



## USER'S GUIDE TO:

# Phoenix Vessel Technology Limited 4" x 350 psi / 400 psi END PORT PRESSURE VESSELS

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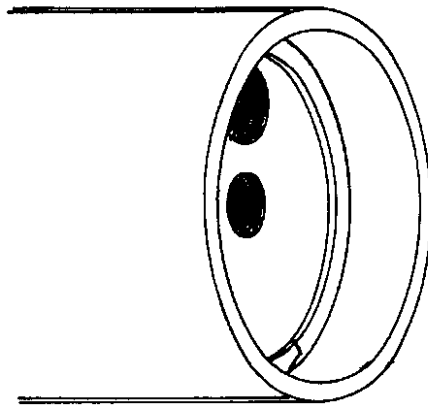
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## FORWARD

Phoenix Vessel Technology Limited is a major manufacturer of Glass Reinforced Plastic Pressure vessels which are used as housings for reverse osmosis membrane elements. It is one of a small number of companies with Code X accreditation of the American Society of Mechanical Engineers.

Vessels are produced to cover a range of pressures upto 1000 psi and to house upto six 40" membrane elements.

Each vessel has a documented history in terms of the manufacturing process and the materials used. Before despatch, each vessel is tested to 1.1 times working pressure to ensure structural integrity.



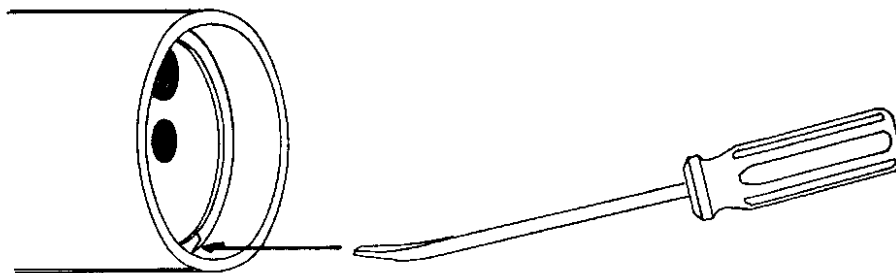
## SECTION ONE

### MAINTENANCE GUIDE

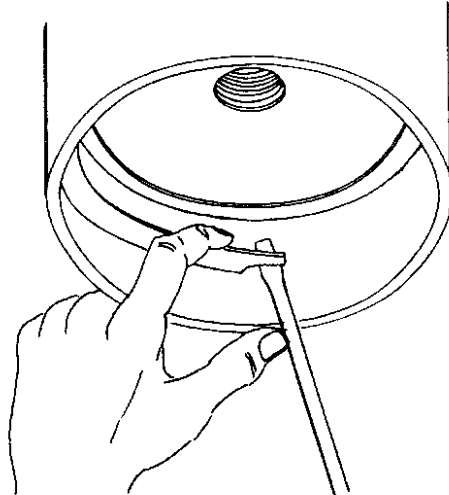
#### 1.1 REMOVING END CAP FROM VESSEL

- 1.1.1 Ensure system is NOT pressurised before starting work.
- 1.1.2 Remove all pipework connected to the vessel end cap.
- 1.1.3 Using a screwdriver lever out the end of the spiroloc circlip from the groove in the vessel. Hold the end of the circlip from springing back into the groove and remove the remaining part by running an index finger behind the circlip with a rotating movement.

**Note: If the end of the screwdriver is bent over by 15 -30 degrees then extraction is considerably easier.**

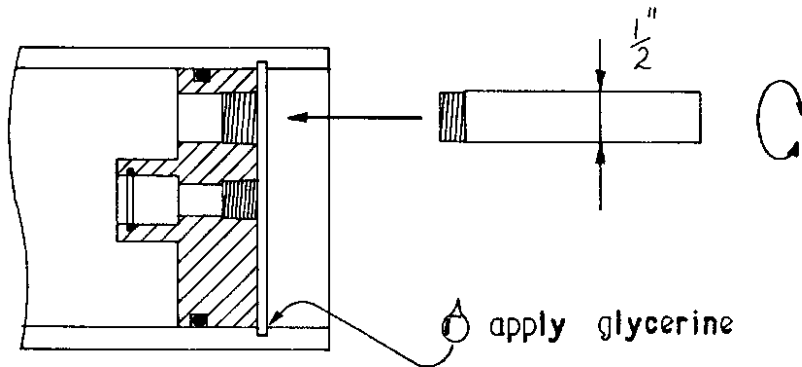


**Note : Any loose debris should be removed by flushing with water and any sharp edges made smooth by lightly abrading with waterproof silicone carbide paper (200 Grade or finer). This should be done before removing the plastic end cap as this will ease extraction.**

