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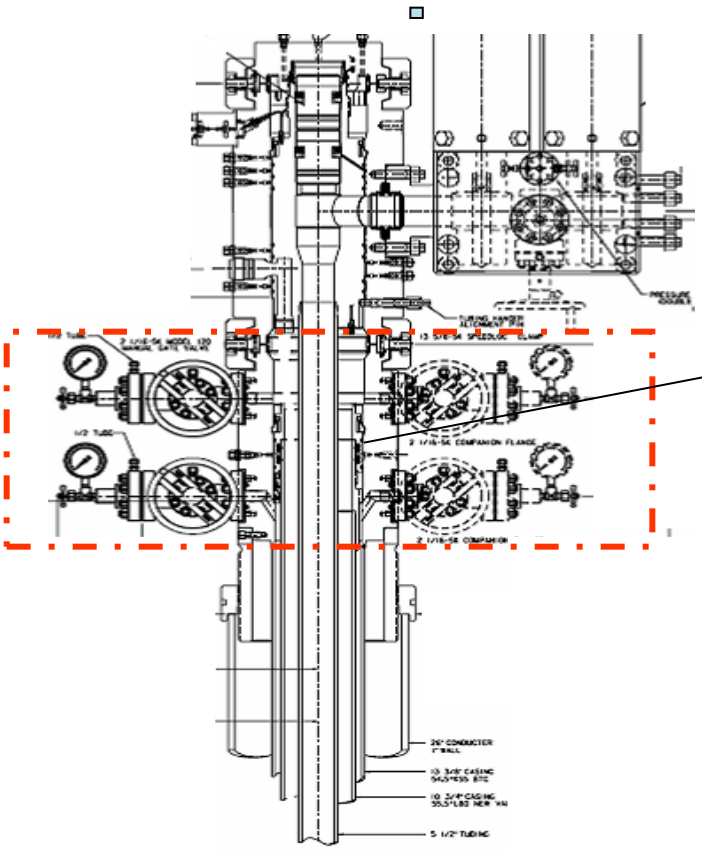
North Sea Platform
13-3/8” Casing Hanger Annulus Pack-off
Product & Procedure Overview
Ref: AB374RM 04-07-2007

The following is based on limited information available at the time of this evaluation

History:
Tests have indicated annulus pressure between the existing seal structure at the 13-3/8” Pack-off. At present it has not been determined as to which seal is damaged i.e. above or below or both.



