ACE®
HPLC Columns

Product Catalog

Ultra-Inert Base Deactivated Columns for Reversed Phase HPLC

ACE®

ACE® Ultra-Inert Base Deactivated HPLC Columns

ACE C18	ACE C18-HL	ACE C8	ACE C4
ACE CN	ACE Phenyl	ACE AQ	ACE C18-300
ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300

To Place an Order or for Technical Assistance
Call: 1.800.441.7508
Or Call: 1.610.358.9696
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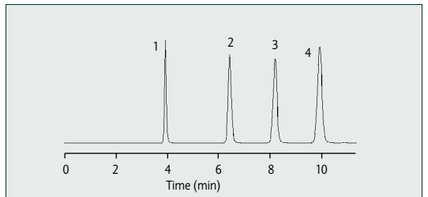
ACE®

ACE® Ultra-Inert Base Deactivated HPLC Columns

- **Performance –** excellent peak shape for basic and acidic compounds
- **Selectivity –** available in seven bonded phases
- **Guaranteed reproducibility –** complete column/batch validation

In spite of the recent advances in column technology, peak tailing and poor column-to-column reproducibility continue to be problems for some samples. Even a small amount of silanol interaction, interaction that is difficult to mask even with modern base deactivation bonding techniques, can cause unacceptable peak tailing. And subtle changes in silanol activity, changes that column manufacturers routinely miss, can cause significant changes in retention and selectivity, especially when separating polar basic compounds.

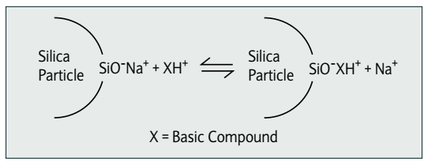
Figure 1
Excellent Peak Shape for Basic Compounds



Column:	**ACE C18 4.6 x 250 mm, 5 µm**
Mobile Phase:	80% MeOH 20% 0.025M KH_2PO_4, pH 6.0
Flow Rate:	1.0 mL/min
Temperature:	22˚C
Sample:	1. Desipramine 2. Doxepin 3. Imipramine 4. Amitriptyline

ACE Columns provide excellent peak shape and efficiency for basic compounds over a broad mobile phase pH range, and without having to add amine modifiers.

Figure 2 **Peak Tailing Interaction**



Acidic silanols on the surface of silica stationary phase supports can form ion-exchange sites that interact with basic compounds. This ion-exchange interaction will often contribute to peak retention and cause peak tailing. ACE stationary phases virtually eliminate these interactions.

ACE Stationary Phases Virtually Eliminate the Negative Effects of Silanols on HPLC Separations

ACE columns are manufactured using ultra-pure silica that has extremely low silanol activity. This ultra-pure silica is efficiently bonded and exhaustively end-capped using proprietary technology. The result is a silica based stationary phase that has virtually eliminated the negative effects of silanols on chromatographic separations.

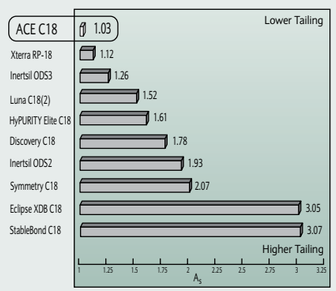
Excellent Peak Shape for Basic and Acidic Compounds

The ultra-inert characteristics of the ACE columns make them the ideal choice for separating polar basic compounds. When compared to other modern base deactivated columns, ACE columns consistently produce measurably better peak shape and column efficiency when separating troublesome basic compounds.

Selectivity

ACE HPLC Columns offer unparalleled performance and guaranteed reproducibility, making ACE the finest columns available in today's market. ACE columns are available in seven bonded phases (C18, C18-HL, AQ, C8, C4, CN, Phenyl) each offering a unique, and in some cases, dramatically different selectivity. ACE may be the only HPLC columns you need to solve your separation problems.

Figure 3 **Asymmetry Comparison**



Conditions	
Columns:	4.6 x 150 mm, 5 µm
Mobile Phase:	80% Methanol 20% 0.05 M Phosphate buffer, pH7
Flow Rate:	2.0 mL/min
Temperature:	24˚C
Sample:	Amitriptyline

The above data was obtained from the National Institute of Standards and Technology (NIST), Certificate of Analysis for Standard Reference Material 870 - "Column Performance Test Mixture for Liquid Chromatography" at the NIST Internet site http://ois.nist.gov/srmcatalog/certificate/870.pdf in September 2002. The NIST test mixture, which is designed to characterize general aspects of HPLC was revised in December 2002.

Choosing the Bonded Phase That's Best for Your Application

As a general rule, retention varies inversely with chain length of the bonded phase.

Retention: C18-HL > C18 > C8, AQ > Phenyl > C4 ≥ CN

MAC-MOD recommends starting most method development projects with C8, knowing that if more retention, and hence more resolution, is needed your next choice is C18. Starting with C8 offers the benefit of shorter analysis times and/or lower organic solvent use. The elution order for most compounds will be the same on the aliphatic (C18, C8, C4) phases. If a different elution order is desired for compound verification or to resolve matrix components, changing to a phenyl or CN phase is far simpler than trying to change selectivity by mobile phase changes. In many cases, the CN and Phenyl phases will offer a significant difference in selectivity from the aliphatic phases.

Choose ACE AQ Columns for Polar Retention

For highly polar compounds requiring high aqueous mobile phases, ACE AQ is the column of choice. This C18 bonded phase with unique integral polar functionality gives excellent retention, performance and reproducibility, even when used with 100% aqueous mobile phases.

Need Even More Resolution? Choose 3 µm ACE Columns

With today's increased pace of drug discovery, fast and efficient methods are the rule. Short, narrow-bore columns are replacing the conventional 4.6 x 250 mm versions. ACE HPLC columns are available in both 3 µm and 5 µm particle sizes. Although 5 µm particles are sufficient for most applications, greater efficiency can be obtained by using smaller particles. This increased efficiency is an advantage in shorter (< 150 mm) column lengths. Because of the excellent flow characteristics of ACE silica, you will not experience the high back pressures often encountered with other columns.

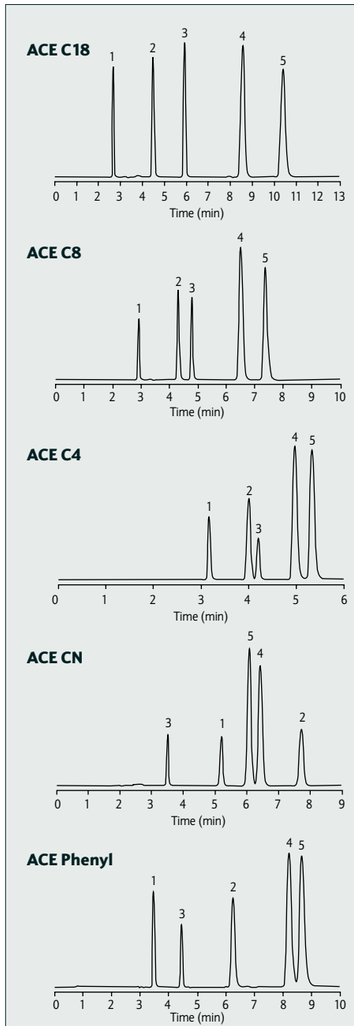
Capillary, Rapid Analysis, LC/MS and Preparative Columns

All ACE bonded phases are available in 3 µm, 5 µm, and 10 µm particle sizes. So regardless of your application, you can scale up or scale down and be assured of the same selectivity. If fast, high resolution preparative chromatography is needed, ACE materials are available in up to 50.8 mm diameter columns.

Specifications for ACE Phases

Phase	Pore Size (Å)	Particle Size (µm)	Surface Area (m2/g)	Carbon Load (%)	Encapped	USP Classification
C18	100	3, 5, 10	300	15.5	Yes	L1
C18-HL	90	3, 5, 10, 15	400	20.0	Yes	L1
C8	100	3, 5, 10	300	9.0	Yes	L7
C4	100	3, 5, 10	300	5.5	Yes	L26
CN	100	3, 5, 10	300	5.5	Yes	L10
Phenyl	100	3, 5, 10	300	9.5	Yes	L11
AQ	100	3, 5, 10	300	14.0	Yes	L1
C18-300	300	3, 5, 10	100	9.0	Yes	L1
C8-300	300	3, 5, 10	100	5.0	Yes	L7
C4-300	300	3, 5, 10	100	2.6	Yes	L26
CN-300	300	3, 5, 10	100	2.6	Yes	L10
Phenyl-300	300	3, 5, 10	100	5.3	Yes	L11

Figure 4
Alternate Selectivity Offered with ACE C18, C8, C4, CN and Phenyl Phases



Column:	**ACE 4.6 x 250 mm, 5 µm**
Mobile Phase:	20% 0.025M KH_2PO_4, pH 6.0 80% MeOH
Flow Rate:	1.0 mL/min
Temperature:	22˚C
Sample:	1. Norephedrine 4. Imipramine 2. Nortriptyline 5. Amitriptyline 3. Toluene

Amitriptyline is commonly used to demonstrate silanol activity on HPLC columns. The ACE columns provide measurably better peak shape and column efficiency compared to other popular base deactivated columns.

Excellent Chemical Stability: Acidic Conditions

At low pH, column deterioration is caused by hydrolysis of the bonded phase, with a decrease in retention observed. The nature of the silica surface and bonding density are critical parameters. Conventional bonded phases are more susceptible to hydrolysis due to the lower purity silica and a low surface coverage. However, ACE phases combine an ultra high purity silica with dense bonding techniques to effectively prevent ligand cleavage under such conditions.

The high stability of ACE C18, C8, C4, CN and Phenyl phases is demonstrated in Figure 5. After three months usage at pH 1.8, no retention loss is observed with any ACE phase. Even cyano bonded phases (regarded to be most vulnerable to hydrolysis) show excellent resistance, as also shown by Figure 6.

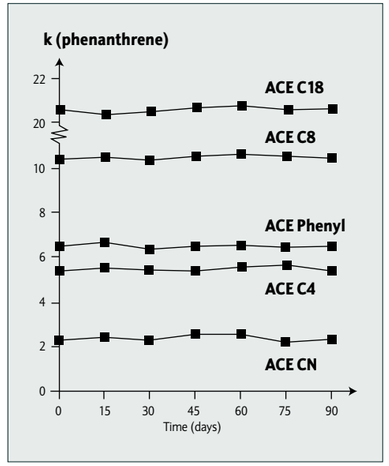
Excellent Chemical Stability: Basic Conditions

At high pH, column degradation is caused by dissolution of the silica support, resulting in a decrease of column efficiency. Conventional phases are more susceptible to dissolution due to low surface coverage. Again, the ultra high purity ACE silica coupled with unique dense bonding technology effectively inhibits silica dissolution (See Figure 7).

Exceptional Reproducibility

Subtle changes in silanol activity are one of the primary causes of column-to-column selectivity changes. Base deactivated columns generally have better reproducibility than other column types due to fewer interactions between silanols and polar compounds. ACE columns, by virtually eliminating silanol interactions, provide an outstanding level of column-to-column reproducibility for polar compounds.

