	Bent needle. The needle also fails to reach the lower switch when lowered into the wash station.	Use the Needle Maintenance wizard to replace the needle (see Section 4.5.2).
	Carousel needs homing	Select Operations > Smart Reinit.
	Carousel tray out of alignment	Call Waters Technical Service (see Appendix D).
Bent needle	Needle hitting bottom of vial	Use correct vials and holders and ensure that they are installed properly.
Sample (carousel) compartment does not heat on request (Temperature LED stays yellow and does not turn green)	Sample (carousel) door not closed	Close the sample door completely.
	Overtemp condition because the new set point you selected is lower than the current temperature	Wait for the compartment to cool. Control is regained when temperature drops to the specified range.
System appears normal and heaters are running at full power, but sample (carousel) compartment does not reach temperature set point	Failed overtemp switch (high-temperature thermal fuse failure)	Perform the OverTemp test (see Section 5.2.2).

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Injector tower (in sample compartment) does not heat on request (Temperature LED stays yellow and does not turn green)	Overtemp condition because the new set point you selected is lower than the current temperature	Wait for the compartment to cool. Control is regained when temperature drops to the specified range.
System appears normal and heaters are running at full power, but injector tower (in sample compartment) does not reach temperature set point	Failed overtemp switch (high-temperature thermal fuse failure)	Perform the OverTemp test (see Section 5.2.2).
Vial mixer is not working (no audible response)	Failed mixer motor	Call Waters Technical Service (see Appendix D).
Vial mixer has a high-pitched audible whine	Stalled mixer motor	Determine whether the vial holder rotates freely in the carousel. Look for damage or obstructions around the mixer magnet (in the sample compartment), which can prevent rotation.
Excess or unusual noise when aspirating a sample	Needle arm is dirty or requires adjustment	Call Waters Technical Service (see Appendix D).
Injection valve does not switch between inject and load positions; Did Not Reach Switch error message displayed; injection chromatogram incorrect	Failed switch: You hear valve move (actuate) and Did Not Reach Switch error message displayed	Call Waters Technical Service (see Appendix D).
	Failed motor: Valve cannot be heard to actuate and no Did Not Reach Switch error message displayed	Call Waters Technical Service (see Appendix D).
	Frozen rotor cartridge; motor stalls	Call Waters Technical Service (see Appendix D).

Table 5-11 Sample Manager Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Syringe does not draw sample	Loose fitting between needle and syringe	Look for leaks and/or low vacuum reading on the syringe pressure channel.
	Blockage between needle and syringe	Look for high vacuum reading on the syringe pressure channel, which can indicate a blockage. Call Waters Technical Service (see Appendix D).
	Blocked needle vent	Inspect vents for blockage and replace needle if blocked.
	Worn syringe seal	Examine syringe for leaks around seal. Replace syringe if needed (see Section 4.5.3).
	Solenoid valve failure error message; valve not heard	Call Waters Technical Service (see Appendix D).
Unable to filter a sample filter vial, but needle punctures vial	Too much particulate matter in bottom of sample filter vial prevents the filter ram from pressing completely down, so insufficient sample is filtered, and needle cannot reach sample to aspirate	Inspect filter in sample filter vial and change filter if blocked (see Section 4.5.6). Examine the sample for excessive particulates; remove particulate matter (for example, by external filtration or low-speed centrifugation) before adding sample to sample filter vial.
Leaks in the carousel drip tray and waste tubing	Blocked needle wash and/or waste tubing	Determine the cause of the leaks. Replace the tubing (see Section 4.5.15).

5.7 Correcting Detector Problems

5.7.1 Refractometer Problems

The most common source of a refractometer problem is a change in solution temperature or density caused by factors other than sample concentration, particularly these:

- **Environmental factors** – Even small changes in temperature or density can cause baseline drift. Ensure that the system has reached equilibration before running samples (see Section 3.4).
- **Nonhomogeneous solution** – The refractometer measures the difference in refraction between a pure reference solvent and a homogeneous sample solution within a chromatographic band. If the sample solution is not homogeneous, the light passing through the sample may be absorbed, scattered, or refracted unpredictably. This can result in shifts in retention time and broad, tailing peaks. Most common problems of this nature are due to improper solvent preparation (see Appendix C, Solvent Considerations).

5.7.2 Viscometer Problems

Consult Table 5-12 when you suspect that the viscometer has a problem.

Table 5-12 Viscometer Hardware Troubleshooting

Symptom	Possible Cause	Corrective Action
Relative viscosity is noisy; P1 and P2 show excursions in the same direction	Solvent manager problem	See Section 5.5.
	Leak outside the viscometer	• Look for increased vapor levels by right-clicking in the top or bottom plot (in the Plot menu), and then selecting Detector Vapor or Carousel Vapor. • To enable the vapor sensors, see Section 3.3.4. • Inspect the analysis compartment for leaks, especially the area near the viscometer.

Table 5-12 Viscometer Hardware Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Relative viscosity is noisy; P1 and P2 show excursions in the opposite direction	Air trapped in viscometer lines	Purge the viscometer at least 30 minutes (see Section 3.4.4).
	Viscometer leak	• Look for elevated vapor sensor readings in analysis compartment. • Visually inspect the analysis compartment for leaks, especially near the viscometer.
P1 goes to full scale even with very low flow	First capillary is blocked	Call Waters Technical Service (see Appendix D).
Both P1 and P2 go to twice the normal pressure	Second capillary is blocked	Call Waters Technical Service (see Appendix D).
P1 goes to zero; P2 goes to twice the normal pressure	Third capillary is blocked	Call Waters Technical Service (see Appendix D).

5.8 Correcting Miscellaneous Problems

This section describes symptoms, causes, and corrective actions related to the onboard CPU, the user interface, and other system problems. For details about user interface problems and solutions, see the following topics in the Diagnostics and Troubleshooting book in the *Alliance GPC 2000 Series System Help*:

- User Diagnostics and Service Maintenance Dialog Box
- Status Code Summary
- General System Troubleshooting
- Login Troubleshooting
- Instrument Performance Troubleshooting
- Instrument Operation Troubleshooting

- Acquisition Troubleshooting
- File Storage Troubleshooting
- Viewer Troubleshooting
- Error Message Troubleshooting

Use Table 5-13 when you suspect that the problem is within the onboard CPU or the user interface.