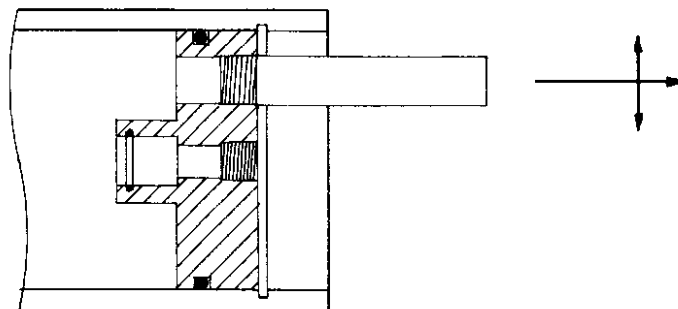


1.1.4 Insert a  $\frac{1}{2}$ " pipe threaded at one end (BSPT) into the feed or reject port. Lubricate the edges of the groove with glycerine.

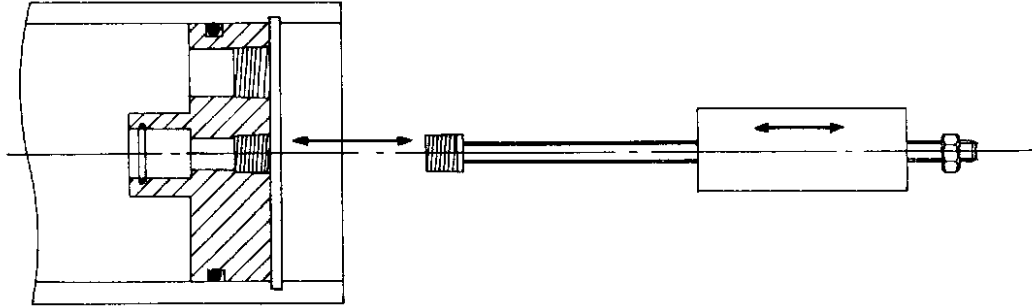
Note: Take care not to damage the threads of the end cap when inserting the pipe.



1.1.5 Grasp the pipe and remove the end cap with a gentle rocking motion.



1.1.6 If the end cap cannot be removed as indicated then the use of an extractor will be necessary. This can be supplied by Phoenix Vessel Technology Limited and is illustrated below.





## 1.2 LOADING MEMBRANES

This Section is provided as a Guide only, reference should be made to the element manufacturers recommendations for loading.

### 1.2.1 UNLOADING

- (a) Ensure system is NOT pressurised before starting work.
- (b) Remove both end caps from vessel.
- (c) Remove element from vessel following element manufacturers recommendations.

**NOTE : Sharp debris may scratch vessel bore . This should be removed before unloading elements.**

### 1.2.2 CHECKS BEFORE LOADING

(a) Check the inside of the vessel for debris which may scratch the vessel. Remove any that is found by flushing with water or by using a clean cloth. Stubborn debris which adheres to the vessel may be removed by lightly polishing the area with waterproof silicone carbide paper. Use 400 Grade (fine) to start with and finish with 600 Grade (very fine). It will help to moisten the grit paper with water during use. Avoid continuously rubbing the same spot in the same direction. Afterwards remove any debris with water or by using a clean cloth.