Figure 5 **Acid Stability, pH 1.8**



Conditions for Figures 5 & 6

Column:	**ACE 4.6 x 150 mm**
Mobile Phase:	50% CH_3CN 50% H_2O
Flow Rate:	1.0 mL/min
Temperature:	22˚C
Sample:	1. Uracil 2. Dimethyl phthalate 3. Toluene 4. Biphenyl 5. Phenanthrene

Acidic Exposure Conditions:

Mobile Phase:	50% CH_3CN 50% 0.1% TFA in H_2O, pH 1.8
Flow Rate:	1.0 mL/min
Temperature:	22°C

Figure 6 **ACE CN Stability at pH 1.8**

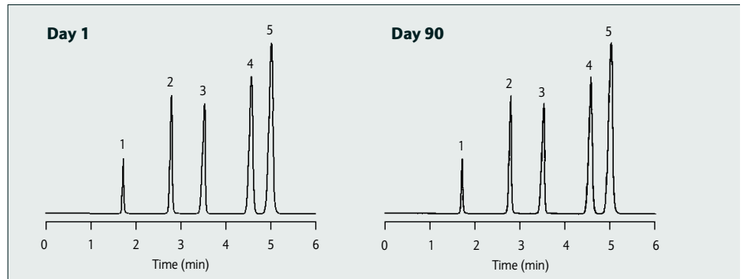
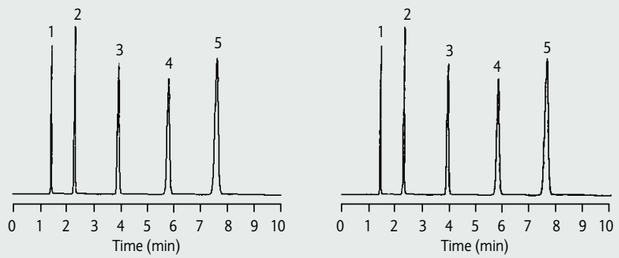


Figure 7 **ACE C18 Stability at pH 11.0**



Column:	**ACE C18 4.6 x 150 mm**
Mobile Phase:	50% CH_3CN 50% H_2O
Flow Rate:	1.0 mL/min
Temperature:	22°C
Sample:	1. Uracil 2. Dimethyl phthalate 3. Toluene 4. Biphenyl 5. Phenanthrene

Basic Exposure Conditions:

Mobile Phase:	50% CH_3CN 50% 0.025M pyrrolidine in H_2O, pH 11.0
Flow Rate:	1.0 mL/min
Temperature:	22°C

Fully Validated Columns

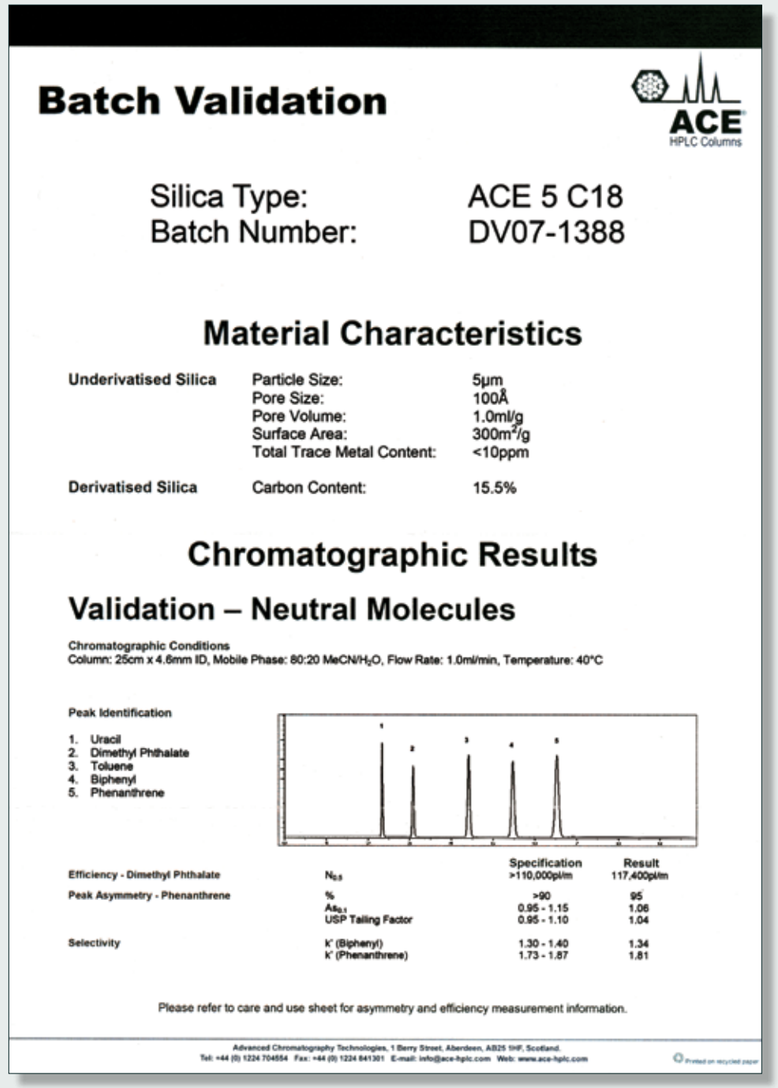
A series of stringent quality assurance tests are performed in the manufacturing process. Each batch of packing material and each packed column are extensively tested to ensure excellent chromatographic performance and dependable column-to-column reproducibility.

Silica Manufacture

Ultra pure reagents and strict control of the manufacturing process result in a high purity silica with uniform surface characteristics.

Advanced bonding techniques are then employed, resulting in a range of highly base deactivated phases that combine superb reproducibility with excellent stability.

Figure 8a **Extensive Testing Yields Fully Validated HPLC Columns - Batch Validation**



Batch Validation

ACE HPLC Columns

Silica Type: ACE 5 C18
Batch Number: DV07-1388

Material Characteristics

Underivatised Silica	Particle Size:	5µm
	Pore Size:	100Å
	Pore Volume:	1.0ml/g
	Surface Area:	300m^2/g
	Total Trace Metal Content:	<10ppm
Derivatised Silica	Carbon Content:	15.5%

Chromatographic Results

Validation – Neutral Molecules

Chromatographic Conditions
Column: 25cm x 4.6mm ID, Mobile Phase: 80:20 MeCN/H_2O, Flow Rate: 1.0ml/min, Temperature: 40°C

Peak Identification
1. Uracil
2. Dimethyl Phthalate
3. Toluene
4. Biphenyl
5. Phenanthrene

		Specification	Result
Efficiency - Dimethyl Phthalate	$N_{0.5}$	>110,000pl/m	117,400pl/m
Peak Asymmetry - Phenanthrene	%	>90	95
	$As_{0.1}$	0.95 - 1.15	1.06
	USP Tailing Factor	0.95 - 1.10	1.04
Selectivity	K' (Biphenyl)	1.30 - 1.40	1.34
	K' (Phenanthrene)	1.73 - 1.87	1.81

Please refer to care and use sheet for asymmetry and efficiency measurement information.

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Batch Validation

Every batch is extensively tested for selectivity and surface activity with a range of acidic, basic and neutral molecules.

ACE HPLC columns have the most stringent batch validation specification of any reversed phase material.

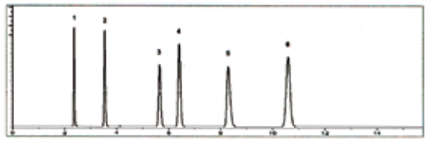
Figure 8b **Extensive Testing Yields Fully Validated HPLC Columns - Batch Validation**

Validation - Acidic Molecules

Chromatographic Conditions
Column: 25cm x 4.6mm ID, Mobile Phase: 35:65 MeCN/0.1%TFA in H_2O, Flow Rate: 1.0ml/min, Temperature: 22°C

Peak Identification

1. Uracil
2. 4-Hydroxybenzoic acid
3. Acetylsalicylic acid
4. Benzoic acid
5. 2-Hydroxybenzoic acid
6. Ethyl paraben



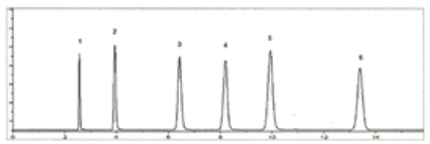
		Specification	Result
Peak Asymmetry - Benzoic acid	%	>90	94
	$As_{0.1}$	<1.50	1.30
	USP Tailing Factor	<1.30	1.19
Selectivity	k'(Ethyl paraben)	3.29 - 3.57	3.40
	k'(4-Hydroxybenzoic acid)/k'(Ethyl paraben)	0.139 - 0.145	0.141
	k'(Acetylsalicylic acid)/k'(Ethyl paraben)	0.390 - 0.406	0.397
	k'(Benzoic acid)/k'(Ethyl paraben)	0.480 - 0.500	0.489
	k'(2-Hydroxybenzoic acid)/k'(Ethyl paraben)	0.704 - 0.732	0.717

Validation - Basic Molecules

Chromatographic Conditions
Column: 25cm x 4.6mm ID, Mobile Phase: 80:20 MeOH/0.025M KH_2PO_4 (pH6.0), Flow Rate: 1.0ml/min, Temperature: 22°C

Peak Identification

1. Uracil
2. Desipramine
3. Doxepin
4. Imipramine
5. Amitriptyline
6. Phenanthrene



		Specification	Result
Peak Asymmetry - Amitriptyline	%	>90	91
	$As_{0.1}$	<1.30	1.26
	USP Tailing Factor	<1.20	1.17
Selectivity	k'(Phenanthrene)	4.08 - 4.42	4.25
	k'(Desipramine)/k'(Phenanthrene)	0.120 - 0.130	0.128
	k'(Doxepin)/k'(Phenanthrene)	0.340 - 0.368	0.361
	k'(Imipramine)/k'(Phenanthrene)	0.496 - 0.538	0.527
	k'(Amitriptyline)/k'(Phenanthrene)	0.654 - 0.708	0.697

Material Approval: *J Williams* **Date:** *18th July 2007*
(Quality Control Manager)

Please refer to care and use sheet for asymmetry and efficiency measurement information.

Figure 8c **Extensive Testing Yields Fully Validated HPLC Columns - Column Validation**

Test Chromatogram

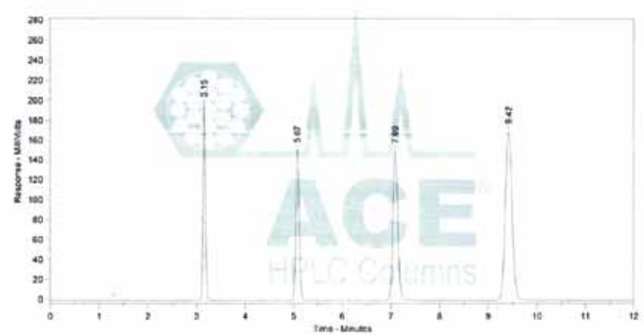
ACE HPLC Columns

COLUMN DETAILS:

Catalogue Number:	ACE-121-2546	Serial Number:	A50039
Packing:	ACE 5 C18	Length:	25cm
Batch:	DV07-1388	Internal Diameter:	4.6mm

EVALUATION CONDITIONS:

Mobile Phase:	MeOH:H2O (85:15)	Storage Solvent:	Mobile Phase
Flow Rate:	1.0 ml/min	Wavelength:	254nm
Pressure:	1480psi	Temperature:	22°C



TEST RESULTS:

			Efficiency	Asymmetry Calculations		
Peak	Identity	t_r (minutes)	$N_{0.5}$	%	$As_{0.1}$	USP Tailing Factor
1	Dimethyl Phthalate	3.15	19100	93	1.36	1.20
2	Toluene	5.07	24400	97	1.22	1.12
3	Biphenyl	7.09	22900	96	1.15	1.09
4	Phenanthrene	9.42	21500	97	1.12	1.07

Please see overleaf for care and use, asymmetry and efficiency information.
ACE® is a registered trademark of Advanced Chromatography Technologies.

Column Validation
All columns are tested with a multicomponent mixture to ensure that excellent performance and peak shape are obtained.

ACE® Rapid Analysis and LC/MS Columns

- 20 mm, 30 mm and 50 mm column lengths
- 1.0, 2.1, 3.0 and 4.6 mm column diameters
- Configured for High Sample Throughput
- Specially Manufactured for High Flow Applications
- Ultra-Inert Stationary Phases for Improved Efficiency and Sensitivity
- Highly Stable Columns for Robust, Reliable LC/MS Methods

The Right Reversed Phase HPLC Column to Use for High Throughput LC/MS Applications

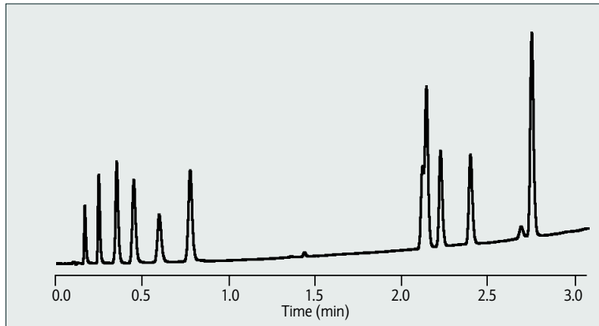
The pressure to get new drugs to market faster requires analytical chemistry tools that can keep up with the frenetic pace of potential lead compound generation during the drug discovery process. By increasing sample throughput, not only does the cost per analysis decrease but, more importantly, critical information can be quickly provided to researchers to screen the large number of compounds generated from synthesis or natural product sources.

Combining mass spectrometry with HPLC has given researchers a powerful analytical tool because of the ability of HPLC to separate complex mixtures and the sensitivity and selectivity of mass spectrometry. The fact that LC/MS is also well suited for high sample throughput makes it the analytical tool of choice for drug discovery.

Configured for High Sample Throughput

To reduce analysis time and increase sample throughput, ACE rapid analysis columns are short in length and packed with high efficiency stationary phases. The shorter column length provides the rapid analysis and the high efficiency 3 micron particles provide the resolution.

Figure 9 **Fast Separations for High Sample Throughput**



Column: **ACE C18, 30 x 3.0 mm, 3 µm**
Mobile Phase: Fast Gradient, 5%B to 100%B, 3 minutes
A: 20mM Phosphate Buffer, pH 2.7
B: 65% Methanol, 35% 20mM Phosphate Buffer, pH 2.7
Flow Rate: 2.0 ml/min

Reproduced with permission of AstraZeneca, Charnwood, UK

An ACE rapid analysis column is used with a fast gradient and at high flow rate to achieve a separation of 10 components in a mixture in less than 3 minutes.

