



## API PLAN 53B SEAL SYSTEMS

### Installation, Operating and Maintenance

#### Applicable to drawing numbers

Water cooler : I/86498, I/86518, I/86523, I/87180.

Finned Tube cooler : I/86499, I/86519, I/86524, I/87181.

FAC air cooler : I/86510, I/86511, I/86512, I/86520, I/86521,  
I/86522, I/87267, I/87268, I/87550, I/87751,  
I/87752, I/87753.

**Plan 53B system** may only be installed, commissioned and maintained by an authorised plant machinery specialist, paying close attention to these instructions and all other relevant regulations. Failure to do this relieves the manufactures from any liability or warranties.

## 2. Safety & 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 for 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

Please comply with any additional warning signs on the system.

### 2.2 Safety Instructions



**ATTENTION**

Every working practice which 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.

## 1. General

### 1.1 Introduction

This Instruction Manual is provided to familiarise the user with Plan 53B system arrangement and its use. The instructions must be read and applied whenever work is done on Plan 53B 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.

The following important terms and definitions are 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 pressurised seal configuration to completely isolate the process liquid from the environment

### 1.2 European Declaration of Incorporation (Machinery Directive, 98/37/EC)

If appropriate this is Attached.

### 1.3 European Declaration of Conformity (Pressure Equipment Directive, 97/23/EC)

In assessing the hazard classification for the EC Pressure Equipment Directive (97/23/EC) in a dual pressurised seal the barrier, the process fluid, the accumulator volume and the design pressure will define the hazard classification.

If appropriate this is Attached.

### 1.4 European Declaration of Conformity (ATEX, 94/9/EC)

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

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.

- Double pressurised mechanical seals should be used for harmful, toxic and lethal products.
- All safety requirements must be strictly followed.
- Every precaution must be taken to ensure personnel safety.
- Full machinery protection is ensured.

Protective clothing must be worn at all times

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 duty, 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 be hazardous or toxic, and a safe collection system is required.

Surface temperatures above 80°C 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.

- During venting or draining of the buffer liquid it should be piped to a vent or reservoir where it can be safely contained or disposed. Periodically the buffer liquid should be checked for contamination and replaced if the contamination level exceeds site acceptability limits or those required under local/international legislation (whichever are the more stringent) on safety and environmental pollution.

- All above according to the local legislation.

- All periodical maintenance checks have to be in accordance with local legislation and rules.

All welding or cutting operations are forbidden without permission from John Crane Italy

**If you are in any doubt please contact your local John Crane office for further information before proceeding**

## 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 & minimising 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.

Plan 53B systems may be shipped first to the rotating equipment vendor to be mounted on the rotating equipment baseplate complete with the connecting product and cooling water pipework. In this event follow the instructions as given in the rotating equipment IOM.

Plan 53B systems, which are to be mounted off the rotating equipment baseplate, shall be shipped directly to site and shall be packed in suitable crates or cases to protect them from damage during shipment. In this event follow the following instructions.

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.

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.

- Plan 53B system should be replaced in their original packaging and if possible the crate/case should be stored away from direct sunlight, in a well-ventilated building with a hard floor.
- Temperature control is not normally necessary, but large temperature fluctuations (> 40°C) 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 itemisation.
- A weekly visual external inspection of the protection and preservation should be undertaken and any deficiencies noticed should be corrected without delay.

Warning : 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 use 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.

The system normally does not require any preservatives, it is resistant against most environmental conditions

#### ATTENTION

Ensure preservatives and cleaning agents do not affect the elastomers

### 4. Description of the System

In all industries where rotating machines (pumps or mixers) work with toxic or flammable fluids double mechanical seals are used to prevent the process fluid from escaping into the surrounding environment.

#### 4.1. DOUBLE PRESSURISED SEALS

Two seals installed "Back to back" or "in series" pressurised by a safe clean barrier fluid at a pressure higher than the process pressure in the seal chamber. Double seals are used when a single seal cannot guarantee satisfactory performance of the machine in which it is installed and if for safety or environmental reasons no product leakage is allowed.

