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Vanquish

UHPLC and HPLC Systems

Operating Manual

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ThermoFisher SCIENTIFIC

Original Operating Manual

Trademarks

Disclaimer

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Manufacturer's address

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Contacting Us

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Ordering Information

For ordering information or sales support for HPLC products, contact your local Thermo Fisher Scientific sales organization. For contact information, go to Contact Us on http://www.thermofisher.com.

Technical Assistance

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Contents

1 Using this Manual

This chapter provides information about this manual, the conventions used throughout the manual, and the reference documentation that is available in addition to this manual.

1.1 About this Manual

This manual provides instructions for installation, set up, start up, shut down, operation, maintenance and troubleshooting of your system.

This manual also contains safety messages, precautionary statements, and special notices. Follow these properly to prevent personal injury, damage to the system, or loss of data.

Note the following:

- The descriptions in this manual refer to a standard one-stack Vanquish™ system configuration. Not all descriptions necessarily apply to your particular system.
- Illustrations in this manual are provided for basic understanding. They can vary from the actual model of the system. However, this does not influence the descriptions. No claims can be derived from the illustrations in this manual.

1.2 Conventions

This section describes the conventions that are used throughout this manual.

1.2.1 Conventions for Safety Messages

The safety messages and precautionary statements in this manual appear as follows:

- Safety messages or precautionary statements that apply to the entire manual and all procedures in this manual are grouped in the Safety chapter.
- Safety messages or precautionary statements that apply to an entire section or to multiple procedures in a section appear at the beginning of the section to which they apply.
- Safety messages that apply to only a particular section or procedure appear in the section or procedure to which they apply. They appear different from the main flow of text.

Safety messages are often preceded by an alert symbol and/or alert word. The alert word appears in uppercase letters and in bold type.

Make sure that you understand and follow all safety messages presented in this manual.

1.2.2 Special Notices

Special notices and informational notes in this manual appear different from the main flow of text. They appear in boxes and a note label identifies them. The label text appears in uppercase letters and in bold type.

NOTICE

Highlights information necessary to prevent damage to the system or invalid test results.

TIP Highlights information of general interest or helpful information that can make a task easier or optimize the performance of the system.

1.2.3 Typographical Conventions

These typographical conventions apply to the descriptions in this manual:

Data Input and Output

The following appears in **bold** type:

- Input that you enter by the keyboard or that you select with the mouse
- Buttons that you click on the screen
- Commands that you enter by the keyboard
- Names of, for example, dialog boxes, properties, and parameters

For brevity, long expressions and paths appear in the condensed form, for example: Click **File > Save as**.

References and Messages

- References to additional documentation appear *italicized*.
- Messages that appear on the screen are identified by quotation marks.

Viewpoint

If not otherwise stated, the expressions *left* and *right* in this manual refer to the viewpoint of a person that is facing the system from the front.

Particularly Important Words

Particularly important words in the main flow of text appear *italicized*.

Electronic Manual Version (PDF)

The electronic version (PDF) of the manual contains numerous links that you can click to go to other locations within the manual. These include:

- Table of contents entries
- Index entries
- Cross-references (in blue text)

1.3 Reference Documentation

In addition to this operating manual, other documentation is available for reference.

Hardware Documentation

Additional hardware documentation includes the following:

- *Operating manuals* for the modules of the Vanquish system
- *Instrument Installation Qualification Operating Instructions*

Thermo Fisher Scientific provides up-to-date operating manuals as PDF (Portable Document Format) files that you can access from our customer manuals web site. To open and read the PDF files, Adobe™ Reader™ or Adobe™ Acrobat™ is required.

Go to the following web site: www.thermofisher.com/HPLCmanuals

Software Documentation

Additional software documentation includes the following:

- *Chromeleon™ Help and documents*
  The *Chromeleon Help* provides extensive information and comprehensive reference material for all aspects of the software.

In addition, the following documentation is available (availability depends on the software version):

- *Installation Guide*
  For basic information about device installation and configuration, refer to the *Installation Guide*.
- *Instrument Configuration Manager Help*
  For specific information about a certain device, refer to the *Instrument Configuration Manager Help.* In Chromeleon 7, devices are called modules.
- *Quick Start Guide*
  For information about the main elements of the user interface and step-by-step guidance through the most important workflows, refer to the *Quick Start Guide*.
- *Reference Card*
  For a concise overview of the most important workflows, refer to the *Reference Card*.

TIP The *Chromeleon Help* and documents are included in the software shipment.

Third-Party Documentation

Refer also to the user documentation provided by the manufacturers of third-party components and materials, for example, Safety Data Sheets (SDSs).

2 Safety

This chapter provides general and specific safety information and informs about the intended use of the system.

2.1 Safety Symbols and Signal Words

2.1.1 Safety Symbols and Signal Words in this Manual

This manual contains safety messages to prevent injury of the persons using the system.

The safety symbols and signal words in this manual include the following:

Always be aware of the safety information. Do not proceed until you have fully understood the information and consider the consequences of what you are doing.

CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

WARNING

Indicates a hazardous situation that, if not avoided, could result in serious injury.

2.1.2 Observing this Manual

Observe the following:

- Before installing or operating the system, read this manual carefully to be familiar with the system and this manual. The manual contains important information with regard to user safety as well as use and care of the system.
- Always keep the manual near the system for quick reference.
- Save this manual and pass it on to any subsequent user.

Read, understand, and comply with all safety messages and precautionary statements presented in this manual.

2.1.3 Safety Symbols on the System

For a list of the safety symbols that appear on a Vanquish system module or on labels affixed to a module, refer to the *Operating Manual* of the module. Follow the safety notices in these manuals to prevent the risk of operator injury or damage to the system.

Safety Symbols on the System Base

Symbol	Description
	Indicates a potential hazard. Refer to this manual to avoid the risk of personal injury and/or to prevent damage to the device.
	Indicates a power button that switches the system between on and off states.

2.2 Intended Use

The intended use of the Vanquish system is to analyze mixtures of compounds in sample solutions.

The system is for use by qualified personnel and in laboratory environment only.

The Vanquish system and its modules are intended to be used as General Laboratory Equipment (GLE).

They are not intended for use in diagnostic procedures.

Laboratory Practice

Thermo Fisher Scientific recommends that the laboratory in which the Vanquish system is used follow best practices for LC analyses. This includes among others:

- Using appropriate standards
- Regularly running calibration
- Establishing shelf life limits and following them for all consumables used with the system
- Running the system according to the laboratory's verified and validated 'lab developed test' protocol

2.3 Safety Precautions

2.3.1 General Safety Information

All users must observe the general safety information presented in this section and all specific safety messages and precautionary statements elsewhere in this manual during all phases of installation, operation, troubleshooting, maintenance, shutdown, and transport of the system.

If the system is used in a manner not specified by Thermo Fisher Scientific, the protection provided by the system could be impaired. Observe the following:

- Operate the system only within its technical specifications.
- Use only the replacement parts and additional components, options, and peripherals specifically authorized and qualified for the system by Thermo Fisher Scientific.
- Perform only the procedures that are described in this operating manual and in supporting documents for the system. Follow all instructions step by step and use the tools recommended for the procedure.
- Open the enclosure of the system and other components only if specifically instructed to do so in this manual.
- Thermo Fisher Scientific cannot be held liable for any damage, material or otherwise, resulting from inappropriate or improper use of the system. If there is any question regarding appropriate usage, contact Thermo Fisher Scientific before proceeding.

2.3.2 Qualification of the Personnel

Observe the information below on the proper qualification of the personnel installing and/or operating the system.

Installation

System configuration without Charger

Only skilled personnel are permitted to install the system and to establish the electrical connections according to the appropriate regulations.

- Thermo Fisher Scientific recommends always having service personnel certified by Thermo Fisher Scientific perform the installation (for brevity, referred to as Thermo Fisher Scientific service engineer).
- If a person other than a Thermo Fisher Scientific service engineer installs and sets up the system, the installer is responsible for ensuring the safety of the system.

System configuration with Charger: Installation by Service Engineer only

Service personnel certified by Thermo Fisher Scientific must perform the installation (for brevity, referred to as Thermo Fisher Scientific service engineer).

Operation

General Operation

The system is designed to be operated only by trained and qualified personnel in a laboratory environment.

All users must know the hazards presented by the system and the substances they are using. All users should observe the related Safety Data Sheets (SDSs).

2.3.3 Personal Protective Equipment

Wear personal protective equipment and follow good laboratory practice to protect you from hazardous substances. The appropriate equipment depends on the hazard. For advice on the hazards and the equipment required for the substances you are using, refer to the material handling and safety data sheet provided by the vendor.

An eyewash facility and a sink should be available nearby. If any substance contacts your skin or eyes, wash the affected area and seek medical attention.

Protective Clothing

To protect you from chemical splashes, harmful liquids, or other contamination, put on appropriate protective clothing, such as a lab coat.

Protective Eyewear

To prevent liquids from striking your eyes, put on appropriate protective eyewear, such as safety glasses with side shields. If there is a risk of splashing liquids, put on goggles.

Gloves

To protect you from harmful liquids and avoid personal injury during maintenance or service, put on appropriate protective gloves.

2.3.4 General Residual Hazards

Pay attention to the following general residual hazards when working with the system:

WARNING—Hazardous Substances

Solvents, mobile phases, samples, and reagents might contain toxic, carcinogenic, mutagenic, infectious, or otherwise harmful substances. The handling of these substances can pose health and safety risks.

- Be sure that you know the properties of all substances that you are using. Avoid exposure to harmful substances. If you have any doubt about a substance, handle the substance as if it is potentially harmful.
- Wear personal protective equipment as required by the hazard and follow good laboratory practice.
- Reduce the volume of substances to the minimum volume required for sample analysis.
- Avoid handling of solvent reservoirs above head height.
- Do not operate the system in a potentially flammable environment.
- Avoid accumulation of harmful substances. Make sure that the installation site is well ventilated.
- Dispose of hazardous waste in an environmentally safe manner that is consistent with local regulations. Follow a regulated, approved waste disposal program.

WARNING—Biohazard

Biohazardous material, for example microorganisms, cell cultures, tissues, body fluids, and other biological agents can transmit infectious diseases. To avoid infections with these agents:

- Assume that all biological substances are at least potentially infectious.
- Wear personal protective equipment as required by the hazard and follow good laboratory practice.
- Dispose of biohazardous waste in an environmentally safe manner that is consistent with local regulations. Follow a regulated, approved waste disposal program.

WARNING—Self-Ignition of Solvents

Solvents with a self-ignition temperature below 150 °C might ignite when in contact with a hot surface (for example, due to leakage in the chromatography system).

Avoid the use of these solvents.

WARNING—Hazardous Vapors

Mobile phases and samples might contain volatile or flammable solvents. The handling of these substances can pose health and safety risks.

- Avoid accumulation of these substances. Make sure that the installation site is well ventilated.
- Avoid open flames and sparks.
- Do not operate the system in the presence of flammable gases or fumes.

CAUTION—Escape of Hazardous Substances from PEEK Capillaries

Some capillaries in the system are made of PEEK. Swelling or attack by acids can cause PEEK capillaries to start leaking or to burst. Certain chemicals, for example, trichlormethane ($CHCl_3$), dimethyl sulfoxide (DMSO), or tetrahydrofuran (THF) can cause PEEK to swell. Concentrated acids, such as sulfuric acid and nitric acid, or a mixture of hexane, ethyl acetate, and methanol, can attack PEEK.

- Swelling or attack is not a problem with brief flushing procedures.
- For more information, refer to the technical literature on the chemical resistance of PEEK.

CAUTION—Allergic Reaction

Some capillaries in the system are made of MP35N™, a nickel/cobalt-based alloy. Individuals with sensitivity to nickel/cobalt may show an allergic reaction from skin contact.

CAUTION—Sparking due to Electrostatic Discharge

Liquid flowing through capillaries can generate static electricity. This effect is particularly present with insulating capillaries and non-conductive solvents (for example, pure acetonitrile). Discharge of electrostatic energy might lead to sparking, which could constitute a fire hazard.

Prevent the generation of static electricity near the chromatography system.

2.3.5 In Case of Emergency

WARNING—Safety Hazard

In case of emergency, disconnect the system modules from the power line.

2.4 Solvent and Additive Information

2.4.1 General Compatibility

To protect optimal functionality of the Vanquish system, observe these recommendations on the use of solvents and additives:

- The system must be used with reversed-phase (RP) compatible solvents and additives only.
- Use only solvents and additives that are compatible with all parts in the flow path.
- Anhydrous methanol may lead to stress failures in titanium surfaces, especially when formic acid or TFA is added to the mixture. Thermo Fisher Scientific recommends adding 3% of water to prevent this.

TIP In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the system modules have been modified for NP applications. See Normal-Phase Compatible Solvents and Additives (▸ page 128).

2.4.2 Piston Seal Compatibility

The table provides information about the piston seals used in the pumps and their solvent compatibility.

Pump	Piston Seals
VC-pumps except VC-P21 and VC-P33	The pumps are shipped with UHMW-PE piston seals. Using tetrahydrofuran, ketones, or ammonium hydroxide as solvents can damage the seals. In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure. Under harsh conditions, consider replacing the UHMW-PE piston seals with carbon-fiber filled PTFE piston seals. Consider the following: • With the piston seals, also replace the seal wash seals (part no. 6040.0306, containing 2 seals for use as both, piston seal and seal wash seal). • Install new pistons. Exchanging the piston seals but keeping the pistons that were used with the UHMW-PE piston seals may impair the seal life of the PTFE seals. • Note that slightly increased abrasion may be observed with these seals, depending on the application. Consider testing the permeability of the static mixer regularly at short intervals.

Pump	Piston Seals
VC-P21 and VC-P33 pumps	The pumps are shipped with carbon-fiber filled PTFE piston seals. Slightly increased abrasion may be observed with these seals, depending on the application. Consider testing the permeability of the static mixer regularly at short intervals.
VF-pumps	The pumps are shipped with UHMW-PE piston seals. Using tetrahydrofuran, ketones, or ammonium hydroxide as solvents can damage the seals. In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure. Under harsh conditions, consider replacing the UHMW-PE piston seals with carbon-fiber filled PTFE piston seals. Consider the following: • With the piston seals, also replace the seal wash seals (part no. 6040.0306, containing 2 seals for use as both, piston seal and seal wash seal). • Install new pistons. Exchanging the piston seals but keeping the pistons that were used with the UHMW-PE piston seals may impair the seal life of the PTFE seals. • In addition, note the following: ♦ Slightly increased abrasion may be observed with the PTFE seals, depending on the application. Consider testing the permeability of the static mixer regularly at short intervals. ♦ The pump should not be operated with pressures higher than 70 MPa. ♦ The pump is no longer biocompatible.
VH-pumps	The pump is shipped with UHMW-PE piston seals. Using tetrahydrofuran, ketones, or ammonium hydroxide as solvents can damage the seals. In rare cases, a shortened lifetime of reversed-phase (UHMW-PE) piston seals has been observed with high pH, ammonium hydroxide containing mobile phases and prolonged exposure.

2.4.3 Allowed pH Ranges

Allowed pH ranges (standard system configuration):

System (Standard Configuration)	Allowed pH ranges	Remarks
Vanquish Core	1-13	• *pH value of 2 (Vanquish Horizon/Flex)*: Short-term use only. The application time should be as short as possible. Flush the system thoroughly after these applications. • *pH value of 1-2 (Vanquish Core)*: The application time should be as short as possible. Flush the system thoroughly after these applications. • *pH values higher than 9.5 with optical detectors*: Avoid using mobile phases with a pH value higher than 9.5 together with optical detectors. This can impair the functionality and optical performance of the detector flow cell.
Vanquish Horizon Vanquish Flex	2-12	

2.4.4 Allowed Concentrations

Allowed concentrations (standard system configuration):

System (Standard Configuration)	Chloride	Buffer	Remarks
Vanquish Core	0.1 mol/L or less	1 mol/L or less	*High chloride concentration*: The application time should be as short as possible. Flush the system thoroughly after these applications.
Vanquish Horizon Vanquish Flex	1 mol/L or less	-	

2.4.5 Further Information

- For information about the materials that are used in the flow path of the Vanquish system, refer to the *Specifications* chapter in the *Operating Manual* for each module.
- Observe the general guidelines and recommendations on the use of solvents and additives in the chromatography system (see Use of Solvents and Additives (▶ page 89)).
- Refer also to the *Operating Manuals* for all modules in the Vanquish system. They may provide additional guidelines and information.

NOTICE

If the system configuration includes a non-standard detector, for example, a charged aerosol detector or refractive index detector, refer to the *Operating Manual* for the detector for specific recommendations regarding solvents and additives.

3 System Overview

This chapter introduces you to the system and the main components.

3.1 System Description (Standard Configuration)

The Vanquish system is designed for use in high performance liquid chromatography (HPLC) and ultra-high performance liquid chromatography (UHPLC) applications. The table shows the standard configurations of three Vanquish systems as an example:

Module	Core system	Flex system		Horizon system
Solvent rack	Vanquish solvent rack			
Detector[1]	VC-D40	VF-D40		VH-D10
Column compartment[2]	VC-C10	VH-C10		VH-C10
Autosampler	VC-A12	VF-A10		VH-A10
Pump	VC-P20	Quaternary: VF-P20	Binary: VF-P10	VH-P10
System base	Vanquish system base			
[1] The appropriate flow cell has to be ordered separately.				
[2] In the standard configuration, the Vanquish system includes one column compartment, installed to the right side of the system. For other configurations, see System Stack Setup (▶ page 47).				

For a description of the solvent rack and system base, see further down in this chapter. For a description of the other modules, refer to the *Operating Manuals* for these modules.

TIP

If your system configuration is a non-standard system configuration including modules other than those listed in the table, for example, a fluorescence detector or a charged aerosol detector, refer to the *Operating Manual* for the module.

3.1.1 Solvent Rack

The solvent rack provides a secure location for placing solvent reservoirs. It can store, for example, 6 x 1 L of solvent and 2 x 0.25 L of wash liquid as shown in the figure. The maximum volume for an individual reservoir should not exceed 5 L.

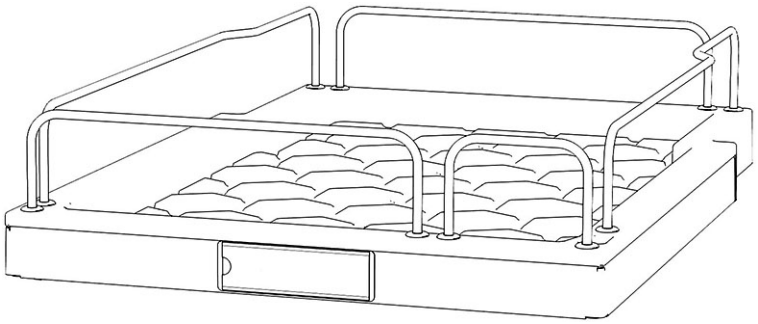

Figure 1: Solvent rack (front view)

The front side of the solvent rack is magnetic. Here, you can attach a magnetic label holder, for example, to show a user-specific system name. Labels are included in the system ship kit.

