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# RATS - ROTATING & TURBOMACHINERY SOCIETY

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**MAINTENANCE  
RELIABILITY  
OPERATIONS**

**TECHNICAL CONFERENCE & WORKSHOPS**  
**LDAR Exceptions - VOC legislation - Ageing Pump Fleets -**

Richard J Smith, AESSEAL plc



ENVIRONMENTAL TECHNOLOGY

Wednesday October 25, 2023  
DOW Centennial Centre - Fort Saskatchewan



# Volatile Organic Compounds (VOC) legislation

- Facilities subject to the Regulations
- a) Produces liquid petroleum products by means of the processing, using distillation, of
  - crude oil or bitumen
  - mixtures of crude oil or bitumen and other hydrocarbon compounds, or
  - partially refined feedstock derived from crude oil or bitumen; or
- b) Produces petrochemical products and is operated in an integrated way with a facility referred to in paragraph (a) that is adjacent to it and with which it has at least one operator in common.
- LDAR - Leak Detection and Repair
  - Dec 1 2020 Section 1 – subject to 2 and 3
  - Jan 1 2022 Section 3 -10 LDAR requirements
  - Jan 1 2023 Sections 11 – 16 Sampling pressure relief systems, Compressors
  - **Beginning 2023 statutory reporting - permit**

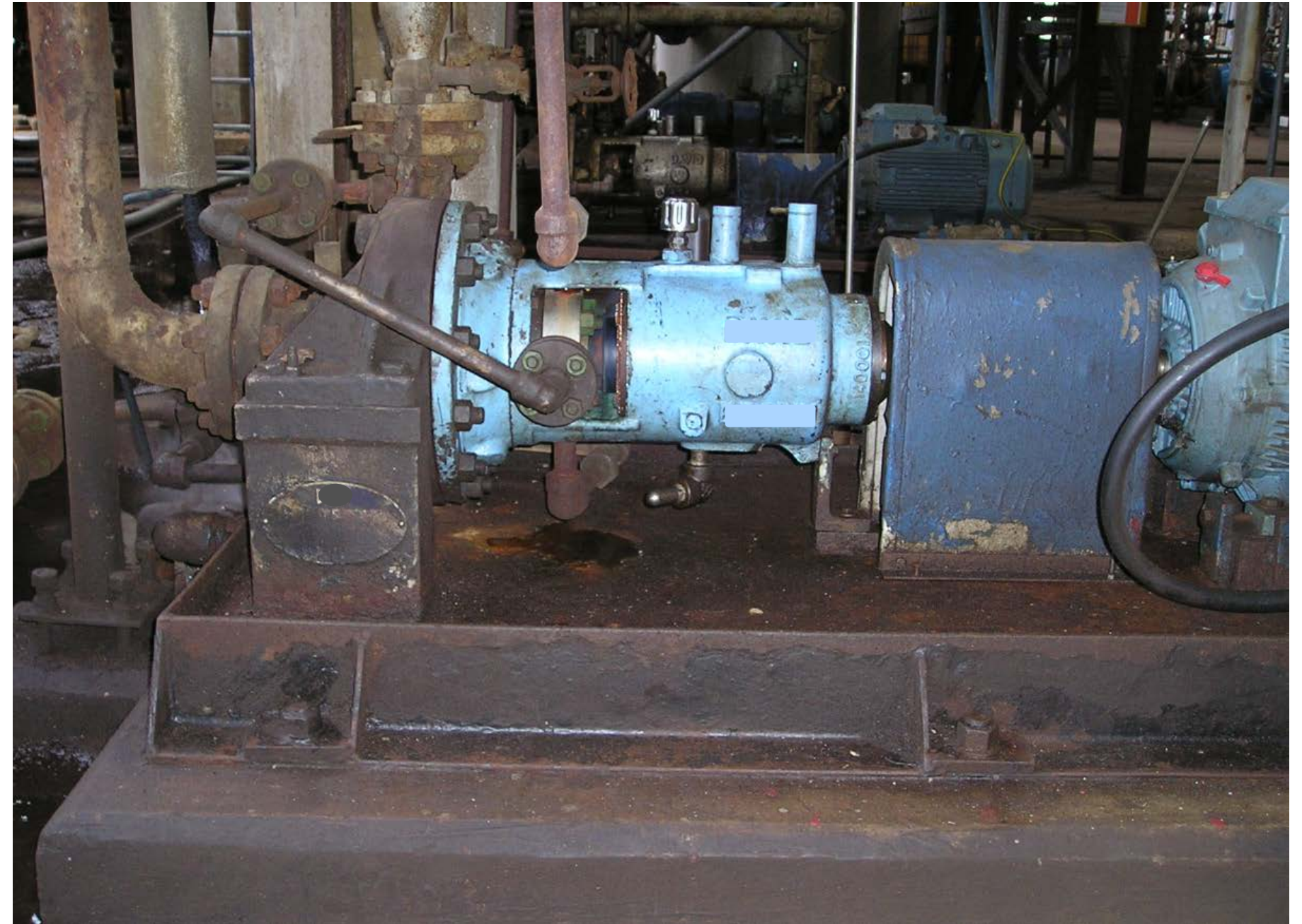
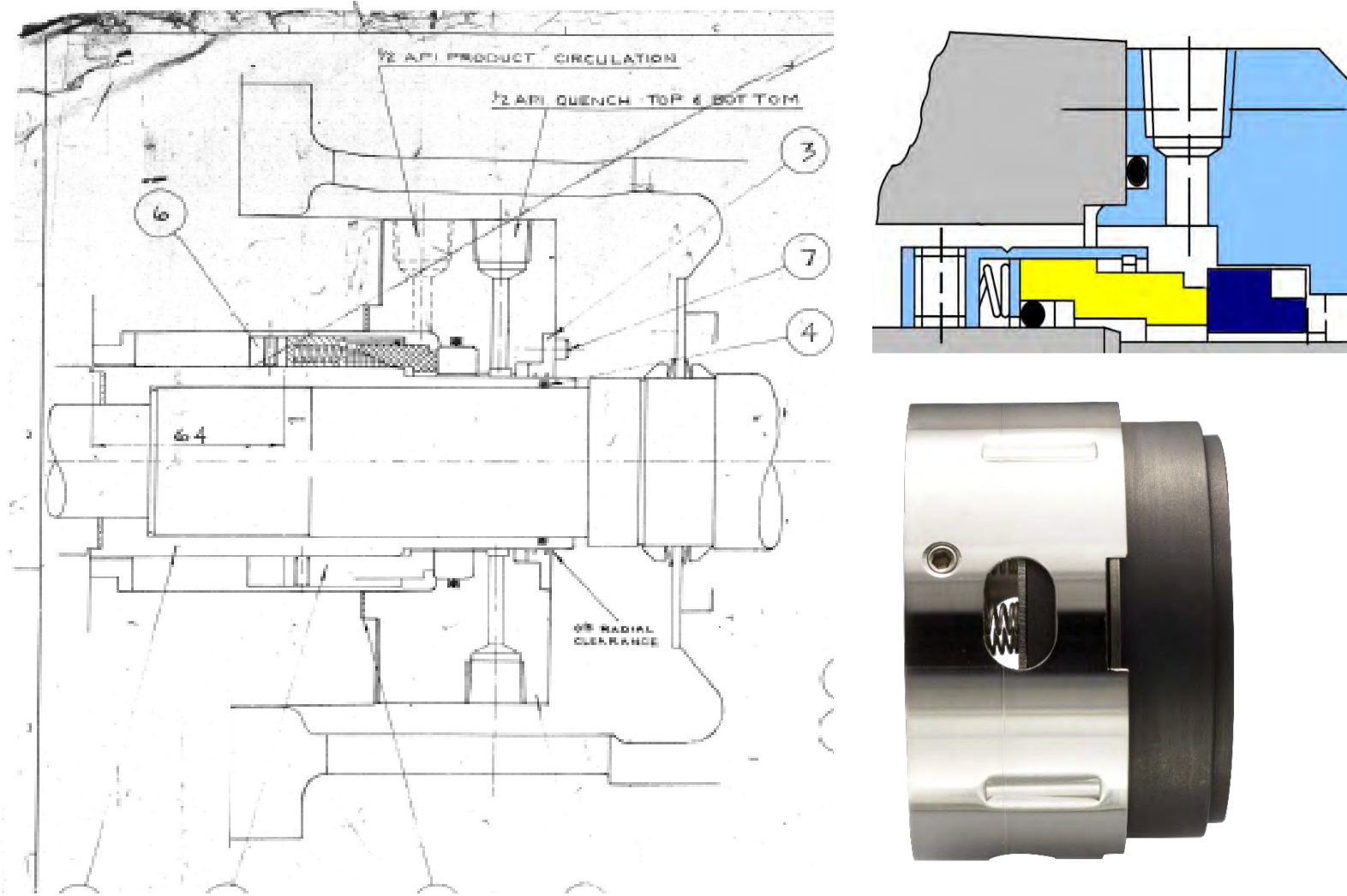
The image shows the front cover of a Canadian government publication. At the top center is the Royal Coat of Arms of Canada, with the word "CANADA" underneath. Below the coat of arms, the word "CONSOLIDATION" is on the left and "CODIFICATION" is on the right. In the center, the title "Reduction in the Release of Volatile Organic Compounds Regulations (Petroleum Sector)" is written in English, with its French equivalent "Règlement sur la réduction des rejets de composés organiques volatils (secteur pétrolier)" to its right. Below the title, the identifier "SOR/2020-231" is on the left and "DORS/2020-231" is on the right. Further down, the text "Current to August 16, 2023" and "Last amended on January 1, 2023" is on the left, and "À jour au 16 août 2023" and "Dernière modification le 1 janvier 2023" is on the right. At the bottom, the publication information "Published by the Minister of Justice at the following address: http://laws-lois.justice.gc.ca" is on the left, and "Publié par le ministre de la Justice à l'adresse http://lois-laws.justice.gc.ca" is on the right.



