PLAN 53B

BARRIER LIQUID SYSTEMS

Installation, Operation & Maintenance Instructions

1. General

1.1 INTRODUCTION

This instruction manual is provided to familiarize the user with the system arrangement and its use. The instructions must be read and applied whenever work is done on the system, and must be available to the operating and maintenance personnel.

These instructions will help to avoid danger and increase reliability. They should be used with the appropriate mechanical seal instruction manual.

John Crane reserves the right to change the system and specifications described.

The following important term and definition is used in this document.

BARRIER LIQUID

A fluid supplied at a pressure above the pump seal chamber pressure. It is introduced between the two seals of a dual pressurized seal configuration to completely isolate the process liquid from the environment.

1.2 EUROPEAN AND/OR UK DECLARATION OF INCORPORATION (MACHINERY DIRECTIVE 2006/42/EC, AND UK SI 2008 NO. 1597)

Where appropriate this is attached.

1.3 EUROPEAN AND/OR UK DECLARATION OF CONFORMITY (PRESSURE EQUIPMENT DIRECTIVE 2014/68/EU, AND UK SI 2016 NO. 1105)

In assessing the hazard classification for the European or UK pressure equipment directive/regulations, the barrier liquid will determine the classification as long as a low pressure alarm is used.

Where appropriate this is attached.

1.4 EUROPEAN AND/OR UK DECLARATION OF CONFORMITY (ATEX 2014/34/EU, AND EQUIPMENT AND UK SI 2016 NO. 1107)

These instructions are intended for use with the barrier system operating in Equipment Group II, category 2GD and 3GD.

The Declaration covers the complete seal and system and the Maximum Surface temperature is recorded in the Mechanical Seal instruction manual.

If appropriate this is attached.

2. Safety and environment

The safety notes refer to the system supplied. They can never be exclusive, and must be used in connection with the relevant safety regulations the machine, auxiliary equipment, plant and sealed product..

2.1 WARNING SYMBOLS

The following symbols are used in this instruction manual to highlight information of particular importance:

Danger - Mandatory instructions designed to prevent personal injury or extensive damage.

Warning of electric current.

ATTENTION Special instructions or information to avoid damage to the system or its surroundings.

NOTE Information for easy installation and efficient operation.

Environmental note

Compliance is required with any additional warning signs affixed to the system.

2.2 SAFETY INSTRUCTIONS

ATTENTION

Every working practice that compromises personal safety is to be avoided. All safety requirements in this document must be strictly adhered to.

In the event of an operating problem, the machinery must be switched off immediately and made safe! Problems must be solved promptly.

Ensure suitable protective clothing is used when maintaining the system.

Plan 53B systems are commonly used with dual seal configurations to reduce the hazard potential from flammable, explosive, toxic or lethal process fluids. The intermediate, protective barrier liquid, in certain failure modes, may risk being contaminated. During any maintenance operation operators must thus assume they will be exposed to the liquid or gaseous properties of the process fluid and have suitable protective gloves, clothing, respirators and equipment.

Particular note must be taken of the relevant guidelines for the electrical installations.

A slight leakage will occur during normal seal operation. Depending on the barrier liquid, this leakage can appear as a gas, a liquid or a solid. In case of a worn or defective seal, the leakage will increase. The leakage may cause a hazard if it contacts a hot surface, and a safe collection system is thus required.

Surface temperatures above 60°C/140°F should be protected against accidental contact.

The equipment sealed by this seal system must be operated within its recommended design limits.

Compounds containing PTFE, fluorocarbons and perfluoroelastomers should never be burnt as the fumes and residues are highly toxic. If this accidentally occurs, protective equipment should be worn as hydrofluoric acid may be present.

Additional equipment/flanges/joint seals used within the system are to be rated for the appropriate electrical and pressure requirements and are to be chemically compatible with the barrier fluid.