3.1.2 System Base

The system base is a mandatory part of the Vanquish system. It is the bottom part of the system stack and carries the pump, autosampler, and detector in a standard configuration.

The system base provides:

- Power button for power on/off control of all modules
- Drawer to store tools and small system parts
- Drain port for connecting a system waste line
- Locks to toggle between moveable and stationary mode
- Dedicated mounting space for optional Vanquish System Controller

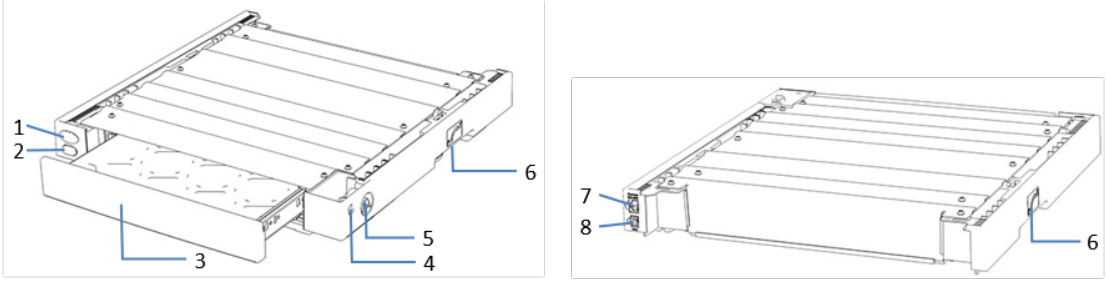

Figure 2: System base (front and rear view)

No.	Description
1	Blind cap/Vanquish System Controller power button If a Vanquish system controller is installed, the power button allows power on/off control of the system controller.
2	System power button Allows power on/off control for all modules of the system that are connected to the system base via the System Interlink port.
3	Drawer for tools Allows storing any tools that are necessary to install or maintain the Vanquish system. Push the drawer front to open or close the drawer.
4	Detector waste outlet For guiding the waste line from the detector to waste.
5	System drain port For connecting the system waste line.
6	Locks - on the left and right side of the system base Allows toggling between movable and stationary.
7	System Interlink port Allows connecting the other modules for power on/off control from the Vanquish system base.
8	VSC port Allows connecting the optional system controller.

3.2 Operation

The system is designed to be operated from a computer configured with the Chromeleon Chromatography Data System (CDS). The Chromeleon software provides complete instrument control, data acquisition, and data management.

For a basic description of instrument control and automated sample analysis with the Chromeleon software, see Operating the System from the Software (▶ page 91).

TIP The system can be operated also with other data systems, such as Thermo Scientific™ Xcalibur™. In this case, installation of additional software is required in addition to the data system software. For details, contact the Thermo Fisher Scientific sales organization.

Keypads are available inside the system modules, allowing you to perform certain basic functions directly from each module.

4 Unpacking

This chapter provides information for unpacking the system and informs you about the scope of delivery.

4.1 Unpacking

Damaged Packaging, Defective on Arrival

Inspect the shipping container for signs of external damage and, after unpacking, inspect the system for any signs of mechanical damage that might have occurred during shipment.

If you suspect that the system may have been damaged during shipment, immediately notify the incoming carrier and Thermo Fisher Scientific about the damage. Shipping insurance will compensate for the damage only if reported immediately.

Unpacking the Solvent Rack and System Base

To unpack the solvent rack and system base, follow these steps:

1. Place the shipping container on the floor and open it.
2. Remove the ship kit.
3. Carefully remove the solvent rack and liquid reservoirs from the shipping container.
4. Place the solvent rack on a stable surface.
5. Carefully remove the system base from the shipping container.
6. *If applicable*
   Remove any additional packing material.
7. Place the system base on a stable surface.

TIP Keep the shipping container and all packing material. These items will be needed if the system is transported to a new location or shipped.

Unpacking the System Modules

For details on unpacking and moving the system modules, refer to the *Operating Manual* of each module.

4.2 Scope of Delivery

The following items are included in the delivery:

- System base
- Solvent rack
- Solvent reservoirs
- Ship Kit
  For details about the kit content, see Ship Kit (page 139).
- System operating manual (downloadable from customer manual web site)

5 Installation

This chapter specifies the requirements for the installation site and describes how to set up, install, and configure the system.

5.1 Safety Guidelines for Installation

Pay attention to the following safety guidelines:

Observe all warning messages and precautionary statements presented in Safety Precautions (page 19).

Observe all warning messages and precautionary statements presented in the *Safety Guidelines for Installation* section in the *Operating Manual* for the individual modules of the Vanquish system.

5.2 Installing the System

A Thermo Fisher Scientific service engineer installs and sets up the Vanquish system, including all modules and options or parts shipped with them. The service engineer checks that the installation is correct and that the Vanquish system and modules operate as specified. The engineer also demonstrates the basic operation and main features.

The following description refers to the standard system configuration, see System Description (Standard Configuration) (▸ page 30).

If your system configuration is a non-standard system configuration and includes, for example, a fluorescence detector or a charged aerosol detector, refer to the *Operating Manual* for the module for installation and operation details.

If personnel other than a Thermo Fisher Scientific service engineer installs the system, follow the steps below.

1. Pay attention to the safety guidelines and observe all site requirements.
   For the safety guidelines when installing the system, see Safety Guidelines for Installation (▸ page 40). For the site requirements, see Site Requirements (▸ page 43).
2. Set up the system hardware. See Setting Up the Hardware (▸ page 47).
3. Set up the flow connections. See Setting Up the Flow Connections (▸ page 73).
4. Turn on the system. See Turning On the System (▸ page 79).

TIP

Before turning on the power to a Vanquish system module for the first time, verify that the chromatography software is installed on the data system computer. When the power is turned on, the required USB drivers are automatically found and the Windows™ operating system can detect the device.

5. Set up the system in the software. See Setting Up the System in the Software (▸ page 80).
6. Flush the system. See Flushing the System (▸ page 82).

7. *Recommended*:
   Perform Instrument Installation Qualification.

   In the Chromeleon software, a wizard is available to guide you through the qualification process. On the **Chromeleon 7 Console**: Click **Tools > Instrument Qualification > Installation Qualification**.

   Follow the instructions in the *Instruments Installation Qualification Operating Instructions*. The manual provides information about the required materials and detailed instructions.

NOTICE

If the system is operated with another data system, refer to the documentation for the software that you are using and/or perform the qualification manually. The *Instruments Installation Qualification Operating Instructions* provide information about the parameters to be adapted and the required settings.

8. *Recommended*: Perform Operational Qualification.
   The qualification kit includes all materials required for the qualification and detailed instructions.

5.3 Site Requirements

The operating environment is important to ensure optimal performance of the system.

This section provides important requirements for the installation site. Note the following:

- Make sure that the installation site has enough power outlets for all devices in the system.
- Operate the system only under appropriate laboratory conditions
- For specifications, see Specifications (page 133).

5.3.1 Workbench

The Vanquish system is designed to be placed on a workbench. If the workbench shall carry a complete Vanquish system and possibly other instruments, the bench must be capable to bear the weight of all devices and instruments, including solvents.

For dimensions and weight, see Specifications (page 133).

Workbench Requirements

Part	Requirements
Workbench	• Sturdy • A height that ensures convenient access to the interior of each device in the system. • The bench top must be dry, clean, and resistant to chemicals. • If the system stack is to be stabilized with the Bench Clamp kit, the workbench top must fulfill *one* of the following requirements: ♦ Thickness: Between 15 and 50 mm or ♦ Material: Soft enough for wood screws
Site for the workbench	The workbench must stand in a secure and level position that is free of vibrations.

System Clearance Requirements

Side	Requirements
On the sides	• Allow sufficient free space for electrical connections and for proper air circulation • At least 5 cm of clearance on each side • If the system includes a Charger or a Vanquish Display, allow at least 10 cm of clearance on the left side.
On the rear	• Allow sufficient free space for electrical connections and for proper air circulation • At least 15 cm of clearance
Top	At least 30 cm of clearance above the top

5.3.2 Power Considerations

CAUTION—Electric Shock or Damage to the Device

Connecting the device to a line voltage higher or lower than specified could result in personal injury or damage to the device.

Connect the device to the specified line voltage only.

5.3.3 Power Cord

The power cords are designed to match the wall socket requirements of the country in which they are used. The end of the power cords that plugs into the power socket on the device is identical for all power cords. The end of the power cords that plugs into the wall socket is different.

WARNING—Electric Shock or Damage to the Device

- Never use a power cord other than the power cords provided by Thermo Fisher Scientific for the device.
- Only use a power cord that is designed for the country in which you use the device.
- Do not use extension cords.
- Never plug the power cord to a power socket that is shared with other equipment (for example, multiple sockets).
- Operate the device only from a power outlet that has a protective ground connection.
- In case of emergency, it must be possible to reach the power cord easily at any time to disconnect the device from the power line.

WARNING—Electric Shock or Damage to a Product

Misuse of the power cords could cause personal injury or damage the instrument. Use the power cords provided by Thermo Fisher Scientific only for the purpose for which they are intended. Do not use them for any other purpose, for example, for connecting other instruments.

5.3.4 Condensation

NOTICE—Condensation in the device can damage the electronics.

- When using, shipping, or storing the device, avoid or minimize conditions that can lead to a build-up of condensation in the device. For example, avoid significant or fast changes in environmental conditions.
- If you suspect that condensation is present, allow the device to warm up to room temperature. This may take several hours. Wait until the condensation is gone completely before connecting the device to the power line.

5.3.5 Operating Conditions

When operating the system, make sure that the installation site meets these general environmental and operating conditions. For specified ambient temperature and humidity, see Specifications (▷ page 133).

Temperature

Temperature fluctuations can affect the performance of the system. Avoid locations with significant changes in temperature and strong air drafts. For example, do not place the system in the direct sunlight, near heating or cooling sources, or under an air duct.

Humidity

The relative humidity of the operating environment is important for the performance of the system. Operate the system in the specified humidity range, with no condensation.

When the humidity is too high, condensation may occur, causing damage to the electronic components in the system. When the humidity is too low, static electricity may accumulate and discharge, shortening the life of the electronic components.

Ventilation

Make sure that the installation site is well ventilated at any time to avoid potential health hazards and safety risks, which may be caused by handling hazardous substances, volatiles or gases.

Vibration and mechanical shocks

Vibrations and mechanical shocks may affect the performance of the system. Therefore, the installation site should be free of vibrations. Avoid mechanical shocks and avoid placing the system in locations where vibrations are caused by other instruments.

Electromagnetic interference

Electromagnetic sources of strong interference may affect the performance of the system. In close proximity to the system, avoid operating equipment generating strong electric or magnetic fields and only operate certified laboratory equipment. Do not connect equipment that may cause power disturbances to the same power network used to supply the system.

5.4 Setting Up the Hardware

This section describes how to set up the hardware and provides information about the system connectors and cables.

1. Set up the system stack. For details, see System Stack Setup (▶ page 47).
2. Connect the Waste Lines. For details, see Connecting the Waste Lines (▶ page 55).
3. Attach the column compartment. For details, see Attaching the Column Compartment to the System Stack (▶ page 62).
4. Connect the required signal cables. For details, see Signal Cable Connections (▶ page 65).
5. Connect power cords to the power-inlet connectors of all modules. For details, see Connecting Power Cables (▶ page 71).

5.4.1 System Stack Setup

CAUTION—Heavy Load, Bulky Device

The system modules are too heavy or bulky for one person alone to handle safely. To avoid personal injury or damage to the system modules, observe the following guidelines:

- Physical handling of the modules, including lifting or moving, requires a team effort of two persons.
- A team effort is in particular required when lifting the modules into the system stack or when removing them.
- *Modules with carrying handles*: Use the carrying handles that were shipped with the modules to move or transport the modules. Never move or lift the modules by the front doors. This will damage the doors or the modules. *Modules without carrying handles*: To lift or move the modules, grasp the modules by the sides. Do not move or lift the modules by the front door. This will damage the door or the modules.

The system modules are arranged in a system stack. The arrangement depends on the system configuration.

The descriptions below refer to the standard Vanquish system (one-stack configuration). The one-stack configuration is the standard configuration, as it optimizes the flow path for minimum delay volume.

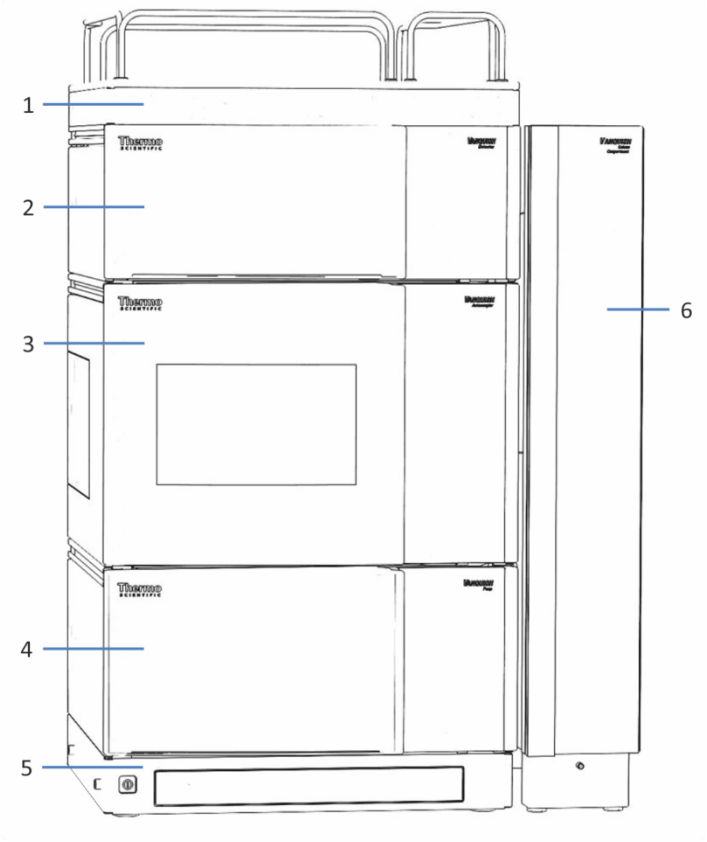

Figure 3: Vanquish system, standard configuration (example)

No.	Description
1	Solvent Rack
2	Detector
3	Autosampler
4	Pump
5	System Base
6	Column Compartment

5.4.1.1 Safety Guidelines for Setting Up the System Stack

Observe the following safety message and the explanations below.

WARNING—Risk of tilting system stack

A one-stack configuration may exceed the maximum allowed height. If the system configuration is higher, the system stack poses a tilting risk which can entail personal injury.

If your configuration is higher, you need to stabilize the stack with one of the following safety measures:

- Use a stack stabilization kit (see table below).
- Build up the system in two separate stacks.

The following table shows which stack stabilization kit you need for which stack height. The heights are measured from the table surface to the solvent rack railing. Due to production and installation tolerances, the actual stack height can be up to 2 cm higher than the limit. This tolerance is acceptable.

Stack height	Stabilization required
Up to 100 cm	None Example: Configuration with pump, autosampler, diode array detector and charged aerosol detector
Up to 123 cm	One of the following kits: • Bench clamp kit • Stack stabilizer kit • IonBench with stack mounting kit
Up to 139 cm	Bench clamp kit
139 cm and higher	Build up the system in two separate stacks

5.4.1.2 Installing the System Stack

NOTICE

Moving the Vanquish system stack after installation even over short distances on the workbench can damage and impair the functionality of the system base.

- Therefore, install the system stack at the final location.
- If you have to move the system after installation, see Moving the System Stack (Unlocking/Locking) (▷ page 52).

1. Place the system base on the workbench.
2. Unlock the system base (see Unlocking the System Base (▷ page 52)) to be able to shift the system base slightly for better access to all system parts.
3. *Only if you intend to guide the waste line of the system drainage toward the system's rear*:
   Press the clips as shown in the left image and attach them onto the system base at the positions shown in the right image.

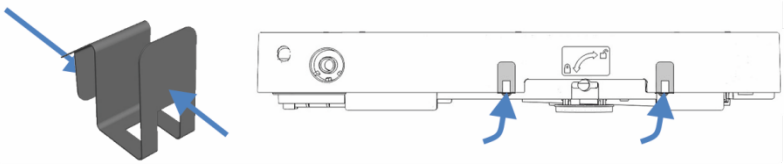

Figure 4: Clip (left) and attaching the clips onto the system base (right)

4. Lift the pump by its carrying handles. Place the pump on the system base approximately 5 cm before the end of the rails. Push the pump towards the rear until the pump clicks into place.
5. Loosen the screws on the carrying handles, using a screwdriver (Torx™ T20). Do not remove the screws from the carrying handles completely.

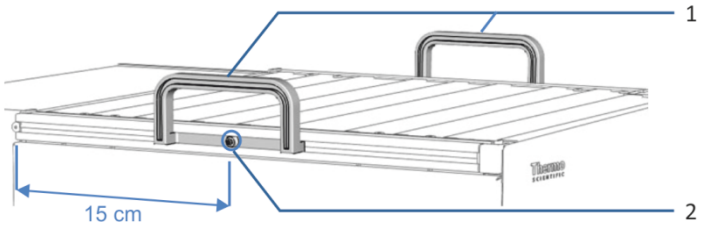

Figure 5: Carrying handles

No.	Component
1	Carrying handles
2	Attachment screw (one on each carrying handle)

6. Remove the two carrying handles by sliding them off the rails toward the rear.

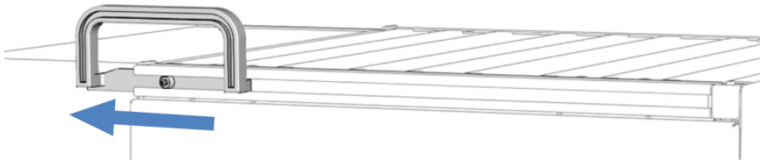

Figure 6: Sliding off the carrying handle from the left rail

7. Repeat the previous three steps for the autosampler and detector by placing the autosampler on the pump, and the detector on the autosampler.

8. Place the solvent rack on the detector approximately 5 cm before the end of the rails. Push the solvent rack towards the rear until it clicks into place.

9. Measure the stack height from the table surface to the solvent rack railing and check whether a stack stabilization is needed (see Safety Guidelines for Setting Up the System Stack (▸ page 49)). If necessary, stabilize the stack.

10. Connect the waste lines (see Connecting the Waste Lines (▸ page 55)).

TIP

System modules on the system stack have protective caps on the rear of the housing. Remove them after installing the system stack and before attaching the column compartment to the system stack.

11. Attach the column compartment to the system stack (see Attaching the Column Compartment to the System Stack (▸ page 62)).

12. Loosen or remove any shipping locks. Refer to the *Operating Manual* for each module for information on shipping locks that need to be removed.

5.4.2 Moving the System Stack (Unlocking/Locking)

The system base has a locking mechanism. Before you move the system base, for example, for installation and maintenance, you need to unlock the system base. To prevent it from being moved during operation on the workbench, lock it.

If your system configuration includes one column compartment, you can switch between the moveable and stationary mode using the system base locking tools shipped with the system base.

Figure 7: System base locking tool

If your system includes two or three column compartments or a Charger, a Thermo Fisher Scientific service engineer must dismount the mentioned modules before you can (un)lock the system base with the locking tools.

