

HPLC Process Columns

Dynamic Axial Compression Columns for GMP
Biopharmaceutical Manufacturing

Technical overview: all values are indicative and subject to customer URS

Column type	HPLC preparative process column for GMP environments
Compression principle	Dynamic Axial Compression through an internal hydraulic compression chamber acting on the piston. Bed compression pressure is generated and maintained by a pump integrated in the column frame.
Packing configuration	Up to Ø450 mm: packing unit integrated in the column frame. Above Ø450 mm: external packing unit supplied for piston movement during column packing and unpacking. Bed compression is always integrated in the column frame.
Compression fluid	20% ethanol in water
Wetted steel	AISI 316L as standard; Duplex stainless steel optional
Polymer and seal materials	PTFE, FEP and PEEK
Operating pressure	Up to 100 bar (configuration dependent)
Design pressure	20% above operating pressure
Operating temperature	Up to 50 °C standard; higher on request
Diameter range	Standard HPLC column configurations from Ø50 mm to Ø800 mm i.d. Larger project specific configurations can be evaluated according to customer URS.
Column frame and movement	Column tube mounted in stainless steel frame with integrated rotation; mobile frame with lockable wheels up to Ø800 mm i.d.; no fixed floor installation
Bed height range	50 mm minimum; maximum bed height configuration dependent
Flow direction	Upflow and downflow
Packing direction	Downflow
Process connections	HPP as standard; BVCO or Fitok available as options. Type and size specified per project
Surface finish (wetted)	$R_a \leq 0.65 \mu\text{m}$
Leak indication	Passive atmospheric cavity between hydraulic and process zones
Certification	PED as standard; ASME design available on request
ATEX	Designed to customer specified ATEX zone classification
Documentation	GMP documentation package including material certificates, individual pressure test certificate and IQ/OQ support documentation. Additional customer specific documentation can be supplied according to URS
Lifecycle support	Spare parts, technical support, maintenance services and operator training available according to agreed lifecycle support scope.



HPLC Process Columns

Peak Biotech HPLC columns are stainless steel, high pressure Dynamic Axial Compression (DAC) columns for preparative chromatography in GMP production environments. The columns are designed and manufactured in Denmark according to PED as standard, with ASME design available as an option for selected configurations.

The compression principle is based on an internal hydraulic compression chamber acting on the piston. This provides controlled axial bed compression without an external overhead compression frame. The design supports a compact column geometry for production facilities where installation height, operator access, cleaning and maintenance access are important.

The HPLC column architecture is based on a column tube mounted in a stainless steel column frame. The column frame is designed to support 360-degree rotation of the column tube.

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The HPLC column architecture is based on a column tube mounted in a stainless steel column frame. The column frame is designed to support 360-degree rotation of the column tube.

The column frame always includes a compression fluid tank and a high-pressure pump used to generate and maintain bed compression pressure. For columns up to and including Ø450 mm, a packing unit is integrated in the column frame. For column diameters above Ø450 mm, the packing unit is supplied as an external standalone hydraulic unit.

For HPLC columns, the packing unit is used for controlled piston movement during packing setup and unpacking. Bed compression pressure is generated by the high-pressure pump integrated in the column frame.

Peak Biotech HPLC columns are built on a mobile stainless steel column frame with lockable wheels. The design allows the column to be repositioned without fixed floor installation, according to site procedures and facility requirements. Smooth external surfaces and defined service access areas support cleaning procedures and GMP housekeeping.

Peak Biotech HPLC Columns Offer:

- Dynamic Axial Compression through an internal hydraulic compression chamber acting on the piston
- Column tube mounted in a stainless-steel column frame with 360-degree rotation
- High-pressure bed compression system integrated in the column frame for all HPLC column sizes
- Packing unit integrated in the column frame up to and including Ø450 mm; external standalone packing unit supplied above Ø450 mm for controlled piston movement during packing setup and unpacking
- Mobile column frame with lockable wheels and no fixed floor installation as standard
- AISI 316L stainless steel as standard, with Duplex stainless steel available as an option
- 20% ethanol in water as compression fluid
- Passive leak indication through an atmospheric cavity between hydraulic and process zones
- Smooth external surfaces and defined service access areas for cleaning, maintenance and GMP housekeeping
- Designed to customer specified ATEX zone classification
- GMP documentation package including material certificates, individual pressure test certificate and IQ/OQ support documentation
- Spare parts, technical support, maintenance services and operator training available according to agreed lifecycle support scope

Compact Installation Height for GMP Facilities

Peak Biotech HPLC columns use an internal hydraulic compression chamber acting on the piston. This provides Dynamic Axial Compression without an external overhead compression frame and supports a compact column geometry for GMP production facilities.

The mobile column frame is designed without fixed floor installation as standard, supporting layout planning, maintenance access and operation in qualified GMP areas according to production site procedures.

The compact column architecture is relevant for both new production facilities and existing GMP suites where installation height, access around the column, cleaning procedures and service access are important design considerations.

