

selecting

Hollow Fiber
Cartridges
and Systems





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About this guide

This guide describes how to select hollow fiber ultrafiltration and microfiltration membrane cartridges manufactured by Amersham Biosciences. The guide provides you with background information on membrane applications; details the broad range of membrane pore sizes, fiber inner diameters, fiber path lengths and cartridge membrane areas offered; and specifies membrane cartridge physical characteristics. Cartridge accessories and Amersham Biosciences separation systems well-matched for each cartridge size are highlighted.

Target audience

This document is intended for experienced users of ultrafiltration and microfiltration products. Specifically, the guide addresses the needs of scientists, process engineers and technicians who operate laboratory, pilot and production cross flow membrane systems. Our customer service and technical support teams are ready to assist both the experienced and the novice user. In the USA, you can contact us by calling 1-800-526-3593. Outside the USA, you can contact your local Amersham Biosciences representative using the telephone numbers listed on the back cover of this user guide.

Where to find more information

For further information please contact us in the US at:

Voice: 1-800-526-3593

Fax: 1-877-295-8102

or, visit our Web site at:

www.amershambiosciences.com

For additional contact information at our offices around the world, refer to the listings on the back cover of this user guide.

Please visit our Web site at www.amershambiosciences.com, where you can learn about all of Amersham Biosciences chromatography and membrane products for biopharmaceutical processing. The latest edition of this guidebook as well as all of our technical literature is available for download through links provided at this site.

Safety

When using any laboratory, pilot or process scale separation equipment, the potential exists for personal injury unless you follow established safety procedures. When using Amersham Biosciences products, you should follow OSHA, federal, state and local safety regulations. You should follow your company's safety procedures, good engineering practices and the safety instructions provided in the Amersham Biosciences user guides.

This guide uses highlighted blocks of text with flags to provide safety information and expert advice:



Safety

WARNING: A safety warning flag describes conditions or actions that can cause bodily harm and describes how to avoid the risk.



Expert advice

CAUTION: An expert advice caution flag describes conditions or actions that can cause equipment damage and describes how to avoid the risk.



Expert advice

TIP: An expert advice tip flag provides you with information to use your hollow fiber membrane cartridge and system efficiently to achieve the best results.

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Introduction

Amersham Biosciences manufactures a complete selection of hollow fiber cross flow ultrafiltration and microfiltration membranes. These membranes are supplied as 25 different self-contained cartridge designs ranging from 16 cm² to 28 m² of effective membrane area. These designs are configured both to afford convenient linear scaling and to optimize any candidate application around reproducible and predictable fluid mechanics.

The combination of these cartridge features results in over 900 hollow fiber cartridge products to draw upon when considering any new separations application, offering the broadest selection range available for membrane separations. When faced with this long list of membrane and cartridge design options, even the most experienced bioprocess scientist may be overwhelmed with how to begin to select the appropriate cartridge. While we invite you to contact us directly to help with this task, we outline here a logical sequence that will serve as your roadmap for any future projects.

Amersham Biosciences cartridges are available in a broad spectrum of pore sizes (Table 1).

Ultrafiltration (NMWC)	Microfiltration (microns)
1,000	0.1
3,000	0.2
5,000	0.45
10,000	0.65
30,000	
50,000	
100,000	
300,000	
500,000	
750,000	

Table 1. Membrane pore size availability

Selecting a hollow fiber cross flow membrane cartridge

Four steps to fit any candidate cross flow application

Membrane selection—Which membrane will result in the best product yield? Users should avoid the temptation to select an “open membrane” hoping to accelerate the process time (see Table 2 for recommended pore sizes). Often these attempts will backfire, resulting in prolonged processes and low yields. Any process time can be abbreviated by utilizing sufficient membrane area and appropriate operating conditions.

Flow path selection—Amersham Biosciences hollow fiber membranes are available in a variety of lumen diameters and three standard cartridge lengths. Selecting the correct flow path allows the membrane to operate at an equilibrium state with efficient use of recirculation flow.

Process sequence and operating conditions—How will this device be operated? At what temperature? What is an appropriate recirculation flow rate at what pressures? What is the target process time? Cross flow membranes perform best under equilibrium conditions such as found in constant volume diafiltration. Amersham Biosciences Technical Services

offers you over 10 years of experience in typical GMP membrane separation bioprocesses to suggest an appropriate sequence coupled to a cartridge design with membrane area proportionate to your needs.

Membrane cartridge preparation and maintenance—The Amersham Biosciences operating guide offers detailed protocols for the preparation of hollow fiber cartridges. Once a membrane cartridge has been used in a process, most users will elect to clean and store it for a subsequent process run. Amersham Biosciences hollow fiber cartridges are effectively cleaned using a simple treatment with sodium hydroxide at 50 °C (122 °F). Users usually adopt a clean water flux test to confirm that the cleaning is complete, by comparing the cleaned filter’s flux to a benchmark value that was determined when the filter was new. If the process requires a validated aseptic environment, either an autoclavable cartridge or a cartridge designed for Steam-in-place (SIP) operation will be necessary.

Application	Ultrafiltration (NMWC)	Microfiltration (µm)
Bacterial/pyrogen removal	10,000	
Protein concentration	3,000, 5,000, 10,000, 30,000	
Enzyme concentration	10,000, 30,000, 50,000	
Virus concentration/purification/removal	100,000, 300,000, 500,000, 750,000	
Protein/antigen recovery from fermentation broth	500,000, 750,000	0.1, 0.2, 0.45, 0.65
Bacterial cell concentration	500,000	0.1, 0.2
Insect cell concentration		0.1, 0.2
Mammalian cell concentration		0.2, 0.45, 0.65
Yeast concentration		0.1, 0.2, 0.45
Continuous cell culture perfusion		0.1, 0.2, 0.45
Red blood cell washing		0.45, 0.65
Red blood cell stroma removal	500,000	0.1
Hemoglobin concentration	5,000, 10,000	
Peptide concentration	1,000, 3,000	

Table 2. Recommended pore sizes for select applications

What type of cross flow application do you have in mind?

Although most biopharmaceutical purification processes involve six or more individual steps that eventually must work in concert with one another, initially each separation task must be approached as a single entity.

By convention, the industry has designated certain operations as “upstream” or “primary recovery” involving cells and/or cell debris. After the suspended solids are removed and the target material

reaches a semi-purified condition, the process is often designated as “downstream.” In the end, the product must be processed to achieve the appropriate final drug formulation and format—liquid, powder, capsule and the like.

Regardless of what expression source is being used or the nature of the final drug, Amersham Biosciences hollow fiber cross flow membrane cartridges have proven equally at home in both upstream and downstream applications, delivering reproducible separations run after run.

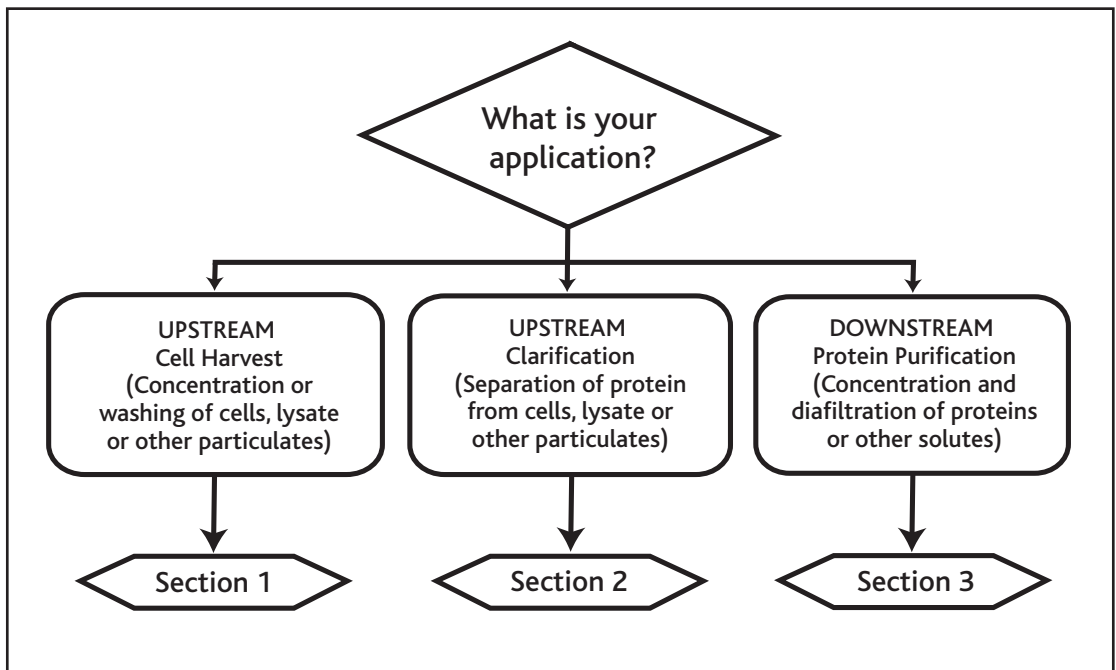


Figure 1. Application roadmap

Applications related to membrane choice, flow path and operation

Upstream cell harvest

(concentrating and/or washing particulated starting materials)

Examples:

- Concentration of *E.coli* fermentation broth
- Removal of culture media from mammalian cell culture bioreactors
- A linearly scalable alternative to centrifugation or single-pass depth filtration
- Concentration and washing of latex particles for diagnostic applications

Selection guidelines

<p>Membrane selection (Suggested pore sizes)</p>	<p>(In order of preference) 500,000 & 750,000 NMWC ultrafiltration (UF) or 0.1 µm microfiltration (MF) (Note: some specialized processes such as bacterin concentration are designed to retain both particulate and soluble components using very tight pore sizes, e.g.; 30,000 NMWC or 10,000 NMWC UF membranes.)</p>
<p>Flow path selection (Cartridge housing designs are listed on page 23. Cartridge lengths can be found in Chapter 2, Table 7, "Nominal dimensions of Amersham Biosciences hollow fiber cartridges" on page 21)</p>	<p>Short path length cartridges (nominally 30-60 cm) Larger lumen diameter fibers (0.75 to 1.0 mm) (Consult Amersham Biosciences Technical Support for other cartridge design choices when working with extremely viscous starting feed streams.)</p>
<p>Process sequence and operating conditions (See Operating Guide for additional details)</p>	<p>Recirculation flow rate: 8,000 sec⁻¹ to 16,000 sec⁻¹ shear rate for fouling feed streams, 2,000 sec⁻¹ to 4,000 sec⁻¹ for shear-sensitive feed streams Process Sequence: concentration dependent flux, position cell-washing step before flux declines very far. Use low to moderate transmembrane pressures < 1 barg (< 15 psig) Process Temperature: room temperature to 37 °C (98.6 °F) works best, but only if process components are stable in higher temperatures; otherwise 4-12 °C (39-53.6 °F) works well, but with lower flux</p>
<p>Typical cartridge models (See pages 34, 40 and 63 for complete list of model numbers)</p>	<p>Labscale: UFP-500-E-4MA (Autoclavable) Pilot Scale: UFP-500-E-9A (Autoclavable) Process Scale: UFP-500-E-65MSM (Steam-in-place, requires stainless steel housing)</p>

Membrane cartridge preparation and maintenance

Refer to our Operating Guide for recommendations on standard protocols and further information on cartridge preparation, cleaning, sterilization, storage and validation procedures.

Table 3. Selection guidelines for upstream cell harvest

Hollow fiber membrane cross flow filtration is widely employed for cell concentration, which is typically the “dewatering” of bacterial or mammalian cell culture. This process is usually considered a straightforward concentration of particulates, but often includes a cell-washing step to remove media components prior to the succeeding steps, such as homogenization (microfluidization). This process is best performed with “tight pore size” microfiltration membranes, or “open pore size” ultrafiltration membranes. Historically the most popular membrane for harvesting *E.coli* has been our 500,000 NMWC ultrafiltration membrane. Although this may seem counter-intuitive, the flow rate curves in Figure 2 may help to illustrate why the largest pore size is often not the best choice for a cell-harvesting process.

With all particulated feed streams, larger lumen diameter fibers (0.75 to 1.0 mm ID) are the most suitable. Generally, this is at least partly due to the particulated, viscous nature of the starting material. In addition, upstream cell-harvest processes may also involve sticky, fouling components, such as lipopolysaccharides in the case of *E. coli*.

Permeate flow rates are often uncontrolled and can be fairly high for mammalian cell-culture processes—sometimes ranging 80-120 l/mh for low cell density starting volumes,—but may be lower for higher-density processes such as *E.coli*, bacterin or lysate concentration.

The level of solids loading in the starting material helps determine flow path length, with shorter flow path length cartridges often suggested. A cartridge length of 30 cm or 60 cm is preferred over 110 cm path length cartridges, because the longer cartridges will exhibit higher inlet pressure. This higher pressure differential arises from increased dynamic friction at required recirculation flow rates in the longer cartridges. Pump capacity can be used to its maximum during particulate concentration by arraying multiple cartridges (2 to 4) in series for pilot scale and large scale processes, provided that each permeate stream is separately metered out (see discussion of permeate flow control on page 11).

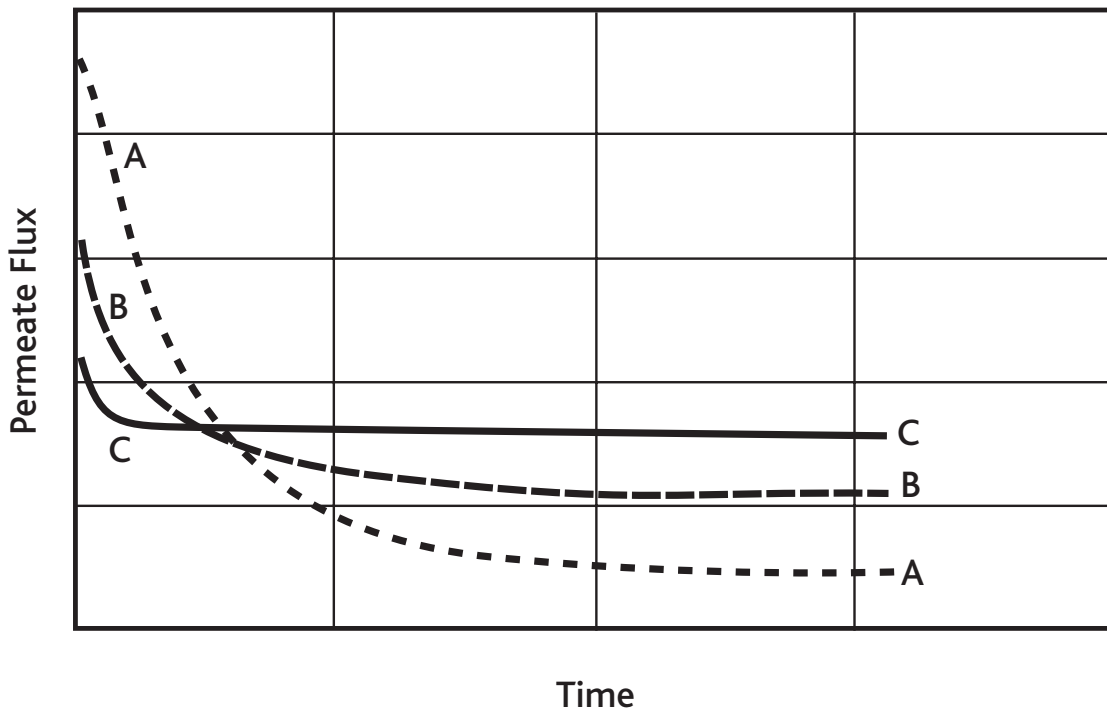


Figure 2. Flux in relation to pore size. Membrane A pore size > membrane B pore size > membrane C pore size.

Upstream clarification of target material

(expressed protein, carbohydrate, virus, etc.)
from a particulated starting material such as cells or lysate.

Examples:

Separation of monoclonal antibody from hybridoma cell culture.

Purification of adenovirus from 293 cell culture.

Clarification of plasmid from bacterial alkaline lysate.

Selection guidelines

Membrane selection (Suggested pore sizes)

Select the smallest pore size that still allows efficient passage of the target molecule (in general, 10X larger opening than the target protein). For most mammalian cell culture clarification, 0.2 to 0.8 μm pore sizes are used.

Flow path selection (Cartridge housing designs are listed on page 23. Cartridge lengths can be found in Chapter 2, Table 7, "Nominal dimensions of Amersham Biosciences hollow fiber cartridges" on page 21)

Short path length cartridges (nominally 30-60 cm)
Larger lumen diameter fibers (0.75 to 1.0 mm)
(Consult Amersham Biosciences Technical Support for other cartridge design choices when working with extremely viscous starting feed streams.)

Process sequence and operating conditions (See Operating Guide for additional details)

Recirculation flow rate: 8,000 sec^{-1} to 16,000 sec^{-1} shear rate for fouling feed streams, 2,000 sec^{-1} to 4,000 sec^{-1} for shear-sensitive feed streams
Process Sequence: flux (and protein passage) dependent on concentration of particulates. To get best protein passage, position cell-washing step after partial concentration, but before flux declines. Use of Permeate Flow Control is strongly recommended (see details on this technique below) Low transmembrane pressure (<0.7 barg [10 psig]) is usually very important for best protein passage to prevent blinding of membrane by particulates.
Process Temperature: Room temperature works best, but only if process components are stable at this temperature; otherwise 4-12 $^{\circ}\text{C}$ (39-53.6 $^{\circ}\text{F}$) works well, but with lower flux.

Typical cartridge models (See pages 35, 41 and 64 for complete list of model numbers)

Labscale: CFP-2-E-4MA (Autoclavable)
Pilot Scale: CFP-6-D-6A (Autoclavable)
Process Scale: CFP-4-E-65MSM (Steam-in-place, requires stainless steel housing)

Membrane cartridge preparation and maintenance

Refer to our Operating Guide for recommendations on standard protocols and further information on cartridge preparation, cleaning, sterilization, storage and validation procedures.

Table 4. Selection guidelines for a particulated starting material

Clarification of particulated starting material demands larger lumen diameter fibers (0.75 to 1.0 mm ID). Unlike cell harvesting, or any other simple particulate concentration, clarification of a target molecule from a solution containing particulates requires more attention to process equilibrium. Since protein passage is of paramount concern in clarification processes, open pore size microfiltration membranes, such as 0.2 to 0.8 μm pore size, are typically recommended, especially for larger recombinant proteins and monoclonal antibodies. In general, choose a membrane pore size that is at least 10X larger than the target material to pass through the membrane. Operators must exert more deliberate control of transmembrane pressure and more careful timing of concentration and cell washing to promote protein passage. Even though retentate backpressure is almost certainly reduced or even absent, further steps can also be taken to reduce transmembrane pressure to prevent premature fouling of the membrane. Experience has shown that permeate flow control (Figure 3) can be useful in further reducing inlet transmembrane pressure due to feed pump velocity. This practice is shown in the following diagram:

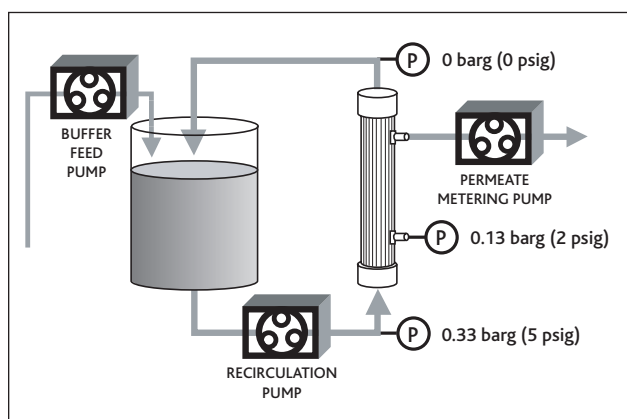


Figure 3. Permeate flow control

The amount of reduction in the permeate flow compared to unregulated permeate flow is dependent on the nature of the starting feed stream. Lower flow rates are recommended if the target molecule is very large, if the particulates are variable in size or if the particulates are very sticky and fouling (Figure 4). A typical monoclonal antibody clarification from hybridoma cell culture with intact cells may be controlled at approximately 30 to 50 l/mh, whereas clarification of enzyme from bacterial lysate is almost always at approximately 10 l/mh.

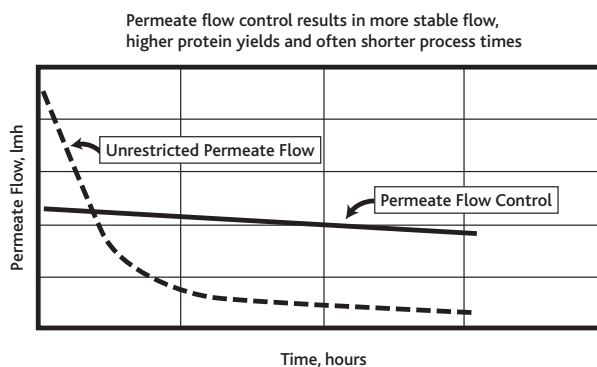


Figure 4. Reducing inlet transmembrane pressure minimizes blinding of open membranes

In clarification tasks, the presence of upstream particulates demands use of shorter path length (30-60 cm) cartridges. Pilot scale and large scale processes often employ multiple 30 cm path length cartridges in series with individually controlled permeate streams to manage frictional pressure drop and reduce inlet transmembrane pressures. Contact Amersham Biosciences Membrane Separations technical support staff for more details on clarification system design when scaling up.

To promote maximum protein passage, good clarification process design is required (for example, partial concentration followed by brief diafiltration). Particulates can interfere with passage of protein as they become more concentrated. Proper timing of the diafiltration step is therefore essential. It is better to perform a brief diafiltration at a point where protein is still passing freely—that is, not being retained by a secondary rejection layer (gel polarization layer) composed of concentrated particulates.

Downstream protein purification by ultrafiltration concentration and diafiltration

Examples:

Concentration and buffer exchange of adenovirus for gene therapy applications.

Concentration of plasmids or oligonucleotides from chromatography column eluates.

The most widely used applications for cross flow ultrafiltration membranes are downstream: concentration and diafiltration of the previously clarified biomolecule as it is loaded onto and eluted from the chromatography columns. These applications are relatively easy separations to perform due to the purity of the starting materials. Although ultrafiltration cassette products are the dominant design in this type of processing, many users have found favor with the hollow fiber design due to their ease of use as well as the option for Steam-in-place sterilization. Users processing materials that are particularly shear-sensitive will also appreciate the gentle flow path in the hollow fiber design, resulting in increased yields.

Selection guidelines

Membrane selection (Suggested pore sizes)

Select the largest pore size that retains the target molecule (in general, choose a membrane 3-5X smaller than the target protein). For example, either 30,000 or 50,000 NMWC ultrafiltration membranes are recommended for mAb concentration and diafiltration.

Flow path selection (Cartridge housing designs are listed on page 23. Cartridge lengths can be found in Chapter 2, Table 7, "Nominal dimensions of Amersham Biosciences hollow fiber cartridges" on page 21)

Short path length cartridges (nominally 30-60 cm)
Larger lumen diameter fibers (0.75 to 1.0 mm)
(Consult Amersham Biosciences Technical Support for other cartridge design choices when working with extremely viscous starting feed streams.)

Process sequence and operating conditions (See Operating Guide for additional details)

Recirculation flow rate: 8,000 sec⁻¹ to 16,000 sec⁻¹ shear rate for fouling feed streams, 2,000 sec⁻¹ to 4,000 sec⁻¹ for shear-sensitive feed streams.
Process Sequence: Flux increase is linear with increasing pressure up to the inflection point. To get best flux vs. time profile, position a diafiltration step after partial concentration, but before flux declines to the point that diafiltration efficiency is affected (TMPs of 1-3 barg [15 to 45 psig] are often used, see details below). Typically, a more open pore size (>30,000 NMWC) membrane offers a flux greater than or equal to 30 l/mh, whereas a tighter pore size (3,000 to 10,000 NMWC) membrane flux is usually ~5-15 l/mh.
Use these estimates to size your cartridge by surface area, permeate volumes generated and process time objective.
Process Temperature: Room temperature works best, but only if process components are stable at this temperature; otherwise 4-12 °C (39-53.6 °F) works well, but with lower flux.

Typical cartridge models (See page 28 for complete list of model numbers)

Labscale: UFP-10-C-4X2MA (Autoclavable)
Pilot Scale: UFP-5-C-9A (Autoclavable)
Process Scale: UFP-30-C-85MSM (Steam-in-place, requires stainless steel housing)

Membrane cartridge preparation and maintenance

Refer to our Operating Guide for recommendations on standard protocols and further information on cartridge preparation, cleaning, sterilization, storage and validation procedures.

Table 5. Selection guidelines for purification and concentration

In general, choose a membrane that is 3-5X smaller in NMWC rating than the molecular weight of the target protein. For example, either 30,000 or 50,000 NMWC ultrafiltration membranes are recommended for concentration and diafiltration of monoclonal antibody solutions such as column chromatography eluates. Always retain the permeate in sequential aliquots for analysis of the target protein, an analysis that can give valuable insight and perhaps suggest process modifications. For example, if you determine that there is target protein in the permeate, but you observe it decreasing from one aliquot to the next, the decreasing yield may be due to a secondary rejection layer caused by components in your starting material forming a gel polarization layer that inhibits subsequent passage of your target molecule, acting as a secondary filtration layer. Gaining this knowledge, you may elect to temporarily redirect your permeate stream back to the recirculation reservoir to refilter it and retain more target protein. Alternately you may also decide to go to the next smaller pore size (NMWC) offered in Amersham Biosciences wide selection of ultrafiltration membranes.

Protein concentration and diafiltration processing is usually suited to smaller lumen diameter fibers, such as 0.5 mm ID fibers (0.25 mm ID fibers are available, but limited to 10,000 NMWC rating only). This is feasible because protein solutions being processed are typically well-clarified. There are exceptions, as, for example, if your protein solution is very viscous or contains some high-viscosity component such as glycerol or sucrose, or if either condition is accompanied by cold-room processing (e.g., 4 °C / 39 °F). For these cases, choose a 1.0 mm ID fiber to avoid rapidly increasing inlet pressures as your solution reaches final concentrations.

Longer path length cartridges and higher transmembrane pressures benefit clarified downstream processing. Amersham Biosciences ultrafiltration membranes are rated for up to 5 barg (75 psig) inlet pressures in some applications—for example, cold room processing at 4 °C (39 °F). Most protein purification processes use feed pressures up to 2 barg (30 psig) and transmembrane pressure of about 1.4 barg (20 psig). Unlike water flux, process permeate flux is linear with pressure, up to the inflection point, as shown in Figure 5.

