Restek LC Accessories

Diagnosing and Preventing High Back Pressure in LC Systems

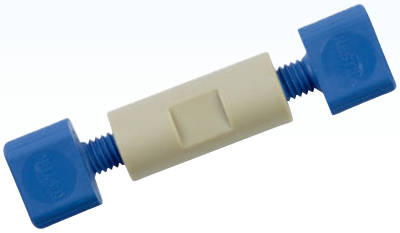
RESTEK Pure Chromatography www.restek.com

Diagnosing and Preventing High Back Pressure in LC Systems

High pressure.

It's a fact of life for HPLC and UHPLC analyses. The force that is necessary to push a liquid mobile phase through a tightly packed bed of tiny particles, even at relatively low flow rates, can cause tremendous back pressure. Fortunately, LC instruments are designed to handle this, but problems will appear when a clog in the system causes the back pressure to climb above the normal range. Clogs arise when particulates are created (in the case of seal wear or mobile phase precipitation) or are introduced (by mobile phase impurities or sample particulates) into the flow path and become lodged somewhere in the various narrow tubing and instrument channels, small-pore frits, or interstitial spaces between column packing materials.

We'll talk about the three major sources of these particulates and address some techniques for mitigating them and preventing high back pressure in LC instruments. But, effective troubleshooting and establishing an appropriate routine maintenance plan to prevent future problems starts with knowing what "normal" looks like.



What Does "Normal" Look Like?

In order to figure out if you have a high back pressure problem, you need to know what your pressure normally should be. Having a baseline to compare your actual pressure against can be a tremendous help in identifying a problem and diagnosing it.

Ideally, you would generate a "normal" baseline for the instrument with and without the column installed. By simply removing the column and replacing it with a union, you will see what your normal system pressure looks like. Now, imagine a situation where you're observing high back pressures in your LC. In that case, replacing the column with the union again and noting whether or not the pressure returns to the normal, system-only pressure will quickly determine if the problem is column or system related. When replacing the column with a union, be sure to use a union that can handle the system pressure (PEEK connectors are reliable up to ≤5000 psi and stainless steel connectors can be used up to ≤20,000 psi). If your LC software allows you to record your system pressure while you acquire data, that is another great way of keeping records of what "normal" looks like during analysis and column re-equilibration.

Finally, understanding the differences that mobile phase composition has on system pressure can help avoid a false alarm. For instance, switching your organic mobile phase from acetonitrile to methanol will result in an increase in system pressure, all other conditions remaining the same, simply because methanol is more viscous than acetonitrile. Also, during gradient analysis, as your mobile phase composition is changing with the gradient program, pressure will change for the same reason. So, not all pressure changes are a symptom of a problem.

Causes of Abnormally Elevated Pressure

High back pressure in LC instruments is usually caused by foreign material blocking the flow of mobile phase. Although crimped PEEK or stainless steel tubing will occasionally be the culprit, particulates clogging the system are most often the cause. Note that PEEK tubing is incompatible with tetrahydrofuran and will swell if exposed to it, so avoid that combination to maintain the durability of your PEEK tubing and prevent tubing-related problems.

Particulates are frequently the source of the elevated back pressure, and the following sections cover the main sources of particulates and how to prevent them from clogging your LC system.

- The sample
- The mobile phase
- Instrument wear and tear

The Sample

Preventing high back pressure in LC systems and protecting your instrument and column against premature maintenance or shortened lifetime starts with your sample.

Samples typically contain particulates that can easily clog a variety of components in your instrument. Whether those particulates exist in your sample from the beginning, or they precipitate out at some later stage in the analytical process, understanding the characteristics of your sample and knowing how to mitigate problems it might cause is your first, and one of your best, lines of defense against unexpected instrument downtime for high back pressure problems in LC instruments.

Whenever possible, consider filtering your sample prior to analysis. Syringe filters and filter vials are both viable options for effective filtration. Alternatively, centrifugation is very effective, especially if you pair it with an adjustment of the needle insertion depth to make sure the injector is drawing from the supernatant. Sample preparation to remove particulates can pay dividends when it comes to keeping your instrument up and running, but even if you choose to perform a relatively simple "dilute-and-shoot" technique, having a plan for preventative maintenance can help avoid unexpected interruptions to your workflow.

Even a sample that has undergone extensive sample preparation could pose a risk if the solvent used for the sample is mismatched with the initial mobile phase composition. For example, components of a sample in DMSO may end up crashing out of solution immediately if introduced into a highly aqueous mobile phase, and that situation can cause clogs, especially in the column. This mismatch can also result in poor chromatography, especially for early eluting compounds.

Using a guard column or an UltraShield pre-column filter, and changing it as part of your routine preventative maintenance plan, can mitigate the risk sample particulates pose to your analytical column. If something is going to clog, it is best that it is not your analytical column! When using a guard column, always select the system that is designed for your analytical columns. Restek offers three guard column systems: EXP guards for Raptor and Force columns; Roc guards for Roc columns; and Trident guards for Ultra, Viva, and Pinnacle DB columns.

The Mobile Phase

The two main contributors to system or column clogging due to the mobile phase are bacterial growth in poorly maintained aqueous mobile phase bottles and buffer salts that precipitate out of solution, typically as a result of large changes in mobile phase composition. In all cases, be sure to only use HPLC-grade chemicals in the preparation of your mobile phases. And it's always a good idea to use mobile phase filters, which are available in both glass and stainless steel.