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2.3 ENVIRONMENTAL ASPECTS

2.3.1 COMPANY POLICY EXTRACT

"It is the policy of John Crane to manage its business activities in an environmentally responsible manner, comply with all relevant laws and regulations, prevent pollution, and continually improve its environmental performance, certification to the latest issue of ISO 14001 ensures compliance."

John Crane adopts the '**Design For the Environment**' **(DFE)** principle in making this product. Using this product will benefit the environment **directly** by:

- **Reducing waste** of precious resources through decreasing the risk of leakage and minimizing energy consumption.
- **Preventing pollution** through controlling harmful emissions to the atmosphere and ground contamination.
- **Preserving valuable materials** through the use of high quality durable materials.

2.3.2 RECYCLING

PRODUCT REFURBISHMENT

This product has been designed for long life.

BARRIER LIQUID RECYCLING OR DISPOSAL

Replacement of barrier liquid is required as part of the normal maintenance operation. Recycling of liquid should be considered but if this is impractical because of contamination then an environmentally controlled form of disposal must be arranged.

DISPOSAL

When the product is considered to be beyond economical repair and potential reuse, it should be disposed of by **environmentally beneficial** means. The product can be disassembled with ease.

SCRAPPED COMPONENTS

These should be handled with extra care due to possible contamination. They should be **recycled** through **local** industrial recycling plants.

PACKAGING

All packaging materials used are made from recyclable, environmentally friendly materials.

When in doubt or for further information and advice on this subject, please consult John Crane.

3. Transportation and storage

Transport and store the system where possible in its original packaging.

It is necessary to protect and preserve the integrity of the equipment between shipment and installation/start-up at site. This is particularly important when extended periods of storage are envisaged.

When seal systems are shipped first to a rotating equipment manufacturer, it is customary for them to be mounted on a skid by the rotating equipment manufacturer.

Seal systems and generally all auxiliary sealing products installed on rotating equipment skids should be packed in suitable crates or cases by the rotating equipment manufacturer to protect them from damage during shipment. All openings to the system are closed and sealed for shipping.

On arrival at site and before unloading for storage, a visual inspection of the crate/case should be carried out for signs of damage during shipment. In the event of any damage the crate/case must be opened, and the contents thoroughly examined for signs of equipment damage. All bolts and threaded connections should be checked for signs that they have come loose during transport. If any seals are broken, then the system is assumed to be contaminated and shall be cleaned accordingly. All loose connections or bolts should be correctly tightened to eliminate any loosening which has occurred during transportation or as part of the cleaning process.

If the parts are considered acceptable with no visual signs of damage, the crate/case should be properly closed again prior to storage.

After checking for shipment damage, the following recommendations should be undertaken to prevent deterioration arising from long-term storage.

- Seal systems should be stored in their original packaging and if possible the crate/case should be stored away from direct sunlight, in a wellventilated building with a hard floor.
- Temperature control is not normally necessary, but large temperature fluctuations greater than > 40°C/72°F should be avoided.
- If stored outdoors, it is recommended that the crate/case be placed on square timber bearers resting on a concrete or similar hard surface.
- The crate/case must then be wrapped with waterproof tarpaulin to prevent ingress of water and dirt.
- Loose components or accessories in the case should be stored as above, after proper itemization.
- A weekly visual external inspection of the protection and preservation should be undertaken and any deficiencies noticed should be corrected without delay.
- The system must be stored far from backwater to avoid the MIC phenomenon (microbial corrosion).

NOTE Should water, condensation, sand, dirt or other contaminant enter the system, through package/ tarpaulin damage or improperly positioned covers, the cause of the problem must be eliminated and the equipment thoroughly dried and cleaned before re-storing.

If used system parts are to be transported to the manufacturer or a third party they have to be cleaned, decontaminated and require safe handling instructions externally attached.

