

# HPLC Column Selection Guide



The uniform spherical shape of Restek silica allows optimal packing, for better reproducibility and lower back pressure, resulting in extended column life.

Restek Corporation manufactures a variety of columns for reversed phase or normal phase applications. The Allure™ and Ultra column product lines contain 19 different phases, and we continue to develop additional unique HPLC products. Pinnacle II™ and Pinnacle™ DB columns are based on silica we manufacture in our own laboratories, so you can be assured of their quality, from raw material synthesis through packing and testing.

We pack bonded phases into a wide range of column dimensions, including standard analytical columns in lengths of 30 to 250mm, internal diameters of 1.0 to 4.6mm, and particle sizes of 3 or 5µm. Preparative and semi-preparative columns are available, as well. These hundreds of column choices can make column selection overwhelming. The chart below, and the information on the back of the chart, are general guidelines to help simplify the column selection process.



Restek HPLC Column	End Cap?	Pore Size (Å)	Carbon Load (%)	Applications	Chromatographic Properties	Similar Phases	USP Code
<b>Pinnacle™ DB C18</b>	Y	140	11	Hydrophobic C18 phase suitable for a wide range of compounds, neutral through weakly basic.	Highly base-deactivated spherical silica manufactured by Restek Corp. Monomeric C18 bonding.	Hypersil® BDS C18	L1
<b>Pinnacle™ DB C8</b>	Y	140	6	Applications similar to Pinnacle™ DB C18, but with less hydrophobic retention. Less retention can be useful for shortening analysis time, if resolution is adequate.	Highly base-deactivated spherical silica manufactured by Restek Corp. Monomeric C8 bonding. Similar to Pinnacle™ DB C18, but the shorter alkyl chain provides less hydrophobic retention.	Hypersil® BDS C8	L7
<b>Pinnacle™ DB Cyano</b>	Y	140	4	Suitable for a wide range of compounds, from acidic through weakly basic. Also useful for confirmation of analyses on C18 or C8. Can be used in normal phase or reversed phase mode of separation.	Cyano bonding on highly base-deactivated spherical silica manufactured by Restek Corp.	Hypersil® BDS Cyano	L10
<b>Pinnacle™ DB Silica</b>	NA	140	NA	Normal phase separations.	Highly base-deactivated spherical silica manufactured by Restek Corp.	Hypersil® BDS	L3
<b>Pinnacle II™ C18</b>	Y	110	13	Superior general purpose C18 for neutral and acidic analytes.	Intermediate carbon load and surface area, suitable for a wide range of neutral to acidic compounds. Silica manufactured by Restek Corp.	Hypersil® ODS; Spherisorb® ODS	L1
<b>Pinnacle II™ PAH</b>	Y	110	P	Maximum resolution of polynuclear aromatic hydrocarbons.	Proprietary stationary phase; resolves 16 PAHs in US EPA Method 610. Silica manufactured by Restek Corp.	Unique	
<b>Pinnacle II™ C8</b>	Y	110	7	Superior general purpose C8 for neutral and acidic analytes.	Provides shorter retention times for hydrophobic compounds than C18. Silica manufactured by Restek Corp.	Hypersil® C8	L7
<b>Pinnacle II™ Cyano</b>	Y	110	4	Superior general purpose cyano for weakly basic analytes. Can be used in normal phase or reversed phase mode of separation.	More rugged than bare silica for normal phase analyses. Silica manufactured by Restek Corp.	Hypersil® Cyano; Spherisorb® Cyano	L10