Attention: *Waters recommends that you install only Waters-supplied software on the Alliance GPC 2000 Series system's onboard CPU. Installation of other software may cause improper operation and/or poor performance of your GPC 2000 system.*

Table 5-13 Miscellaneous Troubleshooting

Symptom	Possible Cause	Corrective Action
System does not power on	Power cord not connected properly	Examine the power cord connections.
	No power at outlet	Test the line voltage.
	Power supply fuse blown	Call Waters Technical Service (see Appendix D).
Monitor screen is blank (power off)	Monitor not powered on	Power on the monitor.
	Monitor cable not connected properly	Examine the monitor's power cord and the connections to the onboard CPU.
	Monitor is in a screen saver mode that displays a blank screen	Move the mouse, or press an arrow key. You can change the screen saver (see Windows 2000 documentation).

Table 5-13 Miscellaneous Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Monitor screen is blue (power on) but no messages or applications appear	Windows 2000 problem	• Power-off the inner power button behind the sample compartment door; wait 10 seconds, and then power on. • Examine the cable connections. • If the problem is not solved, see the Windows 2000 documentation. • If the problem is not solved, reload the Empower software with GPC and/or GPCV software. • If the problem is not solved, reload the Alliance GPC 2000 or GPCV 2000 software.
No response from keyboard or mouse	Keyboard cable or mouse cable not connected properly	Check the keyboard cable and the mouse cable connections to the onboard CPU.
Overtempera-ture error	Temperature too high; compart-ment heater shut down	Perform the OverTemp test (see Section 5.2.2).
Fans not working	Power not on	Power-on the system.
	Problem with fan	Call Waters Technical Service (see Appendix D).
Multiple, cascading error messages	The major subsystems need to be reinitialized.	Select Operations > Smart Reinit.
Slow CPU performance	Hard drive is almost full	• Archive (back up and delete) data files and logs (see Section 4.7.1). • Ensure that only Waters-supplied software is installed on the onboard CPU.

Table 5-13 Miscellaneous Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Alliance or Windows 2000 user interface not responding	Cable not connected properly	Inspect the monitor, keyboard, and mouse cable connections to the onboard CPU.
	Alliance system problem	• Select Operations > Smart Reinit. • If the problem is not solved, power-off the inner power button behind the sample compartment door; wait 10 seconds, and then power on.
	Windows 2000 problem	• See the Windows 2000 documentation. • If the problem is not solved, reload the Empower software with GPC and/or GPCV software. • Reload the Alliance GPC 2000 or GPCV 2000 software.
Network or server not responding	Network problem	• Power-off the inner power button behind the sample compartment door; wait 10 seconds, and then power-on. • If the problem is not solved, examine the cable connections. • If the problem is not solved, call your network expert.
Error message displays: “invalid temperature slew rate” or “too many injections per vial”.	Corrupt file	Follow this procedure to delete the Config.NVO file: 1. Start > Programs > GPC2000 Chromatography > Shutdown GPC2000 Platform. 2. In Explorer, locate the Waters\GPC2000\Persist directory and delete the Config.NVO file. 3. Restart the application (Start > Programs > GPC2000 Chromatography > Start GPC2000 Platform).

Appendix A
System and Component Specifications

The following specifications apply to the Alliance GPC and GPCV 2000 system configurations as originally shipped.

- Physical (Table A-1)
- Environmental (Table A-2)
- Electrical (Table A-3)
- Solvent management system (Table A-4)
- Computer specifications (Table A-5)
- Sample management system (Table A-6)
- Minimum required sample volumes (Table A-7)
- Refractometer (Table A-8)
- Viscometer (Table A-9)
- I/O card (Table A-10)

A.1 Physical Specifications

Table A-1 Physical Specifications

Item	Specification
Height Depth Width Weight	24 in. (61 cm) 22 in. (56 cm) 37 in. (94 cm) 365 lb. (166 kg)
Wetted surface materials	316 stainless steel, ultra-high molecular weight polyethylene (UHMWPE), sapphire, ruby, Tefzel® (ETFE), Teflon® (FEP and PTFE), polyetheretherketone (PEEK), Fluoroloy G, glass, Vespel®, 400 stainless steel, Kalrez®, quartz
Temperature ranges	Solvent management compartment: ambient plus 5 to 50 °C Sample management (carousel) compartment: ambient plus 5 to 180 °C Analysis (column/detector) compartment: ambient plus 5 to 180 °C

A.2 Environmental Specifications

Table A-2 Environmental Specifications

Item	Specification
Operating temperature (ambient)	10 to 32 °C (50 to 90 °F)
Room temperature variation	Less than 1.5 °C/hr. (long term) or 0.25 °C/min (short term) for best results
Relative humidity	20 to 80%, noncondensing
Acoustic noise	<65 dB (A)

Table A-2 Environmental Specifications (Continued)

Item	Specification
Solvent compatibility	Compatible with most common GPC solvents, such as THF and TCB (see Appendix C). Solvents consistent with materials of construction. Salts and buffers can reduce seal life, especially at high pressures. When buffers are used, the optional Seal Wash Kit is suggested.
Shipping and storage temperature	–40 to 65 °C
Shipping and storage humidity	20 to 80%, noncondensing

A.3 Electrical Specifications

Table A-3 Electrical Specifications

Item	Specification
Power requirements	100 to 240 VAC; 50/60 Hz; single phase; 20 A maximum; power transients and fluctuations should be minimized; grounded alternating current (AC) power source. A single, dedicated electrical service outlet is recommended. Note that a line conditioner or uninterruptible power supply (UPS) would enhance long-term input voltage stability. Main power cable equipped with a NEMA type 6-15 plug that is included.
Grounding	The GPCV 2000 instrument, as well as any peripheral devices or instruments connected to it, must be connected to a properly grounded power outlet. The ground connection in all these outlets must be the same, and connect to a common point near the service panel and the system. Finally, consider using a line conditioner or an uninterruptible power supply (UPS) for optimum long-term input voltage stability.

A.4 Solvent Management System Specifications

Table A-4 Solvent Management System Specifications

Item	Specification
Number of solvents	Maximum of two in isocratic mode; programmable from three positions: solvent A, solvent B (and safety shut-off)
Solvent degassing	Vacuum degas, dual channel, two chambers, <10 mL internal volume per chamber[a]
Programmable flow rate range	0.000 and 0.010 to 10.000 mL/min in 0.001-mL/min increments
Compressibility compensation	Automatic and continuous
Flow ramping	0.01 to 5.00 mL/min per minute
Maximum operating pressure	5000 psi (345 bar); programmable upper and lower limits
Flow precision	≤0.075% RSD absolute, without flow markers or software correction, based on elution volume/retention time; 6 replicates[a]
Flow accuracy	±1% or 10 µL/min, whichever is greater[a]

a. Valid for 0.3 to 2 mL/min flow rate

A.5 Control Specifications

Table A-5 Control Specifications

Item	Specification
Onboard CPU (located on slide-out chasis, behind the solvent manager compartment door)	Pentium III processor, 600 MHz or greater
	512 RAM
	Data storage media (60-GB hard drive minimum, CD R/W, and 1.44 MB floppy drives)
	Serial card (PCI)
	External monitor, keyboard, mouse
	Parallel output port optionally connect Windows® 2000-compatible printer
	RJ45 network port (connects the system to a network)

