



LENNTECH

8" END PORT PRESSURE VESSEL

TECHNICAL MANUAL

LENNTECH

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Introduction

BEL, founded in 1966, specializes in the design and manufacture of a variety of products made from advanced composite materials. With over 40 years of experience, the company has developed and mastered the innovative technologies necessary to manufacture the highest quality composite products. Combining innovation, technology, responsibility and dedication, our goal is to become the leader in providing commercial and industrial composite vessels for our clients needs.

BEL pressure vessels are manufactured from filament wound fiber reinforced plastic (FRP), wound over precision mandrels, using a superior epoxy resin, which results in the ultimate combination of physical strength and an ultra smooth inside surface. Vessels are tested according to the requirements of ASME code section X, the internationally recognized standard for pressure vessel construction.

BEL holds ISO 9001 quality systems certification, and its quality assurance is also approved for in-house final inspection by many of its customers.

The BEL family of pressure vessels is designed to be used as housings for all 4", 8", 9" and 16" inch spiral-wound Reverse Osmosis (RO), Nanofiltration (NF) and Ultra filtration (UF) membrane elements.

The pressure vessels are manufactured in different configurations, according to the required operating pressures, filtration type, and piping layout. In order to enhance interchangeability and facilitate the use and maintenance of the vessels, the utilization of identical parts and sub-assemblies has been maximized throughout the design of the vessel. For better performance and longer service life, each model is manufactured from the highest quality and highest performing materials of construction.

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1. Safety Precautions

- i. BEL pressure vessels are designed for high pressure operations. Improper installation, operation service or maintenance may cause severe damage to property, physical injury or death.
- ii. BEL pressure vessels are designed for water treatment only.
- iii. **PRESSURE AND TEMPERATURE DESIGN LIMITS** - Operation of a vessel outside the design limits will make void the warranty and may result in vessel fatigue with possible eventual explosive head failure. Although each vessel is tested at 110% of the design pressure **LONG-TERM OPERATION ABOVE DESIGN PRESSURE MUST BE PREVENTED**. Permeate port pressure **MUST NOT EXCEED 125 psi**. Vessels should **NOT BE CONTINUOUSLY OPERATED AT TEMPERATURES ABOVE 120°. (49° C)**.
- iv. The pressure vessel should not be use as a support. Piping manifolds and other fittings should be properly designed system framework. **OPERATING PERSONNEL SHOULD BE DISCOURAGED FROM APPLYING UNDUE FORCE TO ANY FITTINGS CONNECTED DIRECTLY TO A PRESSURE VESSEL.**
- v. Only qualified mechanics, experienced in working with high pressure hydraulic systems, should be allowed to disassemble or assemble the vessel.
- vi. Regularly inspect the system so as to ensure that the various components have not deteriorated or been damaged. Replace any faulty component, make sure the reason for the fault has been found and fixed as well.
- vii. Make sure that vessels and associated pipe systems are fully depressurized before attempting any service or maintenance operation.
- viii. Be careful not to scratch the inside wall of the shell, especially at the inner sealing area near the groove.
- ix. Corroded parts may cause difficulties in removing the head or other components. Do not try to force remove components before all visible signs of corrosion have been eliminated.
- x. Never attempt to repair or disassemble the feed/concentrate port in a side port vessel without consulting BEL.
- xi. Inspect end closures regularly; replace components that have deteriorated and correct causes of corrosion.
- xii. Do not tolerate Leaks, or allow end closures to be routinely wetted in any way.

2. Installation notes

- i. Provide adequate room for serving at both ends of vessel. Elements are installed from the upstream end, pushed through towards the downstream end and eventually removed from the downstream end.
- ii. Make sure that the vessel is horizontally installed on support saddles.
- iii. The vessels must not be rigidly clamped in place, mounting design must allow for both radial and axial expansion (typically up to 0.5 mm radial and up to 2-3 mm axial). Restriction can result in damage to the vessel and other system components.
- iv. Straps should be tightened enough to hold the vessel onto the support pads, but never so tightly as to restrict expansion.
- v. A flexible piping connection should be provided in order to prevent unwanted loads transfer from the manifolds to the permeate connection and to permit decoupling the header from the vessel.
The recommended permeate port connection is a U-bend pipe with flexible connections at each end.
- vi. The piping system must be connected to the ports using flexible connectors in order to allow relative movement of the vessels and the piping system. (Victaulic or equivalent connections are recommended).