Captain Wellhead & Tree

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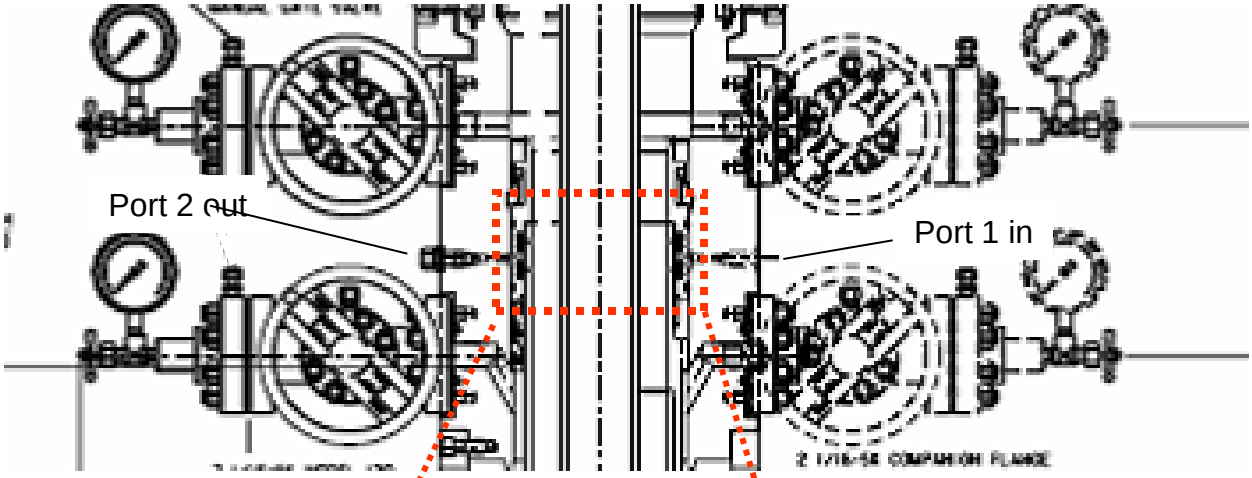
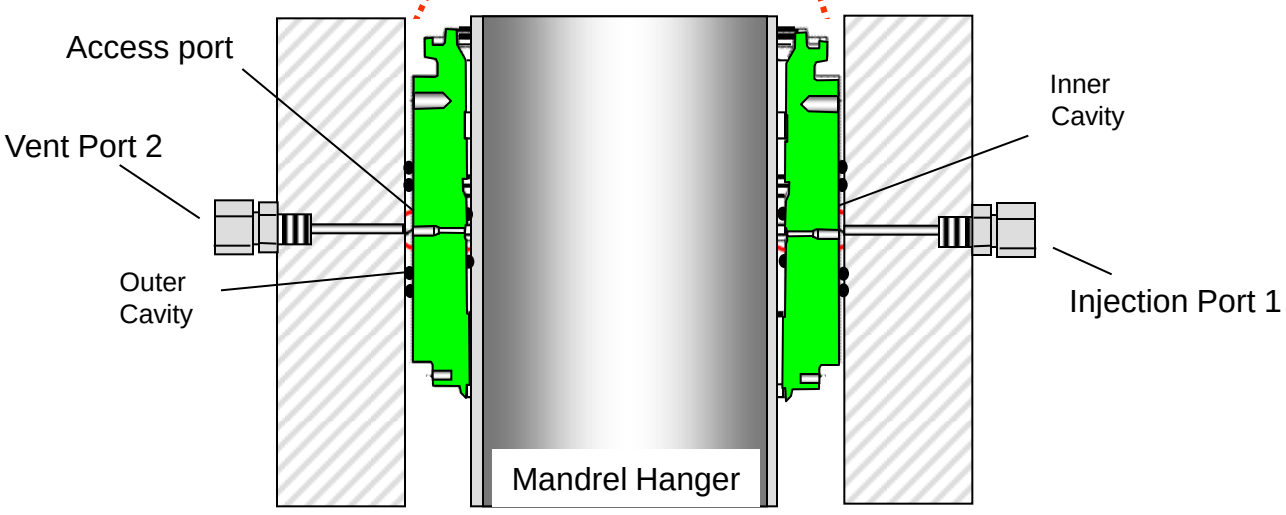
Application Review:
The 13-3/8” Pack-off is designed with resilient elastomer support seals. This design supports 6 sealing areas, two at the top
(outer) two in the centre which are (inner) and two at the bottom which are (outer). There are two access ports to provide communication between both cavities.

There are two external test ports at the wellhead supported by injection fittings
Port 1 in and port 2 out.,





13-3/8” Pack-Off Mandrel Type

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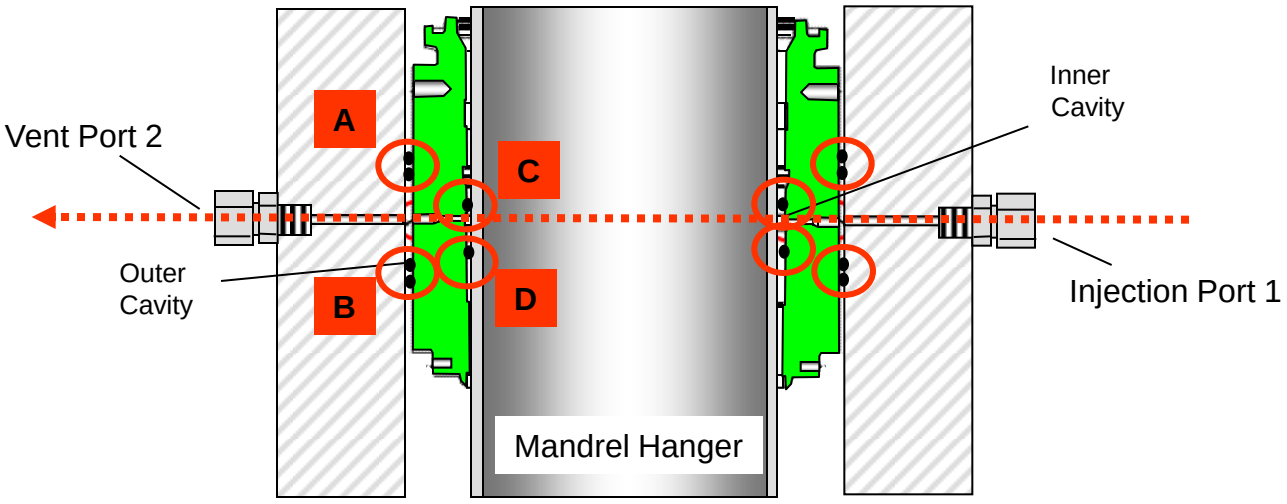
Seal design review:

Possible leak paths (elastomer seal) : (Example only)
A/ Upper outer seal
B/ Lower outer seal
C/ Upper inner seal
D/ Lower inner seal



13-3/8” Pack-Off

The sealant will flow to the leak point with deployment pressure via the injection port. It is difficult to determine which seal is damaged and at what leak rate.