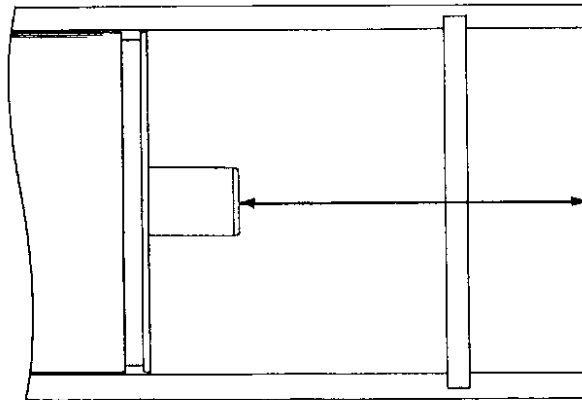
**NOTE : Fine grade Scotchbrite may be substituted for water- proof silicone carbide paper.**

- (b) Check that there are no sharp edges to the membrane element which could scratch the vessel. Contact the element manufacturer if these cannot be easily removed.
- (c) Check the element brine seal for wear and or cuts. Consult the element manufacturer for spares and advice.

### 1.2.3 LOADING

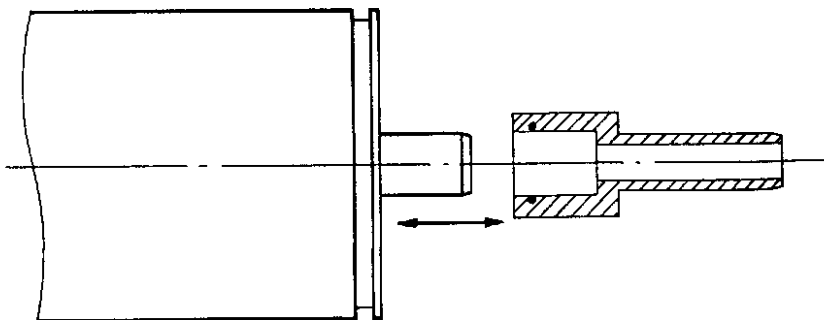
- (a) Lubricate the inside of the vessel with glycerine. If this is not available then flood vessel with clean water.
- (b) Check with the element manufacturer concerning the position of the brine seal. Normally this is placed on the upstream end of the element with the recessed part of the seal pointing upstream.
- (c) Push the elements into the vessel from the upstream end.

- (d) As each element is loaded insert the interconnector. To ease insertion glycerine should be applied to the O-seals.
- (e) Care should be taken to ensure that the weight of the element is not taken on the interconnectors during loading.
- (f) The final element should be inserted 2.5" in from the end of the vessel.



- (g) The plug and adaptor (multi element vessels) should be removed from the vessel before loading the elements - they may be fitted to either end of the element train.