Ultra-Inert Stationary Phases for Improved Efficiency and Sensitivity

Unwanted interaction between solutes and acidic silanols on the surface of silica-based stationary phases is the major cause of poor column efficiency and poor sensitivity when analyzing polar compounds by HPLC. Stationary phases used in ACE HPLC columns are made using ultra-inert silica as the stationary phase support. This silica is then densely covered by the bonded phase so completely that silanol interference is essentially eliminated. The result is a stationary phase that provides superior peak shape, making it particularly well suited for high throughput, high sensitivity LC/MS applications.

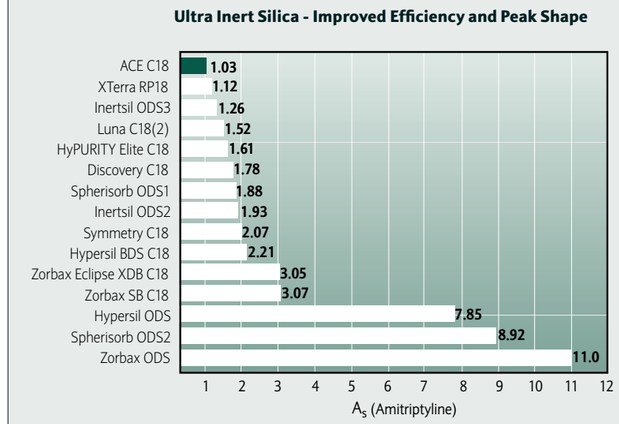
By eliminating silanol interference, mobile phase additives that can contaminate mass spectrometers or reduce sensitivity can be avoided. For example, TFA is often used to improve peak shape and resolution when separating proteins and peptides by reversed phase HPLC. But, TFA in the mobile phase will suppress electrospray ionization of analytes and reduce sensitivity. The extremely inert character of ACE phases permits the use of mobile phases without damaging amounts of additives.

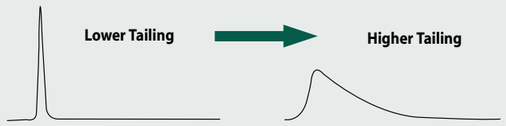
ACE® Stationary Phases Virtually Eliminate the Negative Effects of Silanols on HPLC Separations

Figure 10 **Independent Column Comparison of HPLC Columns**

- **Leading 5 µm C18 Column Brands**
- **Basic Molecule Testing**
- **Peak Asymmetry Investigation**

This bar graph, generated from data produced by the National Institute of Standards & Technology, compares columns according to peak asymmetry. The lower the peak asymmetry, the lower the interference from silanols. The ACE C18 showed the least silanol interference of any of the C18 columns tested.





Column: 150 x 4.6 mm, 5µm
Mobile Phase: 80:20 MeOH/5mM potassium phosphate buffer (pH 7.0)
Flow: 2.0 ml/min
Temperature: 24°C

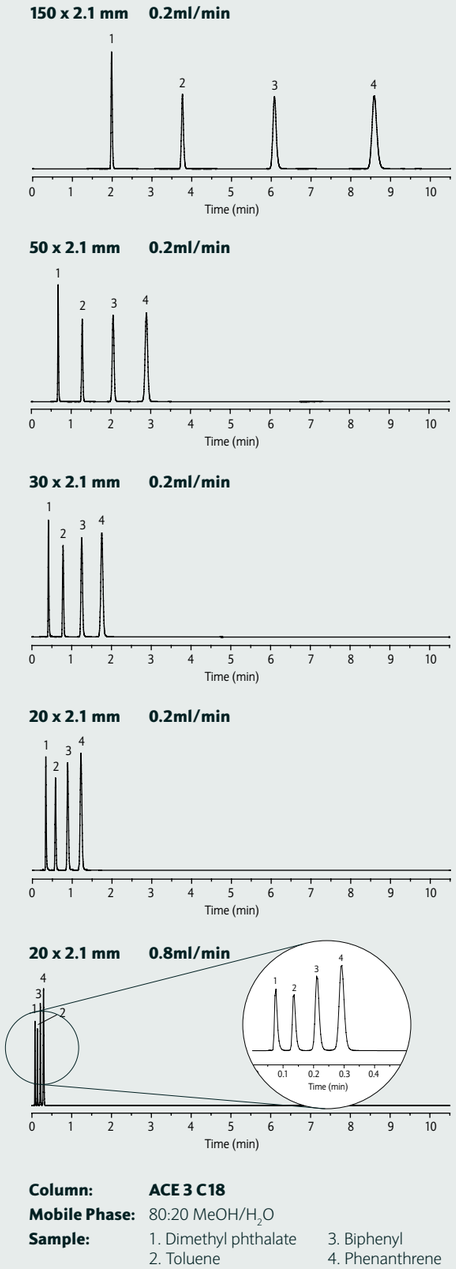
Data obtained from the National Institute of Standards and Technology (NIST), USA

The above data was obtained from the National Institute of Standards and Technology (NIST), Certificate of Analysis for Standard Reference Material 870 - "Column Performance Test Mixture for Liquid Chromatography" at the NIST Internet site http:/ois.nist.gov/srm catalog/certificates/870.pdf in September 2002. The NIST test mixture, which is designed to characterize general aspects of HPLC was revised in December 2002.

ACE ultra inert base deactivated HPLC columns virtually eliminate the negative effects of silanols in HPLC separations. This unequalled performance is now available in 20, 30 and 50 mm length columns, with diameters from 1.0 to 4.6 mm ID. The ACE columns are suitable for high throughput and LC/MS applications, and are the ideal choice for high volume screening assays used for drug analysis and combinatorial libraries where robust, reproducible columns are essential.

Apart from being the most inert HPLC columns on the market, they are also the most efficient, and are manufactured and validated to the same exacting standards as all ACE columns. Increased efficiency is an important benefit given the short columns typically used in LC/MS and rapid analysis applications.

Figure 11
Using ACE HPLC Columns for Fast Separations



Column: ACE 3 C18
Mobile Phase: 80:20 MeOH/H_2O
Sample: 1. Dimethyl phthalate 2. Toluene 3. Biphenyl 4. Phenanthrene

ACE HPLC columns are available in 20mm and 30mm lengths enabling rapid, reproducible high throughput screening at elevated flow rates.

Increased Sensitivity

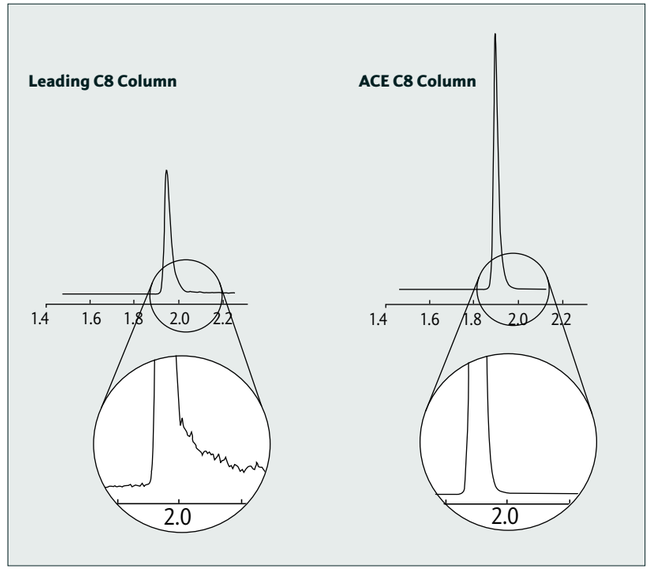
ACE HPLC columns, by virtue of their inert characteristics, give inherently higher sensitivity because of the sharp, narrow peaks produced by their stationary phases. When there is a limited amount of sample for analysis, which is often the case in drug discovery, sensitivity can be increased by choosing columns with smaller internal diameters. As the column internal diameter decreases, the volume of the chromatographic peaks also decreases, concentrating the sample and increasing sensitivity. Columns with 2.1 mm and 1.0 mm internal diameters are particularly attractive for situations where the amount of sample is limited but sensitivity is important.

Figure 12
The Effect of Column ID on Sensitivity

Column ID	Relative Sensitivity
4.6 mm	1.0
3.0 mm	2.3
2.1 mm	4.8
1.0 mm	21

As the column internal diameter decreases, the volume of the chromatographic peaks decreases, concentrating the sample and increasing sensitivity. If the same amount of sample is injected, a column with an ID of 2.1 mm will give about 5 fold the sensitivity of a column with an ID of 4.6 mm.

Figure 13 **Effect of Tailing on Sensitivity**



This figure compares the LC/MS signal intensity on two different brands of HPLC columns. Because ACE stationary phases are more inert, with less silanol interference, the chromatographic peak produced by the ACE C8 column has less tailing and, therefore, provides greater sensitivity. The highly inert characteristics of the ACE HPLC columns give them inherently higher sensitivity than other columns.

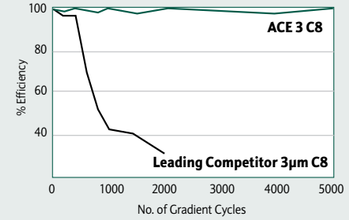
Specially Manufactured for High Flow Applications

To maximize sample throughput, very high mobile phase linear velocity (flow rate) is often used, sometimes 3 to 4 times higher than would be used for typical HPLC applications. This puts extra strain on the column packing bed and causes early failure due to voids or channels that develop. ACE stationary phases are mechanically very strong and able to withstand aggressive packing techniques. This has permitted the development of proprietary packing technology that is designed specifically to produce columns robust enough for high throughput applications.

Highly Stable Columns for Robust, Reliable Methods

ACE HPLC columns, by virtue of their high bonding density and ultra-inert characteristics, can be used with mobile phase conditions that are optimal for LC/MS applications. Stability at both low and high pH and compatibility with volatile buffers makes these the right columns for demanding situations such as standard methods and open access LC/MS. The proprietary packing technology used to specially manufacture these columns for high throughput applications produces extremely durable HPLC columns that are the key to robust LC/MS methods.

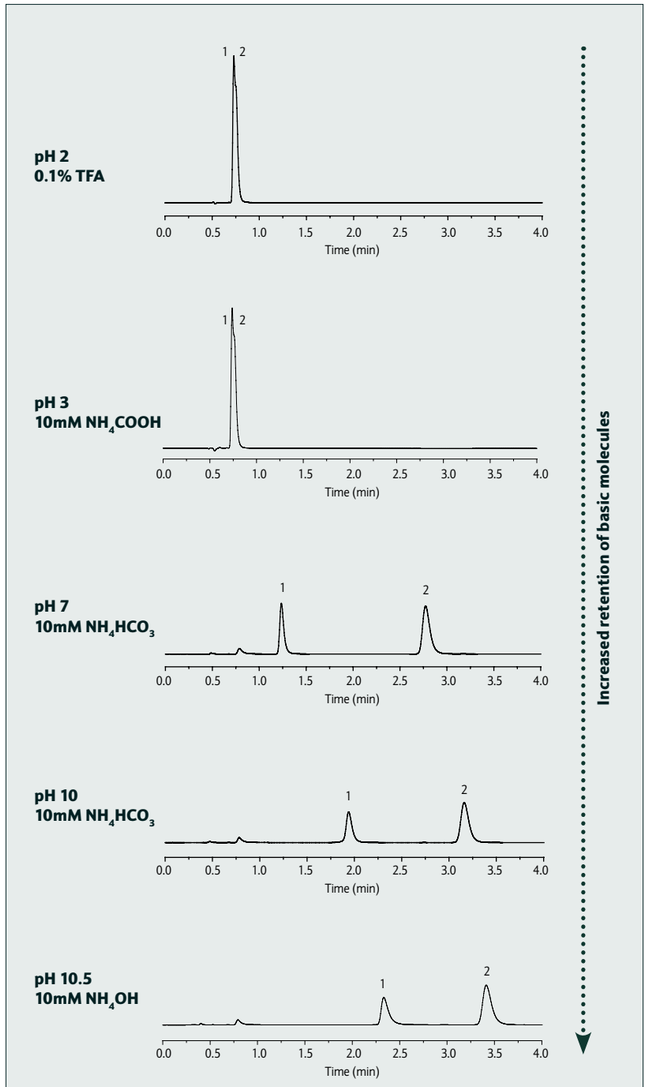
Figure 14 **Columns Specially Manufactured for Long Life Under High Throughput Conditions**



Column: 50 x 3.0 mm
Gradient: Fast gradient cycling
5% to 95% Acetonitrile in 2.25 minutes
Flow Rate: 1.25 ml/min

In this lifetime test under high flow and fast gradient conditions, the specially manufactured ACE HPLC column showed no loss in performance after over 5,000 gradient cycles. A typical "fast analysis" column failed to provide acceptable performance after less than a 1,000 gradient cycles.