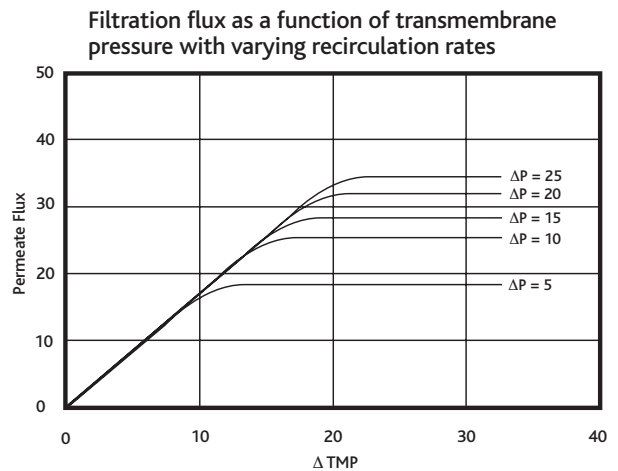


Figure 5. Flux as a function of transmembrane pressure

Diafiltration efficiency is a function of flux and number of volumes of buffer exchanged in the recirculating protein solution. If the protein solution becomes too concentrated prior to diafiltration, effectiveness of diafiltration is decreased.

The best method for diafiltration is constant-volume, continuous diafiltration, in contrast to discontinuous diafiltration, where the protein solution is subjected to multiple iterations of concentration and redilution. Discontinuous diafiltration is less efficient because of the extra volume of buffer exchange required and disequilibrium created by the constantly changing concentration. Figures 6 and 7 illustrate the relationship between number of wash volumes and percent removal of low molecular weight contaminants, and the equipment set-up.

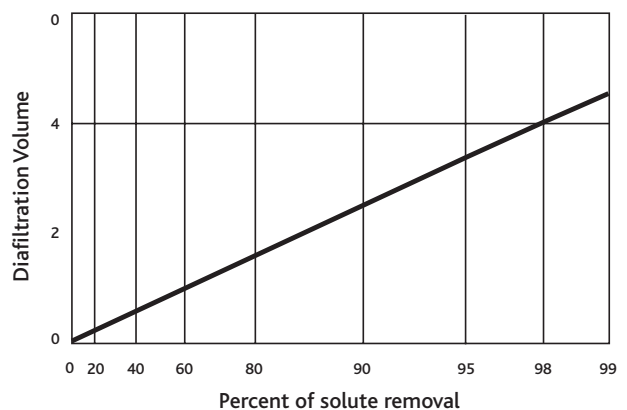


Figure 6. Relationship between diafiltration volume and solute removal

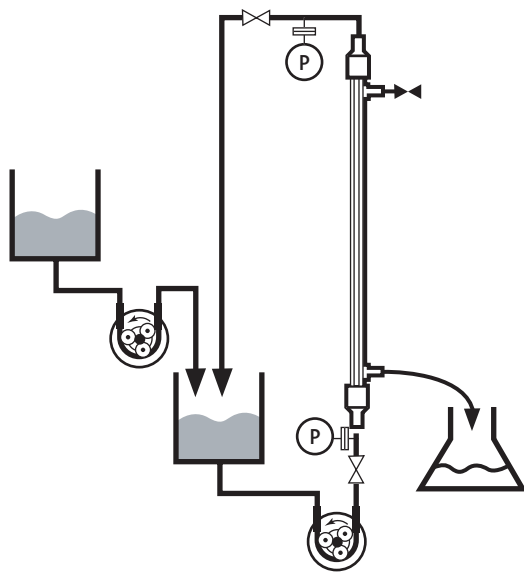


Figure 7. Continuous diafiltration diagram

Cartridge selection illustrated with process examples

When you consider any membrane separation task, always ask these three questions:

1. What is the starting volume? (number of milliliters or liters of cell culture, etc., that you have to process)
2. What is the process description? (concentration factor and volume of diafiltration buffer exchange compared to retentate volume)
3. What is the target process time? (dependent on scale: Laboratory [0-10 liters]: typically 1-2 hours; pilot/process: typically 2-8 hours or more)

Process example:

Monoclonal Antibody Clarification and Concentration, from four liters of hybridoma cell culture.

This is actually two process tasks, each with a separate process description:

Step A. The removal of cells and cell debris from the antibody expressed in the culture supernatant

Parameter	Value
Starting volume	4 liters of cells plus mAb's
Process description	5X concentration, followed by 3X diafiltration
Process time	labscale, 1-2 hours

Referring to the Selection guidelines in Table 3:

Membrane selection:

A 0.2 or 0.45 μm microfiltration membrane is required to provide maximum passage of the antibody.

Flow path selection:

Because of the particulated feed stream, 1.0 mm ID fibers and a fiber length of 30 or 60 cm are recommended.

Process sequence and operating conditions:

To prevent pore plugging of this open pore size membrane, permeate flow control is employed at a rate of 50 l/mh (flow controlled at 50 liters per m^2 of membrane surface area per hour). The process parameters indicate that the permeate volume generated will be 5.6 liters (5X concentration of 4 liters = 3.2 liters, plus 3X diafiltration of the 0.8-liter retentate = 2.4 liters). Therefore, to complete this task in 1-2 hours at a constant flow rate of 50 l/mh, a membrane surface area between 560 and 1,120 cm^2 is suggested.

Step B. The concentration and diafiltration of antibody clarified from Step A.

Parameter	Value
Starting volume	5.6 liters of clarified mAb's culture supernatant
Process description	20X concentration, followed by 5X diafiltration
Process time	lab-scale, 1-2 hours

Referring to the Selection guidelines in Table 5:

Membrane selection

A 30,000 or 50,000 NMWC ultrafiltration membrane is selected for retention of antibody (a rating 3-5X smaller than the 150 kD antibody).

Flow path selection

Now that the feed stream has been clarified, 0.5 mm ID fibers and a fiber length of 60 cm are recommended.

Process sequence and operating conditions

Typically, more open ultrafiltration hollow fiber membranes (such as 30,000 NMWC) offer a protein concentration process flux of approximately 30 l/mh. From the process description, the permeate volume generated will be 6.72 liters (20X concentration of 5.6 liters of permeate from Step A = 5.32 liters, plus 5X diafiltration of the 280 ml retentate = 1.4 liters). Therefore, to complete this task in 1-2 hours at an average flux of 30 l/mh, a membrane surface area between 1,120 and 2,240 cm² is suggested.

Cartridge selection

For more information on how to interpret cartridge model number designations, see page 17.

Cartridge	Membrane area	Processing time
Step A CFP-2-E-5A or CFP-4-E-5A	1,200 cm ²	56 minutes
Step B UFP-30-C-6A	4,800 cm ²	28 minutes
Total process time		1 hour 24 minutes

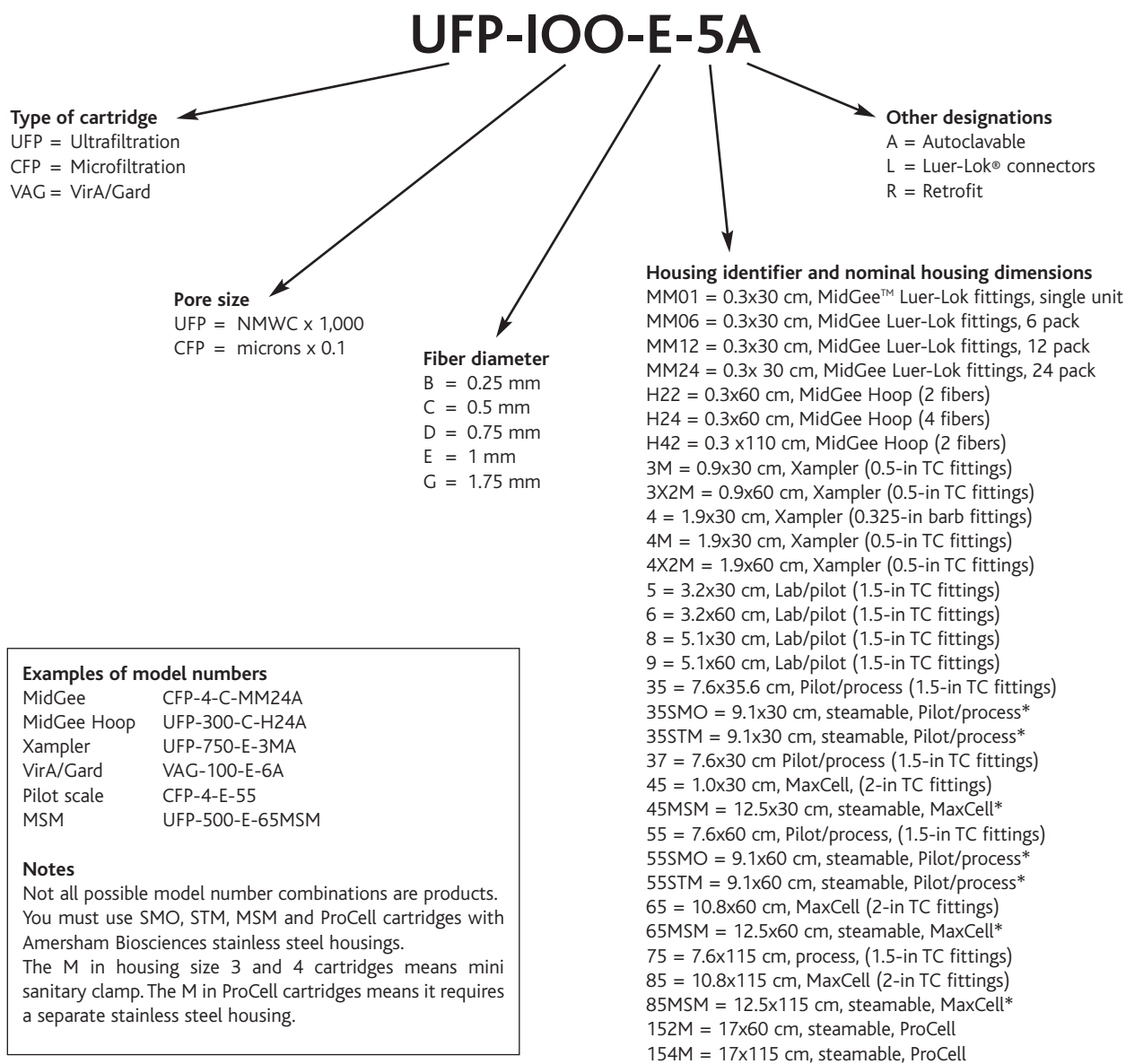
How do you identify and order the right cartridge?

Amersham Biosciences cartridges are provided in a range of housing sizes that enables users to choose the right separations technology for a given application (see Table 6).

MidGee & MidGee Hoop cartridges			Lab and pilot scale cartridges				Pilot and process scale cartridges			
Housing identifier	Lumen ID (mm)	Membrane area (cm ²)	Housing identifier	Lumen ID (mm)	Membrane area		Housing identifier	Lumen ID (mm)	Membrane area	
					m ²	ft ²			m ²	ft ²
MM	0.25	25	3M	0.25	0.037	0.40	35	0.25	2.7	29
	0.5	26		0.5	0.014	0.15		0.5	1.35	14.5
	0.75	24		0.75	0.012	0.13		0.75	1	10.8
	1	16		1	0.011	0.12		1	0.92	9.9
H22	0.75	29	3X2M	0.5	0.029	0.31	35SMO 35STM	1	0.92	9.9
	1	38		1	0.023	0.24				
H24	0.5	42	4, 4M	0.25	0.120	1.29	37	1	0.95	10.2
H42	0.5	41		0.5	0.065	0.70	45	0.5	3.5	37
				0.75	0.046	0.50		0.75	2.65	28.5
	1	73	1	0.042	0.45	1	2.5	27		
			4X2M	0.5	0.14	1.5	45MSM	1	2.3	25
				0.75	0.095	1.02				
			5	0.25	0.375	4	55	0.5	3.25	35
				0.5	0.20	2.1		0.75	2.5	27
				0.75	0.16	1.7		1	2.1	23
				1	0.12	1.3		1.75	1.8	19.4
			6	0.5	0.48	5.2	55SMO	1	2.1	23
				0.75	0.37	4				
				1	0.28	3	55STM	0.5	3.25	35
				1.75	0.23	2.5		0.75	2.5	27
			8	0.25	0.9	9.7	55R	1	2.1	23
				0.5	0.53	5.7		0.5	3.25	35
				0.75	0.41	4.4		1	2.1	23
				1	0.36	3.9				
			9	0.5	1.15	12.5	65	0.5	6.1	66
				0.75	0.93	10		1	4.4	47
				1	0.84	9		1.75	3.5	38
				1.75	0.59	6.3				
						65MSM	0.5	5.6	60	
						1	4.2	45		
						75	0.5	6	65	
						75R	1	3.7	40	
						85	0.5	13	140	
							1	9	97	
						85MSM	1	9	95	
						152M	1	9.5	102	
						154M	0.5	28	300	
							1	19	205	

Table 6. Nominal cartridge specifications

To identify and order the proper hollow fiber cartridge, you must understand the model numbering convention. Each group of numbers or letters in the model number represents information about the cartridge. A complete description of the model number convention is presented in Figure 8.



*Requires stainless steel housing

NOTE: Fittings indicated above are for feed/retentate connections only

Figure 8. Key to cartridge model number conventions

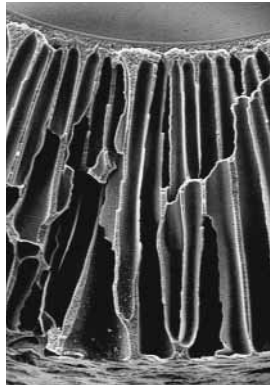
Unique macrovoid-free structure of Amersham Biosciences hollow fiber membranes

Most traditional ultrafiltration membranes—whether flat sheet, hollow fiber, spiral, or tubular—contain large macrovoids in their substructure (Figure 9). Macrovoids are undesirable because:

- They provide weaker support for the separating barrier “skin,” resulting in lower intrinsic strength and increased compaction under pressure.
- They sporadically propagate through the skin during manufacture or over time under process conditions. This can cause “pinhole” imperfections that may reduce product recovery or pass undesirable components.
- They may contribute to pore collapse at elevated temperatures reducing permeate flux and altering rejection characteristics.

All Amersham Biosciences UF membranes have 100% integral, macrovoid-free structures resulting in these advantages:

- Higher membrane strength
- Stable, steady performance over the cartridge lifetime
- Absolute bacteria retention to maintain sterility
- High temperature stability



Conventional ultrafiltration membrane



Amersham Biosciences ultrafiltration membrane

Figure 9. Scanning electron micrographs showing membrane with macrovoids (left) and without macrovoids (right)

Quality assurance and documentation

Quality assurance

All Amersham Biosciences membrane products are subjected to stringent quality control standards to assure the utmost product integrity and consistency. Every hollow fiber membrane cartridge is quality control tested prior to shipment. QC tests include pore size determination and integrity of the membrane, as well as integrity of the complete cartridge assembly.

For ultrafiltration products, each lot of membrane is checked for rejection of one or more standard markers and clean water flux measurements are taken. Finished cartridges are pressure tested for integrity. Water flux and air diffusion measurements are recorded on a representative lot basis. Amersham Biosciences air diffusion standards are approximately three times more stringent than any other manufacturer in the industry.

Each microfiltration cartridge* is bubble point tested (Figure 10) for pore size determination, and clean water flux measurements are taken on a representative sample of cartridges.

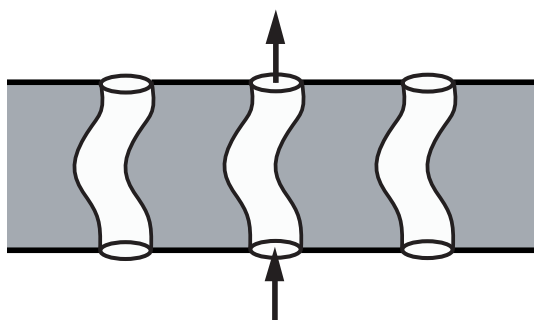


Figure 10. Microfiltration cartridge pores

All Amersham Biosciences hollow fiber cartridges are pressure stressed prior to shipment. Ultrafiltration cartridges are stressed to pressures higher than normal operation pressure.* Microfiltration membranes are stressed to their bubble point.

The combination of clean water flux data, chemical marker rejection data and air diffusion test data clearly define both the separation rating of ultrafiltration membranes and the integrity of the membrane cartridge. Clean water flux and bubble point measurements define microfiltration membrane pore size.

Documentation

Cartridge documentation includes a complete retrieval system conforming to basic United States Food & Drug Administration Good Manufacturing procedures (USFDA GMP). The unique serial number on each cartridge permits tracking of raw materials and QC performance data. A certificate of conformance is packaged with each membrane cartridge.*

All Amersham Biosciences polysulfone ultrafiltration and microfiltration membrane cartridges* are constructed of the same materials, for consistency of performance across our entire product line. All materials of construction* have been tested for biological safety in accordance with USP XXIV Test for Plastics Class IV guidelines and have been shown to be non-toxic.

Where to find more information

Amersham Biosciences provides both a Validation Information Booklet and an Integrity Test Procedure Guide to assist customers with initial validation and continuous quality assurance of our products. In addition, our Hollow Fiber Membrane Cartridge User Guide provides a comprehensive description of performance characteristics and operating parameters of the cartridges detailed in this selection guide.

**Excluding our line of disposable MidGee and MidGee Hoop cross flow membrane cartridges.*

Physical dimensions of cartridges

Introduction

Almost all of Amersham Biosciences hollow fiber membrane cartridges are self-contained in translucent polysulfone housings. The exceptions are Steam-in-place (SIP) products, as well as our high-capacity ProCell modules. Three alternative SIP product types slip into matching stainless steel housings for safety during the steaming process. ProCell modules use stainless steel housings for support and to permit *in-situ* high-temperature water sanitization.

The self-contained design permits factory QC of the entire membrane assembly as well as simple and reliable integrity confirmation on-site. The integral housing design minimizes operator contact with process and cleaning solutions and allows for simple, quick membrane replacement or addition.

Throughout the wide range of membrane surface areas offered, the cartridge flow path lengths have been standardized to be a nominal 30, 60 and 110 cm. This permits scale-up from research through production scale cartridges without a change in device configuration.

Dimensions, end fitting connections and permeate port connections for each cartridge model are listed in Table 7. Similar data for stainless steel housings are provided in Table 8.

Please note that MaxCell cartridges (sizes 45, 65 and 85) require an adaptor kit when first purchased. Both straight (KAMX-16PS) and elbow (KAMX-16PS-EL) kits are offered to provide feed and retentate ports with 2-in sanitary end fittings.



Expert advice

CAUTION: Do not hard pipe permeate ports on self-contained polysulfone cartridges or hang heavy parts on the plastic ports. Use flexible tubing to connect to a manifold where heavy fittings and valves can be properly supported.

Housing identifier	Diameter		Length ^{1,2}		End fitting connections	Permeate connections
	cm	inches	cm	inches		
MidGee	0.3	0.125	30.8	12.12	Luer-Lok (male)	Luer-Lok (male)
MidGee Hoop	0.3	0.125	—	—	Luer-Lok (male)	Luer-Lok (male)
3M [Xampler]	0.9	0.375	31.7	12.5	0.5-in Tri-Clamp	0.25-in tubing nipple
3X2M [Xampler]	0.9	0.375	63.5	25	0.5-in Tri-Clamp	0.25-in tubing nipple
4 [Xampler]	1.9	0.75	36.2	14.25	0.375-in tubing barb	0.375-in tubing nipple
4M [Xampler]	1.9	0.75	34.5	13.6	0.5-in Tri-Clamp	0.375-in tubing nipple
4X2M [Xampler]	1.9	0.75	66	26	0.5-in Tri-Clamp	0.375-in tubing nipple
5	3.2	1.25	31.8	12.5	1.5-in Tri-Clamp	0.5-in tubing nipple
6	3.2	1.25	63.5	25	1.5-in Tri-Clamp	0.5-in tubing nipple
8	5.1	2	34.9	13.75	1.5-in Tri-Clamp	0.5-in tubing nipple
9	5.1	2	63.5	25	1.5-in Tri-Clamp	0.5-in tubing nipple
35	7.6	3	35.6	14	1.5-in Tri-Clamp	1.5-in Tri-Clamp
35SMO	7.6	3	31.2	12.3	Requires SS housing	Requires SS housing
35STM	7.6	3	40.9	16.12	Requires SS housing	Requires SS housing
37	7.6	3	36.8	14.5	1.5-in Tri-Clamp	1.5-in Tri-Clamp
45 [MaxCell]	10.8	4.25	39.4 ³	15.5 ³	Adaptor to 2-in Tri-Clamp	1.5-in Tri-Clamp
45MSM	10.2	4	39.4	15.5	Requires SS housing	Requires SS housing
55	7.6	3	67.3	26.5	1.5-in Tri-Clamp	1.5-in Tri-Clamp
55R	7.6	3	63.5	25	Retrofit	1.5-in Tri-Clamp
55SMO	7.6	3	63	24.8	Requires SS housing	Requires SS housing
55STM	7.6	3	73	28.75	Requires SS housing	Requires SS housing
65 [MaxCell]	10.8	4.25	62.5 ³	24.6 ³	Adaptor to 2-in Tri-Clamp	1.5-in Tri-Clamp
65MSM	10.2	4	62.5	24.5	Requires SS housing	Requires SS housing
75	7.6	3	113	44.5	1.5-in Tri-Clamp	1.5-in Tri-Clamp
75R	7.6	3	109	43	Retrofit	1.5-in Tri-Clamp
85 [MaxCell]	10.8	4.25	120 ³	47.3 ³	Adaptor to 2-in Tri-Clamp	1.5-in Tri-Clamp
85MSM	10.2	4	120	47.3	Requires SS housing	Requires SS housing
152M [ProCell]	15	5.9	62.5	24.6	Requires SS housing	Requires SS housing
154M [ProCell]	15	5.9	120	47.3	Requires SS housing	Requires SS housing

¹Nominal dimensions, not intended for design purposes.

²Drawings showing all relevant reference dimensions are available on request.

³Add 10.8 cm (4.25 in) to MaxCell length for straight adaptors.

Table 7. Nominal dimensions of Amersham Biosciences hollow fiber cartridges

Housing identifier	Required housing	Diameter		Length		End fitting connections	Permeate connections
		cm	inches	cm	inches		
35SMO	SS-35SMO-DP	9.1	3.6	37.3	14.7	1.5-in Tri-Clamp	1.5-in Tri-Clamp
55SMO	SS-55SMO-DP	9.1	3.6	69.3	27.3	1.5-in Tri-Clamp	1.5-in Tri-Clamp
35STM	SS-35STM	9.1	3.6	43.4	17.1	1.5-in Tri-Clamp	1.5-in Tri-Clamp
55STM	SS-55STM	9.1	3.6	75.2	29.6	1.5-in Tri-Clamp	1.5-in Tri-Clamp
45MSM	SS-45MSM-DP	11.4	4.5	52.8	20.8	1.5-in Tri-Clamp ⁴	1.5-in Tri-Clamp
65MSM	SS-65MSM-DP	11.4	4.5	75.7	29.8	1.5-in Tri-Clamp ⁴	1.5-in Tri-Clamp
85MSM	SS-85MSM-DP	11.4	4.5	134	52.7	1.5-in Tri-Clamp ⁴	1.5-in Tri-Clamp
152M	SS-152TC	16.8	6.6	81.2	32.2	1.5-in Tri-Clamp	1.5-in Tri-Clamp
154M	SS-154TC	16.8	6.6	139	54.8	1.5-in Tri-Clamp	1.5-in Tri-Clamp

⁴Elbow adaptors are also available.

Table 8. Nominal dimensions of stainless steel housings for Amersham Biosciences cartridges

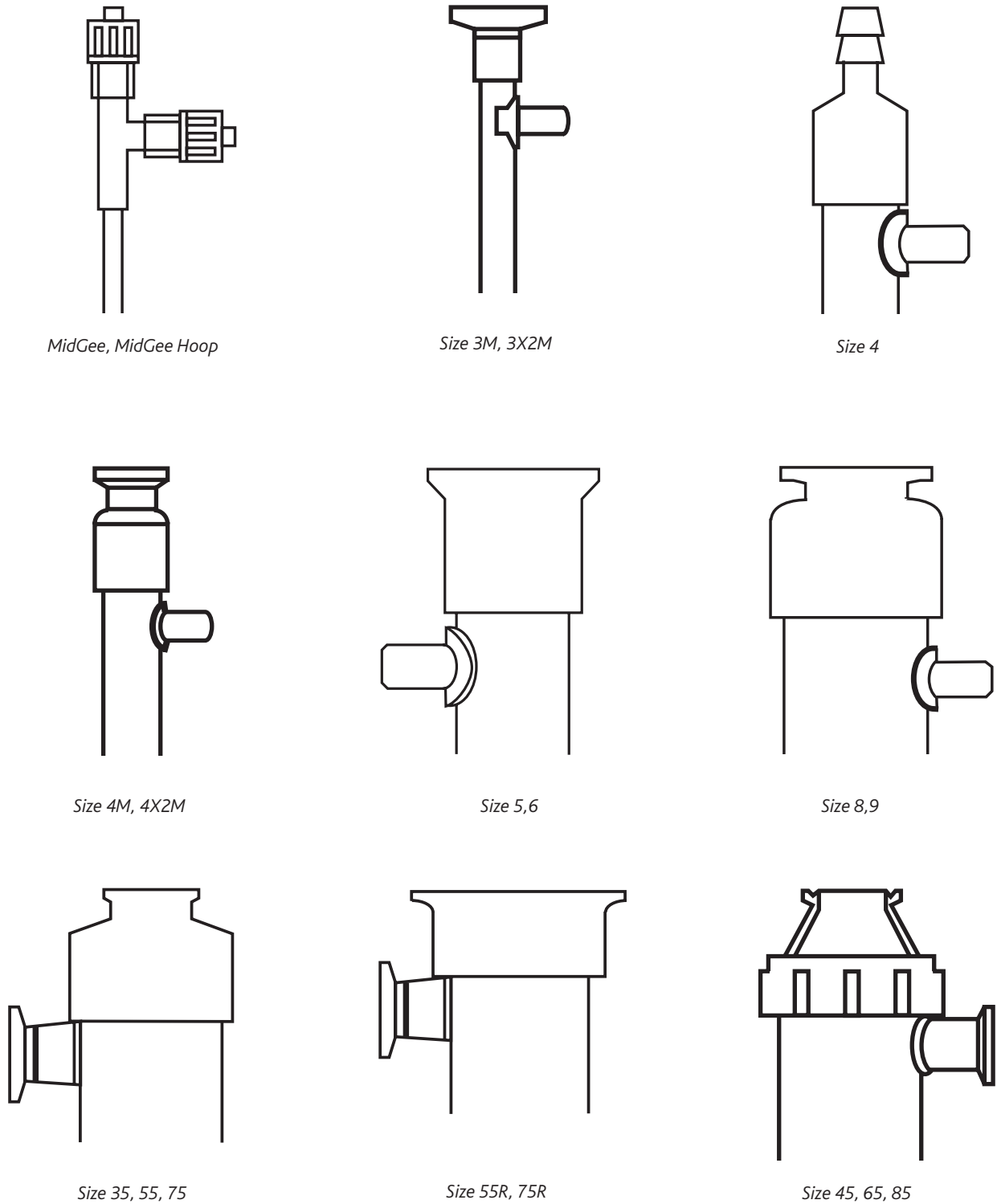


Figure 11. A partial selection of fittings available on Amersham Biosciences hollow fiber membrane cartridges (drawings not to scale)

Research/ lab-scale cartridges

MidGee and MidGee Hoop cross flow membrane filters

Throughout the R&D process, access to product is often limited. As a result, investigations into optimization of operating conditions are sometimes overlooked or even postponed. With MidGee™ and MidGee Hoop™ cartridges, scale-up and scale-down has never been easier. These disposable cartridges have exceptionally low lumen-side and shell-side hold-up volumes, permitting processing of 25 to 200 ml. When combined with our MidJet system, concentration to volumes as small as 2 ml is possible.