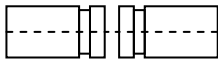
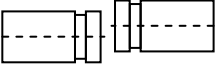
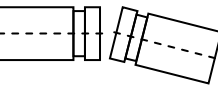
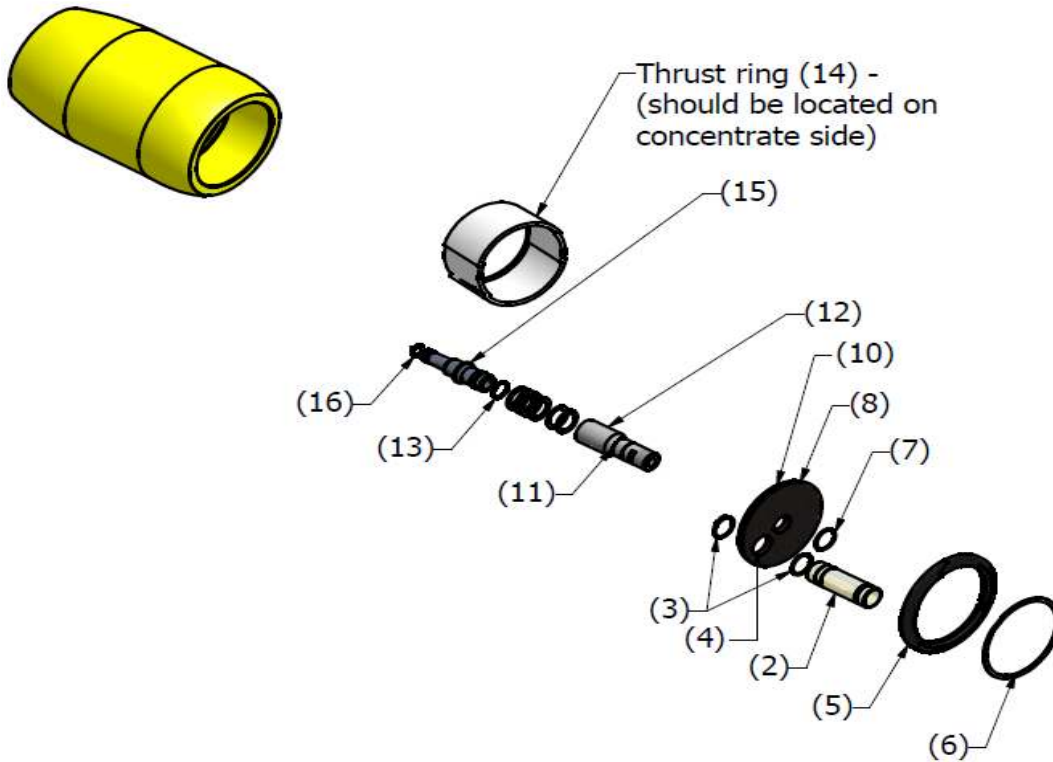
End Port	 Spacing [mm]- X	 Max Offset* [mm]	 Max Angle [Deg]
1.5"	2 + 0.5	3	2.5

Table 2.1

3. Component List

3.1 BEL 8" PRESSURE VESSEL 300 PSI End Port assembly



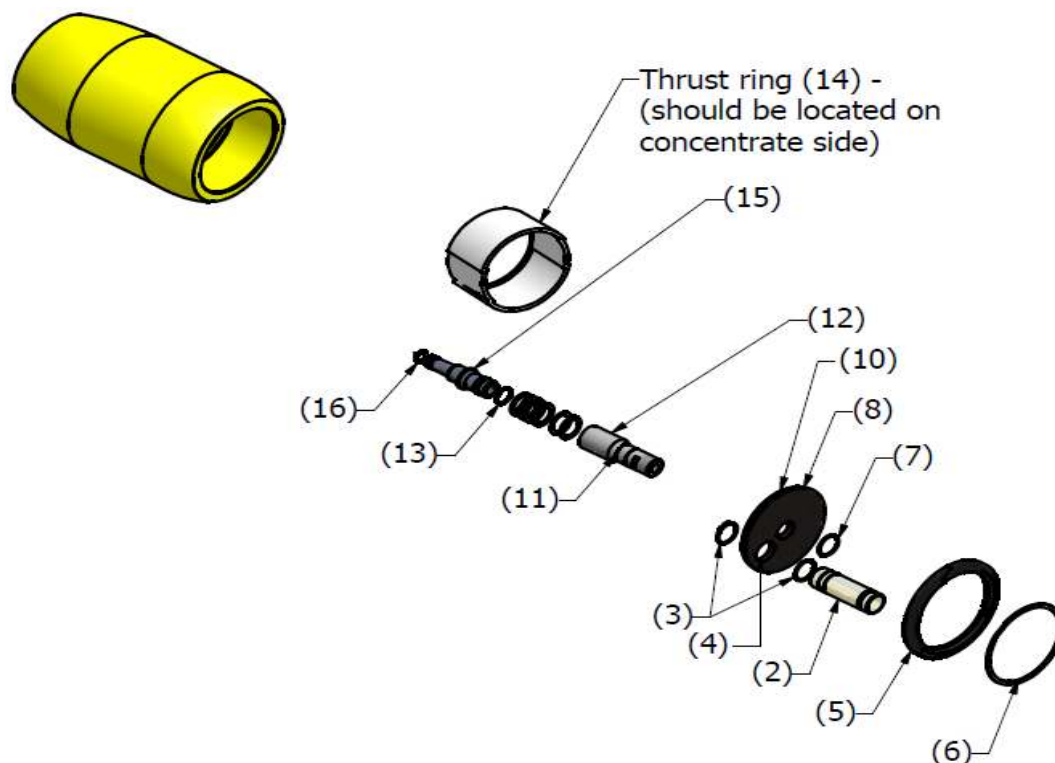
ITEM	QTY	DESCRIPTION	MATERIAL	PART NUMBER
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 0 / 300 /1-8
2	2	End Port 1.5"	Stainless steel	009-150-0600
3	4	Retaining ring for End Port	Stainless steel	55412335
4	2	Seal for End Port	EPDM	55412225
5	2	Support ring	Engineering plastic	285034015
6	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
7	2	Retaining ring for P. Port	Stainless steel	283772336
8	2	Base Plate	Engineering plastic	003-800-0450
9	-	-	-	-
10	2	Seal for Sealing Plate	Engineering plastic	55412339
11	2	Seal for P. Port	EPDM	283776342
12	2	Permeate Port	Engineering plastic	008-801-0125
13	2	Seal for Adapter	Engineering plastic	285773918
14	1	Thrust ring	Engineering plastic	55410419
15	2	Adapter	Engineering plastic	See Table 3.2
16	2-4	Membrane seal	EPDM	55413912 / 55412357 (1.5")
*17	2-3	Saddle	Engineering plastic	55410351
*18	2	Strap Assy.	Stainless steel	55410310
*19	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*20	0-7	Disk spacer - 3mm	Engineering plastic	285779233

