Cryogenic Pressure Regulating Valve
Installation, Operation and Maintenance Manual

Reference Number: IOM_003
Date: 28 July 2010
Issue: A
WARNING!

BEFORE ANY INSTALLATION AND MAINTENANCE WORK CAN COMMENCE ENSURE THE VALVE AND SURROUNDING SYSTEM IS DRAINED OF PRESSURE AND ISOLATED.
# Cryogenic Pressure Regulating Valve

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Disclaimer

PLEASE NOTE: If the valves produced by Bestobell Valves/LNG are refurbished by a third party organisation that is not approved by Bestobell Valves/LNG, then the safety and performance will not be guaranteed and the warranty may be invalid.

If unsure about the installation and operation procedures for this valve, please contact Bestobell Valves/LNG.

Bestobell Valves has produced this manual in order to provide engineering personnel with sufficient general information to enable the operation, installation and effective maintenance of the valve manufactured by Bestobell Valves.

In the interest of product development, the designs and specifications for our products are constantly under review and we therefore reserve the right to make changes and improvements without notice.

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<thead>
<tr>
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<tr>
<td>Title:</td>
<td>TECHNICAL DIRECTOR</td>
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<tr>
<td>Signed:</td>
<td>K. Fretwell</td>
</tr>
<tr>
<td>Date:</td>
<td>16-02-2011</td>
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Introduction

Outline
This manual is broken down into separate sections:

- **Introduction**
  This section provides information about important safety requirements as well as highlighting the precautions taken at Bestobell Valves to ensure the cleanliness of products. Details regarding servicing are also introduced.
- **Installation**
  This details the method of installing the valve on site, and includes information on storage, unpacking and inspection. Preparation of the valve and site is also discussed to allow ease of installation and operation.
- **Hardware Description**
  Introduces the product as well as providing a more detailed description including operating conditions and suitable media. Any further requirements for the effective operation of the valve are also discussed.
- **Operation**
  Provides information on how to operate the valve.
- **Maintenance**
  Provides information relating to the on-site maintenance of the supplied valve, as well as discussing common problems and solutions.

Safety

Read and understand these instructions before installing the valve. Improper installation, operation or maintenance by the owner or operator of this valve can result in personal injury.

Only use genuine Bestobell Valves spares to ensure safe and optimum performance.

Prior to the installation of the valve into the system, ensure the system is de-pressurised and isolated for the duration of the installation and during any subsequent maintenance.

The valve must be installed within a system that has adequate draining and venting provisions.

In cryogenic applications the area of pipe-work to receive the valve must be allowed to reach ambient temperature.

It is essential that the installers and operators are conversant with all of the safety issues relating to the medium within the system, and are fully trained to an adequate standard.
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Wear safety glasses and gloves during any installation or operation of the valve.

Valves must only be used in a circuit protected by suitable equipment.

The valve should be inspected for wear as part of a regular system maintenance programme.

Cryogenic burns can occur if the valve is handled during or after the valve has operated.

Minor leaks from the outlet side of the valve, if allowed to build up in a confined area, can be hazardous. This can be avoided by dissipating into the atmosphere or a well ventilated area.

If valve is to be installed in hazardous climatic conditions or seismic areas, please inform Bestobell Valves Ltd.

Identify the intended flow direction and match the valve orientation with its flow direction arrow.

Ensure that all end connections to the valve are in line and that the pipe work is supported to reduce unwanted stresses, loading and vibration on the valve and system pipe work.

Ensure that all joining materials / components used during the installation of the valve are compatible, and will not cause any deterioration to the valve structure.

When using on CO₂, the internal atmosphere must be dry and moisture free as any bronze components could be affected by carbonic acid.

**DO NOT** check leaks with hands.

**Cleanliness**

Immediately after assembly in a controlled clean room, the valve is sealed in an airtight plastic bag to maintain cleanliness. As such, it is essential to maintain this cleanliness throughout all stages of installation. Particular care should be taken not to contaminate the internals of the valve with grease, moisture, grinding dust, weld/brazing spatter etc.