MidGee cartridges have a nominal 30 cm path length. Their Hoop counterparts have path lengths of 60 and 110 cm, allowing one to match any of Amersham Biosciences larger cartridge path lengths for direct scale-up to pilot/production scale designs.

Schematic drawings of the MidGee cartridges are provided in Figure 13. The Luer-Lok connections on these units mate with optional pressure transducers for digital readout of inlet/outlet and/or permeate pressures.

MidGee cartridge model numbers are detailed in Table 9 for ultrafiltration membranes and Table 10 for microfiltration membranes. MidGee Hoop models are listed in Tables 11 and 12.

Accessories for the MidGee product line are noted in Table 13.



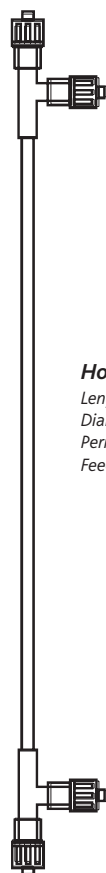
Expert advice

TIP: MidGee and MidGee Hoop filters in combination with our MidJet cross flow filtration system replace stirred cells and dialysis tubing for controllable laboratory separations. One can achieve high product recoveries with minimal shear denaturation.

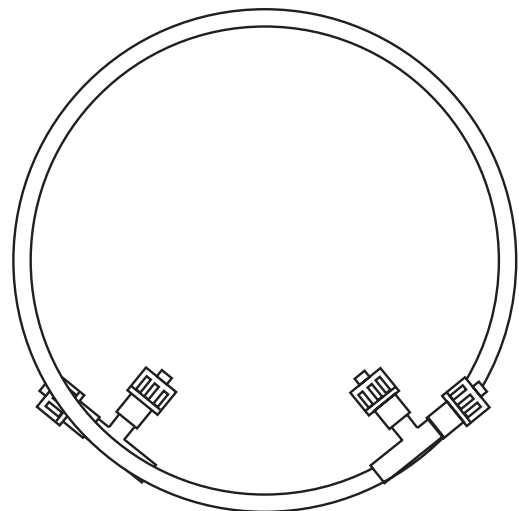


Figure 12. MidGee Hoop and MidGee cartridges

MidGee Hoop and MidGee cartridges are available in 30 cm, 60 cm and 110 cm (110 cm not shown) flow path lengths to permit direct scale-up and scale-down of experimental data.



Housing MM
 Length = 30.8 cm (12.12 in)
 Diameter = 0.3 cm (0.125 in)
 Permeate ports = Male Luer-Lok
 Feed/retentate ports = Male Luer-Lok



Housings H22L, H24L, H42L
 Nominal flow path length (H22L & H24L) = 60 cm (23.6 in)
 (H42L) = 110 cm (43.3 in)
 Diameter = 0.3 cm (0.125 in)
 Hoop diameter = 15.3 cm (6 in)
 Permeate ports = Male Luer-Lok
 Feed/retentate ports = Male Luer-Lok

Figure 13. MidGee and MidGee Hoop cross flow cartridges (drawings not to scale)

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (cm ²)	Nominal flowpath length (cm)
56-4100-01	UFP-1-C-MM06	1,000	0.5	26	30
56-4100-02	UFP-1-C-MM12	1,000	0.5	26	30
56-4100-03	UFP-1-C-MM24	1,000	0.5	26	30
56-4100-05	UFP-3-C-MM06A	3,000	0.5	26	30
56-4100-06	UFP-3-C-MM12A	3,000	0.5	26	30
56-4100-07	UFP-3-C-MM24A	3,000	0.5	26	30
56-4100-09	UFP-10-B-MM06A	10,000	0.25	25	30
56-4100-10	UFP-10-B-MM12A	10,000	0.25	25	30
56-4100-11	UFP-10-B-MM24A	10,000	0.25	25	30
56-4100-13	UFP-10-C-MM06A	10,000	0.5	26	30
56-4100-14	UFP-10-C-MM12A	10,000	0.5	26	30
56-4100-15	UFP-10-C-MM24A	10,000	0.5	26	30
56-4100-17	UFP-10-E-MM06A	10,000	1	16	30
56-4100-18	UFP-10-E-MM12A	10,000	1	16	30
56-4100-19	UFP-10-E-MM24A	10,000	1	16	30
56-4100-21	UFP-30-C-MM06A	30,000	0.5	26	30
56-4100-22	UFP-30-C-MM12A	30,000	0.5	26	30
56-4100-23	UFP-30-C-MM24A	30,000	0.5	26	30
56-4100-25	UFP-30-E-MM06A	30,000	1	16	30
56-4100-26	UFP-30-E-MM12A	30,000	1	16	30
56-4100-27	UFP-30-E-MM24A	30,000	1	16	30
56-4100-29	UFP-50-C-MM06A	50,000	0.5	26	30
56-4100-30	UFP-50-C-MM12A	50,000	0.5	26	30
56-4100-31	UFP-50-C-MM24A	50,000	0.5	26	30
56-4100-33	UFP-50-E-MM06A	50,000	1	16	30
56-4100-34	UFP-50-E-MM12A	50,000	1	16	30
56-4100-35	UFP-50-E-MM24A	50,000	1	16	30
56-4100-37	UFP-100-C-MM06A	100,000	0.5	26	30
56-4100-38	UFP-100-C-MM12A	100,000	0.5	26	30
56-4100-39	UFP-100-C-MM24A	100,000	0.5	26	30
56-4100-41	UFP-100-E-MM06A	100,000	1	16	30
56-4100-42	UFP-100-E-MM12A	100,000	1	16	30
56-4100-43	UFP-100-E-MM24A	100,000	1	16	30
56-4100-45	UFP-300-C-MM06A	300,000	0.5	26	30
56-4100-46	UFP-300-C-MM12A	300,000	0.5	26	30
56-4100-47	UFP-300-C-MM24A	300,000	0.5	26	30
56-4100-49	UFP-300-E-MM06A	300,000	1	16	30
56-4100-50	UFP-300-E-MM12A	300,000	1	16	30
56-4100-51	UFP-300-E-MM24A	300,000	1	16	30
56-4100-53	UFP-500-C-MM06A	500,000	0.5	26	30
56-4100-54	UFP-500-C-MM12A	500,000	0.5	26	30
56-4100-55	UFP-500-C-MM24A	500,000	0.5	26	30
56-4100-57	UFP-500-E-MM06A	500,000	1	16	30
56-4100-58	UFP-500-E-MM12A	500,000	1	16	30
56-4100-59	UFP-500-E-MM24A	500,000	1	16	30

Table 9. Model numbers and specifications for MidGee ultrafiltration cartridges

Code number	Model number	Pore size (µm)	Fiber ID (mm)	Membrane area (cm ²)	Nominal flowpath length (cm)
56-4100-65	CFP-1-E-MM06A	0.1	1	16	30
56-4100-66	CFP-1-E-MM12A	0.1	1	16	30
56-4100-67	CFP-1-E-MM24A	0.1	1	16	30
56-4100-73	CFP-2-E-MM06A	0.2	1	16	30
56-4100-74	CFP-2-E-MM12A	0.2	1	16	30
56-4100-75	CFP-2-E-MM24A	0.2	1	16	30
56-4100-81	CFP-4-E-MM06A	0.45	1	16	30
56-4100-82	CFP-4-E-MM12A	0.45	1	16	30
56-4100-83	CFP-4-E-MM24A	0.45	1	16	30
56-4100-85	CFP-6-D-MM06A	0.65	0.75	24	30
56-4100-86	CFP-6-D-MM12A	0.65	0.75	24	30
56-4100-87	CFP-6-D-MM24A	0.65	0.75	24	30

Table 10. Model numbers and specifications for MidGee microfiltration cartridges



Figure 14. An advanced MidJet system with pressure display shown with optional autoclavable feed, diafiltrate and permeate reservoirs.



Expert advice

TIP: Single MidGee cartridges are available for trial orders. Substitute "-MM01A" for "-MM06A" in any part number listing. For example, to order one CFP-1-E-MM06A cartridge, specify CFP-1-E-MM01A.

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (cm ²)	Nominal flowpath length (cm)
56-4100-88	UFP-3-E-H22LA	3,000	1	38	60
56-4100-89	UFP-10-E-H22LA	10,000	1	38	60
56-4100-90	UFP-30-E-H22LA	30,000	1	38	60
56-4100-91	UFP-50-E-H22LA	50,000	1	38	60
56-4100-92	UFP-100-E-H22LA	100,000	1	38	60
56-4100-93	UFP-300-E-H22LA	300,000	1	38	60
56-4100-94	UFP-500-E-H22LA	500,000	1	38	60
56-4100-95	UFP-750-E-H22LA	750,000	1	38	60
56-4101-00	UFP-3-C-H24LA	3,000	0.5	42	60
56-4101-01	UFP-10-C-H24LA	10,000	0.5	42	60
56-4101-02	UFP-30-C-H24LA	30,000	0.5	42	60
56-4101-03	UFP-100-C-H24LA	100,000	0.5	42	60
56-4101-04	UFP-300-C-H24LA	300,000	0.5	42	60
56-4101-05	UFP-500-C-H24LA	500,000	0.5	42	60
56-4101-06	UFP-3-C-H42LA	3,000	0.5	41	110
56-4101-07	UFP-3-E-H42LA	3,000	1	73	110
56-4101-08	UFP-10-C-H42LA	10,000	0.5	41	110
56-4101-09	UFP-10-E-H42LA	10,000	1	73	110
56-4101-10	UFP-30-C-H42LA	30,000	0.5	41	110
56-4101-11	UFP-30-E-H42LA	30,000	1	73	110
56-4101-12	UFP-50-E-H42LA	50,000	1	73	110
56-4101-13	UFP-100-C-H42LA	100,000	0.5	41	110
56-4101-14	UFP-100-E-H42LA	100,000	1	73	110
56-4101-15	UFP-300-C-H42LA	300,000	0.5	41	110
56-4101-16	UFP-300-E-H42LA	300,000	1	73	110
56-4101-17	UFP-500-C-H42LA	500,000	0.5	41	110
56-4101-18	UFP-500-E-H42LA	500,000	1	73	110
56-4101-19	UFP-750-E-H42LA	750,000	1	73	110

Table 11. Model numbers and specifications for MidGee Hoop ultrafiltration cartridges

Code number	Model number	Pore size (µm)	Fiber ID (mm)	Membrane area (cm ²)	Nominal flowpath length (cm)
56-4100-96	CFP-1-E-H22LA	0.1	1	38	60
56-4100-97	CFP-2-E-H22LA	0.2	1	38	60
56-4100-98	CFP-4-E-H22LA	0.45	1	38	60
56-4100-99	CFP-6-D-H22LA	0.65	0.75	29	60

Table 12. Model numbers and specifications for MidGee Hoop microfiltration cartridges

Code number	Model number	Description
56-4105-75	RBFL-1	Female Luer-Lok to 0.125-in barb, nylon, pkg of 10
56-4105-76	RBFL-2	Female Luer-Lok to 3/32-in barb, nylon, pkg of 10
56-4105-77	RBFL-ML	Female Luer-Lok to male Luer-Lok, nylon, pkg of 10
56-4105-78	RBFL-SC	Female Luer-Lok to solid cap, nylon, pkg of 10
56-4105-88	VT-06	Precision backpressure valve, nylon, size 14 and 16 tubing
56-4106-16	PTSLO2-10	Pump tubing, size 14, silicone, 3.1 m (10 ft)
56-4106-17	PTSLO3-10	Pump tubing, size 16, silicone, 3.1 m (10 ft)

NOTE: For a complete list of MidGee and MidJet system accessories, please refer to Table 53 on page 69.

Table 13. Accessories for MidGee and MidGee Hoop cartridges

All MidGee and MidGee Hoop cartridges are autoclavable except those with 1,000 NMWC ultrafiltration membranes.

Xampler laboratory membrane cartridges

Amersham Biosciences Xampler ultrafiltration and microfiltration cartridges are offered with nominal flowpath lengths of 30 and 60 cm and membrane areas ranging from 0.01 to 0.14 m² (0.12 to 0.15 ft²). These cartridges are ideal for processing volumes from a few hundred mls to about 10 liters of solution.

Xampler cartridges have fully self-contained housings with translucent polysulfone shells and are well-matched to our QuixStand™ benchtop system. When operated in a vertical orientation there is no potential for "dead" or stagnation spots.

Our entire Xampler product line is offered with mini Tri-Clamp end fittings for quick and easy sanitary connection to your lab equipment. These cartridges are identified with an "M" in the suffix of the model number. A select portion of the Xampler line is also offered with barbed end fittings for simple flexible tubing connection. Schematic diagrams showing the alternative cartridge sizes and end fittings are provided in Figure 11.

All of Amersham Biosciences Xampler microfiltration lab-scale cartridges are autoclavable. Moreover, all Xampler ultrafiltration cartridges are autoclavable with the exception of 1,000 NMWC membrane units. An "A" as the model number suffix signifies that the particular cartridge may be autoclaved. Xampler ultrafiltration cartridge specifications and model numbers are listed in Table 16. Xampler microfiltration cartridge details are provided in Table 17.

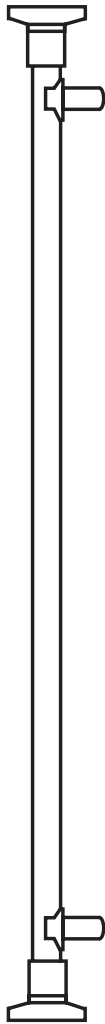


Figure 15. Xampler cartridges



Expert advice

CAUTION: Autoclaving of Amersham Biosciences membrane cartridges is straightforward, but requires adherence to a set of well-established guidelines. These guidelines are presented in detail in our publication, "Hollow Fiber Membrane Cartridge User Guide."

**Housing 3M**

Length = 33.7 cm (13.25 in)
 Diameter = 0.9 cm (0.375 in)
 Permeate ports = 0.25-in tubing nipples
 Feed/retentate ports = 0.5-in Tri-Clamp

Housing 3X2M

Length = 64.7 cm (25.5 in)
 Diameter = 0.9 cm (0.375 in)
 Permeate ports = 0.25-in tubing nipples
 Feed/retentate ports = 0.5-in Tri-Clamp

**Housing 4**

Length = 36.2 cm (14.25 in)
 Diameter = 1.9 cm (0.75 in)
 Permeate ports = 0.375-in tubing nipples
 Feed/retentate ports = 0.375-in tubing barb

**Housing 4M**

Length = 36.7 cm (14.25 in)
 Diameter = 1.9 cm (0.75 in)
 Permeate ports = 0.375-in tubing nipples
 Feed/retentate ports = 0.5-in Tri-Clamp

Housing 4X2M

Length = 66.7 cm (26.3 in)
 Diameter = 1.9 cm (0.75 in)
 Permeate ports = 0.375-in tubing nipples
 Feed/retentate ports = 0.5-in Tri-Clamp

Figure 16. Xampler laboratory scale cartridges (drawings not to scale)

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.25	0.05	0.11	0.23	0.4
0.5	0.06	0.12	0.25	0.5
0.75	0.1	0.2	0.4	0.8
1	0.15	0.3	0.6	1.2

Table 14. Nominal feed stream flow rates (liters/minute) for 3M and 3X2M housings

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.25	0.19	0.38	0.76	1.5
0.5	0.3	0.6	1.2	2.4
0.75	0.4	0.8	1.5	3
1	0.6	1.2	2.5	5

Table 15. Nominal feed stream flow rates (liters/minute) for 4, 4M and 4X2M housings

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² (ft ²))		Nominal flowpath length (cm)
56-4101-20	UFP-1-C-3M	1,000	0.5	0.014	0.15	30
56-4101-21	UFP-1-E-3M	1,000	1	0.011	0.12	30
56-4101-22	UFP-3-C-3MA	3,000	0.5	0.014	0.15	30
56-4101-23	UFP-3-E-3MA	3,000	1	0.011	0.12	30
56-4101-24	UFP-5-C-3MA	5,000	0.5	0.014	0.15	30
56-4101-25	UFP-5-E-3MA	5,000	1	0.011	0.12	30
56-4101-26	UFP-10-B-3MA	10,000	0.25	0.037	0.40	30
56-4101-27	UFP-10-C-3MA	10,000	0.5	0.014	0.15	30
56-4101-28	UFP-10-E-3MA	10,000	1	0.011	0.12	30
56-4101-29	UFP-30-C-3MA	30,000	0.5	0.014	0.15	30
56-4101-30	UFP-30-E-3MA	30,000	1	0.011	0.12	30
56-4101-31	UFP-50-C-3MA	50,000	0.5	0.014	0.15	30
56-4101-32	UFP-50-E-3MA	50,000	1	0.011	0.12	30
56-4101-33	UFP-100-C-3MA	100,000	0.5	0.014	0.15	30
56-4101-34	UFP-100-E-3MA	100,000	1	0.011	0.12	30
56-4101-35	UFP-300-C-3MA	300,000	0.5	0.014	0.15	30
56-4101-36	UFP-300-E-3MA	300,000	1	0.011	0.12	30
56-4101-37	UFP-500-C-3MA	500,000	0.5	0.014	0.15	30
56-4101-38	UFP-500-E-3MA	500,000	1	0.011	0.12	30
56-4101-39	UFP-750-E-3MA	750,000	1	0.011	0.12	30
56-4101-45	UFP-3-C-3X2MA	3,000	0.5	0.029	0.31	60
56-4101-46	UFP-10-C-3X2MA	10,000	0.5	0.029	0.31	60
56-4101-47	UFP-30-C-3X2MA	30,000	0.5	0.029	0.31	60
56-4101-48	UFP-50-C-3X2MA	50,000	0.5	0.029	0.31	60
56-4101-49	UFP-100-C-3X2MA	100,000	0.5	0.029	0.31	60
56-4101-50	UFP-100-E-3X2MA	100,000	1	0.023	0.24	60
56-4101-51	UFP-300-C-3X2MA	300,000	0.5	0.029	0.31	60
56-4101-52	UFP-300-E-3X2MA	300,000	1	0.023	0.24	60
56-4101-53	UFP-500-C-3X2MA	500,000	0.5	0.029	0.31	60
56-4101-54	UFP-500-E-3X2MA	500,000	1	0.023	0.24	60
56-4101-55	UFP-750-E-3X2MA	750,000	1	0.023	0.24	60
56-4101-86	UFP-3-C-4A	3,000	0.5	0.065	0.70	30
56-4101-87	UFP-3-E-4A	3,000	1	0.042	0.45	30
56-4101-88	UFP-5-C-4A	5,000	0.5	0.065	0.70	30
56-4101-89	UFP-5-E-4A	5,000	1	0.042	0.45	30
56-4101-90	UFP-10-B-4A	10,000	0.25	0.120	1.29	30
56-4101-91	UFP-10-C-4A	10,000	0.5	0.065	0.70	30
56-4101-92	UFP-10-E-4A	10,000	1	0.042	0.45	30
56-4101-93	UFP-30-C-4A	30,000	0.5	0.065	0.70	30
56-4101-94	UFP-30-E-4A	30,000	1	0.042	0.45	30

Table 16. Model numbers and specifications for Xampler laboratory scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² (ft ²))		Nominal flowpath length (cm)
56-4101-95	UFP-50-C-4A	50,000	0.5	0.065	0.70	30
56-4101-96	UFP-50-E-4A	50,000	1	0.042	0.45	30
56-4101-97	UFP-100-C-4A	100,000	0.5	0.065	0.70	30
56-4101-98	UFP-100-E-4A	100,000	1	0.042	0.45	30
56-4101-99	UFP-300-C-4A	300,000	0.5	0.065	0.70	30
56-4102-00	UFP-300-E-4A	300,000	1	0.042	0.45	30
56-4102-01	UFP-500-C-4A	500,000	0.5	0.065	0.70	30
56-4102-02	UFP-500-E-4A	500,000	1	0.042	0.45	30
56-4102-03	UFP-750-E-4A	750,000	1	0.042	0.45	30
56-4101-59	UFP-1-C-4M	1,000	0.5	0.065	0.70	30
56-4101-60	UFP-1-E-4M	1,000	1	0.042	0.45	30
56-4101-61	UFP-3-C-4MA	3,000	0.5	0.065	0.70	30
56-4101-62	UFP-3-E-4MA	3,000	1	0.042	0.45	30
56-4101-63	UFP-5-C-4MA	5,000	0.5	0.065	0.70	30
56-4101-64	UFP-5-E-4MA	5,000	1	0.042	0.45	30
56-4101-65	UFP-10-B-4MA	10,000	0.25	0.120	1.29	30
56-4101-66	UFP-10-C-4MA	10,000	0.5	0.065	0.70	30
56-4101-67	UFP-10-E-4MA	10,000	1	0.042	0.45	30
56-4101-68	UFP-30-C-4MA	30,000	0.5	0.065	0.70	30
56-4101-69	UFP-30-E-4MA	30,000	1	0.042	0.45	30
56-4101-70	UFP-50-C-4MA	50,000	0.5	0.065	0.70	30
56-4101-71	UFP-50-E-4MA	50,000	1	0.042	0.45	30
56-4101-72	UFP-100-C-4MA	100,000	0.5	0.065	0.70	30
56-4101-73	UFP-100-E-4MA	100,000	1	0.042	0.45	30
56-4101-74	UFP-300-C-4MA	300,000	0.5	0.065	0.70	30
56-4101-75	UFP-300-E-4MA	300,000	1	0.042	0.45	30
56-4101-76	UFP-500-C-4MA	500,000	0.5	0.065	0.70	30
56-4101-77	UFP-500-E-4MA	500,000	1	0.042	0.45	30
56-4101-78	UFP-750-E-4MA	750,000	1	0.042	0.45	30
56-4102-09	UFP-3-C-4X2MA	3,000	0.5	0.14	1.5	60
56-4102-10	UFP-5-C-4X2MA	5,000	0.5	0.14	1.5	60
56-4102-11	UFP-10-C-4X2MA	10,000	0.5	0.14	1.5	60
56-4102-12	UFP-30-C-4X2MA	30,000	0.5	0.14	1.5	60
56-4102-13	UFP-50-C-4X2MA	50,000	0.5	0.14	1.5	60
56-4102-14	UFP-100-C-4X2MA	100,000	0.5	0.14	1.5	60
56-4102-15	UFP-100-E-4X2MA	100,000	1	0.085	0.9	60
56-4102-16	UFP-300-C-4X2MA	300,000	0.5	0.14	1.5	60
56-4102-17	UFP-300-E-4X2MA	300,000	1	0.085	0.9	60
56-4102-18	UFP-500-C-4X2MA	500,000	0.5	0.14	1.5	60
56-4102-19	UFP-500-E-4X2MA	500,000	1	0.085	0.9	60
56-4102-20	UFP-750-E-4X2MA	750,000	1	0.085	0.9	60

Table 16. Model numbers and specifications for Xampler laboratory scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (μm)	Fiber ID (mm)	Membrane area (m^2) (ft^2)		Nominal flowpath length (cm)
56-4101-40	CFP-1-D-3MA	0.1	0.75	0.012	0.13	30
56-4101-41	CFP-1-E-3MA	0.1	1	0.011	0.12	30
56-4101-42	CFP-2-E-3MA	0.2	1	0.011	0.12	30
56-4101-43	CFP-4-E-3MA	0.45	1	0.011	0.12	30
56-4101-44	CFP-6-D-3MA	0.65	0.75	0.012	0.13	30
56-4101-56	CFP-1-E-3X2MA	0.1	1	0.023	0.24	60
56-4101-57	CFP-2-E-3X2MA	0.2	1	0.023	0.24	60
56-4101-58	CFP-4-E-3X2MA	0.45	1	0.023	0.24	60
56-4102-04	CFP-1-D-4A	0.1	0.75	0.046	0.50	30
56-4102-05	CFP-1-E-4A	0.1	1	0.042	0.45	30
56-4102-06	CFP-2-E-4A	0.2	1	0.042	0.45	30
56-4102-07	CFP-4-E-4A	0.45	1	0.042	0.45	30
56-4102-08	CFP-6-D-4A	0.65	0.75	0.046	0.50	30
56-4101-79	CFP-1-D-4MA	0.1	0.75	0.046	0.50	30
56-4101-80	CFP-1-E-4MA	0.1	1	0.042	0.45	30
56-4101-81	CFP-2-E-4MA	0.2	1	0.042	0.45	30
56-4101-82	CFP-4-E-4MA	0.45	1	0.042	0.45	30
56-4101-83	CFP-6-D-4MA	0.65	0.75	0.046	0.50	30
56-4102-21	CFP-1-D-4X2MA	0.1	0.75	0.095	1.02	60
56-4102-22	CFP-1-E-4X2MA	0.1	1	0.085	0.9	60
56-4102-23	CFP-2-E-4X2MA	0.2	1	0.085	0.9	60
56-4102-24	CFP-4-E-4X2MA	0.45	1	0.085	0.9	60
56-4102-25	CFP-6-D-4X2MA	0.65	0.75	0.095	1.02	60

Table 17. Model numbers and specifications for Xampler laboratory scale microfiltration cartridges

All Xampler cartridges are autoclavable except those with 1,000 NMWC ultrafiltration membranes.