<b>Pinnacle II™ Phenyl</b>	Y	110	6	Superior general purpose phenyl for neutral to weakly basic analytes.	Offers unique selectivity versus traditional alkyl chain phases, especially for aromatic compounds. Silica manufactured by Restek Corp.	Hypersil® Phenyl; Spherisorb® Phenyl	L11
<b>Pinnacle II™ Amino</b>	N	110	2	Excellent general purpose amino phase. Excellent choice for carbohydrate analysis.	Silica manufactured by Restek Corp.	Hypersil® Amino; Spherisorb® Amino	L8
<b>Pinnacle II™ Silica</b>	NA	110	NA	Superior value phase for normal phase separation of polar analytes.	Lower retention than Ultra C18. Silica manufactured by Restek Corp.	Hypersil® Silica	L3
<b>Allure™ C18</b>	Y	60	27	Ideal for MS and light-scattering detection of neutral to slightly polar non-ionic solutes. Excellent for basic compounds, explosives, or steroids.	Most retentive phase for hydrophobic and slightly polar analytes. Mobile phase containing higher percentage of organic modifier contributes to higher sensitivity in ESI-based LC/MS. Extensive deactivation.	Ultracarb® C18; Betamax® Neutral	L1
<b>Allure™ Aqueous C18</b>	N	60	P	Ideal for analyses that require >90% water in the mobile phase. Excellent for highly water soluble or poorly organic soluble compounds, water-soluble vitamins, organic acids. More retention than Ultra Aqueous columns.	Highly retentive and selective for reversed phase separations of polar analytes. Highly base deactivated. Compatible with highly aqueous (up to 100%) mobile phases.		L1
<b>Allure™ Basix</b>	Y	60	12	Ideal for LC/MS of basic solutes. Excellent for basic pharmaceuticals or other amine-containing compounds.	Highly retentive phase for analytes containing amino functionality.	Betamax® Base; Maxsil® CN	L10
<b>Allure™ PFP Propyl</b>	Y	60	17	Excellent for beta-blockers, halogenated compounds, nucleosides, nucleotides, pyridines, pyrimidines, or tricyclic antidepressants. Ideal for MS, ELSD, or NPD detection.	A pentafluorophenyl phase with a propyl spacer. Highly retentive for basic analytes.	Discovery HS F5	
<b>Allure™ Organic Acids</b>	N	60	P	Excellent resolution of challenging organic acids.	Single 30cm column performs equally to two C18 columns in series. (AOAC Method 986.13)	Unique	
<b>Allure™ Silica</b>	NA	60	NA	Highly retentive phase for polar analytes by normal phase separation.	High purity, very high surface area.	Maxsil® Si	L3
<b>Ultra C18</b>	Y	100	20	Ideal for anilines, barbiturates, carbonyls, fat-soluble vitamins, fatty acids, glycerides, phthalates, PTH amino acids, steroids, other acids.	Very retentive, high-purity packing material exhibits excellent peak shape for a wide range of compounds. Excellent first choice general purpose reversed phase column.	Discovery C18; Symmetry C18; Luna® C18; Zorbax® C18; Kromasil® C18; Lichrospher® RP-18; Inertsil® ODS-2; Develosil® C18	L1
<b>Ultra Aqueous C18</b>	N	100	15	Ideal for analyses that require >90% water in the mobile phase. Excellent for highly water soluble or poorly organic soluble compounds, water-soluble vitamins, organic acids.	Highly retentive and selective for reversed phase separations of polar analytes. Extensively base deactivated. Compatible with highly aqueous (up to 100%) mobile phases.	ODS-AQ; Aquasil C18; Zorbax® SB-AQ	L1