In this case, the following conditions should be satisfied :

- a) The area between the seals should be filled with a clean barrier liquid compatible with the pumped fluid.
- b) The pressure of the barrier liquid should not be allowed to fall below the Minimum Operational Pressure ( as quoted on the Operational Data sheet ) to ensure that any leak across the inner seal face will be barrier liquid into the process and not process to atmosphere.
- c) The barrier liquid must be re-circulated and cooled to remove heat input from the process and seals.

#### 4.2. API PLAN 53B SYSTEM.

Barrier liquid is contained in a reservoir under pressure and is generally circulated by means of a pumping ring or scroll fitted to the seal.

With plan. systems, the reservoir is a "bladder type" accumulator which is filled with barrier liquid from a pressurised external source. Prior to filling with barrier liquid the accumulator bladder is 'pre-charged' with nitrogen (see 9 start up).

As loss of barrier liquid will result in a gradual drop of the system pressure a pressure switch or transmitter is used to provide an alarm giving adequate advance warning that additional barrier liquid is required.

#### 4.3 Equipment / Instrument IOM's

Equipment manufacturers instructions are provided as an addenda to this IOM

### 5. Function of the System

The Plan 53B. system should ensure the following functions :

#### 5.1 SEALANT CIRCULATION

Circulation is obtained through one or more of the following :

- a) A thermal siphon effect created by the difference in temperature between the Plan 53B system supply and return pipes causes barrier liquid to re-circulate between seal chamber and cooler.
- b) A pumping ring or scroll fitted to the seal produces forced circulation in the circuit when the rotating equipment is operational.
- c) In special cases a circulation pump installed in the connecting pipework may be required in place of a pumping ring/scroll to achieve the necessary cooling flowrate.

#### 5.2 HEAT DISSIPATION

Heat generated by the mechanical seals and/or positive heat soak from the process is transmitted to the barrier liquid. This heat is removed from the barrier liquid by:

- a) Natural dissipation occurring between the seal chamber, circulation lines and the atmosphere.
- b) An air or water type heat exchanger installed in the circulation line on the plan 53B system.

#### 5.3 SEALANT PRESSURISATION

Is obtained through a combination of the nitrogen pre-charge in the accumulator bladder (see 9 start up) and the barrier liquid applied from a pressurised external source such as a mobile or a fixed Make-up unit.

#### 5.4 TOPPING UP

Periodic topping up from the pressurised external source is necessary to replace barrier liquid lost during normal operation. Generally the top-up period for seals in good condition is 25 days minimum before the low pressure alarm signal. Following an alarm the system must without delay, and before the minimum operational pressure is reached, be recharged with fresh barrier liquid.

#### 5.5 PRESSURE LOSS

Falling system pressure is an indication of leakage, if this is not externally visible at pipe connections, it may indicate deterioration of the seal faces. Pressure loss is monitored by pressure gauge and pressure transmitter and a log of refill periods should be kept as an increasing frequency will indicate seal face wear and allow for planned maintenance.

**6. TERMINATIONS**

The plan 53B system is usually supplied with the following:

- 3/4" ANSI flanged terminations for inter-connecting pipework
- 1/2" ANSI flanged termination with isolating valve for topping-up
- 1/2" ANSI flanged termination with isolating valve and blind flange for drain
- 1/2" ANSI flanged termination with isolating valve and blind flange for vent
- 3/4" ANSI flanged terminations for cooling water (water cooled versions only)

**7. INSTRUMENTATION**

INSTRUMENT	ABBR	DOUBLE SEALS (API Plan 53B.)
Pressure Gauge	PI	STANDARD
Pressure Transmitter	PT	STANDARD
Temperature Gauge	TI	OPTIONAL

**8. INSTALLATION**

Normally, the barrier liquid is circulated through the plan 53B system during operation by means of a pumping ring or scroll fitted to the seal, during standby on hot applications some circulation can take place through thermal siphoning.

Before installing the system consider the following general guidelines:

**8.1 POSITIONING**

The plan 53B system should be installed within 1 metre of the seal chamber

**8.2 ORIENTATION**

The system should be located and orientated as shown on the SPEC sealing agreement drawings, listed at the top of this document.

