Restek LC Accessories

Diagnosing and Preventing High Back Pressure in LC Systems

RESTEK Pure Chromatography

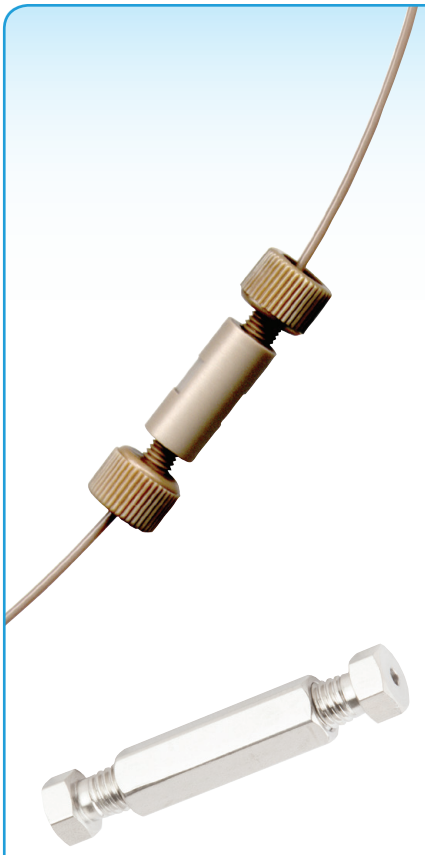
www.restek.com//LCacc

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.

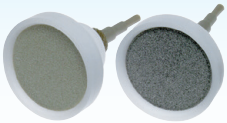
Whenever possible, consider filtering your sample prior to analysis. Syringe filters and filter vials are both viable options for effective filtration. Alternatively, centrifugation is very effective, especially if you pair it with an adjustment of the needle insertion depth to make sure the injector 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. You can access them at www.restek.com/LCmaintBLOG

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

Quickly and reliably connect two pieces of 1/16" tubing. 0.3 mm union bore. End fittings included.

Description	qty.	cat.#
PEEK Union Connector 1/16"	2-pk.	25323

Zero Dead Volume Valco 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.

Description	Union Bore	Valco #	qty.	cat.#
Internal Union	0.15 mm	ZU1XC	ea.	20147
Internal Union	0.25 mm	ZU1C	ea.	20148
Internal Union	0.75 mm	ZU1	ea.	20149
Internal Union	1/16"	ZU1T	ea.	20150

Filtration

Syringe Filters with Luer Lock Inlet

- Luer lock inlet offers leak-tight syringe connection.
- Variety of filter types, porosities, and diameters.
- Color coded for easy identification.
- Rugged polypropylene housing.
- Autoclavable to 121 °C for 15 minutes.
- Quantity break pricing for greater savings.

Size	Porosity	Color	qty.	cat.#
Cellulose Acetate				
4 mm	0.22 µm	green	100-pk.	23972
4 mm	0.45 µm	blue	100-pk.	23973
13 mm	0.22 µm	red	100-pk.	26156
13 mm	0.45 µm	red	100-pk.	26155
25 mm	0.22 µm	red	100-pk.	26158
25 mm	0.45 µm	red	100-pk.	26157
30 mm	0.22 µm	red	100-pk.	23982
30 mm	0.45 µm	red	100-pk.	23983
Nylon				
4 mm	0.22 µm	yellow	100-pk.	23970
4 mm	0.45 µm	pink	100-pk.	23971
13 mm	0.22 µm	pink	100-pk.	26146
13 mm	0.45 µm	pink	100-pk.	26147
25 mm	0.22 µm	pink	100-pk.	26148
25 mm	0.45 µm	pink	100-pk.	26149
30 mm	0.22 µm	pink	100-pk.	23980
30 mm	0.45 µm	pink	100-pk.	23981
PES (polyethersulfone)				
4 mm	0.22 µm	white	100-pk.	23978
4 mm	0.45 µm	blue	100-pk.	23979
13 mm	0.22 µm	green	100-pk.	23966
13 mm	0.45 µm	green	100-pk.	23967
25 mm	0.22 µm	green	100-pk.	23968
25 mm	0.45 µm	green	100-pk.	23969
30 mm	0.22 µm	green	100-pk.	23988
30 mm	0.45 µm	green	100-pk.	23989
PTFE (polytetrafluoroethylene)				
4 mm	0.22 µm	purple	100-pk.	23974
4 mm	0.45 µm	orange	100-pk.	23975
13 mm	0.22 µm	white	100-pk.	26142
13 mm	0.45 µm	white	100-pk.	26143
25 mm	0.22 µm	white	100-pk.	26144
25 mm	0.45 µm	white	100-pk.	26145
30 mm	0.22 µm	white	100-pk.	23984
30 mm	0.45 µm	white	100-pk.	23985
PVDF (polyvinyldifluoride)				
4 mm	0.22 µm	brown	100-pk.	23976
4 mm	0.45 µm	red	100-pk.	23977
13 mm	0.22 µm	blue	100-pk.	26150
13 mm	0.45 µm	blue	100-pk.	26151
25 mm	0.22 µm	blue	100-pk.	26152
25 mm	0.45 µm	blue	100-pk.	26153
30 mm	0.22 µm	blue	100-pk.	23986
30 mm	0.45 µm	blue	100-pk.	23987