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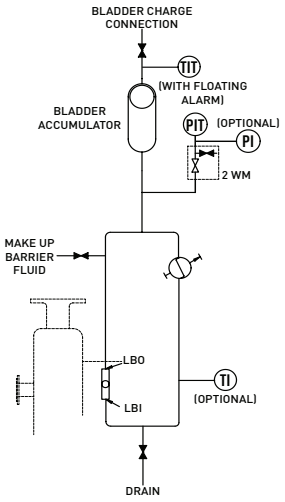
4. Description of the system

4.1 FUNCTION OF THE SYSTEM

The piping plan references used conform to API 682 (4th Edition).



BARRIER LIQUID SYSTEM FOR DUAL PRESSURIZED SEALS (PLAN 53B)

This seal configuration comprises an inner and outer seal between which a barrier liquid is provided at a pressure higher than the process condition on the inner seal. If operated correctly it thus ensures a zero process leakage to the atmosphere. The system manages the barrier liquid and is ordinarily referred to as piping Plan 53B. It provides the following functions:

- An accumulator for the barrier liquid. This provides most of the working volume for the seals.
- Removes heat from the barrier liquid. This is achieved by an air or water cooler installed in the pipework connecting the inlet and outlet of the seals.
- Maintains the set barrier pressure through the energy retained in the gas bladder in the accumulator. A local pressure-indicating transmitter provides monitoring information and a low-pressure alarm warns the operator at a predetermined condition prior to barrier isolation being compromised.
- The system pressure is recharged by replacing barrier liquid lost from the circuit, recompressing the bladder. Various barrier liquid top-up systems are used.
- The bladder is initially charged to a minimum pressure with an inert gas (normally Nitrogen), applied from an external source to a connection on the accumulator.
- Monitors the condition of the inner and outer seal. The rate of change of pressure in the system can be directly related to barrier liquid leakage rate and the condition of the seals. A low-pressure refill alert warns when the system needs replenishment and the time between top-ups can be used as a guide as to the seal's condition.

- Monitors the condition of the inner and outer seal. The rate of change of pressure in the system can be directly related to barrier liquid leakage rate and the condition of the seals. A low-pressure refill alert warns when the system needs replenishment and the time between top-ups can be used as a guide as to the seal's condition.

NOTE API 682 4th Edition includes two possible system refill alarm strategies:

Floating alarm strategy includes a temperature transmitter on the accumulator gas side. The temperature and pressure transmitters are programmed into the plant distributed control system (DCS), or local programmable logic controller (PLC). This allows the pressure alarm to be determined continuously by measuring the current site ambient temperature. This option can provide increased working volume. A nameplate is attached to the system providing details of the bladder precharge, refill and alarm pressure set points for the identified site ambient temperature range. The alarm algorithm data for programming is provided by John Crane.

Fixed alarm strategy is a more traditional approach to system settings and does not include a temperature transmitter on the accumulator gas side. This uses an alarm set point based on the minimum barrier liquid volume at maximum ambient temperature. A nameplate is attached to the system providing details of the bladder pre-charge, refill and alarm pressure set points for the identified site ambient temperature range.

(Refer to General Arrangement Drawing.)

BARRIER LIQUID CIRCULATION

In order to remove heat from the seal area the liquid must circulate around the closed-loop system. One or a combination of alternative methods achieves flow:

- A positive flow inducer installed between the seals and driven by the shaft rotation. This is a requirement on API 682 specifications and with ATEX 2014/34/EU or UK SI 2016 No. 1107 pump services.
- Flow induced by thermosyphon mechanism. This is achieved by the temperature difference in the supply and return pipework causing a variation in the specific gravity. Thermosyphon does not require shaft energy to function and hence is used with lower shaft speeds and barrier pressures. It can also provide circulation in positive flow induced systems when static. (API 682 4th Edition prohibits reliance on thermosyphon to maintain circulation during normal operation).

A separate circulation pump installed in the supply line pipework.