This can become complicated based on the number of leak path combinations. A fluid sealant with a reasonable viscosity will bridge the leak point and displace existing fluids Subject to upper or lower seal damage. Regardless the sealant will flow beyond the existing damaged seal and will establish a solid but flexible pressure containing structure

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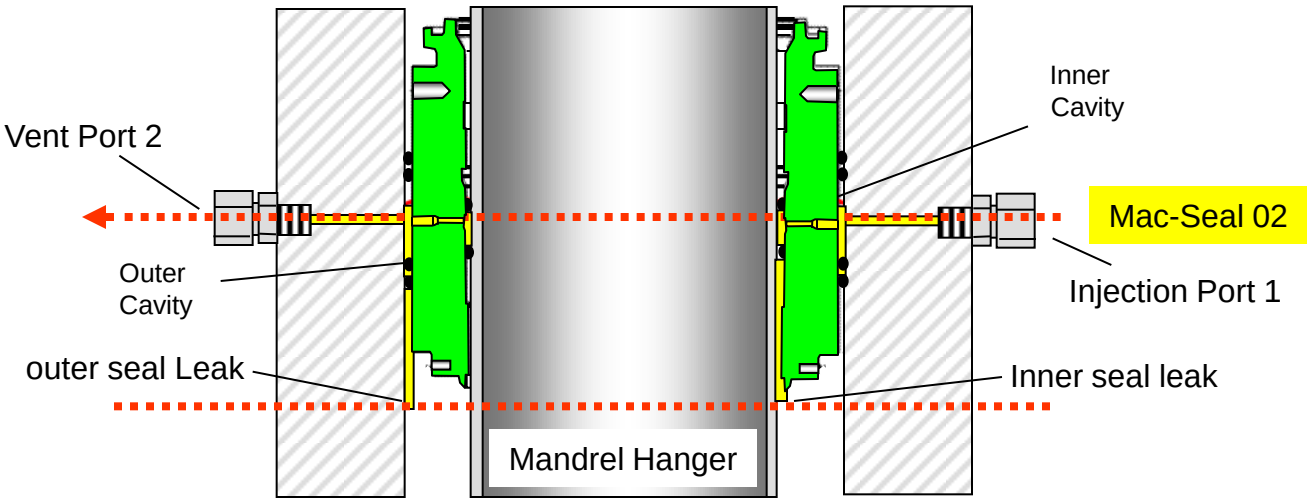

13-3/8" Pack
Injection flow path

Lower inner and outer seals:
The sealants viscosity will support lower seal leakage as the sealant flows through from injection to vent port. Limited existing fluids (test oil) will be displaced (across injection/ vent port). Close vent port and continue to inject set volume of sealant.

To complicate matters it has to be recognised that the leak could be with the lower inner or lower outer seals or both?

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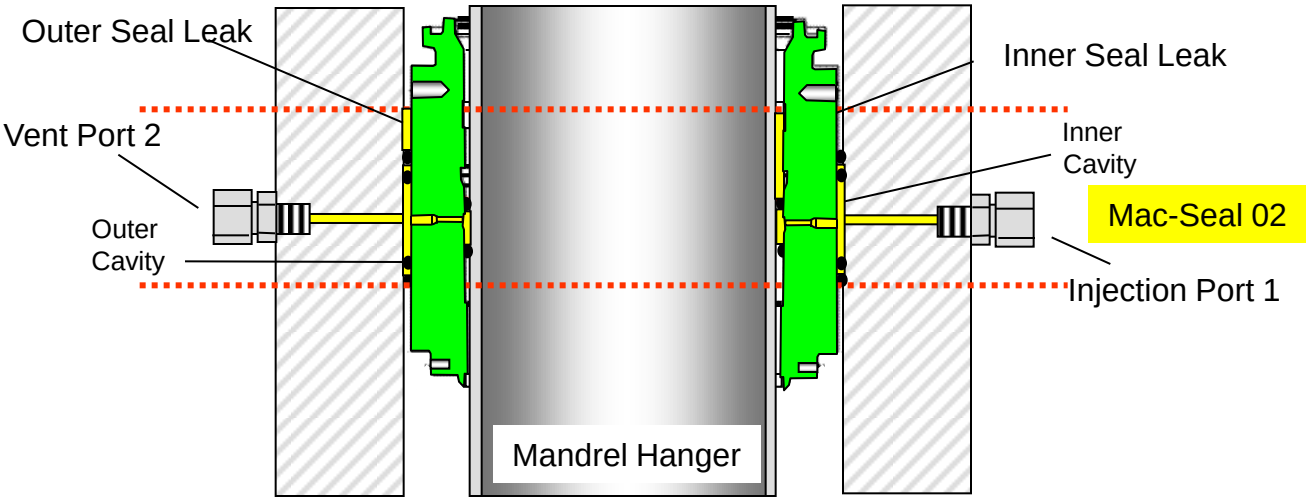