Clean practices will save time later with reduced ‘flushing’ and maintenance.
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Service Intervals

Bestobell Valves recommends that a major service is carried out on its valves in line with the procedures contained in this manual every 2 years.

In addition to this, a regular inspection should take place to ensure correct operational condition.

Regular inspections are suggested on a monthly basis and maintenance work should be carried out in line with this service manual.

It is recommended that the Service Record Sheet enclosed be fully completed at every service interval.

Installation

Personnel carrying out Assembly / Joining / Welding / Inspection must be adequately trained and hold the necessary approvals.

Ensure that environmental conditions (atmospheric pollution) are compatible with the valve materials.

(NOTE: Ensure there is enough space around the valves installed position to allow the removal and refit of the headwork / valve)

Installation Overview

The quality of performance in service is a function of the care taken to ensure good installation. A careful study of these instructions is therefore recommended, as properly installed equipment will normally operate for long periods without problems.

The most critical point in the lifetime of a valve is the time of installation, therefore, proper care at this stage and during any maintenance will increase the probability of trouble free valve service.

It is important to maintain cleanliness throughout all stages of the installation, with particular care being taken not to contaminate the internals of the valve with grease, moisture, grinding dust, weld / brazing spatter or other foreign matter.

Clean practices will save time later with reduced ‘flushing’ and maintenance.
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STORAGE:

The equipment packing cases are NOT waterproof and should be stored in a weatherproof location before use.

UNPACKING:

It is recommended that before any item is unpacked, it should be moved as close as possible to its installed position. This will minimise the possibility of damage during handling.

It is further recommended that each item should only be unpacked immediately before it is required.

Before installation the engineer should check for:

- Damaged Packaging
- Bent or Distorted Items
- Scratches, Dents or Damage

Particular attention should be paid to the sealing faces on the end connection flanges.

TOOLS REQUIRED:

No special tooling is required for the installation of this valve.
WARNING!

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Identify the intended flow direction and match the valve orientation with its flow direction arrow.

Ensure that all end connections to the valve are in line and that the pipe work is supported to reduce unwanted stresses, loading and vibration on the valve and system pipe work.

Ensure that all joining materials / components used during the installation of the valve are compatible, and will not cause any deterioration to the valve structure.
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Hardware Description

The Cryogenic Pressure Regulating Valve (Cryoreg) is designed to provide all pressure regulator functions within one valve.

The standard body material is bronze; however, stainless steel bodies are also available.

Designed for use on all cryogenic pressure vessels including static and transportable tanks; the Cryoreg valve combines each of the following functions in one unit:

1. Pressure build up regulator
2. Economiser valve
3. Thermal relief* on two of the ports

* The Cryoreg provides thermal relief for the PBU inlet and vents this to the economiser outlet. If a stop valve is fitted on all three lines and were all closed then liquid lock would occur, therefore a thermal relief valve must be fitted to the economiser line or the gas (outlet) side of the Cryoreg.

Features and Benefits

- Combined pressure build-up regulator and economiser functions for simpler pipe work and fewer joints.

- High flow characteristics – for closer control of tank pressure.

- Operates on liquid or gas – to suit every installation.

- Single adjustment for both functions – for simpler tank setting.

- High accuracy/low dead band allows higher tank pressure – reduced boil-off in pipelines.

- Dual thermal relief valve action – for added system protection.

- Strainer fitted as standard on inlet and outlet.

- Ball check fitted to economiser outlet as standard.
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**Operation**

In the following explanation, it is assumed that the Cryoreg is fitted downstream of the pressure build-up coil and will therefore be controlling a gaseous flow during the pressure build-up phase of its operation. Operation is identical when fitted upstream of the PBU coil except that liquid will be passed during the pressure build-up phase.

**Function One – Pressure Build-up Regulator**

As liquid or gas is drawn from the tank, the pressure inside the tank will fall. To compensate for this, the Cryoreg will open to allow liquid to pass through the pressure build-up coil. Sufficient gas will thus be generated to bring the tank back to its normal working pressure.