Figure 17. QuixStand benchtop system shown with Xampler 3X2M, 1 liter reservoir and optional PRP-09WM peristaltic pump

Pilot scale cartridges

Introduction

To bridge the several steps between research and production volumes, Amersham Biosciences offers a full range of pilot scale ultrafiltration and microfiltration hollow fiber membrane cartridges. These cartridges feature industry-standard 1.5-in Tri-Clamp sanitary feed and retentate fittings. Both 30 and 60 cm flow path lengths are offered with cartridges that provide an order-of-magnitude membrane area span from 0.12 to 1.15 m² (1.3 to 12.5 ft²). Please feel free to contact our Technical Support team for guidance with linear scaling parameters for small volume processing.

Amersham Biosciences FlexStand™ benchtop system product line is designed to suit the entire range of pilot scale cartridges. Two basic models are offered with optional peristaltic or rotary lobe pumps and polysulfone or stainless steel feed reservoirs. These systems can be cart-mounted for ease of movement between the laboratory and the cold room.

The tables and figures on the following pages provide model numbers, dimensional diagrams and specifications for these pilot scale cartridges. Nominal feed stream flow rates as a function of shear rates are also noted.

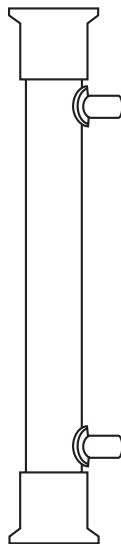


Expert advice

TIP: Membrane productivity (flux) is proportional to the processing temperature. To achieve similar productivity between cold room operations and room temperature trials, the cold room configuration should incorporate three to four times the membrane area used in room temperature trials.



Figure 18. Pilot scale cartridges sizes 6 and 5

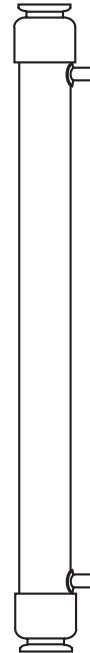


Housing 5

Length = 31.8 cm (12.5 in)
 Diameter = 3.2 cm (1.25 in)
 Permeate ports = 0.5-in tubing nipples
 Feed/retentate ports = 1.5-in Tri-Clamp

Housing 6

Length = 63.5 cm (25 in)
 Diameter = 3.2 cm (1.25 in)
 Permeate ports = 0.5-in tubing nipples on opposite sides
 Feed/retentate ports = 1.5-in Tri-Clamp



Housing 8

Length = 34.9 cm (13.75 in)
 Diameter = 5.1 cm (2 in)
 Permeate ports = 0.5-in tubing nipples
 Feed/retentate ports = 1.5-in Tri-Clamp

Housing 9

Length = 63.5 cm (25 in)
 Diameter = 5.1 cm (2 in)
 Permeate ports = 0.5-in tubing nipples
 Feed/retentate ports = 1.5-in Tri-Clamp

Figure 19. Pilot scale cartridges (drawings not to scale)

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.25	0.65	1.3	2.5	5
0.5	1.1	2.1	4.3	8.6
0.75	1.4	2.8	5.6	11.2
1	2	4	8	16

Table 18. Nominal feed stream flow rates (liters/minute) for housing sizes 5 and 6

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.25	1.6	3.2	6.4	12.8
0.5	2.7	5.4	10.6	21.5
0.75	4.4	8.8	18	35
1	6.1	12.2	24.5	49

Table 19. Nominal feed stream flow rates (liters/minute) for housing sizes 8 and 9

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ²)	Membrane area (ft ²)	Nominal flowpath length (cm)
56-4102-26	UFP-1-C-5	1,000	0.5	0.20	2.1	30
56-4102-27	UFP-1-E-5	1,000	1	0.12	1.3	30
56-4102-28	UFP-3-C-5A	3,000	0.5	0.20	2.1	30
56-4102-29	UFP-3-E-5A	3,000	1	0.12	1.3	30
56-4102-30	UFP-5-C-5A	5,000	0.5	0.20	2.1	30
56-4102-31	UFP-5-E-5A	5,000	1	0.12	1.3	30
56-4102-32	UFP-10-B-5A	10,000	0.25	0.375	4	30
56-4102-33	UFP-10-C-5A	10,000	0.5	0.20	2.1	30
56-4102-34	UFP-10-E-5A	10,000	1	0.12	1.3	30
56-4102-35	UFP-30-C-5A	30,000	0.5	0.20	2.1	30
56-4102-36	UFP-30-E-5A	30,000	1	0.12	1.3	30
56-4102-37	UFP-50-C-5A	50,000	0.5	0.20	2.1	30
56-4102-38	UFP-50-E-5A	50,000	1	0.12	1.3	30
56-4102-39	UFP-100-C-5A	100,000	0.5	0.20	2.1	30
56-4102-40	UFP-100-E-5A	100,000	1	0.12	1.3	30
56-4102-41	UFP-300-C-5A	300,000	0.5	0.20	2.1	30
56-4102-42	UFP-300-E-5A	300,000	1	0.12	1.3	30
56-4102-43	UFP-500-C-5A	500,000	0.5	0.20	2.1	30
56-4102-44	UFP-500-E-5A	500,000	1	0.12	1.3	30
56-4102-45	UFP-750-E-5A	750,000	1	0.12	1.3	30
56-4102-51	UFP-1-C-6	1,000	0.5	0.48	5.2	60
56-4102-52	UFP-3-C-6A	3,000	0.5	0.48	5.2	60
56-4102-53	UFP-3-E-6A	3,000	1	0.28	3	60
56-4102-54	UFP-5-C-6A	5,000	0.5	0.48	5.2	60
56-4102-55	UFP-5-E-6A	5,000	1	0.28	3	60
56-4102-56	UFP-10-C-6A	10,000	0.5	0.48	5.2	60
56-4102-57	UFP-10-E-6A	10,000	1	0.28	3	60
56-4102-58	UFP-30-C-6A	30,000	0.5	0.48	5.2	60
56-4102-59	UFP-30-E-6A	30,000	1	0.28	3	60
56-4102-60	UFP-50-C-6A	50,000	0.5	0.48	5.2	60
56-4102-61	UFP-50-E-6A	50,000	1	0.28	3	60
56-4102-62	UFP-100-C-6A	100,000	0.5	0.48	5.2	60
56-4102-63	UFP-100-E-6A	100,000	1	0.28	3	60
56-4102-64	UFP-300-C-6A	300,000	0.5	0.48	5.2	60
56-4102-65	UFP-300-E-6A	300,000	1	0.28	3	60
56-4102-66	UFP-500-C-6A	500,000	0.5	0.48	5.2	60
56-4102-67	UFP-500-E-6A	500,000	1	0.28	3	60
56-4102-68	UFP-750-E-6A	750,000	1	0.28	3	60

Table 20. Model numbers and specifications for pilot scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4102-74	UFP-3-C-8A	3,000	0.5	0.53	5.7	30
56-4102-75	UFP-10-B-8A	5,000	0.25	0.9	9.7	30
56-4102-76	UFP-10-C-8A	10,000	0.5	0.53	5.7	30
56-4102-77	UFP-30-C-8A	30,000	0.5	0.53	5.7	30
56-4102-78	UFP-50-C-8A	50,000	0.5	0.53	5.7	30
56-4102-79	UFP-100-C-8A	100,000	0.5	0.53	5.7	30
56-4102-80	UFP-100-E-8A	100,000	1	0.36	3.9	30
56-4102-81	UFP-300-C-8A	300,000	0.5	0.53	5.7	30
56-4102-82	UFP-300-E-8A	300,000	1	0.36	3.9	30
56-4102-83	UFP-500-C-8A	500,000	0.5	0.53	5.7	30
56-4102-84	UFP-500-E-8A	500,000	1	0.36	3.9	30
56-4102-85	UFP-750-E-8A	750,000	1	0.36	3.9	30
56-4102-91	UFP-1-C-9	1,000	0.5	1.15	12.5	60
56-4102-92	UFP-3-C-9A	3,000	0.5	1.15	12.5	60
56-4102-93	UFP-3-E-9A	3,000	1	0.84	9	60
56-4102-94	UFP-5-C-9A	5,000	0.5	1.15	12.5	60
56-4102-95	UFP-5-E-9A	5,000	1	0.84	9	60
56-4102-96	UFP-10-C-9A	10,000	0.5	1.15	12.5	60
56-4102-97	UFP-10-E-9A	10,000	1	0.84	9	60
56-4102-98	UFP-30-C-9A	30,000	0.5	1.15	12.5	60
56-4102-99	UFP-30-E-9A	30,000	1	0.84	9	60
56-4103-00	UFP-50-C-9A	50,000	0.5	1.15	12.5	60
56-4103-01	UFP-50-E-9A	50,000	1	0.84	9	60
56-4103-02	UFP-100-C-9A	100,000	0.5	1.15	12.5	60
56-4103-03	UFP-100-E-9A	100,000	1	0.84	9	60
56-4103-04	UFP-300-C-9A	300,000	0.5	1.15	12.5	60
56-4103-05	UFP-300-E-9A	300,000	1	0.84	9	60
56-4103-06	UFP-500-C-9A	500,000	0.5	1.15	12.5	60
56-4103-07	UFP-500-E-9A	500,000	1	0.84	9	60
56-4103-08	UFP-750-E-9A	750,000	1	0.84	9	60

Table 20. Model numbers and specifications for pilot scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (µm)	Fiber ID (mm)	Membrane area (m ²)	Membrane area (ft ²)	Nominal flowpath length (cm)
56-4102-46	CFP-1-D-5A	0.1	0.75	0.16	1.7	30
56-4102-47	CFP-1-E-5A	0.1	1	0.12	1.3	30
56-4102-48	CFP-2-E-5A	0.2	1	0.12	1.3	30
56-4102-49	CFP-4-E-5A	0.45	1	0.12	1.3	30
56-4102-50	CFP-6-D-5A	0.65	0.75	0.16	1.7	30
56-4102-69	CFP-1-D-6A	0.1	0.75	0.37	4	60
56-4102-70	CFP-1-E-6A	0.1	1	0.28	3	60
56-4102-71	CFP-2-E-6A	0.2	1	0.28	3	60
56-4105-61	CFP-2-G-6A	0.2	1.75	0.23	2.5	60
56-4102-72	CFP-4-E-6A	0.45	1	0.28	3	60
56-4102-73	CFP-6-D-6A	0.65	0.75	0.37	4	60
56-4102-86	CFP-1-D-8A	0.1	0.75	0.41	4.4	30
56-4102-87	CFP-1-E-8A	0.1	1	0.36	3.9	30
56-4102-88	CFP-2-E-8A	0.2	1	0.36	3.9	30
56-4102-89	CFP-4-E-8A	0.45	1	0.36	3.9	30
56-4102-90	CFP-6-D-8A	0.65	0.75	0.41	4.4	30
56-4103-09	CFP-1-D-9A	0.1	0.75	0.93	10	60
56-4103-10	CFP-1-E-9A	0.1	1	0.84	9	60
56-4103-11	CFP-2-E-9A	0.2	1	0.84	9	60
56-4105-62	CFP-2-G-9A	0.2	1.75	0.59	6.3	60
56-4103-12	CFP-4-E-9A	0.45	1	0.84	9	60
56-4103-13	CFP-6-D-9A	0.65	0.75	0.93	10	60

Table 21. Model numbers and specifications for pilot scale microfiltration cartridges

All pilot scale cartridges are autoclavable except those with 1,000 NMWC ultrafiltration membranes.

Process scale cartridges

Introduction

Process scale hollow fiber cartridges offered by Amersham Biosciences are provided in 8 basic configurations covering a membrane area range of 0.92 to 28 m² (9.9 to 300 ft²) depending on the fiber internal diameter.

These configurations are:

Housing	Cartridge diameter (cm)	Nominal flowpath length (cm)	Membrane area (m ²)	Notes
35	7.6	30	0.92 to 2.7	
55	7.6	60	1.8 to 3.25	Also available with retrofit ("R") end fittings*
75	7.6	110	3.7 to 6	Also available with retrofit ("R") end fittings*
45	10.8	30	2.5 to 3.5	MaxCell, requires end fitting adaptor kit
65	10.8	60	3.5 to 6.1	MaxCell, requires end fitting adaptor kit
85	10.8	110	9 to 13	MaxCell, requires end fitting adaptor kit
152M	15	60	9.5	ProCell, requires SS housing
154M	15	110	19 to 28	ProCell, requires SS housing

*Please refer to Chapter 6, "Retrofit cartridges" for more information.

All of these process scale cartridges feature sanitary connections for both the feed/retentate and permeate ports. Use of this industry standard makes for easy connections to tanks, pumps, manifolds and instrumentation.

Amersham Biosciences GrandStand™ systems are cart-mounted units designed to accommodate the full range of ultrafiltration and microfiltration process scale cartridges offered by the company. The various GrandStand configurations are capable of concentration and/or diafiltration of solution volume ranging from 50 to 1,000 liters or more.



Expert advice

TIP: These cartridges may be arranged in parallel to provide any membrane area requirement and hence to process any feed volume.

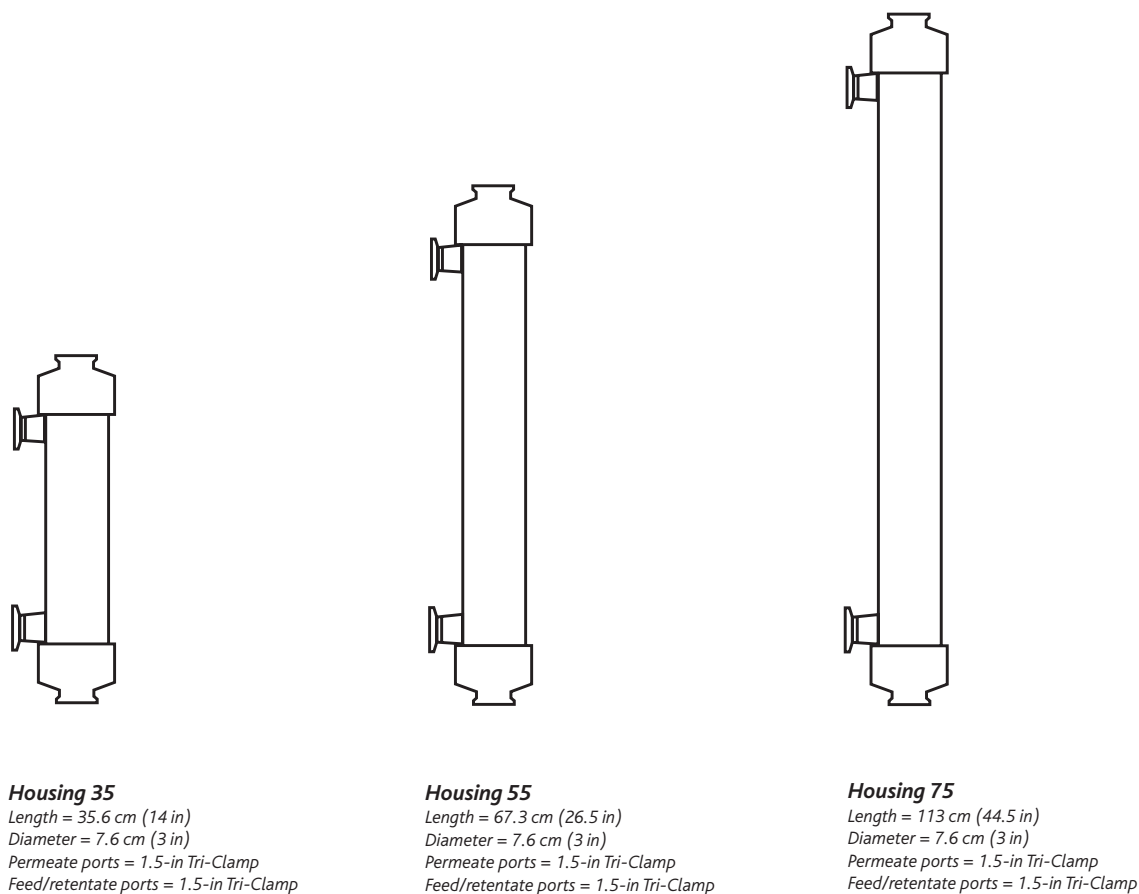


Figure 20. Process scale hollow fiber cartridges sizes 35, 55 and 75 (drawings not to scale)

Nominal lumen ID	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.25	4.5	9	18	36
0.5	6.6	13.2	26	53
0.75	10	20	40	80
1	15	30	60	120

Table 22. Nominal feed stream flow rates (liters/minute) for housing sizes 35, 55, and 75

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ²) (ft ²)		Nominal flowpath length (cm)
56-4103-14	UFP-3-C-35	3,000	0.5	1.35	14.5	30
56-4103-15	UFP-3-E-35	3,000	1	0.92	9.9	30
56-4103-16	UFP-5-C-35	5,000	0.5	1.35	14.5	30
56-4103-17	UFP-5-E-35	5,000	1	0.92	9.9	30
56-4103-18	UFP-10-B-35	10,000	0.25	2.7	29	30
56-4103-19	UFP-10-C-35	10,000	0.5	1.35	14.5	30
56-4103-20	UFP-10-E-35	10,000	1	0.92	9.9	30
56-4103-21	UFP-30-C-35	30,000	0.5	1.35	14.5	30
56-4103-22	UFP-30-E-35	30,000	1	0.92	9.9	30
56-4103-23	UFP-100-C-35	100,000	0.5	1.35	14.5	30
56-4103-24	UFP-100-E-35	100,000	1	0.92	9.9	30
56-4103-25	UFP-300-C-35	300,000	0.5	1.35	14.5	30
56-4103-26	UFP-300-E-35	300,000	1	0.92	9.9	30
56-4103-27	UFP-500-C-35	500,000	0.5	1.35	14.5	30
56-4103-28	UFP-500-E-35	500,000	1	0.92	9.9	30
56-4103-29	UFP-750-E-35	750,000	1	0.92	9.9	30
56-4103-35	UFP-3-C-55	3,000	0.5	3.25	35	60
56-4103-37	UFP-3-E-55	3,000	1	2.1	23	60
56-4103-39	UFP-5-C-55	5,000	0.5	3.25	35	60
56-4103-41	UFP-5-E-55	5,000	1	2.1	23	60
56-4103-43	UFP-10-C-55	10,000	0.5	3.25	35	60
56-4103-45	UFP-10-E-55	10,000	1	2.1	23	60
56-4103-47	UFP-30-C-55	30,000	0.5	3.25	35	60
56-4103-49	UFP-30-E-55	30,000	1	2.1	23	60
56-4103-51	UFP-50-C-55	50,000	0.5	3.25	35	60
56-4103-53	UFP-50-E-55	50,000	1	2.1	23	60
56-4103-55	UFP-100-C-55	100,000	0.5	3.25	35	60
56-4103-57	UFP-100-E-55	100,000	1	2.1	23	60
56-4103-59	UFP-300-C-55	300,000	0.5	3.25	35	60
56-4103-61	UFP-300-E-55	300,000	1	2.1	23	60
56-4103-63	UFP-500-C-55	500,000	0.5	3.25	35	60
56-4103-65	UFP-500-E-55	500,000	1	2.1	23	60
56-4103-67	UFP-750-E-55	750,000	1	2.1	23	60
56-4103-80	UFP-3-C-75	3,000	0.5	6	65	110
56-4103-82	UFP-3-E-75	3,000	1	3.7	40	110
56-4103-84	UFP-5-C-75	5,000	0.5	6	65	110
56-4103-86	UFP-5-E-75	5,000	1	3.7	40	110
56-4103-88	UFP-10-C-75	10,000	0.5	6	65	110
56-4103-90	UFP-10-E-75	10,000	1	3.7	40	110
56-4103-92	UFP-30-C-75	30,000	0.5	6	65	110
56-4103-94	UFP-30-E-75	30,000	1	3.7	40	110
56-4103-96	UFP-50-E-75	50,000	1	3.7	40	110
56-4103-98	UFP-100-C-75	100,000	0.5	6	65	110
56-4104-00	UFP-100-E-75	100,000	1	3.7	40	110
56-4104-02	UFP-300-C-75	300,000	0.5	6	65	110
56-4104-04	UFP-300-E-75	300,000	1	3.7	40	110
56-4104-06	UFP-500-C-75	500,000	0.5	6	65	110
56-4104-08	UFP-500-E-75	500,000	1	3.7	40	110
56-4104-10	UFP-750-E-75	750,000	1	3.7	40	110

Table 23. Model numbers and specifications for process scale ultrafiltration cartridges

Code number	Model number	Pore size (μm)	Fiber ID (mm)	Membrane area (m ²)	Membrane area (ft ²)	Nominal flowpath length (cm)
56-4103-30	CFP-1-D-35A	0.1	0.75	1	10.8	30
56-4103-31	CFP-1-E-35A	0.1	1	0.92	9.9	30
56-4103-32	CFP-2-E-35A	0.2	1	0.92	9.9	30
56-4103-33	CFP-4-E-35A	0.45	1	0.92	9.9	30
56-4103-34	CFP-6-D-35A	0.65	0.75	1	10.8	30
56-4103-69	CFP-1-D-55A	0.1	0.75	2.5	27	60
56-4103-70	CFP-1-E-55	0.1	1	2.1	23	60
56-4103-72	CFP-1-E-55A	0.1	1	2.1	23	60
56-4103-73	CFP-2-E-55	0.2	1	2.1	23	60
56-4103-75	CFP-2-E-55A	0.2	1	2.1	23	60
56-4103-76	CFP-4-E-55	0.45	1	2.1	23	60
56-4103-78	CFP-4-E-55A	0.45	1	2.1	23	60
56-4103-79	CFP-6-D-55A	0.65	0.75	2.5	27	60

Table 24. Model numbers and specifications for process scale microfiltration cartridges

Process scale ultrafiltration cartridges are not autoclavable; however, an autoclavable version of housing size 35 is available on a special order basis.

Process scale microfiltration cartridges with model numbers that end in "A" are autoclavable.

MaxCell process scale cartridges

The streamlined design of our MaxCell™ cartridge with its 10.8 cm diameter is in sharp contrast to the most commonly available 12.7 cm diameter competitive cartridges. MaxCell cartridges have lower hold-up volumes and are lighter and easier for operators to handle. Furthermore, a MaxCell size 85 cartridge with 1 mm ID diameter fibers contains over 40% more membrane area than the larger-diameter competitive unit (please refer to Chapter 6, "Retrofit cartridges," for more information).

MaxCell cartridges are easily manifolded in parallel to handle large process volumes. Their unique end fitting configuration allows excellent visibility of the cartridge ends for inspection and cleaning. Housing size 85, with 0.5 mm ID diameter fibers, contains 13 m² (140 ft²) of membrane area.



Figure 21. MaxCell process scale hollow fiber cartridges

MaxCell cartridge installations require either one Straight adaptor kit (Part No. KAMX-16PS) or one Elbow adaptor kit (Part No. KAMX-16EL-PS) per cartridge.



Safety

WARNING: MaxCell cartridge end fittings can be properly tightened with one of our two MaxCell wrench sets. The standard wrench set, SWR-MX01, is sufficient when only a few cartridges are in use. For large installations, we recommend model SWR-MX02, which maintains a predetermined torque to prevent either under- or over-tightening.

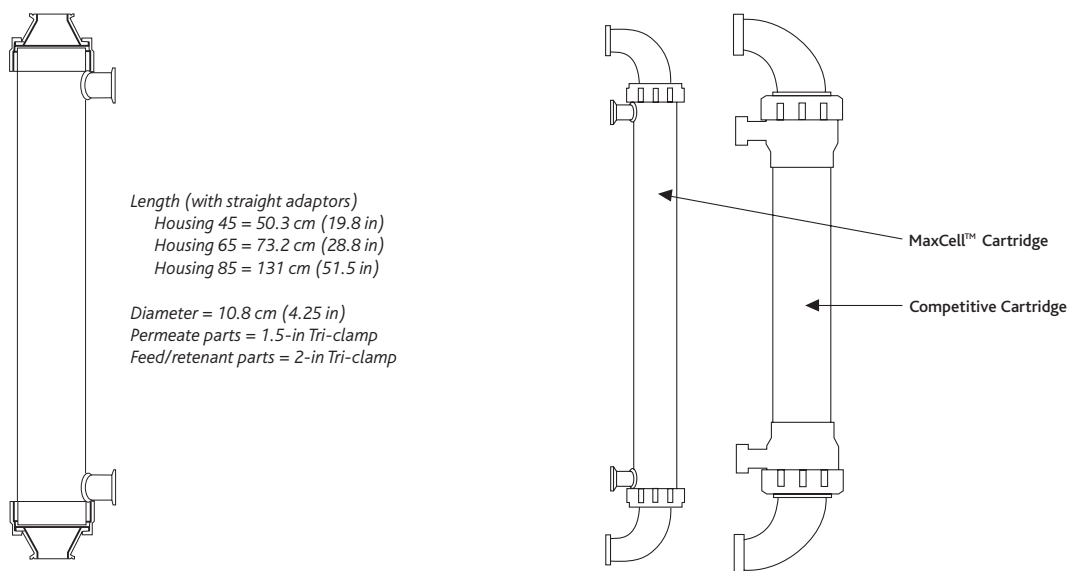


Figure 22. MaxCell process scale hollow fiber cartridges (straight adaptors and locking nuts not included; drawings not to scale)



Figure 23. GrandStand process scale system with MaxCell size 65 cartridge installed

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.5	14	28	55	111
0.75	19	39	77	154
1	31	61	122	245

Table 25. Nominal feed stream flow rates (liters/minute) for housing sizes 45, 65 and 85

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4104-67	UFP-3-C-45	3,000	0.5	3.5	37	30
56-4104-68	UFP-5-C-45	5,000	0.5	3.5	37	30
56-4104-69	UFP-10-C-45	10,000	0.5	3.5	37	30
56-4104-70	UFP-30-C-45	30,000	0.5	3.5	37	30
56-4104-75	UFP-3-C-65	3,000	0.5	6.1	66	60
56-4104-76	UFP-3-E-65	3,000	1	4.4	47	60
56-4104-77	UFP-5-C-65	5,000	0.5	6.1	66	60
56-4104-78	UFP-5-E-65	5,000	1	4.4	47	60
56-4104-79	UFP-10-C-65	10,000	0.5	6.1	66	60
56-4104-80	UFP-10-E-65	10,000	1	4.4	47	60
56-4104-81	UFP-30-C-65	30,000	0.5	6.1	66	60
56-4104-82	UFP-30-E-65	30,000	1	4.4	47	60
56-4104-83	UFP-50-C-65	50,000	0.5	6.1	66	60
56-4104-84	UFP-50-E-65	50,000	1	4.4	47	60
56-4104-85	UFP-100-C-65	100,000	0.5	6.1	66	60
56-4104-86	UFP-100-E-65	100,000	1	4.4	47	60
56-4104-87	UFP-300-C-65	300,000	0.5	6.1	66	60
56-4104-88	UFP-300-E-65	300,000	1	4.4	47	60
56-4104-89	UFP-500-C-65	500,000	0.5	6.1	66	60
56-4104-90	UFP-500-E-65	500,000	1	4.4	47	60
56-4104-91	UFP-750-E-65	750,000	1	4.4	47	60
56-4107-80	UFP-HTS-P-85 ¹	10,000	0.5	13	140	110
56-4104-95	UFP-3-C-85	3,000	0.5	13	140	110
56-4104-96	UFP-3-E-85	3,000	1	9	97	110
56-4104-97	UFP-5-C-85	5,000	0.5	13	140	110
56-4104-98	UFP-5-E-85	5,000	1	9	97	110
56-4104-99	UFP-10-C-85	10,000	0.5	13	140	110
56-4105-00	UFP-10-E-85	10,000	1	9	97	110
56-4105-01	UFP-30-C-85	30,000	0.5	13	140	110
56-4105-02	UFP-30-E-85	30,000	1	9	97	110
56-4105-03	UFP-50-C-85	50,000	0.5	13	140	110
56-4105-04	UFP-50-E-85	50,000	1	9	97	110
56-4105-05	UFP-100-C-85	100,000	0.5	13	140	110
56-4105-06	UFP-100-E-85	100,000	1	9	97	110
56-4105-07	UFP-300-E-85	300,000	1	9	97	110
56-4105-08	UFP-500-C-85	500,000	0.5	13	140	110
56-4105-09	UFP-500-E-85	500,000	1	9	97	110
56-4105-10	UFP-750-E-85	750,000	1	9	97	110

¹High-purity water cartridge produces pyrogen-free permeate and is heat sanitizable.