Figure 15 **ACE HPLC Columns are Compatible with a Wide Range of "MS Friendly" Buffers**



Column: ACE C18, 50 x 2.1 mm, 3 µm
Mobile Phase: 80% MeOH, 20% buffer
Flow Rate: 0.20 ml/min
Temperature: 22°C
Sample: 1) Nortriptyline 2) Amitriptyline
Wavelength: 215 nm

ACE HPLC columns can be used over a broad pH range, allowing for simplified method development on a single column. And, ACE columns are compatible with volatile mobile phase buffers recommended for LC/MS applications.

ACE® 300Å Columns for Peptides and Proteins

- 300Å ultra high purity silica
- Ultimate protein and peptide application column
- C18, C8, C4, CN and Phenyl chemistries
- 3 µm, 5 µm and 10 µm particle sizes
- Unmatched reproducibility
- Exceptional chemical stability

Excellent peak shape and reproducibility have established ACE HPLC columns as the finest available. This quality is now available for protein chemists desiring the utmost in performance and reproducibility for the separation of peptides, proteins and other high molecular weight biomolecules.

ACE 300Å columns are available in an extensive range of dimensions and particle sizes for use in micro-scale separations, LC/MS analyses and high speed preparative analyses up to process scale.

ACE 300Å Columns for Peptide and Protein Analyses

Chromatographers prefer inert stationary phases for the reversed-phase HPLC of ionic compounds because they minimize the negative effect of silanols on the separation.

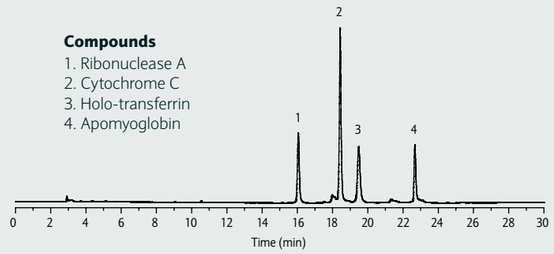
This results in improved peak shape and reproducibility when separating compounds that contain polar functional groups, especially amines.

A new generation of ultra-inert stationary phases, with extremely low silanol activity, has made it possible to achieve even better peak shape and reproducibility when separating these types of compounds.

Scientists working with small molecules have been rapidly adopting this new technology and wide-pore (300Å) ultra-inert phases makes the benefits of this technology available to those wanting to separate peptides and proteins by reversed-phase HPLC.

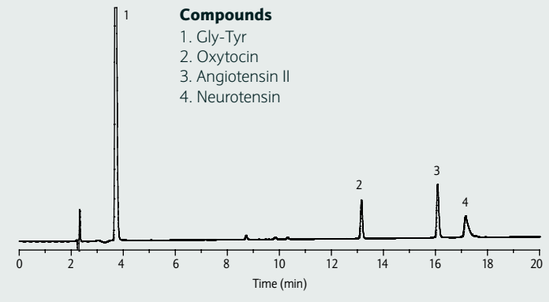
Figure 16 **ACE 300Å Columns for Peptide and Protein Analyses**

Proteins



Column: **ACE 5 C18-300, 250 x 4.6mm**
Flow Rate: 1.0ml/min
Temperature: Ambient
Mobile Phase: A. 0.1% TFA in H_2O
B. 0.1% TFA in MeCN 5% to 70% B in 30 mins
Detection: UV, 280nm

Peptides



Column: **ACE 5 C18-300, 250 x 4.6mm**
Flow Rate: 1.0ml/min
Temperature: Ambient
Mobile Phase: A. 0.1% TFA in H_2O
B. 0.1% TFA in MeCN 10% to 40% B in 25 mins
Detection: UV, 220nm

Comparison of Leading 300Å 5 µm C18 Columns

- **Neutral molecule test for packing integrity**
- **2 basic molecule tests for silica inertness**
- **Peak efficiency and asymmetry comparison**

In order to demonstrate the benefits of ultra-inert phases in biomolecule analysis, several commercially available 300Å pore size reversed-phase columns were tested using three different samples: neutral molecules to measure efficiency, pyridine/phenol to measure silanol activity and antidepressants to measure both silanol activity and metal content. These are the same test procedures typically used to evaluate standard pore size columns (eg 100Å) used for the analysis of small molecules in the chemical and pharmaceutical industries. Columns were ranked by efficiency, N, measured at 10% peak height. In addition to measuring overall efficiency, this value also takes into consideration peak tailing usually caused by silanol interactions. The table below summarizes the performance of various columns as determined by each test along with an overall ranking based on a combination of all three tests.

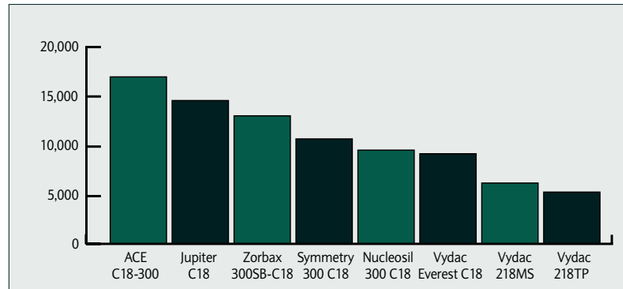
Results

Column efficiency, as measured in Test I, is a reflection of how well a column is packed, as well as particle size and particle size distribution. Although many columns performed similarly in this test, those with lower plate counts reflect poorer physical characteristics of the silica particle. In Test II, efficiencies for pyridine are a good measure of active silanols on the silica surface. Active silanols account for most peak tailing and adsorptive losses of proteins. Since silanol activity is very hard to control in silica manufacture, columns exhibiting low silanol activity are most likely to give consistent results column-to-column and batch-to-batch. In addition, polar and basic compounds will have better peak shapes and hence greater sensitivity on columns with low silanol activity. Since most biomolecules are polar and many are basic, columns with low silanol activity are desirable. In Test III, N values for tricyclic antidepressants measure metal content in addition to active silanol activity. Amitriptyline, chromatographed at neutral pH, is a standard test for measuring silica quality.

Conclusion

The overall ranking of the 300Å columns shown in Figure 17 reflects their performance based on how well they are packed and also the silanol and metal activity of the stationary phase. Chromatographers with experience in HPLC of basic pharmaceuticals know that columns giving good results on these tests will perform best for their samples. The benefits obtained from ultra-inert stationary phases are also important in wide-pore columns designed for the analysis of biomolecules.

Figure 17 **300Å C18 Columns Ranked by Average Efficiency**



Column: **ACE 5 C18-300, 250 x 4.6mm**
Flow Rate: 1.0ml/min
Temperature: Ambient
Mobile Phase: A. 0.1% TFA in H_2O
B. 0.1% TFA in MeCN 5% to 70% B in 30 mins
Detection: UV, 280nm

Efficiency Measurements (N) For Leading 300Å (5 µm, C18, 250 x 4.6mm) HPLC Columns

	Test I	Test II	Test III	Average
ACE C18-300	23,400	14,400	14,000	17,300
Jupiter C18	19,700	12,400	12,400	14,800
Zorbax 300SB-C18	18,900	14,400	6,600	13,300
Symmetry 300 C18	17,500	9,000	6,700	11,000
Nucleosil 300 C18	20,300	6,700	400	9,100
Vydac Everest C18	20,000	5,900	800	8,900
Vydac 218MS	14,600	1,300	1,400	5,800
Vydac 218TP	14,200	1,700	800	5,600

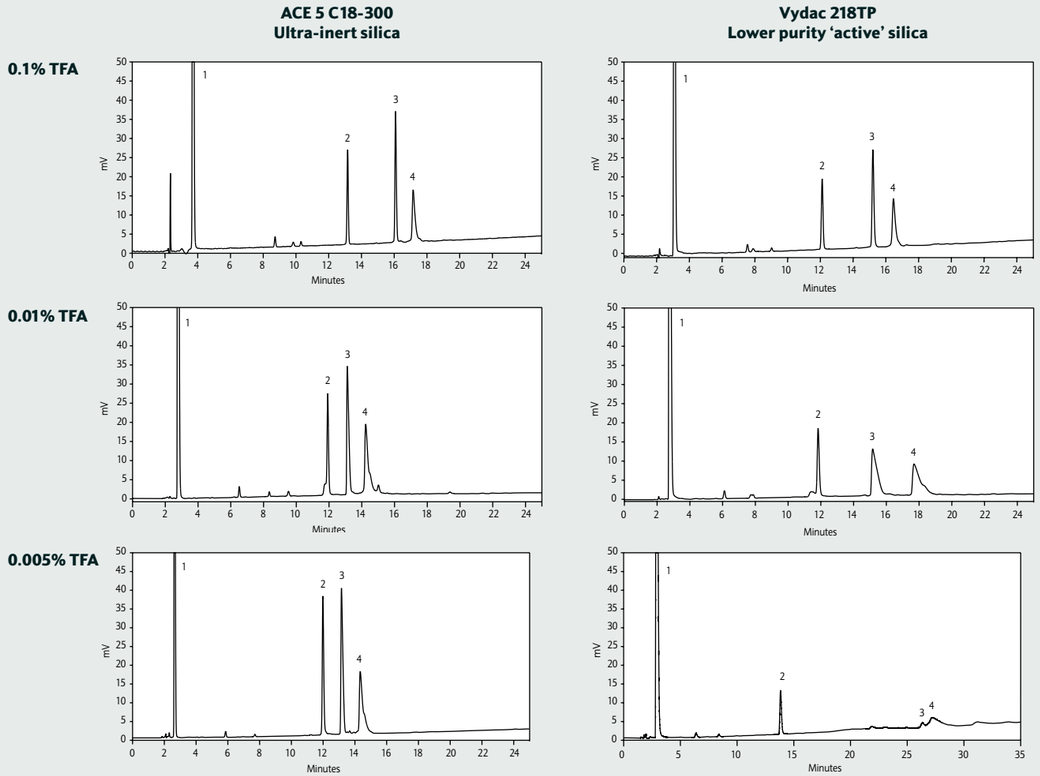
Test I: neutral molecule - toluene
80:20 MeOH/H_2O, 1.0ml/min
Test II: basic molecule 1– pyridine
60:40 MeOH/H_2O, 1.0ml/min
Test III: basic molecule 2 - amitriptyline
80:20 MeOH/25mM KH_2PO_4 (pH 6.0), 1.0ml/min

The Benefits of Ultra-Inert Stationary Phases for the Reversed-Phase HPLC of Biomolecules

Increased Sensitivity

TFA or trifluoroacetic acid is used as a mobile phase additive for reversed-phase separations of peptides and proteins. This additive is typically used to improve both the peak shape and resolution of complex mixtures of peptides and proteins. As shown in Figure 18 , the use of 0.1% TFA in the mobile phase enables a column packed with an active stationary phase to give peak widths comparable to those obtained from a new generation column made from ultra-inert stationary phase. However, as the TFA concentration is lowered to 0.01% and finally 0.005%, peak widths on the ultra-inert phase stay the same, but degrade on the active stationary phase. The ability to analyze peptides and proteins using very low levels of TFA is beneficial for high sensitivity detection by mass spectrometry. TFA complexes with polypeptides and can enhance selectivity. However, this same complexation lowers sensitivity in the mass spectrometer.

Figure 18 **Sensitivity and Peak Shape as a Function of TFA Concentration**



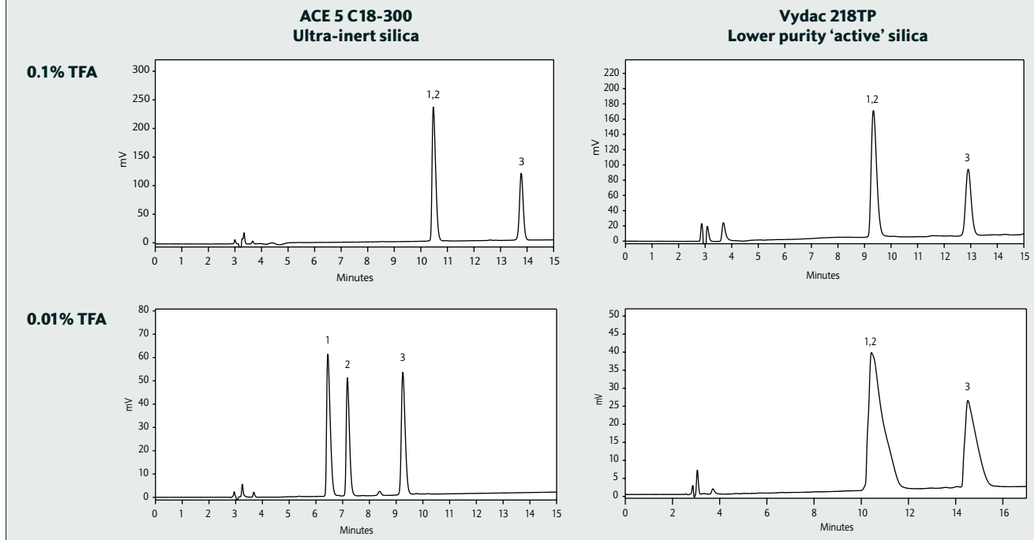
Column: 250 x 4.6mm, 5µm C18 300Å
Mobile Phase: A: TFA in H_2O
B: TFA in MeCN
(% TFA as specified above)
10% to 55% B in 37.5 mins.
Flow Rate: 1.5ml/min
Detection: UV 200nm
Compounds: 1. Gly-Tyr
2. Oxytocin
3. Angiotensin II
4. Neurotensin

Columns based on lower quality silica (chromatograms on right) show a dramatic loss in performance as TFA concentration is lowered. Columns from ultra-inert silica such as ACE maintain performance when TFA concentration is decreased.