<b>Ultra IBD</b>	N	100	12	A polar group assists in deactivating surface silanols and contributes to unique selectivities for acids, bases, zwitterions, and polar compounds.	Intrinsically base-deactivated (IBD) phase, with a polar group embedded in the alkyl bonded phase. Provides unique selectivity while reducing or eliminating the need for mobile phase additives.	Symmetry Shield; Discovery ABZ & ABZ+; Prism®; HyPurity Advance	
<b>Ultra C8</b>	Y	100	12	Excellent peak shape for a wide range of compounds. Selectivity and peak shape similar to Ultra C18, but less hydrophobic retention.	Very retentive, high-purity, base-deactivated reversed phase packing.	Luna® C8; Symmetry C8; Kromasil® C8	L7
<b>Ultra C4</b>	Y	100	9	Ideal for peptides, small proteins, hormones.	Exceptionally stable C4 packing, with high bonding coverage and silanol base-deactivation. Shorter retention than C18 or C8.	Supelcosil Butyl (C4); Delta-Pak® C4	L26
<b>Ultra C1</b>	NA	100	5	Alternative selectivity to Ultra C18 or C8, especially for polar analytes. Shortest chain alkyl phase available for reversed phase separations.	Exceptionally stable C1 packing resists hydrolysis, even under acidic mobile phase conditions. Least retentive reversed phase hydrocarbon packing.	Spherisorb® C1	L13
<b>Ultra Cyano</b>	Y	100	8	Excellent for basic pharmaceuticals, steroids (normal or reversed phase conditions), or other basic compounds.	High-purity cyano phase with reduced silanol activity. Often a better choice than C18 for basic pharmaceuticals. Cyano is the most stable bonded phase for normal phase separations.	Platinum® CN; Develosil® Cyano; Luna® CN	L10
<b>Ultra Phenyl</b>	Y	100	10	Ideal for fatty acids, polynuclear aromatic hydrocarbons, purines and pyrimidines, polar aromatics.	High-purity, highly retentive, base-deactivated phase with alternate selectivity to hydrocarbon phases, especially for aromatic analytes.	Platinum® Phenyl; Supelcosil Phenyl	L11
<b>Ultra Amino</b>	N	100	2	Superior general purpose amino phase. Ideal for carbohydrates.	Recommended for normal phase analyses of mono- and disaccharides and other similar compounds. Can also serve as a weak anion exchanger, with aqueous buffers.	Platinum® Amino; Develosil® NH <sub>2</sub>	L8
<b>Ultra PFP</b>	Y	100	7	Ideal for taxol and precursors, halogenated compounds, amines, esters, or ketones.	A pentafluorophenyl phase. Unique selectivity by interaction with functional groups of organohalogen or other basic analytes.	Fluophase® PFP; Fluosep-RP® Phenyl	L43
<b>Ultra Silica</b>	NA	100	NA	Ideal for normal phase applications.	High purity, high surface area.	Unique	L3
<b>Ultra Carbamate</b>	P	100	P	Rapid analysis of carbamates.	Proprietary stationary phase can process up to twice as many samples per hour, compared to a conventional C18 phase.	Unique	
<b>Ultra Quat</b>	P	100	P	Proprietary phase for paraquat, diquat, and other quaternary amines.	High purity silica. Requires a reagent solution.	Unique	—
<b>Viva™ Wide Pore C18</b>	Y	300	6	Proteins and other higher molecular weight compounds.	Silica manufactured by Restek Corp.	Symmetry® 300 C18; Jupiter® 300 C18; BioBasic® C18; Zorbax® 300 SB-C18	
<b>Viva™ Wide Pore Silica</b>	NA	300	NA	Higher molecular weight compounds by normal phase mode.	Silica manufactured by Restek Corp.	Symmetry® 300 silica; Jupiter® 300 silica; Zorbax® 300 silica	