Practical Consequences for Facility Design and Integration:

- Lower installation height compared with column designs requiring an external overhead compression frame
- Supports integration in GMP production areas where ceiling height, equipment access and cleaning access are important
- Relevant for existing facilities, CMOs and multi-product GMP suites with limited available height or restricted equipment access
- Mobile stainless steel column frame with lockable wheels, allowing the column to be repositioned according to production site handling procedures
- No fixed floor installation as standard, supporting room layout flexibility, maintenance access and equipment movement
- External packing unit supports flexible equipment placement and floor load distribution for larger HPLC columns
- Compact column design with fewer overhead components around the column body, supporting operator access, cleaning procedures and GMP housekeeping
- Reduced installation complexity around the column body, supporting qualification planning, service access and future room layout changes

Column Movement

Peak Biotech HPLC columns are built on a mobile stainless steel column frame with lockable wheels and no fixed floor installation as standard. This allows the column to be repositioned within the production facility according to defined production site handling procedures, including movement to a dedicated packing area. For packed columns, movement should be planned according to column weight, floor conditions, movement distance and production site manual handling requirements.

Typical Applications

Peak Biotech HPLC columns are used for preparative purification in pilot and commercial GMP manufacturing, particularly for high-pressure applications using rigid particle media where stable bed compression and controlled column operation are important.

Typical applications include:

1. Reversed phase chromatography (RPC)
2. Peptide purification using silica based HPLC media
3. Oligonucleotide purification where HPLC operating pressure is required
4. API and intermediate purification using preparative HPLC
5. Small molecule purification using normal phase or reversed phase chromatography
6. High pressure processes using rigid silica or polymeric chromatography media

Peak Biotech HPLC columns can also be specified for multi-product GMP facilities where cleaning, changeover and documentation are defined by customer procedures.

General Column Description

Peak Biotech HPLC columns are specified and manufactured according to customer URS and process requirements. Column diameter, bed height, operating pressure, materials, process connections and documentation scope are defined during project specification.

Scaling preparative chromatography from laboratory to GMP production introduces mechanical and hydraulic conditions that must be controlled at equipment level. At production scale, bed stability, flow distribution, pressure response and reproducibility between packing runs become important operating parameters. Peak Biotech HPLC columns are engineered to support controlled operation through Dynamic Axial Compression, distributor design and mechanically robust stainless-steel construction.

The column includes distributor and frit assemblies at both the piston and column bottom. These assemblies are designed to support consistent mobile phase distribution across the bed diameter and to retain the packed chromatography media during operation.

Indicative examples of typical HPLC column configurations are shown in Table 1. Final dimensions, weights, pressure rating, connections and documentation scope are defined during project specification.

Table 1. Indicative HPLC Column Specifications

Description	i.d. (mm)	Max bed height (mm)	Max bed vol. (L)	Max op. pressure (bar)	Overall height (mm)	Weight, empty (kg)	Footprint (mm x mm)
HPLC 100/600	100	300	5	100	1740	130	820 x 720
HPLC 200/600	200	300	19	100	1840	200	1000 x 920
HPLC 300/600	300	300	42	100	1845	500	1100 x 920
HPLC 450/700	450	350	111	100	2180	830	1520 x 1000 *
HPLC 600/700	600	350	198	100	2200	1280	1480 x 1200 **
HPLC 800/900	800	450	452	100	2200	2060	1650 x 1300 **

- All specifications are indicative examples and do not define the full design range. Peak Biotech HPLC columns are specified and manufactured according to customer URS and process requirements. Final dimensions, weights, operating pressure, materials, connections and documentation scope are confirmed at project level.
- Larger or project specific configurations can be evaluated during project specification.
- Design pressure is 20% above operating pressure.
- Bed height range: minimum 50 mm; maximum bed height as listed above. Bed volumes are indicative at maximum bed height and do not account for resin compression.
- Operating temperature: up to 50 °C as standard; higher temperatures available on request.
- Surface finish on product contacted wetted surfaces: $R_a \leq 0.65 \mu\text{m}$.
- Process connections: HPP as standard; BVCO or Fitok available as options. Type and size are specified per project.
- Certification: PED as standard. ASME design available on request for selected smaller diameters.
- ATEX: Designed to customer specified ATEX zone classification.
- All columns are individually pressure tested. Test certificate is supplied with each column.
- * Up to and including Ø450 mm, the packing unit is integrated in the column frame.
- ** Above Ø450 mm, an external standalone packing unit is supplied for piston movement during packing setup and unpacking. Bed compression is generated and maintained by the high-pressure bed compression system integrated in the column frame.

Column Frame, Tube and Packing Unit **Key Components**

Peak Biotech HPLC columns are built around a pressure-retaining column tube mounted in a mobile stainless steel column frame. The column frame supports column positioning, 360-degree tube rotation, column packing and unpacking.

Column Frame

The column tube is mounted in a mobile stainless-steel frame with lockable wheels. The frame supports column positioning, column packing and unpacking, and 360-degree tube rotation by handwheel. Rotation and column handling functions are operator controlled from the frame and performed according to production site procedures.

Supplied without fixed floor installation as standard, the mobile frame supports repositioning within the production facility according to defined handling procedures.

Integrated in the frame is the high-pressure bed compression system used to generate and maintain bed compression during operation. This system includes a smaller compression fluid tank and pump.

Depending on column diameter, the packing unit is either integrated in the frame or supplied as an external standalone mobile unit. Up to and including Ø450 mm, the packing unit is integrated in the frame. For larger column diameters, the frame is configured for connection to the external packing unit during packing setup and unpacking.