Optimizing Selectivity

The ability of TFA and other mobile phase additives to complex with peptides and proteins can be used to adjust selectivity and improve resolution. As shown in Figure 19, lowering TFA concentration from 0.1% to 0.01% enabled the resolution of angiotensin II and III. In the case of the ultra-inert ACE column, peak shape and sensitivity remained constant with this change, as resolution improved dramatically. In the case of the Vydac column, packed with a more active stationary phase, peak shape was severely degraded.

Figure 19 **Selectivity as a Function of TFA Concentration**



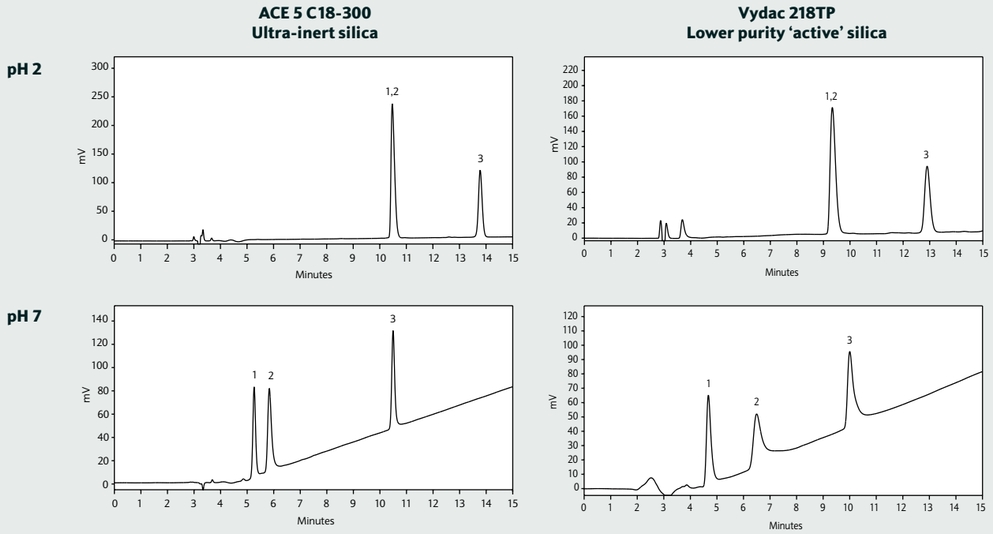
Column: 250 x 4.6mm, 5µm C18 300Å
Mobile Phase: A: TFA in H_2O
B: 80% TFA in MeCN
20% TFA in H_2O
(% TFA as specified above)
25% to 40% B in 15 mins.
Flow Rate: 1.0ml/min
Detection: UV 215nm
Compounds: 1. Angiotensin II
2. Angiotensin III
3. Angiotensin I

Resolution has increased by lowering the TFA concentration. Columns made from lower quality silica show decreased performance.

Increased pH Range

Most biomolecules are charged. Peptides and proteins have numerous charges. From experience with small molecules, it is known that mobile phase pH can be a powerful tool for changing retention and thus optimizing the resolution of charged compounds. The same is true for peptides. Again using angiotensin II and III as an example, Figure 20 shows no resolution of these two peptides at pH 2 on either the ACE ultra-inert column or a column packed with a more active stationary phase. By increasing the pH to 7, both columns now give good resolution. However, whereas the ACE ultra-inert column maintained good peak shape, the more active column showed poorer peak shape and a loss in performance. This phenomenon is observed in most reversed-phase applications with polar compounds. At high pH, silanol interactions are more prevalent and hence peak tailing becomes more apparent on active stationary phases.

Figure 20 **Effect of Mobile Phase pH on Resolution**



Column: 250 x 4.6mm, 5µm C18 300Å
Mobile Phase: pH 2 A: 0.1% TFA in H_2O
B: 0.1% TFA in MeCN
pH 7 A: 10mM NH_4OAc in H_2O
B: MeCN
25% to 40% B in 15 mins.
Flow Rate: 1.0ml/min
Detection: UV 215nm
Compounds: 1. Angiotensin II
2. Angiotensin III
3. Angiotensin I

Adjusting the pH of the mobile phase is a powerful tool for increasing selectivity. Only columns based on ultra-pure silica will maintain performance at higher pH values.

Comparison of Leading Wide Pore Columns

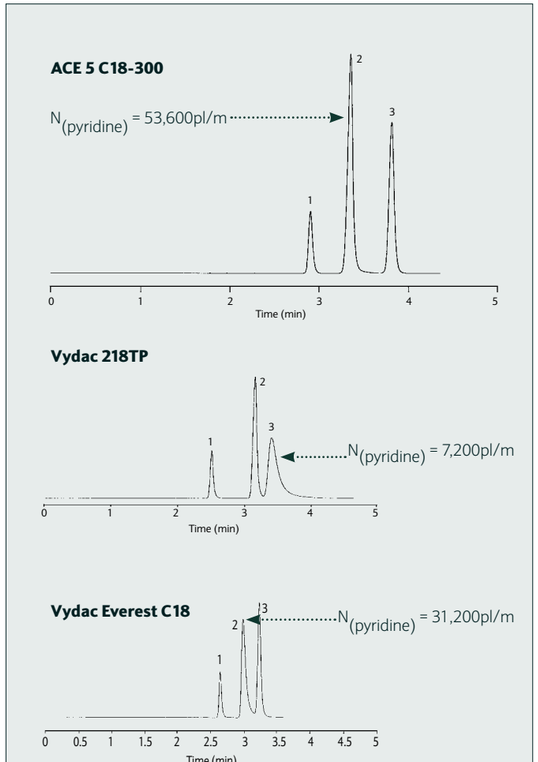
- Leading 300Å 5µm, C18 column brands - 250 x 4.6mm i.d.
- 2 Basic silica inertness tests
- Peak efficiency and asymmetry comparison

Significant differences in efficiency, peak shape and selectivity are seen with these 300Å C18 bonded phases when analyzing basic molecules. These variations are caused by undesirable secondary silanol interactions, which can also result in poor column reproducibility.

Since most biomolecules are polar, and many are basic, these inertness tests can be used to accurately predict the best column for the analysis of biomolecules, where an ultra-inert column with low silanol activity is highly desirable.

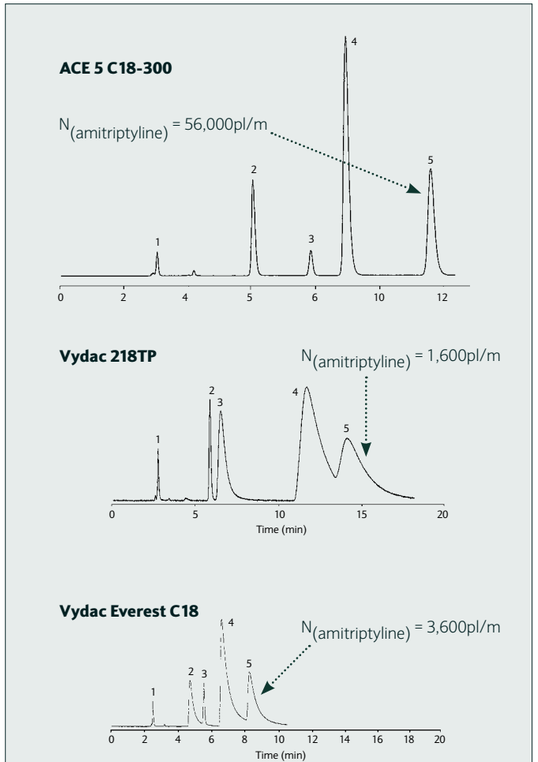
ACE 300Å columns have been repeatedly shown to be the most inert columns available.

Figure 21 **Inertness Test 1**



Mobile Phase: 60:40 MeOH/H_2O
Flow Rate: 1.0 ml/min
Sample: 1) Uracil 2) Pyridine 3) Phenol

Figure 22 **Inertness Test 2**



Mobile Phase: 65:35 MeOH/25mM KH_2PO_4 (pH 6.0)
Flow Rate: 1.0 ml/min
Sample: 1) Norephedrine 2) Nortriptyline
3) Toluene 4) Imipramine 5) Amitriptyline

- Independently tested at The School of Pharmacy, University of Sunderland, UK

ACE® Capillary and Nano Columns

- Capillary (500 µm and 300 µm) and nano (100 µm and 75 µm) dimensions
- Wide range of bonded phases available
- 100Å and 300Å pore sizes
- High efficiency, long lifetime and guaranteed reproducibility
- LC/MS and LC/MS/MS applications

Ultra-Inert High Efficiency Columns

In addition to the extensive range of analytical (1.0-4.6mm ID) through to preparative (21.2-30mm ID) columns, ACE columns are available in capillary (500 µm and 300 µm) and nano (100 µm and 75 µm) dimensions. ACE capillary and nano columns are available with all ACE bonded phase chemistries in both 100Å and 300Å pore sizes. The same features that make ACE ultra-inert base deactivated columns the choice of method development chemists also make them the ideal choice for capillary and nano HPLC applications.

Improved Mass Limit of Detection

Capillary and nano HPLC is gaining acceptance for applications where limited sample amounts lead to problems in detection sensitivity. This is relevant in the areas of pharmacokinetics, trace analysis and in particular the expanding fields of bioanalytical and proteomic analysis. ACE capillary and nano columns are ideal for use with detectors requiring very low flow rates, such as electrospray LC/MS.

ACE capillary and nano HPLC columns offer high sensitivity due to their low dispersion characteristics. The table below shows the theoretical sensitivity increase of each ID column compared with a 4.6mm ID analytical column and 1mm ID microbore column. This increase in sensitivity can be important for accurate quantitation of sample limited applications.

For maximum performance, columns should be used with fully optimized HPLC systems (eg. minimize system dead volume using short lengths of small ID connection tubing).

Sensitivity Increase

Column ID (mm)	Typical Flow Rate (µl/min)	Theoretical Sensitivity Increase[1]
4.6	1000	1
1.0	40	21
0.5	10	85
0.3	3	235
0.1	0.5	2100
0.075	0.3	3760

[1]For same sample mass

ACE® Preparative HPLC Columns

- **Loadability** - high surface area and carbon load for maximum sample capacity
- **Selectivity** - available in 7 bonded phases to optimize resolution and maximize sample capacity. C18, C18-HL, C8, C4, CN, Phenyl, AQ
- **Rugged** - reliable, long-term performance
- **Guaranteed reproducibility** - complete column/batch validation just like the ACE analytical columns

Now Achieve Reproducible High Performance Preparative Separations

Chromatographers with experience in preparative HPLC know what is important, resolution and loadability. The two go hand in hand; the greater the resolution, the higher the sample load, the faster you obtain pure compound. The ability to optimize resolution at the preparative scale means starting with high performance separations at the analytical scale. The same features that make ACE Ultra-Inert Base Deactivated analytical columns the choice of method development chemists also make them the ideal choice for scale-up and process methods.

ACE Preparative Column features:

- Ultra high purity base deactivated silica
- 5, 10 and 15 µm particle sizes available
- Columns are fully validated
- Exceptional reproducibility
- Excellent efficiencies
- Reliable, long-term performance
- 90Å, 100Å and 300Å pore sizes

Choose the Bonded Phase Best for Your Sample

ACE preparative columns are available in 7 bonded phase selectivities including AQ and C18-HL (Hi-Load), making it possible to optimize your preparative resolution and in doing so, increase loadability. See Specifications Table on page 3.