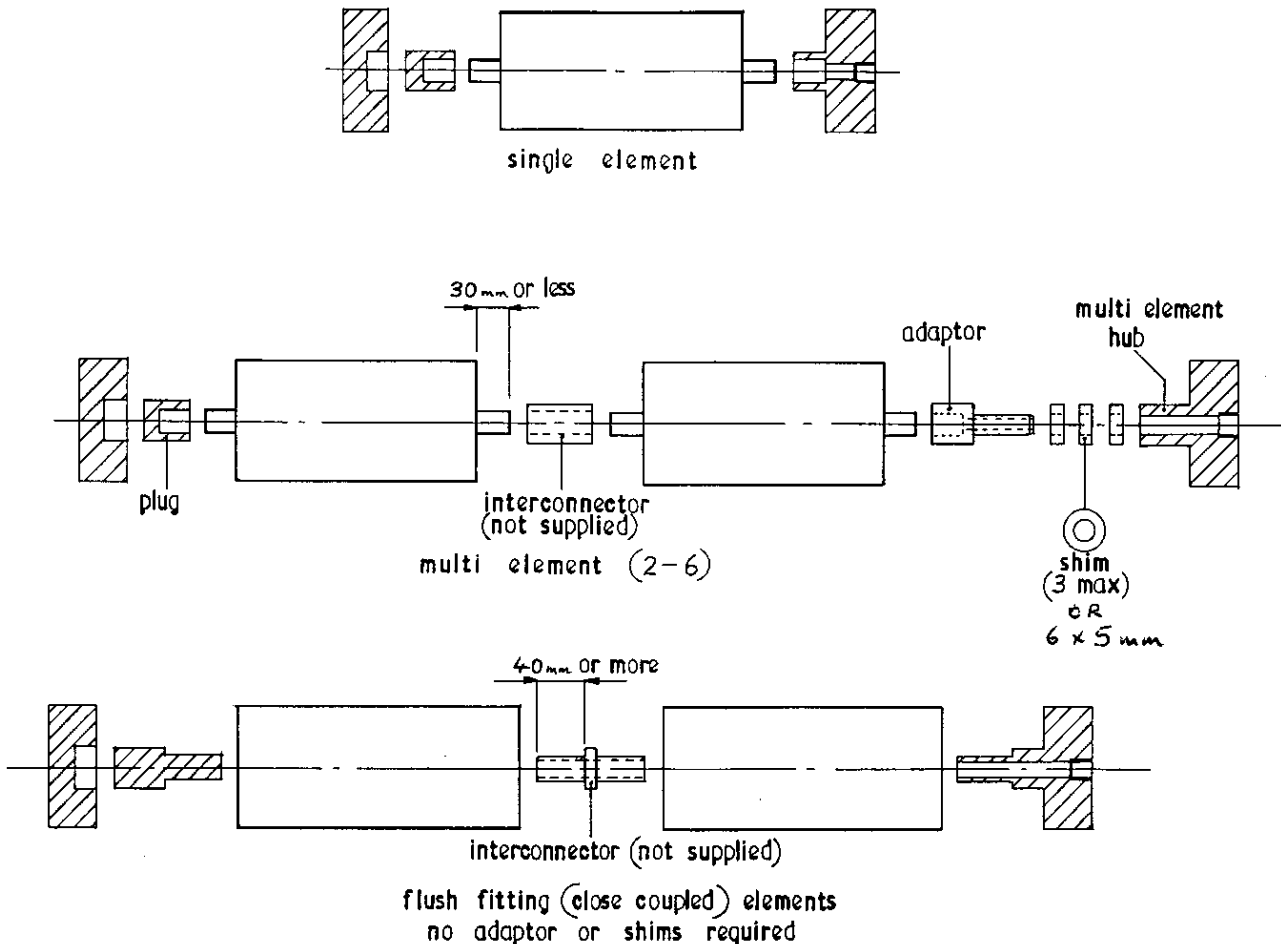
**NOTE: Catastrophic failure of the product line can occur if the adaptor or plug is not fitted and pressure is applied.**



- (h) For single element vessels (i.e. upto 40" of element length) no adaptors or shims are supplied. Multi-element vessels fall into two categories depending on the type of element in the vessel:

- (1) Spigotted type - i.e. has a core tube which is proud of the face of the element. One adaptor and three shims are supplied. The shims are required to ensure that the element remains connected to the pressure vessel end cap, these should be placed between the adaptor and the end cap.

(2) Flush fitting (also referred to as close coupled) element. This type does not require shims or an adaptor.



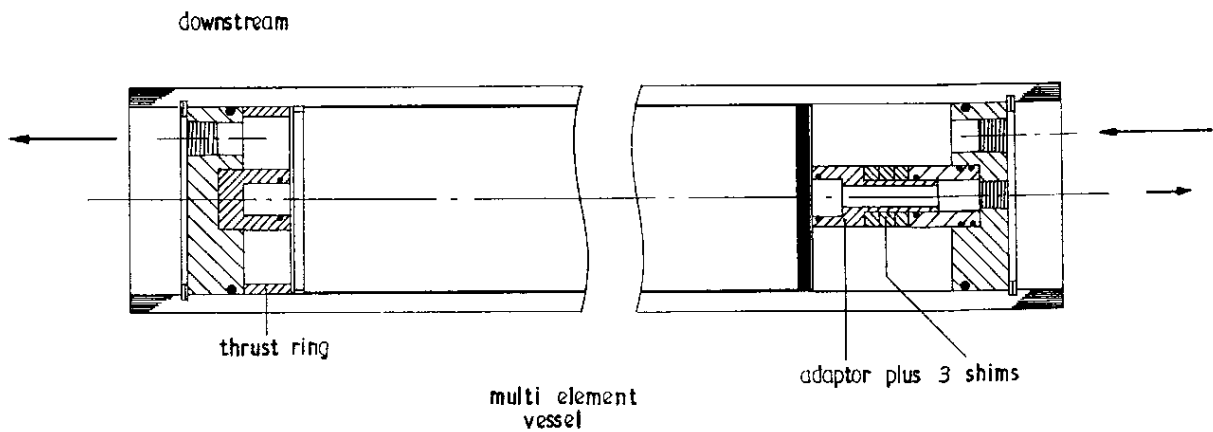
The required number of shims may vary between any two vessels loaded with elements due to tolerance build up, each will require measuring to find the exact number required. There are two ways to do this:

**Method 1** - Work out the end float from element to vessel by measuring the distance from the face of the element to the groove and subtracting the end fitting thickness. Each shim has a thickness of 5 mm, aim to obtain an end float of 2 to 12mm. Thus if the endfloat is 1mm, remove a shim. If it is 13mm, add a shim. A maximum of 6 shims may be fitted.