5.4.2.1 Unlocking the System Base

1. Have the Charger and all but one column compartment dismounted by a Thermo Fisher Scientific service engineer.
2. Insert one locking tool into another.

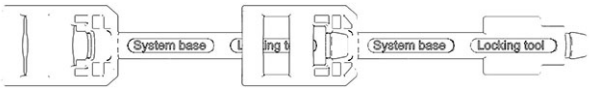

Figure 8: Extended locking tool

3. Insert the combined locking tools into the lock port on the side of the system base where the column compartment is installed.
   If the column compartment is installed on the right side, insert the combined locking tools into the right lock port as shown in the figure below.

4. Insert one locking tool into the lock port on the other side of the system base.

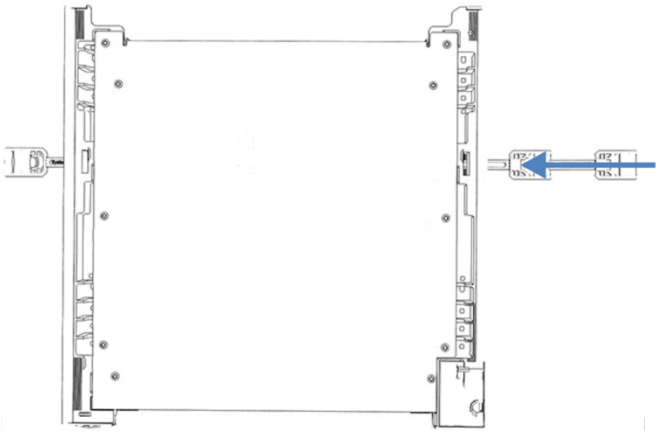

Figure 9: Inserting locking tools into the system base (system base top view)

5. Unlock the system base by turning the locking tools as shown below. In the unlocked position, the locking tools cannot be removed from the system base.

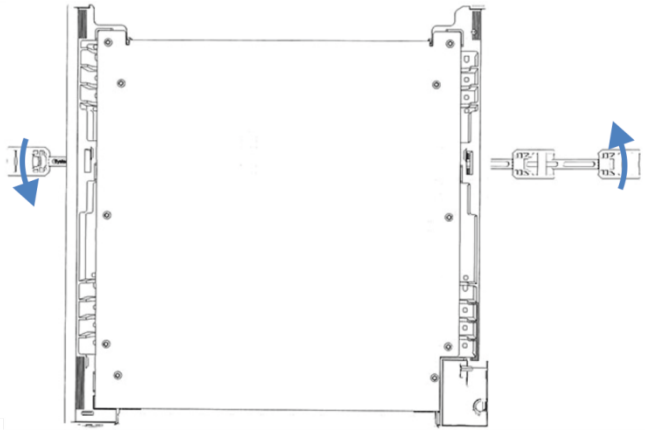

Figure 10: Unlocking the system base

6. Move the system.
7. Lock the system base (see Locking the System Base (▶ page 54)).
8. Have the additional column compartments and the Charger mounted by a Thermo Fisher Scientific service engineer.

5.4.2.2 Locking the System Base

When the system base is in movable mode and one column compartment is installed, locking tools are already inserted into the system base. The following instructions and images assume that the column compartment is installed on the right side of the system.

1. Move the system to the operating position.
2. Lock the system base by turning the locking tools as shown below.

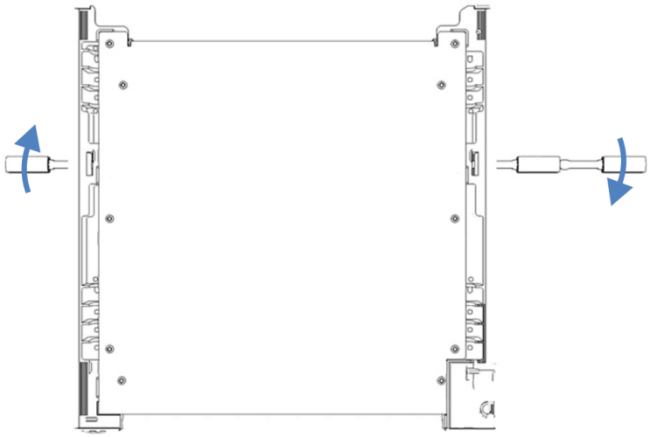

Figure 11: Locking the system base (system base top view)

3. Remove the locking tools and store them in a safe place, for example, in the system base drawer.
4. Have the column compartment(s) and Charger re-installed by a Thermo Fisher Scientific service engineer.

5.4.3 Connecting the Waste Lines

5.4.3.1 Waste Connections Overview

WARNING—Escape of Hazardous Substances

Hazardous substances can escape from waste lines and waste containers if connections and waste containers are not properly installed. Exposure to these substances can pose health and safety risks.

Verify the correct installation of connections and containers by testing the drain system (see Testing the Drain System (▶ page 59)).

The Vanquish system has been designed for optimized and simple leak liquid and waste handling:

- Leak liquid from the solvent rack, detector, autosampler, and pump flows through pipes from the modules to the system base drain port.
- Seal wash and needle wash liquids from the pump and autosampler, as well as condensate from the autosampler, are also guided to the system base drain port.
- Leak liquid from the column compartment flows to the column compartment drain port.
- Waste from the detector can also be routed through the system base.

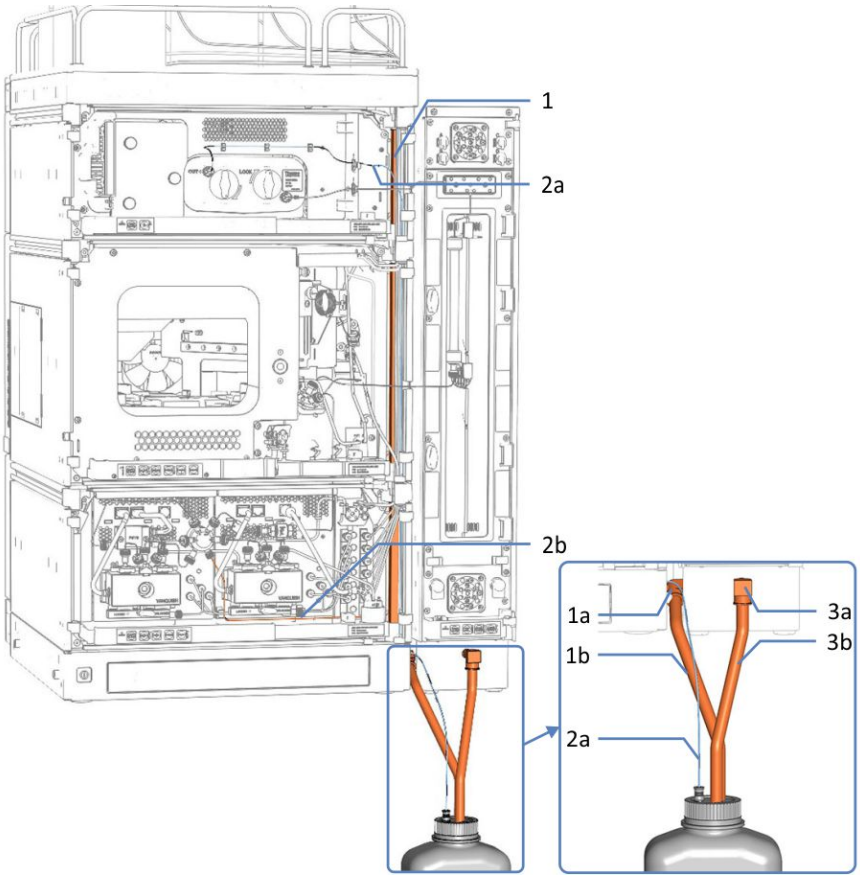

Figure 12: Overview of waste lines in the system (example)

No.	Description
1	Drainage from the modules in the stack to the system base
1a	System drain port
1b	Waste line for system drainage
2	Module waste lines:
2a	Detector waste line
2b	Pump waste line (here in VH-P10 pump)
3	Drainage from the column compartment:
3a	Column compartment drain port
3b	Waste line for column compartment drainage

Make the following connections:

- Connect a waste line to the system drain port (see Connecting the Waste Line to the System Drain Port (Drain Tubing) (▶ page 58)).
- When the waste line is set up, test the drain system (see Testing the Drain System (▶ page 59)).
- Install a detector waste line that connects the flow cell outlet through the detector waste outlet to the waste. For installation instructions, see Installing the Detector Waste Line (▶ page 60).

TIP

Make sure that you guide the detector waste line through the separate outlet in the system base, which is located next to the drain port in the system base.

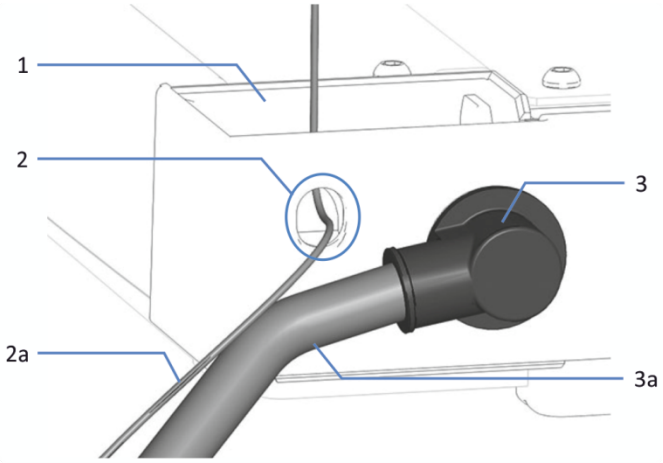

Figure 13: Funnel and waste outlets on the system base

No.	Description
1	Funnel for system drainage
2	Detector waste outlet
2a	Detector waste line
3	System drain port (hidden behind the elbow connection)
3a	System waste line

- If you have to cut tubing to length, use a tubing cutter. Make sure that the cut is at a right angle to the length of the tubing and that the end is free of nicks or burrs.

5.4.3.2 Connecting the Waste Line to the System Drain Port (Drain Tubing)

Parts required

- Drain tubing from ship kit
- Elbow connection piece from ship kit
- Suitable waste container

Follow these steps

1. Push an elbow connection piece into the system drain port as far as it goes in to establish a self-sealing connection.
2. Push the drain tubing into the elbow connection piece with your hand as far as it goes in to establish a self-sealing connection.
3. Route the free end of the drain tubing into a waste container.
4. *Only if guiding the drain tubing toward the system's rear:* Insert the drain tubing into the clips and make sure that the drain tubing does not form a siphon.

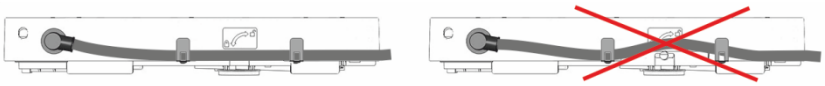

Figure 14: Inserting the drain tubing into clips

TIP

If routing the drain tubing of the column compartment also toward the system's rear, you can insert the drain tubing of the column compartment into the clips as well.

5. Ensure proper drainage of waste (see next section).

Ensuring Proper Drainage of Waste

1. Position the waste container below the level of the system stack. To prevent solvent vapors from evaporating back into the system, make sure that the distance is sufficient.
2. Make sure the drain tubing is neither bent nor pinched.
3. To prevent liquid from flowing back into the system, the entire drain tubing must remain below the drain port. Avoid the formation of siphons.

4. To allow the waste liquid flowing off properly and avoid liquid accumulation in the system base, the end of the waste line must not be submerged in waste liquid (see figure below):

   a) Shorten the tubing if required.

   b) Observe the liquid level in the waste container and empty the waste container as necessary.

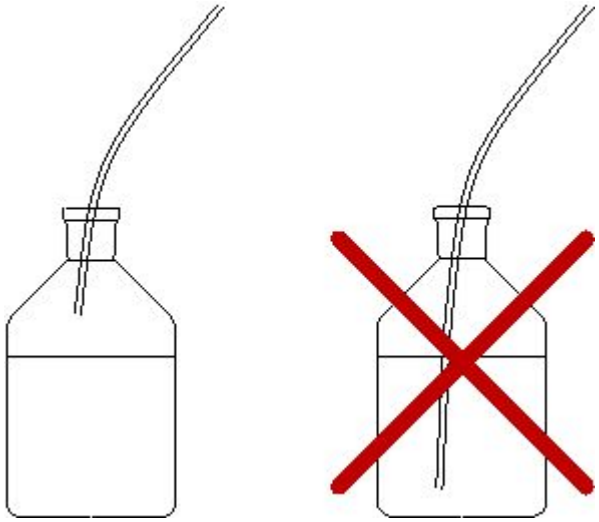

Figure 15: Free end of waste line in waste container

5.4.3.3 Testing the Drain System

Check the drain system for proper drainage of waste:

1. Pour water or isopropanol into the drain in the solvent rack.
2. Verify that the liquid leaves the system at the system drain port and into the waste container.
3. If a leak is visible, find and eliminate the problem.

5.4.3.4 Installing the Detector Waste Line

Parts required

- Detector waste line

TIP The detector waste line connects the flow cell outlet through the detector waste outlet to the waste.

- For instructions on how to connect the waste line through the detector waste outlet to the waste, follow the steps below.
- For instructions on how to connect the waste line from the flow cell outlet, refer to the *Operating Manual* for your Vanquish detector.

- Suitable waste container

Follow these steps

1. Locate the outlet for the detector waste line in the system base (see figure below).
2. Route the waste line through the detector waste outlet.

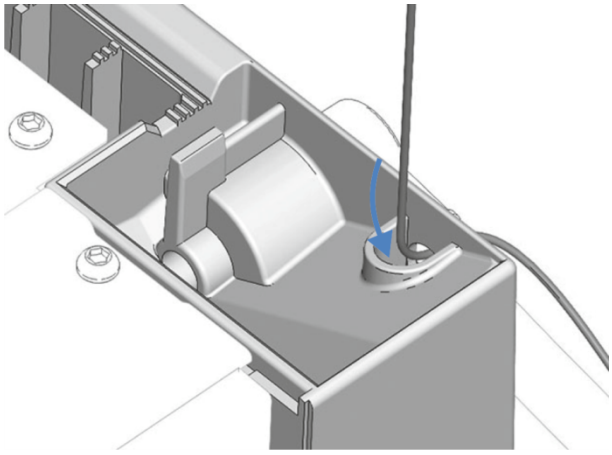

Figure 16: Routing the waste line through the outlet

3. Route the free end of the waste line into a waste container.

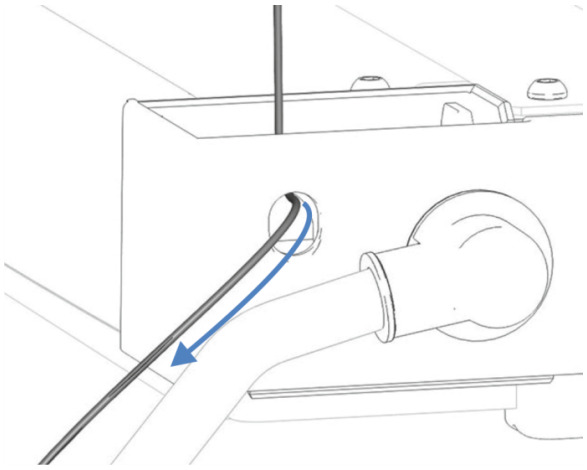

Figure 17: Guiding the waste line to the waste container

4. Ensure proper drainage of the waste from the detector. You may need to cut the waste line to length.
5. Ensure proper drainage of waste (see next section).

Ensuring Proper Drainage of Waste

1. Position the waste container below the level of the system stack. To prevent solvent vapors from evaporating back into the system, make sure that the distance is sufficient.
2. Make sure the drain tubing is neither bent nor pinched.
3. To prevent liquid from flowing back into the system, the entire drain tubing must remain below the drain port. Avoid the formation of siphons.
4. To allow the waste liquid flowing off properly and avoid liquid accumulation in the system base, the end of the waste line must not be submerged in waste liquid (see figure below):
   a) Shorten the tubing if required.
   b) Observe the liquid level in the waste container and empty the waste container as necessary.

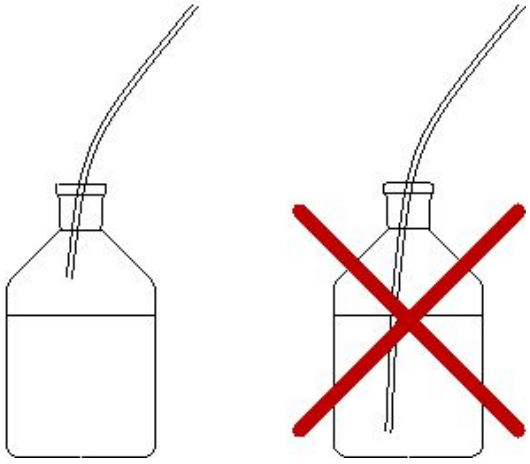

Figure 18: Free end of waste line in waste container

5.4.4 Attaching the Column Compartment to the System Stack

In the standard configuration, the Vanquish system includes one column compartment, installed to the right side of the system.

TIP An extended or left-side configuration of the column compartment is also available. Observe the following notes:

- The extended configuration on the right side can include up to three column compartments. For the extended configuration of the column compartment, up to two conversion kits are required.
- The column compartment can also be installed to the left side of the Vanquish system stack. For the left-side installation, one column compartment requires one conversion kit. Each additional column compartment on the left side requires an additional conversion kit. If a Vanquish Charger or the Vanquish Display is used with the Vanquish system, the column compartment must be attached to the right side of the system.
- For ordering information, contact your local Thermo Fisher Scientific sales organization.

Installation by Service Engineer only

Only service personnel certified by Thermo Fisher Scientific are permitted to install the extended configuration with up to three column compartments or to perform the left-side installation of the column compartment.

For installation of the standard configuration, follow the instructions below.

Parts required

- 4 T-slot nuts
- 2 crosspieces
- 4 screws
- 4 spacers

Tools required

Screwdriver, Torx T20

Follow these steps

1. Align the screw holes of the two T-slot nuts, the spacers and the crosspiece.

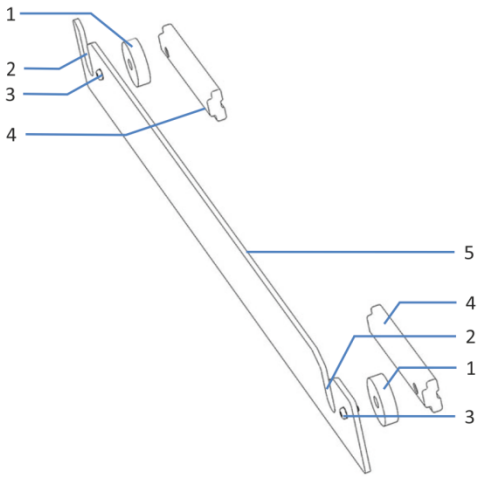

Figure 19: Mounting bar

No.	Description
1	Spacer
2	Groove
3	Screw
4	T-slot nut
5	Crosspiece

2. With the screws, fix the T-slot nuts and the spacers onto the crosspiece.
   The T-slot nuts must face each other, as shown above.