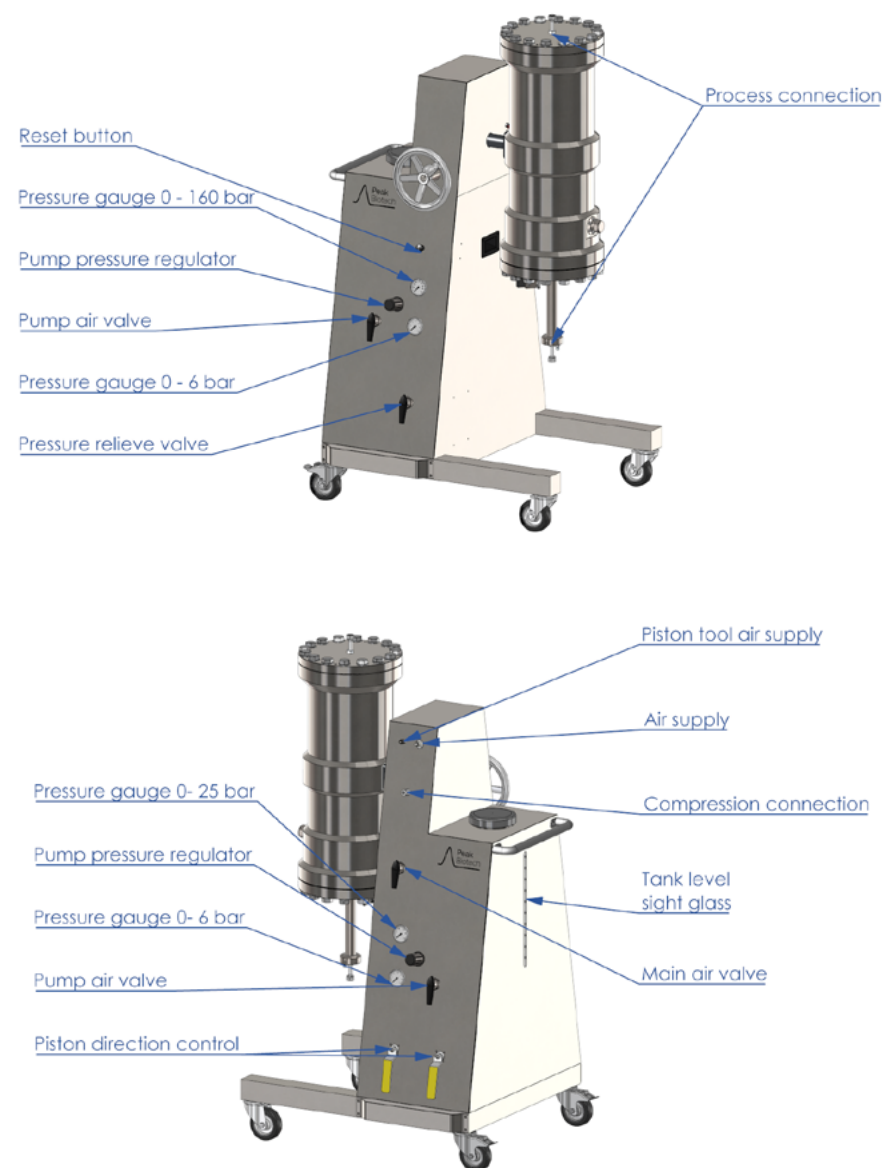


Figure X. Example of a Ø300 mm Peak Biotech HPLC column configuration with mobile stainless steel column frame, lockable wheels, handwheel-operated column tube rotation and integrated packing unit controls.

Column Tube and Internal Components

The column tube forms the main pressure-retaining process chamber and houses the packed chromatography media. Key components are:

- **Column tube** Main pressure-retaining cylinder manufactured in AISI 316L stainless steel as standard, with Duplex stainless steel available as an option.
- **Piston** Moves axially within the column tube under hydraulic pressure and applies compression to the packed bed. The piston carries the top distributor and frit assembly.
- **Piston rod** Serves as the top process connection and mechanical stabiliser for the piston. The piston rod also incorporates the leak indicator cavity.
- **Column top** Upper flange sealing the hydraulic chamber. The column top contacts hydraulic compression fluid only and is not a product-contacted component.
- **Leak indicator port** External port at the piston rod end providing visual indication in case of seal failure between the hydraulic and process zones.
- **Slurry inlet port** Side port on the column tube used for slurry loading during column filling and packing. Final valve and connection configuration is defined during project specification.
- **Top distributor and frit** Fitted to the underside of the piston. The distributor supports mobile phase distribution, while the frit retains the packed chromatography media.
- **Bottom distributor and frit** Fitted to the column bottom and designed according to the same distributor principle as the top assembly. The frit retains the packed chromatography media.
- **Column bottom** Lower flange providing the bottom process connection and housing the bottom distributor and frit assembly. The column bottom is removable for maintenance and resin discharge and is a product-contacted component.