**Method 2** - Fit the maximum number of shims to the adaptor, each has thickness of 10mm and a maximum of 3 maybe fitted to the upstream adaptor. Fit the adaptor onto the core tube of the element. Then remove the large 4" diameter seal from the end fitting so that no resistance will be required to push it into the vessel. Push the end fitting into the vessel until it will go no further. If the full width of the groove in the vessel is visible then the correct number of shims have been fitted. If not, then remove one shim and repeat the above procedure until the groove is visible. Remember to refit the large O-seal.

(i) Normally thrust rings are not provided on 4" vessels. However for those customers specifically requesting thrust rings, care must be taken to position it correctly. The thrust ring must always be placed at the downstream end of the vessel. If the vessel is also a multi element type that requires shims (see (h) of this section) then the adaptor plus shims must be placed upstream and the plug downstream.

**NOTE :** The length of the thrust ring depends on the type of membrane element being used. If in doubt leave it out or refer to Phoenix Vessel Technology for advice.





## 1.3 CLOSING VESSEL

1.3.1 Thoroughly clean all parts and check for the following.

- (a) O-SEALS - cracked, worn or cut areas.
- (b) END CAP - cracks between ports, distorted or bearing edges worn.
- (c) CIRCLIP - Corroded or badly distorted.

Components which show any of the above should be replaced.

**NOTE: It is recommended that O-seals are replaced every time the end cap is rebuilt.**

1.3.2 Check the inside of the vessel for debris which may scratch the vessel. Remove any that is found by flushing with water or by using a clean cloth. Stubborn debris which adheres to the vessel may be removed by lightly polishing the area with waterproof silicone carbide paper. Use 400 Grade (fine) to start with and finish with 600 Grade (very fine). It will help to moisten the grit paper with water during use. Avoid continuously rubbing the same spot in the same direction. Afterwards remove any debris with water or by using a clean cloth.

**NOTE : Fine grade Scotchbrite may be substituted for water- proof silicone carbide paper.**

1.3.3 Lubricate the vessel inside surfaces with glycerine.

1.3.4 Lubricate the assembled end cap with glycerine, particularly the large 4" diameter O-seal.

1.3.5 Insert the end cap squarely into the vessel body sufficient to allow the spiroloc circlip to be inserted fully into the groove in the end of the vessel. If the end fitting is difficult to push into the vessel then use the wooden shaft of a hammer to tap it into position.

**NOTE: Under no circumstances should undue force be used to insert the end cap. A light tap is all that is required.**

If the end cap cannot be easily inserted then the following checks should be carried out.

- (i) Lubricate vessel surfaces with glycerine.
- (ii) The elements may have been pushed too far, proceed as follows: Remove large 4" diameter seal from end cap.
- (iii) Insert end cap into vessel. Without the main seal little effort should be required to connect onto the element. If there is insufficient space to insert the spiroloc circlip then the elements have been pushed too far during loading. Remove the last

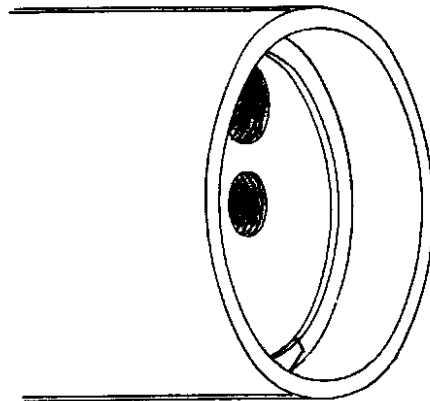
element by pushing it through the vessel taking care to support its weight as it emerges.