3. Slide the T-slot nuts of the mounting bar in the rail on the system housing and push until stop.
   The grooves on the mounting bars must face upwards. Make sure, that the orientation of the crosspiece is as indicated on the picture.

4. Tighten the screws on the mounting bars.

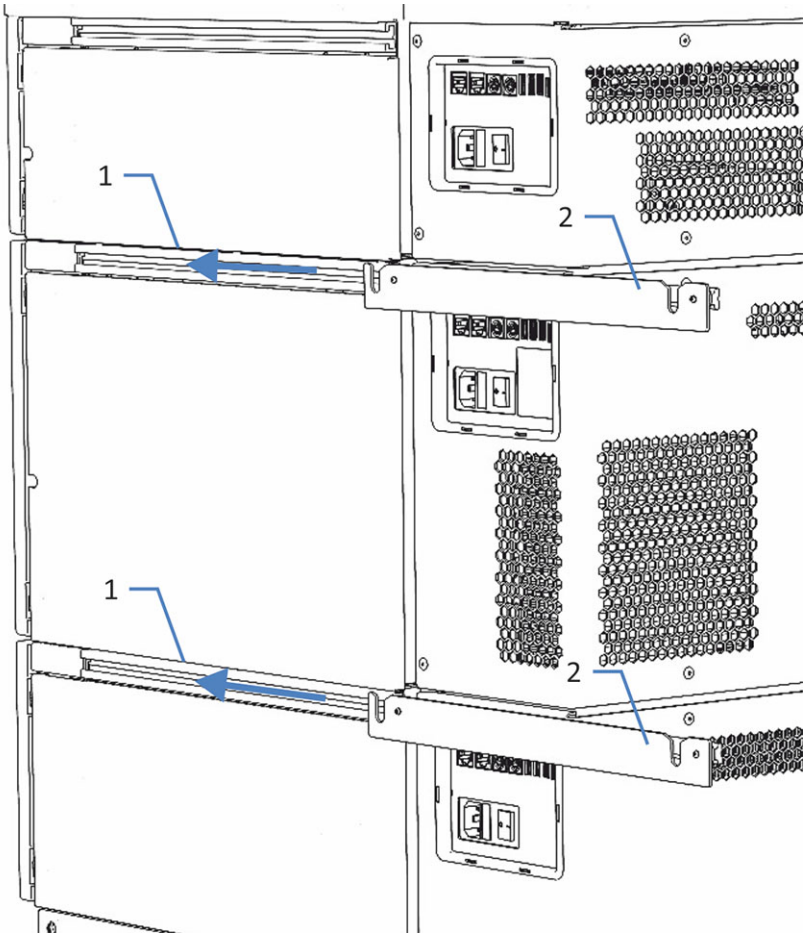

Figure 20: Installing the mounting bars on the system housing

No.	Description
1	Rail
2	Mounting bar

5. Lift the column compartment into vertical position.

6. To insert the holding knobs in the grooves on the mounting bar, grasp the column compartment by its sides and slightly lift the column compartment up.

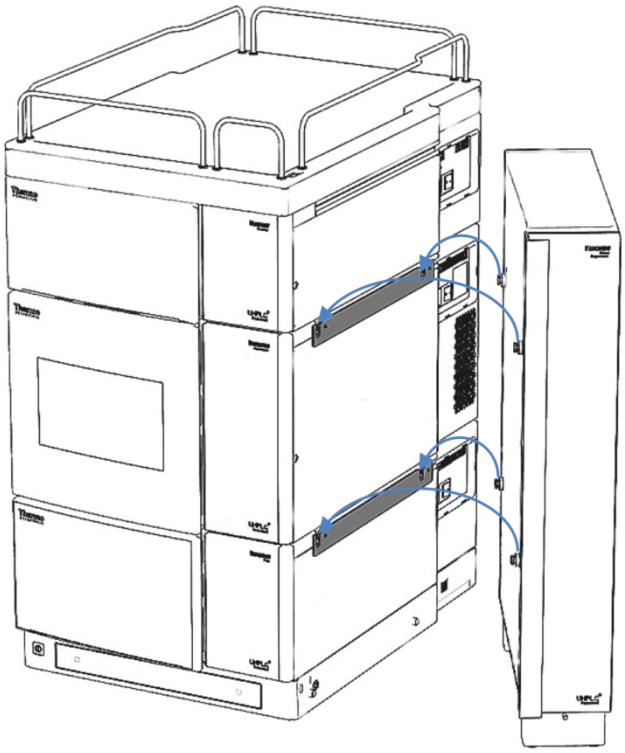

Figure 21: Attaching the column compartment to the system stack

7. Connect a waste line to the column compartment drain port. For instructions, refer to the *Operating Manual* for the column compartment.

See also

Connecting the Waste Lines (▸ page 55)

5.4.5 Signal Cable Connections

This section provides details on the cables and interfaces used to connect the system to a computer or other devices, and details on how to interlink the system modules with each other.

5.4.5.1 Connector Overview

The following connectors are provided on the system modules for power line connection and for signal connections:

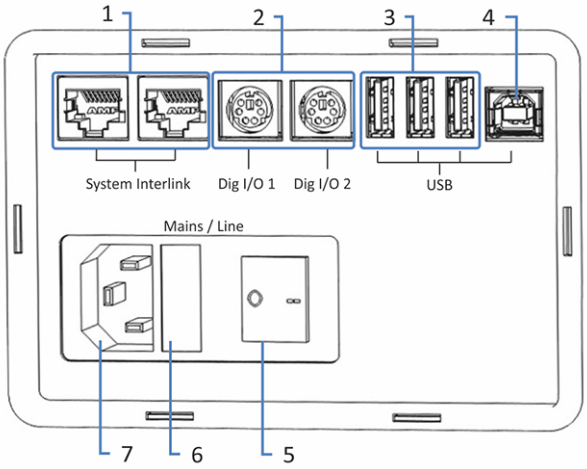

Figure 22: Connectors (here: pump)

No.	Description
1	System Interlink port Allows power on/off control for the system from the Vanquish system base and device communication **Note**: Do not connect cables other than the provided system interlink cables to these ports, as this may damage the electronics. For details on system interlink connections, see System Interlink Connections (▶ page 69).
2	Digital I/O ports (not available in all modules) Allow exchange of digital signals with external instruments For information on connection and pin assignment, refer to the *Operating Manual* for the related module.
3	USB (Universal Serial Bus) hub ("A"-type connector) (not available in all modules) Allows connection to other modules in the Vanquish system
4	USB port ("B" type connector) Allows connection to other modules in the Vanquish system or the computer on which the chromatography data system is installed. For details on USB connections, see USB Connections (▶ page 67).
5	Main power switch (on/off control)
6	Fuse holder
7	Power inlet connector

TIP Thermo Fisher Scientific recommends using the USB ports only as described above. If the USB ports are used for any other purpose, Thermo Fisher Scientific cannot ensure proper functionality.

5.4.5.2 USB Connections

All USB connections require standard USB A-to-B type cable.

Figure 23: USB cable

The flat, rectangular end of the cable is the "A" connector. The smaller, hexagonal end is the "B" connector.

TIP

- The USB standard limits the USB cable length to 5 meters. Each USB device can be separated from the computer or next USB hub by no more than 5 meters.
- After connecting the USB cables and before turning on the power to a device for the first time, verify that the chromatography software is installed on the computer. When the power is turned on, the required USB drivers are automatically found and the Windows™ operating system can detect the device.

Connecting the USB Cables

USB Cable Overview

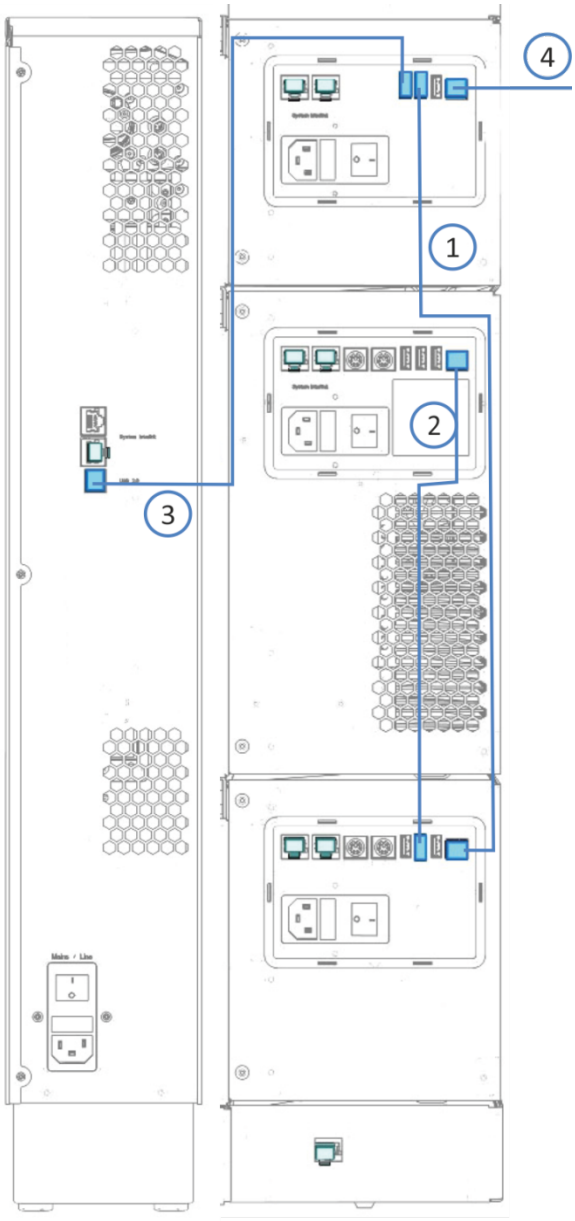

Figure 24: USB cable connections (example)

No.	Description
-	USB connection:
1	From pump to detector
2	From autosampler to pump
3	From column compartment to detector
4	From detector to computer

Follow these steps

1. On the autosampler, pump, and column compartment, connect the "B" connector of a USB cable to the **USB** port.
2. Connect the "A" connector of the USB cable from the pump to the **USB** hub on the UV/VIS detector. Connect the "A" connector of the USB cable from the other modules to the **USB** hub on the UV/VIS detector or pump.
3. Connect the "B" connector of a USB cable to the **USB** port on the UV/VIS detector, and connect the "A" connector of the USB cable to a USB port (2.0 or higher) on the computer.

In order to control the modules that use a USB hub on another module, the module that provides the hub must be turned on.

NOTICE

- Never use defective communication cables. If you suspect that a cable is defective, replace the cable.
- To ensure trouble-free operation, use only the cables provided by Thermo Fisher Scientific for connecting the system.

5.4.5.3 System Interlink Connections

The system interlink connections require a special system interlink cable (Cat. 6 cable).

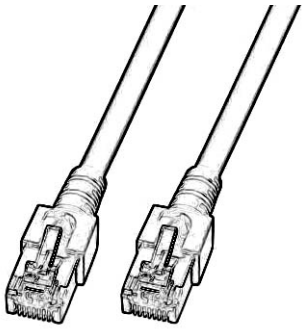

Figure 25: System interlink cable

Connecting the System Interlink Cables

System Interlink Cable Overview

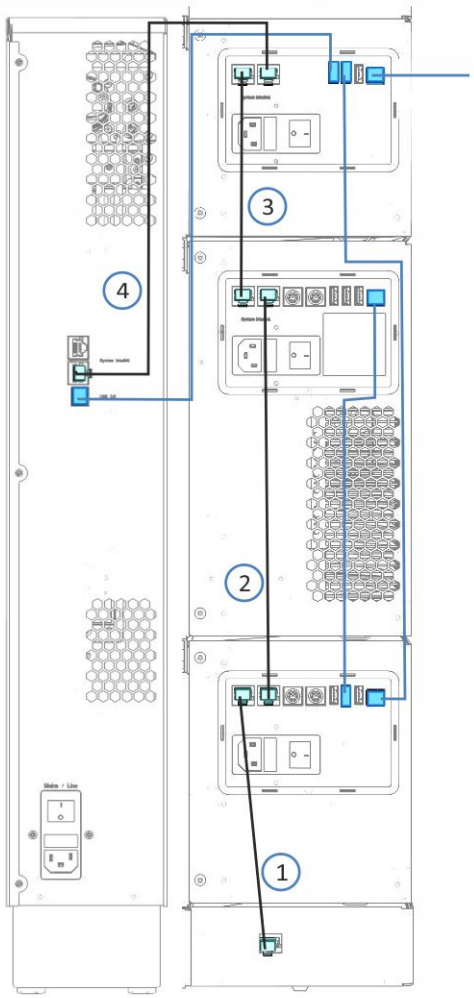

Figure 26: USB and system interlink cable connections (example)

No.	Description
-	System interlink connection:
1	From system base to pump
2	From pump to autosampler
3	From autosampler to detector
4	From detector to column compartment

Follow these steps

1. Connect one end of the system interlink cable to the **System Interlink** port on the system base, and the other end to a **System Interlink** port on the pump.
2. Connect one end of the system interlink cable to the free **System Interlink** port on the pump, and the other end to a **System Interlink** port on the autosampler.
3. Connect one end of the system interlink cable to the free **System Interlink** port on the autosampler, and the other end to a **System Interlink** port on the detector.
4. Connect one end of the system interlink cable to the free **System Interlink** port on the detector, and the other end to a **System Interlink** port on the column compartment.

5.4.6 Connecting Power Cables

This section provides details on how to connect the modules to the power source. Do not turn on the system or modules yet.

NOTICE

Condensation in a device can damage the electronics.

- Before connecting the devices to the power line, be sure that no condensation is present in the devices.
- If you suspect that condensation is present, allow the device to warm up to room temperature slowly. Wait until the condensation is completely gone before proceeding.

Follow these steps

1. Verify that the power switch on each device is set to OFF.
2. Connect the power cord to the power-inlet connector on each device.
3. Connect the free end of the power cords to an appropriate power source.
4. Insert the signal and power cables into the cable clips (see Guiding Cables through the Cable Clips (▸ page 72)).
5. If necessary, move the system to its final position.
6. Lock the system base against moving (see Locking the System Base (▸ page 54)).

5.4.7 Guiding Cables through the Cable Clips

The cable clips can be used to guide signal and power cables in an orderly fashion. The pump and the detector each have one cable clip on each side and the autosampler has two cable clips on each side. The location of the cable clips is shown below.

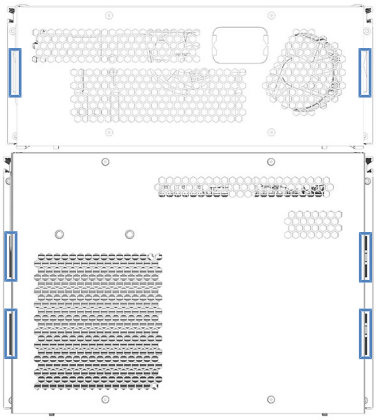

Figure 27: Cable clips in the autosampler and detector

5.5 Setting Up the Flow Connections

5.5.1 General Information and Guidelines

This section gives an overview of the flow connections to and from the system. For details on tubing and capillary connections within and between the modules, refer to the *Operating Manual* of each module.

Flow connections can be filled with hazardous substances. Observe the warning messages and precautionary statements presented in Safety Precautions (▸ page 19).

- Dirty components can contaminate the chromatography system. Contamination leads to poor performance of the modules and entire system or can even cause damage to the modules and system. Therefore:
  - Always wear appropriate gloves.
  - Place the components only on a clean, lint-free surface.
  - Keep your tools clean.
  - Use only lint-free cloth for cleaning.
- The system uses the Viper™ fitting system. For installation instructions and guidelines and for handling recommendations, see Connecting Fittings, Capillaries, and Tubing (▸ page 77).

5.5.2 Flow Connections Overview

The picture illustrates the liquid flow path through the system:

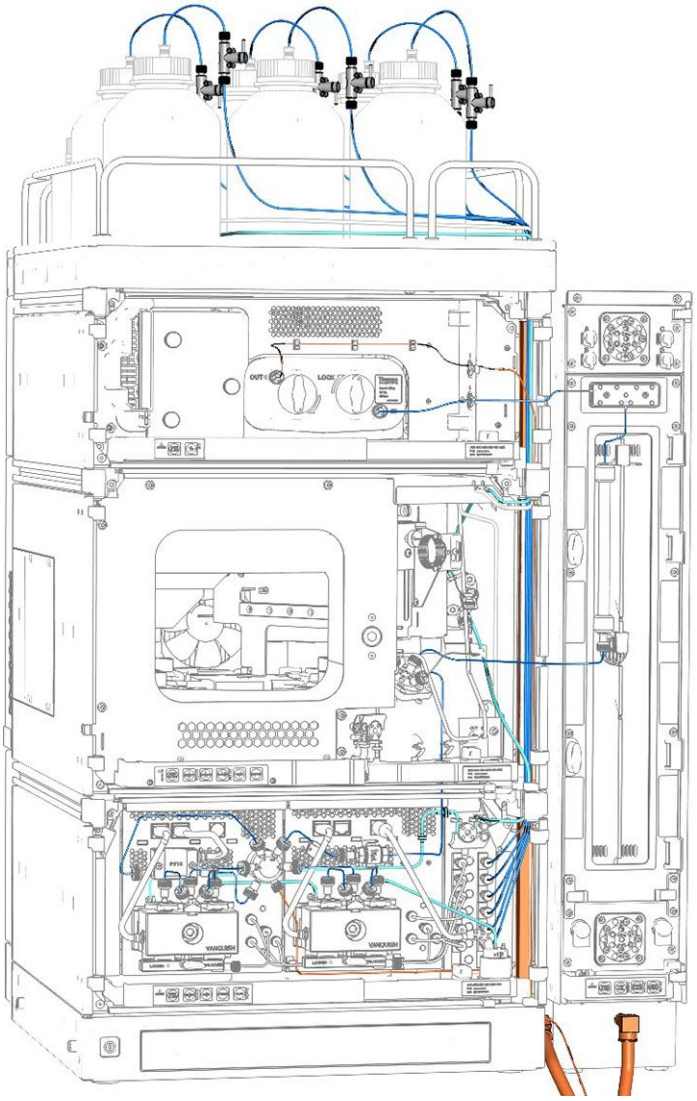

Figure 28: Flow connections in the Vanquish system (example)

Setting up the System Flow Connections

1. Set up the flow connections for the pump. For details, refer to the *Operating Manual* of the pump.
2. Set up the flow connections for the autosampler. For details, refer to the *Operating Manual* of the autosampler.

3. Set up the flow connections for the column compartment except the column. For details, refer to the *Operating Manual* of the column compartment.
   - Connect the pre-heater from port 2 on the autosampler injection valve to the column outlet tubing using a Viper union. The union replaces the column for the flushing procedure.
   - Do not install the column yet!
   - Connect a waste tubing to the outlet from the column compartment, for example, post-column cooler (if applicable) or the detector inlet capillary (depending on system configuration), and column switching valve (if applicable) and route it to waste.
   - Do not install a flow cell yet.
4. Turn on the system (see Turning On the System (▸ page 79)).
5. Set up the system in the chromatography data system (see Setting Up the System in the Software (▸ page 80)).
6. Flush the system without column (see Flushing the System (▸ page 82)).
7. Install a column. For details, refer to the *Operating Manual* of the column compartment. Route the column outlet to waste.
8. Flush the system without flow cell (see Flushing the System (▸ page 82)).
9. Install a flow cell, if applicable. For details, refer to the *Operating Manual* of your Vanquish detector.
10. Flush the system again with flow cell (see Flushing the System (▸ page 82)).