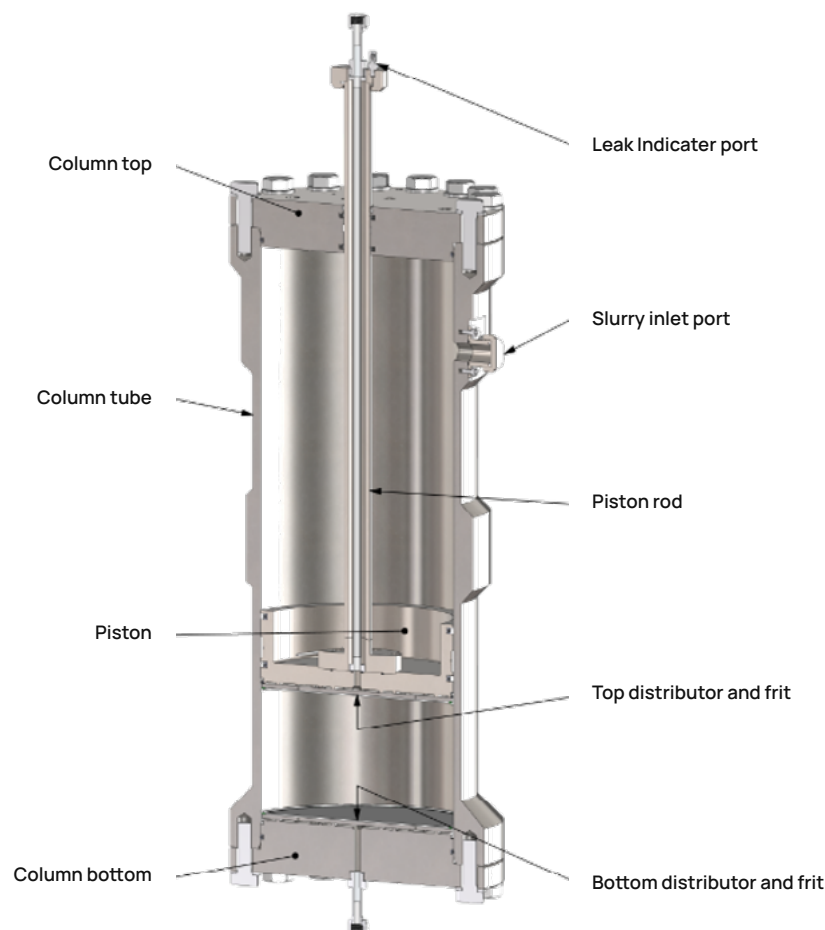


Figure 2. Cross-section of a Peak Biotech HPLC column tube showing piston, piston rod, slurry inlet, leak indication and distributor/frit assemblies at the piston and column bottom.

Packing Unit

The packing unit configuration is defined by column diameter.

For columns up to and including Ø450 mm, the packing unit is integrated in the column frame. For column diameters above Ø450 mm, the packing unit is supplied as an external standalone mobile hydraulic unit. For HPLC columns, the packing unit is used during packing setup and unpacking for controlled piston movement and for supplying the larger compression fluid volume required by the hydraulic compression chamber. For larger HPLC columns, the external packing unit is connected to the column frame during packing setup and unpacking. After packing, the external unit can be disconnected and moved away from the column.

This configuration supports flexible equipment placement and floor load distribution in production areas with defined floor load requirements.



Figure 3. HPLC column configuration up to and including Ø450 mm with packing unit integrated in the mobile column frame.



Figure 4. HPLC column configuration above Ø450 mm with external standalone packing unit connected to the column frame.

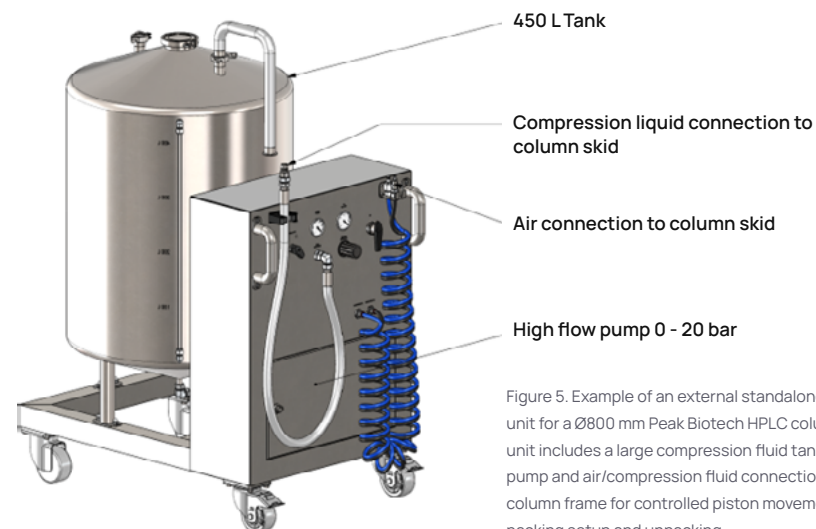


Figure 5. Example of an external standalone packing unit for a Ø800 mm Peak Biotech HPLC column. The unit includes a large compression fluid tank, high-flow pump and air/compression fluid connections to the column frame for controlled piston movement during packing setup and unpacking.

Product-contacted steel parts are manufactured from AISI 316L stainless steel as standard. Duplex stainless steel is available as an option where required by the process, mechanical design or project specification.

Product-contacted polymer and seal materials include PTFE, FEP and PEEK. The distributor is manufactured from PEEK, while the frit is manufactured from AISI 316L stainless steel. Final material selection is confirmed in the project-specific material list.