ENVIRONMENTAL TECHNOLOGY



# Ageing Pump Fleets - Historical review



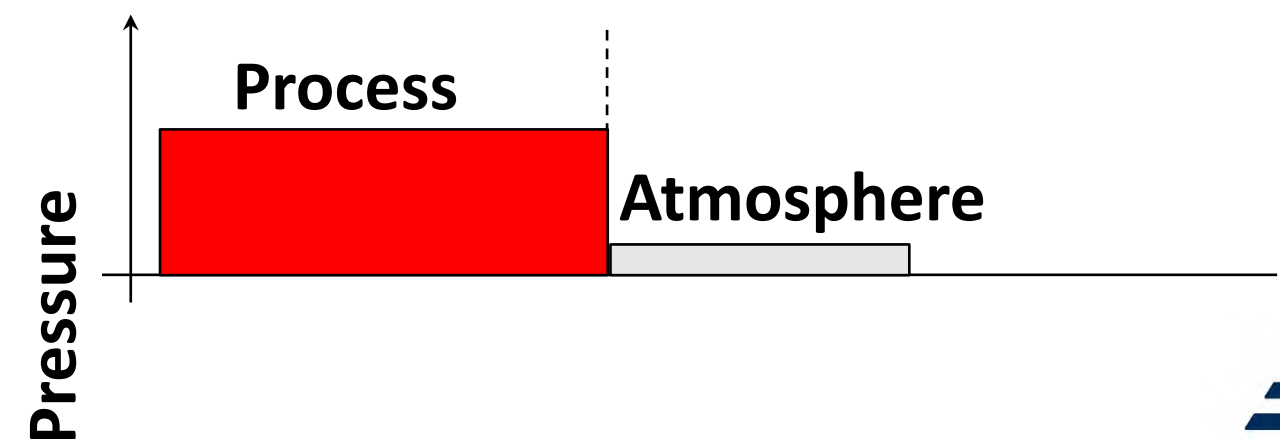
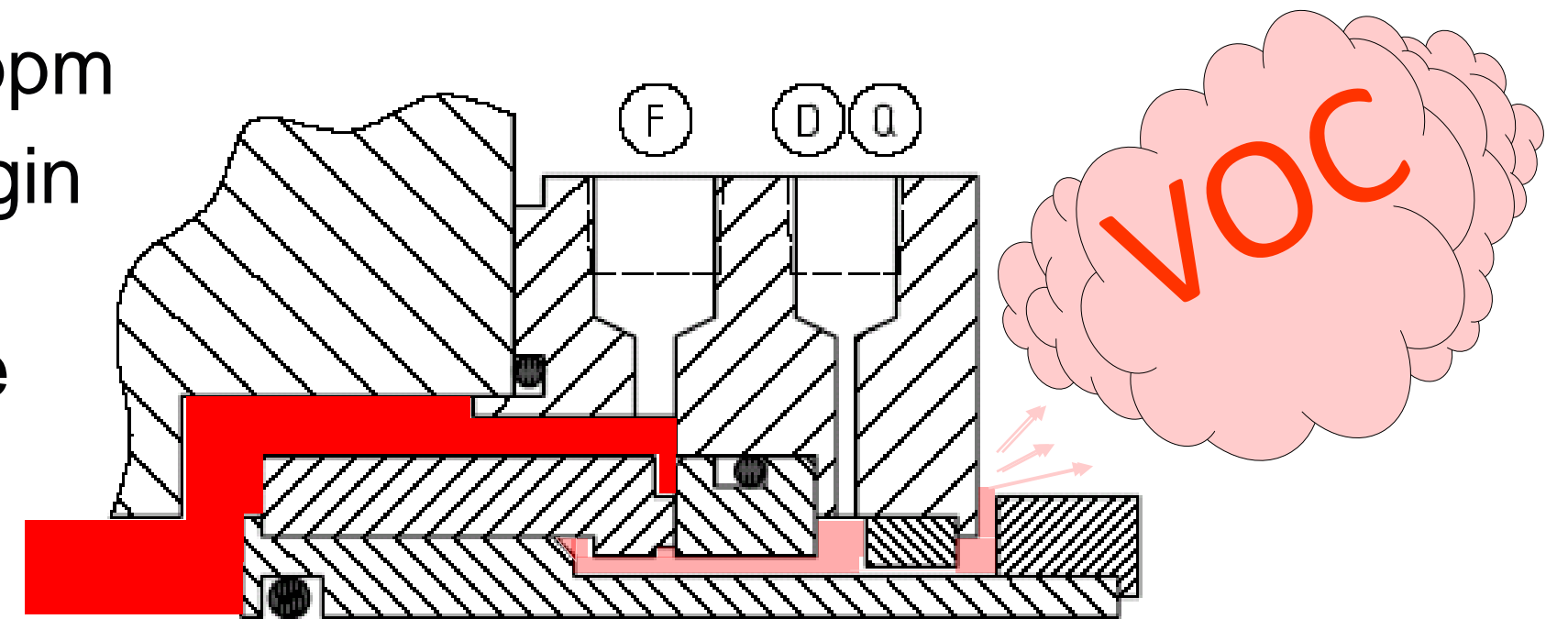
Typical Arrangements  
Single Seal - Pre 94 non-cartridge  
API Standard 682 1<sup>st</sup> edition 1994  
API 610 1995 8<sup>th</sup> edition



# Ageing Pump Fleets – Reliability


- Light hydrocarbon leakage in vapour phase
- Invisible to naked eye
- Well bedded in single seal - stable pump < 1000ppm
- Unstable pump or marginal vapour pressure margin in the seal chamber >1000ppm
- Many pumps operated with high levels of leakage
- Testing regimes EPA method 21
  - ‘can see the invisible’
- Large fleet of single seals will see a reduction in MTBR
- Impact on fleet reliability could be 30%

**Arrangement 1**





# LDAR Components



CANADA

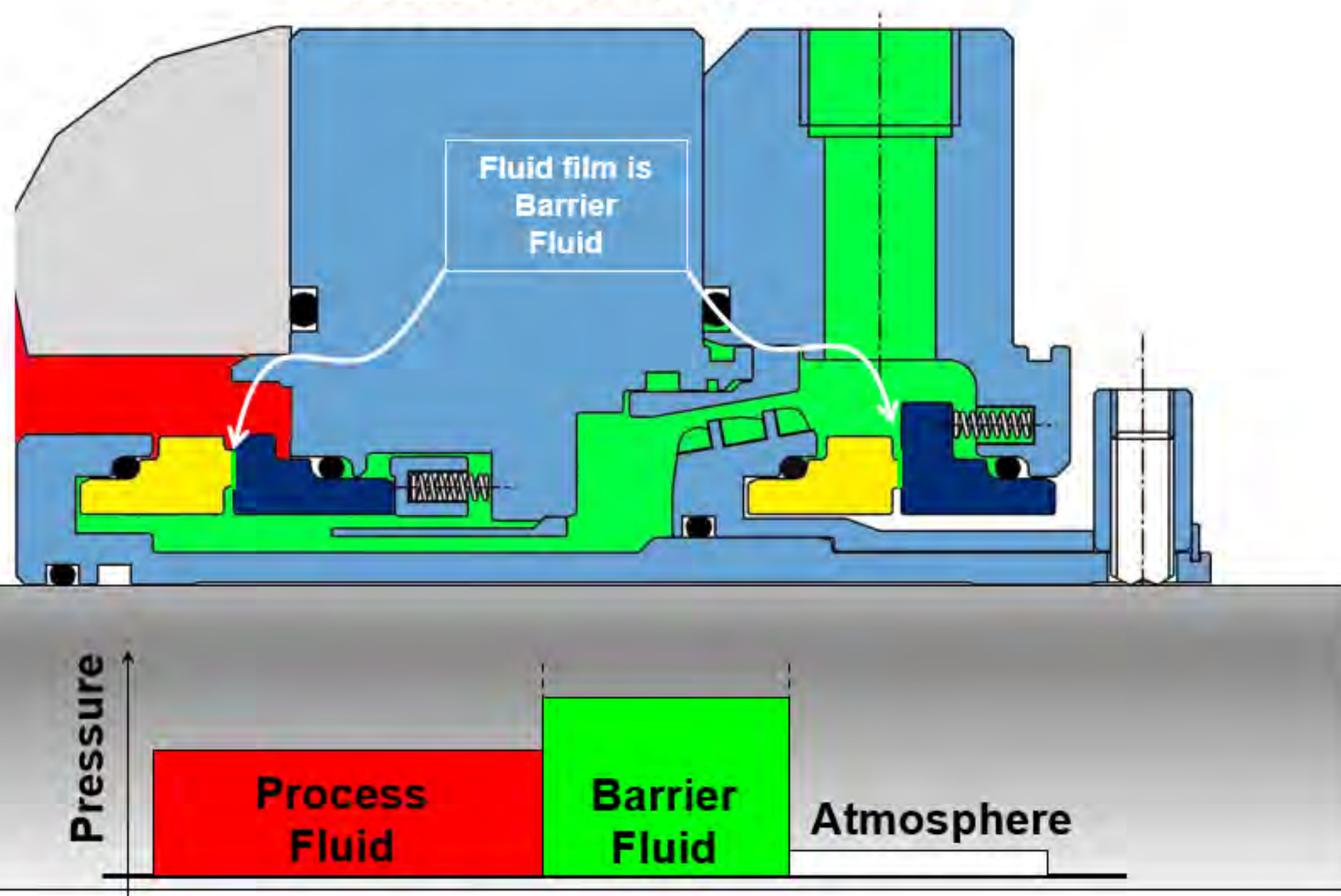
CONSOLIDATION	CODIFICATION
Reduction in the Release of Volatile Organic Compounds Regulations (Petroleum Sector)	Règlement sur la réduction des rejets de composés organiques volatils (secteur pétrolier)
SOR/2020-231	DORS/2020-231
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- Pumps
- Section 4 Equipment components to be listed in inventory
  - Item that are not required to be listed
  - Seal-less pumps, including canned-motor pumps and diaphragm pumps; - Not required to be listed



# LDAR Exceptions

## Pressurised Dual Seals



CANADA

CONSOLIDATION

CODIFICATION

Reduction in the Release of  
Volatile Organic Compounds  
Regulations (Petroleum Sector)

Règlement sur la réduction des  
rejets de composés organiques  
volatils (secteur pétrolier)

SOR/2020-231

DORS/2020-231

Current to August 16, 2023  
Last amended on January 1, 2023

À jour au 16 août 2023  
Dernière modification le 1 janvier 2023

- Section 6 Inspection — equipment components

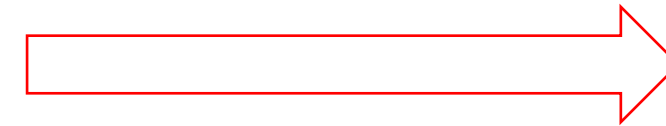
- (3(a)) The following components are exempt from the inspections required by subsections (1) and (2): (a) a pump that has a dual mechanical seal system with a barrier fluid system and that meets the following requirements, namely,



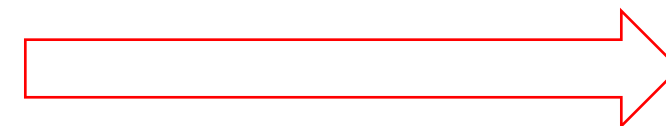
# LDAR Exceptions



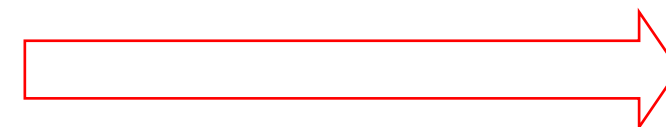
- Section 6 Inspection — equipment components
  - 3(a)(i) the dual mechanical seal system is
- (A) operated with a **barrier fluid** system in which the fluid is at all times at a pressure that is greater than the stuffing box pressure,
- (B) equipped with a **barrier fluid** degassing reservoir that is connected by a closed-vent system to a process gas system, a fuel gas system or a control device, or
- (C) equipped with a system that purges the **barrier fluid** into a process gas system and prevents the release of any VOCs into the environment,
- (iii) the barrier fluid system is equipped with a sensor that is intended to detect any failure of the system;



API Plans  
Plan 53 (ABC), 54, 74



Plan 52?  
Unpressurised buffer fluid?



Plan 72 / 76  
Unpressurised buffer gas ?





# Barrier Fluid Definitions



American  
Petroleum  
Institute

- API Standard 682 4<sup>th</sup> edition May 2014
- *3.1.9 barrier fluid, externally supplied fluid at a pressure above the pump seal chamber pressure, introduced into an Arrangement 3 seal to completely isolate the process liquid from the environment.*
- *3.1.12 buffer fluid, externally supplied fluid, at a pressure lower than the pump seal chamber pressure, used as a lubricant and/or to provide a diluent in an Arrangement 2 seal.*



**FLUIDSEALING**



## Glossary of Terms - B

**barrier fluid** - Externally supplied fluid at a pressure above the pump seal chamber pressure, introduced into an Arrangement 3 seal to completely isolate the process liquid from the environment.