The best way to keep your aqueous mobile phases free of bacterial growth is to make sure they are made fresh and kept capped. High throughput labs are not likely to run into this problem because their mobile phases will be used and replaced long before they have a chance to grow bacteria, but a week or two of storage, especially at mid-range pH values, is an invitation to grow system-clogging bacteria. However, even in high-throughput cases, any residual mobile phase should be discarded, and the bottles cleaned between uses to further mitigate the growth of bacteria. Another remedy is to use opaque or amber solvent bottles to block out the light needed for microbes to grow.

Even bacteria-free mobile phases can cause high back pressure in LC systems if their buffering salts precipitate out of solution as a result of gradients that push mobile phase composition to the point of insolubility. For instance, a gradient that moves to a highly organic phase, especially when using acetonitrile, may result in buffering salts precipitating out of solution and creating obstructions in the chromatographic system. Or, switching lines in your LC without properly flushing the system out could result in highly organic mobile phase moving through lines that previously contained buffered mobile phase, resulting in salts precipitating in the pump.

Instrument Wear and Tear

There aren't too many places where instrument wear and tear will result in high back pressure problems, but they do exist. Pump seals eventually wear down, and that wear can be accelerated when buffers are used. Particulates from chewed-up pump seals can pose a risk, so replacing the seals and any inline filters meant to stop particles generated from them should definitely be a part of your routine maintenance schedule. Additionally, as the first point of contact with your sample, it's not uncommon for your needle or needle seat to become clogged. Also, normal wear on an auto-injector rotor can result in pieces being shed from the rotor material, which can then clog the channels or make their way further downstream. You can avoid having these issues surprise you by having a preventative maintenance schedule in place that routinely replaces these parts. To simplify this, Restek offers convenient preventative maintenance kits that include everything you need for logical, comprehensive routine maintenance of high-wear and problematic components. Individual parts such as piston seals, rotors, and needle seats are also available for unplanned maintenance events.

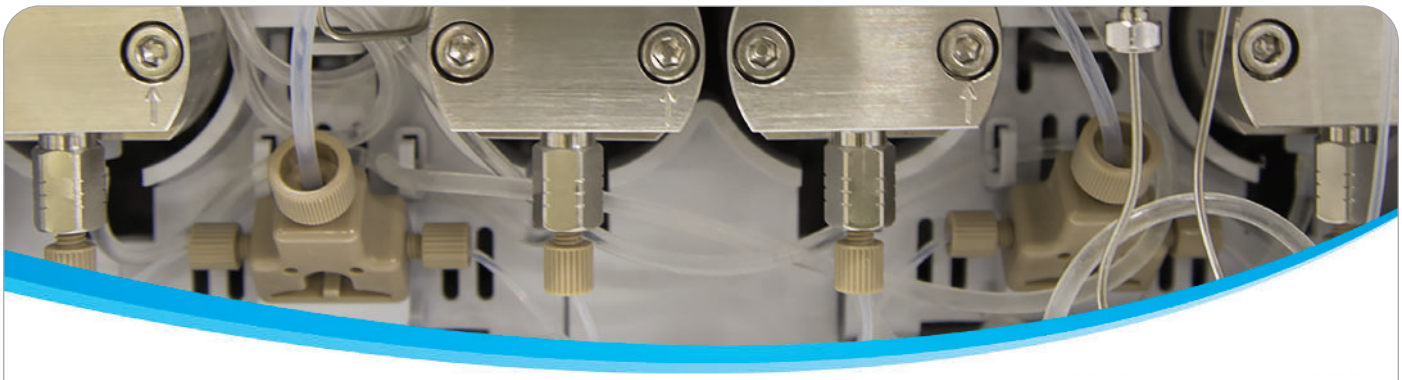
Additional Resources

There are a series of blog posts on Restek's ChromaBLOGraphy that contain additional information about troubleshooting and fixing pressure-related problems that you may encounter.

Your instrument manufacturer's manuals will provide the detail for the components discussed in this article. For additional troubleshooting or chromatography questions, Restek's Technical Service team (support@restek.com) is standing by to help you.

Troubleshooting Elevated Pressure

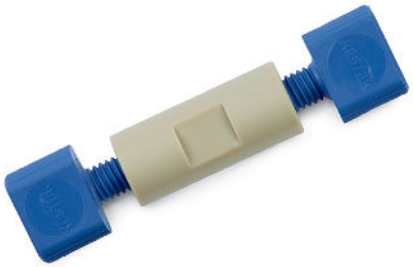
Even extensive sample preparation and a good routine maintenance schedule won't completely eliminate the possibility that you will encounter abnormally high back pressure in your LC instrument. Knowing what "normal" looks like will help you identify problems when they arise, but to accurately diagnose where the system is blocked it's best to isolate one potential source at a time. Starting at the detector and working backwards up the flow path using a systematic approach is the best way to locate an elevated pressure situation and determine the root cause. By either adding or removing components one at a time, you can easily identify where the problem is and resolve the issue causing elevated back pressure. In all cases, as you troubleshoot and work to pinpoint the problem, be sure not to expose your analytical column to unnecessary high-pressure cycles or else you may damage your column in pursuit of the clog. As a last step, be sure to document of all routine and nonroutine maintenance events: a quick review of instrument records can help you determine if future problems can be prevented by adjusting your routine maintenance plan.



Connections

PEEK Union Connector

- Ideal for quickly and reliably connecting PEEK tubing in HPLC systems.
- One-piece, finger-tight fittings—no ferrules required.
- Low dead volume.
- Included end fittings and body made of biocompatible PEEK.
- For 1⁄16" tubing on all 10-32 ports.



Catalog No.	Description	Units
27715	PEEK Union for HPLC, 0.25 mm Bore, 5000 psi, 2-pk.	2-pk.