Table 3.1 *-These parts are not shown on the drawing assembly

PART DESCRIPTION	PART NUMBER
Adapter 1.125" / Adapter 1.125" blind	001-112-0452 / 001-112-1228
Adapter 1.5" / Adapter 1.5" blind	285349324 / 001-150-0458

Table 3.2

3.2 BEL 8" PRESSURE VESSEL 450 PSI End Port assembly



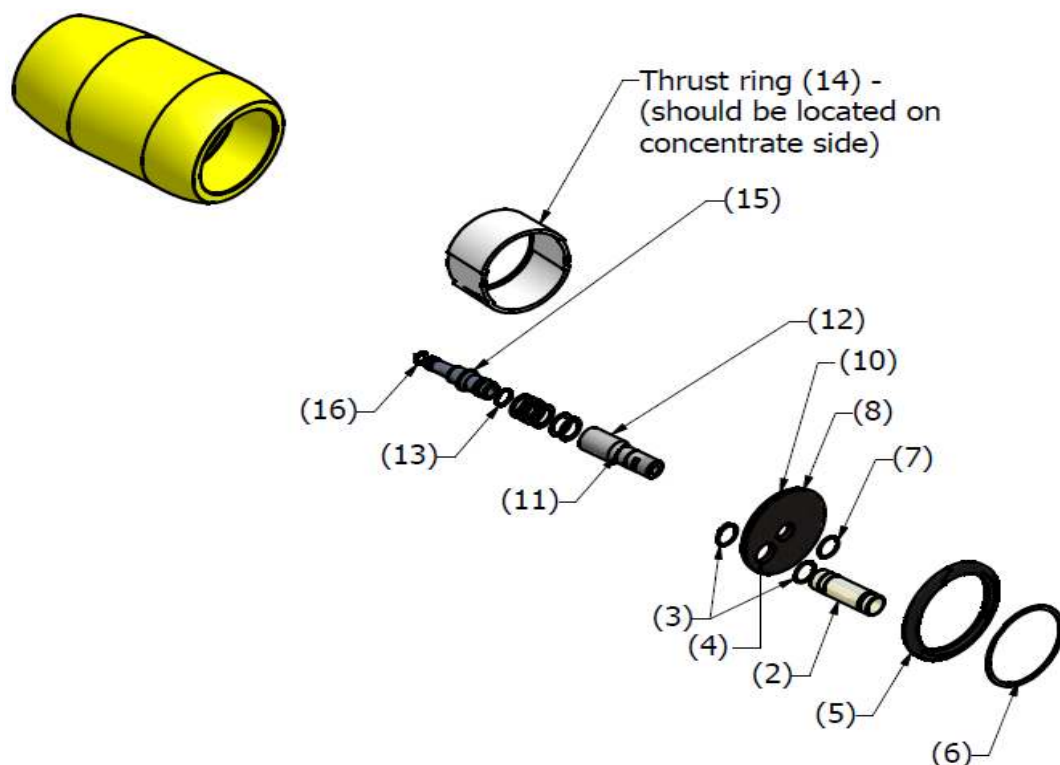
ITEM	QTY	DESCRIPTION	MATERIAL	PART NUMBER
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 0 / 450 / 1-8
2	2	End Port 1.5"	Stainless steel	009-150-0600
3	4	Retaining ring for End Port	Stainless steel	55412335
4	2	Seal for End Port	EPDM	55412225
5	2	Support ring	Aluminum	55410299
6	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
7	2	Retaining ring for P. Port	Stainless steel	283772336
8	2	Base Plate	Engineering plastic	003-800-0450
9	2	-	-	-
10	2	Seal for Sealing Plate	Engineering plastic	55412339
11	2	Seal for P.port	EPDM	283776342
12	2	Permeate Port	Engineering plastic	008-801-0125
13	2	Seal for Adapter	Engineering plastic	285773918
14	1	Thrust ring	Engineering plastic	55410419
15	2	Adapter	Engineering plastic	See Table 3.4
16	2-4	Membrane seal	EPDM	55413912 / 55412357 (1.5")
*17	2-3	Saddle	Engineering plastic	55410351
*18	2	Strap Assy.	Stainless steel	55410310
*19	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*20	0-7	Disk spacer - 3mm	Engineering plastic	285779233