A.6 Sample Management System Specifications

Table A-6 Sample Management System Specifications

Item	Specification
Number of sample vials	24 per carousel (standard) 40 per carousel (optional)
Sample vial sizes	4-mL, 7-mL (filtered), (10-mL is standard)
Number of sample injections	1 to 9 injections per sample vial, depending on loop, sample, and syringe sizes
Sample delivery precision	<1% RSD, based on peak area, six replicate injections
Sample carryover	<0.1% between vials.
Injection accuracy	Sample loops are factory calibrated to within ±1% of tagged value. Sample remaining in loop after sample run reinjected in sample vial.
Sample temperature control	Ambient plus 5 to 180 °C

Table A-6 Sample Management System Specifications (Continued)

Item	Specification
Injection volume range	200 µL, 300 µL, and 400 µL by replacing the sample loop supplied with the instrument 100 µL, 500 µL, and 1000 µL by replacing the sample loop supplied as an option
Filter vial filter porosity	0.5-µm or 2-µm

A.7 Minimum Required Sample Volumes

Table A-7 Minimum Required Sample Volumes for a Single Injection

Sample Loop (µL)	Volume in 4-mL Glass Vial (mL)	Volume in 7-mL Filter Vial (mL)	Volume in 10-mL Glass Vial (mL)
100	1.7	1.1	1.6
200	2.0	1.4	1.4
300	2.3	1.7	2.2
400	2.6	2.0	2.5
500	2.9	2.3	2.8

A.8 Refractometer Specifications

Table A-8 Refractometer Specifications

Item	Specification
Refractive index (RI) range	1.00 to 1.75 refractive index units (RIU) full scale
Measurement range	-5×10^{-3} to $+5 \times 10^{-3}$ RIU
Noise	$<5 \times 10^{-8}$ RIU with 1 mL/min solvent flow[a]
Drift	$<5 \times 10^{-7}$ RIU/hour with 1 mL/min solvent flow[a]
Light source	Light-emitting diode (LED) (880 nm)
Flow cell volume	10 µL
Cell pressure rating	100 psi; built-in pressure relief valve

a. Ambient plus 5 to 160 °C (equilibrated). Drift depends on room temperature drift. For best results, room temperature variation should not exceed 1.5 °C/hr (long term) or 0.25°C/10 min (short term).

A.9 Viscometer Specifications

Table A-9 Viscometer Specifications

Item	Specification
Noise	$<5 \times 10^{-5}$ relative viscosity units (RVU) with 1 mL/min solvent flow[a]
Drift	$<1 \times 10^{-4}$ relative viscosity units (RVU)/hour with 1 mL/min solvent flow[a]
Flow path from RI to viscometer	Serial; no splitting necessary
Viscometer electronics	Integrated into Alliance GPCV 2000 system using Digital Signal Processing (DSP)
Viscometer calibration	User programmable

a. Ambient plus 5 to 160 °C (equilibrated)

A.10 I/O Card Specifications

Table A-10 I/O Card Specifications

Signal	Number	Type	Connector	Specification
Event Inputs	2	Comparator	Terminal Strip	Voltage range: ±30V High voltage: >3.0V ±10% Low voltage: <1.9 V±10% Minimum pulse width: 10 milliseconds
Event Outputs	2	Relay, SPST N.0, Contact closure	Terminal Strip	Maximum voltage: 70 V DC Maximum current: 0.5A DC Contact resistance: 0.2 ohms
Analog Outputs	4	Voltage	Terminal Strip	Voltage range: –2 to 2 V Minimum voltage: –2 V Maximum voltage: 2 V

Appendix B
Spare Parts and Accessories

The part number for the GPC 2000 2000 Series is 176806001; the part number for the GPCV 2000 system is 176806002.

Recommended spare parts for the Alliance GPC 2000 Series system are presented in these tables along with their part numbers:

- Spare parts and accessories (Table B-1)
- Columns (Table B-3, Table B-4, and Table B-5)
- Startup Kit (Table B-6)
- Ventilation Kit (Table B-7)
- Maintenance Kit (Table B-8)

Parts not included in this appendix are not recommended for customer installation or replacement. A list of accessories, manufactured by other vendors, is provided for your convenience.

At the time of its publication, this manual contained the latest spare parts list. When part numbers change, or become available, the Waters web site will reflect those changes. Access the Waters web site, www.waters.com, and follow this path:

Support > Support Center > Connections Elite > Integrated Systems > GPC 2000 Series

Note: *To log on to the Elite Support Center, you must enter your E-mail address and password.*

B.1 Spare Parts and Accessories

Table B-1 Spare Parts and Accessories

Item	Part Number
Inlet check valve cartridge (2)	WAT270941
Solvent inline filter (2-µm)	WAT088084
Sample loops	
20-µL	WAT096224
100-µL	WAT223720
200-µL	700000794
300-µL	700000845
400-µL	700000846
500-µL	700001017
1000-µL	700001018
Syringes	
2.5-mL	WAT077342
5.0-mL	700000784
Carousel	
40 position carousel (for use only with 4 mL glass vials)	700002136
For 10-mL vials	
10-mL glass vials (100)	186001420
Integral 20-mm seal and crimp cap with septum for 10-mL vials and filter vials (100)	600000138
10-mL caps for samples	186001421
Large vial holders (6)	28900174
20-mm cap with septa, 100 pk	700000851
Vapor sensor, organic, solvent (1)	363000100

Table B-1 Spare Parts and Accessories (Continued)

Item	Part Number
For 7-mL filter vials	
Filter vial assembly (plunger, seal, and cup; 24 each)	600000186
Filter vial assembly (plunger, seal, and cup; 6 each)	600000228
Filters for sample filter vials:	
• 0.5-µm (100)	600000163
• 2.0-µm (100)	600000164
Filter vial plunger seals (24)	600000230
Filter vial plunger assembly (6)	600000229
Filter vial cups (24)	600000231
Filter removal tool for sample filter vial	700001027
20-mL crimping tool for 7-mL sample vials	700000847
Decapping pliers	700000852
Large vial holders (6)	600000227
For 4-mL vials	
4-mL glass vials (48)	WAT072710
4-mL vial septa (144)	WAT072714
4-mL vial septa (1440)	WAT073005
Screw caps for 4-mL vials (48)	600000162
4-mL vial holders (6) (for 24-position carousel)	600000232
Large vial holders (6) (for 24-position carousel)	600000227
GPC high molecular weight tubing kit	700002468
Flow-through viscometer kit	700002314
GPC 2000 Enhancement Kit	700002334
Clear Tubing Assembly for Waste Manifold	700002313