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BARRIER LIQUID TOP-UP

Periodic topping-up is required to replace barrier liquid used during normal operation. Typical methods of topping-up are:

- Dedicated top-up hand pump and storage reservoir permanently connected to the system, allowing topping-up without process shut down.
- Mobile top-up trolley which can be used for topping-up multiple systems by use of a hose and quick-connect coupling. This can also be carried out without process shut down.
- Plant-based system supplying an installed barrier liquid manifold.

Without the intended lubrication the seal face temperature will increase and may provide an ignition source in a potentially explosive atmosphere. Equipment and system operation must ensure seal face

4.2 RANGE OF APPLICATION

Barrier systems are designed to service mechanical seals by cooling, lubricating and pressurizing; they must be operated within their performance limits.

The barrier liquid must be clean, with stable properties over the operating temperature and pressure conditions, and not constitute a hazard or introduce potential damage to the environment. The liquid should have good lubricating properties, a viscosity < 15cSt @ 104°F/40°C and be compatible with the process fluid. API 682 (4th Edition) also offers advice on the selection of barrier liquids. It is advised John Crane is contacted for more detailed advice on barrier liquids and a formal approval sought.

Properties of barrier liquids may be the source of flammable or explosive hazards.

If the process or operating conditions are changed from those referenced in this manual, John Crane must be consulted to ensure the sealing system is safe.

Ordinarily a pumping device in the containment chamber circulates the barrier liquid between the dual seals. Thermosyphonic flow should occur statically but dynamically this flow mechanism should only be used in EU/UK Ex zones 1, 2, 21, and 22 that have seal speeds below 2 m/s / 6.5 ft/s (< 12 barg / 174 psig for unbalanced seals and <27 barg / 392 psig for balanced seals).

If the rating of the equipment on which the system is installed exceeds the seal system Maximum Allowable Working Pressure (MAWP) a pressure relief valve, vented to a safe area, should be included. If a safe vent is not possible, the outlet connection should be piped down to grade and appropriate warnings erected adjacent to the valve.

4.3 INSTRUMENTATION AND FITTINGS

The system is usually supplied with the following:

- Flanged or threaded terminations to inter-connecting lines (supply and return)
- Pressure transmitter(s) (with LCD)
- Fill connection
- Vent connection
- Air/Water cooler (if required)
- Accumulator gas charge connection
- Temperature transmitter (on Hazardous Services)

And, upon request with the following possible options:

- Alternative cooler
- Pressure switch(s)
- Pressure gauge
- Temperature indicator
- Refill hand pump with reservoir
- Sun shades for the accumulator and/or instruments

5. Installation and assembly

See Section 8 for General Arrangement Drawing reference.

5.1 INSTALLATION POSITION

The location of the installation position is particularly important for the efficient operation of the system.

Please pay attention to the following points:

- Easy access to the equipment for operation and maintenance
- Easy access to drain plugs/valves and connections
- Sufficient room for removal of the system (see dimensions in the General Arrangement drawing, Section 8)
- Practical installation of all inter-connecting lines. (see Section 5.3)
- Visibility of Instrument transmitters/indicators

ATTENTION Before commencing the start-up procedure, review and become familiar with all the available instructions concerning the equipment, especially the safety warnings.

5.2 PREPARATIONS FOR INSTALLATION

Carry out the following steps prior to assembly:

- Examine system components for any damage caused during transport or storage
- Remove protection caps from pipes and connections
- Keep everything clean when assembling the system

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5.3 ASSEMBLY

The system should be assembled using the Installation Drawing in Section 8 but considering the following.

- The seal gland plate inlet connection should coincide with the lowest point in the barrier circulation circuit.

Any welding of pressure components is strictly forbidden.