Table 3.3 *-These parts are not shown on the drawing assembly

PART DESCRIPTION	PART NUMBER
Adapter 1.125" / Adapter 1.125" blind	001-112-0452 / 001-112-1228
Adapter 1.5" / Adapter 1.5" blind	285349324 / 001-150-0458

Table 3.4

3.3 BEL 8" PRESSURE VESSEL 600 PSI End Port assembly



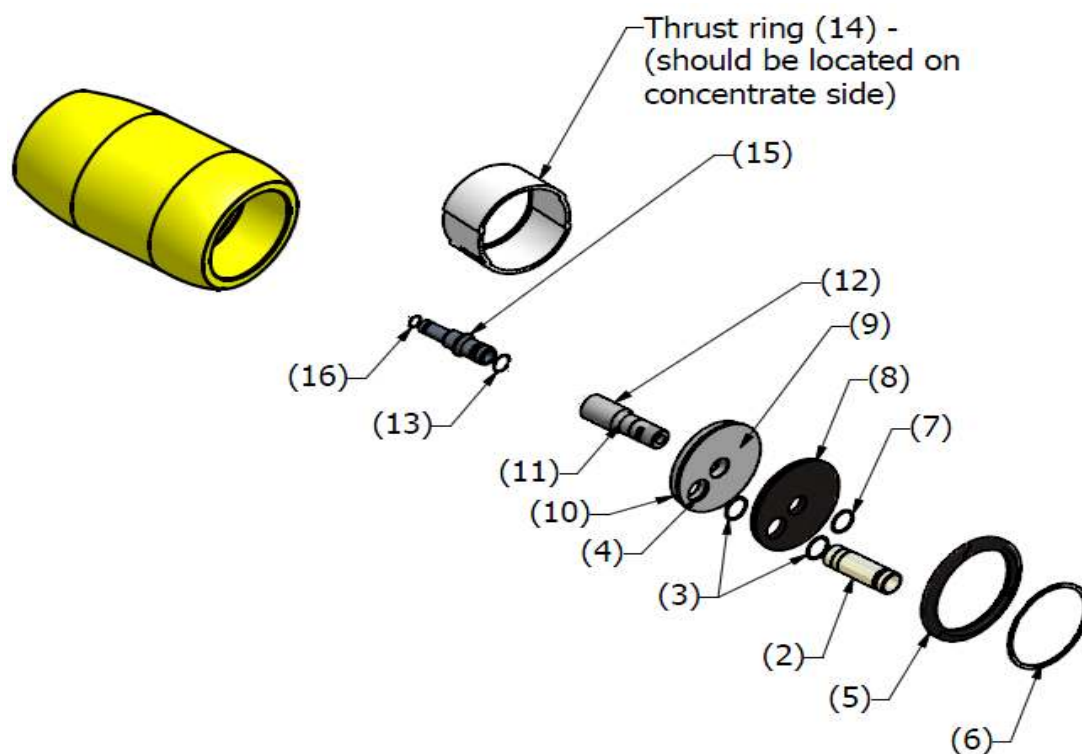
ITEM	QTY	DESCRIPTION	MATERIAL	PART NUMBER
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 0 / 600 /1-8
2	2	End Port 1.5"	Stainless steel	009-150-0600
3	4	Retaining ring for End Port	Stainless steel	55412335
4	2	Seal for End Port	EPDM	55412225
5	2	Support ring	Aluminum	55410299
6	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
7	2	Retaining ring for P. Port	Stainless steel	283772336
8	2	Base Plate	Engineering plastic	003-800-0600
9	-	-	-	-
10	2	Seal for Sealing Plate	Engineering plastic	55412339
11	2	Seal for P. Port	EPDM	283776342
12	2	Permeate Port	Engineering plastic	008-801-0125
13	2	Seal for Adapter	Engineering plastic	285773918
14	1	Thrust ring	Engineering plastic	55410419
15	2	Adapter	Engineering plastic	See Table 3.6
16	4	Membrane seal	EPDM	55413912
*17	2-3	Saddle	Engineering plastic	55410351
*18	2	Strap Assy.	Stainless steel	55410310
*19	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*20	0-7	Disk spacer - 3mm	Engineering plastic	285779233

Table 3.5 *-These parts are not shown on the drawing assembly

PART DESCRIPTION	PART NUMBER
Adapter 1.125" / Adapter 1.125" blind	001-112-1220 / 001-112-1228