Table 2. Materials of Main Components

Component	Material	Product contact
Column tube	AISI 316L stainless steel (Duplex as option)	Yes
Column top	AISI 316L stainless steel (Duplex as option)	No
Column bottom	AISI 316L stainless steel (Duplex as option)	Yes
Piston	AISI 316L stainless steel (Duplex as option)	Yes
Piston rod	AISI 316L stainless steel (Duplex as option)	Yes
Frit	AISI 316L stainless steel	Yes
Distributor	PEEK	Yes
Polymer and seal materials	PTFE, FEP and PEEK	Yes
Compression fluid	20% ethanol in water	No
Column frame and packing unit	AISI 304 and AISI 316 stainless steel, configuration dependent	No

- PTFE = polytetrafluoroethylene; FEP = fluorinated ethylene propylene; PEEK = polyether ether ketone.
- The column top contacts hydraulic compression fluid only and is not a product-contacted component. The column bottom houses the bottom distributor assembly and bottom process connection and is a product-contacted component.
- The compression fluid is part of the hydraulic compression system and is not in product contact during normal operation

Table 3. Material Compatibility Guide

Chemical	SS 316/316L	Duplex	PTFE	FEP	PEEK	Remark
Acetic acid, 20%	+	+	+	+	+	
Acetic acid, 100%	-	+	+	+	O	
Ethanol, 20%	+	+	+	+	+	
Ethanol, 100%	+	+	+	+	+	Below 30 °C
Ethylene glycol, 50%	-	+	+	+	+	
Phosphoric acid, <45%	+	+	+	+	+	
Glycerol, 100%	+	+	+	+	+	
Isopropyl alcohol	+	+	+	+	+	
Formic acid, 10%	+	+	+	+	+	
Sodium chloride	-	+	+	+	+	Diluted only
Hydrochloric acid	-	+	+	+	+	Diluted only
Nitric acid, 10%	+	+	+	+	+	
Nitric acid, 70%	+	+	+	+	+	
Sodium hydroxide, 1 M	+	+	+	+	+	CIP / sanitisation
Hydrogen peroxide	+	+	+	+	+	
Acetonitrile	+	+	+	+	+	
Methanol	+	+	+	+	+	
HPLC 800/900	800	450	452	100	[TBD]	[TBD]

- This table is a general material compatibility guide for individual chemicals and materials that may be used in Peak Biotech column designs and related support equipment. The data are compiled from published material compatibility sources and have not been generated from chemical resistance testing of finished Peak Biotech column assemblies.
- Peak Biotech does not perform chemical resistance testing of the finished column assembly as part of standard project specification. Final material selection for product-contacted parts is defined during project specification based on the customer URS, process requirements, specified chemicals, operating conditions and cleaning procedures.
- Chemical compatibility must always be verified against the actual chemical mixture, concentration, temperature, exposure duration, cleaning procedure and product-contact status relevant to the customer process. Solvent mixtures, buffers and salts may behave differently than the individual components listed in this table, including changes in solubility, precipitation risk and corrosive behaviour.

+ Resistant - Non-resistant O Data not available

Column Packing

Column Packing

Peak Biotech HPLC columns are designed to make resin filling, column packing and unpacking straightforward and controlled using the column frame and the defined packing unit configuration.

The resin filling method depends on column diameter and column configuration. HPLC columns from Ø200 mm and above can be supplied with a slurry inlet for resin loading during filling and packing. For smaller column diameters, the column tube does not provide sufficient space for installation of a slurry inlet valve. These columns are filled by removing the column bottom, introducing the resin into the column, and reinstalling the column bottom before packing.

Column packing is performed with the column in the defined packing position. The piston is moved hydraulically to form and compress the packed bed. Final packing parameters, including slurry concentration, packing pressure, flow conditions and acceptance criteria, are defined according to the chromatography media, process requirements and packing procedure.

For HPLC columns, piston movement during packing setup and unpacking is supported by the packing unit. Bed compression during operation is maintained by the high-pressure bed compression system integrated in the column frame.



Figure 6.

Example Packing Sequence for an HPLC Column Configuration with Slurry Inlet.

Slurry Inlet is Available from Ø200 mm and Above.