- Flowrate predictions are based on inter-connecting pipework assumptions. The following recommendations must be applied:
  - Piping or tubing to have a minimum bore of 0.5"/13.0 mm. (API 682 contains additional minimum requirements on pipe/tube sizing which should be considered where applicable).
  - Stainless steel material.
  - Pipework bends should have a minimum radius of 5xD. There should be a maximum of 6 bends in total.
  - Maximum total length of piping or tubing 16.4 ft/5.0 m.
  - Lines are horizontal or continuously rising (supply) and continuously rising (return) to aid venting. API 682 4th Edition states 0.5" slope per ft/40mm slope per 240mm pipe/tube run.
  - Ensure air coolers are exposed to air or wind flow.
  - Isolating valves in the circulation lines (though not recommended) must be full-bore type.
  - Do not include check valves.
  - Flow transmitters/indicators are not recommended. May be used when a circulation pump is incorporated. If essential only use low resistance designs.

A lower flowrate will reduce the effective cooling and raise the barrier temperature and may provide an ignition source in a potentially explosive atmosphere.

Retained air or gas pockets will severely restrict flowrate and cause damage and overheating in the seal. Install venting devices if self-venting is impractical.

NOTE Due to the nature of thermosyphonic flow and it's relation to the system and seal design, it is not uncommon that the flow direction can differ between seemingly identical systems (API 682 4th Edition prohibits reliance on thermosyphon to maintain circulation during normal operation).

NOTE To assist in the promotion and maintenance of thermosyphonic flow, the warmer pipework leg can be lagged and/ or trace heated. (API 682 4th Edition prohibits reliance on thermosyphon to maintain circulation during normal operation).

- The vent connection from the system should be connected to a safe drain.
- The cooling water connections (if required) must be made, adequately sealed and the flowrate checked and adjusted to the value recommended in the Installation Drawing or Operational Data Sheet, See section 8. The following recommendations must be applied:
  - Clean, cold and filtered fresh water is used.
  - Isolating valves are lockable full-bore type and locked open.
- The system installation is ordinarily supplied with a valved drain connection. If this is not the lowest point in the barrier circuit, or the system can be separately isolated, it is also preferable to install a drain valve at the lowest point in the inter-connecting lines. This will then facilitate draining the seal barrier chamber and pipework.

5.4 ELECTRICAL CONNECTIONS

Only authorized and qualified personnel are permitted to carry out work on electrical systems. International and local safety regulations must be followed in all cases.

Before connecting cables, check the electrical data on the name plate matches the available power supply and complies with the area hazard classification.

Refer to the diagrams in the terminal housing and the supplier's instruction manual for wiring instructions.

Connect the electrical component using flexible conduit or armoured cable to assist removal of the component for maintenance purposes.

When fitted, the circulation pump should be operational before the primary equipment pump is started. Use a suitable controller for the start-up sequence.

If passive switching elements are installed in potentially explosive areas you should add suitable protective devices, following the pertinent rules.

6. Commissioning and decommissioning

6.1 COMMISSIONING

Before starting the machine (pump or mixer) carry out the following operations:

ATTENTION Before commencing the start-up procedure, review and become familiar with all the available instructions concerning the equipment, especially the safety warnings.

A. Use an accumulator pre-charge kit to check the pre-charge pressure in the accumulator bladder. If necessary, re-charge the bladder with nitrogen from a nitrogen bottle to the pre-charge pressure as quoted on the nameplate or General Arrangement Drawing. Note that the correct pre-charge pressure varies according to the ambient temperature. The relationship between ambient temperature and pre-charge pressure is specified on the name plate or General Arrangement Drawing. See Section 8.

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Reducing valves on the nitrogen cylinder/bottle, calibrated and correctly fitted MUST be used when pre-charging the accumulator. Refer to the accumulator instructions.

B. Open the barrier fill connection and the vent valve or vent plug.

C. Using the fill connection, fill the system with the selected barrier liquid using the top-up system chosen until it flows from the vent connection. Close the vent valve and continue pressurising the system. Crack open the vent valve intermittently until all air has been eliminated from the circuit. Close vent valve and continue pressurising the system until the maximum barrier pressure (the working pressure) is achieved. Note that the correct working pressure varies according to the ambient temperature. The relationship between ambient temperature and working pressure is specified on the name plate or General Arrangement Drawing. See Section 8.