13-3/8" Pack-Off
Injection Flow Path

Upper inner and outer seals:
These leak paths will displace existing fluids as the sealant is injected. The vent port will be closed after visual displacement.

To complicate matters it has to be recognised that the leak could be with the lower inner or lower outer seals or both?

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Overview procedure:

Evaluation:

1/ Flatten or balance annulus above and below the pack off
2/ Sting test port 1 & 2 and vent any pressure at the pack-off
3/ Rig up test pump at port 1 and inject oil with port 2, vented monitor oil displacement from port 2.
4/ Close port 2 and try and build up pressure through port 1 T.B.A . (Confirmation)
5/ Bleed down pressure, Sting and vent port 2, Rig down test equipment

Sealant Deployment:

6/ Rig up sealant deployment tools.
7/ inject Mac-Seal 02 without hardener (confirmation of access with the sealant)
8/ Mix sealant and prepare deployment tool, leave a sample of sealant on the wellhead
9/ Inject Mac-Seal 02 until returns are present through port 2
10/ Close port 2 and monitor pressure continue to deploy the remaining sealant
11/ Close port 1 and disconnect deployment tool
12/ Inject a small amount of grease into port 1 & 2 to clear injection fitting
13/ Allow to set

Testing:

14/ Due to the nature of this sealant / seal design it is not recommended to test through the existing ports. These ports should only be used for the deployment of any further future injection of sealant as and when required.

This products converts from a fluid to a solid which is self-energising with annulus pressure (fluid or gas) from above or below. Pressure entering from the side (existing ports) will disturb the static seal structure.

It is recommended that the annulus above the the new seal structure be monitored only.

Tool Clean-up:

15/ Remove cap and place tools in the toolbox. KCI personnel will redress. Allow the sealant to set through the stinger before cleaning.

Mixing instruction provided within the toolbox.

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KCI Mac-Seal - Viscosity 01 to 06
Mixing and Deployment Review Sheet

The KCI Mac-Seal is a compound deployed in a fluid state against pressure (if required). The Mac-Seal is designed to flow around existing materials and annulus areas as a filler and will establish a pressure energised seal.

The product is provided in two parts,
1/ Compound,
2/ Activator,
Both products combined provide a package to meet a specified setting time.
Note: The activator measure is subject to curing time requirements and can not be adjusted please contact the above office for advise if required.
Standard setting time is 2 to 24 hours subject to temperature
Deployment time is 1 to 1-1/2 hours subject to temperature.
Review information label attached to both compound and activator.

Mixing:
Use in well ventilated area.
KCI provide a large container to support mixing and a hand air drive stirrer
Empty compound into container provided and stir gently.
Empty activator into same container and continue to stir approximately 5 minutes.

Deployment: Subject to viscosity
Deployment Tool: Barrel injection Pump, or Cylinder complete with interface fitting, manifold, feed hose etc.
Place the pump into the container.

Allow the Mac-Seal fluid to displace any grease within the feed line prior to connecting to the manifold assembly.
Note: if the sealant is being deployed through an existing grease / injection fitting. Remove the manifold and inject a small amount of grease to flush the check valve only.

Cleaning the tool and accessories:
Return to KCI for redress
Note: This product is required to be deployed by KCI trained and registered personnel or sub-contractors.