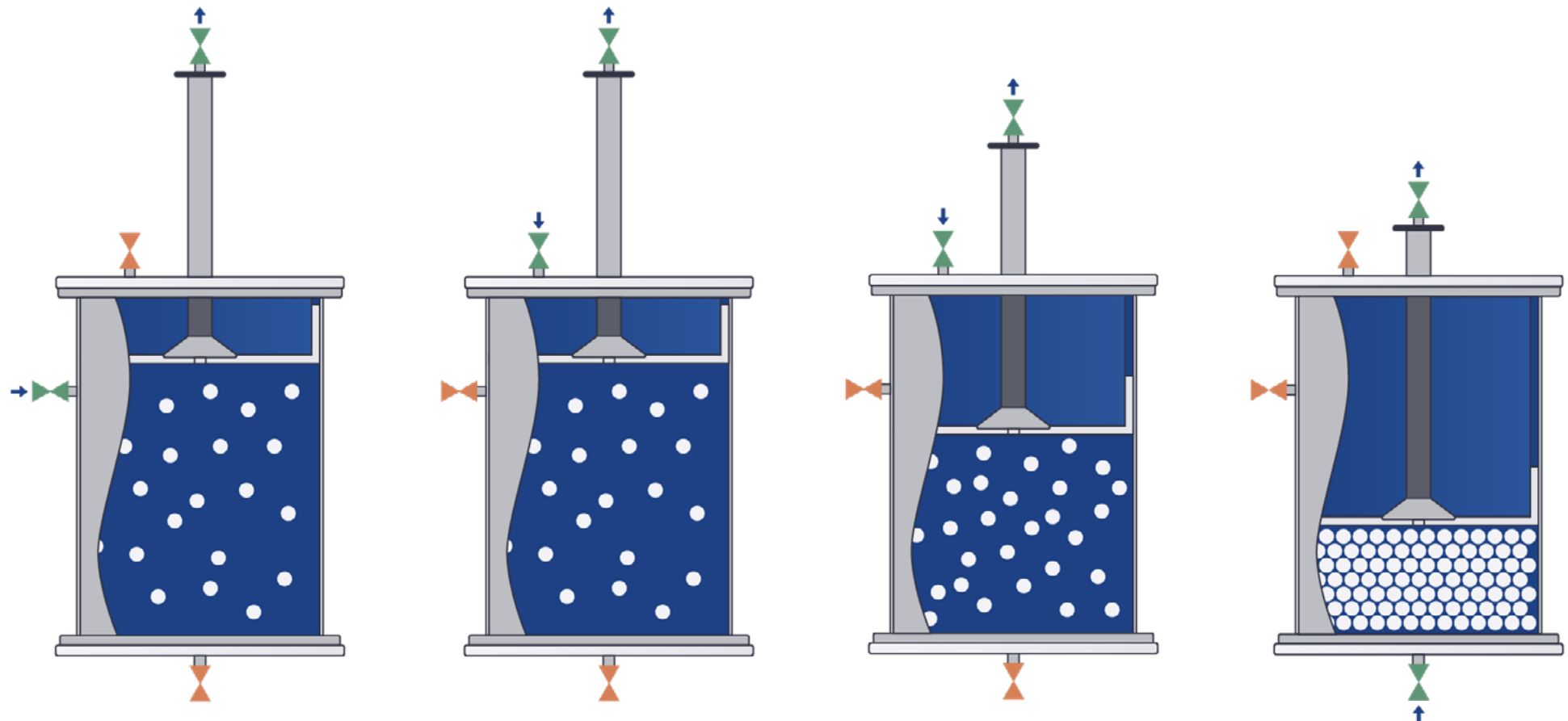
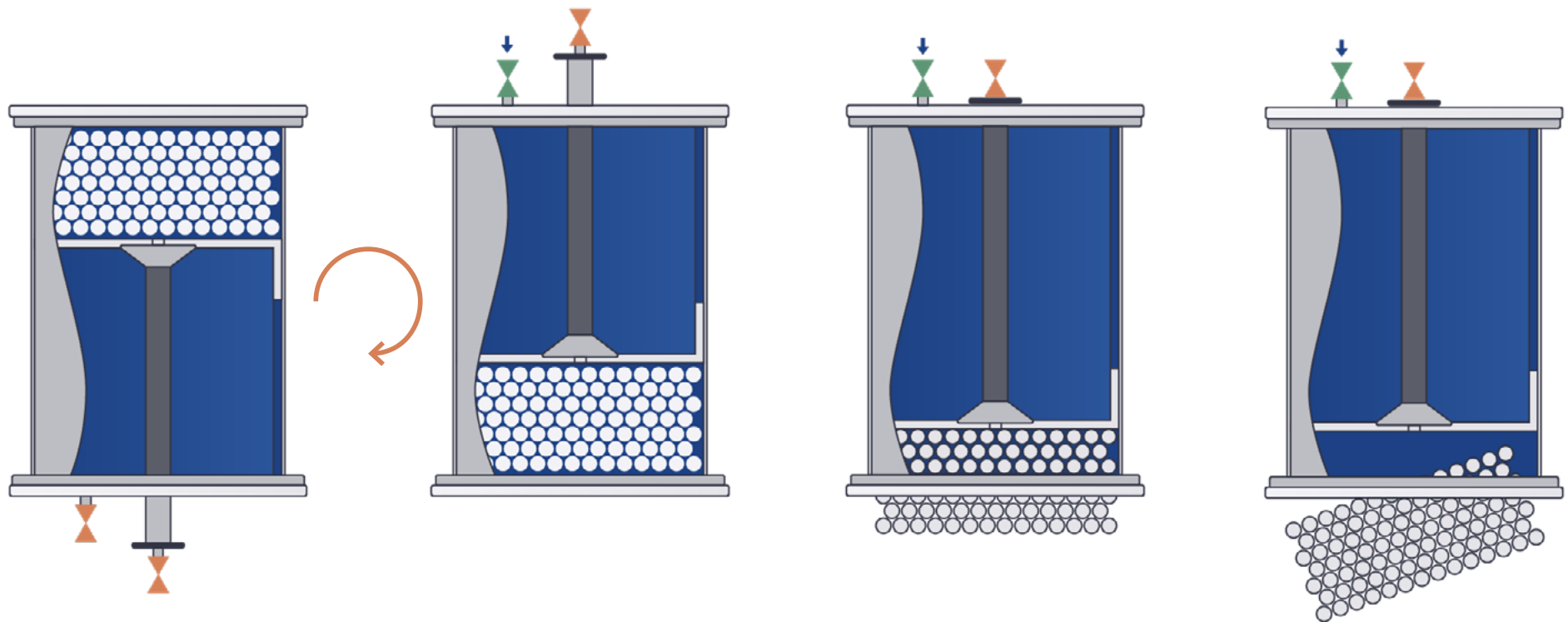


Figure 7.