Valco Connector, Zero-Dead-Volume Internal Union

Ends of tubing seat squarely at bottoms of fitting details. Made of 300-series stainless steel. For use with 1⁄16" OD tubing. Stainless steel ferrules included.

Not recommended for HPLC use. Instead, please use unions for UHPLC (cat.#s 27736 – 27739).

20147

Catalog No.	Description	Units
20147	Valco Connector, Zero-Dead-Volume Internal Union, 1/16", 0.15 mm Bore, ea.	ea.
20148	Valco Connector, Zero-Dead-Volume Internal Union, 1/16", 0.25 mm Bore, ea.	ea.
20149	Valco Connector, Zero-Dead-Volume Internal Union, 1/16", 0.75 mm Bore, ea.	ea.
20150	Valco Connector, Zero-Dead-Volume Internal Union, 1/16", 1/16" Bore, ea.	ea.

Stainless-Steel Valco Union for UHPLC

- Ideal for quickly and reliably connecting stainless steel tubing in UHPLC systems.
- For 1⁄16" tubing on all 10-32 ports.
- Body made of 316 stainless steel.
- Includes 303 stainless steel nuts and 316 stainless steel ferrules.
- Low dead volume.
- Rated to 20,000 psi (1375 bar).
- ¼" head on all nuts.

27736

Catalog No.	Description	Units
27736	Stainless-Steel Valco Union for UHPLC, 0.15 mm Bore, 20,000 psi, ea.	ea.
27737	Stainless-Steel Valco Union for UHPLC, 0.25 mm Bore, 20,000 psi, ea.	ea.
27738	Stainless-Steel Valco Union for UHPLC, 0.75 mm Bore, 20,000 psi, ea.	ea.
27739	Stainless-Steel Valco Union for UHPLC, 1/16" Bore, 20,000 psi, ea.	ea.

Filtration

Cut costs, not quality!

ordering notes

Price per 100-pack. Price breaks are available for 5 and 10 packs. Your correct price will be reflected on your invoice.

FREE sample packs available. Use these handy packs for method development or to compare with your current brand. Request yours today by adding -248 to the part number. Sample pack orders cannot be placed online—please call. Limit one sample pack per customer.

Syringe Filters with Luer Lock Inlet

- Luer lock inlet offers leak-tight syringe connection.
- Variety of filter types, porosities, and diameters.
- Labeled (13, 25, and 30 mm, only) and color coded for easy identification.
- Rugged polypropylene housing.
- Autoclavable to 121 °C for 15 minutes.
- Quantity break pricing for greater savings.

Note: Syringe filters are for laboratory use only.

Description	Color	Diameter	Porosity	qty.	cat.#
Cellulose Acetate					
Syringe Filter	Green	4 mm	0.22 µm	100-pk.	23972
	Blue	4 mm	0.45 µm	100-pk.	23973
	Red	30 mm	0.22 µm	100-pk.	23982
	Red	30 mm	0.45 µm	100-pk.	23983
	Red	13 mm	0.45 µm	100-pk.	26155
	Red	13 mm	0.22 µm	100-pk.	26156
	Red	25 mm	0.45 µm	100-pk.	26157
	Red	25 mm	0.22 µm	100-pk.	26158
Nylon					
Syringe Filter	Yellow	4 mm	0.22 µm	100-pk.	23970
	Pink	4 mm	0.45 µm	100-pk.	23971
	Pink	30 mm	0.22 µm	100-pk.	23980
	Pink	30 mm	0.45 µm	100-pk.	23981
	Pink	13 mm	0.22 µm	100-pk.	26146
	Pink	13 mm	0.45 µm	100-pk.	26147
	Pink	25 mm	0.22 µm	100-pk.	26148
	Pink	25 mm	0.45 µm	100-pk.	26149
PES (polyethersulfone)					
Syringe Filter	Green	13 mm	0.22 µm	100-pk.	23966
	Green	13 mm	0.45 µm	100-pk.	23967
	Green	25 mm	0.22 µm	100-pk.	23968
	Green	25 mm	0.45 µm	100-pk.	23969
	White	4 mm	0.22 µm	100-pk.	23978
	Blue	4 mm	0.45 µm	100-pk.	23979
	Green	30 mm	0.22 µm	100-pk.	23988
	Green	30 mm	0.45 µm	100-pk.	23989
PP (polypropylene)					
Syringe Filter	Blue	25 mm	0.22 µm	100-pk.	28935
	Black	25 mm	0.45 µm	100-pk.	28936
PTFE (polytetrafluoroethylene)					
Syringe Filter	Purple	4 mm	0.22 µm	100-pk.	23974
	Orange	4 mm	0.45 µm	100-pk.	23975
	White	30 mm	0.22 µm	100-pk.	23984
	White	30 mm	0.45 µm	100-pk.	23985
	White	13 mm	0.22 µm	100-pk.	26142
	White	13 mm	0.45 µm	100-pk.	26143
	White	25 mm	0.22 µm	100-pk.	26144
	White	25 mm	0.45 µm	100-pk.	26145
PVDF (polyvinyldifluoride)					
Syringe Filter	Brown	4 mm	0.22 µm	100-pk.	23976
	Red	4 mm	0.45 µm	100-pk.	23977
	Blue	30 mm	0.22 µm	100-pk.	23986
	Blue	30 mm	0.45 µm	100-pk.	23987
	Blue	13 mm	0.22 µm	100-pk.	26150
	Blue	13 mm	0.45 µm	100-pk.	26151
	Blue	25 mm	0.22 µm	100-pk.	26152
	Blue	25 mm	0.45 µm	100-pk.	26153

Cellulose Acetate, Nylon, PES, PP, PVDF—hydrophilic applications
PTFE—hydrophobic applications

Thomson SINGLE StEP Filter Vials

Thomson SINGLE StEP Standard Filter Vials with Screw-Top Caps

- Recommended for samples containing less than 10% solid particulates.
- Minimize sample loss by eliminating multiple transfers.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, PES, or nylon.
- Preslit PTFE/silicone caps help eliminate broken autosampler needles and cored septa.
- Rugged polypropylene vial houses insert with 450 µL loading capacity and low dead volume (120 µL).
- Fit most standard 12 x 32 mm autosamplers, including UHPLC instruments.