Syringe filters are for laboratory use only.

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

Cut costs, not quality!

Price breaks available!

Price per 100-pack. Price breaks are available at 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.

Simply squeeze particulates and contaminants out of your sample!

Filtration

Thomson SINGLE StEP Filter Vials

- Easy-to-use vials offer fast sample filtration and require only a squeeze of your fingers.
- Rugged polypropylene vial houses insert with 250 µL loading capacity and extremely low dead volume.
- Fit most standard 12 x 32 mm autosamplers, including UHPLC instruments.

Thomson SINGLE StEP Standard Filter Vials

- 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.
- Pre-slit PTFE/silicone caps help eliminate broken autosampler needles and cored septa.

Porosity	Color	qty.	cat.#
Nylon			
0.2 µm	black pre-slit cap	100-pk.	25891
0.45 µm	pink pre-slit cap	100-pk.	25892
PES (polyethersulfone)			
0.2 µm	grey pre-slit cap	100-pk.	25897
PTFE (polytetrafluoroethylene)			
0.2 µm	green pre-slit cap	100-pk.	25893
0.45 µm	blue pre-slit cap	100-pk.	25894
PVDF (polyvinyldifluoride)			
0.2 µm	red pre-slit cap	100-pk.	25895
0.45 µm	yellow pre-slit cap	100-pk.	25896

Patent No. 7,790,117

Thomson SINGLE StEP Low Evaporation Filter Vials

- Enhanced evaporation prevention technology ensures less than 0.4% evaporation over 24 hours.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, or nylon.

Porosity	Color	qty.	cat.#
Nylon			
0.2 µm	black cap	100-pk.	25870
0.45 µm	purple cap	100-pk.	25871
PTFE (polytetrafluoroethylene)			
0.2 µm	green cap	100-pk.	25868
0.45 µm	blue cap	100-pk.	25872
PVDF (polyvinyldifluoride)			
0.2 µm	red cap	100-pk.	25869
0.45 µm	yellow cap	100-pk.	25873

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.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, PES, or nylon.
- Pre-slit PTFE/silicone caps help eliminate broken autosampler needles and cored septa.

Porosity	Color	qty.	cat.#
Nylon			
0.2 µm	black pre-slit cap	100-pk.	25878
0.45 µm	pink pre-slit cap	100-pk.	25879
PES (polyethersulfone)			
0.2 µm	grey pre-slit cap	100-pk.	25880
PTFE (polytetrafluoroethylene)			
0.2 µm	green pre-slit cap	100-pk.	25874
0.45 µm	blue pre-slit cap	100-pk.	25875
PVDF (polyvinyldifluoride)			
0.2 µm	red pre-slit cap	100-pk.	25876
0.45 µm	yellow pre-slit cap	100-pk.	25877

Thomson SINGLE StEP Nano Filter Vials

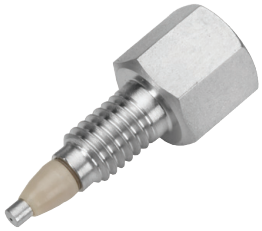
- Ultra-low dead volume allows you to filter as little as 10 µL of sample and still obtain enough filtrate to make a 2 µL injection.
- Color-coded caps allow easy identification of 0.2 µm or 0.45 µm membranes in PVDF, PTFE, PES, or nylon.
- Available with either standard or pre-slit PTFE/silicone caps. Standard caps minimize evaporation and pre-slit caps help eliminate broken autosampler needles and cored septa.