See also

Connecting the Waste Lines (▸ page 55)

5.5.3 Guiding Capillaries and Tubing Through the System

Flow connections between the modules of the Vanquish system are guided through either the tubing chase in the devices or the guide holes or capillary clips of the devices.

Tubing Chase with Tubing Guides

To guide certain tubes and lines from the top module to the bottom module in the Vanquish system stack, the stackable modules have a tubing chase on the inside right. The tubing chase provides four tubing guides.

Each guide can hold up to three tubes or lines. In each module, push the tube (or line) into the appropriate guide.

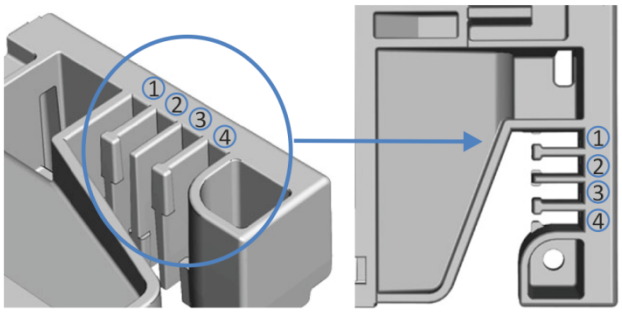

Figure 29: Tubing chase with tubing guides (left: view from inside, right: view from top)

No.	Use for
1	Solvent tubing (up to three solvent lines)
2	Solvent tubing (up to three solvent lines)
3	Wash liquid tubing (seal wash, autosampler needle wash)
4	Detector waste line

Tubing Brackets

Tubing brackets are available for holding the tubing in place. Slip the bracket side onto the drain pipe.

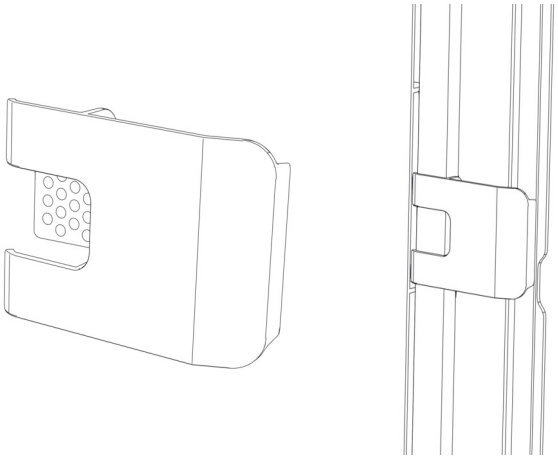

Figure 30: Tubing bracket (left), tubing bracket installed (right)

Dual System Arrangements

The number of tubes may exceed the capacity that the tubing guides can hold. In this case, it is recommended to place the solvent lines in the tubing guides and route any additional tubes freely in the tubing chase.

Guide Holes and Capillary Clips

Guide holes and capillary clips are provided at specific positions on the system modules. Route flow connections from one module to the next module in the Vanquish system through the appropriate guide hole or capillary clip when instructed to do so in the manual.

5.5.4 Connecting Fittings, Capillaries, and Tubing

This section provides information about how to connect and handle capillaries, fittings, and tubing.

5.5.4.1 General Guidelines

When connecting capillaries and tubing, follow these general recommendations:

- Use only the capillaries and tubing (for example, solvent lines or waste tubing) that are shipped with the product or additional or spare capillaries and tubing as recommended by Thermo Fisher Scientific.
- The connectors must be free from contaminants. Even minute particles may cause damage to the system or lead to invalid test results.
- Do not install capillaries or tubes that are stressed, nicked, kinked, or otherwise damaged.
- Install capillaries and fittings only at the positions for which they are intended.

5.5.4.2 Connecting Viper Capillaries

This section describes how to connect Viper™ capillaries. All Viper flow connections in the Vanquish system are designed to be finger-tight.

To connect Viper capillaries with knurls, follow these steps:

NOTICE

- Tighten or loosen Viper capillaries *only* with your fingers. Do not use tools other than the knurl that comes with the capillary.
- To avoid damage to the capillary or connection, tighten and loosen the Viper capillaries *only* when the system pressure is down to zero.

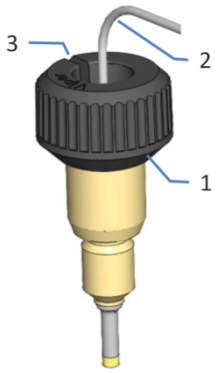

Figure 31: Viper fitting with knurl

No.	Description
1	Knurl
2	Capillary
3	Slot

1. Insert the Viper capillary into the connection port.
2. Tighten the connection by the knurl.

TIP Note the slot in the knurl. You can easily remove the knurl from the capillaries through this slot if space is limited.

3. Check whether the connection leaks. If leakage exists, follow the steps further down.

TIP

Depending on the modules used in the system, you may also find other fitting connections. Refer to the *Operating Manual* for the respective module for information on how to handle these types of fittings.

Resolving Leakage of Viper Fittings with Knurls

1. Tighten the connection a little more.
2. If leakage continues, remove the capillary.
3. Clean the capillary ends carefully by using a lint-free tissue wetted with isopropanol.
4. Reinstall the capillary.
5. If the connection continues to leak, install a new Viper capillary.

5.6 Turning On the System

Preparations

1. Verify that any shipping locks have been properly loosened or removed.

NOTICE—System damage

Shipping locks must be properly loosened or removed before operation to avoid damage to the system.

2. Lock the system base (see Locking the System Base (▸ page 54)).
3. Verify that the chromatography software is installed on the data system computer. When the power is turned on, the required USB drivers are automatically found and the Windows™ operating system can detect the system modules.

Follow these steps

1. Turn on each system module with its main power switch. Verify that the autosampler is turned on before the pump flow is on and pressure builds up.
2. *If optional system controller is installed:* Turn on the system controller by pressing the upper push button on the front left of the system base.
3. Turn on the system power by pressing the lower push button on the front left of the system base (system power button).

TIP Turn a module off with the main power switch, when instructed to do so, for example, during maintenance. Pressing the system power button will not be sufficient to turn off the power to the module completely.

See also

Power On/Off Control (▸ page 86)

5.7 Setting Up the System in the Software

This section describes the basic steps for operating the Vanquish system with the Chromeleon 7 software. For additional information, refer to the Help and documents provided with the software.

This manual assumes that the Chromeleon software is already installed on the data system computer and a valid license is available.

TIP In order to start the Chromeleon Instrument Controller, you must log on under Windows with local administrator privileges, or as a member of the **Windows Chromeleon Operators** user group.

Loading the USB Drivers

1. Turn on the power to the data system computer if it is not yet already on.
2. Turn on the power to all system modules.
   Windows will automatically detect the new devices and perform the USB installation. If Windows fails to detect the devices and launches a wizard instead, this indicates that you connected the devices to the computer and turned on the power for the first time *before* you installed the Chromeleon software. In this case, cancel the wizard, install the software, and then repeat the steps.

Starting the Instrument Controller and Instrument Configuration Manager

1. Start the Chromeleon Instrument Controller.
   Right-click the Chromeleon tray icon on the Windows taskbar (the icon is crossed out in red) and click **Start Chromeleon Instrument Controller**. The icon changes to gold, indicating that the Instrument Controller Service is starting. The icon changes to gray when the Instrument Controller Service is running (idle).

   If the Chromeleon tray icon is not available on the Windows taskbar, click **Start > All Programs** (or **Programs**, depending on the operating system) **>Thermo Chromeleon 7 > Services Manager > Start Instrument Controller**.
2. Start the Chromeleon 7 Instrument Configuration Manager.
   Click **Start > All Programs** (or **Programs**, depending on the operating system) **> Thermo Chromeleon 7 > Instrument Configuration Manager**.

Adding the Vanquish System

1. On the **Edit** menu, click **Add Instrument** to add a new instrument (system).
2. Select the new instrument and click **Add Module** on the **Edit** menu to add the first module.
3. In the **Add module to instrument** dialog box, on the **Manufacturers** list, select **Thermo Scientific HPLC: Vanquish** and on the **Modules** list, select the module you want to add, for example, **Vanquish Binary Pump**. Repeat this step for each module of the system.
4. On the **General** configuration page for each module, make sure that simulation mode is deactivated and click **Browse** to select the module address.
   The Chromeleon software connects to the module and transfers the settings from the device firmware to the software. Check and change the settings on the other configuration pages if necessary. For information about the settings, click **Help** or press the **F1** key.

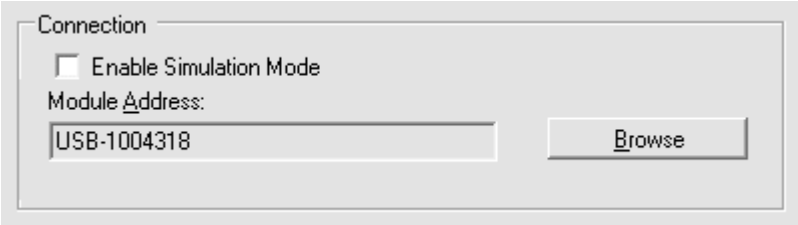

Figure 32: Software configuration: select module address (here: pump)

5. On the **File** menu, click **Save Installation** and then close the Instrument Configuration Manager.

5.8 Flushing the System

This section describes how to flush the Vanquish system after installation. As certain system components are filled with isopropanol during shipment, flushing is required before the system can be operated.

Flushing the System without Column

Follow these steps:

NOTICE

To avoid damage to other modules in the Vanquish system, verify the following before you begin:

- The detector is not connected to the flow path.
- No column is installed in the column compartment.

1. Purge the pump.
2. Have the pump deliver the solvent used for purging for a short time.

Flushing the System with Column Installed

Flush the system again for a short time after connecting the column with a solvent suitable for your application. Follow these steps:

1. Verify that the detector is not connected to the flow path.
2. Have the pump deliver the solvent for a short time. Observe the pressure limit and other properties of the column.

Flushing the System with Column and Flow Cell Installed

Flush the system again for a short time after connecting the flow cell with a solvent suitable for your application. Observe the guidelines for flow cells in the *Operating Instructions* of the detector.

NOTICE

- When the charged aerosol detector is connected in the system flow path, flush the detector only when the detector gas flow is turned on.
- Flush the detector with flow from the pump.

6 Operation

This chapter provides information for routine operation and for shutdown.

6.1 Introduction to this Chapter

The information in this chapter assumes that the initial setup of the system has already been completed. If this is not the case, refer to the instructions in Installation (▷ page 39).

Software descriptions in this manual refer to Chromeleon 7. Terminology may be slightly different with other software versions.

6.2 Safety Guidelines for Operation

When operating the system, pay attention to the following safety guidelines:

Observe all warning messages and precautionary statements presented in Safety Precautions (▶ page 19).

Observe all warning messages and precautionary statements presented in the *Safety Guidelines for Operation* section in the *Operating Manual* for the individual modules of the Vanquish system.

NOTICE

Pay attention also to the following guidelines:

- To prevent damage resulting from leakage or from running the pump dry, always set the lower pressure limit for the pump.
- If there is evidence of leakage in the device, turn off the pump flow and remedy the situation immediately.
- If the pump flow is interrupted, act appropriately to protect the components in the detector. For details, refer to the *Operating Manual* for the detector.
- Always verify that the autosampler is turned on before the pump flow is on and pressure builds up. If the autosampler is turned off, for example, after a power failure, stop the pump flow and wait until the pressure is down to zero before turning on the autosampler or other modules again.

6.3 Power On/Off Control

For easier handling, you can use the power button on the front left of the Vanquish system base (system power button) for power on/off.

Observe the following:

- *All* modules in the Vanquish system that are connected to the system base via system interlink cables are turned on or off simultaneously when the system power button is pressed.
- When the power is on, the system power button is pressed in. When the power is off, the system power button stands out.
- If the main power switch on a device is off, you cannot turn on the device with the system power button.
- To turn off a device completely, you *have to* turn it off with the main power switch on the device. Pressing the system power button will not be sufficient to turn off the power to the device completely.

6.4 Preparing the System for Operation

This section gives information on any additional steps that are required to prepare the system for operation and sample analysis.

Before Operating the System for the First Time

Prepare the system for the first-time operation, observing the following:

NOTICE

Flush the system flow path thoroughly before operating the device for the first time:

- When you install devices or components to the system, always flush them to waste before connecting them in the system flow path. Follow the instructions in Flushing the System (page 82).
- Some components of the system are filled with isopropanol when the system is shipped from the manufacturing site. When operating the system for the first time, use solvents that are miscible with isopropanol. If they are not, use an appropriate intermediate solvent.
- Verify that any air bubbles are completely flushed out of the system flow path.

Refer to the *Operating Manual* for each system module for any steps that may be required before initial operation.

Before Starting Sample Analysis

Before starting an analysis:

- Check the liquid level in the solvent reservoirs. Verify that the amount of solvent is sufficient for the analysis.
- Close the doors of all modules in the Vanquish system, if not already done.
- Make sure that the chromatography system is properly equilibrated (see further down).

System Equilibration

System equilibration should include the following operations:

- Purging the pump (*all* channels, including those not used for the application)
- Flushing the entire chromatography system with the starting solvent to rinse out any solvent from a previous analysis run
- Warming up (or cooling down) all temperature-controlled devices in the system to the starting temperature. Temperature-controlled devices can be, for example
  - Column compartment and post-column cooler
  - Sample compartment thermostatting in the autosampler
  - Flow cell in a fluorescence detector
  - Evaporation tube in a charged aerosol detector
- Turning on the lamp (or lamps) in the UV/VIS detector
- Monitoring the pump pressure and pressure ripple and checking that the pressure is stable and the ripple within reasonable limits for the application
- Monitoring the detector signal and checking whether the detector signal is stable so that the drift and signal noise are within reasonable limits for the application
- Performing an autozero of the detector baseline

TIP The Chromeleon software supports procedures for automatically starting a chromatography system in the software (**Smart Startup**). The startup procedure includes the operations for system equilibration. For details, refer to the *Chromeleon Help*.

6.5 Use of Solvents and Additives

Particles entering the chromatography system can block capillaries and valves, increase wear, and damage the column or system. Especially with aqueous solvents, algae and other microorganisms can grow and deposit in the system and block the solvent line filters. Blocked capillaries or filters can cause increased or unstable system pressure.

TIP In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the system modules have been modified for NP applications. See Normal-Phase Compatible Solvents and Additives (▶ page 128).

For optimum performance of the chromatography system, observe the following guidelines:

Solvent Quality and Filtration

- Use high-quality high-purity solvents (filtered) and additives as required by the application, for example, UHPLC-grade or LC/MS-grade. If a fluorescence detector is used in the system, consider using fluorescence-grade solvents.
  Filtered high-purity solvents are usually labeled accordingly by the vendor.
- Use high-quality water for example, UHPLC-grade or LC/MS-grade (0.2 µm filtered).
- When you use water from water purification systems, polymeric contamination may occur if the purification system is not maintained properly.
- When preparing salt solutions or buffers and preparation is complete, use membrane filtration (0.2 µm) to remove any particulate matter and to reduce microbial growth.
- Use fresh solvents at regular intervals. Avoid adding up (refreshing) solvents. With premixed solvents, be especially sure that they are properly prepared and fresh.
- Always use the appropriate solvent line filters as recommended by Thermo Fisher Scientific. Check the filter frits for permeability at regular intervals and replace them as necessary.
- For best seal performance, do not recycle or recirculate solvents.
- Note the special properties of the solvents, such as viscosity, boiling point, or UV absorption.
- *If a charged aerosol detector is connected in the system flow path:* Observe the specific mobile phase guidelines for the detector in the *Vanquish Charged Aerosol Detector Operating Manual*.

Solvent Reservoirs

- Before filling a solvent reservoir, rinse the reservoir thoroughly with a high-purity solvent.
- To reduce the growth of algae, consider using amber glassware or using appropriate additives, for example, formic acid.
- Avoid using methanol from aluminum reservoirs.

Flushing after Operation

- Flush out buffers and solutions that form peroxides.
- Never leave buffers, salt solutions, or aggressive solvents in the system for a longer period without flow.
- Before you change from a buffer or salt solution to organic solution, flush the system thoroughly with de-ionized water.
- Before you change solvents, make sure that the new solvent is miscible with the previous solvent. If the solvents are not miscible, flocculation may occur.
  Mix immiscible solvents with an intermediate solvent to replace them step by step. For example, use isopropanol.

6.6 Operating the System from the Software

This section describes the basic steps for operating the Vanquish system with the Chromeleon software. For additional information, refer to the Help and documents provided with the software that you are using.

6.6.1 Starting the Instrument Controller and Client

1. Start the Chromeleon Instrument Controller.
   Right-click the Chromeleon tray icon on the Windows taskbar (the icon is crossed out in red) and click **Start Chromeleon Instrument Controller**. The icon changes to gold, indicating that the Instrument Controller Service is starting. The icon changes to gray when the Instrument Controller Service is running (idle).

   If the Chromeleon tray icon is not available on the Windows taskbar, click the **Start** button, then select **Thermo Chromeleon 7 > Services Manager > Start Instrument Controller**.

2. Start the Chromeleon 7 client.
   Click the **Start** button, then select **Chromeleon 7**.

6.6.2 Controlling the System from the ePanel Set

When the chromatography system is not running an automated analysis, you can control the system modules from the ePanel Set. Use the ePanel Set to view status information and perform commands.

To access the ePanel Set:

1. On the **Console**, click the **Instruments** Category Bar.
2. In the Navigation Pane, click the instrument that you want to control.
   The Chromeleon software connects to the instrument and displays the ePanel Set.

   The ePanel Set opens to the **Home** panel, which shows basic status information about each module in the system and provides access to the instrument Audit Trail.