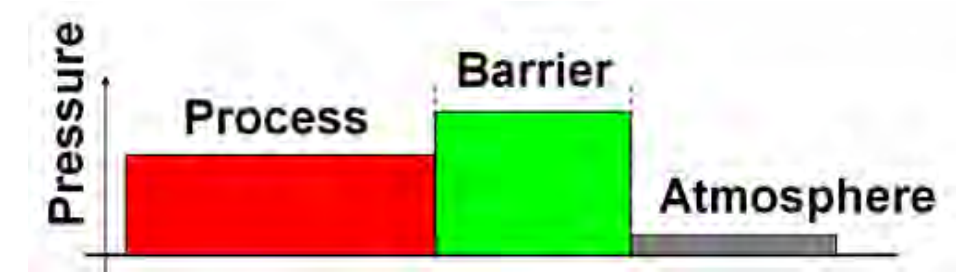
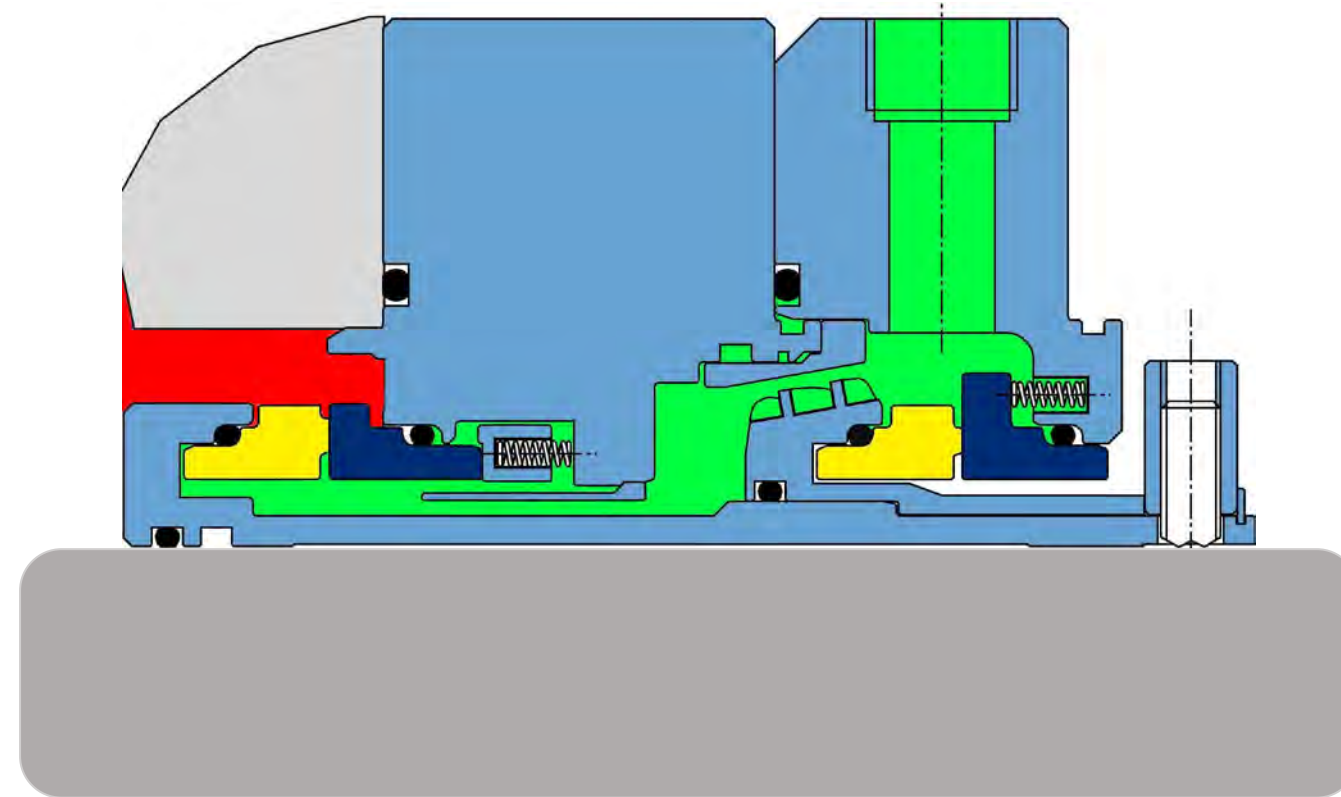
**buffer fluid** - Externally supplied fluid, at a pressure lower than the pump seal chamber pressure, used as a lubricant and/or to provide a diluent in an Arrangement 2 seal.



# LDAR Exceptions



- Unpressurized
  - Arrangement 2 Seal
- Buffer Fluid
  - Liquid or Gas
  - 52 (liquid)
  - 71 (gas)
  - 72 (gas)
  - 75 (gas)
  - 76 (gas)
  - 55 (liquid)



- Pressurized
  - Arrangement 3 Seal
- Barrier Fluid
  - Liquid or Gas
  - 53a (liquid)
  - 53b (liquid)
  - 53c (liquid)
  - 54 (liquid)
  - 74 (gas)

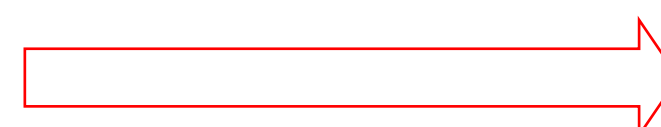
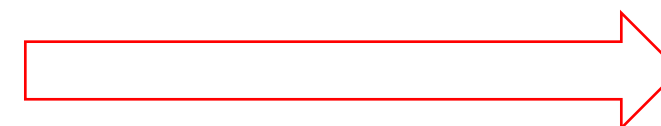
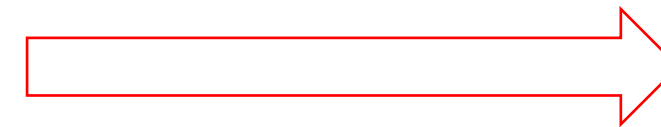
*The principal difference between Arrangement 2 and Arrangement 3 configurations is the concept of containment of leakage versus the elimination of process fluid leakage*



# LDAR Exceptions



- Section 6 Inspection — equipment components
  - 3(a)(i) the dual mechanical seal system is
- (A) operated with a barrier fluid system in which the fluid is at all times at a pressure that is greater than the stuffing box pressure.
- **(B) equipped with a barrier fluid degassing reservoir that is connected by a closed-vent system to a process gas system, a fuel gas system or a control device, or**
- (C) equipped with a system that purges the barrier fluid into a process gas system and prevents the release of any VOCs into the environment,
- (iii) the barrier fluid system is equipped with a sensor that is intended to detect any failure of the system;



API Plans  
Plan 53 (ABC), 54, 74



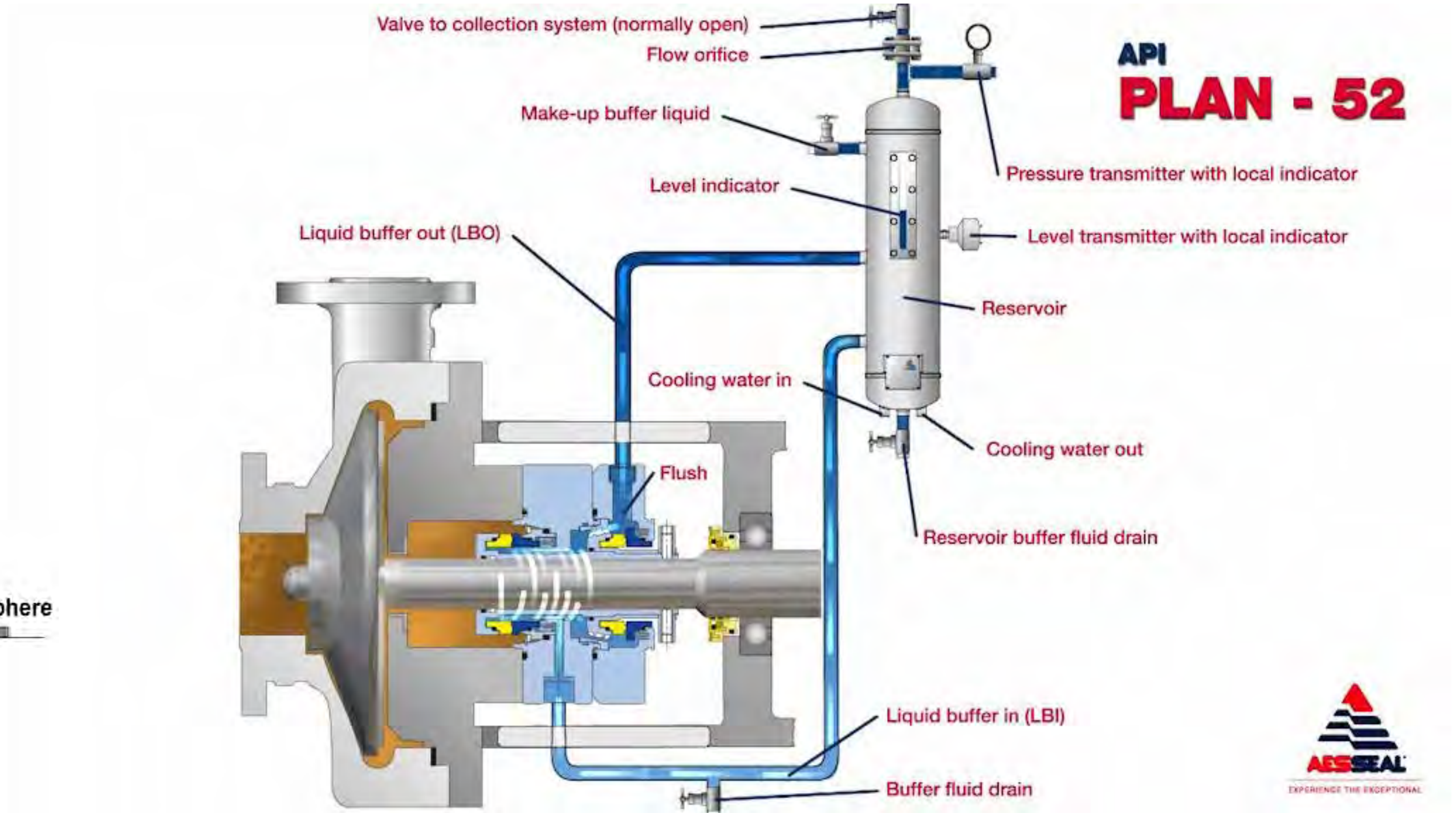
Plan 52?  
Unpressurised buffer fluid?

Plan 72 / 76  
Unpressurised buffer gas ?