Example Unpacking Sequence for a Peak Biotech HPLC Column, Showing Column Positioning, Hydraulic Piston Movement and Resin Discharge through the Column Bottom.

Unpacking is supported by hydraulic piston movement and column rotation. During unpacking, the column can be positioned to support resin discharge through the column bottom according to production site procedures.



Compression

Oil-free Hydraulic Compression Fluid

Peak Biotech HPLC columns use 20% ethanol in water as hydraulic compression fluid. Hydraulic oil is not used in the column compression system.

The compression fluid is used in the internal hydraulic compression chamber acting on the piston. This supports controlled piston movement during packing setup and unpacking, as well as axial bed compression during operation.

Using ethanol/water instead of hydraulic oil supports GMP pharmaceutical production environments where material compatibility, cleaning procedures and leak indication are important design considerations.

The hydraulic compression zone is separated from the process zone by seals and a passive atmospheric leak indication cavity. Any observed leakage must be handled according to production site procedures.

Controlled Axial Compression

Peak Biotech HPLC columns use Dynamic Axial Compression through an internal hydraulic compression chamber acting on the piston. Hydraulic pressure moves the piston axially and applies compression to the packed chromatography bed.

For HPLC columns, bed compression during operation is generated and maintained by the high-pressure bed compression system integrated in the column frame. The column frame provides the relevant air regulation, hydraulic pressure indication and valve functions for directing compression fluid during compression.

Piston movement during packing setup and unpacking is supported by the defined packing unit configuration. For larger HPLC columns, the external packing unit supplies the larger hydraulic fluid volume required during packing setup and unpacking, while bed compression during operation remains controlled from the column frame.

Operational features include:

- Dynamic Axial Compression through an internal hydraulic compression chamber
- Oil-free hydraulic compression fluid based on 20% ethanol in water
- High-pressure bed compression system integrated in the column frame
- Hydraulic pressure indication during compression
- Defined valve functions for compression fluid direction
- Piston movement during packing setup and unpacking through the defined packing unit configuration
- Operating instructions supplied with the column documentation

Distribution System and Leak Indication

Bidirectional Operation with Defined Packing Direction

The piston and column bottom assemblies are designed according to the same distributor principle. The distributor supports mobile phase distribution across the bed diameter, while the frit retains the packed chromatography media during operation.

This design supports process flow in both upflow and downflow direction. Bidirectional operation refers to process flow during column operation; column packing is performed in the defined packing direction according to the packing procedure.

Because the distributor principle is the same at both ends of the column, reverse flow testing can be used as a diagnostic tool when column performance does not meet expectations. Comparing performance in normal and reverse flow can help indicate whether an observed issue is related to the packed bed, distributor area, flow direction or process setup.

Final column performance depends on the complete packing and operating setup, including media type, slurry preparation, bed height, packing pressure, flow rate and process method.

The common distributor principle at both ends can also support maintenance and spare part planning, subject to final column configuration.

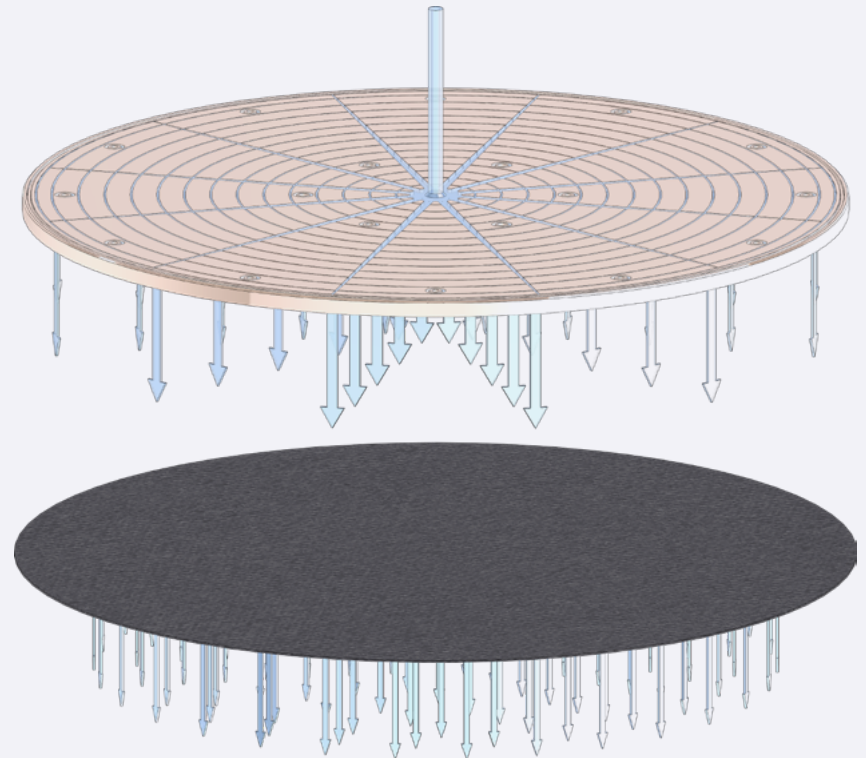


Figure 8. Distributor and frit principle in a Peak Biotech HPLC column, supporting mobile phase distribution during upflow and downflow operation.