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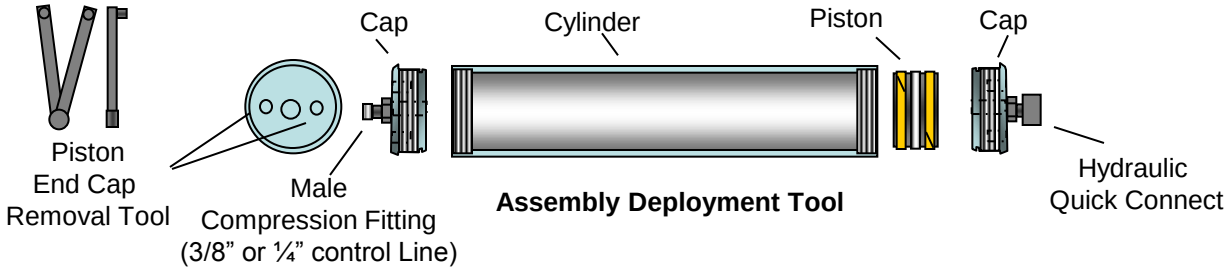
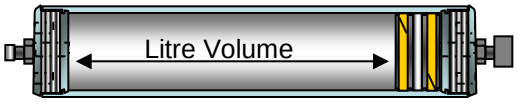
Deployment Tools

Cylinders are provided as the preferred method of deploying the sealant. These are designed as a simple process for preparation / handling, deployment (diver assist) and refurbishment.
The cylinders have been designed to operate with seawater and range from 250mls, 1,3,& 5litre deployment volumes. Operating pressure 5,000psi and 10,000psi.



Assembly Deployment Tool



Litre Deployment Tool

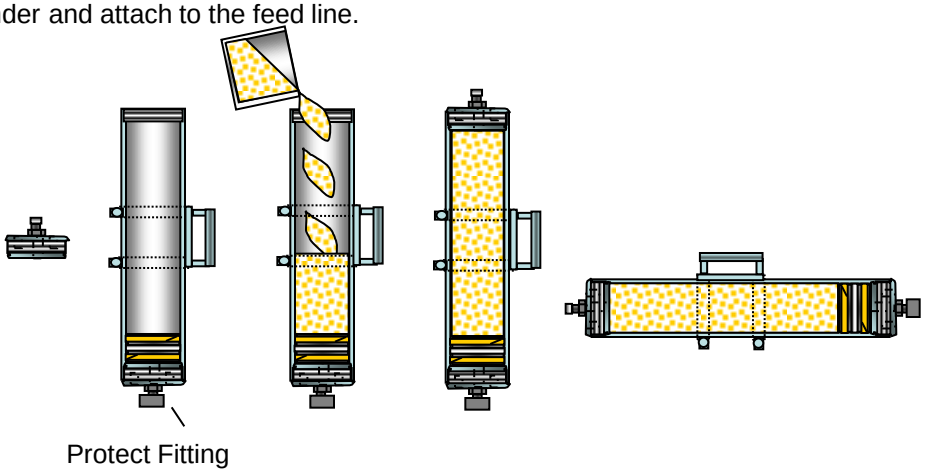
Mixing Instructions

The IBS / Mac-Seal / MS-Sealant is a two-part product i.e. compound and hardener. The product has been provided with set volumes i.e. 250mls , 1,3 & 5 Litre packs of compound (white) and hardener. Pour the set volume of hardener into the compound tub and mix until the sealant is mixed throughout. Pour the mixed compound and hardener into the cylinder and attach to the feed line.

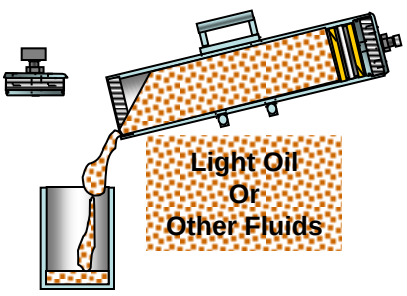
Mac-Seal
Mixed with Hardener

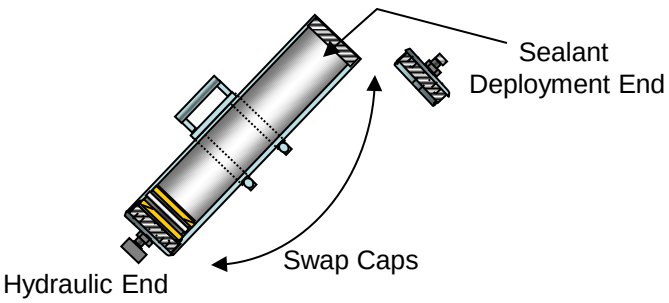
Note: Prepare all cylinders to receive the sealant prior to mixing

Sealant curing time:
3 hours subject to temperature
Sealant deployment time:
1 hours after mixing.