Porosity	Color	qty.	cat.#
Nylon			
0.2 µm	black standard cap	100-pk.	25866
0.2 µm	black pre-slit cap	100-pk.	25886
PES (polyethersulfone)			
0.2 µm	grey standard cap	100-pk.	25867
0.2 µm	grey pre-slit cap	100-pk.	25887
PTFE (polytetrafluoroethylene)			
0.2 µm	green standard cap	100-pk.	25862
0.2 µm	green pre-slit cap	100-pk.	25882
0.45 µm	blue standard cap	100-pk.	25863
0.45 µm	blue pre-slit cap	100-pk.	25883
PVDF (polyvinyldifluoride)			
0.2 µm	red standard cap	100-pk.	25864
0.2 µm	red pre-slit cap	100-pk.	25884
0.45 µm	yellow standard cap	100-pk.	25865
0.45 µm	yellow pre-slit cap	100-pk.	25885

Accessories for Filter Vials

Description	qty.	cat.#
Toggle Press for eXtreme Filter Vials	ea.	25860
Filter Vial Press, Multi-Use: 8 Positions for 30 mL Filter Vials & 48 Position for Autosampler Ready Filter Vials	ea.	25861

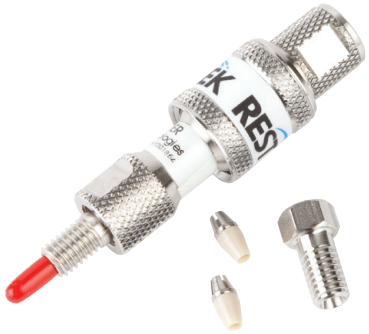
Filtration



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.
- Universal fit—connects easily to any brand column.
- Leaktight to 15,000 psi (1,034 bar).
- 0.5 µm or 0.2 µm stainless steel frit in a stainless steel body with PEEK ferrule.

Description	Filter Porosity	qty.	cat.#
UltraShield UHPLC PreColumn Filter	0.5 µm frit	ea.	24995
		5-pk.	24996
		10-pk.	24997
UltraShield UHPLC PreColumn Filter	0.2 µm frit	ea.	25809
		5-pk.	25810
		10-pk.	25811

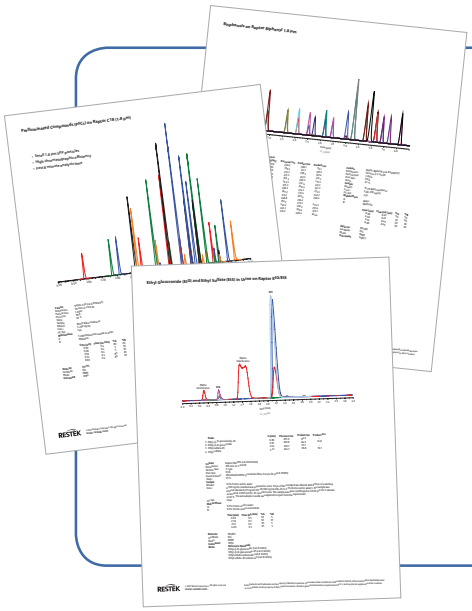


EXP Direct Connect Holder

- 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.# 25937–25939) for tool-free installation.

Description	qty.	cat.#
EXP Direct Connect Holder for EXP Guard Cartridges (includes hex-head fitting & 2 ferrules)	ea.	25808

Maximum holder pressure: 20,000 psi (1,400 bar)



Looking for LC Chromatograms? Find Them Online.

Restek's searchable chromatogram library is a comprehensive database of chromatograms by Restek chemists, partners, and customers.

- Search by compound name, synonym, CAS #, compound class, column name, catalog number, or keyword.
- Add search terms to refine your results.
- Use our quick filters to narrow your result set.

There are hundreds of LC chromatograms in our library—dive in today to find your ideal application.

www.restek.com/chromatograms

Filtration

EXP Guard 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.# 25937–25939) 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 limited–sample preparation techniques.

Hand-Tight Fitting—No Tools Needed!

Unidirectional Raptor EXP Guard Column Cartridge

Holder Body

Raptor EXP Guard Column Cartridges

Description	Particle Size	qty.	5 x 2.1 mm cat.#	5 x 3.0 mm cat.#	5 x 4.6 mm cat.#
Raptor C18 EXP Guard Column Cartridge	UHPLC	3-pk.	9304U0252	9304U0253	
Raptor C18 EXP Guard Column Cartridge	2.7 µm	3-pk.	9304A0252	9304A0253	9304A0250
Raptor C18 EXP Guard Column Cartridge	5 µm	3-pk.	930450252	930450253	930450250
Raptor ARC-18 EXP Guard Column Cartridge	UHPLC	3-pk.	9314U0252	9314U0253	
Raptor ARC-18 EXP Guard Column Cartridge	2.7 µm	3-pk.	9314A0252	9314A0253	9314A0250
Raptor ARC-18 EXP Guard Column Cartridge	5 µm	3-pk.	931450252	931450253	931450250
Raptor Biphenyl EXP Guard Column Cartridge	UHPLC	3-pk.	9309U0252	9309U0253	
Raptor Biphenyl EXP Guard Column Cartridge	2.7 µm	3-pk.	9309A0252	9309A0253	9309A0250
Raptor Biphenyl EXP Guard Column Cartridge	5 µm	3-pk.	930950252	930950253	930950250
Raptor FluoroPhenyl EXP Guard Column Cartridge	UHPLC	3-pk.	9319U0252	9319U0253	
Raptor FluoroPhenyl EXP Guard Column Cartridges	2.7 µm	3-pk.	9319A0252	9319A0253	9319A0250
Raptor FluoroPhenyl EXP Guard Column Cartridges	5 µm	3-pk.	931950252	931950253	931950250
Raptor HILIC-Si EXP Guard Column Cartridge	2.7 µm	3-pk.	9310A0252	9310A0253	9310A0250