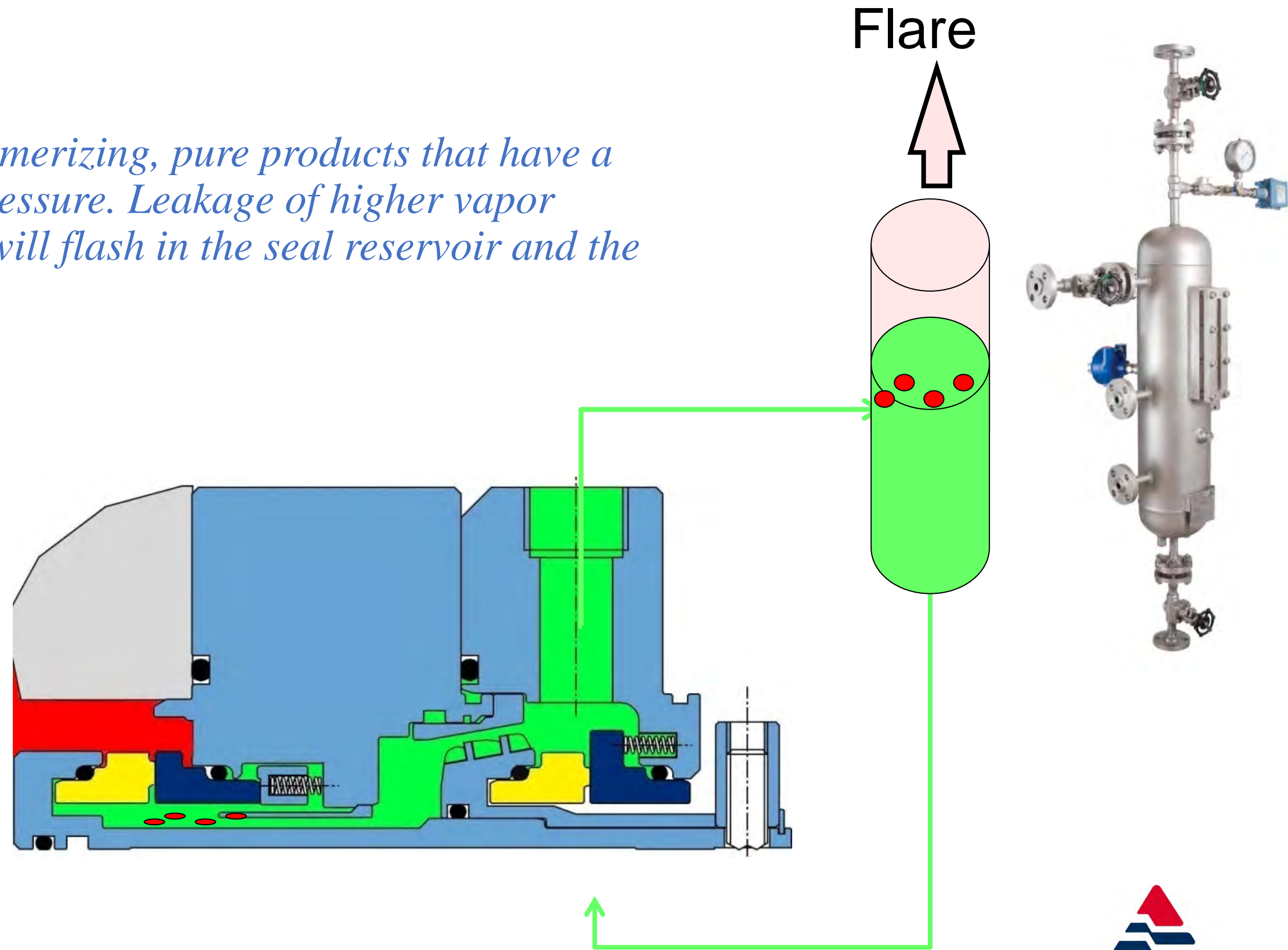
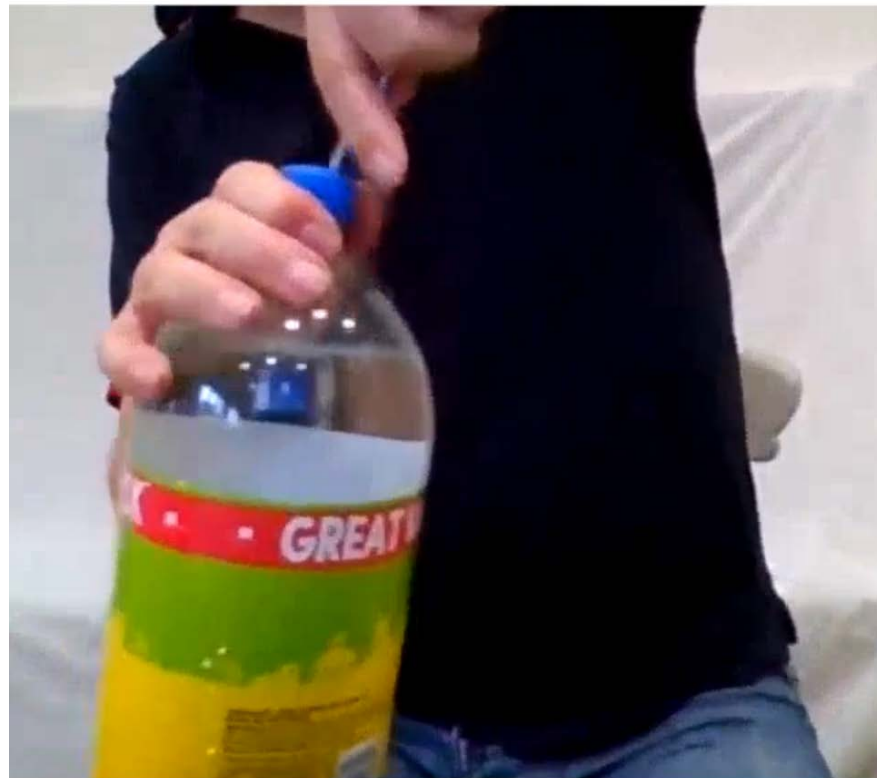
# LDAR Exceptions?



# LDAR Exceptions?

## API Standard 682 4<sup>th</sup> edition

*'Piping Plan 52 works best with clean, nonpolymerizing, pure products that have a vapor pressure higher than the buffer system pressure. Leakage of higher vapor pressure process liquids into the buffer system will flash in the seal reservoir and the vapor can escape to the collection system.'*



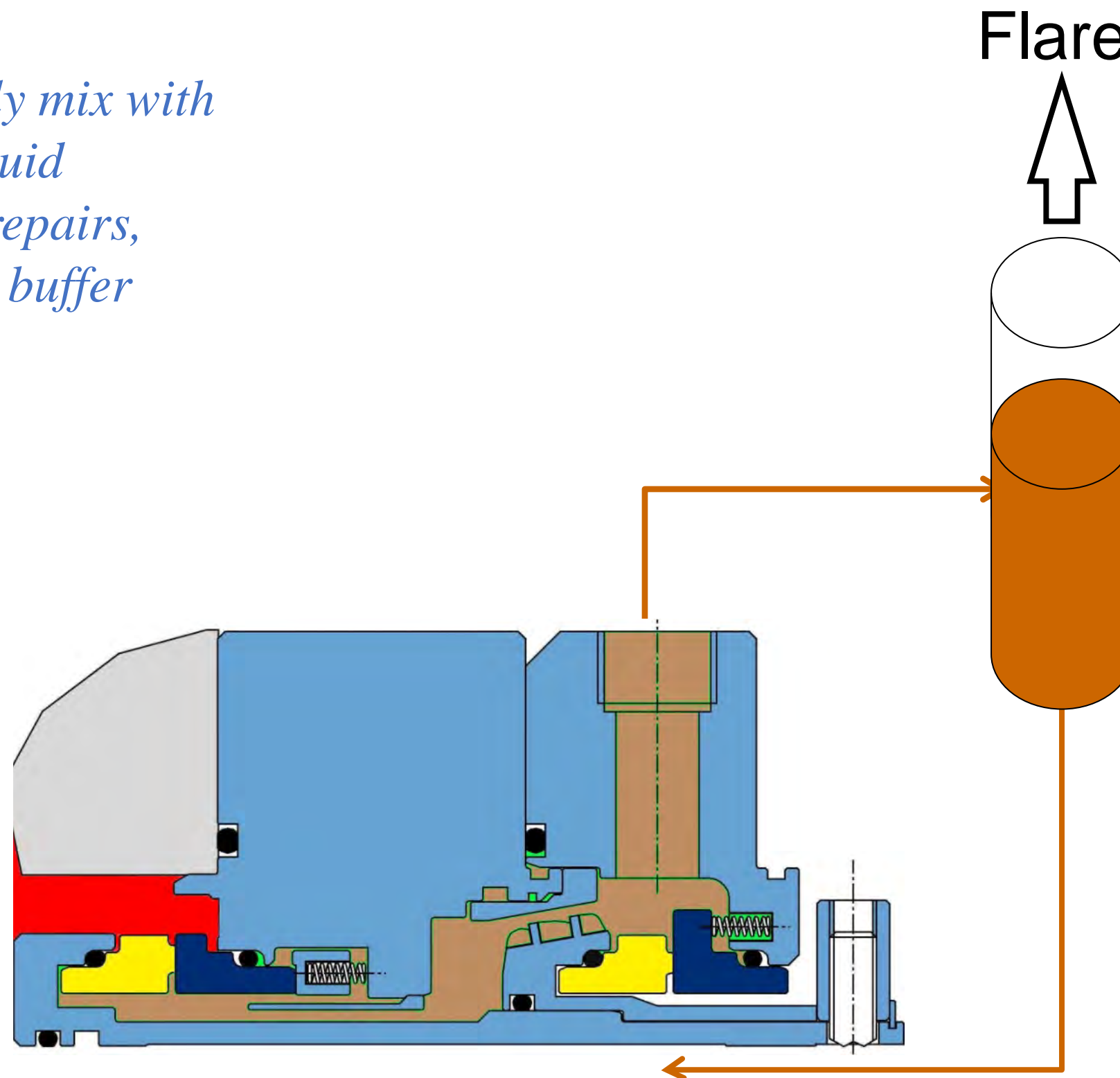


# LDAR Exceptions?

## API Standard 682 4th edition

*Inner seal process liquid leakage will normally mix with the buffer fluid and contaminate the buffer liquid over time. Maintenance associated with seal repairs, filling, draining, and flushing a contaminated buffer system can be considerable.*

- Typical Condensing Leakage – Seal
- Pump Shaft 2.250 60mm
- Stable Operation
- 1cc / hr ~ 8.5 litres / yr
- Unstable Operation
- Vapour Pressure Margin
- Pump Vibration
- ~ 6cc/hr (API 682 Allowable 5.6 grams /hr)
- Seal Pot is full of process in 6 months



Volume at NLL  
20 litres  
5 US Gal



# LDAR Exceptions?

## Plan 52 - Condition Monitoring

- Inner Seal (vaporizing leakage)
  - Pressure With 1/8" (3.2) orifice leakage ~140 SCFH (65NI/min) to activate alarm 10psi (0.7 bar)
- Inner Seal (condensing leakage)
  - Pressure With 1/8" (3.2) orifice leakage ~4 gals/hr. 0.25 l/min to activate alarm 10psi (0.7 bar)
  - Buffer Fluid Level (Transmitter) or High Level Switch (if fitted)
- Outer Seal
  - Buffer Fluid Level
- Maintenance
  - Buffer Fluid Top Up





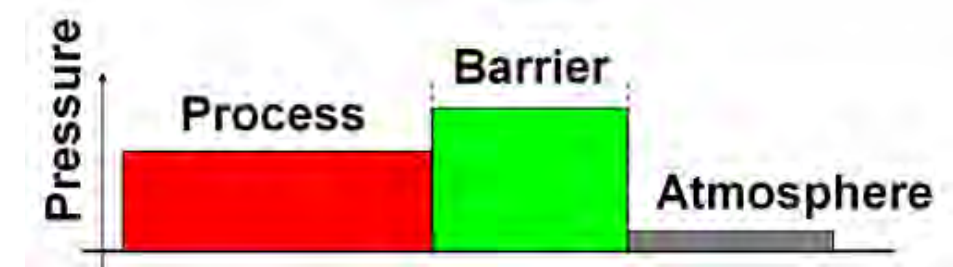
# LDAR Exceptions



- Section 6 Inspection — equipment components
  - 3(a)(i) the dual mechanical seal system is
- (A) operated with a barrier fluid system in which the fluid is at all times at a pressure that is greater than the stuffing box pressure,
- (B) equipped with a **barrier fluid** degassing reservoir that is connected by a closed-vent system to a process gas system, a fuel gas system or a control device, or
- (C) equipped with a system that purges the barrier fluid into a process gas system and prevents the release of any VOCs into the environment,
- (iii) the barrier fluid system is equipped with a sensor that is intended to detect any failure of the system;

API Plans

Plan 53 (ABC), 54, 74



Plan 52?