Table 26. Model numbers and specifications for MaxCell process scale ultrafiltration cartridges

Code number	Model number	Pore size (µm)	Fiber ID (mm)	Membrane area (m ²)	Membrane area (ft ²)	Nominal flowpath length (cm)
56-4104-71	CFP-1-E-45	0.1	1	2.5	27	30
56-4104-72	CFP-2-E-45	0.2	1	2.5	27	30
56-4104-73	CFP-4-E-45	0.45	1	2.5	27	30
56-4104-74	CFP-6-D-45	0.65	0.75	2.65	2.85	30
56-4104-92	CFP-1-E-65	0.1	1	4.4	47	60
56-4104-93	CFP-2-E-65	0.2	1	4.4	47	60
56-4105-64	CFP-2-G-65	0.2	1.75	3.5	38	60
56-4104-94	CFP-4-E-65	0.45	1	4.4	47	6

Table 27. Model numbers and specifications for MaxCell process scale microfiltration cartridges

Code number	Model number	Description
56-4107-26	RBMX-16PS-ST	Straight adaptor for MaxCell cartridge, polysulfone
56-4107-27	RBMX-16PS-EL	Elbow adaptor for MaxCell cartridge, polysulfone
56-4107-21	RB16-12SS	2-in TC to 1.5-in TC concentric adaptor, 316L SS
56-4107-22	RB16-12FNPTSS	2-in TC to 1.5-in female NPT adaptor, 304 SS
56-4107-23	RB16-16FNPTSS	2-in TC to 2-in female NPT adaptor, 304 SS
56-4107-28	EL16-16SS	2-in TC elbow, 316L SS
56-4107-37	KAMX-16PS	Straight adaptor kit for MaxCell cartridge, polysulfone. Kit contains 2 RBMX-16PS-ST polysulfone straight adaptors, 2 polysulfone cartridge end nuts and 2 silicone O-rings
56-4107-38	KAMX-16EL-PS	Elbow adaptor kit for MaxCell cartridge, polysulfone. Kit contains 2 RBMX-16PS-EL polysulfone elbow adaptors, 2 polysulfone cartridge end nuts and 2 silicone O-rings
56-4106-70	CL16-LT	2-in TC toggle clamp, 304 SS
56-4106-79	G16S	2-in TC silicone gasket
56-4106-92	K04ORS	MaxCell O-ring set, 2 silicone O-rings
56-4107-39	SWR-MX01	MaxCell wrench set, standard
56-4107-40	SWR-MX02	MaxCell wrench set, applied torque

Table 28. Accessories for MaxCell process scale cartridges

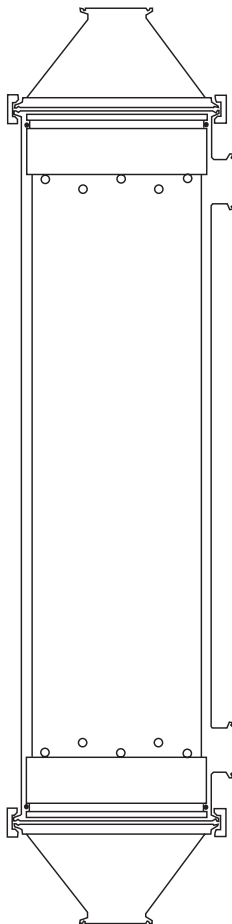
MaxCell process scale cartridges are not autoclavable.

ProCell process scale cartridges

ProCell 15 cm (6 in) diameter hollow fiber cartridges are intended for large production-scale ultrafiltration and microfiltration applications. Containing up to 28 m² (300 ft²) of membrane area in a single, compact module, these cartridges are well-suited to a wide range of bio/pharmaceutical applications, including protein concentration, buffer exchange, cell harvesting and depyrogenation.

ProCell cartridges are available in two path lengths (nominal 60 and 110 cm) and ProCell ultrafiltration cartridges are capable of withstanding up to 3.4 barg (50 psig) transmembrane pressure. The combination of large surface area and high-pressure capability provides extremely high productivity for large-scale processing applications. Moreover, ProCell cartridges can be manifolded in parallel to provide filtration requirements for any volume of feed material.

ProCell modules are fitted into stainless steel housings and secured at each end with an O-ring seal. End-fitting adaptors reduce the feed and retentate connections to 2-in Tri-Clamp. Side port connections are 1.5-in Tri-Clamp.



Housing 152M

Length = 81.3 cm (32 in)
 Diameter = 16.8 cm (6.63 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 2-in Tri-Clamp

Housing 154M

Length = 139 cm (54.8 in)
 Diameter = 16.8 cm (6.63 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 2-in Tri-Clamp

Length and diameter values above are for ProCell cartridges within their respective stainless steel housings.

Figure 24. ProCell process scale cartridge (drawing not to scale)

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.5	30	60	120	240
1	70	140	280	560

Table 29. Nominal feed stream flow rates (liters/minute) for housing sizes 152M and 154M

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4105-11	UFP-500-E-152M	500,000	1	9.5	102	60
56-4105-13	UFP-10-C-154M	10,000	0.5	28	300	110
56-4105-14	UFP-500-E-154M	500,000	1	19	205	110

Table 30. Model numbers and specifications for ProCell process scale ultrafiltration cartridges

Code number	Model number	Pore size (µm)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4105-12	CFP-2-E-152M	0.2	1	9.5	102	60
56-4105-15	CFP-2-E-154M	0.2	1	19	205	110

Table 31. Model numbers and specifications for ProCell process scale microfiltration cartridges

ProCell process scale cartridges are not autoclavable.

Code number	Model number	Description
56-4106-35	SS-152TC	Housing assembly for ProCell 152M cartridges, 316L SS with 2 gaskets and 2 clamps
56-4106-36	SS-154TC	Housing assembly for ProCell 154 cartridges, 316L SS with 2 gaskets and 2 clamps

Table 32. Stainless steel housings for ProCell process scale cartridges

Code number	Model number	Description
56-4106-77	G12S	1.5-in TC gasket, silicone
56-4106-79	G16S	2-in TC gasket, silicone
56-4106-88	G48S	6-in TC [Schedule 5 Pipe] gasket, silicone
56-4106-67	CL12	1.5-in TC quick disconnect clamp, 304 SS
56-4106-70	CL16-LT	2-in TC toggle clamp, 304 SS
56-4106-74	CL48	6-in TC [Schedule 5 Pipe] clamp, 304 SS
56-4106-96	K06ORS	ProCell cartridge O-ring set, 2 silicone O-rings

Table 33. Accessories for ProCell process scale cartridges

Introduction

Amersham Biosciences hollow fiber membrane cartridges can retrofit, and thereby upgrade the performance of, most installed membrane systems. Our Technical Support specialists will work closely with you to select the optimum membrane type and cartridge size for your application.

Depending on the installation, minor changes in system piping may be required, and we are available to assist you with your conversion. For direct retrofits of Amicon® and Romicon® process scale cartridges, the greater membrane area provided by Amersham Biosciences—up to 50% more—reduces processing time, increases system capacity or decreases the total number of cartridges required. The result is a more reliable and cost-effective operation.

In addition to retrofitting 7.6 cm (3 in) and 10.8 cm (4.25 in) Amicon and Romicon cartridges, Amersham Biosciences offers retrofit solutions for a broad range of Amicon laboratory and pilot scale cartridges, and provides options for Enka®, Koch Membrane Systems, Inc. and Asahi Kasei Corporation hollow fiber products.



Expert advice

TIP: There are no industry-wide standards for assigning ultrafiltration membrane molecular weight cut-off designations. Each manufacturer uses different challenge markers and retention distribution criteria to establish the molecular weight cut-off of its membranes. Variations between manufacturers are not uncommon, and it is prudent to determine separation and productivity performance as a means of selecting the optimum replacement membrane. Once the preferred Amersham Biosciences ultrafiltration membrane is selected, consistency in membrane product quality and separation characteristics is assured.

Retrofit cartridges

Type ¹	Membrane ²	Fiber inner diameter ³	Amersham Biosciences cartridge	Notes
H1 HF0.8	PXXX PMXXX	20 20	UFP-XXX-C-4	Amersham Biosciences cartridge connects directly to tubing. No O-rings. Adaptor blocks not required
H1 HF0.3	PXXX PMXXX	43 43	UFP-XXX-E-4	Amersham Biosciences cartridge connects directly to tubing. No O-rings. Adaptor blocks not required
H10 HF10	PXXX PMXXX	20 20	UFP-XXX-C-9	Amersham Biosciences housing size 9 has 25% more membrane area
H5 HF5	PXXX PMXXX	43 43	UFP-XXX-E-9	Amersham Biosciences housing size 9 has 80% more membrane area
H30 HF30	PXXX PMXXX	20 20	UFP-XXX-C-55R	Amersham Biosciences housing size C-55R has 20% more membrane area. Slight offset of permeate ports
H15 HF15	PXXX PMXXX	43 43	UFP-XXX-E-55R	Amersham Biosciences housing size E-55R has 50% more membrane area. Slight offset of permeate ports
H53 HF53	PXXX PMXXX	20 20	UFP-XXX-C-75R	Amersham Biosciences housing size C-75R has 20% more membrane area. Slight offset of permeate ports
H26 HF26	PXXX PMXXX	43 43	UFP-XXX-E-75R	Amersham Biosciences housing size E-75R has 50% more membrane area. Slight offset of permeate ports

¹ Number refers to nominal membrane area in square feet. For example, H10 = 10 ft².

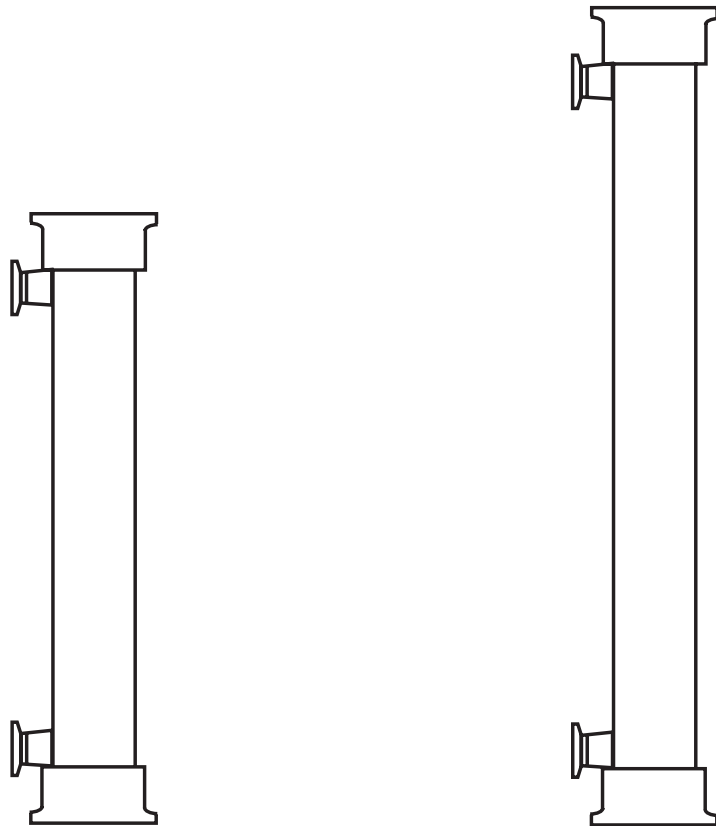
² P and PM = polysulfone. Amersham Biosciences membranes are polysulfone. XXX = the UF membrane NMWC divided by 1,000. For example, 100 = 100,000 NMWC. To retrofit an MP01 membrane, use Amersham Biosciences 0.1 µm microfiltration membrane.

³ The number 20 refers to 20 mil (0.5 mm) lumen diameter. Amersham Biosciences "C" lumen diameter is 0.5 mm. The number 43 refers to 43 mil (1.1 mm) lumen diameter. Amersham Biosciences "E" lumen diameter is 1 mm.

Table 34. Cross-reference table of common retrofit cartridges for Amicon and Romicon units

Housing identifier	Length		Diameter	
	cm	inches	cm	inches
35	35.6	14	7.6	3
55	67.3	26.5	7.6	3
55R	63.5	25	7.6	3
75	113.0	44.5	7.6	3
75R	109.0	43	7.6	3

Table 35. Standard and retrofit cartridge dimensions for 7.6 cm diameter units



Housing 55R

Length = 63.5 cm (25 in)
 Diameter = 7.6 cm (3 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = R style for retrofit

Housing 75R

Length = 109 cm (43 in)
 Diameter = 7.6 cm (3 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = R style for retrofit

Figure 25. Housings 55R and 75R (drawings not to scale)

Steam-in-place cartridges

Introduction

Steam-in-place (SIP) cartridge elements provided by Amersham Biosciences are specifically designed for pharmaceutical manufacturing operations. These elements, which fit securely into stainless steel housings for safe operation during the steaming cycle, are based on the highest-quality, most durable membranes on the market today. Steam-in-place cartridges are available in three standard styles, denoted SMO, STM and MSM.

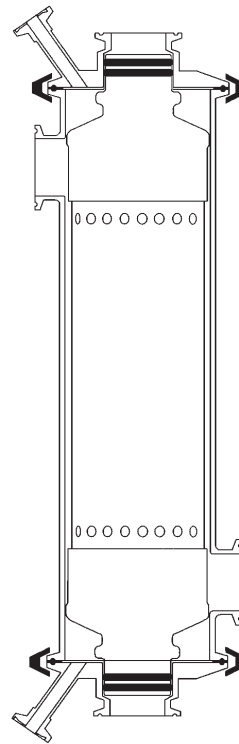
The SMO and STM versions are based on a 7.6 cm (3 in) diameter element. SMO cartridges have an open face and a single O-ring seal at each end. STM units have end caps at each face that neck down to a double O-ring seal, for connection to the stainless steel end fittings. Larger, MaxCell MSM SIP elements have a nominal 10 cm (4 in) diameter and an open face configuration.

You can order a number of accessories for Steam-in-place cartridges. In addition, Amersham Biosciences can provide custom systems. To learn more about which type of cartridge is best for your application, contact your Amersham Biosciences salesperson.

SIP cartridges are available in both ultrafiltration and microfiltration pore sizes, each with a choice of 30 and 60 cm path lengths.

All housing assemblies are of 316L stainless steel with sanitary construction. The O-ring material is silicone. Both end-fitting and permeate ports are 1.5-in sanitary Tri-Clamp configuration, allowing for quick and easy connection to steam and process piping.

STM steam-in-place cartridges



Housing 35STM

Length = 43.4 cm (17.1 in)

Diameter = 9.1 cm (3.6 in)

Permeate ports = 1.5-in Tri-Clamp

Feed/retentate ports = 1.5-in Tri-Clamp

Drain/vent ports = 0.5-in Tri-Clamp

Housing 55STM

Length = 75.2 cm (29.6 in)

Diameter = 9.1 cm (3.6 in)

Permeate ports = 1.5-in Tri-Clamp

Feed/retentate ports = 1.5-in Tri-Clamp

Drain/vent ports = 0.5-in Tri-Clamp

Figure 26. STM steam-in-place cartridge and housing (drawing not to scale)

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.25	4.5	9	18	36
0.5	6.6	13.2	26	53
0.75	10	20	40	80
1	15	30	60	120

Table 36. Nominal feed stream flow rates (liters/minute) for housings 35STM and 55STM

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ²) (ft ²)		Nominal flowpath length (cm)
56-4104-12	UFP-10-E-35STM	10,000	1	0.92	9.9	30
56-4104-13	UFP-30-E-35STM	30,000	1	0.92	9.9	30
56-4104-14	UFP-100-E-35STM	100,000	1	0.92	9.9	30
56-4104-15	UFP-500-E-35STM	500,000	1	0.92	9.9	30
56-4104-19	UFP-3-C-55STM	3,000	0.5	3.25	35	60
56-4104-20	UFP-10-C-55STM	10,000	0.5	3.25	35	60
56-4104-21	UFP-10-E-55STM	10,000	1	2.1	23	60
56-4104-22	UFP-30-C-55STM	30,000	0.5	3.25	35	60
56-4104-23	UFP-30-E-55STM	30,000	1	2.1	23	60
56-4104-24	UFP-50-C-55STM	50,000	0.5	3.25	35	60
56-4104-25	UFP-100-C-55STM	100,000	0.5	3.25	35	60
56-4104-26	UFP-100-E-55STM	100,000	1	2.1	23	60
56-4104-27	UFP-500-E-55STM	500,000	1	2.1	23	60

Table 37. Model numbers and specifications for STM steam-in-place ultrafiltration cartridges

Code number	Model number	Pore size (μm)	Fiber ID (mm)	Membrane area (m ²) (ft ²)		Nominal flowpath length (cm)
56-4104-16	CFP-1-E-35STM	0.1	1	0.92	9.9	30
56-4104-17	CFP-2-E-35STM	0.2	1	0.92	9.9	30
56-4104-18	CFP-4-E-35STM	0.45	1	0.92	9.9	30
56-4104-28	CFP-1-E-55STM	0.1	1	2.1	23	60
56-4104-29	CFP-2-E-55STM	0.2	1	2.1	23	60
56-4104-30	CFP-4-E-55STM	0.45	1	2.1	23	60
56-4109-25	CFP-6-D-55STM	0.65	0.75	2.5	27	60

Table 38. Model numbers and specifications for STM steam-in-place microfiltration cartridges

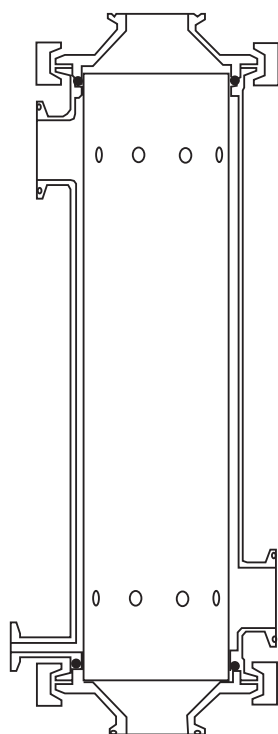
Code number	Model number	Description
56-4106-27	SS-35STM	Housing assembly for 35STM cartridges, 316L SS with 2 gaskets and 2 clamps
56-4106-28	SS-55STM	Housing assembly for 55STM cartridges, 316L SS with 2 gaskets and 2 clamps

Table 39. Stainless steel housings for STM steam-in-place cartridges

Code number	Model number	Description
56-4106-75	G4S	0.5-in TC gasket, silicone
56-4106-77	G12S	1.5-in TC gasket, silicone
56-4106-81	G24S	3-in TC [Schedule 5 Pipe] gasket, silicone
56-4106-65	CL4	0.5-in TC quick disconnect clamp, 304 SS
56-4106-67	CL12	1.5-in TC quick disconnect clamp, 304 SS
56-4106-71	CL24	3-in TC [Schedule 5 Pipe] clamp, 304 SS
56-4106-90	K02ORS	STM cartridge O-ring set, 8 ea, silicone
56-4105-90	VPC4	0.5-in TC permeate-side condensate drain or vent valve, 316L SS

Table 40. Accessories for STM steam-in-place cartridges

SMO steam-in-place cartridges



Housing 35SMO

Length = 37.3 cm (14.7 in)
 Diameter = 9.1 cm (3.6 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 1.5-in Tri-Clamp
 Drain port = 0.5-in Tri-Clamp

Housing 55SMO

Length = 69.3 cm (27.3 in)
 Diameter = 9.1 cm (3.6 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 1.5-in Tri-Clamp
 Drain port = 0.5-in Tri-Clamp

Figure 27. SMO steam-in-place cartridge and housing (drawing not to scale)

Nominal Lumen ID (mm)	Shear Rate ~2,000 sec ⁻¹	Shear Rate ~4,000 sec ⁻¹	Shear Rate ~8,000 sec ⁻¹	Shear Rate ~16,000 sec ⁻¹
0.25	4.5	9	18	36
0.5	6.6	13.2	26	53
0.75	10	20	40	80
1	15	30	60	120

Table 41. Nominal feed stream flow rates (liters/minute) for 35SMO and 55SMO housings

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4104-31	UFP-10-E-35SMO	10,000	1	0.92	9.9	30
56-4104-32	UFP-30-E-35SMO	30,000	1	0.92	9.9	30
56-4104-33	UFP-100-E-35SMO	100,000	1	0.92	9.9	30
56-4104-34	UFP-500-E-35SMO	500,000	1	0.92	9.9	30
56-4104-38	UFP-10-E-55SMO	10,000	1	2.1	23	60
56-4104-39	UFP-30-E-55SMO	30,000	1	2.1	23	60
56-4104-40	UFP-100-E-55SMO	100,000	1	2.1	23	60
56-4104-41	UFP-500-E-55SMO	500,000	1	2.1	23	60

Table 42. Model numbers and specifications for SMO steam-in-place ultrafiltration cartridges

Code number	Model number	Pore size (μm)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4104-35	CFP-1-E-35SMO	0.1	1	0.92	9.9	30
56-4104-36	CFP-2-E-35SMO	0.2	1	0.92	9.9	30
56-4104-37	CFP-4-E-35SMO	0.45	1	0.92	9.9	30
56-4104-42	CFP-1-E-55SMO	0.1	1	2.1	23	60
56-4104-43	CFP-2-E-55SMO	0.2	1	2.1	23	60
56-4104-44	CFP-4-E-55SMO	0.45	1	2.1	23	60

Table 43. Model numbers and specifications for SMO steam-in-place microfiltration cartridges

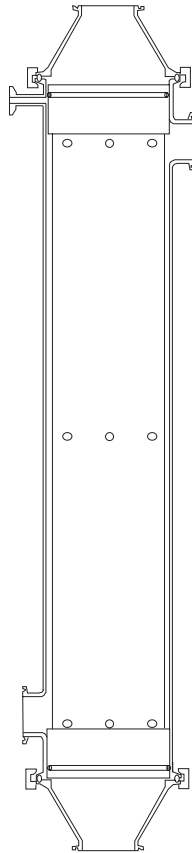
Code number	Model number	Description
56-4106-29	SS-35SMO-DP	Housing assembly with drain port for 35SMO cartridges, 316L SS with 2 gaskets and 2 clamps
56-4106-30	SS-55SMO-DP	Housing assembly with drain port for 55SMO cartridges, 316L SS with 2 gaskets and 2 clamps

Table 44. Stainless steel housings for SMO steam-in-place cartridges

Code number	Model number	Description
56-4106-77	G12S	1.5-in TC gasket, silicone
56-4106-81	G24S	3-in TC [Schedule 5 Pipe] gasket, silicone
56-4106-67	CL12	1.5-in TC quick disconnect clamp, 304 SS
56-4106-71	CL24	3-in TC [Schedule 5 Pipe] clamp, 304 SS
56-4106-91	K03ORS	SMO cartridge O-ring set, 4 ea. silicone

Table 45. Accessories for SMO steam-in-place cartridges

MaxCell MSM steam-in-place cartridges



Housing 45MSM

Length = 52.8 cm (20.8 in)
 Diameter = 9.1 cm (3.6 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 2-in Tri-Clamp
 Drain port = 0.5-in Tri-Clamp

Housing 65MSM

Length = 75.7 cm (29.8 in)
 Diameter = 9.1 cm (3.6 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 2-in Tri-Clamp
 Drain port = 0.5-in Tri-Clamp

Housing 85MSM

Length = 134 cm (52.7 in)
 Diameter = 9.1 cm (3.6 in)
 Permeate ports = 1.5-in Tri-Clamp
 Feed/retentate ports = 2-in Tri-Clamp
 Drain port = 0.5-in Tri-Clamp

Optional elbow adaptors are available for 85MSM stainless steel housing.