The minimum barrier pressure is specified as the 'minimum pressure/shutdown required' on the nameplate or General Arrangement drawing. See Section 8. A low pressure alarm must be set to this value, using the pressure transmitter, to warn operators that there insufficient barrier pressure and the equipment must be shut down.

If no barrier pressure setpoint is specified, the barrier pressure should be set at least 10% or 1.4 bar (20 psi) above the maximum seal chamber pressure, whichever is the greater value. If a low-pressure alarm is set using the pressure transmitter/switch, ensure it is set above the maximum seal chamber pressure and below the barrier pressure. A pressure switch must have an adequate pressure difference between its set point and the barrier pressure to allow the switch to reset.

Dry running of seal faces will cause excessive temperatures which may cause an explosive or flammable risk.

Care should be exercised to ensure the Maximum Allowable Working Pressure (MAWP) is not exceeded during filling and pressurisation.

ATTENTION Avoid dry running under any circumstances, as it will damage the seal.

NOTE With oil-based liquids it is recommended to fill the system slowly to avoid aerating the liquid.

D. Carefully check that there is no leakage from any of the connections. In the event of a leak, tighten the flange, nut or connector. If the leak persists replace the gasket or connector.

E. Open the cooling circuit (if installed) and circulate the required amount of water.

F. (If fitted) Open the vent connections of each instrument valve to vent the instrument lines.

G. Close fill line.

H. Check that any isolating valves in the circuit are locked fully open.

I. Check that all electrical instruments are correctly connected and in compliance with the area classification. This should be carried out by a qualified electrician.

J. Check that the pressure transmitter and temperature transmitter (if fitted) set points are correctly adjusted to suit the duty. Refer to Table 1.

NOTE If a pressure switch is used, it will be impossible to have both a Refill Alert and Minimum Pressure Shutdown Required alarm, meaning there will be a reduced level of safety.

When the floating alarm strategy is used, the refill alert and minimum pressure alarm points must vary with temperature. The relationship between ambient temperature and minimum pressure is specified on the name plate or General Arrangement Drawing. See Section 8.

TABLE 1. Alarm signals

Alarm Name	Instrument	Set point	Notes
Refill Alert (Low Pressure Alarm)	Pressure Indicating Transmitter (PIT) or Pressure Switch (PS)	If pressure drops below the refill alert on the accumulator nameplate (set point varies with temperature for floating alarm strategy)	REQUIRED
Minimum Pressure/ Shutdown Required (Low Low Alarm)	Pressure Indicating Transmitter (PIT)	If pressure drops below the minimum pressure/ Shutdown required on nameplate	REQUIRED (with PIT)
Maximum Pressure Alarm	Pressure Indicating Transmitter (PIT)	If pressure rises above the highest working pressure on nameplate	OPTIONAL

Before start-up, ensure that all personnel and assembly equipment have been moved to a safe distance and that any safety guards are refitted.

K. Start the machine.

L. Check the barrier pressure does not rise beyond the maximum level as the system heats up. After a short period, when the barrier circuit temperature has settled, crack the vent valve and remove any air trapped after flow circulation. Check the pressure setting and top-up to the operating condition. See Section 8.

M. Check suitable flow circulation by measuring the barrier outlet line to confirm there is a suitable temperature rise above the inlet.

N. During and after start-up there should be no significant pressure instability in the system. Any significant variations should be corrected immediately.

O. The cooling water outlet temperature should be < 49°C/120°F. If not, check that the cooling water inlet temperature is low and that the flowrate is correct.

P. The barrier settlement temperature when in service should typically be < 80°C/176°F. Some systems sealing hot process liquids may need to operate above this temperature; suitable warnings and protection must then be applied.