Unpressurised buffer fluid?

Plan 72 / 76

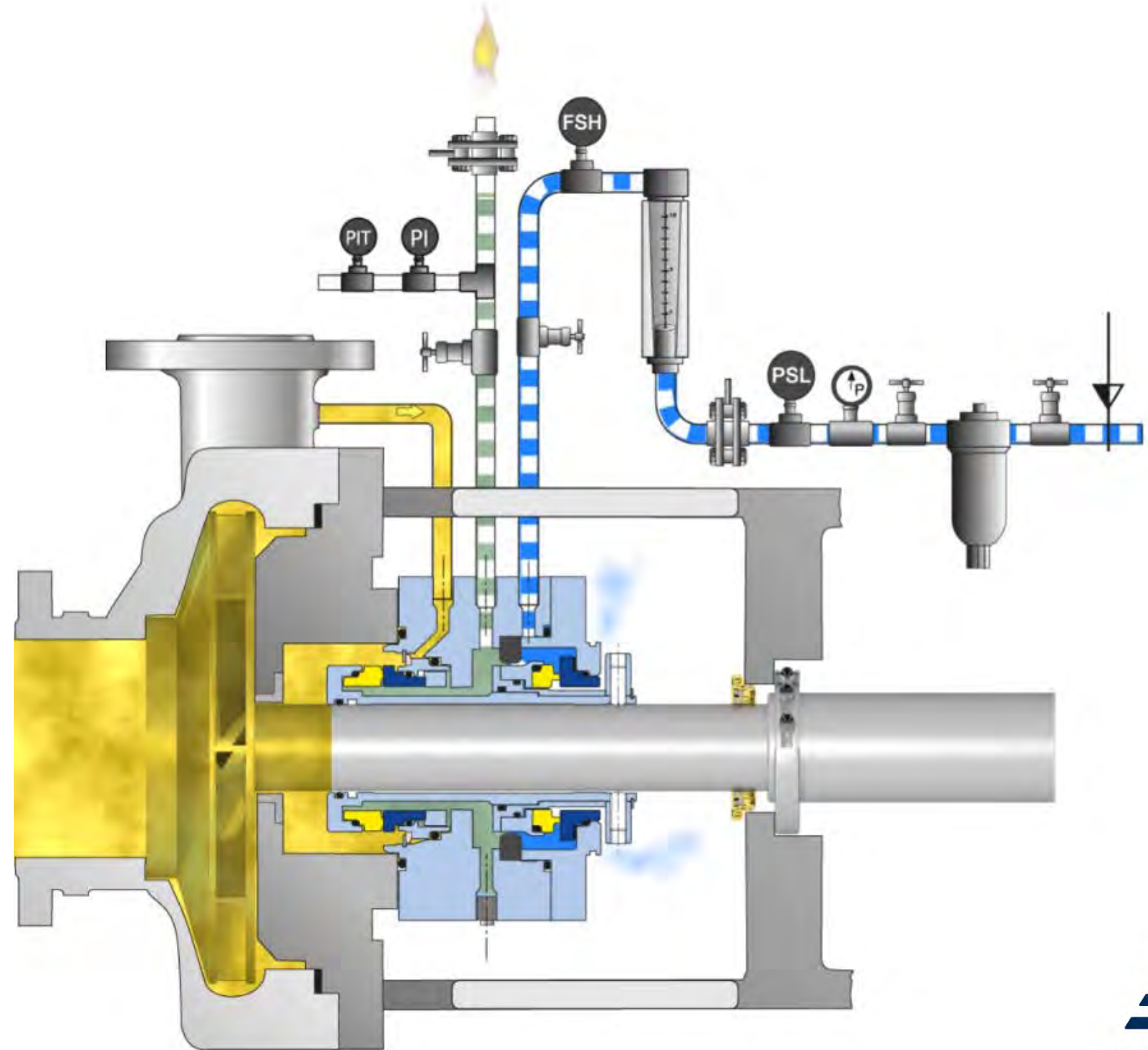
Unpressurised buffer gas ?