Figure 28. MaxCell MSM steam-in-place cartridge and housing (drawing not to scale)



Figure 29. MaxCell MSM steam-in-place cartridge and stainless steel housing

Nominal lumen ID (mm)	Shear rate ~2,000 sec ⁻¹	Shear rate ~4,000 sec ⁻¹	Shear rate ~8,000 sec ⁻¹	Shear rate ~16,000 sec ⁻¹
0.5	14	28	55	111
0.75	19	39	77	154
1	31	61	122	245

Table 46. Nominal feed stream flow rates (liters/minute) for housing sizes 45MSM, 65MSM and 85MSM

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ²)	Membrane area (ft ²)	Nominal flowpath length (cm)
56-4104-45	UFP-10-E-45MSM	10,000	1	2.3	25	30
56-4104-46	UFP-30-E-45MSM	30,000	1	2.3	25	30
56-4104-47	UFP-100-E-45MSM	100,000	1	2.3	25	30
56-4104-48	UFP-500-E-45MSM	500,000	1	2.3	25	30
56-4104-52	UFP-10-C-65MSM	10,000	0.5	5.6	60	60
56-4104-53	UFP-10-E-65MSM	10,000	1	4.2	45	60
56-4104-54	UFP-30-C-65MSM	30,000	0.5	5.6	60	60
56-4104-55	UFP-30-E-65MSM	30,000	1	4.2	45	60
56-4104-56	UFP-100-C-65MSM	100,000	0.5	5.6	60	60
56-4104-57	UFP-100-E-65MSM	100,000	1	4.2	45	60
56-4104-58	UFP-500-E-65MSM	500,000	1	4.2	45	60
56-4104-62	UFP-10-E-85MSM	10,000	1	9	95	110
56-4104-63	UFP-30-E-85MSM	30,000	1	9	95	110
56-4104-64	UFP-100-E-85MSM	100,000	1	9	95	110
56-4104-65	UFP-300-E-85MSM	300,000	1	9	95	110
56-4104-66	UFP-500-E-85MSM	500,000	1	9	95	110

Table 47. Model numbers and specifications for MaxCell MSM steam-in-place ultrafiltration cartridges

Code number	Model number	Pore size (µm)	Fiber ID (mm)	Membrane area (m ²)	Membrane area (ft ²)	Nominal flowpath length (cm)
56-4104-49	CFP-1-E-45MSM	0.1	1	2.3	25	30
56-4104-50	CFP-2-E-45MSM	0.2	1	2.3	25	30
56-4104-51	CFP-4-E-45MSM	0.45	1	2.3	25	30
56-4104-59	CFP-1-E-65MSM	0.1	1	4.2	45	60
56-4104-60	CFP-2-E-65MSM	0.2	1	4.2	45	60
56-4104-61	CFP-4-E-65MSM	0.45	1	4.2	45	60

Table 48. Model numbers and specifications for MaxCell MSM steam-in-place microfiltration cartridges

Code number	Model number	Description
56-4106-31	SS-45MSM-DP	Housing assembly with drain port for 45MSM cartridges, 316L SS with 2 gaskets and 2 clamps
56-4106-32	SS-65MSM-DP	Housing assembly with drain port for 65MSM cartridges, 316L SS with 2 gaskets and 2 clamps
56-4106-33	SS-85MSM-DP	Housing assembly with drain port for 85MSM cartridges, 316L SS with 2 gaskets and 2 clamps
56-4106-34	SS-85MSM-EL-DP	Housing assembly with drain port for 85MSM cartridges, 316L SS with 2 gaskets and 2 clamps and 2 elbow adaptors

Table 49. Stainless steel housings for MaxCell MSM steam-in-place cartridges

Introduction

Removal of viral particles from pharmaceuticals derived from certain biological sources has become a major regulatory requirement. The VirA/Gard™ family of ultrafiltration membrane cartridges offered by Amersham Biosciences provides a physical virus removal step that has been validated through testing at BioReliance Corporation (Rockville, MD, USA).

Our VirA/Gard class of membrane cartridges showcases the integrity, quality and uniform pore size characteristic that have served as the foundation for Amersham Biosciences cartridge product line. You can purchase VirA/Gard cartridges in 30 and 60 cm nominal path lengths with membrane areas ranging from 22 cm² to 4.4 m² (0.025 to 47 ft²).

A physical size exclusion, non-destructive, high-pressure validation test for VirA/Gard membranes has been adopted with statistics corresponding to porcine parvovirus log removal values. The validation test is applied to the entire membrane cartridge (fibers and housing), and accomplishes two objectives. First, cartridge robustness is verified to minimize failure during processing and, second, consistent pore size openings devoid of any large pores are assured. This method is akin to the well-known Bubble Point test for determining the size of the largest pore in sterilizing microfiltration membranes.

Amersham Biosciences VirA/Gard Membrane Validation Report provides viral clearance data and integrity test procedures. The VirA/Gard membrane integrity test is straightforward and non-destructive. The test may be performed both before and after use, permitting assurance of cartridge integrity.

Depending on the application, VirA/Gard Cartridges may be cleaned, integrity tested and reused a number of times.

To learn more about which type of VirA/Gard cartridge is best for your application, contact your Amersham Biosciences salesperson.



Expert advice

TIP: To minimize viral feed solution during membrane testing and validation, VirA/Gard cartridges with 22 cm² of membrane area are offered. These cartridges, designated with housing 1X2MA, have 3 fibers with a nominal flowpath length of 30 cm. Please contact your Amersham Biosciences salesperson for ordering information.

VirA/Gard cartridges

Code number	Model number	Pore size (NMWC)	Fiber ID (mm)	Membrane area (m ² / ft ²)		Nominal flowpath length (cm)
56-4105-16	VAG-100-E-3MA	100,000	1	0.0095	0.1	30
56-4105-17	VAG-100-E-3X2MA	100,000	1	0.0225	0.24	60
56-4105-18	VAG-100-E-4A	100,000	1	0.042	0.45	30
56-4105-19	VAG-100-E-4MA	100,000	1	0.042	0.45	30
56-4105-20	VAG-100-E-5A	100,000	1	0.12	1.3	30
56-4105-21	VAG-100-E-6A	100,000	1	0.28	3	60
56-4105-22	VAG-100-E-8A	100,000	1	0.36	3.9	30
56-4105-23	VAG-100-E-9A	100,000	1	0.84	9	60
56-4105-27	VAG-300-E-3MA	300,000	1	0.0095	0.1	30
56-4105-28	VAG-300-E-3X2MA	300,000	1	0.0225	0.24	60
56-4105-29	VAG-300-E-4A	300,000	1	0.042	0.45	30
56-4105-30	VAG-300-E-4MA	300,000	1	0.042	0.45	30
56-4105-31	VAG-300-E-5A	300,000	1	0.12	1.3	30
56-4105-32	VAG-300-E-6A	300,000	1	0.28	3	60
56-4105-33	VAG-300-E-8A	300,000	1	0.36	3.9	30
56-4105-34	VAG-300-E-9A	300,000	1	0.84	9	60
56-4105-38	VAG-500-E-3MA	500,000	1	0.0095	0.1	30
56-4105-39	VAG-500-E-3X2MA	500,000	1	0.0225	0.24	60
56-4105-40	VAG-500-E-4A	500,000	1	0.042	0.45	30
56-4105-41	VAG-500-E-4MA	500,000	1	0.042	0.45	30
56-4105-42	VAG-500-E-5A	500,000	1	0.12	1.3	30
56-4105-43	VAG-500-E-6A	500,000	1	0.28	3	60
56-4105-44	VAG-500-E-8A	500,000	1	0.36	3.9	30
56-4105-45	VAG-500-E-9A	500,000	1	0.84	9	60
56-4105-46	VAG-500-E-37	500,000	1	0.95	10.2	30
56-4105-47	VAG-500-E-55	500,000	1	2.1	23	60
56-4105-48	VAG-500-E-65	500,000	1	4.4	47	60
56-4105-49	VAG-750-E-3MA	750,000	1	0.0095	0.1	30
56-4105-50	VAG-750-E-3X2MA	750,000	1	0.0225	0.24	60
56-4105-51	VAG-750-E-4A	750,000	1	0.042	0.45	30
56-4105-52	VAG-750-E-4MA	750,000	1	0.042	0.45	30
56-4105-53	VAG-750-E-5A	750,000	1	0.12	1.3	30
56-4105-54	VAG-750-E-6A	750,000	1	0.28	3	60
56-4105-55	VAG-750-E-8A	750,000	1	0.36	3.9	30
56-4105-56	VAG-750-E-9A	750,000	1	0.84	9	60

Table 50. Model numbers and specifications for VirA/Gard viral retention cartridges

VirA/Gard viral retention cartridges with model numbers that end in "A" are autoclavable.

MidJet laboratory system

The MidJet laboratory system enables you to separate, concentrate and diafilter small volumes (up to 200 ml) of biological solutions. This system permits minimal working volumes—as low as 2 to 5 ml. The MidJet system is perfectly matched to our entire line of MidGee and MidGee Hoop hollow fiber cartridges, which are available in a wide range of ultrafiltration and microfiltration pore sizes for a variety of laboratory applications.

The basic MidJet system (Figure 31) includes a peristaltic pump, reservoirs, tubing, fittings, backpressure valve and a stand on which to mount the system components. The Advanced MidJet system includes a basic MidJet system plus pressure transducers and displays for precise pressure and flow control (Figure 30). Precise process control ensures high product recovery and minimal shear denaturation.

Labscale systems



Figure 30. Advanced MidJet labscale separation system with optional autoclavable reservoirs



Figure 31. Basic MidJet labscale separation system

Code number	Model number	Description
56-4106-37	MDG-3SP	Basic MidJet system includes: PRP-08KB peristaltic pump ¹ and exchangeable saddles for size 14 and 16 tubing, mounting platform and a KMDG-2 MidJet accessory kit NOTE: The supplied plug-in power supply for the pump is for North America only; international users must obtain a power supply for local voltages and frequencies
56-4106-38	MDG-4SP	Advanced MidJet system includes: MDG-3SP Basic System plus a PRT-DPM-2 pressure transducer kit and digital panel meter NOTE: The supplied plug-in power supply for the pump is for North America only; international users must obtain a power supply for local voltages and frequencies

¹Max. circulation rate: 50 ml/min with size 14 tubing, 140 ml/min with size 16 tubing.

Table 51. MidJet laboratory systems



Figure 32. MidJet accessory kit

Code number	Model number	Description
56-4105-79	KMDG-1	MidJet accessory kit for use with variable-speed peristaltic pump (Model # PRP-09WM). Pump sold separately. Includes: 6 30-ml reservoirs, polystyrene; 6 120-ml reservoirs, polystyrene; 6 120-ml reservoirs, polystyrene; 12 male Luer-Lok fittings for reservoir caps; 6 screw caps, polypropylene; 1 30-ml reservoir clip; 1 120-ml reservoir clip; 6 cartridge clips; 1 precision backpressure valve for size 14 and 16 tubing, nylon; 10 female Luer-Lok to 1/8-in barb, nylon; 10 female Luer-Lok to 3/32-in barb, nylon; 8 autoclavable caps, 3 ft size 14 tubing, silicone; 3 ft size 16 tubing, silicone; 12 tubing insert sets for 30-ml reservoirs, silicone; 12 tubing insert sets for 120-ml reservoirs, silicone
56-4105-82	KMDG-2	MidJet accessory kit includes: 6 30-ml polystyrene reservoirs (non-autoclavable) and caps, internal tubing sets; 12 20-ml polystyrene reservoirs (non-autoclavable) and caps, internal tubing sets; 4 sets of cap fittings, backpressure valve, 10 Luer-Lok to 0.125-in tubing adaptors; 10 Luer-Lok to 3/32-in tubing adaptors; 6 Luer-Lok to solid cap adaptors, 3 feet each of silicone tubing, sizes 14 and 16
56-4106-53	PRP-09WM	Peristaltic recirculation pump, Watson-Marlow (up to 1.4 lpm with size 17 tubing, and up to 2.0 lpm with size 18 tubing), includes: variable speed drive and manual control system, Flip-Top pump head, pump tubing; 110V/60Hz, 250V/50Hz (dual voltage)
56-4106-10	PRT-DPM-2	Pressure transducers (2) and digital panel readout
56-4106-11	PRT-DPM-3T	Pressure transducers (3), temperature transmitter and digital panel readout
56-4106-14	PT-109-01	Replacement pressure transducer (single unit) Note: requires calibration
56-4106-15	PT-109-02	Replacement pressure transducer (set of 2) Note: requires calibration
56-4106-16	PTSLO2-10	Recirculation Pump Tubing, silicone, size 14, (1.6 mm ID), 3.1 m (10 ft)
56-4106-17	PTSLO3-10	Recirculation Pump Tubing, silicone, size 16, (3.1 mm ID), 3.1 m (10 ft)
56-4105-75	RBFL-1	Female Luer-Lok to 1/8-in barb, nylon, pkg of 10
56-4105-76	RBFL-2	Female Luer-Lok to 3/32-in barb, nylon, pkg of 10
56-4105-77	RBFL-ML	Female Luer-Lok to male luer adaptor, nylon, pkg of 10
56-4105-78	RBFL-SC	Female Luer-Lok to solid cap, nylon, pkg of 10
56-4105-88	VT-06	Precision backpressure valve, nylon, for size 14 and 16 tubing
56-4105-80	MRV-030	MidJet reservoir, 30-ml capacity, polystyrene
56-4105-81	MRV-120	MidJet reservoir, 120-ml capacity, polystyrene
56-4105-83	KMRV-030	MidJet reservoir kit, 30-ml capacity, includes: 12 polystyrene reservoirs (non-autoclavable) and caps, 2 sets of cap fittings, 12 sets of internal tubing
56-4105-84	KMRV-120	MidJet reservoir kit, 120-ml capacity, includes: 12 polystyrene reservoirs (non-autoclavable) and caps, 2 sets of cap fittings, 12 sets of internal tubing
56-4105-86	KMDG-175R01A	Autoclavable MidJet reservoir kit, 175-ml capacity, includes: 3 polycarbonate reservoirs, conical bottom; 3 solid reservoir caps; 3 caps with luer ports; 3 bases to fit MidJet system; standard base
56-4105-87	KMDG-175R02A	Autoclavable MidJet reservoir replacement kit, 175-ml capacity, includes: 6 polycarbonate reservoirs, conical bottom; 3 solid reservoir caps; 6 caps with three luer ports; silicone tubing Note: Kit KMDG-175R01A required for bases

Table 52. Accessories for MidGee cartridges and MidJet systems

QuixStand benchtop system

The QuixStand benchtop system is a compact, laboratory scale cross flow hollow fiber system designed for fast, efficient concentration and/or diafiltration of a wide range of biological solutions. The QuixStand system is capable of rapidly processing solution volumes from as little as 500 ml up to 10 liters, depending on the feed system.

All QuixStand system configurations are designed to accommodate the full range of Amersham Biosciences Xampler hollow fiber ultrafiltration and microfiltration cartridges. When equipped with "M" series cartridges, sanitary pressure gauges and stainless steel sampling/drain valve, the QuixStand system may be used for the preparation of materials for early stage clinical trials.



Figure 33. QuixStand lab-scale separation system with Xampler 4M cartridge, shown with 1 liter reservoir and optional PRP-09WM peristaltic pump

The basic QuixStand system consists of a cartridge support stand, inlet and outlet pressure gauges, and 400 ml and 1 liter reservoirs. The self-contained system also incorporates a precision backpressure control valve and a convenient sampling/drain valve. An optional peristaltic pump with a nominal maximum recirculation rate of 2 liters/minute is available. The low hold-up volume design of the QuixStand system allows minimal working volumes as low as 30 to 50 ml. The QuixStand system can provide efficiency and speed plus true scale-up data impossible to achieve using conventional dialysis tubing or stirred cells.

Several system options and a number of accessories are available for the QuixStand. Contact your Amersham Biosciences salesperson for additional information and assistance in selecting the preferred system for your application.



Figure 34. QuixStand accessory kit

QuixStand systems without pumps

Code number	Model number	Description
56-4107-41	QSM-02S	QuixStand benchtop system with fractional sanitary fittings and NPT-threaded pressure gauges, non-sanitary design, includes: cartridge stand that accepts size 3M, 3X2M, 4, 4M, and 4X2M cartridges; 1 support rod; 2 pressure gauges, threaded, 0-2 barg (0-30 psig); backpressure tubing valve, nylon; reservoir kit with 400-ml and 1000-ml reservoirs, cap, downcomers, clamps, and gaskets; NPT-threaded sampling/drain valve, nylon; QAK-2 accessory kit including clamps, gaskets, O-rings, etc; assembly guide. Not autoclavable
56-4107-42	QSM-03S	Same as QSM-02S system, with fractional sanitary fittings, sanitary pressure gauges and stainless steel sampling/drain valve. Not autoclavable
56-4107-43	QSM-04SA	Same as QSM-02S system, with fractional sanitary fittings, sanitary pressure gauges and stainless steel sampling/drain valve. Autoclavable

QuixStand systems with pumps

Code number	Model number	Description
56-4107-44	QSM-02SP	QuixStand benchtop system with pump, includes: QSM-02S system and PRP-09WM peristaltic recirculation pump (110V/60Hz), and stainless steel system stand
56-4107-77	QSM-02SP/50	Same as QSM-02SP, 220V/50Hz
56-4107-45	QSM-03SP	QuixStand benchtop system with pump, includes: QSM-03S system and PRP-09WM peristaltic recirculation pump (110V/60Hz), and stainless steel system stand
56-4107-78	QSM-03SP/50	Same as QSM-03SP, 220V/50Hz
56-4107-46	QSM-04SAP	QuixStand benchtop system with pump, includes: QSM-04SA system and a PRP-09MPM peristaltic recirculation pump (110V/60Hz), and stainless steel system stand
56-4107-79	QSM-045AP/50	Same as QSM-04SAP, 220V/50Hz

Table 53. QuixStand laboratory scale systems

Code number	Model number	Description
56-4107-47	QRV-2.5	2.5-liter QuixStand reservoir with downcomers only, polysulfone. Not autoclavable
56-4107-48	KQRV-0.4	0.4-liter QuixStand reservoir with cap and downcomers, polysulfone. Autoclavable. Excludes clamps and gaskets
56-4107-49	KQRVA-1.0	1.0-liter QuixStand reservoir with cap and downcomers, polysulfone. Autoclavable. Excludes clamps and gaskets
56-4107-50	QAK-2	QuixStand accessory kit includes: 3 0.5-in TC to 0.375-in barbed adaptors, polysulfone; 5 0.5-in blank-off caps, polysulfone; 2 0.375-in Snapper clamps; 2 0.5-in Snapper clamps; 1 precision backpressure tubing valve, nylon; 2 size 1 and 3 cartridge to 0.5-in TC adaptors, polysulfone; 2 size 4 cartridge to 0.5-in TC adaptors, polysulfone; 5 0.5-in TC gaskets, silicone; 10 2-014 O-rings, silicone; 4 0.25-in cartridge caps, vinyl; 4 0.375-in cartridge caps, vinyl; 16 size 4 cartridge standoffs, Tygon
56-4105-94	HX04-L1-4	Heat exchanger, 0.75-in TC, polysulfone shell, 316L stainless steel tubes
56-4106-53	PRP-09WM	Peristaltic recirculation pump, Watson-Marlow (up to 1.4 lpm with size 17 tubing, and up to 2.0 lpm with size 18 tubing), includes: variable speed drive and manual control system, Flip-Top pump head, pump tubing; 110V/60Hz, 250V/50Hz (dual voltage)
56-4106-52	KPRP-08WP	Dual head add-on kit for PRP-09WM; use with size 17 silicone tubing only
56-4106-41	RLP-250FT/SS	Rotary lobe recirculation pump (110v/60 Hz), FlowTech LABTOP® 250 (approximately 10 lpm flow at 25 psig) with vertical pump head. Includes: variable speed drive and manual control system, 0.75-in Tri-Clamp inlet/outlet, stainless steel rotors, 316L SS rotor housing and shafts, 304 SS gearbox, stainless canopy. High-pressure shutoff switch not included.
56-4106-42	RLP-250FTSS/50	Same as RLP-250FT/SS; 220V/50Hz; high-pressure shutoff switch not included
56-4106-56	RLP-250FT/SS-HPS	Same as RLP-250FT/SS; includes built-in high-pressure shutoff switch
56-4106-57	RLP-250FTSS/50-HPS	Same as RLP-250FT/SS-HPS; 220V/50Hz; includes high-pressure shutoff switch
56-4105-97	PG-01NX04T-30	Pressure gauge, 0-30 psig, 0.125-in NPT with adaptor to "M" fitting, bottom mount
56-4105-98	PG-01NX04T-60	Pressure gauge, 0-60 psig, 0.125-in NPT with adaptor to "M" fitting, bottom mount
56-4105-99	PG-06T-30	Pressure gauge, 0-30 psig, 0.75-in TC, non-autoclavable, bottom mount
56-4106-00	PG-06T-30S	Pressure gauge, 0-30 psig, 0.75-in TC, non-autoclavable, side mount
56-4106-01	PG-06T-60	Pressure gauge, 0-60 psig, 0.75-in TC, non-autoclavable, bottom mount
56-4106-02	PG-06T-60S	Pressure gauge, 0-60 psig, 0.75-in TC, non-autoclavable, side mount
56-4105-90	VPC4	Sampling/drain valve, 0.5-in TC, 316L SS
56-4105-92	VDM-6SS	Diaphragm valve, 0.75-in TC, 316L SS
56-4106-18	PTPM06-10	Peristaltic pump tubing, Bioprene®, size 17, 6.4 mm ID, 3.1 m (10 ft)
56-4106-19	PTPM09-10	Peristaltic pump tubing, Bioprene, size 18, 9.5 mm ID, 3.1 m (10 ft)
56-4106-20	PTPM06-M	Peristaltic pump tubing, Bioprene, size 17, 6.4 mm ID, 5 precut 0.46 m (1.5 ft) lengths with fractional TC fittings, for QS-02S, QS-03S and QS-04SA.
56-4106-21	PTPM09-M	Peristaltic pump tubing, Bioprene size 18, 9.5 mm ID, 5 precut 0.46 m (1.5 ft) lengths with fractional TC fittings, for QS-02S, QS-03S and QS-04SA

Table 54. Accessories for QuixStand laboratory scale systems

FlexStand pilot scale systems

FlexStand™ benchtop pilot scale systems are compact, sanitary hollow fiber ultrafiltration/microfiltration systems for laboratory through pilot scale applications. These cross flow systems are designed for fast, efficient concentration and/or diafiltration of a wide range of biological solutions in process volumes from 5 to 100 liters. The systems accommodate a wide range of Amersham Biosciences cartridges with various housing sizes, pore sizes, lumen diameters and membrane areas.

The FlexStand system is offered in two different configurations:

- Standard system with 1.5-in Tri-Clamp fittings for larger surface area cartridges (housing sizes 5, 6, 8, 9, 35 and 55). This unit has a minimal working volume of approximately 1 to 2 liters depending on choice of recirculation pump and actual piping set-up.
- Low void volume system with 0.75-in Tri-Clamp fittings for smaller surface area cartridges (housing sizes 3M, 3X2M, 4M, 4X2M, 5 and 6).
The minimum working volume for this system is in the 400 to 500 ml range.

Within these configurations, both stand-alone and complete systems with rotary lobe or peristaltic pumps are offered. Thirty-liter stainless steel feed tanks are optional.

Ease of hollow fiber membrane cartridge change-out allows change-over from microfiltration to ultrafiltration sequentially with the same system, as well as performance comparison of different pore size and lumen diameter options quickly and efficiently. Moreover, lab and pilot evaluation data can be used to project scale-up processing requirements.

The FlexStand systems are designed for autoclavability, using mechanically dampened, autoclavable pressure gauges.

Pilot scale systems



Figure 35. Standard FS-01S FlexStand system with a size 9 cartridge installed

Standard FlexStand systems are available both with and without rotary lobe pumps. A 30 liter stainless steel reservoir is also an optional accessory.



Figure 36. Low void volume FlexStand system

The low void volume FlexStand system accommodates Xampler cartridges with fractional Tri-Clamp end fittings and small process scale cartridges (size 5 and 6) with 1.5-in Tri-Clamp endfittings. With a system hold-up volume of less than 125 ml, this system is ideal for concentration/diafiltration of valuable biological solutions. The FS-04LVS-RLP/50 system shown is configured with a size 6 cartridge, LABTOP® 250 rotary lobe pump, high-pressure shutoff switch, diaphragm valves and optional FRV-2A reservoir kit.



Safety

WARNING: Rotary lobe pumps should be equipped with an over-pressure safety cutoff switch for operator safety and for protection of membrane filtration cartridges. Amersham Biosciences offers rotary lobe pumps both with and without these safety switches. Should you elect to operate your pump without this safety device, we suggest that the system never be left unattended during processing or cleaning operations.



Figure 37. FlexStand tubing connector kit



Figure 38. Low void volume FlexStand tubing connector kit



Figure 39. Low void volume to standard FlexStand conversion kit



Figure 40. Standard to low void volume FlexStand conversion kit

FlexStand systems without pumps

Code number	Model number	Description
56-4107-54	FS-01S	Standard FlexStand benchtop pilot system with 1.5-in Tri-Clamp connections for feed inlet/outlet. Includes: stand and support rods; pressure gauge, back mount, 0-4 barg (0-60 psig), mechanically dampened; backpressure valve, pinch-type; blank-off cap; 6 clamps, 1.5-in sanitary type; 6 silicone gaskets, 1.5-in sanitary type; tubing connector kit KTC-2; assembly guide. Autoclavable
56-4107-55	FS-03LVS	Low void volume FlexStand benchtop pilot system, with 0.75-in Tri-Clamp connections for feed inlet/outlet. Includes: stand and support rods; pressure gauge, back mount, 0-4 barg (0-60 psig), mechanically dampened; backpressure valve, pinch-type; blank-off cap; 6 clamps, 0.75-in sanitary type; 6 silicone gaskets, 0.75-in sanitary type; tubing connector kit KTC-FS-03VS; assembly guide. Autoclavable

FlexStand systems with pumps

Code number	Model number	Description
56-4107-56	FS-02RLP	FlexStand benchtop pilot system with rotary lobe pump (110V, 60Hz). Includes: stand and support rods with manifolds; 2 pressure gauges, back mount, mechanically dampened 0-4 barg (0-60 psig) ¹ ; rotary lobe recirculation pump, FlowTech LABTOP 350 (includes low point drain); gear box for LABTOP 350 pump; 1.5-in sanitary diaphragm valve for retentate, stainless steel; 0.75-in sanitary diaphragm valve for low point drain, stainless steel; high-pressure shutoff switch; tubing connector kit KTC-2; set of clamps, gaskets, piping, tubing; assembly guide
56-4107-57	FS-02RLP/50	Same as FS-02RLP except pump is 220V, 50Hz
56-4107-58	FS-04LVS-RLP	Low void volume FlexStand benchtop pilot system, with rotary lobe pump (110V, 60Hz). Includes: stand and support rods with manifolds; 2 pressure gauges, back mount, mechanically dampened 0-4 barg (0-60 psig) ¹ ; rotary lobe recirculation pump, FlowTech LABTOP 250; gear box for LABTOP 250 pump, 2 diaphragm valves, 0.75-in sanitary, stainless steel; high-pressure shutoff switch; tubing connector kit KTC-FS-03VS; set of clamps, gaskets, piping, tubing; assembly guide
56-4107-59	FS-04LVS-RLP/50	Same as FS-04LVS-RLP except pump is 220V, 50Hz

¹0-2 barg (0-30 psig) pressure gauges may be substituted. Please contact your local Amersham Biosciences representative for more information.