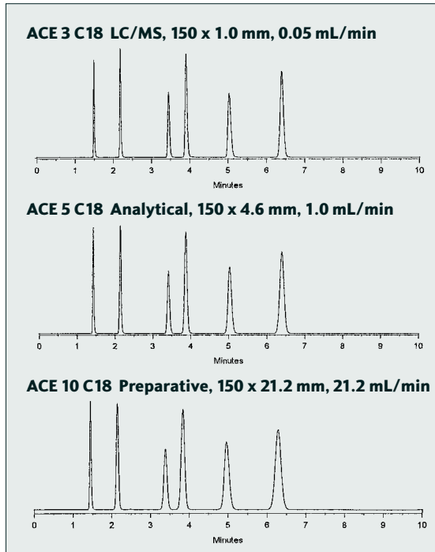
Get High Purity Product Fast

ACE Preparative columns are available in a variety of column dimensions and particle sizes. For maximum loadability, choose 30 mm ID columns. Use a 50 mm length column with a 5 µm particle size to maximize the speed of your separation. To maximize resolution, choose a 250 mm column with 5 µm particle size. See the table below for loading specifications.

Column Sample Capacity (Loadability)

Column Size	ID (mm)	Relative Flow Rate (ml/min)	Weight of Phase (g)	Maximum Sample Per Injection $\alpha < 1.1$	Maximum Sample Per Injection $\alpha > 1.5$
Analytical	4.6	1.0	3.0	4 mg	60 mg
Semi-Prep	10.0	4.7	14	20 mg	280 mg
Prep	21.2	21	64	90 mg	1300 mg
Prep	30.0	42	130	180 mg	2600 mg

Figure 23 **Reproducible Scale-up With ACE C18 Columns**



Mobile phase: 35:65 Acetonitrile/1% TFA in H_2O
Temperature: 22°C
Wavelength: 254nm
Sample: 1) Uracil 2) 4-Hydroxybenzoic acid 3) Acetylsalicylic acid 4) Benzoic acid 5) 2-Hydroxybenzoic acid

ACE® Integral Guard Columns

- Guard column is incorporated into the analytical column's inlet end-fitting
- Ultra low dead volume design provides protection without degrading performance
- Easy to change cartridge design

ACE analytical columns are manufactured with state-of-the–art column fittings that incorporate the guard column as an integral part of the analytical column. To install a guard column on an ACE analytical column, simply replace the standard column inlet end-fitting with the end-fitting designed as a guard column holder. Then, insert a guard cartridge packed with the desired stationary phase into the guard column holder (See photograph). Don't worry about disturbing the packing bed when installing the guard column holder. It is well protected by a PEEK cap, even with the column end-fitting removed.

The integral guard column system is available for columns with internal diameters of 2.1, 3.0, and 4.6 mm. For preparative columns (> 10 mm), the more typical stand-alone style of guard columns are available packed with the appropriate stationary phase. See page 24 for part numbers on preparative guard columns.

If for some reason you prefer to use a stand-alone style of guard column to protect your analytical column, use part number H0001. All 1.0 mm ID columns use a H0001 stand-alone style guard cartridge holder. Connecting tubing and fittings, or a column coupler, will be required to use this guard column.

Using a guard column to protect your analytical column can substantially increase column lifetime and improve the quality of your chromatography. But, to be effective the guard column must be replaced often enough to prevent contaminants from saturating the guard column and bleeding through to the analytical column. The best way to determine the optimum time to replace a guard column for a specific set of sample and mobile phase conditions is through experience. However, it is helpful to have some quantitative measure to help make the replacement decision. By monitoring plate number (N), pressure (P), and resolution (Rs), the performance of the guard and analytical column can be closely watched to determine when a guard column should be replaced. We suggest replacing the guard column when any one of these parameters changes by more than 10%.

Integral Guard Holder	Part Number
For analytical columns 2.1 mm ID	H0004
For analytical columns 3.0 and 4.6 mm ID	H0005

ACE® Part Numbers

100Å Ultra-Inert Base Deactivated Analytical HPLC Columns

Dimensions (mm)	Particle Size (µm)	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
4.6 x 250	5	ACE-121-2546	ACE-122-2546	ACE-123-2546	ACE-124-2546	ACE-125-2546	ACE-126-2546
4.6 x 150	5	ACE-121-1546	ACE-122-1546	ACE-123-1546	ACE-124-1546	ACE-125-1546	ACE-126-1546
4.6 x 150	3	ACE-111-1546	ACE-112-1546	ACE-113-1546	ACE-114-1546	ACE-115-1546	ACE-116-1546
4.6 x 100	5	ACE-121-1046	ACE-122-1046	ACE-123-1046	ACE-124-1046	ACE-125-1046	ACE-126-1046
4.6 x 100	3	ACE-111-1046	ACE-112-1046	ACE-113-1046	ACE-114-1046	ACE-115-1046	ACE-116-1046
4.6 x 75	5	ACE-121-7546	ACE-122-7546	ACE-123-7546	ACE-124-7546	ACE-125-7546	ACE-126-7546
4.6 x 75	3	ACE-111-7546	ACE-112-7546	ACE-113-7546	ACE 114-7546	ACE-115-7546	ACE-116-7546
4.6 x 50	5	ACE-121-0546	ACE-122-0546	ACE-123-0546	ACE-124-0546	ACE-125-0546	ACE-126-0546
4.6 x 50	3	ACE-111-0546	ACE-112-0546	ACE-113-0546	ACE-114-0546	ACE-115-0546	ACE-116-0546
4.6 x 30	5	ACE-121-0346	ACE-122-0346	ACE-123-0346	ACE-124-0346	ACE-125-0346	ACE-126-0346
4.6 x 30	3	ACE-111-0346	ACE-112-0346	ACE-113-0346	ACE-114-0346	ACE-115-0346	ACE-116-0346
4.6 x 20	5	ACE-121-0246	ACE-122-0246	ACE-123-0246	ACE-124-0246	ACE-125-0246	ACE-126-0246
4.6 x 20	3	ACE-111-0246	ACE-112-0246	ACE-113-0246	ACE-114-0246	ACE-115-0246	ACE-116-0246
3.0 x 250	5	ACE-121-2503	ACE-122-2503	ACE-123-2503	ACE-124-2503	ACE-125-2503	ACE-126-2503
3.0 x 150	5	ACE-121-1503	ACE-122-1503	ACE-123-1503	ACE-124-1503	ACE-125-1503	ACE-126-1503
3.0 x 150	3	ACE-111-1503	ACE-112-1503	ACE-113-1503	ACE-114-1503	ACE-115-1503	ACE-116-1503
3.0 x 100	5	ACE-121-1003	ACE-122-1003	ACE-123-1003	ACE-124-1003	ACE-125-1003	ACE-126-1003
3.0 x 100	3	ACE-111-1003	ACE-112-1003	ACE-113-1003	ACE-114-1003	ACE-115-1003	ACE-116-1003
3.0 x 75	5	ACE-121-7503	ACE-122-7503	ACE-123-7503	ACE-124-7503	ACE-125-7503	ACE-126-7503
3.0 x 75	3	ACE-111-7503	ACE-112-7503	ACE-113-7503	ACE-114-7503	ACE-115-7503	ACE-116-7503
3.0 x 50	5	ACE-121-0503	ACE-122-0503	ACE-123-0503	ACE-124-0503	ACE-125-0503	ACE-126-0503
3.0 x 50	3	ACE-111-0503	ACE-112-0503	ACE-113-0503	ACE-114-0503	ACE-115-0503	ACE-116-0503
3.0 x 30	5	ACE-121-0303	ACE-122-0303	ACE-123-0303	ACE-124-0303	ACE-125-0303	ACE-126-0303
3.0 x 30	3	ACE-111-0303	ACE-112-0303	ACE-113-0303	ACE-114-0303	ACE-115-0303	ACE-116-0303
3.0 x 20	5	ACE-121-0203	ACE-122-0203	ACE-123-0203	ACE-124-0203	ACE-125-0203	ACE-126-0203
3.0 x 20	3	ACE-111-0203	ACE-112-0203	ACE-113-0203	ACE-114-0203	ACE-115-0203	ACE-116-0203
2.1 x 250	5	ACE-121-2502	ACE-122-2502	ACE-123-2502	ACE-124-2502	ACE-125-2502	ACE-126-2502
2.1 x 150	5	ACE-121-1502	ACE-122-1502	ACE-123-1502	ACE-124-1502	ACE-125-1502	ACE-126-1502
2.1 x 150	3	ACE-111-1502	ACE-112-1502	ACE-113-1502	ACE-114-1502	ACE-115-1502	ACE-116-1502
2.1 x 100	5	ACE-121-1002	ACE-122-1002	ACE-123-1002	ACE-124-1002	ACE-125-1002	ACE-126-1002
2.1 x 100	3	ACE-111-1002	ACE-112-1002	ACE-113-1002	ACE-114-1002	ACE-115-1002	ACE-116-1002
2.1 x 75	5	ACE-121-7502	ACE-122-7502	ACE-123-7502	ACE-124-7502	ACE-125-7502	ACE-126-7502
2.1 x 75	3	ACE-111-7502	ACE-112-7502	ACE-113-7502	ACE-114-7502	ACE-115-7502	ACE-116-7502
2.1 x 50	5	ACE-121-0502	ACE-122-0502	ACE-123-0502	ACE-124-0502	ACE-125-0502	ACE-126-0502
2.1 x 50	3	ACE-111-0502	ACE-112-0502	ACE-113-0502	ACE-114-0502	ACE-115-0502	ACE-116-0502
2.1 x 30	5	ACE-121-0302	ACE-122-0302	ACE-123-0302	ACE-124-0302	ACE-125-0302	ACE-126-0302
2.1 x 30	3	ACE-111-0302	ACE-112-0302	ACE-113-0302	ACE-114-0302	ACE-115-0302	ACE-116-0302
2.1 x 20	5	ACE-121-0202	ACE-122-0202	ACE-123-0202	ACE-124-0202	ACE-125-0202	ACE-126-0202
2.1 x 20	3	ACE-111-0202	ACE-112-0202	ACE-113-0202	ACE-114-0202	ACE-115-0202	ACE-116-0202
1.0 x 250	5	ACE-121-2501	ACE-122-2501	ACE-123-2501	ACE-124-2501	ACE-125-2501	ACE-126-2501
1.0 x 150	5	ACE-121-1501	ACE-122-1501	ACE-123-1501	ACE-124-1501	ACE-125-1501	ACE-126-1501
1.0 x 150	3	ACE-111-1501	ACE-112-1501	ACE-113-1501	ACE-114-1501	ACE-115-1501	ACE-116-1501
1.0 x 100	5	ACE-121-1001	ACE-122-1001	ACE-123-1001	ACE-124-1001	ACE-125-1001	ACE-126-1001
1.0 x 100	3	ACE-111-1001	ACE-112-1001	ACE-113-1001	ACE-114-1001	ACE-115-1001	ACE-116-1001
1.0 x 75	5	ACE-121-7501	ACE-122-7501	ACE-123-7501	ACE-124-7501	ACE-125-7501	ACE-126-7501
1.0 x 75	3	ACE-111-7501	ACE-112-7501	ACE-113-7501	ACE-114-7501	ACE-115-7501	ACE-116-7501
1.0 x 50	5	ACE-121-0501	ACE-122-0501	ACE-123-0501	ACE-124-0501	ACE-125-0501	ACE-126-0501
1.0 x 50	3	ACE-111-0501	ACE-112-0501	ACE-113-0501	ACE-114-0501	ACE-115-0501	ACE-116-0501

ACE guard column cartridges for analytical columns 3.0 and 4.6 mm ID. Five guard cartridges per pack. Holder (H0005) required.

Dimensions (mm)	Particle Size (µm)	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
3.0 x 10	3	ACE-111-0103GD	ACE-112-0103GD	ACE-113-0103GD	ACE-114-0103GD	ACE-115-0103GD	ACE-116-0103GD
3.0 x 10	5	ACE-121-0103GD	ACE-122-0103GD	ACE-123-0103GD	ACE-124-0103GD	ACE-125-0103GD	ACE-126-0103GD
Integral guard holder for above		H0005	H0005	H0005	H0005	H0005	H0005

ACE guard column cartridges for narrow bore columns 2.1 mm ID. Five guard cartridges per pack. Holder (H0004) required.

Dimensions (mm)	Particle Size (µm)	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
2.1 x 10	3	ACE-111-0102GD	ACE-112-0102GD	ACE-113-0102GD	ACE-114-0102GD	ACE-115-0102GD	ACE-116-0102GD
2.1 x 10	5	ACE-121-0102GD	ACE-122-0102GD	ACE-123-0102GD	ACE-124-0102GD	ACE-125-0102GD	ACE-126-0102GD
Integral guard holder for above		H0004	H0004	H0004	H0004	H0004	H0004

ACE guard column cartridges for narrow bore columns 1.0 mm ID. Five guard cartridges per pack. Holder (H0004) required.