6.2 DECOMMISSIONING

ATTENTION When the machine is stopped, the system pressure must be maintained until the machine itself is unpressurized.

Work on the seal or system must only be carried out when the machine is stationary, and secured against any unforeseen start-up. Isolation from connections to pressurization sources, vent or flare systems must be carried out.

Before carrying out any work on the seal or system, the barrier liquid must be fully depressurized and drained.

If the equipment has been used on toxic or hazardous fluids, ensure all precautions are taken to avoid personnel hazards such as correct decontamination when draining the barrier system and removal of any dangerous gas remaining in the reservoir. Remember fluid is often trapped during draining.

NOTE It is recommended that a pressure test is carried out on the system after any repair and before operation on the equipment.

7. Maintenance

7.1 REGULAR MAINTENANCE CHECKS

Check the following as part of regular site walk-around checks for trouble-free operation:

- That the connections are leak-free.
- Barrier liquid temperature (when displayed).
- Barrier pressure. Compare with the refill value and minimum value.
- Cooling water availability to the cooler (if fitted).
- Any abnormal leakage rate from the outer seal.
- Condition of alarm signals (see Section 7.4).
- There is no accumulation of dust on any part of the Plan 53B. Remove any built-up dust as required.

7.2 BARRIER TOP-UP

This is required to replenish lost barrier volume. The system is typically sized to allow at least 28 days to pass between top-up intervals. Top-up is carried out by various methods (see Section 4.1).

- Barrier top-up is required when the 'refill alert' is signalled by the pressure indicating transmitter when the barrier pressure drops below the refill alert setpoint. The top-up procedure should be carried out before the completion of the following work shift, from when the refill alert is triggered, and before the pressure falls to the 'minimum pressure/shutdown required' setpoint. Ensure the replenishment liquid is the correct specification, clean and free from contamination.
- Ensure the replenishment liquid is the correct specification, clean and free from contamination.

If barrier liquid systems need replenishment when in service this should only be done with fill systems that exclude air ingress and/or prevent gas leakage to the atmosphere.

- Using the fill connection, top-up the system with the selected barrier liquid using the top-up system chosen, until the maximum barrier pressure (the working pressure) is achieved. The correct working pressure varies according to the ambient temperature, as specified on the name plate or General Arrangement Drawing. See Section 8. If no temperature measurement is available, top up to the working pressure at the lowest temperature shown. Note that this may lead to more frequent refills.
- Check the pressure in the barrier system. If it has risen above the recommended pressure, crack open the vent valve and reduce the pressure to the required value. Close vent valve.

7.3 BARRIER MAINTENANCE

After the first 100 operating hours, and after every subsequent 6 months:

- Change the barrier liquid.
- Check system and inter-connecting lines are clean and free of corrosion and deposits.

These maintenance intervals may need to be shortened if the operating conditions are extreme.

7.4 INDICATORS AND ALARMS

The instrumentation on the system has the specific purpose of signalling eventual malfunction of the mechanical seals. Possible alarm signals indicating a malfunction are as shown in Table 2.

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TABLE 2. Possible alarm signals indicating a malfunction			
Effect	**Instrument**	**Action**	**Cause**
Rising pressure	Pressure Gauge (PG)	–	H to K
Falling Pressure	Pressure Gauge (PG)	–	E to F, or K
Refill Alert (Low Pressure Alarm)	Pressure Indicating Transmitter (PIT)	A	E to F
Minimum Pressure/ Shutdown Required (Low Low Alarm)	Pressure Indicating Transmitter (PIT)	B	Excessive E to F, or G
Maximum Pressure Alarm	Pressure Indicating Transmitter (PIT)	C	H to L
Rising Temperature	Temperature Gauge	D	H to K

Actions	
A	Recharge system with fresh buffer liquid (see 7.2)
B	Shut down machine to prevent damage or loss of containment
C	Check coalescing filter and gas supply
D	Investigate cause of increased temperature. Monitor to ensure temperature does not rise above safe levels (see Section 6.1, item p)