Table 55. FlexStand pilot scale systems

Pumps and pump accessories

Code number	Model number	Description
56-4106-43	RLP-350DPFT	Rotary lobe recirculation pump, FlowTech LABTOP 350 (110V, 60Hz), (approximately 30 lpm at 1.7 barg). Includes: variable speed drive and manual control system, 1.5-in Tri-Clamp horizontal inlet/outlet, 316L SS rotors, rotor housing, and shafts; 304 SS gearbox, stainless steel canopy, and low point drain port for complete liquid removal. High-pressure shutoff switch not included
56-4106-58	RLP-350DPFT-HPS	Same as RLP-350DPFT. Includes built-in high-pressure shutoff switch
56-4106-44	RLP-350DPFT/50	Same as RLP-350DPFT; 220V, 50Hz. High-pressure safety shutoff switch not included
56-4106-59	RLP-350DPFT/50-HPS	Same as RLP-350DPFT; 220V, 50Hz. Includes built-in high-pressure shutoff switch
56-4106-41	RLP-250FT/SS	Rotary lobe recirculation pump (110V, 60Hz), FlowTech LABTOP 250 (approximately 10 lpm flow at 1.7 barg) with vertical pump head. Includes: variable speed drive and manual control system, 0.75-in Tri-Clamp inlet/outlet, stainless steel rotors, 316L SS rotor housing and shafts, 304 SS gearbox, and stainless steel canopy. High-pressure safety shutoff switch not included
56-4106-56	RLP-250FT/SS-HPS	Same as RLP-250FT/SS. Includes built-in high-pressure shutoff switch
56-4106-42	RLP-250FTSS/50	Same as RLP-250FT/SS; 220V, 50Hz. High-pressure shutoff switch not included
56-4106-57	RLP-250FTSS/50-HPS	Same as RLP-250FT/SS; 220V, 50Hz. Includes built-in high-pressure shutoff switch
56-4107-60	YS-01-12TCSS	Y strainer for RLP-350DPFT pump suction protection, 1.5-in TC, 316L SS
56-4106-45	PRP-01MF	Peristaltic recirculation pump, Masterflex single head, flowrate up to 13 lpm. Includes: variable-speed drive and manual control system, Easy-Load® pump head, pump tubing
56-4106-46	PRP-01MF/50	Same as PRP-01MF; 220V, 50Hz
56-4106-47	KPRP-02MF	Dual-head add-on kit for PRP-01MF peristaltic pump, increases pump flowrate up to 26 lpm. Includes: Easy-Load pump head, pump tubing, clamps, Y-connectors, mounting hardware. Requires either PRP-01MF or PRP-01MF/50 pump. Use only with silicone tubing

Table 56. Pumps and pump accessories for FlexStand pilot scale systems

FlexStand system tubing

Code number	Model number	Description
56-4106-22	PTPM12	Peristaltic pump tubing—Bioprene size 82, 12.7 mm (0.5-in) ID, 7.6 m (25 ft) long
56-4106-23	PTSL12	Peristaltic pump tubing—Silicone size 82, 12.7 mm (0.5-in) ID, 7.6 m (25 ft) long
56-4106-24	FTTY06	Flexible tubing—Tygon® S-50-HL 6.3 mm (0.25-in) ID, 15.2 m (50 ft) long
56-4106-25	FTTY09	Flexible tubing—Tygon S-50-HL 9.5 mm (0.375-in) ID, 50 ft (15.2 m) long
56-4106-26	FTTY12	Flexible tubing—Tygon S-50-HL 12.7 mm (0.5-in) ID, 15.2 m (50 ft) long

Table 57. Tubing for FlexStand pilot scale systems

Code number	Model number	Description
56-4107-61	KFSM12	Conversion kit to change low void volume FlexStand to standard system. Includes: 2 1.5-in TC tee fittings, SS; 6 1.5-in TC toggle clamps, SS; 6 1.5-in TC gaskets, silicone; 4 1.5-in manifold inserts; 4 6-32 set screws, SS; 1 KTC-2 tubing connector kit
56-4107-62	KFSM04	Conversion kit to change standard FlexStand to low void volume system. Includes: 2 low holdup TC tee fittings, SS; 2 0.5-in TC clamps, SS; 6 0.5-in TC gaskets, silicone; 2 0.5-in TC to 0.375-in barbed adaptors, polysulfone; 4 0.5-in manifold inserts; 2 1.5-in to 0.5-in TC adaptors, polysulfone; 4 6-32 set screws, SS; 1 KTC-FS-03VS tubing connector kit
56-4107-63	TK01-30SS	Tubing connector kit for FS-01S system (one kit included with basic system). Includes: 4 0.5-in to 0.5-in tubing connectors, polypropylene; 8 0.5-in Snapper® clamps; 8 0.375-in Snapper clamps; 2 tubing pinch clamps; 2 1.5-in TC clamps, nylon; 6 1.5-in TC gaskets, silicone; 2 1.5-in to 0.375-in barbed adaptors, polysulfone; 4 1.5-in to 0.5-in barbed adaptors, polysulfone; 2 1.5-in to 0.75-in barbed adaptors, polysulfone; 2 1.5-in TC blank-off caps, polysulfone; 1 #1 Allen wrench, 1 #2 Allen wrench, 2 6-32 set screws, SS; 2 10-32 set screws, SS; 2 5/16-18 x 1 in hex bolts, SS; 2 5/16 flat washers, SS
56-4107-64	KTC-2	Tubing connector kit for FS-03LVS system (one kit included with basic system). Includes: 2 0.5-in to 0.5-in tubing connectors; 8 0.5-in Snapper clamps; 8 0.375-in Snapper clamps; 8 0.25-in Snapper clamps; 1 tubing pinch clamp; 6 0.5-in TC to 0.375-in barbed adaptors, polysulfone; 4 1.5-in TC gaskets, silicone; 6 0.5-in TC blank-off caps, polysulfone; 2 1.5-in TC blank-off caps, polysulfone; 6 0.5-in TC gaskets, silicone; 2 0.75-in TC gaskets, silicone; 2 0.5-in TC clamps, SS; 2 0.5-in to 0.25-in tubing connectors, polypropylene; 2 1.5-in to 0.5-in TC adaptors, polysulfone; 4 1.5-in TC toggle clamps, SS; 2 0.5-in TC to 0.5-in barbed adaptors, polysulfone; 2 0.75-in elbows, polysulfone; 2 0.75-in tee fittings, polysulfone; 1 #1 Allen wrench, 1 #2 Allen wrench, 2 6-32 set screws, SS; 2 10-32 set screws, SS; 2 5/16-18 x 1 in hex bolts, SS; 2 5/16 flat washers, SS
56-4107-65	KTC-FS-03VS	Tubing connector kit for FS-03LVS system (one kit included with basic system). Includes clamps, adaptors, and gaskets
56-4109-31	PG-TCP30B	Pressure gauge, 0 to 2 barg (0 to 30 psig), back mount, mechanically dampened. Autoclavable
56-4106-04	PG-TCP60	Pressure gauge, 0 to 4 barg (0 to 60 psig), back mount, mechanically dampened. Autoclavable
56-4106-06	PG-TCV30P30	Vacuum/pressure gauge, -2 to 2 barg (-30 to 30 psig), back mount, mechanically dampened. Autoclavable
56-4107-66	RVK-1	FlexStand reservoir kit. Includes: 2 liter graduated polysulfone reservoir with open top; supports, clamps, gaskets, and adaptors. Not autoclavable
56-4107-67	FRV-2A	FlexStand reservoir kit. Includes: 2 liter polysulfone reservoir with supports and sealable top for diafiltration; clamps, gaskets, and adaptors. Autoclavable
56-4107-68	FRV-PPK-2A	Replacement 2 liter reservoir, polysulfone, body only. Autoclavable
56-4107-70	FRV-5A	FlexStand reservoir kit. Includes: 5 liter polysulfone reservoir with supports and sealable top for diafiltration; clamps, gaskets, and adaptors. Autoclavable
56-4107-71	FRV-PPK-5A	Replacement 5 liter reservoir, polysulfone body only. Autoclavable
56-4107-69	FRV-CP2/5A	Replacement reservoir cap, 2 or 5 liter FlexStand reservoir, polysulfone. Autoclavable
56-4107-72	KDV-F1	Drain valve kit (for FS-01S system). Includes: custom 1.5-in TC x 0.5-in TC tee (316 SS), sanitary plug valve (316 SS), 0.5-in TC silicone gasket and 304 SS clamp
56-4107-73	KPCM-1	Manual permeate control kit. Includes: mechanically-dampened vacuum/pressure gauge with clamps, gaskets, backpressure valve, supports, and tubing adaptors
56-4105-92	VDM-6SS	Diaphragm valve, 0.75-in TC, 316L SS
56-4105-93	VDM-12SS	Diaphragm valve, 1.5-in TC, 316L SS
56-4105-91	VBF12	Butterfly valve, 1.5-in TC, 316L SS, silicone seat
56-4105-95	HX12-L1-8	Heat exchanger, 1.5-in TC, polysulfone shell, 316L SS tubes, 5.1 cm diameter x 34 cm long
56-4105-96	HX12-L2-9	Heat exchanger, 1.5-in TC, polysulfone shell, 316L SS tubes, 5.1 cm diameter x 63 cm long

Table 58. Accessories for FlexStand pilot scale systems

Process scale systems

GrandStand systems

GrandStand™ process systems are designed to support a wide selection of Amersham Biosciences hollow fiber ultrafiltration and/or microfiltration cartridges. With its unique flexible support system in place, the system can accommodate cartridges of any length. Standard systems are supplied with rotary lobe pumps that are adequate for operating either a single MaxCell process scale cartridge containing membranes with 0.5 or 1 mm lumen diameters, or two of these cartridges in parallel. This results in a potential maximum (with 0.5 mm ID fibers) of 13 m² (140 ft²) of membrane area for the single position system and 26 m² (280 ft²) for the dual GrandStand. Smaller diameter cartridges may be easily accommodated.

GrandStand systems are designed to allow rapid membrane changeover to cartridges of the same or different length by way of an adjustable cartridge manifold. Moreover, the system can easily accommodate Amersham Biosciences hollow fiber cartridges with an alternate pore size and/or lumen diameter. Sequential batch processing with microfiltration membranes for clarification followed by ultrafiltration to concentrate the clarified stream can be accomplished economically with a single system.

A polypropylene clean-in-place tank is included. Sanitary extensions are in place for connection to tanks or other process components. Optional accessories such as heat exchangers and data acquisition packages are also available.

This system is intended to operate independently, with no sequencing or interfacing with other process components. Instrumentation to allow automated operation will be quoted upon request.

Standard GrandStand system features include:

- Positive displacement rotary lobe pump for gentle recirculation of biological solutions
- Sanitary inlet and outlet pressure gauges
- Polypropylene cone-bottom, clean-in-place tank
- Programmable AC inverter featuring a multitude of functions including the ability to set the pump acceleration time as well as to monitor pump speed
- Sliding manifold accommodates a wide range of Amersham Biosciences pilot-process cartridges
- Narrow profile to fit through standard door openings
- Designed for easy interchange between process and cleaning cycles

Several cost-saving standard design configurations are available for quick delivery. Contact your Amersham Biosciences salesperson for more information.



Figure 41. Single position GrandStand system with a MaxCell size 65 cartridge installed

Custom engineered systems

Amersham Biosciences custom builds pilot and process scale ultrafiltration and microfiltration systems. We would welcome the opportunity to discuss your system needs and provide a proposal.

Contact your Amersham Biosciences salesperson for more information.



Figure 42. Custom engineered system with Steam-in-place capability



Figure 43. Custom engineered system using multiple MaxCell process scale cartridges

Parts and accessories

Introduction

Many types of adaptors, fittings and accessories are offered by Amersham Biosciences to help maximize the ease of use and effectiveness of our hollow fiber membrane cartridges and systems. These parts include several components with fractional Tri-Clamp end fittings for connection to size 3M, 3X2M, 4M and 4X2M cartridges as well as our QuixStand systems.

For flexible tubing connection to either the fractional Tri-Clamp or the standard 1.5-in Tri-Clamp fittings on feed, retentate and permeate ports, we provide a number of kits complete with adaptors, gaskets, clamps and blank-off caps for cartridge storage.

The following tables and figures detail adaptors, fittings, adaptor kits, clamps, gaskets and O-rings, tubing, valves, pressure indicators, heat exchanges and pumps that support our cartridges and systems.

Adaptors and fittings

Code number	Model number	Description
56-4106-98	RB4-2PS	0.5-in TC to 0.25-in tubing adaptor, polysulfone
56-4109-79	KRB4-2PS	0.5-in TC to 0.25-in tubing adaptor, polysulfone, pack of 2
56-4106-99	RB4-3PS	0.5-in TC to 0.375-in barbed adaptor, polysulfone
56-4109-80	KRB4-3PS	0.5-in TC to 0.375-in barbed adaptor, polysulfone, pack of 2
56-4107-00	RB4-4PS	0.5-in TC to 0.5-in barbed adaptor, polysulfone
56-4109-81	KRB4-4PS	0.5-in TC to 0.5-in barbed adaptor, polysulfone, pack of 2
56-4107-01	RB4-6PS	0.5-in TC to 0.75-in barbed adaptor, polysulfone
56-4109-82	KRB4-6PS	0.5-in TC to 0.75-in barbed adaptor, polysulfone, pack of 2
56-4107-02	RB4-MLPC	0.5-in TC to male Luer-Lok adaptor, polycarbonate
56-4109-83	KRB4-MLPC	0.5-in TC to male Luer-Lok adaptor, polycarbonate, pack of 2
56-4107-03	EL4-4PS	0.5-in TC elbow, polysulfone
56-4107-04	T4-4PS	0.5-in TC tee fitting, polysulfone
56-4107-05	T4-4SS	0.5-in TC tee fitting, 316L SS
56-4107-06	T4M-L-2PS	0.5-in TC x 0.25-in tubing adaptor x male Luer-Lok tee
56-4107-07	RB12-4MPS	1.5-in TC to 0.5-in TC adaptor, polysulfone
56-4109-84	KRB12-4MPS	1.5-in TC to 0.5-in TC adaptor, polysulfone, pack of 2
56-4107-08	RB12-3PS	1.5-in TC to 0.375-in barbed adaptor, polysulfone
56-4109-85	KRB12-3PS	1.5-in TC to 0.375-in barbed adaptor, polysulfone, pack of 2
56-4107-09	RB12-4PS	1.5-in TC to 0.5-in barbed adaptor, polysulfone
56-4109-86	KRB12-4PS	1.5-in TC to 0.5-in barbed adaptor, polysulfone, pack of 2
56-4107-10	RB12-6PS	1.5-in TC to 0.75-in barbed adaptor, polysulfone
56-4109-87	KRB12-6PS	1.5-in TC to 0.75-in barbed adaptor, polysulfone, pack of 2
56-4107-11	RB12-3MNPTK	1.5-in TC to 0.375-in male NPT adaptor, PVDF
56-4107-12	RB12-4MNPTK	1.5-in TC to 0.5-in male NPT adaptor, PVDF
56-4107-13	RB12-6MNPTK	1.5-in TC to 0.75-in male NPT adaptor, PVDF
56-4107-14	RB12-8MNPTK	1.5-in TC to 1-in male NPT adaptor, PVDF
56-4107-15	RB12-8FNPTSS	1.5-in TC to 1-in female NPT adaptor, 304 SS
56-4107-16	RB12-10MNPTK	1.5-in TC to 1.25-in male NPT adaptor, PVDF
56-4107-17	RB12-12MNPTK	1.5-in TC to 1.5-in male NPT adaptor, PVDF
56-4107-18	RB12-12FNPTSS	1.5-in TC to 1.5-in female NPT adaptor, 304 SS
56-4107-19	RB12-MLPC	1.5-in TC to male Luer-Lok adaptor, polycarbonate
56-4109-88	KRB12-MLPC	1.5-in TC to male Luer-Lok adaptor, polycarbonate, pack of 2
56-4107-20	T12-12SS	1.5-in TC tee fitting, 316L SS
56-4107-21	RB16-12SS	2-in TC to 1.5-in TC concentric adaptor, 316L SS
56-4107-22	RB16-12FNPTSS	2-in TC to 1.5-in female NPT adaptor, 304 SS
56-4107-23	RB16-16FNPTSS	2-in TC to 2-in female NPT adaptor, 304 SS
56-4107-24	RB32-12PS-CV	"R" end fitting to 1.5-in TC adaptor, polysulfone, sweep
56-4107-25	RB32-12PS-ST	"R" end fitting to 1.5-in TC adaptor, polysulfone, straight
56-4107-26	RBMX-16PS-ST	Straight adaptor for MaxCell cartridge, polysulfone
56-4107-27	RBMX-16PS-EL	Elbow adaptor for MaxCell cartridge, polysulfone
56-4107-28	EL16-16SS	2-in TC elbow, 316L SS

Table 59. Cartridge adaptors

Adaptor kits with stainless steel clamps

Code number	Model number	Description
56-4107-29	KA4-3PS	0.5-in TC to 0.375-in tubing adaptor kit. Contains 2 RB4-3PS polysulfone adaptors, 2 FB4PS polysulfone blank-off caps, 2 G4S silicone gaskets and 2 CL4 304 SS clamps
56-4107-31	KA12-3PS	1.5-in TC to 0.375-in tubing adaptor kit. Contains 2 RB12-3PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets and 2 CL12-LT 304 SS clamps
56-4107-32	KA12-4PS	1.5-in TC to 0.5-in tubing adaptor kit. Contains 2 RB12-4PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets and 2 CL12-LT 304 SS clamps
56-4107-33	KA12-6PS	1.5-in TC to 0.75-in tubing adaptor kit. Contains 2 RB12-6PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets and 2 CL12-LT 304 SS clamps

Adaptor kits with nylon clamps

Code number	Model number	Description
56-4109-16	KA4-2PS-NY	0.5-in TC to 0.25-in tubing adaptor kit. Contains 2 RB4-2PS polysulfone adaptors, 2 FB4PS polysulfone blank-off caps, 2 G4S silicone gaskets and 2 CL4-NY nylon clamps
56-4107-30	KA4-3PS-NY	0.5-in TC to 0.375-in tubing adaptor kit. Contains 2 RB4-3PS polysulfone adaptors, 2 FB4PS polysulfone blank-off caps, 2 G4S silicone gaskets and 2 CL4-NY nylon clamps
56-4107-34	KA12-3PS-NY	1.5-in TC to 0.375-in tubing adaptor kit. Contains 2 RB12-3PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets and 2 CL12-NY nylon clamps
56-4107-35	KA12-4PS-NY	1.5-in TC to 0.5-in tubing adaptor kit. Contains 2 RB12-4PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets and 2 CL12-NY nylon clamps
56-4107-36	KA12-6PS-NY	1.5-in TC to 0.75-in tubing adaptor kit. Contains 2 RB12-6PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets and 2 CL12-NY nylon clamps

Table 60. Adaptor kits

Code number	Model number	Description
56-4106-60	FB4PS	0.5-in TC blank-off cap, polysulfone
56-4109-89	KFB4PS	0.5-in TC blank-off cap, polysulfone, pack of 2
56-4106-61	FB12PS	1.5-in TC blank-off cap, polysulfone
56-4109-90	KFB12PS	1.5-in TC blank-off cap, polysulfone, pack of 2
56-4106-62	FB12SS	1.5-in TC blank-off cap, 316L SS
56-4109-91	KFB12SS	1.5-in TC blank-off cap, 316L SS, pack of 2
56-4106-63	FB16K	2-in TC blank-off cap, PVDF
56-4109-92	KFB16K	2-in TC blank-off cap, PVDF, pack of 2
56-4106-64	FB16SS	2-in TC blank-off cap, 316L SS
56-4109-93	KFB16SS	2-in TC blank-off cap, 316L SS, pack of 2

Table 61. Cartridge blank-off caps

Code number	Model number	Description
56-4106-65	CL4	0.5-in TC quick disconnect clamp, 304 SS
56-4106-66	CL4-NY	0.5-in TC quick disconnect clamp, nylon
56-4106-67	CL12	1.5-in TC quick disconnect clamp, 304 SS
56-4106-68	CL12-NY	1.5-in TC quick disconnect clamp, nylon
56-4106-69	CL12-LT	1.5-in TC toggle clamp, 304 SS
56-4106-70	CL16-LT	2-in TC toggle clamp, 304 SS
56-4106-71	CL24	3-in TC [Schedule 5 Pipe] quick disconnect clamp, 304 SS
56-4106-72	CL32	"R" end fitting clamp, 301 SS
56-4106-73	CL32TC	MSM 4-in TC [Schedule 5 Pipe] clamp, 304 SS
56-4106-74	CL48	6-in TC [Schedule 5 Pipe] clamp, 304 SS

Table 62. Clamps

Code number	Model number	Description
56-4109-94	KG4S	0.5-in TC gasket, silicone, pack of 4
56-4109-95	KG6S	0.75-in TC gasket, silicone, for use with 0.75-in pressure gauges and pressure switch, pack of 4
56-4109-96	KG12S	1.5-in TC gasket, silicone, pack of 4
56-4109-97	KG12B	1.5-in TC gasket, Buna-N, pack of 4
56-4109-98	KG16S	2-in TC gasket, silicone, pack of 4
56-4106-92	K04ORS	MaxCell O-ring set, silicone, pack of 2
56-4106-93	K04ORB	MaxCell O-ring set, Buna-N, pack of 2

Table 63. Gaskets and O-rings

Code number	Model number	Description
56-4107-26	RBMX-16PS-ST	Straight adaptor for MaxCell cartridge, polysulfone
56-4107-27	RBMX-16PS-EL	Elbow adaptor for MaxCell cartridge, polysulfone
56-4107-21	RB16-12SS	2-in TC to 1.5-in TC concentric adaptor, 316L SS
56-4107-22	RB16-12FNPTSS	2-in TC to 1.5-in female NPT adaptor, 304 SS
56-4107-23	RB16-16FNPTSS	2-in TC to 2-in female NPT adaptor, 304 SS
56-4107-28	EL16-16SS	2-in TC elbow, 316LSS
56-4107-37	KAMX-16PS	Straight adaptor kit for new installation. Kit contains 2 polysulfone RBMX-16PS-ST straight adaptors, 2 polysulfone cartridge end nuts and 2 silicone O-rings. Kit KAMX-16PS or kit KAMX-16EL-PS required for each new MaxCell cartridge
56-4107-38	KAMX-16EL-PS	Elbow adaptor kit for new installation. Kit contains 2 polysulfone RBMX-16PS-EL elbow adaptors, 2 polysulfone cartridge end nuts and 2 silicone O-rings. Kit KAMX-16PS or kit KAMX-16EL-PS required for each new MaxCell cartridge
56-4106-70	CL16-LT	2-in TC toggle clamp, 304 SS
56-4107-39	SWR-MX01	MaxCell wrench set, standard
56-4107-40	SWR-MX02	MaxCell wrench set, applied torque

Table 64. MaxCell accessories

Code number	Model number	Description
56-4106-16	PTSL02-10	Peristaltic pump tubing, silicone size 14, 1.6 mm ID, 3.1 m (10 ft)
56-4106-17	PTSL03-10	Peristaltic pump tubing, silicone size 16, 3.1 mm ID, 3.1 m (10 ft)
56-4106-18	PTPM06-10	Peristaltic pump tubing, Bioprene size 17, 6.4 mm ID, 3.1 m (10 ft)
56-4106-19	PTPM09-10	Peristaltic pump tubing, Bioprene size 18, 9.5 mm ID, 3.1 m (10 ft)
56-4106-20	PTPM06-M	Peristaltic pump tubing, Bioprene size 17, 6.4 mm (0.25-in) ID, 5 precut 0.46 m (1.5 ft) lengths with fractional TC fittings, for QS-02S, QS-03S and QS-04SA
56-4106-21	PTPM09-M	Peristaltic pump tubing, Bioprene size 18, 9.5 mm (0.375-in) ID, 5 precut 0.46 m (1.5 ft) lengths, with fractional TC fittings, for QS-02S, QS-03S and QS-04SA
56-4106-22	PTPM12	Peristaltic pump tubing—Bioprene size 82, 12.7 mm (0.5-in) ID, 7.6 m (25 ft) long
56-4106-23	PTSL12	Peristaltic pump tubing—silicone size 82, 12.7 mm (0.5-in) ID, 7.6 m (25 ft) long
56-4106-24	FTTY06	Flexible tubing—Tygon S-50-HL, 6.4 mm (0.25-in) ID, 15.2 m (50 ft) long
56-4106-25	FTTY09	Flexible tubing—Tygon S-50-HL, 9.5 mm (0.375-in.) ID, 15.2 m (50 ft) long
56-4106-26	FTTY12	Flexible tubing—Tygon S-50-HL, 12.7 mm (0.5-in) ID, 15.2 m (50 ft) long

Table 65. Tubing

Code number	Model number	Description
56-4105-97	PG-01NX04T-30	Pressure gauge, 0-30 psig, 0.125-in NPT, with adaptor to 0.5-in TC fitting, bottom mount
56-4105-98	PG-01NX04T-60	Pressure gauge, 0-60 psig, 0.125-in NPT, with adaptor to 0.5-in TC fitting, bottom mount
56-4105-99	PG-06T-30	Pressure gauge, 0-30 psig, 0.75-in TC, bottom mount, non-autoclavable
56-4106-00	PG-06T-30S	Pressure gauge, 0-30 psig, 0.75-in TC, side mount, non-autoclavable
56-4106-01	PG-06T-60	Pressure gauge, 0-60 psig, 0.75-in TC, bottom mount, non-autoclavable
56-4106-02	PG-06T-60S	Pressure gauge, 0-60 psig, 0.75-in TC, side mount, non-autoclavable
56-4106-03	PG-TCP30	Pressure gauge, sanitary 1.5-in TC, 0-2 barg (0-30 psig), mechanically dampened, back mount, autoclavable
56-4106-04	PG-TCP60	Pressure gauge, sanitary 1.5-in TC, 0-4 barg (0-60 psig), mechanically dampened, back mount, autoclavable
56-4106-05	PG-TCP60S	Pressure gauge, sanitary 1.5-in TC, 0-4 barg (0-60 psig), mechanically dampened, side mount
56-4106-06	PG-TCV30P30	Vacuum/pressure gauge, -2 to 2 barg (-30 to 30 psig), mechanically dampened, back mount, autoclavable
56-4106-07	PG-NPT30B	Pressure gauge, 0.25-in NPT, 0-2 barg (0-30 psig), back mount
56-4106-08	PG-NPT30L	Pressure gauge, 0.25-in NPT, 0-2 barg (0-30 psig), lower mount
56-4106-09	KPG-NPT30T	Pressure gauge kit, 0.25-in NPT, fitted on nylon tee, 9-mm (0.375-in) barb connections, 0-2 barg (0-30 psig)
56-4106-10	PRT-DPM-2	Two pressure transducers with digital panel readouts
56-4106-11	PRT-DPM-3T	Three pressure transducers and temperature with digital panel readouts
56-4106-14	PT-109-01	Replacement pressure transducer, requires calibration, single unit
56-4106-15	PT-109-02	Replacement pressure transducer, requires calibration, pack of 2