# LDAR Exceptions?

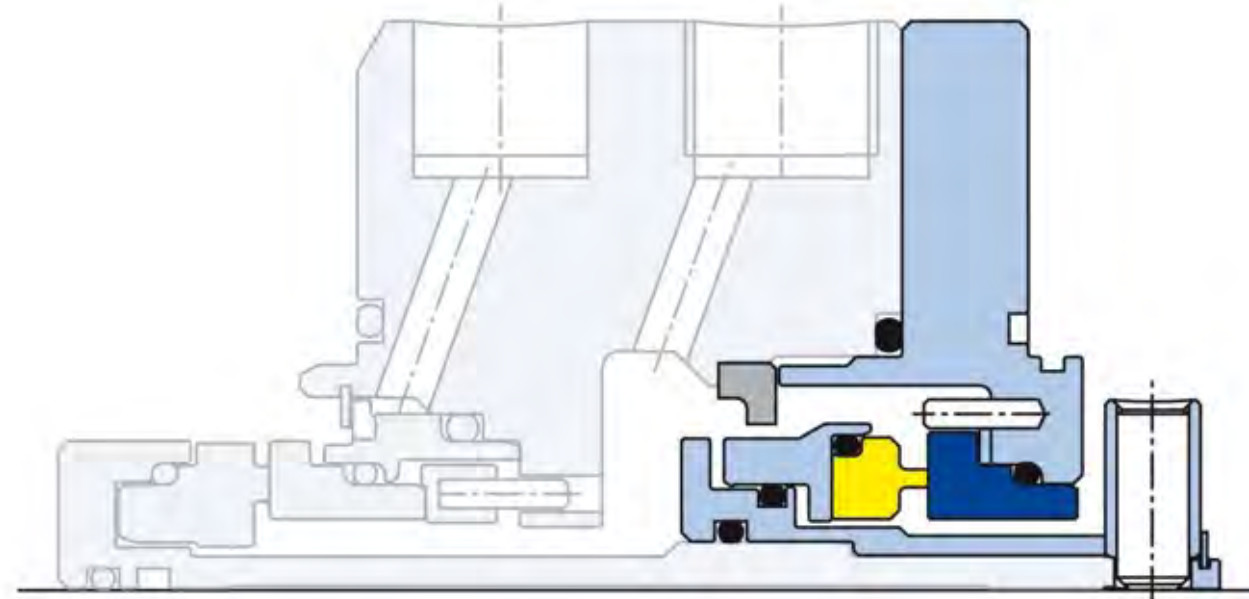


Dry Containment Seal?  
Plan 72/76?  
Unpressurised buffer gas



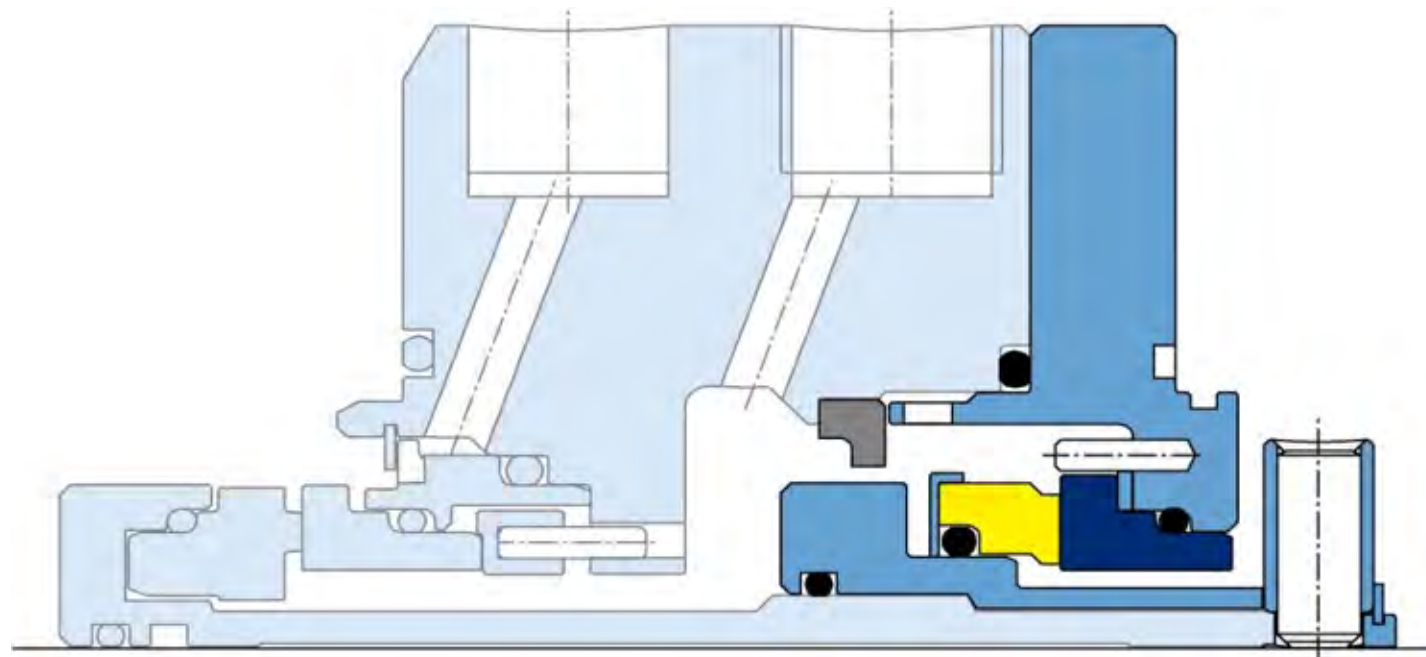


# LDAR Exceptions?

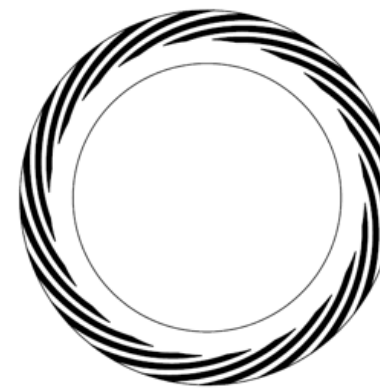


Contacting

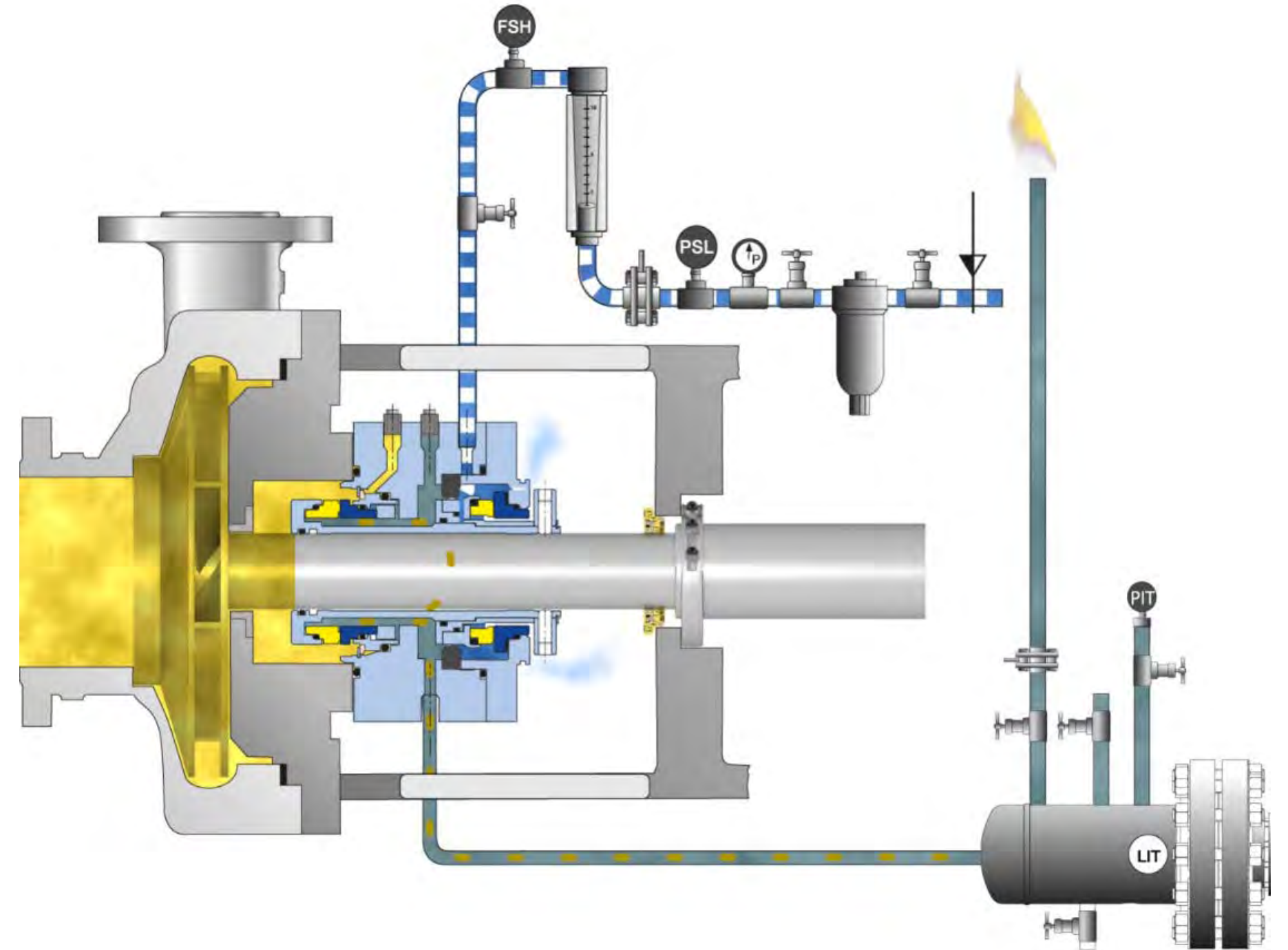
API Standard 682 4<sup>th</sup> edition May 2014  
*“A containment seal is an Arrangement 2 seal that normally operates in a vapour (gas buffer or no buffer) but will seal the process fluid for a limited time in the event of an inner seal failure”*



Non Contacting



# LDAR Exceptions?

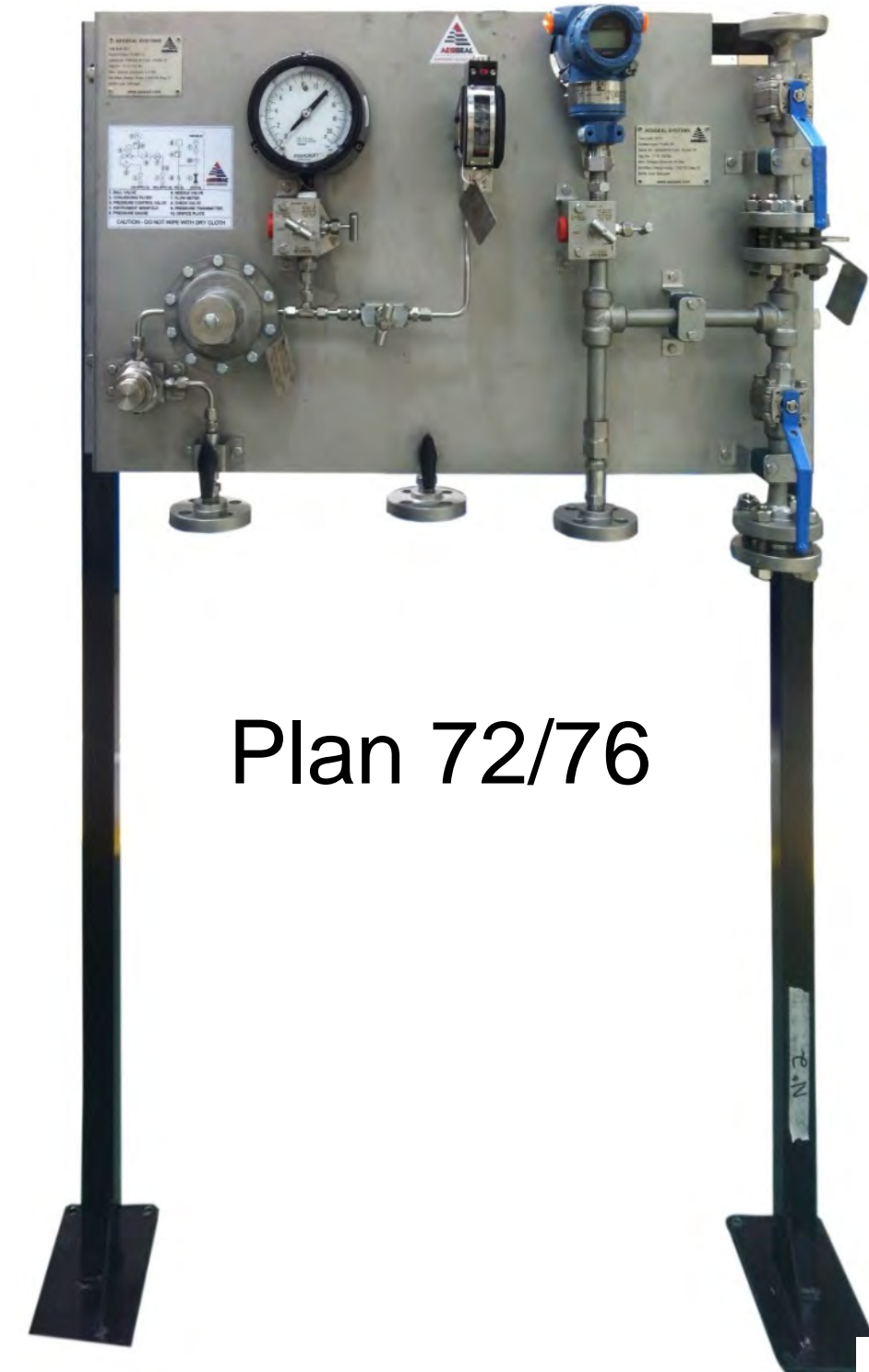
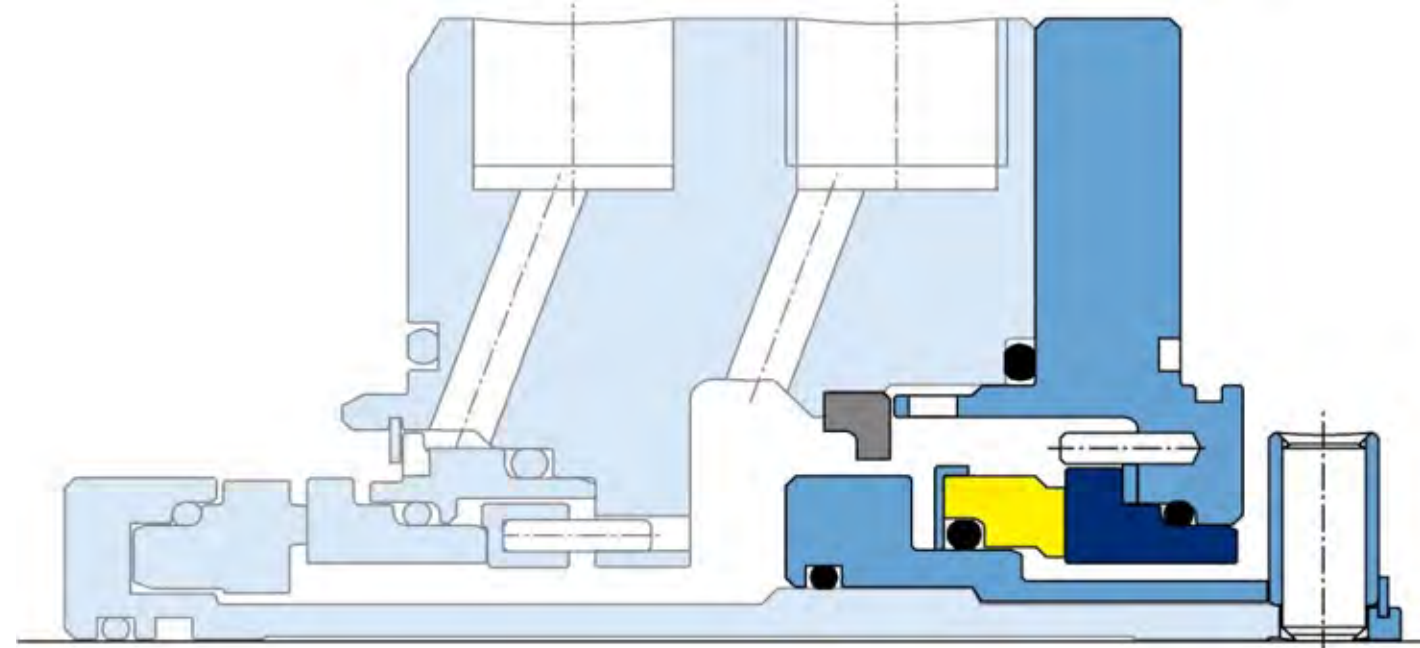


Dry Containment Seal?  
Plan 72/75?  
Condensing Leakage  
Unpressurised buffer gas