Table B-1 Spare Parts and Accessories (Continued)

Item	Part Number
Seal-Wash Option Installation Kit (includes the following)	WAT270872
Seal-wash plunger seal (2)	WAT270160
Seal-wash tube seal (4)	WAT270668
Seal-wash face seal (2)	WAT271051
Pump solenoid	WAT270594
Ferrule, 1/8-in., Tefzel (2)	WAT046-01
Compression screw, 1/8-in., PEEK (2)	WAT046-12
Diffuser assembly	WAT007272
Shrink marker, Pump Wash In	WAT270520
Tubing, 0.062 in. ID × 0.120 in. OD × 175 in. (444.5 cm)	WAT270714
Tubing, Teflon, awg 9 thin wall	WAT024036
Installation procedure	WAT271232
Mixing Reservoir	
Kontes Ultra-Ware® Reservoir (5 liter) with three hole PTFE cap (1)	Kontes number 953980-5002
Magnetic stir bar, 1 1/4 in.	Kontes 791190-0114
Kalrez O-ring, size 216 (1)	Kontes 758240-0216
Polyethylene pan (25 x 22 x 13.5 cm) (1)	Nalgene 7120-0010
Stainless steel solvent filter (2)	WAT025531
Reservoir	
Kontes Ultra-Ware Reservoir (5 liter) with graduations (1)	Kontes number 953922-5002
Kontes 3-port MP delivery cap (1)	Kontes number 953913-0000

B.2 Styragel Columns

Table B-3 lists the Styragel columns that are packed in toluene. For Styragel columns packed in THF or DMF, refer to the *Waters HPLC Columns and Supplies Catalog*. The Styragel column abbreviations are defined in Table B-2. For organic separations, you can use three types of Styragel columns:

- Styragel HMW (20-µm particle size) – Use with shear-sensitive, ultra-high molecular weight polymer samples at temperatures between ambient and 180 °C. High-porosity, 10-µm fits accompany these columns.
- Styragel HT (0-µm particle size) – Use with mid-molecular to high-molecular weight samples at temperatures between ambient and 180 °C.
- Styragel HR (5-µm particle size) – Use with low-molecular to mid-molecular weight samples. These columns afford high resolution at temperatures between ambient and 80 °C.

Table B-2 Styragel Column Abbreviations

Abbreviation	Definition
HR	High Resolution
RT	Room Temperature
HT	High Temperature
AQ	Aqueous
MB	Mixed Bed
L	Low Molecular Weight range
M	Medium Molecular Weight range
L/M	Low/Medium Molecular Weight range
H	High Molecular Weight range

Table B-3 Styragel Columns

Type	Effective Molecular Weight Range	Part Number (300 mm × 7.8 mm ID In Toluene)	Part Number (300 mm × 4.6 mm ID In Toluene)
HMW 2 (20-µm)	$100 – 1 \times 10^4$	WAT054490	Not available
HMW 6E (20-µm)	$5{,}000 – 2 \times 10^7$	WAT044203	WAT046815
HMW 7 (20-µm)	$5 \times 10^5 – 1 \times 10^8$	WAT044200	WAT046800
HT 2 (10-µm)	$100 – 1 \times 10^4$	WAT054476	Not available
HT 3 (10-µm)	$500 – 5 \times 10^4$	WAT044206	WAT045915
HT 4 (10-µm)	$5{,}000 – 6 \times 10^5$	WAT044209	WAT045930
HT 5 (10-µm)	$5 \times 10^4 – 4 \times 10^6$	WAT044212	WAT045945
HT 6 (10-µm)	$2 \times 10^5 – 1 \times 10^7$	WAT044215	WAT045960
HT 6E (10-µm)[a]	$5{,}000 – 1 \times 10^7$	WAT044218	WAT045975
HR 0.5 (5-µm)[b]	10 – 1,000	WAT044230	WAT045830
HR 1 (5-µm)	100 – 5,000	WAT044233	WAT045845
HR 2 (5-µm)	$500 – 2 \times 10^4$	WAT044236	WAT045860
HR 3 (5-µm)	$500 – 3 \times 10^4$	WAT044221	WAT045875
HR 4 (5-µm)	$5{,}000 – 6 \times 10^5$	WAT044224	WAT045890
HR 5 (5-µm)	$5 \times 10^4 – 4 \times 10^6$	WAT054464	Not available
HR 6 (5-µm)	$2 \times 10^5 – 1 \times 10^7$	WAT054470	Not available
HR 4E (5-µm)	$50 – 1 \times 10^5$	WAT044239	WAT045800
HR 5E (5-µm)	$2{,}000 – 4 \times 10^6$	WAT044227	WAT045815

a. Provided with the Startup Kit

b. Use LS-compatible or preconditioned column(s) for optimal results in LS or viscometry. This minimizes detector contamination by particulates that manifest themselves as signal noise.

B.3 Ultrahydrogel Columns

Table B-4 lists Ultrahydrogel columns, which are packed in water (7.8 mm ID × 300 mm length).

Table B-4 Ultrahydrogel Columns

Type	Effective Molecular Weight Range	Part Number
120	200 – 5,000	WAT011520
250	1,000 – 8×10^5	WAT011525
500	5,000 – 3×10^5	WAT011530
1000	1×10^4 – 1×10^6	WAT011535
2000	5×10^4 – 7×10^6	WAT011540
Linear	200 – 7×10^6	WAT011545
DP	200 – 5,000	WAT011550

B.4 HSPgel Columns

Table B-5 lists HSPgel (high-speed GPC analysis) columns, which are packed in either THF or water (6.0 mm ID × 150 mm length).