P= proprietary  
 NA= not applicable  
 All columns: recommended pH range is 2.5–7.5; temp. limit 80°C.  
 Column lifetimes can be shortened by operating at pH and/or temperature extremes.

Call Restek Now for the Right Column for Your Tough Analysis 1-800-356-1688

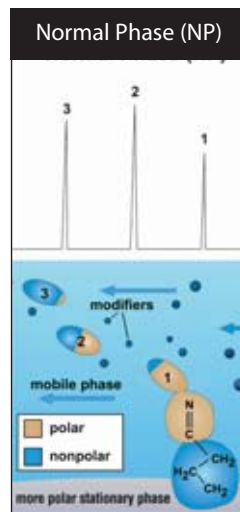
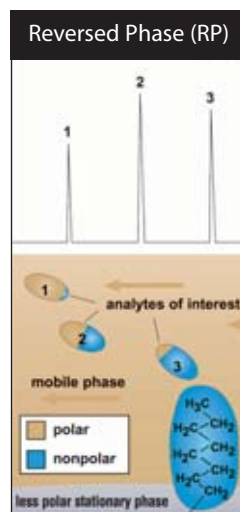
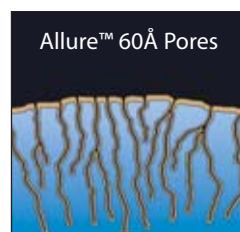


### Choosing a Stationary Phase

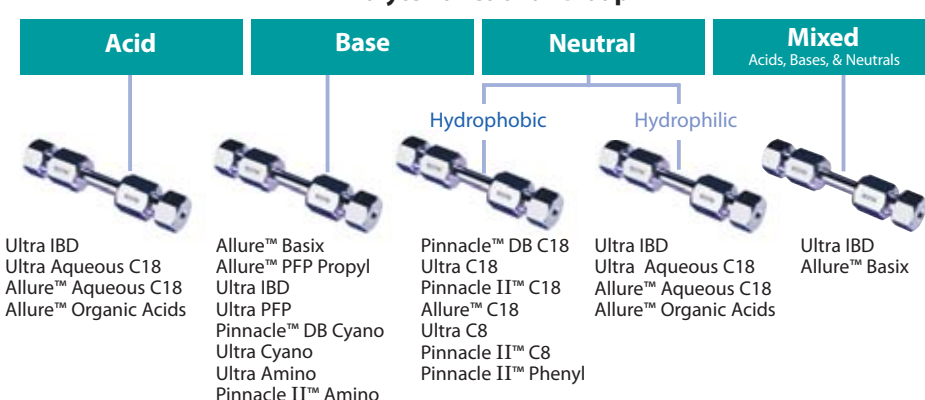
- Most critical decision in column selection.
- Based on analyte solubility and chemical differences among analytes.
- Analyte solubility dictates mode of separation: Reversed phase - analytes soluble in water and/or polar organic solvent (e.g., acetonitrile, methanol). Mobile phase more polar than stationary phase. Normal phase - analytes soluble in nonpolar solvent (e.g., hexane). Mobile phase less polar than stationary phase.

### Pore Size

- Small molecules (<2000mw) generally analyzed on material with pore size  $\leq 200\text{\AA}$  (typical size: 60 $\text{\AA}$ –180 $\text{\AA}$ ).
- Large molecules (>2000mw) generally analyzed on material with pore size  $\geq 300\text{\AA}$ .
- Surface area inversely related to pore size (the smaller the pores the larger the surface area).
- Stationary phase loading directly related to surface area (the larger the surface area the higher the stationary phase loading).



### Analyte Functional Group



### Choosing a Mode

#### Sample Characteristics

Sample soluble in:	Ionic Strength	Analytes primarily differ by:	Recommended Mode:
water and/or polar organics	nonionic	hydrophobicity/hydrophilicity	RP
	weakly ionic	hydrophobicity/hydrophilicity	RP with ion suppression
	nonionic/weakly ionic	size (>2000MW)	SEC (GFC)
	strongly ionic	hydrophobicity/hydrophilicity	RP-IP, IEX
nonpolar organics	nonionic	hydrophobicity/hydrophilicity	NP
	weakly ionic	hydrophobicity/hydrophilicity	NP with ion suppression
	nonionic/weakly ionic	size (>2000MW)	SEC (GFC)

RP - reversed phase  
SEC - size exclusion chromatography  
GFC - gel filtration chromatography  
RP-IP - reversed phase-ion pair ion exchange  
NP - normal phase  
GPC - gel permeation chromatography  
IEX - ion exchange

### Column Dimensions

#### ID

- Theoretically, resolution and pressure are independent of ID, if the mobile phase flow rate is adjusted to maintain the same linear velocity.
- Smaller column ID can increase sensitivity if sample is limited.
- Smaller column ID can reduce / eliminate need for flow splitting in LC/MS.
- Column ID <3.2mm requires reducing extra column volume (tubing, injector, detector flow cell).