# LDAR Exceptions?



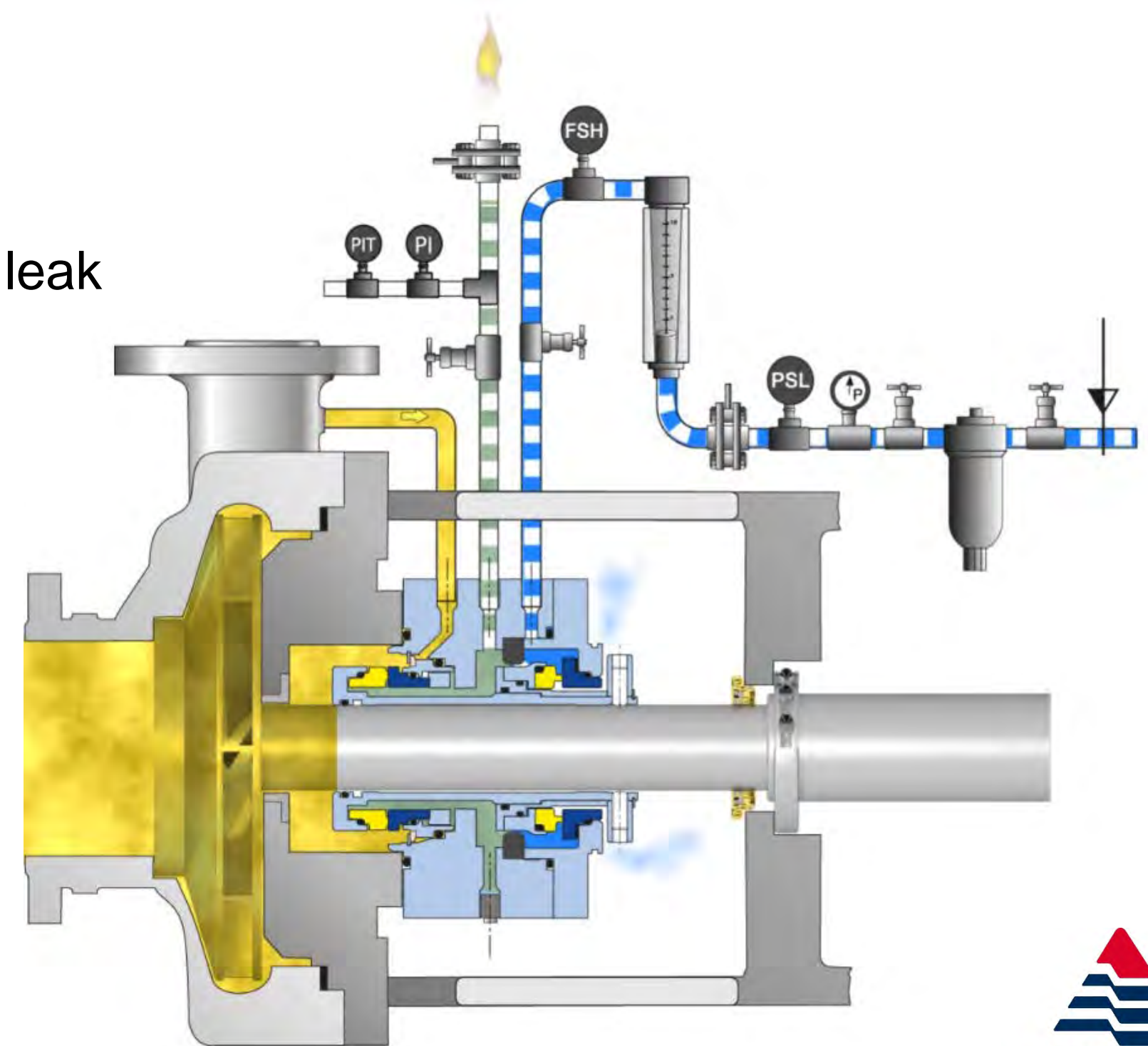
Plan 72/76



- Inner (Process) Seal
  - 76 vaporizing leakage
    - Pressure With 1/8" (3.2) orifice leakage ~140 SCFH (65NI/min) to activate alarm 10psi (0.7 bar)
  - 75 condensing leakage
    - Pressure With 1/8" (3.2) orifice leakage ~4 gals/hr. 0.25 l/min to activate alarm 10psi (0.7 bar)
    - Fluid Level Transmitter (If specified)
- Outer (Containment) Seal
  - Plan 72 No Monitoring via instrumentation
  - **(iii) the barrier fluid system is equipped with a sensor that is intended to detect any failure of the system;**
  - Best in class users – Manual pressure test periodically

# LDAR Exceptions?

- There are large populations of containment seal installed in Canada
- Most without Plan 72 (gas purge)
- Would be non-compliant with VOC LDAR exception.
- Secondary containment device – reliability compromised
- Potential loss of containment in the event of primary seal leak





# Containment Seal Bad Practice – Condensing Leakage plan 76



Gasoline

API 610 BB5 Pump 80mm (3.149")

30°C (86°F)

Seal Chamber Pressure 0.9 barg 13.7 psig

SG 7.8 Vapour pressure 0.014 bara 0.2 psia





# Containment Seal Bad Practice -



Removed after 2 years service life

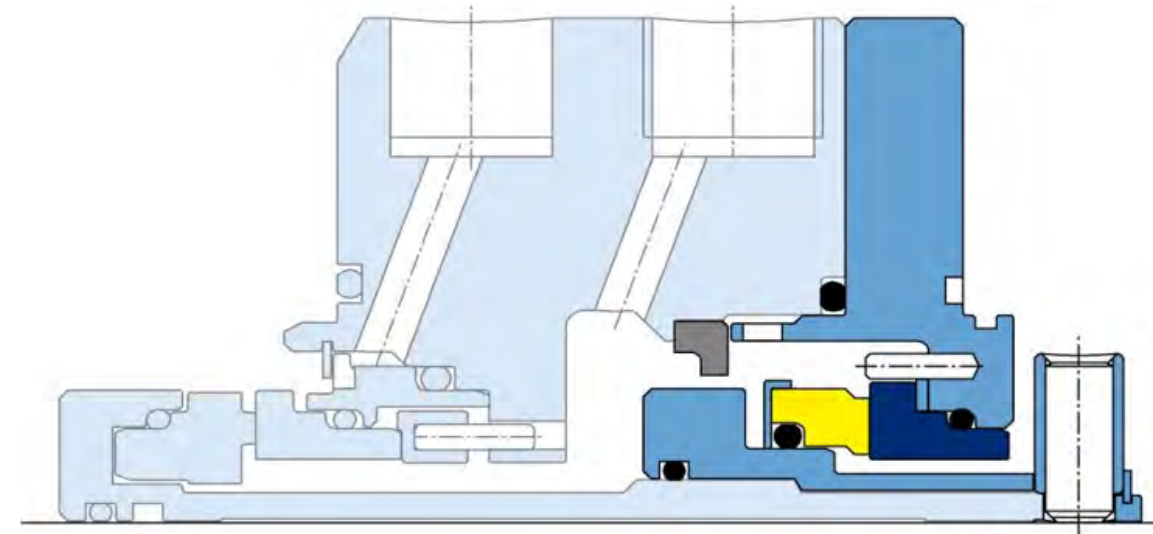


Removed after 3 years service life





# Containment Seals Safety Considerations



- Condition of the containment seal in a plan 72/76 or 75 is not known or monitored .
- If the containment seal is faulty and the inner seal fails then there is a loss of containment.
- The higher the reliability of the inner seals the higher the probability the containment seal is worn out or not functioning at end of seal life.
- By comparison Dual Seals 52 or 53 the outer seal condition is continuously monitored by the liquid level
- Dry Containment seals can (should) be integrity tested in situ periodically
- Bowden, P. E. Fone, C. J proposed weekly\*

\*Proceedings Of The 19th International Pump Users Symposium. 2002, Turbo machinery Laboratory



# LDAR Exceptions



- Section 6 Inspection — equipment components
  - 3(a)(i) the dual mechanical seal system is
    - (A) operated with a **barrier fluid** system in which the fluid is at all times at a pressure that is greater than the stuffing box pressure,
    - (B) equipped with a **barrier fluid** degassing reservoir that is connected by a closed-vent system to a process gas system, a fuel gas system or a control device, or
    - (C) equipped with a system that purges the **barrier fluid** into a process gas system and prevents the release of any VOCs into the environment,
    - (iii) the barrier fluid system is equipped with a sensor that is intended to detect any failure of the system;

API Plans  
Plan 53 (ABC), 54, 74

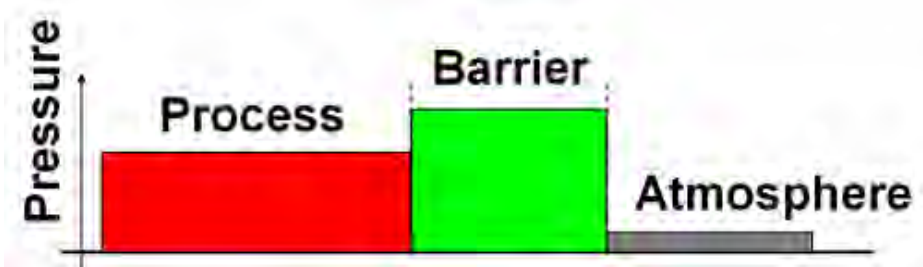


Plan 52?  
Unpressurised buffer  
fluid?  
Plan 72 / 76  
Unpressurised buffer gas ?