Catalog No.	Cap Color	Material	Porosity	Units
27896	Black	Nylon	0.2 µm	100-pk.
27897	Pink	Nylon	0.45 µm	100-pk.
27895	Gray	PES (polyethersulfone)	0.2 µm	100-pk.
28307	Green	PTFE (polytetrafluoroethylene)	0.2 µm	100-pk.
28306	Blue	PTFE (polytetrafluoroethylene)	0.45 µm	100-pk.
27894	Red	PVDF (polyvinyldifluoride)	0.2 µm	100-pk.
27898	Yellow	PVDF (polyvinyldifluoride)	0.45 µm	100-pk.

Patent No. 7,790,117

Easy-to-use vials offer fast sample filtration and require only a squeeze of your fingers.

Thomson SINGLE StEP Low-Evaporation Filter Vials with Screw-Top Caps

- Enhanced evaporation prevention technology, and no preslit in the cap membrane ensures less than 0.4% evaporation over 24 hours.
- Easy-to-use vials offer fast sample filtration and require only a squeeze of your fingers.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, or nylon.
- Rugged polypropylene vial houses insert with 450 µL loading capacity and low dead volume (120 µL).
- Fit most standard 12 x 32 mm autosamplers, including UHPLC instruments.

Catalog No.	Cap Color	Material	Porosity	Units
28308	Green	PTFE (polytetrafluoroethylene)	0.2 µm	100-pk.
28309	Blue	PTFE (polytetrafluoroethylene)	0.45 µm	100-pk.
28311	Red	PVDF (polyvinyldifluoride)	0.2 µm	100-pk.
28312	Black	Nylon	0.2 µm	100-pk.
28313	Pink	Nylon	0.45 µm	100-pk.
28315	Yellow	PVDF (polyvinyldifluoride)	0.45 µm	100-pk.

Thomson SINGLE StEP Nano Filter Vials

- Ultra-low dead volume allows you to filter as little as 10 µL of sample and still obtain enough filtrate to make a 2 µL injection.
- Easy-to-use vials offer fast sample filtration and require only a squeeze of your fingers.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, PES, or nylon.
- Available with either standard or preslit PTFE/silicone caps. Standard caps minimize evaporation and preslit caps help eliminate broken autosampler needles and cored septa.
- Rugged polypropylene vial houses insert with 250 µL loading capacity and extremely low dead volume (8 µL).
- Fit most standard 12 x 32 mm autosamplers, including UHPLC instruments.

Catalog No.	Cap Color	Material	Porosity	Units
25862	Green	PTFE (polytetrafluoroethylene)	0.2 µm	100-pk.
25863	Blue	PTFE (polytetrafluoroethylene)	0.45 µm	100-pk.
25864	Red	PVDF (polyvinyldifluoride)	0.2 µm	100-pk.
25865	Yellow	PVDF (polyvinyldifluoride)	0.45 µm	100-pk.
25866	Black	Nylon	0.2 µm	100-pk.
25867	Gray	PES (polyethersulfone)	0.2 µm	100-pk.
25882	Green	PTFE (polytetrafluoroethylene)	0.2 µm	100-pk.
25883	Blue	PTFE (polytetrafluoroethylene)	0.45 µm	100-pk.
25885	Yellow	PVDF (polyvinyldifluoride)	0.45 µm	100-pk.
25886	Black	Nylon	0.2 µm	100-pk.
25887	Gray	PES (polyethersulfone)	0.2 µm	100-pk.

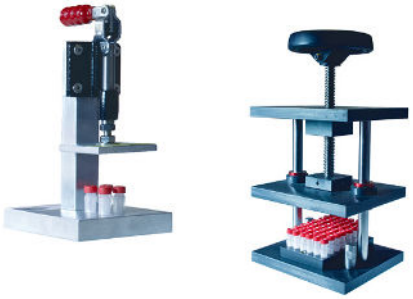
Thomson SINGLE StEP eXtreme Filter Vials

- Provide multilayer filtration for viscous samples and samples containing up to 30% solid particulates.
- Allow compounds to be separated from matrix, resulting in both higher signal-to-noise ratios and more differentiated peaks.
- Easy-to-use vials offer fast sample filtration and require only a squeeze of your fingers.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, or nylon.
- Preslit PTFE/silicone caps help eliminate broken autosampler needles and cored septa.
- Rugged polypropylene vial houses insert with 450 µL loading capacity and low dead volume (120 µL).
- Fit most standard 12 x 32 mm autosamplers, including UHPLC instruments.

Catalog No.	Cap Color	Material	Porosity	Units
27899	Green	PTFE (polytetrafluoroethylene)	0.2 µm	100-pk.
27900	Red	PVDF (polyvinyldifluoride)	0.2 µm	100-pk.
27901	Pink	Nylon	0.45 µm	100-pk.
27902	Blue	PTFE (polytetrafluoroethylene)	0.45 µm	100-pk.