Table B-5 HSPgel Columns

Type	Solvent	Effective Molecular Weight Range[a]	Part Number
HSPgel HR 1.0	THF	100 – 1000	186001741
HSPgel HR 2.0	THF	500 – 10,000	186001742
HSPgel HR 2.5	THF	1,000 – 20,000	186001743
HSPgel HR 3.0	THF	2,000 – 60,000	186001744
HSPgel HR 4.0	THF	10,000 – 400,000	186001745
HSPgel HR MB-L	THF	500 – 700,000	186001746
HSPgel HR MB-M	THF	1,000 – 4,000,000	186001747
HSPgel HR MB-H	THF	5,000 – >10,000,000	186001748
HSPgel RT 1.0	THF	100 – 1,000	186001749

Table B-5 HSPgel Columns (Continued)

Type	Solvent	Effective Molecular Weight Range[a]	Part Number
HSPgel RT 2.0	THF	500 – 10,000	186001750
HSPgel RT 2.5	THF	1,000 – 20,000	186001751
HSPgel RT 3.0	THF	2,000 – 60,000	186001752
HSPgel RT 4.0	THF	10,000 – 400,000	186001753
HSPgel RT 5.0	THF	25,000 – 4,000,000	186001754
HSPgel RT 6.0	THF	50,000 – 10,000,000	186001755
HSPgel RT 7.0	THF	100,000 – >15,000,000	186001756
HSPgel RT MB-L	THF	100 – 10,000	186001757
HSPgel RT MB-L/M	THF	500 – 400,000	186001758
HSPgel RT MB-M	THF	1,000 – 4,000,000	186001759
HSPgel RT MB-H	THF	5,000 – >10,000,000	186001760
HSPgel AQ 2.5	H_2O	500 – 2,000	186001785
HSPgel AQ 3.0	H_2O	1,000 – 60,000	186001786
HSPgel AQ 4.0	H_2O	10,000 – 400,000	186001787
HSPgel AQ 5.0	H_2O	50,000 – 4,000,000[b]	186001788
HSPgel AQ 6.0	H_2O	100,000 – 10,000,000[b]	186001789
HSPgel AQ MB-H	H_2O	500 – 10, 000, 000[b]	186001790
HSPgel HT 1.0	THF	100 – 1,000	186001761
HSPgel HT 2.0	THF	500 – 10,000	186001762
HSPgel HT 2.5	THF	1,000 – 20,000	186001763
HSPgel HT 3.0	THF	2,000 – 60,000	186001764
HSPgel HT 4.0	THF	10,000 – 400,000	186001765
HSPgel HT 5.0	THF	25,000 – 4,000,000	186001766
HSPgel HT 6.0	THF	50,000 – 10,000,000	186001767
HSPgel HT 7.0	THF	100,000 –> 15,000,000	186001768
HSPgel HT MB-L	THF	100 – 1,000	186001769
HSPgel HT MB-L/M	THF	500 – 400,000	186001770
HSPgel HT MB-M	THF	1,000 – 4,000,000	186001771

Table B-5 HSPgel Columns (Continued)

Type	Solvent	Effective Molecular Weight Range[a]	Part Number
HSPgel HT MB-H	THF	5,000 –> 10,000,000	186001772
HSPgel HT 1.0	ODCB	100 – 1,000	186001773
HSPgel HT 2.0	ODCB	500 – 10,000	186001774
HSPgel HT 2.5	ODCB	1,000 – 20,000	186001775
HSPgel HT 3.0	ODCB	2,000 – 60,000	186001776
HSPgel HT40	ODCB	10,000 – 400,000	186001777
HSPgel HT 5.0	ODCB	25,000 – 4,000,000	186001778
HSPgel HT 6.0	ODCB	50,000 – 10,000,000	186001779
HSPgel HT 7.0	ODCB	100,000 –>15,000,000	186001780
HSPgel HT MB-L	ODCB	100 – 1,000	186001781
HSPgel HT MB-L/M	ODCB	500 – 400,000	186001782
HSPgel HT MB-M	ODCB	1,000– 4,000,000	186001783
HSPgel HT MB-H	ODCB	5,000 –> 10,000,000	186001784

a. MW ranges for HR and RT are based on polystyrene chain lengths and polyethylene oxide change lengths for AQ series.
b. Exclusion limits for AQ series are extrapolated from the highest MW PEO standard (~900, 000).

B.5 Startup Kit

The startup kit (part number 200000154) contains the parts needed to set up the system for operation. The startup kit list, supplied with the startup kit, provides a list of the parts included listed in Table B-6.

Table B-6 Startup Kit

Item	Part Number
Alliance GPC 2000 Series System startup kit	200000154

B.6 Ventilation Option Kit

The Ventilation Option Kit (part number 200000120) contains the parts to connect the Alliance GPC 2000 Series system to the ventilation system during bench top installation.

Table B-7 Ventilation Option Kit

Item	Part Number
Vent gate (sliding, adjustable)	700000973
Exhaust hose, 4-in. diameter × 10 ft. (3.0 m)	WAT075181
Hose clamp (2)	WAT075182

B.7 Maintenance Kit

The maintenance kit (part number 201000111) contains the tool and replacement parts for the annual preventive maintenance program for the Alliance GPC 2000 Series system.

Table B-8 Maintenance Kit

Item	Part Number
Seal insertion and removal tool	WAT039803
Piston seals	WAT270938
Solvent reservoir filters (2)	WAT025531
Face seals (4)	WAT270939
Solvent inline filter, 2-µm	WAT088084
Pre-detector inline filter, 10-µm	700000938
Injection valve cartridge	700000853
Piston (plunger) for solvent manager (2)	WAT271067
Sample needle	700000743
Syringe, 5-mL	700000784
Vapor sensor, organic, solvent (3)	363000100
Vapor sensor gasket	405000683
Vapor sensor mounting plate screws	WAT081265

Appendix C
Solvent Considerations

This appendix provides information about preparing and using solvents with the Alliance GPC 2000 Series system.

Caution: *To avoid chemical hazards, always observe safe laboratory practices when you operate the Alliance GPC 2000 Series system and when you handle solvents. Refer to the Material Safety Data Sheets for the solvents you use.*

Proper solvent preparation can prevent many chromatographic system problems. Most solvent-related problems can be prevented through degassing, filtration, use of high-quality solvents, proper plumbing, and avoiding immiscible solvent combinations.

C.1 Solvent Degassing

Solvent degassing prevents bubble formation (outgassing) and provides:

- Stable baselines and enhanced sensitivity
- Reproducible retention times for eluting peaks
- Reproducible injection volumes for quantitation
- Stable pump operation

The Alliance GPC 2000 Series system provides inline solvent degassing. Inline degassing removes gases from the solvent as the solvent passes through a gas-permeable membrane enclosed in a vacuum chamber. The vacuum in the chamber accelerates the rate at which the dissolved gas diffuses through the gas-permeable membrane. This method provides an automatic, continuous method of removing dissolved gases, and allows for efficient solvent changeover.

Gas Solubility

The amount of gas that can dissolve in a given volume of liquid depends on:

- The chemical affinity of the gas for the liquid
- The temperature of the liquid
- The pressure applied to the liquid

Changes in the composition, temperature, or pressure of the solvent can lead to outgassing.

Effects of Intermolecular Forces

Nonpolar gases (N_2, O_2, CO_2, He) are more soluble in nonpolar solvents than in polar solvents. Generally, a gas is most soluble in a solvent with intermolecular attractive forces similar to those in the gas (“like dissolves like”).