Table 3.6

3.4 BEL 8" PRESSURE VESSEL 1000 PSI End Port assembly



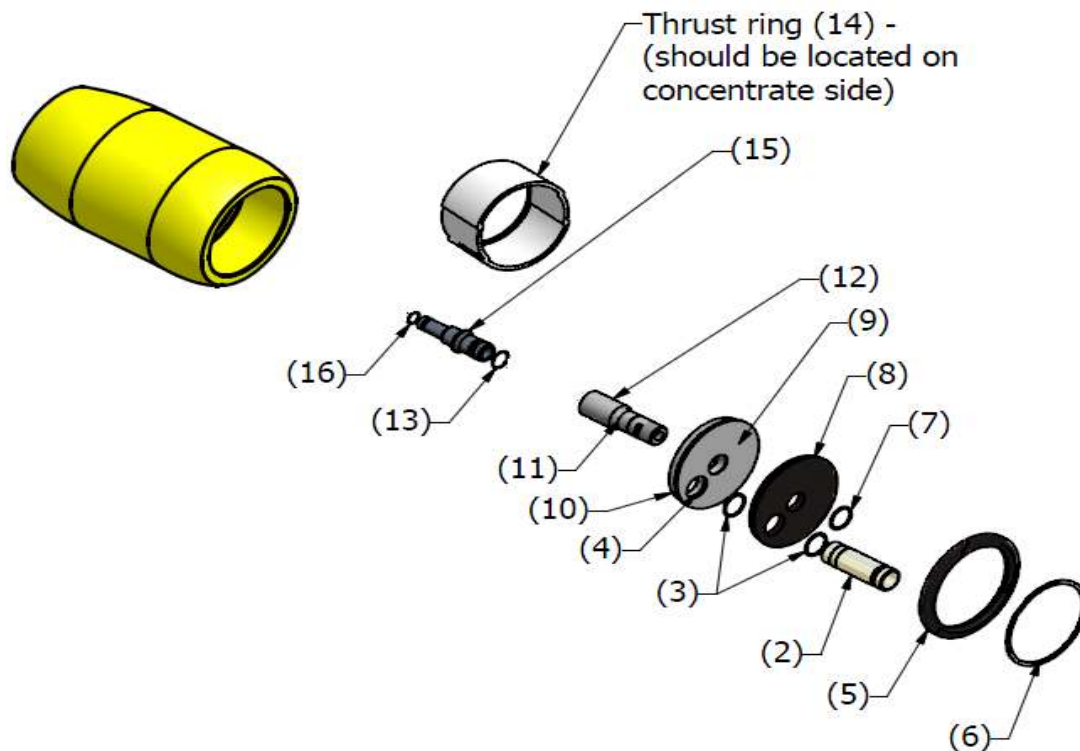
ITEM	QTY	DESCRIPTION	MATERIAL	PART NUMBER
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 0 / 1000 / 1-8
2	2	End Port 1.5"	Super duplex stainless steel	283153204
3	4	Retaining ring for End Port	Stainless steel	55412335
4	2	Seal for End Port	EPDM	55412225
5	2	Support ring	Aluminum	005-861-1200
6	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
7	2	Retaining ring for P. Port	Stainless steel	283772336
8	2	Base Plate	Aluminum	283154220
9	2	Sealing Plate	Engineering plastic	013-800-1201
10	2	Seal for Sealing Plate	EPDM	007-080-0092
11	2	Seal for P. Port	EPDM	283776342
12	2	Permeate Port	Engineering plastic	008-801-0125
13	2	Seal for Adapter	Engineering plastic	285773918
14	1	Thrust ring	Engineering plastic	55410419
15	2	Adapter	Engineering plastic	See Table 3.8
16	4	Membrane seal	EPDM	55413912
*17	2-3	Saddle	Engineering plastic	55410351
*18	2	Strap Assy.	Stainless steel	55410310
*19	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*20	0-7	Disk spacer - 3mm	Engineering plastic	285779233

Table 3.7 *-These parts are not shown on the drawing assembly

PART DESCRIPTION	PART NUMBER
Adapter 1.125" / Adapter 1.125" blind	001-112-1220 / 001-112-1228

Table 3.8

3.5 BEL 8" PRESSURE VESSEL 1200 PSI End Port assembly



ITEM	QTY	DESCRIPTION	MATERIAL	PART NUMBER
1	1	Body of Pressure Vessel	Glass/Epoxy, acc. F.I.227	8 / 0 / 1200 / 1-8
2	2	End Port 1.5"	Super duplex stainless steel	009-150-1200
3	4	Retaining ring for End Port	Stainless steel	55412335
4	2	Seal for End Port	EPDM	55412225
5	2	Support ring	Aluminum	005-861-1200
6	2	Retaining ring (finger hook)	Stainless steel	011-801-1202
7	2	Retaining ring for P. Port	Stainless steel	283772336
8	2	Base Plate	Aluminum	283154220
9	2	Sealing Plate	Engineering plastic	013-800-1201
10	2	Seal for sealing Plate	EPDM	007-080-0092
11	2	Seal for P.port	EPDM	283776342
12	2	Permeate Port	Engineering plastic	008-801-0125
13	2	Seal for Adapter	Engineering plastic	285773918
14	1	Thrust ring	Engineering plastic	55410419
15	2	Adapter	Engineering plastic	See Table 3.10
16	4	Membrane seal	EPDM	55413912
*17	2-3	Saddle	Engineering plastic	55410351
*18	2	Strap Assy.	Stainless steel	55410310
*19	0-3	Disk spacer - 1mm	Engineering plastic	285779231
*20	0-7	Disk spacer - 3mm	Engineering plastic	285779233