Accessories for Filter Vials

Catalog No.	Product Name	Units
25860	Toggle Press for eXtreme Filter Vials	ea.
25861	Filter Vial Press, Multi-Use, 8 Positions for 30 mL Filter Vials & 48 Position, for Autosampler Ready Filter Vials	ea.



UltraShield UHPLC PreColumn Filter

- Cost-effective protection for UHPLC systems.
- Reliable way to filter out particulates and extend column lifetime.
- Minimize extra column volume and maximize UHPLC sample throughput vs. guard cartridges.
- Connects easily to any column with Parker-style ports; not compatible with Waters columns.
- Leak tight to 15,000 psi (1034 bar).
- 0.5 µm or 0.2 µm stainless-steel frit in a stainless-steel body with PEEK ferrule.

24995

Catalog No.	Product Name	Units
24995	UltraShield UHPLC PreColumn Filter, 0.5 µm Frit, ea.	ea.
24996	UltraShield UHPLC PreColumn Filter, 0.5 µm Frit, 5-pk.	5-pk.
24997	UltraShield UHPLC PreColumn Filter, 0.5 µm Frit, 10-pk.	10-pk.
25809	UltraShield UHPLC PreColumn Filter, 0.2 µm Frit, ea.	ea.
25810	UltraShield UHPLC PreColumn Filter, 0.2 µm Frit, 5-pk.	5-pk.
25811	UltraShield UHPLC PreColumn Filter, 0.2 µm Frit, 10-pk.	10-pk.

Specifications
Inlet/Outlet: Female/Male 10-32
Port Geometry: Parker (1/16 CPI)
Material: stainless steel, PEEK ferrule
Filter: 0.5 µm or 0.2 µm stainless steel
Pressure Rating: 15,000 psig (1034 bar)
Wrench Flat: 5/16"

EXP Direct Connect Holder

- Free-Turn architecture lets you change cartridges by hand without breaking inlet/outlet fluid connections—no tools needed.
- Patented titanium hybrid ferrules can be installed repeatedly without compromising high-pressure seal.
- Auto-adjusting design provides ZDV (zero dead volume) connection to any 10-32 female port.
- EXP direct connect holder requires separate guard column cartridges; available from Restek in 2.1, 3.0, and 4.6 mm.
- Pair with EXP hand-tight fitting (cat.# 25937–25938) for tool-free installation.

To help protect your investment and further extend the life of our already-rugged LC columns, Restek offers the patent-pending guard column hardware developed by Optimize Technologies. A Restek LC guard cartridge in an EXP direct connect holder is the ultimate in column protection, especially when using dilute-and-shoot or other minimal sample preparation techniques.

25808

Catalog No.	Product Name	Units
25808	EXP Direct Connect Holder for EXP Guard Cartridges, Includes Fitting & Ferrules	ea.

Maximum holder pressure: 20,000 psi (1400 bar).
Intellectual Property: optimizetech.com/patents

Filtration

EXP Guard Cartridges

Hand-Tight Fitting—No Tools Needed!

Unidirectional Raptor EXP Guard Column Cartridge

Holder Body

Raptor EXP Guard Column Cartridges

- Free-Turn architecture lets you change cartridges by hand without breaking inlet/outlet fluid connections—no tools needed.
- Patented titanium hybrid ferrules can be installed repeatedly without compromising high-pressure seal.
- Auto-adjusting design provides ZDV (zero dead volume) connection to any 10-32 female port.
- Guard column cartridges require EXP direct connect holder (cat.# 25808).
- Pair with EXP hand-tight fitting (cat.# 25937–25938) for tool-free installation.
- Great with any Raptor column to get ultimate protection from particulates and matrix contamination, especially when using dilute-and-shoot or other minimal sample preparation techniques.
- Raptor SPP LC columns combine the speed of SPP with the resolution of USLC technology.