Refer to Section 1.2 'Loading Elements' for further information.

**NOTE: Remember to refit all O-seals, and plugs/solid adaptors to the central core tube of the last element in the stack.**

1.3.6 With the end fitting in place insert the spiroloc circlip into the groove in the vessel. The best technique to use is to lead one end of the circlip into the groove using thumb or index finger and to move thumb round the inside of the vessel pushing the remainder of the circlip into the groove. This is the reverse of the removal sequence refer to Section 1.1 'Opening Vessel'.

**NOTE : A partially or badly assembled vessel is dangerous.**





## SECTION TWO

### INSTALLATION

#### 2.1 HANDLING

2.1.1 Vessels may be stored horizontally in any warehouse where the temperatures are as follows:

Maximum 45 deg C (113 F)

Minimum 0 deg C ( 32 F)

2.1.2 DO NOT subject the vessel to sharp blows or impacts as this may damage the vessel wall.

2.1.3 DO NOT scratch the vessel inside wall.

2.1.4 Slings wrapped around the vessel wall and suspended from the forks of a fork lift truck are safer and more stable than using forks alone.

2.1.5 Forks should always be padded before being brought into contact with any part of the vessel body.

#### VESSEL DAMAGE

This should be reported to the shipping company upon receipt.  
Contact Phoenix Vessel Technology for advice if in doubt.



## 2.2 VESSEL SUPPORT POSITION

The bending stresses generated in a long pressure vessel can be considerable and should not be ignored. Careful choice of support position can minimise bending stresses to an acceptably low level. Always follow instructions stated on the Assembly Drawing for each particular vessel design and length ordered.

The following is the recommended support positions for 4" vessels.

No. of 40" Elements	No. of Supports	Distance Between Supports (mm)		Distance Between Outer Supports (mm)	
		Max	Min	Max	Min
1	2	800	200		
2	2	1810	620		
3	2	2270	1640		
4	2	2660	2660		
3	3			2830	1640
4	3			3920	2660
5	3			4250	3670
6	3			4650	4650

Vessel Static Deflection Plots are available upon request from Phoenix Vessel Technology Limited.



## 2.3 CONNECTIONS TO VESSEL

2.3.1 Mount vessels using support saddles provided on horizontal surface at the recommended support position and tighten straps to eliminate movement, do not tighten to more than drawing recommended torque.

**NOTE : Excessive torque applied to the straps may damage the vessel wall.**

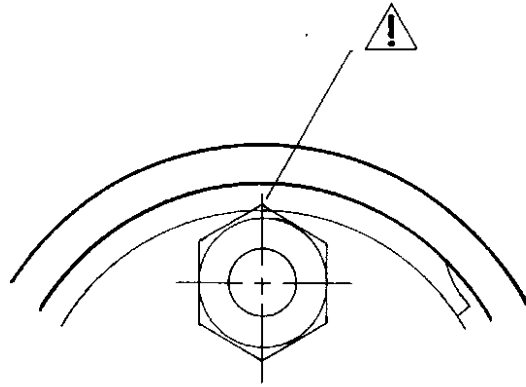
2.3.2 Provide pressure relief device. This should be set to no more than 105% of design pressure.

2.3.3 Allow for an expansion of 0.5mm per metre length of vessel at design pressure.

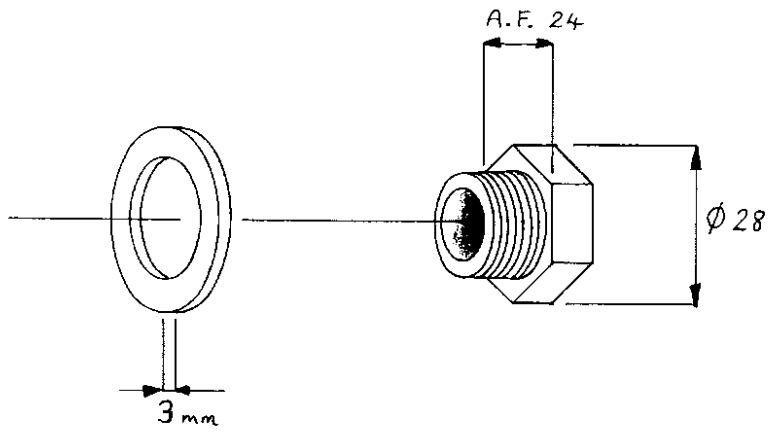
2.3.4 Connections to end cap are 1/2" BSPT female thread for the feed and reject ports and 3/8" BSPT female for the product line. The maximum torque applied to the threaded connections should be as stated in the table below. Note that when the vessel is working in an environment which is hotter than the assembly temperature the thread torque reduces. Similarly as the temperature reduces the assembly torque increases. This is due to thermal expansion of the thermoplastic end cap. Obviously a lightly torqued fitting may leak at high temperature and so recommended torque figures should be followed. If a pre-set torque wrench is used to tighten the fitting into the end cap make sure that at least three 'clicks' are heard i.e. that the torque level is checked at least three times. Often some additional movement is obtained at the second and third attempts.