Dimensions (mm)	Particle Size (µm)	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
1.0 x 10	3	ACE-111-0101GD	ACE-112-0101GD	ACE-113-0101GD	ACE-114-0101GD	ACE-115-0101GD	ACE-116-0101GD
1.0 x 10	5	ACE-121-0101GD	ACE-122-0101GD	ACE-123-0101GD	ACE-124-0101GD	ACE-125-0101GD	ACE-126-0101GD
Stand-alone guard holder for above		H0001	H0001	H0001	H0001	H0001	H0001

Note: *A stand-alone guard cartridge holder is available for all the guard cartridges listed above. The part number for this guard cartridge holder is H0001. Connecting tubing and fittings, or a column coupler (part number C0001), is required to use this stand-alone guard cartridge holder.*

ACE® Part Numbers

300Å Ultra-Inert Base Deactivated Analytical HPLC Columns for Peptides/Proteins

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
4.6 x 250	5	ACE-221-2546	ACE-222-2546	ACE-223-2546	ACE-224-2546	ACE-225-2546
4.6 x 150	5	ACE-221-1546	ACE-222-1546	ACE-223-1546	ACE-224-1546	ACE-225-1546
4.6 x 150	3	ACE-211-1546	ACE-212-1546	ACE-213-1546	ACE-214-1546	ACE-215-1546
4.6 x 100	5	ACE-221-1046	ACE-222-1046	ACE-223-1046	ACE-224-1046	ACE-225-1046
4.6 x 100	3	ACE-211-1046	ACE-212-1046	ACE-213-1046	ACE-214-1046	ACE-215-1046
4.6 x 75	5	ACE-221-7546	ACE-222-7546	ACE-223-7546	ACE-224-7546	ACE-225-7546
4.6 x 75	3	ACE-211-7546	ACE-212-7546	ACE-213-7546	ACE 214-7546	ACE-215-7546
4.6 x 50	5	ACE-221-0546	ACE-222-0546	ACE-223-0546	ACE-224-0546	ACE-225-0546
4.6 x 50	3	ACE-211-0546	ACE-212-0546	ACE-213-0546	ACE-214-0546	ACE-215-0546
4.6 x 30	5	ACE-221-0346	ACE-222-0346	ACE-223-0346	ACE-224-0346	ACE-225-0346
4.6 x 30	3	ACE-211-0346	ACE-212-0346	ACE-213-0346	ACE-214-0346	ACE-215-0346
4.6 x 20	5	ACE-221-0246	ACE-222-0246	ACE-223-0246	ACE-224-0246	ACE-225-0246
4.6 x 20	3	ACE-211-0246	ACE-212-0246	ACE-213-0246	ACE-214-0246	ACE-215-0246
3.0 x 250	5	ACE-221-2503	ACE-222-2503	ACE-223-2503	ACE-224-2503	ACE-225-2503
3.0 x 150	5	ACE-221-1503	ACE-222-1503	ACE-223-1503	ACE-224-1503	ACE-225-1503
3.0 x 150	3	ACE-211-1503	ACE-212-1503	ACE-213-1503	ACE-214-1503	ACE-215-1503
3.0 x 100	5	ACE-221-1003	ACE-222-1003	ACE-223-1003	ACE-224-1003	ACE-225-1003
3.0 x 100	3	ACE-211-1003	ACE-212-1003	ACE-213-1003	ACE-214-1003	ACE-215-1003
3.0 x 75	5	ACE-221-7503	ACE-222-7503	ACE-223-7503	ACE-224-7503	ACE-225-7503
3.0 x 75	3	ACE-211-7503	ACE-212-7503	ACE-213-7503	ACE-214-7503	ACE-215-7503
3.0 x 50	5	ACE-221-0503	ACE-222-0503	ACE-223-0503	ACE-224-0503	ACE-225-0503
3.0 x 50	3	ACE-211-0503	ACE-212-0503	ACE-213-0503	ACE-214-0503	ACE-215-0503
3.0 x 30	5	ACE-221-0303	ACE-222-0303	ACE-223-0303	ACE-224-0303	ACE-225-0303
3.0 x 30	3	ACE-211-0303	ACE-212-0303	ACE-213-0303	ACE-214-0303	ACE-215-0303
3.0 x 20	5	ACE-221-0203	ACE-222-0203	ACE-223-0203	ACE-224-0203	ACE-225-0203
3.0 x 20	3	ACE-211-0203	ACE-212-0203	ACE-213-0203	ACE-214-0203	ACE-215-0203
2.1 x 250	5	ACE-221-2502	ACE-222-2502	ACE-223-2502	ACE-224-2502	ACE-225-2502
2.1 x 150	5	ACE-221-1502	ACE-222-1502	ACE-223-1502	ACE-224-1502	ACE-225-1502
2.1 x 150	3	ACE-211-1502	ACE-212-1502	ACE-213-1502	ACE-214-1502	ACE-215-1502
2.1 x 100	5	ACE-221-1002	ACE-222-1002	ACE-223-1002	ACE-224-1002	ACE-225-1002
2.1 x 100	3	ACE-211-1002	ACE-212-1002	ACE-213-1002	ACE-214-1002	ACE-215-1002
2.1 x 75	5	ACE-221-7502	ACE-222-7502	ACE-223-7502	ACE-224-7502	ACE-225-7502
2.1 x 75	3	ACE-211-7502	ACE-212-7502	ACE-213-7502	ACE-214-7502	ACE-215-7502
2.1 x 50	5	ACE-221-0502	ACE-222-0502	ACE-223-0502	ACE-224-0502	ACE-225-0502
2.1 x 50	3	ACE-211-0502	ACE-212-0502	ACE-213-0502	ACE-214-0502	ACE-215-0502
2.1 x 30	5	ACE-221-0302	ACE-222-0302	ACE-223-0302	ACE-224-0302	ACE-225-0302
2.1 x 30	3	ACE-211-0302	ACE-212-0302	ACE-213-0302	ACE-214-0302	ACE-215-0302
2.1 x 20	5	ACE-221-0202	ACE-222-0202	ACE-223-0202	ACE-224-0202	ACE-225-0202
2.1 x 20	3	ACE-211-0202	ACE-212-0202	ACE-213-0202	ACE-214-0202	ACE-215-0202
1.0 x 250	5	ACE-221-2501	ACE-222-2501	ACE-223-2501	ACE-224-2501	ACE-225-2501
1.0 x 150	5	ACE-221-1501	ACE-222-1501	ACE-223-1501	ACE-224-1501	ACE-225-1501
1.0 x 150	3	ACE-211-1501	ACE-212-1501	ACE-213-1501	ACE-214-1501	ACE-215-1501
1.0 x 100	5	ACE-221-1001	ACE-222-1001	ACE-223-1001	ACE-224-1001	ACE-225-1001
1.0 x 100	3	ACE-211-1001	ACE-212-1001	ACE-213-1001	ACE-214-1001	ACE-215-1001
1.0 x 75	5	ACE-221-7501	ACE-222-7501	ACE-223-7501	ACE-224-7501	ACE-225-7501
1.0 x 75	3	ACE-211-7501	ACE-212-7501	ACE-213-7501	ACE-214-7501	ACE-215-7501
1.0 x 50	5	ACE-221-0501	ACE-222-0501	ACE-223-0501	ACE-224-0501	ACE-225-0501
1.0 x 50	3	ACE-211-0501	ACE-212-0501	ACE-213-0501	ACE-214-0501	ACE-215-0501

ACE guard column cartridges for analytical columns 3.0 and 4.6 mm ID. Five guard cartridges per pack. Holder (H0005) required.

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
3.0 x 10	3	ACE-211-0103GD	ACE-212-0103GD	ACE-213-0103GD	ACE-214-0103GD	ACE-215-0103GD
3.0 x 10	5	ACE-221-0103GD	ACE-222-0103GD	ACE-223-0103GD	ACE-224-0103GD	ACE-225-0103GD
Integral guard holder for above		H0005	H0005	H0005	H0005	H0005

ACE guard column cartridges for narrow bore columns 2.1 mm ID. Five guard cartridges per pack. Holder (H0004) required.

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
2.1 x 10	3	ACE-211-0102GD	ACE-212-0102GD	ACE-213-0102GD	ACE-214-0102GD	ACE-215-0102GD
2.1 x 10	5	ACE-221-0102GD	ACE-222-0102GD	ACE-223-0102GD	ACE-224-0102GD	ACE-225-0102GD
Integral guard holder for above		H0004	H0004	H0004	H0004	H0004

ACE guard column cartridges for narrow bore columns 1.0 mm ID. Five guard cartridges per pack. Holder (H0004) required.

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
1.0 x 10	3	ACE-211-0101GD	ACE-212-0101GD	ACE-213-0101GD	ACE-214-0101GD	ACE-215-0101GD
1.0 x 10	5	ACE-221-0101GD	ACE-222-0101GD	ACE-223-0101GD	ACE-224-0101GD	ACE-225-0101GD
Stand-alone guard holder for above		H0001	H0001	H0001	H0001	H0001

Note: *A stand-alone guard cartridge holder is available for all the guard cartridges listed above. The part number for this guard cartridge holder is H0001. Connecting tubing and fittings, or a column coupler (part number C0001), is required to use this stand-alone guard cartridge holder.*

ACE® Part Numbers

100Å Ultra-Inert Base Deactivated Capillary and Nano HPLC Columns

Dimensions (mm)	Particle Size (µm)	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
0.075 x 250	5	ACE-121-2500075	ACE-122-2500075	ACE-123-2500075	ACE-124-2500075	ACE-125-2500075	ACE-126-2500075
0.075 x 150	5	ACE-121-1500075	ACE-122-1500075	ACE-123-1500075	ACE-124-1500075	ACE-125-1500075	ACE-126-1500075
0.075 x 150	3	ACE-111-1500075	ACE-112-1500075	ACE-113-1500075	ACE-114-1500075	ACE-115-1500075	ACE-116-1500075
0.075 x 100	5	ACE-121-1000075	ACE-122-1000075	ACE-123-1000075	ACE-124-1000075	ACE-125-1000075	ACE-126-1000075
0.075 x 100	3	ACE-111-1000075	ACE-112-1000075	ACE-113-1000075	ACE-114-1000075	ACE-115-1000075	ACE-116-1000075
0.10 x 250	5	ACE-121-25001	ACE-122-25001	ACE-123-25001	ACE-124-25001	ACE-125-25001	ACE-126-25001
0.10 x 150	5	ACE-121-15001	ACE-122-15001	ACE-123-15001	ACE-124-15001	ACE-125-15001	ACE-126-15001
0.10 x 150	3	ACE-111-15001	ACE-112-15001	ACE-113-15001	ACE-114-15001	ACE-115-15001	ACE-116-15001
0.10 x 100	5	ACE-121-10001	ACE-122-10001	ACE-123-10001	ACE-124-10001	ACE-125-10001	ACE-126-10001
0.10 x 100	3	ACE-111-10001	ACE-112-10001	ACE-113-10001	ACE-114-10001	ACE-115-10001	ACE-116-10001
0.30 x 250	5	ACE-121-25003	ACE-122-25003	ACE-123-25003	ACE-124-25003	ACE-125-25003	ACE-126-25003
0.30 x 150	5	ACE-121-15003	ACE-122-15003	ACE-123-15003	ACE-124-15003	ACE-125-15003	ACE-126-15003
0.30 x 150	3	ACE-111-15003	ACE-112-15003	ACE-113-15003	ACE-114-15003	ACE-115-15003	ACE-116-15003
0.30 x 100	5	ACE-121-10003	ACE-122-10003	ACE-123-10003	ACE-124-10003	ACE-125-10003	ACE-126-10003
0.30 x 100	3	ACE-111-10003	ACE-112-10003	ACE-113-10003	ACE-114-10003	ACE-115-10003	ACE-116-10003
0.30 x 50	5	ACE-121-05003	ACE-122-05003	ACE-123-05003	ACE-124-05003	ACE-125-05003	ACE-126-05003
0.30 x 50	3	ACE-111-05003	ACE-112-05003	ACE-113-05003	ACE-114-05003	ACE-115-05003	ACE-116-05003
0.30 x 30	5	ACE-121-03003	ACE-122-03003	ACE-123-03003	ACE-124-03003	ACE-125-03003	ACE-126-03003
0.30 x 30	3	ACE-111-03003	ACE-112-03003	ACE-113-03003	ACE-114-03003	ACE-115-03003	ACE-116-03003
0.50 x 250	5	ACE-121-25005	ACE-122-25005	ACE-123-25005	ACE-124-25005	ACE-125-25005	ACE-126-25005
0.50 x 150	5	ACE-121-15005	ACE-122-15005	ACE-123-15005	ACE-124-15005	ACE-125-15005	ACE-126-15005
0.50 x 150	3	ACE-111-15005	ACE-112-15005	ACE-113-15005	ACE-114-15005	ACE-115-15005	ACE-116-15005
0.50 x 100	5	ACE-121-10005	ACE-122-10005	ACE-123-10005	ACE-124-10005	ACE-125-10005	ACE-126-10005
0.50 x 100	3	ACE-111-10005	ACE-112-10005	ACE-113-10005	ACE-114-10005	ACE-115-10005	ACE-116-10005
0.50 x 50	5	ACE-121-05005	ACE-122-05005	ACE-123-05005	ACE-124-05005	ACE-125-05005	ACE-126-05005
0.50 x 50	3	ACE-111-05005	ACE-112-05005	ACE-113-05005	ACE-114-05005	ACE-115-05005	ACE-116-05005
0.50 x 30	5	ACE-121-03005	ACE-122-03005	ACE-123-03005	ACE-124-03005	ACE-125-03005	ACE-126-03005
0.50 x 30	3	ACE-111-03005	ACE-112-03005	ACE-113-03005	ACE-114-03005	ACE-115-03005	ACE-116-03005