Catalog No.	Product Name	Units
9304U0252	Raptor C18 EXP Guard Column Cartridge, UHPLC, 5 x 2.1 mm, 3-pk.	3-pk.
9304U0253	Raptor C18 EXP Guard Column Cartridge, UHPLC, 5 x 3.0 mm, 3-pk.	3-pk.
9304A0252	Raptor C18 EXP Guard Column Cartridge, 2.7 µm, 5 x 2.1 mm, 3-pk.	3-pk.
9304A0253	Raptor C18 EXP Guard Column Cartridge, 2.7 µm, 5 x 3.0 mm, 3-pk.	3-pk.
9304A0250	Raptor C18 EXP Guard Column Cartridge, 2.7 µm, 5 x 4.6 mm, 3-pk.	3-pk.
930450252	Raptor C18 EXP Guard Column Cartridge, 5 µm, 5 x 2.1 mm, 3-pk.	3-pk.
930450253	Raptor C18 EXP Guard Column Cartridge, 5 µm, 5 x 3.0 mm, 3-pk.	3-pk.
930450250	Raptor C18 EXP Guard Column Cartridge, 5 µm, 5 x 4.6 mm, 3-pk.	3-pk.
9314U0252	Raptor ARC-18 EXP Guard Column Cartridge, UHPLC, 5 x 2.1 mm, 3-pk.	3-pk.
9314U0253	Raptor ARC-18 EXP Guard Column Cartridge, UHPLC, 5 x 3.0 mm, 3-pk.	3-pk.
9314A0252	Raptor ARC-18 EXP Guard Column Cartridge, 2.7 µm, 5 x 2.1 mm, 3-pk.	3-pk.
9314A0253	Raptor ARC-18 EXP Guard Column Cartridge, 2.7 µm, 5 x 3.0 mm, 3-pk.	3-pk.
9314A0250	Raptor ARC-18 EXP Guard Column Cartridge, 2.7 µm, 5 x 4.6 mm, 3-pk.	3-pk.
931450252	Raptor ARC-18 EXP Guard Column Cartridge, 5 µm, 5 x 2.1 mm, 3-pk.	3-pk.
931450253	Raptor ARC-18 EXP Guard Column Cartridge, 5 µm, 5 x 3.0 mm, 3-pk.	3-pk.
931450250	Raptor ARC-18 EXP Guard Column Cartridge, 5 µm, 5 x 4.6 mm, 3-pk.	3-pk.
9309U0252	Raptor Biphenyl EXP Guard Column Cartridge, UHPLC, 5 x 2.1 mm, 3-pk.	3-pk.
9309U0253	Raptor Biphenyl EXP Guard Column Cartridge, UHPLC, 5 x 3.0 mm, 3-pk.	3-pk.
9309A0252	Raptor Biphenyl EXP Guard Column Cartridge, 2.7 µm, 5 x 2.1 mm, 3-pk.	3-pk.
9309A0253	Raptor Biphenyl EXP Guard Column Cartridge, 2.7 µm, 5 x 3.0 mm, 3-pk.	3-pk.
9309A0250	Raptor Biphenyl EXP Guard Column Cartridge, 2.7 µm, 5 x 4.6 mm, 3-pk.	3-pk.
930950252	Raptor Biphenyl EXP Guard Column Cartridge, 5 µm, 5 x 2.1 mm, 3-pk.	3-pk.
930950253	Raptor Biphenyl EXP Guard Column Cartridge, 5 µm, 5 x 3.0 mm, 3-pk.	3-pk.
930950250	Raptor Biphenyl EXP Guard Column Cartridge, 5 µm, 5 x 4.6 mm, 3-pk.	3-pk.
9319U0252	Raptor FluoroPhenyl EXP Guard Column Cartridge, UHPLC, 5 x 2.1 mm, 3-pk.	3-pk.
9319U0253	Raptor FluoroPhenyl EXP Guard Column Cartridge, UHPLC, 5 x 3.0 mm, 3-pk.	3-pk.
9319A0252	Raptor FluoroPhenyl EXP Guard Column Cartridge, 2.7 µm, 5 x 2.1 mm, 3-pk.	3-pk.
9319A0253	Raptor FluoroPhenyl EXP Guard Column Cartridge, 2.7 µm, 5 x 3.0 mm, 3-pk.	3-pk.
9319A0250	Raptor FluoroPhenyl EXP Guard Column Cartridge, 2.7 µm, 5 x 4.6 mm, 3-pk.	3-pk.
931950252	Raptor FluoroPhenyl EXP Guard Column Cartridge, 5 µm, 5 x 2.1 mm, 3-pk.	3-pk.
931950253	Raptor FluoroPhenyl EXP Guard Column Cartridge, 5 µm, 5 x 3.0 mm, 3-pk.	3-pk.
931950250	Raptor FluoroPhenyl EXP Guard Column Cartridge, 5 µm, 5 x 4.6 mm, 3-pk.	3-pk.
9310A0252	Raptor HILIC-Si EXP Guard Column Cartridge, 2.7 µm, 5 x 2.1 mm, 3-pk.	3-pk.
9310A0253	Raptor HILIC-Si EXP Guard Column Cartridge, 2.7 µm, 5 x 3.0 mm, 3-pk.	3-pk.
9310A0250	Raptor HILIC-Si EXP Guard Column Cartridge, 2.7 µm, 5 x 4.6 mm, 3-pk.	3-pk.
9311A0252	Raptor Polar X, 2.7 µm, 5 x 2.1 mm EXP Guard Column Cartridge, 3-pk.	3-pk.

Maximum cartridge pressure: 1034 bar/15,000 psi* (UHPLC); 600 bar/8700 psi (2.7 µm); 400 bar/5800 psi (5 µm).
* For maximum lifetime, recommended maximum pressure for UHPLC particles is 830 bar/12,000 psi.
Intellectual Property: optimizetech.com/patents

Force EXP Guard Cartridges

Catalog No.	Product Name	Units
962950252	Force Biphenyl EXP Guard Cartridge, 5 x 2.1 mm, 3-pk.	3-pk.
962950253	Force Biphenyl EXP Guard Cartridge, 5 x 3.0 mm, 3-pk.	3-pk.
962950250	Force Biphenyl EXP Guard Cartridge, 5 x 4.6 mm, 3-pk.	3-pk.
963450252	Force C18 Guard Cartridge, 5 x 2.1 mm EXP, 3-pk.	3-pk.
963450253	Force C18 Guard Cartridge, 5 x 3.0 mm EXP, 3-pk.	3-pk.
963450250	Force C18 Guard Cartridge, 5 x 4.6 mm EXP, 3-pk.	3-pk.
963950252	Force FluoroPhenyl EXP Guard Cartridge, 5 x 2.1 mm, 3-pk.	3-pk.
963950253	Force FluoroPhenyl EXP Guard Cartridge, 5 x 3.0 mm, 3-pk.	3-pk.
963950250	Force FluoroPhenyl EXP Guard Cartridge, 5 x 4.6 mm, 3-pk.	3-pk.

Maximum cartridge pressure: 600 bar/8700 psi.
Intellectual Property: optimizetech.com/patents

Roc LC Guard Column Holder

- Protect your Roc LC columns with minimal effect on retention, peak shape, or efficiency.
- Requires separate guard column cartridges (available from Restek).