Causes	
E	Leakage from the inboard seal (process side) or outboard seal (atmospheric side)
F	Leakage from a flange, joint or accumulator bladder
G	Barrier fluid not topped up within required interval
H	Process temperature rise
I	Inadequate cooling or flow of barrier circuit
J	Abnormally high process pressure
K	Changes in ambient temperature
L	Barrier fluid topped up above the normal working pressure at the ambient temperature

The signal from the pressure transmitter can be used either:

- LOCALLY (with a Klaxon and/or beacon)
- REMOTELY (in the control room)

On critical items the alarm signal could be utilized as a trip function for the plant machinery.

Consult the specific instrument manufacturers manual should there be a malfunction.

John Crane must be consulted in the event of any abnormal malfunction of the sealing system. Excessive leakage rate, premature failure, high relative temperatures are all considered examples of abnormal malfunction.

7.5 SPARE PARTS

Spare parts must conform to the established technical specifications of the manufacturer. This is guaranteed with John Crane spare parts.

You are advised to stock the most important wear parts on site.

The following data is necessary for spare part orders:

- John Crane code/part number
- John Crane order/ref no.
- Part description
- Quantity

7.6 ANNUAL MAINTENANCE CHECKS

Disconnection shall be made by plant person in charge of authorization.

Before any maintenance operation the system pressure must be fully discharged, and the equipment allowed to cool to ambient temperature. A suitable container should be available to contain drained barrier liquid.

All parts requiring maintenance must be thoroughly decontaminated prior to any work commencing.

All flange joints should be checked for tightness and if necessary, the gaskets changed using replacements available from John Crane. If necessary, and prior to refilling with fresh barrier liquid, the system should be flushed with a compatible liquid to remove any internal contamination.

Where required by code or local regulations the walls of pressurised vessels should be internally checked for corrosion damage. Where damage exceeds any corrosion allowance the vessels must be replaced.

Condition of the bladder should be checked, either by visual inspection, or by confirming that the bladder holds the pre-charge pressure before recommissioning.

7.7 HEAT EXCHANGER MAINTENANCE

Heat exchangers in plan 53B systems must be regularly checked to ensure that the cooling surface has not degraded or fouled. The cooling water side of a water-cooled heat exchanger should be regular backflushed or cleaned at a frequency depending on the rate of scaling or quality of the water used. See local site regulations for guidance.

7.8 BARRIER CONTAMINATION

If there is any evidence a reverse pressure event has occurred, and/or the barrier fluid has been contaminated with process fluid, the plan 53B must be fully stripped down and cleaned to remove all traces of process fluid before recommissioning.

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7.9 INSTRUMENT MAINTENANCE

All instruments require regular calibration, following local processes and regulations. See the supplier's instruction manual for and additional instructions for maintenance of electrical instruments.

8. Accompanying documents

- General Arrangement Drawing (Job Specific) or General Arrangement Drawing (Generic)
- Component supplier instructions
- Installation Drawing

9. Cold environments

For environments with low ambient temperatures, winterisation features may be added to the plan 53B. These may include:

- Instruments may be supplied mounted in a heated enclosure. The heating element requires electrical connection as part of the installation and assembly procedure (see Section 5.4)
- Heat tracing and/or insulation may be required to maintain the temperature of the fluids in the 53B. This heat tracing and/or insulation may be supplied with the Plan 53B, or may be applied on site as required.
- Care must be taken during commissioning and operation, that the barrier fluid is brought up to operating temperature before the machine is started, and the correct temperature is maintained throughout operation.

North America
United States of America
Tel: 1-847-967-2400

Europe
United Kingdom
Tel: 44-1753-224000

Latin America
Brazil
Tel: 55-11-3371-2500

Middle East & Africa
United Arab Emirates
Tel: 971-481-27800

Asia Pacific
Singapore
Tel: 65-6518-1800