Table 3.9 *-These parts are not shown on the drawing assembly

PART DESCRIPTION	PART NUMBER
Adapter 1.125" / Adapter 1.125" blind	001-112-1220 / 001-112-1228

Table 3.10

4. Maintenance

4.1 Head disassembly

- i. **Pressure relieve** - Stop all pumps and relieve pressure.
- ii. Disconnect all pipes from ports connecting the vessel's heads with the manifolds.
- iii. Engage your forefinger in the hook of the retaining ring, lift it up and pull it out of the groove, by running your fingers behind the retaining ring as it continues to exit the groove. As shown in Fig 4-A



Fig 4-A

- iv. Remove the three locker segments from the groove starting from the small segment.
- v. **head extraction** -
 - a - Tight the puller legs (see annex 1) to the vessel wall as shown in Fig 4-B to support the puller to the vessel.



Fig 4-B

- b- Screw in fully the cup to the permeate port (clockwise) while supporting the back side of the puller. As shown in Fig 4-C



Fig 4-C

- c- Screw out the Puller's handle (counterclockwise) until the Head assembly is extracted, after that pull out the Puller with the Head assembly.

4.2 Visual inspection

Once the head have been disassembled perform a visual inspection of the vessel head and fittings, to locate any signs of corrosion or salt concentrations if corrosion or salt concentrations are found, follow the following steps:

Component inspection

- i. Use a small wire brush to loosen any large deposits.
- ii. Place components in a shallow container of soapy water and scrub their surfaces with medium-grade Scotch-Brite until all corrosion is removed.
- iii. Rinse components with clear water.
- iv. Blow components dry with compressed air.
- v. Examine components for damage that may affect structural strength or sealing properties.

Vessel inspection

- i. If any case of deposit of foreign material has been discovered scrub surface with a fine Scotch-Brite and a mild detergent solution, clean both ends of the vessel, up to 20 cm into the vessel.
- ii. If during inspection scratches are found on the inner surface of the vessel up to 20 cm depth, grind the area carefully with sand paper until it is smooth

4.3 Head Reassembly

- i. Apply a layer of Lubricant (see 4.5.i) on the O-ring (the amount of the Lubricant should be just enough to give a lustre to the O-ring) and on the bell internal groove.
- ii. Place the pusher (see Annex 1) carefully inside the Base Plate Permeate Port as shown in Fig 3-D. **To avoid property damage do not bend the tool inside the Base Plate Permeate port.**



Fig 4-D

- iii. Push the sliding hammer quickly towards the pusher until it strikes the Head assembly to its place as shown in Fig 4-E. **To avoid personal injury, always grasp the pusher puller handle with both hands.**

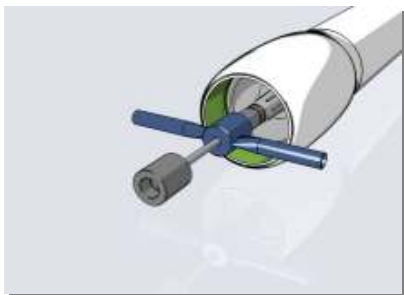


Fig 4-E

- iv. With the head assembly inserted into the vessel (once the head is in the correct position, the support ring

groove is exposed) slide the three segments into the locking groove and Insert the retaining ring as shown in Figs 4-F, 4-G, 3-H.



Fig 4-F



Fig 4-G



Fig 4-H

- v. Insert the retaining ring into the groove of the Support ring and continue running your fingers behind the retaining ring as it continues to enter the groove.
As shown in Figs 4-I, 4-J.



Fig 4-I



Fig 4-J

4.4 Permeate Port disassembly

- i. Use a screwdriver in order to remove the retaining ring which holds the Permeate Port to its place As shown in Fig 4-K



Fig 4-K

- iii. Use a screwdriver in order to remove the retaining ring that installed at the inner side of the Base Plate, as shown in Fig 4-M.



Fig 4-N

- ii. Disassemble the Permeate port from the Base/Seal Plate by pressing the threaded end of the permeate port as shown in Fig 4-L In case of High pressure vessel (1000-1200 psi) remove the Sealing Plate from the Base plate.



4.5 Permeate Port reassembly

- i. Apply a small amount of lubricant (Molykote 111 or equivalent, Glycerin can be used as well) on the seals Seal for End port, Seal for Permeate Port as shown in Fig 4-O.



Fig 4-O

- ii. Install Seals on the base plate and Permeate port for 300-600 psi or on the sealing plate and Permeate port for 1000-1200 psi. Visually check the seals for any mechanical damage. As shown in Fig 4-P.