#### Length

- If all else is equal: shorter columns provide faster analyses and less backpressure; longer columns provide greater resolution
- Efficiency (N) is directly related to column length, but is a square root factor in resolution: therefore, a 4-fold increase in length is needed to double resolution

$$[R = \frac{1}{4} (\alpha - 1 / \alpha) (\sqrt{N}) (k' / k' + 1)]$$

$\alpha$ : selectivity  $k'$ : capacity

### Optimum Flow Rate

ID (mm)	5 $\mu$ m Particles Flow Rate (mL/min.)	3 $\mu$ m Particles Flow Rate (mL/min.)
4.6	1.00	1.5
3.2	0.50	0.73
2.1	0.20	0.31
1.0	0.05	0.07

### Trident™ Direct Guard Column System

Unlike “one size fits all” guard systems, the Trident™ Direct system gives you the power to select the right level of protection for your analysis. The system offers three levels of protection and guard cartridges in four dimensions, with a variety of bonded phases to match your analytical column. The economical, leak-free cartridge design provides an unprecedented combination of convenience, economy, and reliability. The foundation of the Trident™ Direct system is a reusable direct connect holder that easily attaches to any HPLC column using CPI- or Waters®-style end fittings.\* The system is available in the following configurations to match different protection level needs: in-line filter, in-line filter with holder for 10mm guard cartridge, and in-line filter with holder for 20mm guard cartridge. The guard cartridges are available in 2.1 and 4.0mm ID and are interchangeable within the appropriate length holder. Use 4.0mm ID guard with 4.6 or 4.0mm ID analytical column, 2.1mm ID guard with 2.1 - 3.2mm ID analytical column.

### Trident™ Direct Guard Column System

Description	qty.	cat.#
High-pressure filter	ea.	25082
10mm guard cartridge holder without filter	ea.	25083
10mm guard cartridge holder with filter	ea.	25084
20mm guard cartridge holder without filter	ea.	25085
20mm guard cartridge holder with filter	ea.	25086
Connection tip for Waters®-style end fittings	ea.	25088
PEEK® tip standard fittings	ea.	25087
Replacement cap frits: 4mm, 2.0 $\mu$ m	5-pk.	25022
Replacement cap frits: 4mm, 0.5 $\mu$ m	5-pk.	25023
Replacement cap frits: 2mm, 2.0 $\mu$ m	5-pk.	25057

\*The standard PEEK® tip in Trident™ Direct systems is compatible with Parker®, Upchurch®, Valco®, and other CPI-style fittings. To use Trident™ Direct systems with Waters®-style end fittings, the tip must be replaced with cat.# 25088.

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Other Trademarks: Aqasil, Betamax, BioBasic, Fluophase, Hypersil, Prism, HyPurity Advance (Thermo Electron Corp.); Delta-Pak, Spherisorb, Symmetry, Waters (Waters Corp.); Develosil, Jupiter, Luna, Maxsil, Ultracarb (Phenomenex, Inc.); Discovery, Supelcosil (Sigma-Aldrich Co.); Fluosep-RP (ES Industries); Inertsil (GL Sciences, Inc.); Kromasil (Eka Chemicals); LiChrospher (Merck KGaA); Parker (Parker Instrumentation Division); PEEK (Vitrex plc); Platinum (Alltech Associates, Inc.); Upchurch (Upchurch Scientific); Valco (Valco Instruments Co., Inc.); Zorbax (Agilent Technologies, Inc.).

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Please see Restek's Chromatography Products Catalog for more HPLC columns and accessories.

## INNOVATIVE PRODUCTS

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