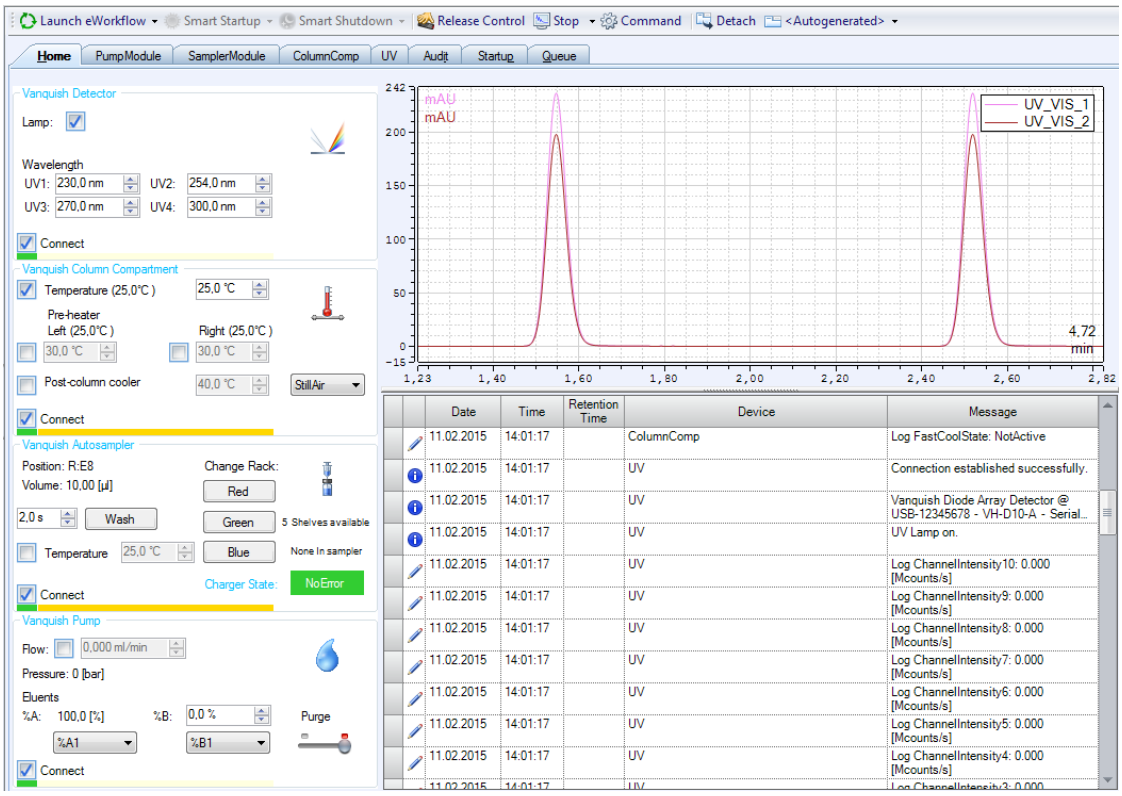

Figure 33: Chromeleon 7 ePanel for a Vanquish system (example)

3. On the ePanel Set, click the tab for a module.
4. Use the controls (for example, buttons, sliders) to perform commands.

5. If a function that you want to perform is not available on a panel, press the **F8** key to open the **Command** window. From this window, you can access all commands that are available for the system.

TIP

The commands and parameters that are available in the **Command** window may vary, depending on the user level in the **Command** window (**Normal**, **Advanced**, or **Expert**). To change the user level, right-click in the commands list and select a different user level.

6.6.3 Monitoring the Baseline

When an instrument is idle, you can monitor the baseline signals without starting a sequence. During baseline monitoring, the monitored signals are displayed on the real-time signal plot on the ePanel for the module. You may have to add the signal to the plot in the Plot Properties (for details, refer to the *Help*).

To monitor the baseline signals:

1. Open the ePanel Set.
2. On the toolbar above the ePanel Set, click **Monitor Baseline**:

Figure 34: Monitor Baseline icon

3. In the **Select Channels to Monitor** dialog box, select the signals that you want to monitor.
4. To stop monitoring the baseline, click **Stop** on the toolbar.

TIP

Monitor baseline data is overwritten each time baseline monitoring is started. If you want to save the data permanently, define the location in the **Monitor Baseline Save Preferences** dialog box. For details, refer to the *Help*.

6.6.4 Running Automated Sample Analysis

Automated sample analysis with the chromatography system involves creating and running a sequence. In a sequence, you determine how the injections of a sample are analyzed and in which order they are processed. Each injection of a sequence is processed by using an instrument method, which defines the property values and timed control commands for each module. For details how to create an instrument method using the Instrument Method Wizard, refer to the *Help*.

Chromeleon 7 supports several methods for creating a new sequence. The most important are:

TIP

If no eWorkflows are available, you can create a new eWorkflow as described in the *Help*. As an alternative, use the Sequence Wizard to create the sequence.

- eWorkflows (preferred method)
  eWorkflows provide a set of predefined templates and rules for creating a new sequence.
- Sequence Wizard

Creating a Sequence via eWorkflows

1. On the **Console**, click the **eWorkflows** Category Bar.
2. In the **Navigation Pane**, click the eWorkflow name.
3. In the Work Area, click the instrument name, and then click **Launch**.
4. The eWorkflow Wizard guides you through the process. Complete the steps in the wizard. For detailed information about a wizard page, click the Help icon.
   After you finish the wizard, the sequence is displayed in the Data view of the **Console**.

Creating a Sequence via Sequence Wizard

1. On the **Console** menu bar, click **Create > Sequence**.
2. The Sequence Wizard guides you through the process. Complete the steps in the wizard. Specify the number of samples and/or standards, the instrument method, processing method, and report template that you want to use. For detailed information about a wizard page, click the Help icon.
   After you finish the wizard, the sequence is displayed in the Data view of the **Console**.

Starting the new sequence

For details how to control sequences, assign them to instruments, start the sequence run, and manage queues, refer to the *Chromeleon Help*.

6.7 Shutting Down the System

If the system will not be operated for some time, observe the general guidelines outlined below.

Interrupting Operation of the System for a Short Period

To interrupt operation of the system for a short period (short-term shutdown), for example, overnight, observe these guidelines for the Vanquish system modules, as required by your system arrangement:

- For your Vanquish detector, note the following:

Detector Type	Description
Charged aerosol detector	Check that sufficient gas is available to continue gas flowing through the detector. This is to prevent any build-up of residue from solvents or analytes. Gas must be flowing when pump flow is delivered to the detector.
UV/VIS detectors	The lamp(s) in the detector can remain turned on. *Variable wavelength detector and VH-D10 diode array detector only:* The shutter can be moved to a closed position for protection of the flow cell.
Fluorescence detector	Turn off temperature control for the flow cell.

- Apply a flow of 0.05 mL/min and have the pump deliver an appropriate solvent.
  Check the lower pressure limit for the pump and adapt the value if necessary. If the pressure falls below the lower limit, the pump stops the flow.
- Set the injection valve in the autosampler to the Inject position.
- Make sure that the temperature of the column does not exceed 40 °C.
- When resuming operation, let the flow equilibrate and verify that the operating parameters for the other system modules are set as required before proceeding.

TIP The Chromeleon software provides procedures for automatically preparing the chromatography system for shutdown. The procedures include, for example, operations for reducing the flow rate, reducing the temperature in temperature-controlled devices, and turning off the detector lamps. For information about **Smart Shutdown** and **Smart Standby**, refer to the *Chromeleon Help*.

Interrupting Operation of the System for a Longer Period

To interrupt operation for a longer period, follow the instructions below. Also observe the instructions and guidelines for the long-term shutdown for the other system modules in the Operating Manual for each module.

1. Remove the column.
2. Flush the system with an appropriate solvent (minimum HPLC-grade). Observe the following:

TIP With a Vanquish Core system that has been modified for using normal-phase compatible solvents and additives, see the information about the flushing liquid in Considerations with Normal-Phase Compatible Solvents and Additives (▷ page 130).

Situation after Shutdown	If no additive is used	If an additive is used
System remains in the laboratory after shutdown	Flush the system, for example with methanol. 100% acetonitrile should not be used.	Flush the system with several volumes of methanol and water (50:50) (for example, 1.0 mL/min for 10 minutes with the standard system) to prevent salt buildup in the fluidics. If the solvents in the device are not miscible with water, use an appropriate intermediate solvent.
System shall be transported or shipped after shutdown	Flush the system with isopropanol.	Flush the system first with several volumes of methanol and water (50:50) (for example, 1.0 mL/min for 10 minutes with the standard system) to prevent salt buildup in the fluidics. If the solvents in the device are not miscible with water, use an appropriate intermediate solvent. Afterward, flush the system with isopropanol.

3. Turn off the system with the system power button on the system base.
   If one of the modules shall be removed from the system stack, turn off *all* system modules with their main power switch. Pressing the system power button will not be sufficient to turn off the power to the devices completely.

If the system shall be transported or shipped after shutdown, follow the instructions in Transporting or Shipping the System (▷ page 107).

7 Maintenance and Service

This chapter gives general guidelines on maintenance and transport of the system.

7.1 Introduction to Maintenance and Service

This chapter describes the routine maintenance that the user may perform for the system.

Additional maintenance or service procedures must be performed only by service personnel certified by Thermo Fisher Scientific (for brevity, referred to as Thermo Fisher Scientific service personnel).

7.2 Safety Guidelines for Maintenance and Service

When performing maintenance or service procedures, pay attention to the following safety guidelines:

Observe all warning messages and precautionary statements presented in Safety Precautions (page 19).

WARNING—High Voltage

High voltages are present inside the device that could cause an electric shock.

Do not open the housing or remove protective panels unless specifically instructed to do so in this manual.

WARNING—Escape of Hazardous Substances from Flow Connections

Flow and capillary connections can be filled with substances that can pose health risks. Solvent can spray when capillaries burst, slip out of their fittings, or are not properly tightened or when capillary connections are otherwise open.

- Wear appropriate protective equipment and follow good laboratory practice.
- Before starting maintenance or repair procedures, flush out harmful substances with an appropriate solvent.

WARNING—Tilting Liquid Reservoirs

Liquids in the reservoirs on the solvent rack might contain harmful substances. Spilling of these substances can pose health and safety risks.

To prevent the reservoirs from tilting, be careful not to pull on the liquid lines when performing maintenance.

CAUTION—Spraying Solvent

Solvents can spray when under high pressure.

- Stop the pump flow prior to opening the flow path.
- Wait until the system pressure is down to zero.
- When opening the flow path, wear appropriate protective equipment.

CAUTION—Hot Surfaces

Surfaces inside the system may become hot during operation. Touching hot parts might cause burns.

Allow hot surfaces to cool down before starting replacement or maintenance procedures.

CAUTION—Hydrostatic Pressure

Solvent may spill when you open the flow path. This is due to hydrostatic pressure in the system when the solvent reservoirs are located above the pump outlet. Before you loosen a connection in the flow path:

- Turn off the pump flow and wait until the system pressure is down to zero.
- Unscrew the caps of the solvent reservoirs and remove the solvent lines together with the caps from the reservoirs.
- Empty the solvent lines. Refer to the *Operating Manual* for the pump.
- Retighten the reservoir caps.

CAUTION—Electric Shock or Damage to the Device

After the power to the device is turned off, the device is still energized as long as the power cord is connected. Repair work on the device while the device is connected to power could lead to personal injury.

- Always unplug the power cord before starting repair work inside the device.
- If you were instructed to remove any housing covers or panels, do not connect the power cord to the device while the cover or panels are removed.

7.3 General Rules for Maintenance and Service

For successful maintenance and service procedures, follow the rules and recommendations below.

General Rules

- Use only the replacement parts specifically authorized and qualified for the device by Thermo Fisher Scientific.

Opening Flow Path Connections

- Before opening the flow path to replace capillaries in the system, turn off the pump flow and wait until the system pressure is down to zero.
- Dirty components can contaminate the chromatography system. Contamination leads to poor performance of the modules and entire system or can even cause damage to the modules and system. Therefore:
  - Always wear appropriate gloves.
  - Place the components only on a clean, lint-free surface.
  - Keep your tools clean.
  - Use only lint-free cloth for cleaning.

Depot Repair

- If you need to return a system module for depot repair, follow the instructions in section Transporting or Shipping the System (▸ page 107).

See also

Consumables and Replacement Parts (▸ page 143)

7.4 Routine and Preventive Maintenance

Optimum system performance, maximum uptime of the system, and accurate results can be obtained only if the system is in good condition and properly maintained.

7.4.1 Maintenance Plan

Perform the maintenance procedures in the table on a regular basis. The frequency given in the table is a suggestion. The optimum frequency for maintenance depends on several factors, such as the types and amounts of samples and solvents used with the system.

Frequency	What you should do...
Daily	• Inspect the flow connections for signs of leakage or blockage. • When you use buffers or salt solutions, flush the system thoroughly after use with an appropriate solvent that does not contain buffers or salts.
Regularly	• Solvent line filter frits: regularly check the filter frits for permeability. Replace the filter frits at regular intervals. This is especially important when using aqueous solvents. Aqueous solvents may contaminate the filters with algae and other microorganisms that deposit on the filter frits. Therefore, also replace the solvents at regular intervals. Rinse the reservoirs thoroughly before refilling them. • Empty the waste container or containers. • Inspect the flow connections for damage, such as cracks, nicks, cuts, or blockage. • Check the drain system for blockage (see Testing the Drain System (▸ page 59)). If a leak alarm is triggered or if a leak is visible, find and eliminate the blockage. • Clean the system (see Cleaning or Decontaminating the System (▸ page 105)). • Check that all warning labels are still present on the system and clearly legible. If they are not, contact Thermo Fisher Scientific for replacement.
Annually	Have Thermo Fisher Scientific service personnel perform preventive maintenance once a year.

7.4.2 Cleaning or Decontaminating the System

Cleaning and decontamination must be performed by qualified personnel wearing suitable personal protective equipment. Always observe national and local regulations.

NOTICE

Wipe up all liquids spilled onto the system immediately. If surfaces are exposed for longer periods, these liquids can cause damage.

Decontamination

Decontamination is required, for example, when leakage or spillage has occurred, or before service or transport of the system. Use a suitable cleaning detergent or disinfectant to ensure that the treatment renders the system safe to handle.

Parts required

- Suitable cleaning detergent (or disinfectant)
- Purified water
- Lint-free cloths or wipes

CAUTION—Explosive Gas Mixtures from Alcoholic Cleaning Detergents

Alcohol-containing cleaning detergents may form flammable and explosive gas mixtures when exposed to air.

- Use such cleaning detergents only when required and only in adequately ventilated rooms.
- Avoid open flames or exposure to excessive heat during the cleaning process.
- Wipe the cleaned components thoroughly dry after cleaning. Do not operate the device before it is completely dry.

NOTICE

Observe the following:

- Only use cleaning detergents that will not damage the surfaces of the system.
- Never use sharp tools or brushes for cleaning any surfaces.
- Do not use sprays for cleaning.
- Prevent cleaning detergent from entering the flow path.
- Do not use excessively wetted cloth or wipes for cleaning. Prevent any liquids from entering the functional components of the device. Liquids can cause a short circuit when getting in contact with the electronic components.

Preparations

1. Turn off the power to the system and disconnect the power cord from the power source.

Follow these steps

1. Wipe the surfaces clean with a clean, dry, soft, lint-free cloth or wipe. If necessary, slightly dampen the cloth or wipe with a solution of lukewarm water and a suitable cleaning detergent.
2. Allow the cleaning detergent to react as recommended by the manufacturer.
3. Wipe the cleaned surfaces with purified water to ensure that all cleaning detergent residues have been removed.
4. Wipe the surfaces dry using a soft, lint-free cloth or wipe.

7.5 Transporting or Shipping the System

NOTICE

Moving the Vanquish system stack even over short distances on the workbench can damage and impair the functionality of the system base. Observe the following:

- *Configuration with one column compartment*: Before moving the system stack, unlock the system base using the locking tools.
- *Configuration with two or three column compartments or a Charger:* Before moving the system stack, dismount the system stack (for instructions, see below).

Dismounting the system stack

Preparations

1. Turn off all modules with their main power switch.
2. Remove the solvent reservoirs and solvent lines from the solvent rack.
3. Remove all flow connections between the modules within the Vanquish system and all waste lines.
4. Remove all signal cables and power cords.
5. Grasp the system by its sides and slightly lift the column compartment up and out of the grooves on the mounting bars.
6. Lift the front part of the solvent rack and remove the solvent rack by pulling it towards the front.
7. Remove the detector, autosampler, and pump as described in the next section.

Removing the System Modules

1. Slide the carrying handles that were installed when the system was shipped on the rails at the right and left of the module from the rear as shown in the figure below.
   The final position of the handles must match the foam spacers used for transport (15 cm from the rear of the module to the center of the handle).

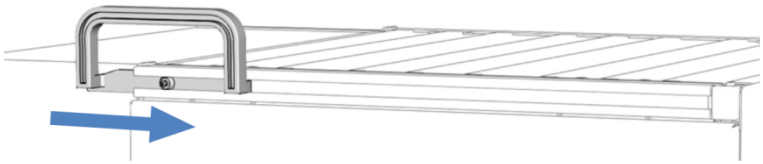

Figure 35: Sliding the carrying handle on the left rail

2. Fix the attachment screws on the carrying handles as shown below.

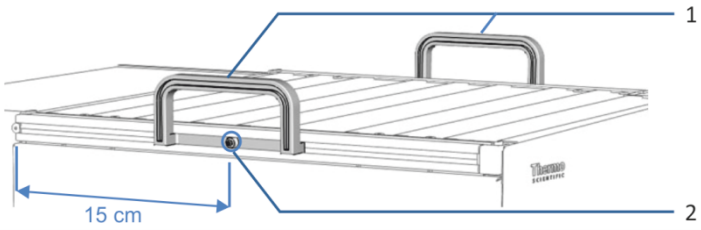

Figure 36: Carrying handles attached

No.	Description
1	Carrying handles
2	Attachment screw (one on each carrying handle)

CAUTION—Risk of Injury and Device Damage

Handles can slide off the device if the attachment screws are not fixed properly. Also, the slide-in module can fall out if not fixed properly. This could cause personal injury and damage to the device. Verify the following before lifting a device:

- The handles are fixed properly and cannot slide off the device.
- The four screws on the slide-in module are tightened and the slide-in module cannot fall out (for the location of the screws, refer to the operating manual of the respective system module).

3. Lift the front part of the module by using the carrying handles. Remove the module from the stack towards the front and carefully place it on a stable surface.

Shipping the Solvent Rack and System Base

To ship the solvent rack and/or system base, follow these steps:

1. Follow the unpacking instructions in this manual in the reverse order.
   Use only the original packing material and shipping container. If the original shipping container is not available, appropriate containers and packing material can be ordered from the Thermo Fisher Scientific sales organization.
2. If you need to return the solvent rack or system base to Thermo Fisher Scientific, contact your local Thermo Fisher Scientific support organization for the appropriate procedure.

CAUTION—Possible Contamination

Hazardous substances may have contaminated the device during operation and may cause personal injury to service personnel.

- Decontaminate all parts of the device that you want to return for repair.
- Fill in and sign the Health and Safety Form. Thermo Fisher Scientific refuses to accept devices for repair if the Health and Safety Form is missing, incompletely filled in, or unsigned.

Transporting or Shipping other System Modules

For details on transporting or shipping the other system modules, refer to the Transporting or Shipping section in the *Operating Manual* of each module.

8 Troubleshooting

This chapter is a guide to troubleshooting issues that may arise during operation of the system.

8.1 General Information about Troubleshooting

This section gives information about operating issues that might occur during the operation of a Vanquish system.

If you are unable to resolve a problem following the instructions given here or if you experience problems that are not covered in this section, contact Thermo Fisher Scientific Technical Support for assistance. See the contact information at the beginning of this manual.

To facilitate device identification, have the serial number and technical name available when communicating with Thermo Fisher Scientific.

Status Indicators

The status indicator LED bar (Light Emitting Diodes) on the front side of each module and the **STATUS** LED on the keypad inside each module provide quick visual feedback on the operational status of the module. If the firmware detects a problem, the status indicators are red.