300Å Ultra-Inert Base Deactivated Capillary and Nano HPLC Columns for Peptides/Proteins

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
0.075 x 250	5	ACE-221-2500075	ACE-222-2500075	ACE-223-2500075	ACE-224-2500075	ACE-225-2500075
0.075 x 150	5	ACE-221-1500075	ACE-222-1500075	ACE-223-1500075	ACE-224-1500075	ACE-225-1500075
0.075 x 150	3	ACE-211-1500075	ACE-212-1500075	ACE-213-1500075	ACE-214-1500075	ACE-215-1500075
0.075 x 100	5	ACE-221-1000075	ACE-222-1000075	ACE-223-1000075	ACE-224-1000075	ACE-225-1000075
0.075 x 100	3	ACE-211-1000075	ACE-212-1000075	ACE-213-1000075	ACE-214-1000075	ACE-215-1000075
0.10 x 250	5	ACE-221-25001	ACE-222-25001	ACE-223-25001	ACE-224-25001	ACE-225-25001
0.10 x 150	5	ACE-221-15001	ACE-222-15001	ACE-223-15001	ACE-224-15001	ACE-225-15001
0.10 x 150	3	ACE-211-15001	ACE-212-15001	ACE-213-15001	ACE-214-15001	ACE-215-15001
0.10 x 100	5	ACE-221-10001	ACE-222-10001	ACE-223-10001	ACE-224-10001	ACE-225-10001
0.10 x 100	3	ACE-211-10001	ACE-212-10001	ACE-213-10001	ACE-214-10001	ACE-215-10001
0.30 x 250	5	ACE-221-25003	ACE-222-25003	ACE-223-25003	ACE-224-25003	ACE-225-25003
0.30 x 150	5	ACE-221-15003	ACE-222-15003	ACE-223-15003	ACE-224-15003	ACE-225-15003
0.30 x 150	3	ACE-211-15003	ACE-212-15003	ACE-213-15003	ACE-214-15003	ACE-215-15003
0.30 x 100	5	ACE-221-10003	ACE-222-10003	ACE-223-10003	ACE-224-10003	ACE-225-10003
0.30 x 100	3	ACE-211-10003	ACE-212-10003	ACE-213-10003	ACE-214-10003	ACE-215-10003
0.30 x 50	5	ACE-221-05003	ACE-222-05003	ACE-223-05003	ACE-224-05003	ACE-225-05003
0.30 x 50	3	ACE-211-05003	ACE-212-05003	ACE-213-05003	ACE-214-05003	ACE-215-05003
0.30 x 30	5	ACE-221-03003	ACE-222-03003	ACE-223-03003	ACE-224-03003	ACE-225-03003
0.30 x 30	3	ACE-211-03003	ACE-212-03003	ACE-213-03003	ACE-214-03003	ACE-215-03003
0.50 x 250	5	ACE-221-25005	ACE-222-25005	ACE-223-25005	ACE-224-25005	ACE-225-25005
0.50 x 150	5	ACE-221-15005	ACE-222-15005	ACE-223-15005	ACE-224-15005	ACE-225-15005
0.50 x 150	3	ACE-211-15005	ACE-212-15005	ACE-213-15005	ACE-214-15005	ACE-215-15005
0.50 x 100	5	ACE-221-10005	ACE-222-10005	ACE-223-10005	ACE-224-10005	ACE-225-10005
0.50 x 100	3	ACE-211-10005	ACE-212-10005	ACE-213-10005	ACE-214-10005	ACE-215-10005
0.50 x 50	5	ACE-221-05005	ACE-222-05005	ACE-223-05005	ACE-224-05005	ACE-225-05005
0.50 x 50	3	ACE-211-05005	ACE-212-05005	ACE-213-05005	ACE-214-05005	ACE-215-05005
0.50 x 30	5	ACE-221-03005	ACE-222-03005	ACE-223-03005	ACE-224-03005	ACE-225-03005
0.50 x 30	3	ACE-211-03005	ACE-212-03005	ACE-213-03005	ACE-214-03005	ACE-215-03005

ACE® Part Numbers

100Å Preparative Ultra-Inert Base Deactivated HPLC Columns

Dimensions (mm)	Particle Size (µm)	ACE C18-HL	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
10.0 x 50	5	ACE-321-0510	ACE-121-0510	ACE-122-0510	ACE-123-0510	ACE-124-0510	ACE-125-0510	ACE-126-0510
10.0 x 75	5	ACE-321-7510	ACE-121-7510	ACE-122-7510	ACE-123-7510	ACE-124-7510	ACE-125-7510	ACE-126-7510
10.0 x 100	5	ACE-321-1010	ACE-121-1010	ACE-122-1010	ACE-123-1010	ACE-124-1010	ACE-125-1010	ACE-126-1010
10.0 x 150	5	ACE-321-1510	ACE-121-1510	ACE-122-1510	ACE-123-1510	ACE-124-1510	ACE-125-1510	ACE-126-1510
10.0 x 250	5	ACE-321-2510	ACE-121-2510	ACE-122-2510	ACE-123-2510	ACE-124-2510	ACE-125-2510	ACE-126-2510
21.2 x 50	5	ACE-321-0520	ACE-121-0520	ACE-122-0520	ACE-123-0520	ACE-124-0520	ACE-125-0520	ACE-126-0520
21.2 x 50	10	ACE-331-0520	ACE-131-0520	ACE-132-0520	ACE-133-0520	ACE-134-0520	ACE-135-0520	ACE-136-0520
21.2 x 75	5	ACE-321-7520	ACE-121-7520	ACE-122-7520	ACE-123-7520	ACE-124-7520	ACE-125-7520	ACE-126-7520
21.2 x 75	10	ACE-331-7520	ACE-131-7520	ACE-132-7520	ACE-133-7520	ACE-134-7520	ACE-135-7520	ACE-136-7520
21.2 x 100	5	ACE-321-1020	ACE-121-1020	ACE-122-1020	ACE-123-1020	ACE-124-1020	ACE-125-1020	ACE-126-1020
21.2 x 100	10	ACE-331-1020	ACE-131-1020	ACE-132-1020	ACE-133-1020	ACE-134-1020	ACE-135-1020	ACE-136-1020
21.2 x 150	5	ACE-321-1520	ACE-121-1520	ACE-122-1520	ACE-123-1520	ACE-124-1520	ACE-125-1520	ACE-126-1520
21.2 x 150	10	ACE-331-1520	ACE-131-1520	ACE-132-1520	ACE-133-1520	ACE-134-1520	ACE-135-1520	ACE-136-1520
21.2 x 250	5	ACE-321-2520	ACE-121-2520	ACE-122-2520	ACE-123-2520	ACE-124-2520	ACE-125-2520	ACE-126-2520
21.2 x 250	10	ACE-331-2520	ACE-131-2520	ACE-132-2520	ACE-133-2520	ACE-134-2520	ACE-135-2520	ACE-136-2520
30.0 x 50	10	ACE-331-0530	ACE-131-0530	ACE-132-0530	ACE-133-0530	ACE-134-0530	ACE-135-0530	ACE-136-0530
30.0 x 100	10	ACE-331-1030	ACE-131-1030	ACE-132-1030	ACE-133-1030	ACE-134-1030	ACE-135-1030	ACE-136-1030
30.0 x 150	10	ACE-331-1530	ACE-131-1530	ACE-132-1530	ACE-133-1530	ACE-134-1530	ACE-135-1530	ACE-136-1530
30.0 x 250	10	ACE-331-2530	ACE-131-2530	ACE-132-2530	ACE-133-2530	ACE-134-2530	ACE-135-2530	ACE-136-2530

ACE guard column cartridges for preparative columns 10.0 or 21.2 mm ID. Three guard cartridges per pack. Holder (H0002) required.

Dimensions (mm)	Particle Size (µm)	ACE C18-HL	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
10 x 10	5	ACE-321-0110GD	ACE-121-0110GD	ACE-122-0110GD	ACE-123-0110GD	ACE-124-0110GD	ACE-125-0110GD	ACE-126-0110GD
10 x 10	10	ACE-331-0110GD	ACE-131-0110GD	ACE-132-0110GD	ACE-133-0110GD	ACE-134-0110GD	ACE-135-0110GD	ACE-136-0110GD
Guard holder for above		H0002	H0002	H0002	H0002	H0002	H0002	H0002

ACE guard column cartridges for preparative columns 30.0 mm ID. A single guard cartridge. Holder (H0006) required.

Dimensions (mm)	Particle Size (µm)	ACE C18-HL	ACE C18	ACE C8	ACE C4	ACE CN	ACE Phenyl	ACE AQ
20 x 20	5	ACE-321-0220GD	ACE-121-0220GD	ACE-122-0220GD	ACE-123-0220GD	ACE-124-0220GD	ACE-125-0220GD	ACE-126-0220GD
20 x 20	10	ACE-331-0220GD	ACE-131-0220GD	ACE-132-0220GD	ACE-133-0220GD	ACE-134-0220GD	ACE-135-0220GD	ACE-136-0220GD
Guard holder for above		H0006	H0006	H0006	H0006	H0006	H0006	H0006

300Å Preparative Ultra-Inert Base Deactivated HPLC Columns for Peptides/Proteins

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
10.0 x 50	5	ACE-221-0510	ACE-222-0510	ACE-223-0510	ACE-224-0510	ACE-225-0510
10.0 x 75	5	ACE-221-7510	ACE-222-7510	ACE-223-7510	ACE-224-7510	ACE-225-7510
10.0 x 100	5	ACE-221-1010	ACE-222-1010	ACE-223-1010	ACE-224-1010	ACE-225-1010
10.0 x 150	5	ACE-221-1510	ACE-222-1510	ACE-223-1510	ACE-224-1510	ACE-225-1510
10.0 x 250	5	ACE-221-2510	ACE-222-2510	ACE-223-2510	ACE-224-2510	ACE-225-2510
21.2 x 50	5	ACE-221-0520	ACE-222-0520	ACE-223-0520	ACE-224-0520	ACE-225-0520
21.2 x 50	10	ACE-231-0520	ACE-232-0520	ACE-233-0520	ACE-234-0520	ACE-235-0520
21.2 x 75	5	ACE-221-7520	ACE-222-7520	ACE-223-7520	ACE-224-7520	ACE-225-7520
21.2 x 75	10	ACE-231-7520	ACE-232-7520	ACE-233-7520	ACE-234-7520	ACE-235-7520
21.2 x 100	5	ACE-221-1020	ACE-222-1020	ACE-223-1020	ACE-224-1020	ACE-225-1020
21.2 x 100	10	ACE-231-1020	ACE-232-1020	ACE-233-1020	ACE-234-1020	ACE-235-1020
21.2 x 150	5	ACE-221-1520	ACE-222-1520	ACE-223-1520	ACE-224-1520	ACE-225-1520
21.2 x 150	10	ACE-231-1520	ACE-232-1520	ACE-233-1520	ACE-234-1520	ACE-235-1520
21.2 x 250	5	ACE-221-2520	ACE-222-2520	ACE-223-2520	ACE-224-2520	ACE-225-2520
21.2 x 250	10	ACE-231-2520	ACE-232-2520	ACE-233-2520	ACE-234-2520	ACE-235-2520

ACE guard column cartridges for preparative columns 10.0 or 21.2 mm ID. Three guard cartridges per pack. Holder (H0002) required.

Dimensions (mm)	Particle Size (µm)	ACE C18-300	ACE C8-300	ACE C4-300	ACE CN-300	ACE Phenyl-300
10 x 10	5	ACE-221-0110GD	ACE-222-0110GD	ACE-223-0110GD	ACE-224-0110GD	ACE-225-0110GD
10 x 10	10	ACE-231-0110GD	ACE-232-0110GD	ACE-233-0110GD	ACE-234-0110GD	ACE-235-0110GD
Guard holder for above		H0002	H0002	H0002	H0002	H0002

Notes

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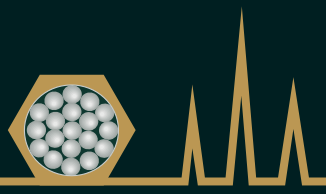

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HPLC Columns