**8.3 PIPEWORK AND CONNECTIONS**

Refer to the appropriate drawing for inter-connecting details and comply with the specific instructions..

Avoid sharp bends and elbows in the inter-connecting pipework to minimise frictional resistance which will impede the circulation flow.

Lines should be installed so as to be self venting with high point vents if necessary to prevent vapour locks.

Isolating valves should not be fitted in the circulation lines to and from the seals unless they are lockable full bore type and locked open.

It is recommended that the system vent connection be piped to a safe collection area.

Refer to the system drawing for additional information.

Be sure to vent the Plan 53B system before start-up. Be sure that any airlock is removed. It could be necessary to repeat venting operations a few times.

If water cooler is installed on the Plan 53B system, It is user responsibility to install the cooler so to avoid shell over-pressurisation resulting from blocking in of the water side while process fluid is passing through the tubes. This can be accomplished through the addition of pressure relief protection or operating procedure

**8.4 EXTERNAL CONNECTIONS**

Connect the system vent & drain terminations as recommended on the system drawing.

Connect the cooling coil terminations to the cooling circuit supply/return pipework.

Refer to appropriate system drawing for termination details and locations.

**8.5 ELECTRICAL CONNECTIONS**

Refer to diagrams included in terminal housing and also to the manufacturers instruction manual for wiring instructions. Wiring should only be carried out by qualified personnel taking care to observe the appropriate area classification requirements



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

**8.6 DRAINING THE CIRCUIT**

The system is fitted with a drain connection, however, it may also be preferable to install a drain valve at the lowest point of the interconnecting pipework to facilitate draining the seal chamber and pipework particularly if this is below the system level and or isolation valves are fitted in the interconnecting pipework. The system and pipework must be drained before any maintenance is undertaken.

**8.7 BARRIER LIQUIDS**

A general guide to the application characteristics of typical barrier liquids is given in the table below, however no change in liquid type should be undertaken without prior consultation with John Crane.

TEMPERATURE RANGE		BARRIER LIQUID
-10°C	+120°C	LIGHT MINERAL OILS (approx 10 cst @ 40°C)
-10°C	+ 300°C	HEAT TRANSFER OILS (approx 10 cst @ 40°C)
-5°C	+150°C	ETHYLENE GLYCOL
-30°C	+80°C	50/50 ETHYLENE GLYCOL/WATER MIX
-100°C	+50°C	ISOPROPYL ALCOHOL

Water may also be used as a barrier liquid when the environment and/or duty temperatures do not present a problem of vaporisation, frost, or salt sedimentation capable of affecting mechanical seals performance. Maximum recommended operating temperature +70°C.

- a) The barrier liquid must be clean, free from solids and have low viscosity.
- b) The barrier liquid must be stable at both environmental and working temperature to avoid vaporisation, solidification or foaming.
- c) The barrier liquid should have good lubricating properties and resistance to ageing.
- d) The barrier liquid must be compatible with the process fluid.
- e) Leakage of the barrier liquid into the atmosphere should be safe and acceptable.

## 9. PRE-COMMISSIONING PROCEDURE

If the system has been stored empty for 1 month or more, the following procedure should be followed:

- 1) First make sure that you put the gas into the bladder of the accumulator at a very very slow rate (approx. 1bar - 2 bar pressure). You must allow the bladder to fully expand and close the poppet valve before you open the Nitrogen gas valve fully.
- 2) When the poppet valve has closed, (usually it takes about 3 to 4 minutes or you can check that the poppet valve has closed by viewing it through the Bleed hole at the bottom of the accumulator), the accumulator is now ready to pre-charge and you can proceed as per 7.1.