Instrument Audit Trail Messages

If the device firmware detects a problem, the problem is reported to the chromatography data system.

The data system logs information about all events related to instrument operation for the current day in an Instrument Audit Trail. The Instrument Audit Trail is named with the current date, using the format yyyymmdd. For example, the Instrument Audit Trail for May 15, 2019, is named 20190515.

The Instrument Audit Trails can be found on the ePanel Set (Audit ePanel). In addition, Audit Trails for each instrument are available in the Chromeleon 7 Console Data view, in the folder of the Instrument.

Messages in the Instrument Audit Trail are preceded by an icon. The icon identifies the seriousness of the problem. For possible causes and recommended remedial actions, see the Messages section in the *Operating Manual* of the module that is in error state.

8.2 System Troubleshooting

This section is a guide to troubleshooting issues that may arise during operation of the Vanquish system.

Locate the tables in the following sections for the type of symptom you have, find the possible cause, and use the description of the solution to help you solve your problem quickly.

TIP

For information on troubleshooting issues that may arise during operation with the Vanquish charged aerosol detector and the Vanquish fluorescence detector, refer to the respective *Operating Manual* for the detector.

This section provides information on symptoms and causes directly related to the Vanquish system modules and connections between the modules. For information on general chromatography and application troubleshooting, refer to the technical literature.

8.2.1 Peak Shape

Peak tailing

Possible Cause	Remedial Action
Extra column volume too large	Use short capillary connections with a suitable inner diameter. Use appropriate Viper capillaries.
Improper capillary connections	Check fittings for correct placement. Loosen and retighten Viper fittings (refer to the *Viper Installation and Operation Guide*). Use only the appropriate fittings (see Connecting Fittings, Capillaries, and Tubing (▶ page 77)).

Peak broadening

Possible Cause	Remedial Action
Flow cell volume too large	Use a smaller volume flow cell.
Extra-column volume too large	• If early peaks are broader than later eluting ones, check the capillary I.D. and length, sample loop size, flow cell, for example. • Use a capillary with a smaller volume for the connection between column compartment and detector.
Temperature gradient in column	• Use a pre-heater. • If forced air mode is used, consider switching to still air mode (refer to *Column Compartment Operating Manual*).
Detector response time too long and/or data collection rate too low	Select a suitable response time and/or data collection rate.

Possible Cause	Remedial Action
Capillaries clogged	Replace the capillaries.
Sample loop clogged	Replace the sample loop (refer to *Split Sampler Operating Manual*).
Solvent selector/ proportioning valve defective	Contact Technical Support.

8.2.2 Ghost Peaks, Negative Peaks and Spikes

Ghost peaks

Possible Cause	Remedial Action
Contamination (typically injection unit or column)	Flush the system using an appropriate solvent.
Improper reference wavelength	The sample must not absorb in the range of the reference wavelength. Consider using a method without reference wavelength.
Selected bandwidth too high	Select a lower bandwidth.
Degassing channels contaminated	Purge the pump (all channels) to rinse the degassing channels (refer to *Pump Operating Manual*).

Negative peaks

Possible Cause	Remedial Action
Improper reference wavelength	The sample must not absorb in the range of the reference wavelength. Consider using a method without reference wavelength.
Wrong polarization of analog output	If you are using analog output, check the analog output polarization.

Spikes

Possible Cause	Remedial Action
Air trapped in flow cell	• Check all fluid connections for tightness, in particular in the intake path. • Degas the mobile phase. • Install a restrictor at the flow cell outlet, observing the pressure specification of the respective flow cell and the general guidelines for the flow cell. **Note**: Excessive backpressure will destroy flow cells!
Particles in flow cell	• Flush the system (see Flushing the System (▶ page 82)). If you suspect that a capillary is contaminated with particles, in particular between the column and the flow cell, replace the capillary. • Flush the flow cell with different flows if particles are trapped in flow cell. • Check if the column is defective.
UV/VIS lamp old, defective, or not properly installed	Check if the lamp is properly seated. Replace the lamp (refer to *Detector Operating Manual*).

Possible Cause	Remedial Action
Electrical interferences from other instruments	Avoid operation of equipment generating strong electric or magnetic fields in close proximity. Do not connect equipment that may cause power disturbances to the same power network used to supply the system.
Column temperature significantly above boiling point of mobile phase	• Install a restrictor at the flow cell outlet, observing the pressure specification of the respective flow cell and the general guidelines for the flow cell. **Note**: Excessive backpressure will destroy flow cells! • Install a post-column cooler (refer to *Column Compartment Operating Manual*).

8.2.3 Peak Area Precision

Contamination or carry-over

Possible Cause	Remedial Action
Contamination in the system	Flush the system using an appropriate solvent.
Autosampler carry-over	The needle may be contaminated. Wash the needle in the wash port. If carry-over persists, replace the needle seat (refer to *Split Sampler Operating Manual*).

Environmental conditions

Possible Cause	Remedial Action
Unstable environmental conditions	Make sure that the temperature and air humidity are constant. Use column thermostatting. Avoid draft. Use insulation on the capillary from the column compartment to the detector.

Capillary problems

Possible Cause	Remedial Action
Capillary connections not installed properly or not tight, dead volumes in capillary connections	Properly install the capillary connections. Tighten the capillary connections. Replace capillary.

Pump problems

Possible Cause	Remedial Action
Piston seals in pump leaking	Replace the seals (refer to *Pump Operating Manual*).
Air trapped in pump head	Purge the pump (refer to *Pump Operating Manual*).
Baseline fluctuations	See "Periodic baseline fluctuations" in Baseline (page 119).
Pump pulsation or flow fluctuations	See "Pressure pulsation or inconstant pressure" in Pressure (page 118).
Irreproducible gradient	Change the gradient. Check the solvent line filters for permeability. Replace the filter frits if necessary (refer to *Pump Operating Manual*).

Inappropriate detector settings

Possible Cause	Remedial Action
Improper wavelength, e.g., in a UV spectrum flank	Choose a detection wavelength that is located near the apex of the spectrum.
Detector response time too short	Select a longer response time.
Detector response time too long	Peaks are eventually not separated any more. Select a shorter response time.

Injection volume variation

Possible Cause	Remedial Action
Autosampler draws air from vial	There is not enough amount of sample in the vial, the needle height setting is incorrect, or there are too many replicates.
Air trapped in autosampler flow path	Perform a wash cycle. Check that the injection valve is in Inject position and the flow components of the autosampler are flushed with solvent.
Draw speed too high	Select a lower draw speed.
Gas content of sample too high or saturated	Reduce the draw speed. Degas the sample if possible.
Needle clogged or needle tip deformed	Replace the needle (refer to *Split Sampler Operating Manual*).
Piston seals in autosampler metering device leaking	Replace the metering device head (refer to *Split Sampler Operating Manual*).
Injection valve or other autosampler components leaking	Inspect the autosampler and the connections on the injection valve. Tighten leaking connections. Replace leaking parts (refer to *Split Sampler Operating Manual*).
Needle seat worn out	Replace the needle seat (refer to *Split Sampler Operating Manual*).

8.2.4 Flow

No flow

Possible Cause	Remedial Action
Leak in system	Find and eliminate the leak.
Inlet and/or outlet check valve contaminated or defective	Clean the inlet check valve or outlet check valve, and replace the check valve if necessary (refer to *Pump Operating Manual*).
Air trapped in pump heads	Purge the pump (refer to *Pump Operating Manual*) and check in the chromatography data system whether the degasser has reached the operating vacuum (Degasser Vacuum = OK).
Air trapped in autosampler flow path	Perform a wash cycle (refer to *Split Sampler Operating Manual*).
Column temperature too high – eluent evaporating	Select a lower column temperature (refer to *Column Compartment Operating Manual*).

Flow fluctuations

Possible Cause	Remedial Action
Pump inlet path clogged	Check the solvent inlet lines, solvent line filters, and solvent selectors/proportioning valve, for example, for signs of clogging.
Air trapped in pump inlet path	• Purge the pump. • Inspect the degasser for indications for leakage. Check in the chromatography data system whether the degasser has reached the operating vacuum (Degasser Vacuum = OK). Degassing may not work properly if the flow rate is too high. • Inspect the capillary and solvent line connections for leakage; tighten loose fitting connections.
Inlet and/or outlet check valve contaminated or defective	Clean the inlet check valve or outlet check valve, and replace the check valve if necessary (refer to *Pump Operating Manual*).
Piston seals not sealing tightly	Replace the piston seals (refer to *Pump Operating Manual*).

8.2.5 Pressure

Pressure pulsation or inconstant pressure

Possible Cause	Remedial Action
Air trapped in the system	Purge the pump (refer to *Pump Operating Manual*).
Inlet and/or outlet check valve contaminated or defective	Clean the inlet check valve or outlet check valve, and replace the check valve if necessary (refer to *Pump Operating Manual*).
Pump inline filter (or static mixer) clogged	Check the permeability of the inline filter (or static mixer). Replace the inline filter (or static mixer) if necessary (refer to *Pump Operating Manual*).
Solvent line filter clogged	Check the solvent line filters for permeability. Replace the filter frits if necessary (refer to *Pump Operating Manual*).
Pump head compression values not reached	Check the compression values and take remedial action (refer to *Pump Operating Manual*).
System clogged with particles	Samples and insufficient solvent purity are frequently the source for particles clogging the system. Follow the instructions for resolving clogging in the autosampler (refer to *Split Sampler Operating Manual*).

High backpressure

Possible Cause	Remedial Action
One or more capillaries in the system clogged or damaged by bending	Check the capillaries in the system systematically from the detector to the pump. Replace the capillaries as needed.
Pump inline filter (or static mixer) clogged	Check the permeability of the inline filter (or static mixer). Replace the inline filter (or static mixer) if necessary (refer to *Pump Operating Manual*).
Pre-heater clogged	Rinse the pre-heater capillary in reverse direction, using an appropriate solvent. If necessary, replace the pre-heater (refer to *Column Compartment Operating Manual*).
Column switching valve clogged	Check the valve for indications of blockage. Replace the valve if necessary (refer to *Column Compartment Operating Manual*).
Post-column cooler clogged or defective	Rinse the post-column cooler capillary in reverse direction using an appropriate solvent. If necessary, replace the post-column cooler (refer to *Column Compartment Operating Manual*).
Flow cell clogged	Clean the flow cell. Replace the flow cell if necessary (refer to *Detector Operating Manual*).
Contamination in the system	Flush the system with an appropriate solvent.

Low backpressure

Possible Cause	Remedial Action
Leak in system	Find and eliminate the leak.

8.2.6 Retention Time Variation

Decreasing retention times

Possible Cause	Remedial Action
Improper mobile phase composition	Check premixed mobile phase. Perform an OQ gradient accuracy test. A solvent selector/proportioning valve may be defective. Contact Technical Support.
Increasing flow rate	Check flow rate settings. Perform OQ flow precision test.

Increasing retention times

Possible Cause	Remedial Action
Improper mobile phase composition	Check premixed mobile phase. Perform an OQ proportioning test. A solvent selector/proportioning valve may be defective. Contact Technical Support.
Decreasing flow rate	Check capillary connections for leaks. Check flow rate settings.
Piston seal leakage	Check the pump for piston seal leakage (refer to *Pump Operating Manual*).

Scattering retention times

Possible Cause	Remedial Action
Imprecise solvent proportioning	• Perform an OQ eluent proportioning test. • Clean the inlet check valve or outlet check valve, and replace the check valve if necessary (refer to *Pump Operating Manual*). • A solvent selector/proportioning valve may be defective. Contact Technical Support.
Pressure fluctuations from pump	• Purge the pump. • Check the compression values and take remedial action (refer to *Pump Operating Manual*). • Check the pump for piston seal leakage (refer to *Pump Operating Manual*). • Check the solvent line filters for permeability. Replace the filter frits if necessary (refer to *Pump Operating Manual*).

8.2.7 Baseline

High baseline drift

Possible Cause	Remedial Action
System not sufficiently equilibrated	Flush the system until equilibration. Usually, a volume of 5–10 times the column volume will be sufficient.
Unstable environmental conditions	1. Make sure that the temperature and the humidity are constant. You can determine temperature fluctuations by recording the temperature channels. 2. Verify on the detector that the lamp house cover is properly installed and that the front doors are closed. Avoid draft.
Flow cell contaminated	Clean the flow cell. Replace the flow cell if necessary (refer to the *Detector Operating Manual*).

Possible Cause	Remedial Action
UV/VIS lamp not stable	Allow the lamp and optics to warm up for at least 60 minutes. If the lamp is old, you may need to replace the detector lamp (refer to the *Detector Operating Manual*). A new lamp may need burn-in time before the first analysis. For details, refer to the *Detector Operating Manual*.
Absorption of eluent changes when gradient is run	Absorbing additives may change the absorption spectrum, depending on the solvent. Consider varying additive concentrations to level the drift.

Non-periodic baseline fluctuation, high noise

Possible Cause	Remedial Action
Pressure fluctuations from pump	• Purge the pump (refer to the *Pump Operating Manual*). • Perform a basic tightness test (see Basic Tightness Test (▶ page 124)), or test the pump for leakage as described in the *Pump Operating Manual*. • Clean the check valves (refer to the *Pump Operating Manual*).
Air trapped in the system	Purge the system as necessary (refer to the *Pump Operating Manual*).
UV/VIS lamp old or not properly installed	Check that the lamp is correctly installed. Replace the lamp (refer to the *Detector Operating Manual*).
Improper reference wavelength	The sample must not absorb in the range of the reference wavelength. Consider using a method without reference wavelength.
Detector response time too short	Select a suitable response time.
Improper wavelength or optical bandwidth	Select an appropriate wavelength. Select a higher bandwidth in particular with critical conditions (low absorption, few light).
Flow cell not properly installed	Check that the flow cell is installed properly (refer to the *Detector Operating Manual*).
Detector defective	Contact Technical Support.
Optical transmission of the flow cell too low (Vanquish system with VH-D10 detector only)	Check the lamp age and replace the lamp, if necessary. Use the **Cell Transmission Check / Flow Cell Wash** button on the ePanel for the module and follow the instructions. For this procedure, a diagnostic cell for the VH-D10 is required. If you do not have a diagnostic cell, compare the cell transmission (light intensity) values of the flow cell before and after a wash procedure and check whether the cell transmission (light intensity) has increased. If it has not increased, perform an extended wash cycle and check whether the cell transmission (light intensity) has increased.

Periodic baseline fluctuation, pulsation

Possible Cause	Remedial Action
Pressure fluctuations from pump	• Purge the pump (refer to the *Pump Operating Manual*). • Perform a basic tightness test (see Basic Tightness Test (▷ page 124)), or test the pump for leakage as described in the *Pump Operating Manual*. • Clean the check valves (refer to the *Pump Operating Manual*).
Air trapped in the system	Purge the system (refer to the *Pump Operating Manual*).
Improper reference wavelength	The sample must not absorb in the range of the reference wavelength. Consider using a method without reference wavelength.
UV/VIS lamp defective or not properly installed	Check that the lamp is correctly installed. Replace the lamp (refer to the *Detector Operating Manual*).
Piston calibration value mismatch	Verify that the calibration value of the piston (imprinted on the rear of the piston) corresponds to the related piston calibration value in the chromatography data system. Adapt the value in the data system if necessary.

8.2.8 Temperature Control

Column compartment temperature does not change although the set point has not been reached

Possible Cause	Remedial Action
Ambient temperature too high or setpoint lower than the specified difference to the ambient temperature	Reduce the ambient temperature (for example, by ventilating the room).
Temperature control turned off	Check the setting for TempCtrl in the chromatography data system (**TempCtrl=On** turns temperature control on).
Ventilation grid obstructed	Make sure that the ventilation grids of the column compartment are not obstructed in any way.
Ambient air enters column chamber	• Improper sealing of the column chamber may impair the heating and cooling performance of the column compartment and lead to a considerable amount of condensed water. • When guiding capillaries through the column chamber cover seal, make sure that the cover seals properly. If the chamber cover seal is damaged, replace the chamber cover (refer to *Column Compartment Operating Manual*). • Also, make sure that the front door is properly closed.
Column compartment defective	Contact Technical Support.

Pre-heater does not reach set temperature

Possible Cause	Remedial Action
Pre-heater not installed correctly	The performance may be impaired if the thermal contact is imperfect, or if the pre-heater inlet and outlet are exchanged. Reinstall the pre-heater (refer to *Column Compartment Operating Manual*).
Pre-heater defective	Replace the pre-heater (refer to *Column Compartment Operating Manual*).

Post-column cooler does not reach set temperature

Possible Cause	Remedial Action
Post-column cooler not installed correctly	Verify that the post-column cooler screws are tightened and the post-column cooler is seated properly.

Autosampler does not reach set temperature

Possible Cause	Remedial Action
Ambient temperature or humidity too high	Reduce the ambient temperature (for example, by ventilating the room), and/or ambient humidity.

8.2.9 Power and Communication

Entire system has no power (all LED bars off (dark))

Possible Cause	Remedial Action
System power button turned off	Turn on the system with the power button on the front left of the system base.

Single module has no power (LED bar off (dark))

Possible Cause	Remedial Action
Module power turned off	Turn on the module with its main power switch.
Module not connected to the mains	Connect the power cord.
Fuse has blown	Replace the fuses (refer to *Operating Manual* of the module).
Error in electronic system	Contact Technical Support.

One or more modules cannot be turned off from the power button on the system base

Possible Cause	Remedial Action
System power connection interrupted	Check the system interlink connections between the system base and the system modules, see Signal Cable Connections (▸ page 65).

Module cannot be operated from the chromatography data system

Possible Cause	Remedial Action
No connection between module and computer	• Check the USB connections from the system to the computer, see Signal Cable Connections (▶ page 65). If the module uses a USB hub on another module, check that the module that provides the hub is turned on. • Check the USB port on the computer. USB standard 2.0 is required.
Repeated unexpected disconnects in the chromatography data system	Install a USB Isolator. For ordering information, see Optional Accessories (▶ page 141).

8.2.10 System Diagnostics

For the Vanquish system modules, diagnostics features are supported in the Chromeleon software. With these features, the user can check and monitor the performance and reliability of certain components.

Manual Testing

You can run the following tests from Chromeleon:

Test	Available for	Remarks
Basic Tightness Test	Pump and autosampler	Depending on the Vanquish system configuration, the available tests may vary. If a test is grayed out in the Chromeleon software, the test is currently not available. When a test is running, the LED bar on the module shows a blue running light.
Grating Motor Test	Variable wavelength detector	
Intensity Test	Variable wavelength detector	
Shutter Motor Test	Variable wavelength detector	

Automatic Testing

You can set up a schedule in Chromeleon for automatic testing. Automatic testing is possible only for tests and functions that can run unattended, without further user interaction, for example the *Basic Tightness Test*.

Test Failed

To ensure that you run sequences only on fully operational modules, the Chromeleon software prevents you from starting a sequence if a diagnostic test has failed. If a test failed, take remedial action and repeat the test. A user with special control privileges in the Chromeleon software can override the failed test result. Refer to the *Chromeleon Help*.