In this phase of operation, flow is from port A to port B via the pressure build-up seat on the multi-function disc away from the main seat. This upward movement arises as a result of the force in the pressure setting spring overcoming the pressure force acting over the sensing diaphragm. As soon as the pressure in the tank has recovered, the diaphragm assembly is pushed back down again, stopping the flow.

**Function Two – Economiser Valve**

When heat leaks into a cryogenic storage tank, liquid will revert to its gas phase leading to a pressure rise in the tank. Left unchecked, the process may continue until the relief valve lifts, wastefully venting gas to the atmosphere.

The function of an economiser valve is to divert excess gas into the supply line. Providing the customer is drawing gas, diverting the flow in this manner will prevent the relief valve lifting, avoiding waste and reducing the overall cost of storing the liquefied gas.

To accomplish this, a flow path is formed within the Cryoreg to allow gas to pass from port B, up through the centre of the valve to exit via the economiser port C. The flow path is formed from the downward movement of the diaphragm (which senses tank pressure), having overcome the force in the pressure setting spring. This occurs when the tank pressure exceeds the valve set pressure by more than 0.54 barg.

Note that this mechanism is also used to provide thermal relief into the economiser from outlet B.
Function 3 – Thermal Relief

Inadvertent closure of the valve supplying the pressure build-up coil could lead to liquid being trapped between the coil and the Cryoreg.

A thermal relief valve would normally be required to protect the coil associated pipe work from the high pressures generated by warming of the trapped liquid. This function, however, is built into the Cryoreg, which will automatically vent the gas into either the economiser line (port C) or the gas supply line to the tank (port B).

This function is accomplished by the differential pressure across the bellows assembly forcing it to compress, leaving the multi-function disc in place. This allows a flow path to form from port A, up through the centre of the bellows to exit from the economiser port.

Remember that thermal relief is provided on port B by the economiser function described above, giving protection under all foreseeable circumstances.

The Cryoreg is also seen in its ability to control the flow of liquid when fitted upstream of the pressure build-up coil, or gas when fitted downstream. Typical pipe work layouts are shown.
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Technical Data / Description

Maximum working pressure: 40 bar.

Designed and engineered for use with O₂, N₂, Ar, CO₂, CH₄, He, CHF, Kr, Ne, He, H₂, C₂H₄, N₂O, SF₆, LPG, LNG.

ISO 9001 accreditation – designed and manufactured to ASTM B31.3 and BSEN1626.

Optional full material traceability backed by BSEN 10204 3.1/3.2 certification.

Marking according to Pressure Equipment Directive 97/23/EC.

Marking to Directive 99/36/EC only on written request complete with purchase order.
The Cryoreg is available with a choice of springs to give optimum control in all applications. Set pressure tolerance will normally be held on gas +/- 3% and liquid side +/- 5%.

DN15 – DN25 bull nose end connections available.