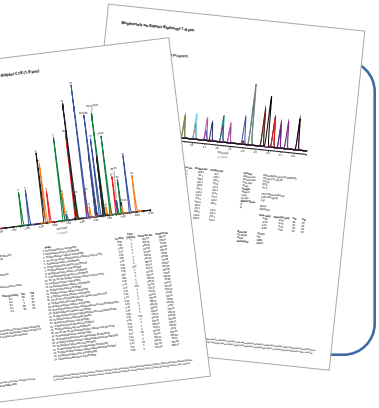
Catalog No.	Product Name	Units
25812	Roc LC Guard Column Holder for 10 x 4.0 mm Roc Guard Cartridges	ea.


25812

Roc LC Guard Column Cartridges

- Protect your Roc LC columns with minimal effect on retention, peak shape, or efficiency.
- Guard column cartridges require Roc guard column holder (cat.# 25812).

Catalog No.	Product Name	Units
953350210	Roc C8 Guard Cartridge, 10 x 4.0 mm, 3-pk.	3-pk.
953450210	Roc C18 Guard Cartridge, 10 x 4.0 mm, 3-pk.	3-pk.
953650210	Roc Cyano Guard Cartridge, 10 x 4.0 mm, 3-pk.	3-pk.
953550210	Roc Phenyl-Hexyl Guard Cartridge, 10 x 4.0 mm, 3-pk.	3-pk.
953050210	Roc Silica Guard Cartridge, 10 x 4.0 mm, 3-pk.	3-pk.



Looking for LC Chromatograms? Find Them Online.

Restek's searchable chromatogram library contains hundreds of chromatograms and allows you to search using a variety of terms, add more terms to refine your results, or use the filters to quickly narrow your results.

www.restek.com/chromatograms

27470
Level 1: Filter Holder Only

27472
Level 2: Cartridge Holder Only

27474
Level 3: Filter Holder and Cartridge Holder Power Pack

Trident LC Column Protection System

Superior Protection in an Easy-to-Install Design.

- Match your needs with three levels of protection: filter only, cartridge only, or filter and cartridge.
- Durable metal tip with replaceable PEEK ferrule means easy installation onto column without tools.
- Improved thread design and materials create an optimal seal that releases and reseals easily, allowing multiple installations without galling and binding.
- Easy-to-remove cap frit simplifies filter and cartridge replacement.
- Direct connection eliminates tubing and connectors that increase system volume and leak potential.
- Low-dead-volume design has negligible effect on chromatography.

Unlike "one size fits all" guard systems, the Trident LC column protection system gives you the power to select just the right level of protection for your work. With three levels of protection and a variety of guard cartridges and cap frits, you can select the best combination to match your specific analytical needs. Choose a filter alone to remove particulate matter, a guard cartridge alone to remove irreversibly adsorbed compounds, or both a filter and a guard cartridge for maximum protection. The economical, leak-free design provides a highly versatile combination of convenience, economy, and reliability.

The foundation of the Trident LC column protection system is a reusable, direct connect holder that easily attaches to any HPLC column with standard 10-32 thread ports.* The holder's durable metal tip and replaceable PEEK ferrule allow a leak-tight seal onto the column to be made quickly and easily without tools. Guard cartridges are available in both 2.1 and 4.0 mm IDs, and the redesigned holder houses either size securely. Because the holder components are machined from specialized materials that will not gall or bind, an optimal seal is created that will withstand rigorous repeated use when installed according to instructions. The holder has also been designed for easy removal of the cap frit, allowing you to replace the cap frit filter in just seconds.

Finally, since the Trident LC column protection system is engineered to be exceptionally low dead volume; it has minimal effect on retention, peak shape, and efficiency. Protect your analytical column and preserve method chromatography with a Trident LC column protection system.

Catalog No.	Product Name	Type	Units
27470	Trident LC Column Protection System, Level 1, Filter Only, ea.	Level 1: Filter Holder Only	ea.
27471	Trident LC Column Protection System, Level 1, Filter Only, 4-pk.	Level 1: Filter Holder Only	4-pk.
27472	Trident LC Column Protection System, Level 2, Cartridge Holder Only, ea.	Level 2: Cartridge Holder Only	ea.
27473	Trident LC Column Protection System, Level 2, Cartridge Holder Only, 4-pk.	Level 2: Cartridge Holder Only	4-pk.
27474	Trident LC Column Protection System, Level 3, Filter Holder and Cartridge Holder Power Pack, ea.	Level 3: Filter Holder and Cartridge Holder Power Pack	ea.
27475	Trident LC Column Protection System, Level 3, Filter Holder and Cartridge Holder Power Pack, 4-pk.	Level 3: Filter Holder and Cartridge Holder Power Pack	4-pk.

* Fittings on all LC columns have 10-32 threads; however, seat depth varies. An improper seat will yield a poor connection and may affect chromatography. While all Restek LC columns will provide a zero-dead-volume connection when used with a properly installed Trident LC column protection system, analysts should consult the manufacturer for non-Restek column connections. A detailed discussion about port configurations can be found at www.restek.com/Pages/faq_lc

Glass Solvent Filter

- Restek Bluestem glass solvent filter provides clean mobile phase to extend the life of columns and pump seals.
- 15 µm borosilicate glass frit sits lower than conventional glass filters to draw more mobile phase from each bottle.
- Blue filter stem allows instant visual confirmation of upright filter orientation.
- Connects to standard 1/8" OD (3.2 mm) PTFE tubing using your existing frit adaptor. For best performance, we recommend using Restek's frit adaptor (sold separately as cat.# 26392).

Prevent the particulates and microbial growth in your LC solvents from entering your instrument with the new Restek Bluestem glass solvent filter.

26431

26392

Catalog No.	Product Name	Units
26431	Glass Solvent Filter, 15 µm Frit	ea.
26392	Frit Adaptor, PTFE, 4-pk.	4-pk.