KCI provides the sealant as a fixed volume package i.e. compound & hardener. In the event that more that one package is required the cylinder can be re-used by emptying the hydraulic fluid and swapping the caps.





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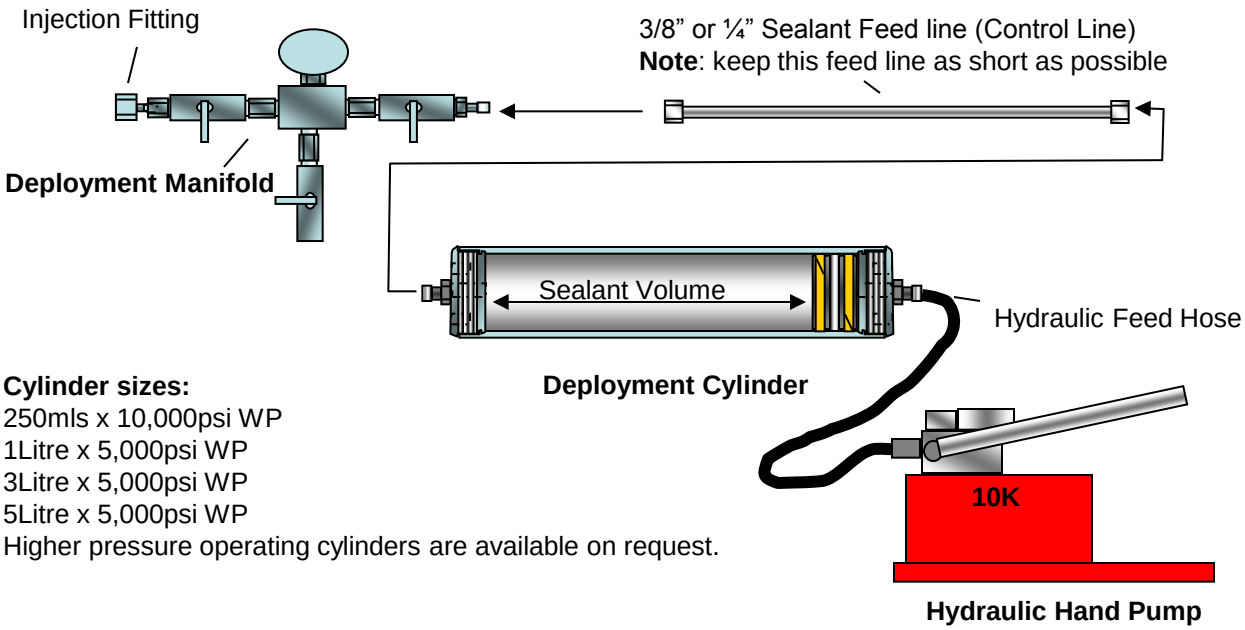
KCI IBS / Mac-Seal / MS-Sealant Deployment Tools



Cylinder sizes:
250mls x 10,000psi WP
1Litre x 5,000psi WP
3Litre x 5,000psi WP
5Litre x 5,000psi WP
Higher pressure operating cylinders are available on request.

Note: This product is required to be deployed by KCI trained and registered personnel or sub-contractors.

Tooling review:
The pump can be used directly for the evaluation of the leak path. With volumes over 3litres a pump will be provided with a high volume / low pressure and low volume / high pressure button.

The hydraulic feed hose is provided with quick connects.

The cylinder is designed to provide repeat applications.

The sealant feed line is recommended to be as short as possible.

The KCI manifold is designed to provide 2 barriers at all times (if required) with venting capabilities). **Note the gauge has a filled grease box to prevent the sealant from entering the gauge, ensure this is in place before deploying the sealant.**

Deployment Review:
Mix the compound and hardener as per mixing instructions.
Remove the cylinder cap and pour in the mixed sealant and replace the cap.
Connect the feed line and Manifold to the cylinder
Connect the hydraulic feed hose and pump to the cylinder and displace the sealant through to the injection interface fitting.
Leave a sample on the wellhead. This will confirm internal sealant structure i.e. cured condition.
Connect the tool package to the injection port and deploy the sealant in accordance with the application and KCI method procedure..

Note: If any ongoing deployment is a part or full cylinder fill, displace any air prior to connecting the cylinder to the feed line.