Fig 4-P

- iii. Insert the End port into the Base Plate As shown in Fig 4-Q and install the retaining ring in the direction of the arrow until it fits the End port groove.



Fig 4- Q

- iv. Place the base plate as shown in Fig 4-R and use a screwdriver to install the retaining ring until it fits the End port groove.



Fig 4- R

- v. Align the base plate and the End port installed in it with the sealing plate opening, couple both parts by pushing them together until they touch each other as shown in Fig 4-S.



Fig 4-S

- vi. Insert the Permeate port from the inner side of the base plate and carefully push it all the way, as shown in Fig 4-T.

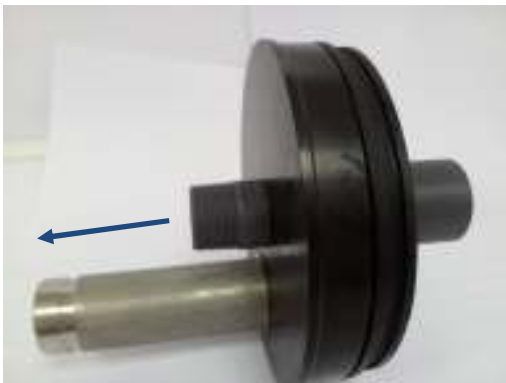


Fig 4-T

- vii. Install the retaining ring as shown in Fig 4-U in order to secure the Permeate port to place.



Fig 4-U

- viii. Insert the O-ring seal into the groove of the Plate (Base plate at 300-600 psi or sealing plate at 1000-1200 psi) in the direction of the arrow as shown in Fig 4-V Until it fits into the groove.



Fig 4-V

- ix. Apply a thin layer of Lubricant (see 4.5.i) on the Adapter seal thereafter insert the Adapter into the Permeate port (with a plastic mallet) as shown in Fig 4-W.



Fig 4-W

4.6 Loading the membrane element

- | | |
|--|--|
| <ul style="list-style-type: none"> i. Flush the vessel with fresh water to remove dust and debris. ii. Install a thrust ring in the downstream of the vessel. iii. Insert Head assembly, without the O-ring into the downstream end of the vessel. iv. Install the segments of the support ring into the locking groove. v. Inspect the membrane element surface to find any imperfections that could scratch the vessel bore element loading. If a defect is found, which cannot be easily corrected contact the element manufacturer. vi. Apply a thin layer of lubricant (see 4.5.i) to lubricate the inside of the vessel near the groove. This will assist membrane element loading and reduce the risk of inadvertently scratching the vessel bore. vii. Install the brine seal on the upstream end of the membrane element so that the seal's open side faces upstream (if it is not already installed by the manufacturer). viii. Load the first element into the upstream of the vessel .Leave 10 cm of the element projecting out of the vessel to facilitate connection with the next element. ix. Apply a small amount of Lubricant (see 4.5.i) onto the O-ring of the interconnector | <ul style="list-style-type: none"> x. Line up the next element and assemble it to the inter connector which is already on the first element. Carefully maintain element alignment during assembly, misalignment may result damage to the membrane and vessel parts. xi. Line up the next element and assemble it to the interconnector which is already on the first element. xii. Carefully push the two elements into the vessel until the second element is projecting from the vessel approximately 10 cm. Repeat the above steps until all membrane elements have been assembled. xiii. Calculate the correct shimming distance (see Annex 2) in order to avoid impact damage on the membrane and head parts during pressure drop. xiv. Insert the shimming spacers on the upstream head assembly (Membrane adapter) so that the sum of their lengths will be equal to the shimming distance. xv. Install the upstream head assembly as described in section 3.3. xvi. Remove the downstream head assembly and reassemble it with the O-ring. |
|--|--|

ANNEX 1

BEL Puller For 8" pressure vessels heads installation

This tool designated to extract BEL head assembly for 8" pressure vessels. Before disassemble any of the vessels parts ensure internal pressure has been unloaded.

Note:

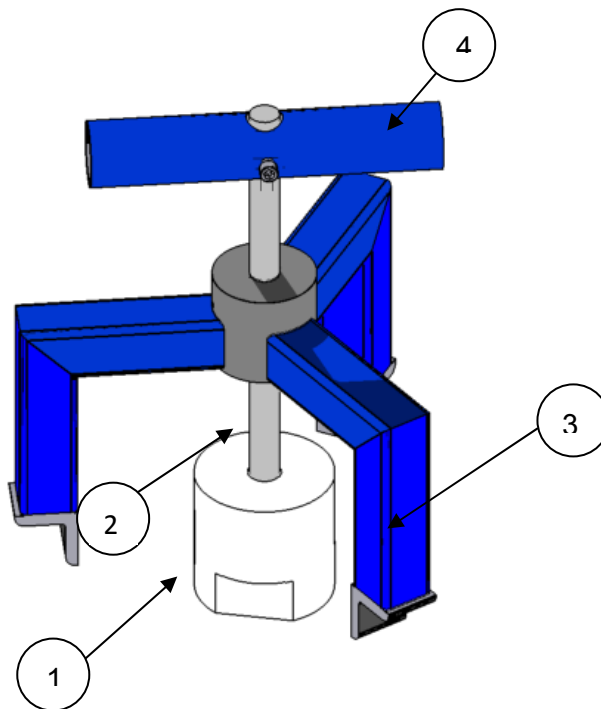
It is highly recommended to replace all seals each time the head is reassembled.
A seal replacement kit is available from **BEL**'s Customer Service.