It is advised to go 10% higher than your required pre-charge pressure to allow the gas to cool down. The pressure will then drop to approx. your pre-charge pressure, any further adjustment needs to be carried out later

## 10. START UP

**Before starting the machine** (pump or mixers) **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) Using an accumulator pre-charge kit check the pre-charge pressure in the accumulator bladder. If necessary re-charge the bladder with nitrogen from a nitrogen bottle to the Precharge pressure as quoted on the nameplate.
- b) Fill the system, from a pressurised external source, via the fill connection with the appropriate barrier liquid up to the seal system normal working pressure, the system pressure gauge can be used for this purpose.
- c) Vent the pipework loops by cracking open the vent valve. Close the vent when all air has been eliminated from the circuit. Check the pressure again and top-up the system if necessary to the normal working pressure.
- d) During and after start up there should be no significant pressure instability in the system. Any significant variations should be corrected immediately.
- e) Before any reading vent the pressure instruments to eliminate any residual air in the pressure lines.
- f) Check carefully that there is no leakage from any of the joints, if a leak is found tighten the flanged connection nuts and, if necessary, replace the sealing gaskets.
- g) Make sure that all electrical instruments are correctly connected to the suitable rating Voltage.

**This should be carried out by a qualified electrician.**

- ⚠** Before start-up, ensure that all personnel and assembly equipment have been moved to a safe distance and that any safety guards are refitted
- h) Start the main process machine

## 11. RUNNING

## 11.1 NORMAL RUNNING

The equipment shall be kept clean and free from debris to allow ease of access and reading of the instrumentation. Care should be taken to prevent damage to the system from accidental knocks and/or exposure to excessive sources or heat. Disconnection of any part of the system should not be undertaken without the appropriate authorisation and until all pressure has been completely discharged and system allowed to cool. All joints broken for maintenance should be plugged off to prevent ingress of dirt.

During normal operation the only attention required is to monitor the system pressure and recharge the barrier liquid to the Maximum Operational pressure to ensure continued operation. Recharging should be carried out as soon as possible after activation of the low pressure alarm and before reaching the minimum operational pressure of the system.

Periodic visual checking (at least every 48 hours) of the pressure/temperature within the system is recommended.

## 11.2 SIGNALS AND ALARMS

The standard instrumentation on plan 53B. systems has the specific purpose of monitoring loss of barrier liquid through a drop in pressure. **Logging the period between refills will indicate seal condition.** Increasing refill frequency is an indication of seal wear. The optional temperature gauge is used to monitor changes in barrier liquid temperature. The table below shows cause and effect for the various instrument readings.

INSTRUMENT	ABBR.	DOUBLE SEALS - API PLAN 53MOD	
		EFFECT	CAUSE
PRESSURE GAUGE	PI	↓ (visual)    ↑ (visual)	[ B to D ] – ( G to J )
PRESSURE TRANSMITTER	PT	☒	A
TEMPERATURE GAUGE	TI	↑	E to J
LEGEND.                      ↑ = Rising value (visual)    ↓ = Falling value (visual) ☒ = Alarm signal (remote)			

## CAUSE

- A) Recharge system with fresh barrier liquid
- B) Leakage from the inboard seal (process side)
- C) Leakage from the outboard seal (atmospheric side)
- D) Leakage from a flange or joint
- E) Lack of barrier liquid circulation
- F) Inadequate supply of cooling water
- G) Scaling or blockage of cooler
- H) Abnormal process temperature rise
- I) Excessive seal heat
- J) Abnormally high process pressure

The signal from the pressure transmitter can be used either:

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

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

## 11.3 NAME AND DATA PLATE

A name and data plate is fitted to each system, giving identification data plus calculation and design standards used.

Should you need further information or advice please contact your nearest John Crane regional office quoting the system code number

## 12. DECOMMISSIONING

**ATTENTION** When the machine is stopped, the Plan 53B system pressure must be maintained until the machine itself is unpressurised.

- ⚠** Work on the seal or Plan 53 system must only be carried out when the machine is stationary, and secured against any unforeseen start-up and it is isolated from connections to pressurisation sources.

- Before carrying out any work on the seal or system the barrier liquid must be fully depressurised 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

## 13. MAINTENANCE

Maintenance must be carried out by qualified personnel only on a no more than annual frequency.

**Disconnection shall be made after plant person in charge of authorisation.**

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.

**Note:** It is recommended that a pressure test is carried out on the system after any repair and before operation on the equipment