Maximum cartridge pressure: 1,034 bar/15,000 psi* (UHPLC), 600 bar/8,700 psi (2.7 µm); 400 bar/5,800 psi (5 µm)
* For maximum lifetime, recommended maximum pressure for UHPLC particles is 830 bar/12,000 psi.

Raptor SPP LC columns combine the speed of SPP with the resolution of USLC technology. Learn more at **www.restek.com/raptor**

Force EXP Guard Column Cartridges

Description	qty.	5 x 2.1 mm cat.#	5 x 3.0 mm cat.#	5 x 4.6 mm cat.#
Force Biphenyl EXP Guard Column Cartridge	3-pk.	962950252	962950253	962950250
Force C18 EXP Guard Column Cartridge	3-pk.	963450252	963450253	963450250
Force FluoroPhenyl EXP Guard Column Cartridge	3-pk.	963950252	963950253	963950250

Maximum cartridge pressure: 600 bar/8,700 psi.
Apply Force LC columns to all of your HPLC and UHPLC instrument platforms at www.restek.com/force

Filtration

Roc LC Guard Column Holder

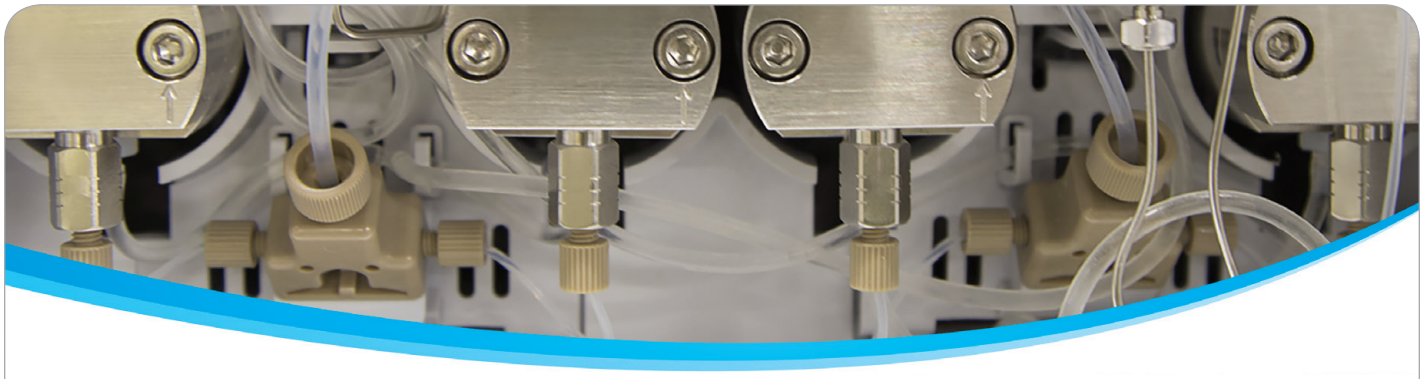
- Protect your Roc LC columns with minimal effect on retention, peak shape, or efficiency.
- Requires separate guard column cartridges (available from Restek).

Description	qty.	cat.#
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).

Description	qty.	10 x 4.0 mm cat.#
Roc C8 Guard Cartridge	3-pk.	953350210
Roc C18 Guard Cartridge	3-pk.	953450210
Roc Cyano Guard Cartridge	3-pk.	953650210
Roc Phenyl-Hexyl Guard Cartridge	3-pk.	953550210
Roc Silica Guard Cartridge	3-pk.	953050210



Keep Your LC Work Flowing with Restek Maintenance Supplies

Restek is a 100% employee-owned company and the last major independent provider of chromatography supplies in the industry. We proudly work with every analyst to keep any make or model of LC up and running its best, and our line of 100% guaranteed LC instrument replacement parts meets and often exceeds the original instrument manufacturer's performance. For seals, valves, lamps, and many more OEM-equivalent supplies, visit **www.restek.com/LCacc**

Filtration

Trident LC Column Protection System

Redesigned to be more rugged and easier to use!