Table 66. Pressure indicators

Code number	Model number	Description
56-4105-88	VT-06	Tubing valve, size 14 & 16 tubing, nylon
56-4105-89	VT-09	Tubing valve, 0.375-in OD tubing (e.g., size 17), nylon
56-4105-90	VPC4	0.5-in TC drain/vent valve, 316L SS
56-4105-91	VBF12	1.5-in TC butterfly valve, 316L SS, silicone seat
56-4105-92	VDM-6SS	Diaphragm valve, 0.75-in TC, 316L SS
56-4105-93	VDM-12SS	Diaphragm valve, 1.5-in TC, 316L SS

Table 67. Valves

Code number	Model number	Description
56-4105-94	HX04-L1-4	Heat exchanger, 0.75-in TC, 0.9 cm diameter x 25 cm long, polysulfone shell, 316L SS tubes
56-4105-95	HX12-L1-8	Heat exchanger, 1.5-in TC, 5.1 cm diameter x 34 cm long, polysulfone shell, 316L SS tubes
56-4105-96	HX12-L2-9	Heat exchanger, 1.5-in TC, 5.1 cm diameter x 63 cm long, polysulfone shell, 316L SS tub

Table 68. Heat exchangers

Code number	Model number	Description
56-4106-43	RLP-350DPFT	Rotary lobe recirculation pump, FlowTech LABTOP 350 (110V, 60Hz), (approximately 30 lpm at 1.7 barg). Includes: variable speed drive and manual control system, 1.5-in Tri-Clamp horizontal inlet/outlet, 316L SS rotors, rotor housing, and shafts; 304 SS gearbox, stainless canopy, and low point drain port for complete liquid removal. High-pressure shutoff switch not included
56-4106-58	RLP-350DPFT-HPS	Same as RLP-350DPFT. Includes built-in high-pressure shutoff switch
56-4106-44	RLP-350DPFT/50	Same as RLP-350DPFT; 220V, 50Hz. High-pressure safety shutoff switch not included
56-4106-59	RLP-350DPFT/50-HPS	Same as RLP-350DPFT; 220V, 50Hz. Includes built-in high-pressure shutoff switch
56-4106-41	RLP-250FT/SS	Rotary lobe recirculation pump (110V, 60Hz), FlowTech LABTOP 250 (approximately 10 lpm flow at 1.7 barg) with vertical pump head. Includes: variable speed drive and manual control system, 0.75-in Tri-Clamp inlet/outlet, stainless steel rotors, 316L SS rotor housing and shafts, 304 SS gearbox and stainless canopy. High-pressure safety shutoff switch not included
56-4106-56	RLP-250FT/SS-HPS	Same as RLP-250FT/SS. Includes built-in high-pressure shutoff switch
56-4106-42	RLP-250FTSS/50	Same as RLP-250FT/SS; 220V, 50Hz. High-pressure shutoff switch not included
56-4106-57	RLP-250FTSS/50-HPS	Same as RLP-250FT/SS; 220V, 50Hz. Includes built-in high-pressure shutoff switch
56-4106-45	PRP-01MF	Peristaltic recirculation pump, Masterflex single head, flowrate up to 13 lpm. Includes: variable-speed drive and manual control system, Easy-Load® pump head, pump tubing
56-4106-46	PRP-01MF/50	Same as PRP-01MF for 220V, 50 Hz power source
56-4106-47	KPRP-02MF	Dual-head add-on kit for PRP-01MF peristaltic pump, increases pump flowrate up to ~26 lpm. Includes: Easy-Load® pump head, pump tubing, clamps, Y-connectors and mounting hardware. Requires either PRP-01MF or PRP-01MF/50 pump. Use only with silicone tubing
56-4106-53	PRP-09WM	Peristaltic recirculation pump, Watson-Marlow (up to 1.4 lpm with size 17 tubing, and up to 2.0 lpm with size 18 tubing), includes: variable speed drive and manual control system, flip-top pump head, pump tubing; 110V/60Hz, 250V/50Hz (dual voltage)
56-4106-52	KPRP-08WP	Dual-head add-on kit for PRP-09WM; use with size 17 silicone tubing only

Table 69. Pumps



Safety

WARNING: Rotary lobe pumps should be equipped with an over-pressure safety cutoff switch for operator safety and for protection of membrane filtration cartridges. Amersham Biosciences offers rotary lobe pumps both with and without these safety switches. Should you elect to operate your pump without this safety device, we suggest that the system never be left unattended during processing or cleaning operations.

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glossary

Adsorption

The binding of molecules to a surface as a result of a chemical or physio electric interaction between the membrane surface and the molecule.

Air diffusion rate

The rate at which air diffuses through the wetted pores of a membrane at a given differential pressure. Measuring the air diffusion rate is a method used to check the integrity of a membrane filter.

Asymmetric membrane

A membrane that is made such that the pore size increases through the membrane matrix.

Autoclave, autoclavability

An autoclave is a device that uses saturated steam at a specified pressure over time to kill microorganisms and thus achieve sanitization or sterilization. Because many materials change properties when exposed to moisture, heat and pressure, products destined for this process must be specially engineered for autoclavability.

Back flushing, backwash

Reversing the permeate flow to mechanically clean the membrane.

Beta ratio

A standard method of rating a filter's ability to remove particles.

Binding

The process by which some components in a feed solution adhere to the membrane. Binding can be desirable in some instances, but often, as in the case of protein, binding during sterile filtration can result in a loss of valuable product.

Biosafety tests

A class of tests that determine whether a filter's materials of construction can induce systemic toxicity, skin irritation, sensitization reaction or other biological responses. These tests are often completed by labs *in vivo* or *in vitro*. For example, United States Pharmacopoeia Class VI Plastics Test involves both the implantation and extraction of drugproduct contact surfaces to demonstrate that these materials are not toxic to various mammalian cells.

Blinded

When a filter is blinded, it means that particles have filled the pores and the flow through the filter from the feed side to the permeate side is reduced or stopped.

Bubble point

The minimum pressure required to overcome the capillary forces and surface tension of a liquid in a fully wetted membrane filter. The bubble point value is determined by observing when bubbles first begin to emerge on the permeate side or downstream side of a fully wetted membrane filter when pressurized with a gas on the feed (upstream) side of the membrane filter.

Bubble point test

The test procedure for determining the bubble point of the largest pores in a microfiltration membrane.

Buffer exchange

Filtration process used for the removal of smaller ionic solutes, whereby the feed solution is washed, usually repeatedly, and one buffer is removed and replaced with an alternative buffer.

Cartridge or cartridge filter

A filtration or separation device having a membrane encapsulated within a housing. The housing normally has feed and permeate ports and, in the case of cross flow filters, a retentate port. All of these ports may be used to control the flow parameters of fluid into and out of the housing and through the membrane.

Cassette

A device used for cross flow filtration, typically in a rectangular form comprised of stacked flat sheets of membrane integrally bonded together. Most cassettes are typically designed to fit into a standard cassette holder where the feed, permeate and any retentate ports mate with appropriate fittings on the cassette holders.

Cell harvesting

The process of concentrating (dewatering) the cell mass after fermentation. Cell slurries in excess of 70% wet cell weight are achievable. The cells may also be washed to prepare them for further processing, such as freezing or lysing. Unlike clarification processing, with cell harvesting, the cells are the target material.

Channel height

The height of the path that the feed/retentate solution must pass through for a flat membrane cassette.

Channel length

The total length that the feed solution must travel along a flat cassette to reach the retentate outlet.

Chemical compatibility

The ability of the components of a filter to resist chemicals that can influence the filter's performance. For example, some chemicals could cause the filter to shed particles or swell, or dissolve filter components. Repeatable performance requires that filters are resistant to all the chemicals that they are exposed to at a given concentration, temperature and total exposure time.

CIP, Clean-in-place

The process of cleaning a filtration device without removing it from its filtration system.

Composite membrane

A membrane that is made up of two or more layers that are usually chemically or structurally different.

Concentrate

Also called retentate. The part of the process solution that does not pass through a cross flow membrane filter.

Concentration

Cross flow filtration process in which the components that do not pass through the membrane remain in the feed loop and therefore increase in concentration as filtrate leaves the system.

Concentration factor

The concentration factor equals the ratio of the initial feed volume to retentate volume after separation. For example, if the initial feed volume is 100-ml and the final retentate volume is 20-ml, the concentration factor is 5x.

Concentration polarization

The buildup of molecules of dissolved substances (solutes) on the surface of the membrane filter during filtration. The concentration polarization layer increases resistance to filtrate flow and reduces the permeate flux, thus decreasing filtration efficiency.

Cross flow filtration

Also called tangential flow filtration. In cross flow filtration, the feed solution flows parallel to the surface of the membrane. Driven by pressure, some of the feed solution passes through the membrane filter. Most of the solution is circulated back to the feed tank. The movement of the feed solution across the membrane surface helps to remove the buildup of foulants on the surface.

Cross flow rate

Also called retentate flow rate. The flow rate of solution that remains in the feed loop as measured in the retentate line.

Cutoff

Nominally, the smallest entity that will pass through a separation device to become permeate (filtrate)—larger particles (where retention is >90%) are thus "cut off" from the permeate. Actual cutoff values of any given device or lot of devices usually must be determined empirically.

See *Molecular weight cutoff (MWCO)* and *Nominal molecular weight cutoff (NMWC)*.

Dead-ended filtration

Also called normal flow filtration. In dead-ended filtration, liquid flows perpendicular to the filtration media, and all of the feed passes through.

Depth filter

A thick filter that captures contaminants within its pore structure using entrapment and adsorption. A membrane filter primarily captures contaminants on its surface.

Depyrogenate

The removal or decomposition of pyrogens (lipopolysaccharides, endotoxins) from a process solution.

Diafiltration

Diafiltration is a unit operation that incorporates ultrafiltration membranes to remove salts or other microsolute from a solution. Small molecules are separated from a solution while retaining larger molecules in the retentate. Microsolute are generally so easily washed through the membrane that for a fully permeated species about three volumes of diafiltration solution will eliminate 95%—99% of the microsolutes.

See *Buffer Exchange*.

Dialysis

Removal of small molecules from a solution of macromolecules by allowing them to diffuse through a semi-permeable membrane into water or a buffer solution. This osmotic pressure separations method is controlled by the concentration gradient of salts across the membrane.

Differential pressure

In cross flow filtration the pressure drop along the cartridge between the feed (inlet) port and the retentate (outlet) port.

Diffusion

Movement of gas molecules caused by a concentration gradient.

Direct flow filtration

Filtration process where the entire feed stream flows through the filter's media. Also called *normal flow filtration* and *dead-end filtration*.

Downstream processing

Starting with a feed stream free of cells and cell debris, the purification sequences involving chromatography and membrane separations to achieve final product purity.

Effective area

In a membrane separations device, the active area of the membrane exposed to flow.

Endotoxin

The outer cell wall of gram-negative bacteria, also known as *LPS (lipopolysaccharides)* and *pyrogens*.

EtO, Ethylene oxide sterilization

A sterilization process still common for biomedical products, in which product is subjected to steam and highly toxic ethylene oxide gas. Because many materials change properties when exposed to moisture and EtO byproducts, products destined for this process must be specially engineered for EtO sterilization.

Extractables

Substances that may dissolve or leach from a membrane device during filtration and contaminate the process solution. For example, the leachates might include wetting agents in the membrane, membrane cleaning solutions or substances from the materials used to encase the membrane.

Feed

Material or solution that is introduced into a membrane separation system device.

Feed pressure

The pressure measured at the feed port of a separation device such as a cartridge or cassette.

Filter area

The surface area of filter media inside a separation device.

Filter efficiency

Filter efficiency represents the percentage of particles that are removed from the fluid by the filter.

Filtrate

Also called permeate. The portion of the process fluid that passes through the membrane.

Flowpath length, nominal flowpath length

The total length that a feed solution travels from inlet to outlet. Flowpath length is an important parameter to consider when doing any process development, system design or scale-up or scale-down experiments. The flow path length and other fluid channel geometries such as lumen diameter or channel height can affect the fluid dynamics of the system and will directly affect pump requirements and differential pressure of the filtration step.

Flux

Flux represents the volume of solution flowing through a given membrane area during a given time. Expressed as LMH (liters per square meter per hour).

$$\text{flux (normalized to } 20^{\circ}\text{C)} = \text{flux at measured temperature } (^{\circ}\text{C}) \times \frac{20^{\circ}\text{C}}{\text{measured temperature } (^{\circ}\text{C})}$$

Fouling

A build up of material on the membrane surface that can slow down and alter a filtration process.

Fractionation

Separation of molecules in a solution based on differences in the molecular weight of the molecules.

Gamma sterilization

A type of sterilization process accomplished by bombarding the object to be sterilized with electron beam, x-ray or ^{60}Co or ^{137}Cs irradiators. All generate forms of gamma rays, radiant energy at short wavelength (0.1 nm or less). The governing standard is ISO 11137—Sterilization of Healthcare Products—Requirements for Validation and Routine Control—Radiation Sterilization. Because some product materials can be adversely affected by gamma radiation, objects destined for gamma sterilization must be engineered specifically for this process.

Gel layer

During the filtration process, the thin layer of particles or molecules that may build up at the membrane surface. It is also referred to as the concentration polarization layer. High TMP can lead to an increase in the thickness of the gel layer and negatively impact the filtration process by reducing flux and inhibiting passage through the membrane.

Hold-up volume

Quantity of fluid remaining within the filtration media after draining the system.

Hollow fiber

The tube-like structure made from a membrane and sealed inside a cross flow cartridge. When in use, the feed stream flows into the inner diameter of one end of the hollow fiber and the retentate (the material that does not permeate through the walls of the hollow fiber) flows out the other end. The material that passes through the membrane (walls of the hollow fiber) is called the permeate.

Housing

The mechanical structure that surrounds and supports the membrane or filter element. The housing normally has feed, retentate and permeate ports that direct the flow of process fluids into and out of the filter assembly.

Hydrophilic

Filters that wet out easily with water and work well with aqueous solutions.

Hydrophobic

Filters that do not wet out easily with water but typically do wet out easily with nonpolar solvents such as alcohol. Once wetted, many aqueous solutions can be processed in a hydrophobic filter.

In vitro

An experiment performed in a test tube, Petri dish or other lab apparatus with parts of a living organism, such as testing a drug with tissue samples. From Latin, meaning "in glass."

In vivo

An experiment performed using a living organism. From Latin, meaning "in live [subjects]."

Inlet pressure

The pressure driving a fluid into the feed port of a separation device.

Isoelectric point

The pH at which a protein carries no electric charge.

Lumen

The inner open space or cavity of a single hollow fiber element that is used in the construction of hollow fiber cartridges.

Macrovoid

A generally undesirable open space in a membrane filter that is appreciably larger than the average of the pore openings in a given filter. Macrovoids can lead to pinhole defects resulting in unwanted passage that directly affects final product yield. Macrovoids can also affect the overall membrane strength and thus the device's ability to maintain integrity under pressure.

Media exchange

A filtration step used to exchange one type of media for an alternative type of media during an aseptic cell culture separation.

Media migration

Media migration occurs when solid components of a filter (particles, adhesives, etc.) break free of the filter and enter the process solution.

Medium (media)

The component of a separation device that actually filters the process solution. For example, the membrane in a cartridge or cassette.

Membrane

A thin layer of a highly engineered material with pores used to separate particulates, biological matter and molecules from a solution.

Membrane recovery

The degree to which the original performance of a membrane can be restored by cleaning.

Microfiltration

The process of removing particles from a liquid by passing it through a porous membrane under pressure. Microfiltration usually refers to removing submicron-size particles.

Micron (micrometer, μm)

One one-millionth of one meter.

Microporous membrane

A thin, porous film or hollow fiber having pores ranging from 0.01 to 10 μm . Science and industry use microporous membranes to separate suspended matter from liquids.

Minimum process volume

The least amount of fluid able to be handled effectively by a process system.

Molecular weight

Mass of one molecule of a nonionic substance in atomic mass units.

MWCO, Molecular weight cutoff

The size designation in Daltons (D) for ultrafiltration membranes. The molecular weight of the globular protein that is 90% retained by the membrane. No industry standard exists; hence the MWCO ratings of different manufacturers are not always comparable.

Nanofiltration

Separation processes targeted for solutes having molecular weights from 500 to 1,000D.

See **Molecular weight cut off (MWCO)**.

Nominal filter rating

A rating that indicates the percentage of particles of a specific size or molecules of a specific molecular weight that will be removed by a filter. No industry standard exists; hence the ratings from manufacturer to manufacturer are not always comparable.

NMWC, Nominal molecular weight cutoff

In ultrafiltration, the molecular weight size of a protein or other solute (in thousands of Daltons) that will be retained to 90% by the membrane.

See *Molecular weight cutoff*.

Normal flow filtration

Also called dead-ended filtration. In normal flow filtration, liquid flows perpendicular to the filter media, and all of the feed passes through.

NWP, Normalized water permeability

The water flux at 20 °C.

Oleophobic

Membranes that repel nonpolar fluids such as oil and lubricants.

Particle size distribution

The distribution of particle sizes (number or weight fraction) in a fluid.

Permeate

Also called filtrate. The portion of a process fluid that passes through a membrane.

pH

Negative logarithm of the hydronium ion (H_3O^+) concentration in an aqueous solution. Indicates the acidity or alkalinity of a substance.

PLC, Programmable logic controller

A purpose-made device for industrial control. Microprocessors, now common in desktop computers, were originally devised in the 1970s for PLCs or for the types of operations common to PLCs (polling or checking sensors and activating/deactivating valves and switches compared against programmed presets or default levels).

Pleating

Folding filter media to increase the surface area that can be fitted into a given separation device.

Pore size distribution

The range of pore sizes in a membrane. The tighter the pore size distribution, the better control one has over the filtration process.

Porosity

A measurement of the open space in a membrane. Also called open area or membrane void volume.

Pressure drop

The difference in pressure between two points.

Protein passage

The passage of protein into the permeate stream.

Pyrogen

A substance that produces a fever within a warm-blooded animal when injected into the bloodstream. Filtration materials of construction that come in contact with injectable liquids must meet pyrogenicity standards.

Recovery

Percentage of the target substance that can be collected in the retentate or permeate solution after processing.

Residence time

The time required for an incremental unit of feed solution to pass through a separation device.

Retentate

The portion of the feed solution that does not pass through a cross flow membrane filter.

Retention

The ability of a separation device to retain an entity of a given size.

Reverse osmosis

Type of crossflow filtration used for removal of very small solutes (<1,000 Daltons) and salts. It uses a semi-permeable membrane under high pressure to separate water from ionic materials. High pressure is necessary to overcome the natural osmotic pressure created by the concentration gradient across the membrane.

Sanitization

A cleaning process that destroys most living microorganisms.

Separation

During operation, the separation device divides a liquid or gas feed stream into separate components.

Shear rate

A ratio of velocity and distance expressed in units of sec^{-1} . The shear rate for a hollow fiber cartridge is based on the flowrate through the fiber lumen and can be calculated as follows:

Where:

g = shear rate, sec^{-1}

q = flowrate through the fiber lumen cm^3/sec

r = fiber radius, cm

$$g = \frac{4q}{\pi r^3}$$

Sieving

Removal of particulates from a feed stream as a result of entrapment within the depth of the membrane pore structure.

SIP, Steam-in-place

The process of sterilizing a tank or process device, such as a hollow fiber cartridge, with steam, without removing the device from the separation system.

Size exclusion

Mechanism for removing particulates from a feed stream based strictly on the size of the particles versus the pore size that the feed stream is being filtered through. Retained particulates are held back because they are larger than the pore opening.

Solute

An ionic or organic compound dissolved in a solvent; for example, the sugar in a cup of coffee is a solute.

Starling flow

A portion of filtrate (permeate) that is driven back through the membrane in the reverse direction near the outlet of the cartridge, due to the high permeability of these membranes in the presence of permeate pressure. This phenomenon is most often associated with the operation of microfiltration membranes using permeate flow control.

Sterilization

A process that removes/destroys all microorganisms from a solution or a solution processing system.

See *Autoclave*, *EtO Ethylene oxide sterilization*, *Gamma sterilization*.

Surface filter

A filter in which particles larger than the pores are retained on the surface of the filter.

Tangential flow filtration

Also called cross flow filtration. In tangential flow filtration, the feed solution flows parallel to the surface of the membrane. Driven by pressure, some of the feed solution passes through the membrane filter. Most of the solution is circulated back to the feed tank. The movement of the feed solution across the face of the membrane surface helps to remove the buildup of foulants on the surface.

Thermal stability

The ability of a membrane and filtering device to maintain its performance during and after exposure to excursions of temperature, such as the elevated temperatures experienced during high-temperature processing or steam sterilization.

Throughput

(1) The volume of solution that will pass through a separation device before the filtrate output drops to an unacceptable level.

(2) The rate at which a separation system will generate filtrate.

Titer reduction

The measurement of a filter's ability to remove microbes or virus from a fluid.

TMP, Transmembrane pressure

The force that drives liquid flow through a cross flow membrane. During filtration, the feed side of the membrane is under higher pressure than the permeate side. The pressure difference forces liquid through the membrane.

Tubule

Tube-like structure (larger ID fibers than hollow fibers) made from ultrafiltration or microfiltration membrane and sealed inside a cross flow cartridge. When in use, the feed stream flows into one end of the tubule and the retentate (the material that does not permeate through the walls of the tubule) flows out the other end. The material that does flow through the membrane (walls of the tubule) is called the permeate.

Turbidity

The measure of relative sample clarity of a liquid. Measurements are based on the amount of light transmitted in straight lines through a sample. The more light that is scattered by fine solids or colloids, the less clear (and more turbid) the solution. Often reported in NTU (nephelometric turbidity unit).

Ultrafiltration

The separation of macrosolutes based on their molecular weight or size.

Upstream

The feed side of a separation process.

Upstream processing

Cellular separations including cell lysates, cell harvesting, clarification and cell culture perfusion.

Viral clearance

The removal of viral contamination using specialized membranes or chromatography. In order to ensure that therapeutic drugs derived from certain sources are fully rid of any viral contamination, these protein solutions undergo viral clearance to inactivate or remove viral materials.

Viscosity

A measurement of a fluid's resistance to shear. A slow-flowing liquid such as gear oil has a higher viscosity than a free-flowing liquid such as mineral spirits. In a given separation process, higher-viscosity, Newtonian fluids have a lower flow rate through a cartridge than do lower-viscosity fluids.

Void volume

Quantity of fluid required to completely fill a section of piping. Also, the amount of open space within membrane filter media.

Water flux

Measurement of the amount of water that flows through a cartridge. Clean water flux refers to the flux measurement made under standardized conditions on a new (and cleaned) membrane cartridge.

See *Flux*.

Yield

The amount of particulates or molecules of interest (product) that can be recovered from the cross flow filtration process. Also called recovery.

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CFP-1-E-55STM	56-4104-28	58	CL32	56-4106-72	87
CFP-1-E-5A	56-4102-47	41	CL32TC	56-4106-73	87
CFP-1-E-65	56-4104-92	49	CL4	56-4106-65	59, 87
CFP-1-E-65MSM	56-4104-59	64	CL48	56-4106-74	52, 87
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CFP-1-E-H22LA	56-4100-96	29	FB12PS	56-4106-61	87
CFP-1-E-MM06A	56-4100-65	27	FB12SS	56-4106-62	87
CFP-1-E-MM12A	56-4100-66	27	FB16K	56-4106-63	87
CFP-1-E-MM24A	56-4100-67	27	FB16SS	56-4106-64	87
CFP-2-E-152M	56-4105-12	51	FB4PS	56-4106-60	87
CFP-2-E-154M	56-4105-15	51	FRV-2A	56-4107-67	79
CFP-2-E-35A	56-4103-32	45	FRV-5A	56-4107-70	79
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CFP-2-E-45	56-4104-72	49	FS-02RLP	56-4107-56	77
CFP-2-E-45MSM	56-4104-50	64	FS-02RLP/50	56-4107-57	77
CFP-2-E-4A	56-4102-06	35	FS-03LVS	56-4107-55	77
CFP-2-E-4MA	56-4101-81	35	FS-04LVS-RLP	56-4107-58	77
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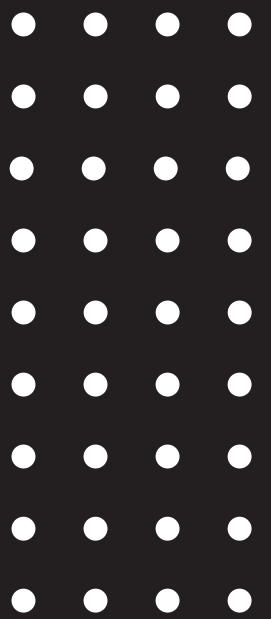
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**Amersham
Biosciences**

Asia Pacific

Tel: +852 2811 8693

Fax: +852 2811 5251

Australia

Tel: +61 2 9899 0999

Fax: +61 2 9899 7511

Austria

Tel: 01 576 0616 23

Fax: 01 576 0616 27

Belgium

Tel: 0800 73 888

Fax: 03 272 1637

Canada

Tel: 1 800 463 5800

Fax: 1 800 567 1008

**Central, East and
Southeast Europe**

Tel: +43 1 982 3826

Fax: +43 1 985 8327

Denmark

Tel: 45 16 2400

Fax: 45 16 2424

Finland and Baltics

Tel: 358-(0)9-512 39 40

Fax: 358-(0)9-512 17 10

France

Tel: 01 6935 6700

Fax: 01 6941 9677

Germany

Tel: 0761 4903 406

Fax: 0761 4903 405

Italy

Tel: 02 27322 1

Fax: 02 27302 212

Japan

Tel: 81 3 5331 9336

Fax: 81 3 5331 9370

Latin America

Tel: +55 11 3933 7300

Fax: +55 11 3933 7306

Middle East and Africa

Tel: +30 (10) 96 00 687

Fax: +30 (10) 96 00 693

Netherlands

Tel: 0165 580 410

Fax: 0165 580 401

Norway

Tel: 2318 5800

Fax: 2318 6800

Portugal

Tel: 21 417 7035

Fax: 21 417 3184

Russia and other C.I.S. and N.I.S

Tel: +7 (095) 232 0250, 956 1137

Fax: +7 (095) 230 6377

Southeast Asia

Tel: 60 3 8024 2080

Fax: 60 3 8024 2090

Spain

Tel: 93 594 49 50

Fax: 93 594 49 55

Sweden

Tel: 018 612 1900

Fax: 018 612 1910

Switzerland

Tel: 01 802 81 50

Fax: 01 802 81 51

UK

Tel: 0800 616928

Fax: 0800 616927

USA

Tel: +1 800 526 3593

Fax: +1 877 295 8102