Part number: 069-080-0101 +069-080-2510 (for 1.25" BSP adapter)

Kit assembly

Tool must be assembled as shown on illustration 1.

Figure 1 –Puller assembly



(1) BSP Puller cap, (2) Threaded Rod

(3) BSP (4) Handle

BEL Pusher For 8" and pressure vessels heads installation

This tool designated to install BEL head assembly for 8" and pressure vessels.

Note:

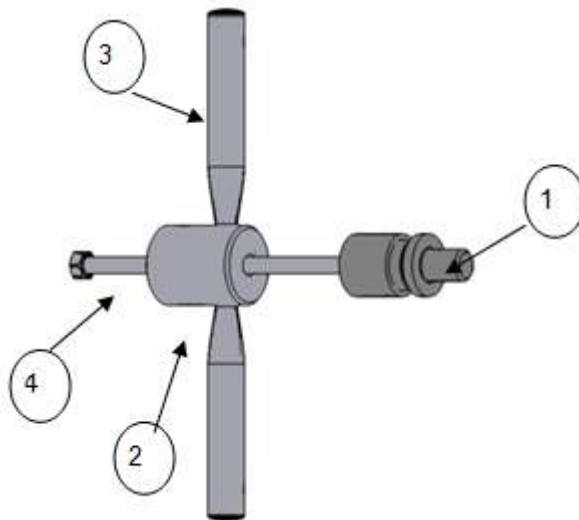
It is highly recommended to replace all seals each time the head is reassembled.
A seal replacement kit is available from **BEL's** Customer Service.

(**Part number:** 069-080-0200)

Kit assembly

Tool must be assembled as shown on illustration 1. Ensure tool's handle is located far from the BSP pusher (part 1).

Figure 2 – Pusher-Puller assembly



(1) BSP pusher, (2) Sliding hammer (3) Handles (4) Rod

ANNEX 2

Shimming procedure

Correct shimming is needed in order to keep minimum Permeate Port movement at operation time, **shimming should be applied at the feed side only.**

For the shimming procedure make sure the membranes fully pressed to the Thrust ring at the brine side (measure can be taken like the shimming procedure and it suppose to be like the sum of the parts), and the shimming at brine side is clearly making unified surface with the Thrust ring and the adapter.

Correct shimming can be achieved by calculating the delta between the fixed dimensions of the Sealing plate + Permeate port ($t_{\text{Sealing plate + Permeate port}}$) + the Base plate ($t_{\text{BASE PLATE}}$) and distance between the end of the groove and the membrane after pushing the membranes inside (call it X), this will bring you to the nominal shimming dimension:

- $$X - t_{\text{Sealing plate + Permeate port}} - t_{\text{BASE PLATE}} - t_{\text{LOCKER}} - 2 =$$

$$\text{Shimming dimnsion}(mm)$$

Or without the LOCKER thickness if you'll take the measures from the inside of the LOCKER (put the locker in the groove and take the measure):

- $$X - t_{\text{Sealing plate + Permeate port}} - t_{\text{BASE PLATE}} - 2 =$$

$$\text{Shimming dimnsion}(mm)$$

ANNEX 3

O-Ring replacement and scratches treatment procedure

1. Preparations

Please prepare the following items before procedure:

- i. New intact O-Ring seal suitable with Base/Sealing Plate type.
- ii. BEL Base/Sealing Plate. Ensure O-Ring groove is clean and free of scratches.
- iii. Clean cloth.
- iv. Lubricant.
- v. BEL Pusher-Puller (optional).

2. O-Ring Replacement procedure

- i. Clean vessel internal surface at sealing area (O-Ring area) with clean damp cloth after the disassembling of the head assembly from the vessel.
- ii. Ensure vessel sealing area is smooth and free of scratches. See next procedure for scratch treating.
- iii. Assemble Permeate Port Head parts (e.g. Base Plate, Sealing Plate, Adapter, O-Rings and Shims) and apply full and reach layer of lubricant on seals, vessel's groove and vessel's sealing area.
- iv. Install Head using BEL's pusher-puller.

3. Scratches treatment procedure

- i. Clean vessel internal surface at sealing area (O-Ring area) with clean damp cloth.
- ii. Locate the scratch at the O-Ring sealing area. Scratches out of this area will not cause leaks, therefore will not be treated.
- iii. Grind out the scratch using Extra-Fine sand paper (P400) until scratch is flat and smooth. DO NOT grind deep into the vessel, this might cause permanent damage to the vessel.

Note: In case of deep scratches or layers delamination please consult BEL engineering department.