See also

- Basic Tightness Test (▶ page 124)
- Grating Motor Test (▶ page 124)
- Intensity Test (▶ page 125)
- Shutter Motor Test (▶ page 125)

8.2.10.1 Basic Tightness Test

The **Basic Tightness Test** checks the tightness of the pump and autosampler.

Follow these steps

1. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
   The test runs automatically without further user interaction.
2. If the test fails, check the Instrument Audit Trail for a message. For remedial actions refer to the *Troubleshooting* section in the *Operating Manual* for the module for which the test failed.

8.2.10.2 Grating Motor Test

The **Grating Motor Test** checks the mechanical stability of the grating drive.

Follow these steps

1. Install the diagnostic cell in the detector.
2. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
3. Depends on the test result:

Test result	Action
Passed	Reinstall the flow cell of your application.
Failed	Contact Thermo Fisher Scientific Technical Support.

8.2.10.3 Intensity Test

The **Intensity Test** is a test to measure the intensity of the detector lamp and the transmission performance ("intensity") of the optics. The test is available for the diode array detector and for the variable wavelength detector.

Follow these steps

1. Install the diagnostic cell in the detector.
2. Turn on the detector lamps (one or both) that you want to test.
3. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
4. Depends on the test result:

Test result	Action
Passed	Reinstall the flow cell of your application.
Failed	1. Replace the lamp. Refer to the *Operating Manual* for the detector. 2. If the test fails with the new lamp, the optics may be defective. Contact Thermo Fisher Technical Support.

8.2.10.4 Shutter Motor Test

The **Shutting Motor Test** checks the mechanical stability of the shutter motor and filter paddle.

Follow these steps

1. Install the diagnostic cell in the detector.
2. Turn on the detector lamps (one or both).
3. Run the test from the Chromeleon software. Refer to the *Chromeleon Help*.
4. Depends on the test result:

Test result	Action
Passed	Reinstall the flow cell of your application.
Failed	Contact Thermo Fisher Scientific Technical Support.

9 Modifying the System for Specific Applications

9.1 Normal-Phase Compatible Solvents and Additives

This section applies to Vanquish Core system modules.

In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used if the system modules are modified with the components from the Normal-Phase (NP) kit.

9.2 Modifying the System Modules

This section applies to Vanquish Core system modules.

When

To use very non-polar and harsh organic solvents, such as 100% acetonitrile, n-hexane, tetrahydrofuran, and similar solvents.

Parts required

- Normal phase (NP) kit, including the parts and instructions for modifying the pump and autosampler and for replacing the detector waste line.
- Tubing cutter
- Pistons (for pumps VC-10, VC-P20, VC-P32, VC-P40)
  Modifying the pump includes replacing the UHMW-PE piston seals with PTFE seals. Exchanging the piston seals but keeping the pistons that were used with the UHMW-PE piston seals may impair the seal life of the PTFE seals.

Additional parts required as applicable

- NP-compatible VC-detector flow cell
  If you need assistance on the NP compatibility of your flow cell, contact your local Thermo Fisher Scientific sales organization.
- NP column switching valve for column compartment

Preparations

1. Turn off the pump flow and wait until the system pressure is down to zero.
2. Unscrew the cap of the seal wash reservoir.
3. Together with the cap, remove the seal wash line from the reservoir.
4. To empty the seal wash line, press down the lever of the seal wash pump. Release the lever when the line is empty.

Follow these steps

1. Modify the system components with the components from the NP kit. Follow the instructions in the installation guide that comes with the kit.
2. As applicable:
   a) Replace the pump pistons. Refer to the *Operating Manual* for the pump.
   b) Replace the flow cell with an NP-compatible flow cell. Refer to the *Operating Manual* for the detector.
   c) Replace the column switching valve with an NP-compatible valve. Refer to the *Operating Manual* for the column compartment.
3. Observe the specific information for operation in Considerations with Normal-Phase Compatible Solvents and Additives (page 130).

9.3 Considerations with Normal-Phase Compatible Solvents and Additives

After the installation of the NP kit, the system remains compatible with reversed-phase applications. The pH range of the system is not affected by application of the NP kit, see Allowed pH Ranges (▷ page 27).

When running applications with normal-phase compatible solvents and additives, observe the information in this section on:

- Seal wash liquid
- Long-term shutdown
- Routine and preventive maintenance

Seal Wash Liquid

Use seal wash liquid that fulfills the following requirements:

- The seal wash liquid is miscible with the solvent that is used in the pump.
- The seal wash liquid is compatible with the seal wash tubing.
- The seal wash liquid provides certain conductivity for reliable performance of the seal wash detector.
  For NP applications, ammonium formate in isopropanol (2 mmol/L) is recommended.

Interrupting Operation of the System for a Longer Period

To interrupt operation for a longer period and restart operation afterward, follow the instructions in Shutting Down the System (▷ page 96).

Use the following liquids for flushing:

Situation	Action
No additive is used	Flush the system with isopropanol. 100% acetonitrile should not be used. Flushing liquids should be minimum HPLC-grade.
Additive is used	1. Flush the system with several volumes of an appropriate pure solvent (for example, 1.0 mL/min for 10 minutes with the standard system). 2. Flush the system with isopropanol. Flushing liquids should be minimum HPLC-grade.

Routine and Preventive Maintenance

- Observe the information in the *Routine and Preventive Maintenance* section in the *Operating Manuals* for the system modules.
- Depending on the application, slightly increased abrasion may be observed with normal-phase piston seals. Therefore, consider testing the static mixer for permeability at shorter intervals. Refer to the *Operating Manual* for the pump.

10 Specifications

This chapter provides important system specifications.

10.1 System Specifications

The physical conditions of a standard system are specified as follows:

Type	Specification		
Materials in the flow path	For materials in the flow path, refer to the *Operating Manuals* for the modules in your system. For solvent and additive information, see Solvent and Additive Information (▶ page 25).		
Biocompatibility	Core system in the standard configuration: No	Horizon/Flex system in the standard configuration: Yes	
Control	System base power button Chromeleon 7 The system can be operated also with other data systems. For details, contact the Thermo Fisher Scientific sales organization.		
Good Laboratory Practice (GLP) features	Predictive Performance functions for scheduling maintenance procedures based on the actual operating and usage conditions of the system. All system parameters logged in the Chromeleon Audit Trail.		
Safety features	Leak detection and safe leak handling		
Range of use	Indoor use only		
Ambient operating temperature	5 °C - 35 °C		
Ambient storage temperature	-20 °C - 45 °C		
Ambient operating humidity	20% - 80% relative humidity, non-condensing		
Ambient storage humidity	Maximum 60% relative humidity, non-condensing		
Operating altitude	Maximum 2000 m above sea level		
Pollution degree	2		
Emission sound pressure level	System with one column compartment, without Charger: Typically approx. 55 dB(A), max. approx. 75 dB(A)		
System dimensions (height x width x depth)	System with one column compartment, without Charger: 82 cm x 55 cm x 62 cm		
System weight With one column compartment, without Charger	Vanquish Core Approx. 80 kg	Vanquish Flex: Approx. 90 kg	Vanquish Horizon: Approx. 110 kg

10.2 Solvent Rack and System Base Specifications

The physical conditions of the solvent rack and system base (without the Vanquish System Controller) are specified as follows. For specifications of the other modules in the Vanquish system, refer to the *Specifications* section in the *Operating Manual* for each module.

Type	Specification
System Interlink	1 System Interlink port (RJ45-8 connector)
Max. volume of an individual solvent reservoir	5 L
Solvent rack dimensions (height x width x depth)	12 cm x 42 cm x 62 cm
Solvent rack weight	4 kg
System base dimensions (height x width x depth)	6 cm x 42 cm x 42 cm
System base weight	5 kg
System base user input	System base power button

11 Accessories, Consumables and Replacement Parts

This chapter describes the standard accessories that are shipped with the system and the accessories that are available as an option. This chapter also provides information for reordering consumables and replacement parts.

11.1 General Information

The system must be operated only with the replacement parts and additional components, options, and peripherals specifically authorized and qualified by Thermo Fisher Scientific.

Accessories, consumables, and replacement parts are always maintained at the latest technical standard. Therefore, part numbers are subject to change. If not otherwise stated, updated parts will be compatible with the parts they replace.

11.2 Ship Kit

This section lists the content of the ship kit. The kit content is subject to change and may vary from the information in this manual. Refer to the content list included in the kit for the most recent information about the kit content at the time when the system is shipped.

For reordering information, see Consumables and Replacement Parts (▷ page 143).

Ship Kit for Vanquish Core system

Item	Quantity in shipment
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules.	1
Viper union	1
Tubing connector, straight, for tubing I.D. 1.0 – 2.0 mm, set of 5	1
Tubing connector, tapered, I.D. 1/16"	5
Viper capillary kit, Vanquish Core system, including: • Capillary pump-autosampler, stainless steel, I.D. x length 0.18 x 350 mm length • Passive pre-heater, stainless steel, I.D. x length 0.18 x 530 mm	1
Drainage kit, Vanquish system, including: • L piece (elbow, pack of 4, different sizes) • Drain tubing, 6.25 m length • Clip (set of 2)	1
Paper label for magnetic label holder	1
System interlink cable	1
Screwdriver, Torx T10	1
Reservoir cap	6

Ship Kit for Vanquish Flex and Horizon system

Item	Quantity in shipment
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules.	1
Viper inline filter	1
Viper union	1
Tubing connector, straight, for tubing I.D. 1.0 – 2.0 mm, set of 5	1
Tubing connector, tapered, I.D. 1/16"	5
Viper capillary kit, Vanquish Horizon and Flex system, including: • Capillary pump-autosampler, MP35N, I.D. x length 0.1 x 350 mm length • Active pre-heater, MP35N, I.D. x length 0.1 x 380 mm • Passive pre-heater, MP35N, I.D. x length 0.1 x 530 mm	1
Drainage kit, Vanquish system, including: • L piece (elbow, pack of 4, different sizes) • Drain tubing, 6.25 m length • Clip (set of 2)	1
Paper label for magnetic label holder	1
Screwdriver, Torx T10	1
System interlink cable	1
Reservoir cap	6

11.3 Optional Accessories

Stack Stabilizers

Item	Part No.
Bench clamp kit Stabilizes system stacks with a height of max. 139 cm	6036.1740
Stack stabilizer kit Stabilizes system stacks with a height of max. 123 cm	6036.1710
IonBench including stack mounting kit Stabilizes system stacks with a height of max. 123 cm	6036.1720

Vanquish Solvent Monitor

Description	Part No.
Vanquish Solvent Monitor To actively monitor the liquid level in solvent reservoirs and waste containers in real time. Monitoring is based on real physical measurement.	
Solvent monitor, 4-channel version	6230.1320
Solvent monitor, 8-channel version	6230.1310

Vanquish User Interface

Item	Part No.
Vanquish User Interface Consists of the Vanquish System Controller and the Vanquish Display. Can be used to display and monitor the vital parameters of the overall system and of attached modules.	6036.1170

Method Development and Transfer Kits

Item	Part No.
Extension Kit for Automated Method Scouting Kit including solvent reservoirs, flow connection components and a 10-position 11-port solvent selection valve extending the number of supported solvents for method scouting.	6036.0100
Method Transfer Kit Contains a loop capillary kit and a switching valve to adjust the system gradient delay volume to the desired HPLC method.	6036.2100
Strong solvent loop Vanquish (for Vanquish Core systems) Loop to increase the volume between autosampler and column for successful transfer of applications using strong-eluting sample solvents.	6036.2200

Normal-Phase Kits

Description	Part No.
Normal-Phase (NP) kit In a Vanquish Core system, normal-phase (NP) compatible solvents and additives may be used only if the system modules have been modified for NP applications. The Vanquish NP kit is designed for the use of the Vanquish Core HPLC system with normal phase applications, e.g. based on n-hexane or tetrahydrofuran. The system remains compatible with reverse phase applications after the modification. Also, the pH-range of the system is not affected by the NP kit. The kit includes the parts and instructions for modifying the pump and autosampler and for replacing the detector waste line. **NOTE**: Depending on the system configuration, additional parts may be required. See Modifying the System Modules (▶ page 128).	6036.3972
Normal-Phase (NP) tubing kit The kit includes the replacement tubing and tubing connectors, for replacing the following: • All seal wash lines from the seal wash reservoir to the seal wash pump and from the seal wash pump to the pump heads and on to the seal wash detector (opaque white tubing) • The peristaltic tubing in the seal wash pump (light yellow tubing) • The needle wash line from the needle wash reservoir to the needle wash pump and from the needle wash pump to the wash port (clear tubing) • The detector waste line (capillary and fitting)	6036.3973
For device-specific replacement parts, refer to the *Operating Manual* for the module.	

Miscellaneous

Item	Part No.
Manual injection valve Includes all parts needed for manual sample injection: System fixture, 20 µL sample loop, and syringe.	6230.1600
Capillary, Viper, MP35N, I.D. x length 0.13 x 350 mm (for Horizon and Flex systems)	6083.2410
Capillary, Viper, MP35N, I.D. x length 0.13 x 500 mm (for Horizon and Flex systems)	6083.2411
USB isolator The USB Isolator improves the reliability of the USB connection between the USB port of an HPLC system module and the data system computer.	6287.0540

11.4 Consumables and Replacement Parts

11.4.1 Capillaries and Tubing

Single Parts

Description	Part No.
Capillary pump-autosampler, stainless steel, I.D. x length 0.18 x 350 mm (for Core systems)	6040.2375
Capillary pump-autosampler, MP35N, I.D. x length 0.1 x 350 mm (for Horizon and Flex systems)	6042.2340
Active pre-heater[1], MP35N, I.D. x length 0.1 x 380 mm (for Horizon and Flex systems)	6732.0110
Passive pre-heater[1], stainless steel, I.D. x length 0.18 x 530 mm (for Core systems)	6732.0170
Passive pre-heater[1], MP35N, I.D. x length 0.1 x 530 mm (for Horizon and Flex systems)	6732.0174
Vanquish system drainage L pieces, set of 4, different sizes	6036.0003
Viper inline filter Installed between a column and a Viper capillary to filter particles bigger than 0.5 µm	6036.1045
Viper union	6040.2304
[1]: For more information about column compartment-specific parts, refer to the *Accessories, Consumables and Replacement Parts* section in the Operating Manual for the column compartment.	

Drainage Kit

Description	Part No.
Drainage kit, Vanquish system, including: • L piece (elbow, pack of 4, different sizes) • Drain tubing, 6.25 m length • Clip (set of 2)	6036.1120

Viper Capillary Kits

Vanquish Core System

Description	Part No.
Viper capillary kit, Vanquish Core system, including (parts are available separately, see table in section *Single Parts*): • Capillary, stainless steel, I.D. x length 0.18 x 350 mm • Passive pre-heater, stainless steel, I.D. x length 0.18 x 530 mm	6036.2302

Vanquish Horizon and Flex System

Description	Part No.
Viper capillary kit, biocompatible, Vanquish Flex system, including (parts are available separately, see table in section *Single Parts*): • Capillary, MP35N, I.D. x length 0.1 x 350 mm • Active pre-heater, MP35N, I.D. x length 0.1 x 380 mm • Passive pre-heater, MP35N, I.D. x length 0.1 x 530 mm	6036.2303A

11.4.2 Solvents and Wash Systems

Reservoirs for solvents and wash liquids

Description	Part No.
Reservoir, 1 L, including cap	2270.0012
Reservoir, 0.25 L, including cap	2270.0026
Cap for reservoirs, screw-cap (pack of 4)	6270.0013
Cap plug to close open holes in the reservoir cap (pack of 20)	6000.0047
Retaining guide to keep the liquid line in place in the reservoir cap (pack of 5)	6000.0042
Plugs and retaining guides for reservoir caps, kit including • Cap plug to close open holes in the reservoir cap (pack of 10) • Retaining guide to keep the liquid line in place in the reservoir cap (pack of 5)	6030.9101

Solvent Lines and Solvent Line Filters

For information about the solvent lines and solvent line filters, refer to the *Consumables and Replacement Parts* section in the *Operating Manual* for the pump.

11.4.3 Fuses and Cables

Description	Part No.
Fuses kit, Vanquish system The kit includes the appropriate fuses for the Vanquish system modules.	6036.0002
System interlink cable (RJ45), 0.5 m	6036.0004
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 1 m	6035.9035A
USB cable, type A to type B, high-speed, USB 2.0 Cable length: 5 m	6911.0002A

11.4.4 Other Parts

Description	Part No.
Base module (system base), (all Vanquish systems)	6036.1100
Packing material	6036.7005
Solvent rack	6036.1350
System base locking tool	6036.1160

12 Appendix

This chapter provides additional information about compliance.

12.1 Compliance Information

Thermo Fisher Scientific performs complete testing and evaluation of its products to ensure full compliance with applicable domestic and international regulations.

For details on compliance, also see the Compliance Information section in the *Operating Manual* for each module in the Vanquish system.

12.1.1 Declarations of Conformity

CE Declaration of Conformity

The device has satisfied the requirements for the CE mark and is compliant with the applicable requirements.

EAC Declaration of Conformity

The device has satisfied the requirements for the EAC mark and is compliant with the applicable requirements.

RoHS Compliance

This product complies with the RoHS (Restrictions of Hazardous Substances) directives:

- *European RoHS Directive*
  Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

  The CE mark on the device indicates that the product is compliant with the directive.

- *China RoHS regulations*
  Measures for Administration of the Pollution Control of Electronic Information Products

  One of the following logos may be present on the device if applicable:

Logo	Description
	The green logo marks items that do not contain the hazardous substances identified by the regulations.
	The orange logo including a one-digit or two-digit number marks items that contain hazardous substances identified by the regulations. The number indicates the environment-friendly use period (EFUP) of the item. During this period, the item (when used as intended) will not cause serious damage to human health or environment. For more information, go to http://www.thermofisher.com/us/en/home/technical-resources/rohs-certificates.html

UKCA Declaration of Conformity

The device has satisfied the requirements for the UKCA mark and is compliant with the applicable requirements.

12.1.2 WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive. It is marked with the following symbol:

Figure 37: WEEE symbol

Thermo Fisher Scientific has contracted with one or more recycling or disposal companies in each European Union (EU) Member State, and these companies should dispose of or recycle this product. For further information, contact Thermo Fisher Scientific.

12.1.3 FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the U.S. FCC Rules.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. 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 expense.

12.1.4 Manual Release History

Revision	Covering
5.0	Vanquish Core system with system base VC-S01-A-02, Vanquish Flex system and Vanquish Horizon system with system base VF-S01-A-02
4.0	Vanquish Core system with system base VC-S01-A-02, Vanquish Flex system with system base VF-S01-A-02, Vanquish Horizon system with system base VH-S01-A-02
3.0a	Vanquish Flex system with system base VF-S01-A-02, Vanquish Horizon system with system base VH-S01-A-02
3.0	Vanquish Flex system with system base VF-S01-A-02, Vanquish Horizon system with system base VH-S01-A-02
2.0	Vanquish Flex system (103 MPa) with system base VF-S01, Vanquish system (151 MPa) with system base VH-S01
1.0	Vanquish system (151 MPa) with system base VH-S01

The instructions were prepared in English (original instructions). Other language versions are translations based on the English original instructions.

Index

T

U

V

W

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