**Installation and Maintenance**

**Spares Kit**

1. Body
2. Cover
3. Coupling
4. Thrust plate
5. Thrust plate
6. Disc
7. Seat
8. Seal, non-reversible
9. Diaphragm
10. Spring
11. Spring
12. Strainer
13. Gasket
14. Gasket
15. Label
16. Label
17. Gasket
18. Bellows sub assembly
19. Setscrew
20. Nut, lock
21. Nut, lock
22. Screw, socket cap
23. Circlip
24. Drive Screw
25. Ball
26. Circlip
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<table>
<thead>
<tr>
<th>Kit Number</th>
<th>Name</th>
<th>Contents</th>
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<tbody>
<tr>
<td>CKCSP1</td>
<td>SEAL KIT</td>
<td>1 SEAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 GASKETS</td>
</tr>
<tr>
<td></td>
<td>BELLOWS/SEAL KIT</td>
<td>1 BELLOWS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 SPRING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 SEAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 GASKETS</td>
</tr>
<tr>
<td>CKCSP3</td>
<td>DIAPHRAGM KIT (HP)</td>
<td>1 DIAPHRAGM ASSY</td>
</tr>
<tr>
<td></td>
<td>(10.0 - 25.0 BAR)</td>
<td>1 GASKET</td>
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<tr>
<td>CKCSP4</td>
<td>DIAPHRAGM KIT (LP)</td>
<td>1 DIAPHRAGM ASSY</td>
</tr>
<tr>
<td></td>
<td>(1.5 to 12.0 BAR)</td>
<td>1 GASKET</td>
</tr>
<tr>
<td>CKCSP5</td>
<td>MAINSPRING KIT (HP)</td>
<td>1 SPRING</td>
</tr>
<tr>
<td></td>
<td>(10.0 top 25.0 BAR)</td>
<td>1 GASKET</td>
</tr>
<tr>
<td>CKCSP6</td>
<td>MAINSPRING KIT (MP)</td>
<td>1 SPRING</td>
</tr>
<tr>
<td></td>
<td>(4.0 to 12.0 BAR)</td>
<td>1 GASKET</td>
</tr>
<tr>
<td>CKCSP7</td>
<td>MAINSPRING KIT (LP)</td>
<td>1 SPRING</td>
</tr>
<tr>
<td></td>
<td>(1.5 to 4.0 BAR)</td>
<td>1 GASKET</td>
</tr>
<tr>
<td>CKCSP8</td>
<td>GASKET SET</td>
<td>2 GASKETS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 GASKET</td>
</tr>
<tr>
<td>CK30A1REPKITLP</td>
<td>REPAIR KIT (LP)</td>
<td>1-CCKSP4</td>
</tr>
<tr>
<td></td>
<td>(1.5 to 12.0 BAR)</td>
<td>1 SEAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 GASKETS</td>
</tr>
<tr>
<td>CK30A1REPKITHP</td>
<td>REPAIR KIT (HP)</td>
<td>1-CCKSP3</td>
</tr>
<tr>
<td></td>
<td>(10.0 to 25.0 BAR)</td>
<td>1 SEAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 GASKETS</td>
</tr>
</tbody>
</table>

**NOTE:**
Please ensure that when ordering Spares the parts being ordered match the pressure rating of parts either fitted, or being fitted.

E.g. CK30A1REPKITHP or CKCSP3 must only be used in conjunction with CKCSP5.

**Installation Method**

Install the valve in the pipe work with the connections as shown in either of the figures on the following page.

Ensure that the direction arrows on the valve are pointing in the correct direction.

Ensure that the physical environment will not cause the drain hole in the cover to become blocked.
The valve may be fitted on either the liquid or gas side of the pressure build up coil at the discretion of the customer.

Ensure that there is a minimum of 200mm head between the highest liquid level and the point at which the economiser outlet joins the customer supply line.

Install the Cryoreg with the pressure setting screw downwards; this prevents ice formation inside the cover which would impede correct operation of the valve.

To set the valve at the correct pressure (it is usually supplied with the pressure setting screw at mid spring range unless otherwise requested) slacken off the setting screw locknut. Screw the pressure setting screw into the valve until the correct working pressure is obtained.
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Care should be taken to ensure that safe working pressures are not exceeded.

As an indication and to assist in the initial setting of the valve the approximate rates of adjustment shown below apply for the three available springs.

<table>
<thead>
<tr>
<th>Spring Range Bar</th>
<th>Sensitivity (Bar/ Turn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 to 5</td>
<td>0.75</td>
</tr>
<tr>
<td>4.0 to 12.0</td>
<td>2</td>
</tr>
<tr>
<td>10.0 to 25.0</td>
<td>5</td>
</tr>
</tbody>
</table>

Refit / Refurbishment Method

STEP 1:
Unscrew the Setscrew from the top of the valve.

Leave the lock nut at its current setting.

Step 2:
Unscrew each of the six socket cap screws and lift off the cover.
**STEP 3:**
Remove the large spring and thrust plate over the top of the diaphragm assembly.

**STEP 4:**
Remove the diaphragm assembly from the body.

**STEP 5:**
Remove the lock nut from over the top of the diaphragm discs.

NOTE: Hold the square below the diaphragm discs in a vice with soft jaws to prevent damage to this end; take care not to damage the lapped seat face.