- 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 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.

Description	qty.	cat.#	qty.	cat.#
Level 1: Filter Holder Only Includes: filter holder; cap frit filter (4 mm, 2.0 µm); and PEEK ferrule	ea.	27470	4-pk.	27471
Level 2: Cartridge Holder Only Includes: cartridge holder and PEEK ferrule	ea.	27472	4-pk.	27473
Level 3: Filter Holder and Cartridge Holder Power Pack Includes: filter holder; cap frit filter (4 mm, 2.0 µm); cartridge holder; and PEEK ferrule	ea.	27474	4-pk.	27475

* Fittings on all HPLC and UHPLC 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 http://www.restek.com/Pages/faq_lc#top

Filtration

Bluestem 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 (also 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.

Description	Similar to Agilent Part #	qty.	cat.#
Glass Solvent Filter, 15 µm frit	5041-2168	ea.	26431
Frit Adaptor, PTFE	5062-8517	4-pk.	26392

Last Drop Filter

The flat filter element sits parallel to the bottom of the mobile phase reservoir, allowing the filter to draw 98% of the mobile phase without drawing air into the system. Conventional cylindrical mobile phase filters begin to draw air into the system when approximately 10% of the solvent remains in the reservoir. The Last Drop filter allows more analyses per batch of mobile phase and helps reduce hazardous waste. 22.1 mm OD.

Description	qty.	cat.#
Last Drop Filter, 2 µm	ea.	25314
Last Drop Filter, 10 µm	ea.	25315

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

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.

Description	qty.	cat.#
Hub-Cap (assembly of the bottle cap and plug)	kit	26541
Hub-Cap Multi-Pack	3-pk.	26542

Maintenance

LC Maintenance Kits

Simplify routine maintenance with these handy kits for LC.

- Significant savings over instrument manufacturer prices.
- High quality components in every kit.
- Wide selection of PM Kits for your HPLC systems.

Description for Agilent LCs	Model #	Similar to Agilent part #	qty.	cat.#
Autosampler PM Kit Includes: rotor seal; piston seals (2); needle assembly; needle seat; finger caps (3)	1100, 1200	G1313-68709	kit	25271
Pump PM Kit Includes: PTFE frits (2); outlet cap; gold disk seal; active inlet cartridge; piston seals (4); glass solvent filters (2)	1050, 1100, 1200	G1311-68710	kit	25270
Pump PM Kit Includes: sapphire plunger (2); piston seals (2); outlet ball check valve; active inlet cartridge; PTFE frits (5)	1100, 1200	5065-4499	kit	25915
Description for Waters LCs	**Model #**	**Similar to Waters part #**	**qty.**	**cat.#**
ACQUITY BSM Pump Kit Includes: 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)	ACQUITY UPLC BSM	201000173	kit	25797
ACQUITY I2V BSM Pump Kit Includes: 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)	ACQUITY UPLC I2V BSM	201000197	kit	25798
ACQUITY H-Class QSM Pump Kit Includes: 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	ACQUITY H-CLASS QSM	201000233	kit	25799
2690/2695 Pump & Autosampler PM Kit Includes: sapphire plungers (2); seal wash plunger seals (4); head plunger seals (4); 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	Alliance 2690, 2695	WAT270944	kit	25143
600 Pump PM Kit Includes: PerformancePLUS cartridges (4); sparge diffusers (4); Super Seals (2); solvent reservoir 10 µm filters (4); sapphire plungers (2); reference valve button; valve disk spacer; valve disk; TFE ball plug; TFE seat; ruby ball; inlet tube body assembly manifold insert; insert seal; belleville washers (2); flat washer	600 Pump	WAT052675	kit	25144
717 Autosampler PM Kit Includes: 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	717 Autosampler	WAT052669	kit	25145
616 Pump PM Kit Includes: sapphire plungers (2); sparge diffusers (4); solvent reservoir 10 µm filters (4); plunger seals (2); plunger wash seals (2); O-rings (2); backup rings (2); check valve cartridges (4)	616 Pump	WAT052672	kit	25146
515 Pump PM Kit Includes: 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)	515 Pump	WAT052587	kit	26519
1525 Pump PM Kit Includes: sapphire plungers (4); check valve cartridges (8); plunger seals (4); solvent reservoir 10 µm filters (2); reference valve button; valve disk spacer; valve disk	1525 Pump	201000114	kit	26430

Find us at www.restek.com/lc

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