Passive Leak Indication

Between the hydraulic chamber and the process zone, an atmospheric, pressure-free cavity is built into the column architecture. This cavity provides an external indication route in the event of seal failure before direct migration between hydraulic and process zones can occur.

The leak indication function is passive and does not rely on electronics, sensors or calibration. Any observed leakage at the indicator port must be handled according to production site deviation procedures, and the relevant seals must be inspected before further operation.

Maintenance and Service Access

Peak Biotech HPLC columns are designed with defined service access to key product-contacted and wear components, including frit assemblies, distributor assemblies, piston seals, rod seals, scraper seals and O-rings.

The mobile column frame and 360-degree tube rotation support positioning of the column during resin discharge, inspection, cleaning and scheduled maintenance. Maintenance activities are performed according to the column documentation and production site procedures by trained personnel using Peak Biotech approved spare parts.

Accessible Wear Components

Key wear components can be accessed through defined disassembly and maintenance procedures. This includes piston seals, rod seals, O-rings, scraper seals, frit assemblies and distributor-related components.

Routine maintenance includes inspection for leakage, wipe-down of external surfaces and cleaning of relevant components after disassembly. Replacement intervals depend on operating conditions, packing cycles, inspection findings and production site maintenance procedures.

Frit and Distributor Assemblies

The frit and distributor assemblies are accessible during scheduled maintenance. The frit is a critical product-contacted component that retains the packed chromatography media. The distributor supports liquid distribution across the column diameter.

During scheduled maintenance, frit and distributor assemblies can be inspected, cleaned and reused when their condition remains within defined acceptance criteria. If the frit is damaged, blocked or no longer suitable for use, it can be replaced according to the column documentation and approved maintenance procedure.

The condition of the frit and distributor assemblies is relevant for column performance, pressure response and maintenance planning. The distributor principle at the piston and column bottom supports consistent service logic across both ends of the column, subject to final column configuration.

The pressure-retaining column tube and other pressure-retaining parts are not routine service components. Any intervention involving pressure-retaining parts must be handled according to applicable pressure equipment requirements and project documentation.

Project-specific maintenance tools and handling support can be supplied according to column size, component weight, facility layout and production site procedures. Support equipment, maintenance tools and lifecycle services are described in the following section.

Support Equipment, **Maintenance Tools**

Peak Biotech can supply support equipment and maintenance tools according to column configuration, chromatography media, maintenance procedure and production site requirements. Support equipment and tools are defined during project specification based on customer URS, column size, component weight, facility layout and production site procedures.

Slurry Support Equipment

Peak Biotech slurry units support preparation, handling and transfer of chromatography media slurry before column filling and packing. The slurry unit configuration is defined during project specification based on customer URS, media type, slurry volume, slurry concentration and process requirements.

Rotating slurry units are primarily intended for HPLC applications with silica-based media. In this design, the complete slurry tank rotates to support mixing of media and slurry buffer and to help maintain a homogeneous slurry before transfer to the column. Rotating slurry units are typically specified up to 150 L.

Standing slurry units are normally selected for slurry volumes above 150 L and for soft media applications. For soft media, the unit can be equipped with a top mixer for gentle slurry handling.

Slurry units are manufactured in stainless steel sanitary design and can be configured with bottom outlet, CIP connection, sanitary process connections, diaphragm pump for slurry transfer and project-specific process connections. Final volume, material selection, connections and documentation scope are specified according to project requirements. Full specifications for Peak Biotech slurry units are provided in a dedicated slurry unit Product Data Sheet, available separately.

Bottom Handling Support

Bottom handling support can be supplied for removal, positioning and transport of column bottom assemblies during scheduled maintenance on relevant column sizes.

The handling concept is specified according to column size, component weight, facility layout and production site procedures.

Additional Process Equipment

Buffer tanks, fraction tanks, CIP/SIP units and other process equipment can be included where relevant to the agreed project scope.

These items are specified separately from the HPLC column configuration and supplied according to customer URS, process requirements and facility layout.

Maintenance Tools

Project-specific maintenance tools can be supplied to support seal, frit, distributor, piston and column bottom service.

Tool scope is defined according to column size, column configuration and maintenance procedure. Typical tools may include guide rods, Piston Tool, pullers, scraper ring tools, extension rods, piston rod caps and other handling aids required for controlled maintenance activities.

Lifecycle Support

Lifecycle support for Peak Biotech columns is structured around maintaining stable, compliant long-term operation, not only reactive maintenance activities. The objective is predictable column performance across years of production use, with minimal unplanned downtime.

- **Spare Parts** original components available individually or as predefined kits tailored to each column configuration; consistent architecture supports part availability across years of service
- **Technical Support** remote process support and optional on-site assistance during initial packing, commissioning, troubleshooting, and column qualification
- **Maintenance Services** planned preventive maintenance support with structured spare part replacement; scheduled visits reduce unplanned failures and support GMP change control
- **Qualification Support (IQ/OQ)** execution or support of Installation Qualification and Operational Qualification activities; documentation structured for regulatory submission
- **Operator Training** practical training in column handling, packing procedures, seal replacement, and maintenance practices; supports consistent operation across shift changes
- **Global Coverage** services delivered globally under a structured zone-based support model





Ordering Information

Column configurations, dimensions, slurry support equipment, movement concept, maintenance equipment and additional process equipment are specified per project. For ordering information, technical specifications, and quotations, please contact Peak Biotech.

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