Effects of Temperature

If the heat of solution is exothermic, the solubility of the gas decreases when you heat the solvent. If the heat of solution is endothermic, the solubility of the gas increases when you heat the solvent. For example, the solubility of helium in water decreases with an increase in temperature, but the solubility of helium in benzene increases with an increase in temperature.

Effects of Partial Pressure

The mass of gas dissolved in a given volume of solvent is proportional to the partial pressure of the gas in contact with the vapor phase of the solvent. If you decrease the partial pressure of the gas, the amount of that gas in solution also decreases.

C.2 Solvent Filtration

A solvent must always be filtered with a 0.5-µm (or smaller) filter before use (with filters in the solvent reservoirs). The removal of particles ensures reliable operation of the check valves, piston seals, and other components in the system. The use of a Solvent Clarification Kit is recommended.

Always filter solvents after mixing them, especially in the case of buffers. Insoluble impurities are a source of particulates. After filtration, store solvents in a closed, particulate-free bottle.

After a solvent is filtered, it does not need to be filtered daily, provided that bacterial growth or a reaction that produces an insoluble product does not occur. If a filtered solvent is unused for more than one week, it is good practice to filter it again before use. For recommendations on specific solvents, see Table C-2.

C.3 Solvent Quality

Clean solvents are necessary to obtain reproducible results and to operate your HPLC system with minimal instrument maintenance. Dirty solvents can cause baseline noise and drift, and can block solvent reservoir and inlet filters with particulate matter. Always use HPLC-grade solvents to ensure the best possible chromatographic results. Filter solvents through 0.5-µm filters before use.

C.4 Flow Path Plumbing

Cavitation (formation of vapor bubbles in the solvent) occurs when solvent flow through the inlet pathway is restricted enough to cause a localized drop in solvent flow path pressure. The key to preventing cavitation is to avoid inlet restrictions. The most common causes of inlet restrictions are crimped inlet lines and plugged inlet filters. Inlet lines with tubing longer than 48 in. (120 cm) or with tubing of less than 0.085 in. (2 mm) ID may also cause cavitation.

Placing the solvent reservoirs at or below the pump level also promotes cavitation. Place reservoirs at least 4 in. (10 cm) above the pump level to help prevent cavitation.

Attention: *To prevent damage to the system and to allow full system access, do not place any items on top of the system.*

C.5 Solvent Miscibility

Before you change solvents, refer to Table C-1 to determine the miscibility of the new solvent with the previous solvent. When you change solvents, keep in mind that:

- A change involving two miscible solvents may be made directly.

- A change involving two solvents that are not totally miscible (for example, chloroform and water) requires an intermediate solvent (such as methanol) that is miscible with both initial and final solvents.
- Temperature affects solvent miscibility. If you are running a high-temperature application, consider the effect of the higher temperature on solvent miscibility.
- Buffers dissolved in water may precipitate when mixed with organic solvents. Before you switch from a buffer to an organic solvent, flush the buffer out of the system with HPLC-grade water.

Attention: *To prevent immiscibility and/or precipitation problems when switching between solvents, use an intermediate solvent that is miscible with both solvents.*

Using Miscibility Numbers (M Numbers)

Use M numbers to predict the miscibility of a liquid with a standard solvent (see Table C-1). A liquid is classified in the M-number system by testing its miscibility with a series of standard solvents. A correction term of 15 units is then either added or subtracted from the cutoff point for miscibility.

To predict the miscibility of two liquids, subtract the smaller M value from the larger M value.

- If the difference between the two M numbers is 15 or less, the two liquids are miscible in all proportions at 15 °C.
- A difference of 16 between the two M number values indicates that the liquids are miscible only in the temperature range of 25 to 75 °C, with 50 °C as the optimal temperature.
- If the difference between the two M number values is 17 or greater, the liquids are immiscible or their critical solution temperature is above 75 °C.

Some solvents are immiscible with solvents at both ends of the lipophilicity scale. These solvents are assigned two M numbers:

- The first number, which is always smaller than 16, indicates the degree of miscibility with highly lipophilic solvents.
- The second number, which is always larger than 16, indicates the degree of miscibility with hydrophilic solvents. A large difference between the two M numbers indicates a limited range of miscibility.

For example, some fluorocarbons are immiscible with the standard solvents and have M numbers of 0 and 32. Two liquids that each have two M numbers are usually miscible with each other.

Table C-1 Solvent Characteristics

Polarity Index	Solvent	Viscosity [η] CP, 20 °C	Boiling Point at 1 atm (°C)	Miscibility (M) Number
–0.3	*n*-decane	0.92	174.1	29
–0.4	Isooctane	0.50	99.2	29
0.0	*n*-hexane	0.313	68.7	29
0.0	Cyclohexane	0.98	80.7	28
1.7	Butyl ether	0.70	142.2	26
1.8	Triethylamine	0.38	89.5	26
2.2	Isopropyl ether	0.33	68.3	—
2.3	Toluene	0.59	100.6	23
2.4	*p*-xylene	0.70	138.0	24
2.7	Orthodichlorobenzene (ODCB)	1.32 (25 °C)	180.48	21
3.0	Benzene	0.65	80.1	21
3.3	Benzyl ether	5.33	288.3	—
3.4	Methylene chloride	0.44	39.8	20
3.7	Ethylene chloride	0.79	83.5	20
3.9	Butyl alcohol	3.00	99.5	—
3.9	Butanol	3.01	117.5	15
4.2	Tetrahydrofuran (THF)	0.55	66.0	17
4.3	Ethyl acetate	0.47	77.1	19
4.3	1-propanol	2.30	97.2	15
4.3	2-propanol	2.35	117.7	15
4.4	Methyl acetate	0.45	56.3	15, 17
4.5	Methyl ethyl ketone (MEK)	0.43	80.0	17
4.5	Cyclohexanone	2.24	155.7	28
4.5	Nitrobenzene	2.03	210.8	14, 20

Table C-1 Solvent Characteristics (Continued)

Polarity Index	Solvent	Viscosity [η] CP, 20 °C	Boiling Point at 1 atm (°C)	Miscibility (M) Number
4.6	Benzonitrile	1.22	191.1	15, 19
4.8	Dioxane	1.54	101.3	17
5.2	Ethanol	1.20	78.3	14
5.3	Pyridine	0.94	115.3	16
5.3	Nitroethane	0.68	114.0	—
5.4	Acetone	0.32	56.3	15, 17
5.5	Benzyl alcohol	5.80	205.5	13
5.7	Methoxyethanol	1.72	124.6	13
6.2	Acetonitrile	0.37	81.6	11, 17
6.2	Acetic acid	1.26	117.9	14
6.4	Dimethylformamide (DMF)	0.90	153.0	12
6.5	Dimethyl acetamide	2.14	166.1	13
6.5	Dimethylsulfoxide (DMSO)	2.24	189.0	9
6.6	Methanol	0.60	64.7	12
6.7	N-Methyl-2 pyrrolidone (NMP)	1.67 (25 °C)	202	13
7.3	Formamide	3.76	210.5	3
9.0	Water	1.00	100.0	—
10.0	Trichlorobenzene (TCB)	1.89	213.0	—
	Hexafluoroisopropanol (HFIP)	1.02 (25 °C)	58.2	

C.6 Solvent Viscosity

Generally, viscosity is not important when you operate your HPLC system with a single solvent or under low pressure. However, when you use highly viscous solvents, monitoring the pressure during the run can help prevent pressure buildup and the resulting column problems.