**STEP 6:**
Remove the diaphragms and replace the gasket. If the diaphragms are in good condition re-use, if not replace. Tighten the lock nut back on top to 33Nm (24 lb.ft).

<table>
<thead>
<tr>
<th>Valve Operating Pressure</th>
<th>Number of Diaphragms Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 – 5.0</td>
<td>3</td>
</tr>
<tr>
<td>4.0 – 12.0</td>
<td>3</td>
</tr>
<tr>
<td>10.0 – 25.0</td>
<td>4</td>
</tr>
</tbody>
</table>
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STEP 7:
Unscrew each socket cap screw from the coupling.

STEP 8:
Remove the circlip from the groove inside the threads of the coupling.

STEP 9:
Remove the ball from the coupling – replace this if worn with the one from the spares kit.

STEP 10:
Remove the small spring from inside the bellows.
STEP 11:
Remove the bellows and discard the gasket underneath. Replace it with the new one from the spares kit.

STEP 12:
Remove the seal with pliers and discard. Replace the seal with the new one from the spares kit and place back inside the body.

Place the seal with the two raised seat faces downwards into the body and the single seat face upwards towards the bellows.

STEP 13:
Replace the bellows with the one from the spares kit if it is damaged or excessively worn.

STEP 14:
Insert the small spring inside the bellows.
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STEP 15:
Reinsert the ball into the coupling.

Secure the ball in place by re-attaching the circlip.

STEP 16:
Replace the coupling ensuring that the gasket is in position. Tighten the socket cap screws to 12NM (9 lb.ft), working alternately on opposite corners to apply equal pressure to the face, to secure the coupling to the body.

STEP 17:
Invert the body. Remove and discard the main body gasket and replace with the new one from the spares kit.

STEP 18:
Replace the diaphragm assembly into the body.
**STEP 19:**
Replace the large spring and thrust plate over the top of the diaphragm assembly.

**STEP 20:**
Place the cover onto the spring. Screw each of the six socket cap screws back into the body.

Do not initially fully tighten each screw; gradually tighten each one until all the screws are tightened to the specified torque.

**STEP 21:**
Screw the setscrew back into the valve down to the lock nut. Ensure the lock nut is then secured in this position.
## Troubleshooting

<table>
<thead>
<tr>
<th>SYMPTOM:</th>
<th>FAULT:</th>
<th>SOLUTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRESSURE CONTINUES TO BUILD UP.</td>
<td>PRESSURE SETTING SCREW NOT SET CORRECTLY.</td>
<td>SET THE PRESSURE SETTING SCREW TO THE CORRECT PRESSURE (SEE PAGE 9).</td>
</tr>
<tr>
<td>PRESSURE CONTINUES TO BUILD UP.</td>
<td>IF LINES A AND B AND THE OUTSIDE OF THE VALVE AT THESE PORTS ARE FROSTY BUT THE ECONOMISER OUTLET (PORT C) IS NOT FROSTY THIS COULD INDICATE THAT FOREIGN MATTER OR ICE IS PRESENT AROUND THE SEAL.</td>
<td>ENSURE THAT ALL MAINTENANCE IS CARRIED OUT IN A CLEAN ENVIRONMENT AND THAT NO FOREIGN MATTER IS ALLOWED INTO THE SYSTEM.</td>
</tr>
<tr>
<td>PRESSURE CONTINUES TO BUILD UP.</td>
<td>IF PORTS B AND C ARE FROSTED BUT PORT A IS NOT, THIS COULD INDICATE THAT REVERSE FLOW OR SIPHONING IS OCCURRING. EITHER THE CHECK VALVE OR THE ECONOMISER IS FAULTY.</td>
<td>REPAIR OR REPLACE THE FAULTY CHECK VALVE.</td>
</tr>
<tr>
<td>PRESSURE CONTINUES TO BUILD UP.</td>
<td>A CHECK VALVE IS NOT FITTED.</td>
<td>FIT A CHECK VALVE</td>
</tr>
</tbody>
</table>
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Contact Details

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# Cryogenic Pressure Regulating Valve

**Reference Number:** IOM_003  
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## Service Record

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