Assembly Temp (C)	Feed/Reject Max Torque +/- 0.5 Nm (lbft)	1/2" BSPT Approx No. turns past 'Handtight'	Product Line Max Torque +/- 0.5 Nm (lbft)	3/8" BSPT Approx No. turns past 'Handtight'
40	11.5 (8.5)	2.75	9.0 (6.6)	2.25
30	12.0 (8.8)	2.75	9.5 (7.0)	2.25
20	12.5 (9.2)	3.0	10.0 (7.4)	2.5
10	13.0 (9.6)	3.25	10.5 (7.7)	2.5
0	13.5 (9.9)	3.25	11.0 (8.1)	2.75

2.3.5 When inserting the feed and reject connections make sure that there is clearance between the connection and the spiroloc circlip. If a fitting with a hexagonal nut is being used make sure that the points of the hexagon do not contact. If there is no clearance, leaks may occur due to side loads generated by contact between the spiroloc and the connection.



not recommended  
contact may cause leaks



use washer if  $\phi > 28$  mm  
A.F. > 24 mm



## SECTION THREE

### OPERATION

#### 3.1 CORROSION

Whilst every effort has been taken to ensure that end fittings have adequate corrosion resistance it is the responsibility of the purchaser to assess that the materials offered are suitable for the specific corrosion environment.

Alternate materials are available with enhanced corrosion resistance, contact Phoenix Vessel Technology Limited for advice.

End fittings should be maintained dry and free from corrosion.

Vessel leaks should be investigated and corrected.



## 3.2 OPERATING CONDITIONS

### DESIGN SPECIFICATION

Internal Diameter: To fit any 4" nominal diameter element

Length: Up to 240" of membrane elements

Working Fluid: Water

**NOTE : The standard materials of construction may not be compatible with cleaning and preserving fluids. Alternative materials are available on request.**

Design Pressure: 350 psi (24.1 bar)  
400 psi (27.6 bar)

Test Pressure: 1.1 times design pressure for upto 15 minutes maximum

Design Temp: 20 to 113 deg F (-7 to 45 deg C)

**NOTE: Although the minimum design temperature is 20 deg F the vessel should not be allowed to freeze solid. This will damage the vessel wall and make replacement necessary.**

Expansion: 0.5 to 0.75 mm per metre length of vessel at design pressure

Vacuum condition: Vessel end fittings will move out of position under vacuum loads. Contact Phoenix Vessel Technology for advice.

Support Position: 2 supports for 1 to 4 (40") elements.  
3 supports for 5,6 (40") elements and any length supported outside of recommended support range ( refer to 'Vessel Support Position' Section 2.2 of User's Guide).



### 3.3 SAFETY PRECAUTIONS

Fibreglass reinforced pressure vessels will provide years of safe service if properly installed and maintained. This section is for guidance only and should be used in conjunction with the recommendations in the previous sections. Attention is drawn to the boxed areas of text which highlight potential problem areas and safety recommendations.

- 3.3.1 Provide pressure relief device. This should be set to no more than 105% of design pressure.
- 3.3.2 Before pressurisation visually check that the spiroloc circlip is fully engaged in the groove in the end of the vessel.
- 3.3.3 DO NOT stand in line of end fitting while pressurisation takes place.



## SECTION FOUR

### APPENDIX

#### 4.1 SPARE PARTS LIST

For part numbers and descriptions please refer to the relevant Technical Information Sheet.