C.7 Using Buffers

When you use aqueous buffers, adjust the pH, filter to remove insoluble material, then blend with organic modifier as appropriate. After you use a buffer, flush the buffer from the pump with at least 10 mL of HPLC-grade water. For shutdowns lasting more than one day, flush the pump with 20% methanol/water to prevent growth of microorganisms.

C.8 Removing Buffered Solvent

If your system includes aqueous buffered solvent, remove the buffered solvent from the flow path at the end of the day or when the samples have finished running.

Note: *To avoid damage to your columns, ensure that the flow path bypasses the columns.*

To remove buffered solvent from the flow path:

1. Remove the column set from the flow path:
   a. Select Setup > Current Instrument Method to open the Current Instrument Method dialog box.
   b. Click the Detector tab.
   c. Click Column Bypass in the Column area, and then click OK.
   d. Save the instrument method with a new name.
2. Replace the buffered solvent with 100% HPLC-quality water, and then purge the viscometer for 20 minutes (Section 3.4.4, Purging the Sense-Tube Viscometer).
3. Purge the refractometer for 5 minutes (Section 3.4.3, Purging the Refractometer).
4. Purge the injector with 30 mL (Section 3.4.2, Purging the Injector).
5. Replace the seal-wash solvent with a solution of 80% methanol:20% water or a miscible solvent, then prime the seal-wash pump for 10 min. (select Operations > Seal Wash Prime).
6. Replace the 100% water (solvent reservoir) with a solution of 90% methanol:10% water, and then flush the system for 10 minutes (select Operations > Auto Wash Prime).
7. Restore the column set to the flow path:
   a. Select Setup > Current Instrument Method to open the Current Instrument Method dialog box.

b. Click the Detector tab.

c. Click Column Bypass in the Column area, and then click OK.

C.9 Solvent Settings

You can lower but must not raise the temperature and pressure limits for the solvents, as defined in the Mobile Phase A and Mobile Phase B pages in the Instrument Configuration Editor.

Table C-2 shows solvent compatibility with the solvent manager plunger seal that can be used in the Alliance GPC 2000 Series system.

Table C-2 Solvent Manager Plunger Seal and GPC Solvent Compatibility

Solvent / Plunger Seal Compatibility	**Standard Yellow**	**Standard Yellow Seal with Seal Wash**	**Optional Alliance Clear-Seal**	**Optional Alliance Clear-Seal with Seal Wash**	**Notes**
Chloroform ($CHCl_3$)	May be used	Recommended	May be used	Recom-mended	Use seal wash. Seal wash solvent is CH_3OH.
DMAC (Dimethylaceta-mide)	Do not use	Do not use	Do not use	Strongly recom-mended	DMAC is typically used with LiBr or LiCl at 0.05 M. Use seal wash. Seal wash solvent is 50/50 CH_3OH/H_20.
DMF (Dimethyl-formamide)	Do not use	Do not use	Do not use	Strongly recom-mended	Use with 0.05 M LiBr or LiCl. Use seal wash. Seal wash solvent is 50/50 CH_3OH/H_20.
DMSO (Dimethyl sulfoxide)	May be used	Recommended	May be used	Recom-mended	Use a seal wash. Seal wash solvent is CH3OH.

Table C-2 Solvent Manager Plunger Seal and GPC Solvent Compatibility (Continued)

Solvent / Plunger Seal Compatibility	Standard Yellow	Standard Yellow Seal with Seal Wash	Optional Alliance Clear-Seal	Optional Alliance Clear-Seal with Seal Wash	Notes
HFIP (Hexafluoro-isopropanol)	Yes		Yes This is usually used with 0.05 M sodium trifluoroacetate or other salt.		Yes
Methylene chloride (CH_2Cl_2)	May be used	Recommended	May be used	Recommended	Use seal wash. Seal wash solvent is CH_3OH.
NMP (N-Methyl-2 pyrrolidone)	Do not use	Do not use	Do not use	Strongly recommended	NMP is typically used with LiBr or LiCl at 0.05 M. Use seal wash. Seal wash solvent is 50/50 CH_3OH/H_20.
ODCB (Ortho-dichlorobenzene)	Yes		No		Yes
	Note: *Filter through 100- to 200-µm active silica in addition to the 0.5 or 0.2-µm membrane filter. Suggested ramp rate: 0.5 mL/min/min.*				
TCB (Trichlorobenzene)	Yes		No		Yes
	Note: *If the TCB is treated with Santonox™ anti-oxidant, filter it through a bed of 100- to 200-µm activated silica gel and an 0.45-µm membrane filter. Suggested ramp rate: 0.5 mL/min/min.* ***Note:*** *The seal-wash seals are not compatible with trichlorobenzene (TCB).*				

Table C-2 Solvent Manager Plunger Seal and GPC Solvent Compatibility (Continued)

Solvent / Plunger Seal Compatibility	Standard Yellow	Standard Yellow Seal with Seal Wash	Optional Alliance Clear-Seal	Optional Alliance Clear-Seal with Seal Wash	Notes
THF (Tetrahydrofuran)	Recommended	Strongly recommended	Recommended	Strongly recommended	Initial (dry) priming is improved by first priming with IPA or CH_3OH. If using the seal wash option, use 50/50 CH_3OH/H_20.
	Note: *If using unstabilized THF, ensure that the solvent is fresh. Previously opened bottles of THF can contain peroxide contaminants, which cause baseline drift.*  ***Caution:*** *Peroxides are potentially explosive if concentrated, heated, or taken to dryness.*				
Toluene	May be used	May be used	Recommended	May be used	If using the seal wash option, use CH_3OH as the seal wash solvent.
Water	May be used	Recommended	May be used	Recommended	Aqueous GPC applications usually use salts and/or buffers. Use seal wash. Seal wash solvent is 20/80 CH_3OH/H_20.