Last Drop Filter

- Protect your instrument and column by filtering your mobile phase of contaminants and particulates.
- Choose stepped connector for 1.5/2.2/3.5 mm ID tubing or flangeless connector for 1/8" OD tubing.
- Filter elements available in 316 stainless steel or metal-free PTFE.
- Housing made of PTFE, connector of PEEK, optional flangeless connector ferrule of ETFE (not in flow path).

Flow rates measured with methanol/water (1:1), ultrasonically degassed. Flow rates can vary with solvent and tubing ID.

Catalog No.	Product Name	Flow Rate	Units
27817	Last Drop Filter, Stainless Steel, 2 µm, Stepped Connector, Used with 1.5/2.2/3.5 mm Tubing	28 mL/min	ea.
27819	Last Drop Filter, Stainless Steel, 10 µm, Stepped Connector, Used with 1.5/2.2/3.5 mm Tubing	30 mL/min	ea.

Hub-Cap 4-Liter Bottle Tops

Hub-Cap bottle tops are a great way to neatly keep your mobile phase lines where they belong. Use them instead of plastic paraffin film, aluminum foil, or tape on your mobile phase reservoirs.

26541

Hub-Cap (assembly of the bottle cap and plug)

Catalog No.	Product Name	Units
26541	Hub-Cap Kit, Assembly of the Bottle Cap and Plug, Kit	kit
26542	Hub-Cap Multi-Pack, 3-pk.	3-pk.

Maintenance


25271


25270


25915


25799


25143

LC Maintenance Kits

Catalog No.	Product Name	Includes	Similar To	Units
25271	Autosampler Preventive Maintenance Kit, for Agilent 1100, 1200 HPLC Systems	Rotor seal; piston seals (2); needle assembly; needle seat; finger caps (3)	Agilent G1313-68709	kit
25270	Pump Maintenance Kit, for Agilent 1050, 1100, 1200 HPLC Systems	PTFE frits (2); outlet cap; gold disk seal; active inlet cartridge; piston seals (4); glass solvent filters (2)	Agilent G1311-68710	kit
25915	Pump Preventive Maintenance Kit, Ext Iso, for Agilent 1050, 1100, 1200 HPLC Systems	Sapphire plunger (2); piston seals (2); outlet ball check valve; active inlet cartridge; PTFE frits (5)	Agilent 5065-4499	kit
25797	BSM Pump Preventive Maintenance Kit, for Waters ACQUITY UPLC BSM	in-line filter assembly, stainless steel frit; tube assembly, transducer to check valve; tube assembly, SSV to in-line filter; primary check valve (2); wash seal, float flanged, (2); head plunger seal kit (2); sapphire plungers, (2); air filter, pump; air filter, pump handle; mixer assembly, 50 µl; accumulator check valve, double ball & seat (2); solvent bottle filter, stainless steel (7); pump O-ring, (PTFE)	Waters 201000173	kit
25798	I2 V Pump Preventive Maintenance, Kit, for Waters ACQUITY UPLC I2V BSM	Tube assembly, SSV to I2v; transducer to check valve, tube assembly, I2v; wash seal, float flanged (2); head plunger seal kit (2); sapphire plungers (2); air filter, pump; air filter, pump handle; mixer assembly, 50 µL; filter frit cartridge, stainless steel; accumulator check valve, double ball & seat (2); check valve cartridge (2); solvent bottle filter, stainless steel (7); pump O-ring, (PTFE)	Waters 201000197	kit
25799	H-Class QSM Pump Preventive Maintenance Kit, for Waters ACQUITY H-CLASS QSM	solvent bottle filter, stainless steel (5); 20 micron frit holder assembly; tube assembly, transducer to check valve; wash seal, float flanged (2); head plunger seal kit (2); sapphire plungers (2); check valve, double ball & seat (2); I2 check valve cartridge; air filter, door; pump O-ring, (PTFE); mixer assembly, 100 µL	Waters 201000233	kit
25143	Preventive Maintenance Kit, for Waters Alliance 2690, 2695	sapphire plungers (2); seal wash plunger seals (2); head plunger seals (2); wash tube seals (4); sparge diffuser; filter insert; face seals (4); solvent reservoir 10 µm filters (4); 250 µL syringe; check valve cartridges (2); wash tube seal; seal wash tube; PTFE washer; filter retainer; lower wash seal frit; needle wash frit; TFE washer; needle assembly; gold injector seals (2); stainless steel ferrule; compression screw; seal wash face seals (2)	Waters WAT270944	kit
25145	Preventive Maintenance Kit, for Waters 717 Autosampler	seal pack assembly; tube assembly (0.020" ID); needle; needle compression screw; 0.062 stainless steel ferrule; precolumn filter assembly; filter insert; 250 µL WISP syringe	Waters WAT052669	kit
26519	Preventive Maintenance Kit, for Waters 515 Pump	PerformancePLUS check valves (4); sparge diffuser; solvent reservoir 10 µm filter; sapphire plungers (2); plunger seals (2); pivot inserts (2); pivot guides (2); washer (2); plunger springs (2); retaining rings (2)	Waters WAT052587	kit
26430	Preventive Maintenance Kit, for Waters 1525 Pump	sapphire plungers (4); check valve cartridges (8); plunger seals (4); solvent reservoir 10 µm filters (2); reference valve button; valve disk spacer; valve disk	Waters 201000114	kit

Find us at **www.restek.com/lc**

RESTEK
Pure Chromatography

Questions? Contact us or your local Restek representative (www.restek.com/contact-us).

www.restek.com

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