Appendix D
Related Reference Material

D.1 References

For more information on GPC, GPCV, LS viscometry, polymers, HPLC, and Windows software, consult these sources:

- *Alliance GPC 2000 Series System Help.*
- *Empower GPC, GPCV, and LS Software Help.*
- *Plastics and Polymers*, A. Baptiste, Waters Corp., Milford, MA, 1998. Available through Connections University, a Waters Corp. course program.
- *Polymer Handbook*, J. Brandrup, E.H. Immergut: John Wiley & Sons, Publisher; Third edition, 1989.
- *Data Reduction in Multidetector Size Exclusion Chromatography,* Y. Brun; J. Liq. Chrom. & Rel. Technology, 21 (13), 1979 – 2015 (1998).
- *Modern Size-Exclusion Liquid Chromatography*, W.W. Yau, J.J. Kirkland, D.D. Bly, Wiley Press, 1979.
- R. Nielson, P. Alden, and J. Yang, "High-Speed Gel Permeation Chromtography," *American Laboratory,* Vol. 36: 2004, pp. 34-44.
- Waters Web site for more information on GPC products:

  www.waters.com\Applications\Polymer Analysis\Polymer Applications
- GPC 2000 System Overview & Start-Up Video, Waters Corp., 1999.
- Microsoft Windows 2000 Software Help and printed manuals.

Related Documentation

***Waters Licenses, Warranties, and Support*:** Provides software license and warranty information, describes training and extended support, and tells how Waters handles shipments, damages, claims, and returns.

Printed Documentation

***Waters Alliance GPC 2000 Series System Release Notes*:** A printed document that contains last-minute information about the product. Also provides supplementary information about specific Alliance GPC 2000 Series system software releases.

Styragel Column Care and User Manual for details on Styragel columns.

Ultrahydrogel Column Care and Use Manual for details on Ultrahydrogel columns.

HSPgel Columns for High Speed GPC Analysis Column Care and Use Manual for details on the HSPgel columns.

Online Documentation

***Waters Alliance GPC 2000 Series System Help*:** A Help system that describes all system windows, menus, and dialog boxes. Also includes reference information and procedures for performing tasks using the system software.

Documentation on the Web

Related product information and documentation can be found on the World Wide Web. Our address is http://www.waters.com.

D.2 Contacting Waters Technical Service

Customers in the USA and Canada should report diagnostic or parts replacement problems they cannot resolve to Waters Technical Service (800 252-2751). Others should phone their local Waters subsidiary or Waters corporate headquarters in Milford, Massachusetts (USA), or they may visit http://www.waters.com, and click Offices.

For complete information on reporting shipping damages and submitting claims, see Waters Safety Notices, Licenses, Warranties, and Support.

You can correct many system problems using the information in Chapter 5 and the Troubleshooting Tables in the *Alliance GPC 2000 Series System Help*. If you cannot correct a condition for a Waters product, contact Waters Technical Service and have the following information available:

- Up-to-date normal operation log and test sample chromatogram for the method
- Nature of symptom(s)
- Installed options and model, including presence or absence of a viscometer

- System serial number (on the back of the system, or inside the sample compartment at the back-left bottom corner)
- Flow rate
- Operating pressure and temperature
- Solvent(s)
- Sizes of sample loop and syringe
- Types and serial numbers of columns
- Sample description
- Data system, including Empower software
- Non-Waters detection systems (if applicable)
- Version numbers of all software
- Initial survey of system problems

Capturing Service Data

If your local Waters service representative requires additional information, he or she may ask you to create and send a CD of your data files. GPC 2000 software includes a special utility called Capture Service Data that automatically captures the data files the service representative requires. When you run this utility, a folder is created on your desktop called “Service Diagnostic Data.” If a service personnel request data files, comply with the request by copying this folder onto a CD, and sending it to them for troubleshooting purposes.

Creating a Troubleshooting CD

1. Select Start > Programs > Gpc2000 Chromatography > Capture Service Data.

   The Capture Service Data window opens, displays a list of files that are being created, and closes automatically (Figure D-1).

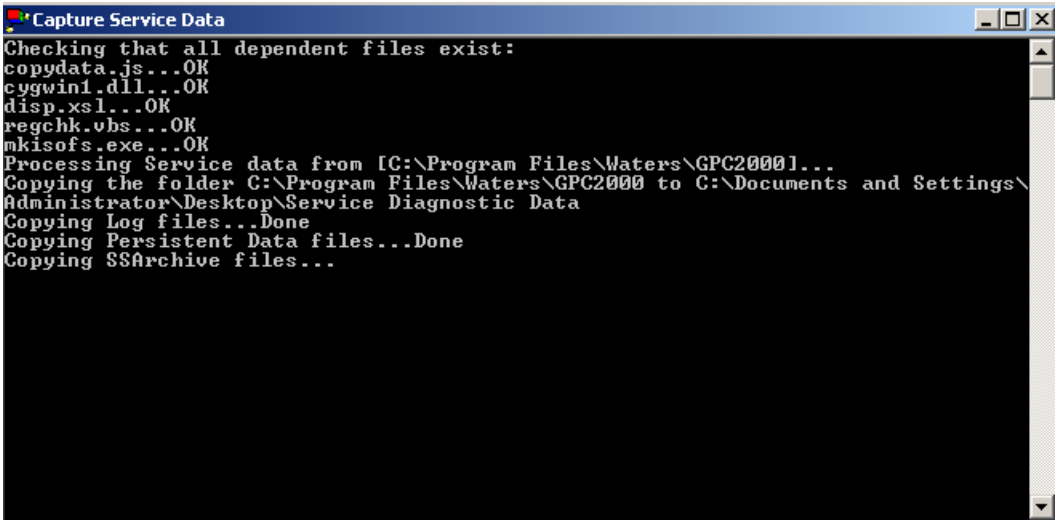


Figure D-1 Capture Service Data

A desktop folder is automatically created called Service Diagnostic Data.

2. Open the solvent compartment door and insert a blank writable CD into the CD drive.

   Note: *Keep the solvent compartment door open. The CD drive opens automatically after CD replication.*

3. To copy the folder to a CD, select Programs > Roxio CD Creator 5 > Applications > Easy CD Creator.
4. From the Select Source list, select Desktop, and then Service Diagnostic Data.
5. Click Add, and then click Record. The Record CD Setup dialog box appears.
6. Click Start Recording. The Record CD Progress dialog box appears and displays the progress of the CD data replication.
7. When the replication process is complete, click OK, and then close the Roxio Easy CD Creator window.
8. Remove the CD from the CD drive and close the solvent compartment door.

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