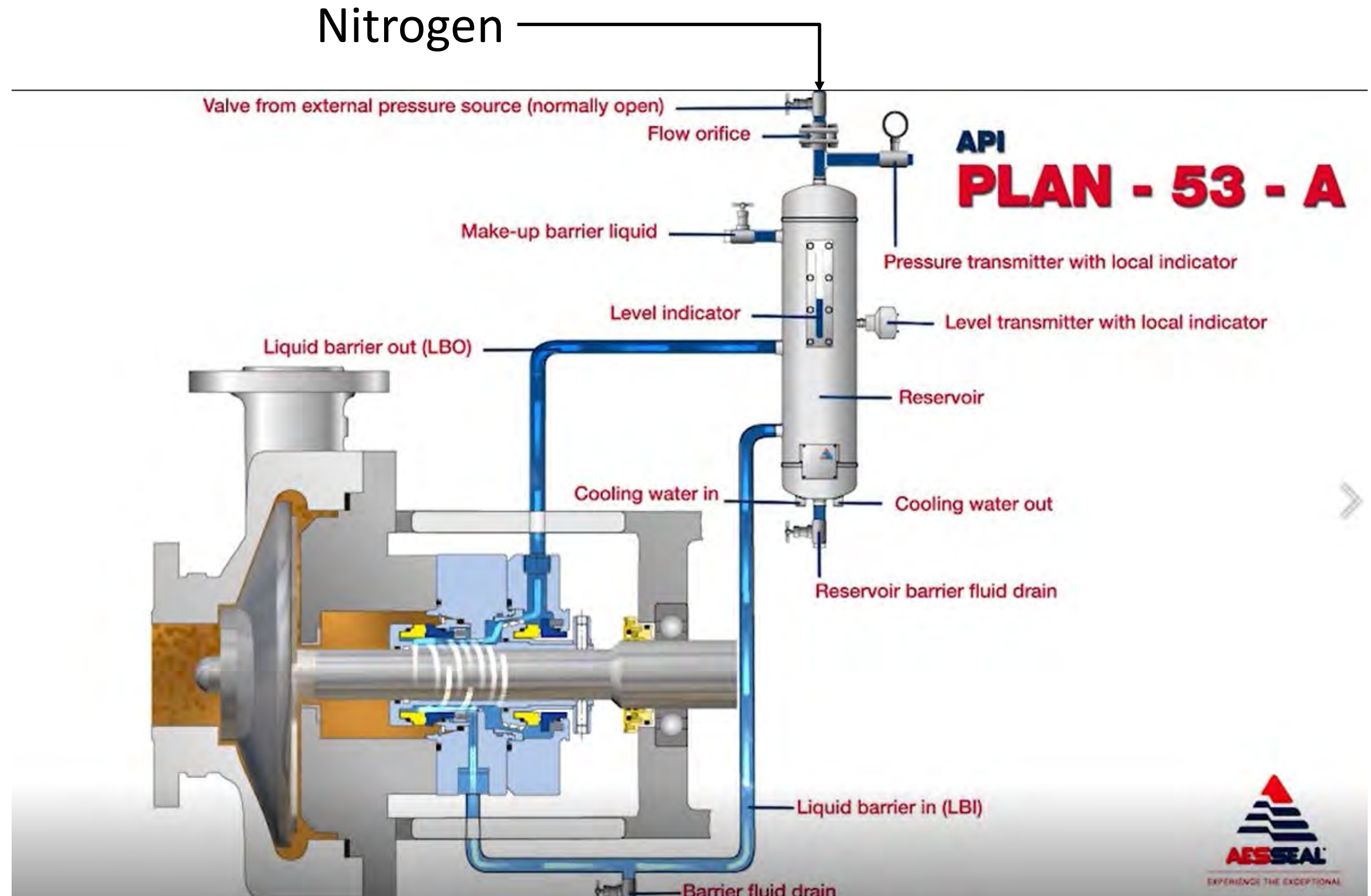




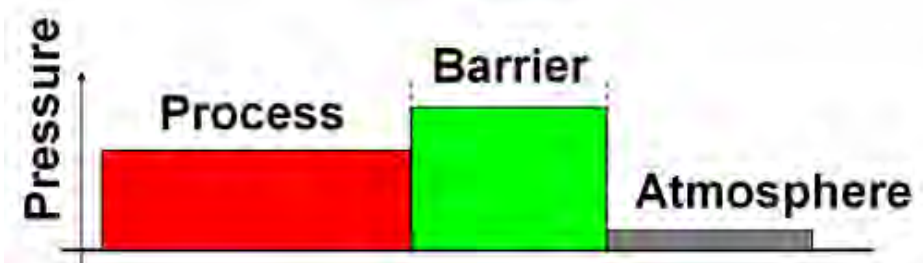
# LDAR Exceptions



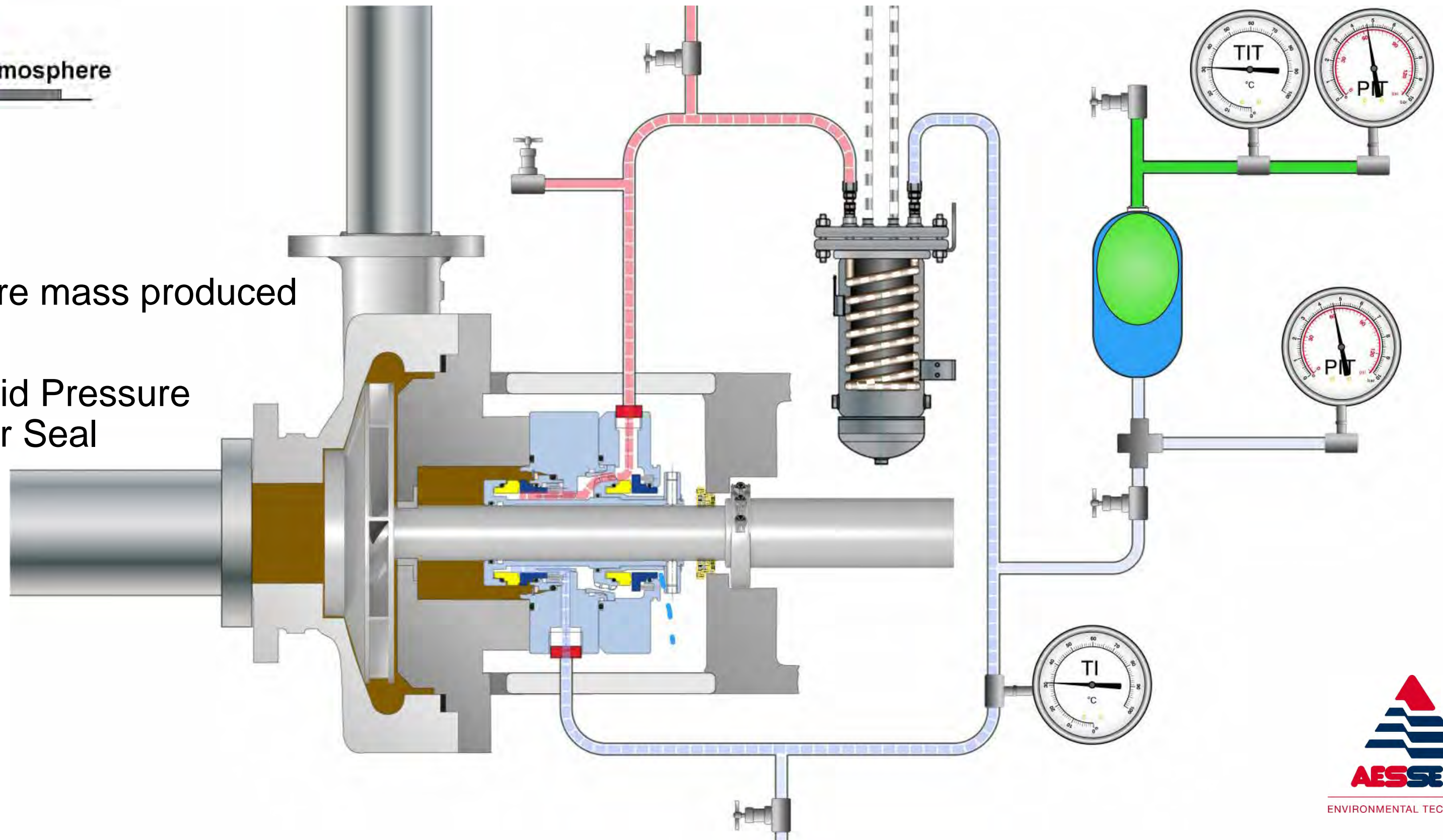
- Plan 53A
- Advantages
  - Simple
- Limitations
  - Pressure <150psi 10 bar
  - Nitrogen
    - Pressure Available
    - Security



# LDAR Exemptions



- **Plan 53B**
- Advantages
  - Stand Alone
  - Accumulators are mass produced
- Limitations
  - High Barrier Fluid Pressure Differential Inner Seal

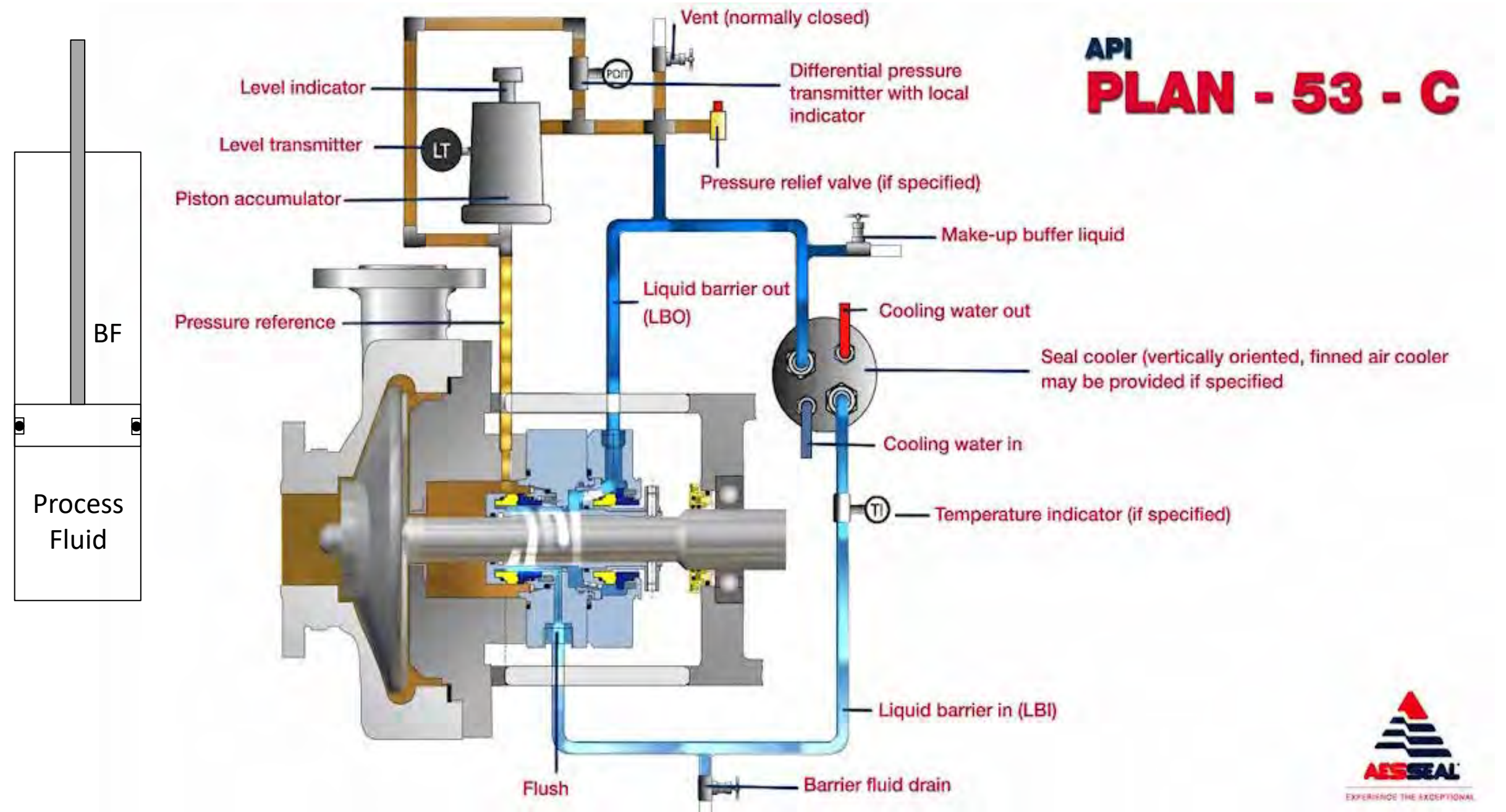




# LDAR Exceptions

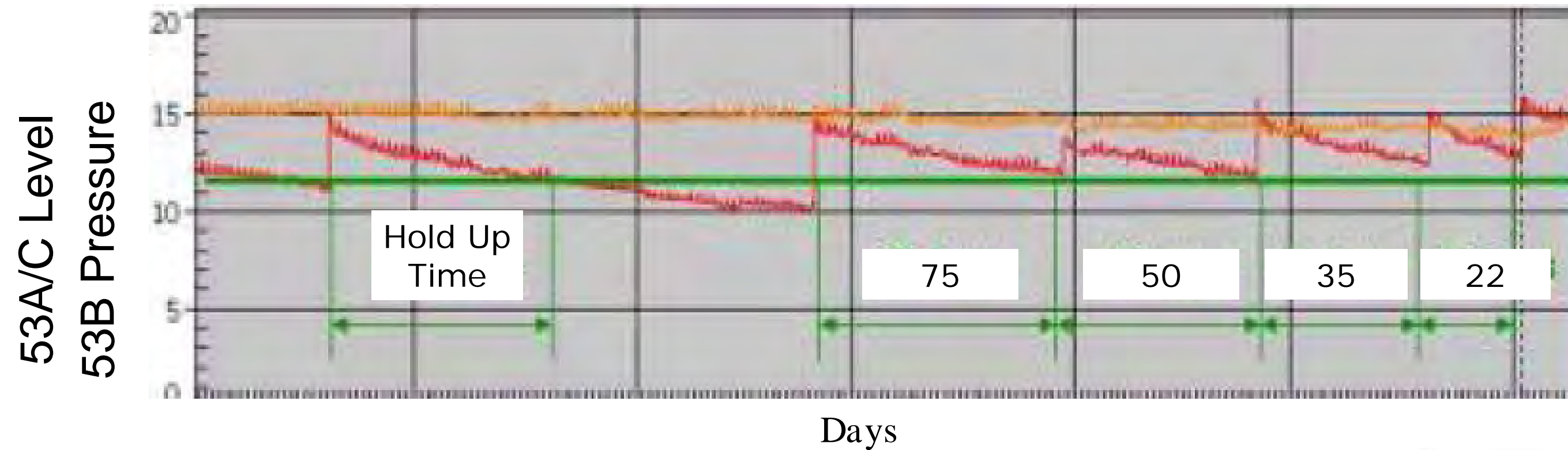


- Plan 53C
- Advantages
  - Stand Alone
  - Constant Pressure Differential Inner Seal
- Limitations
  - Clean Fluids
  - Can be Expensive



# LDAR Exemptions

## Plan 53A 53B 53C – Condition Monitoring

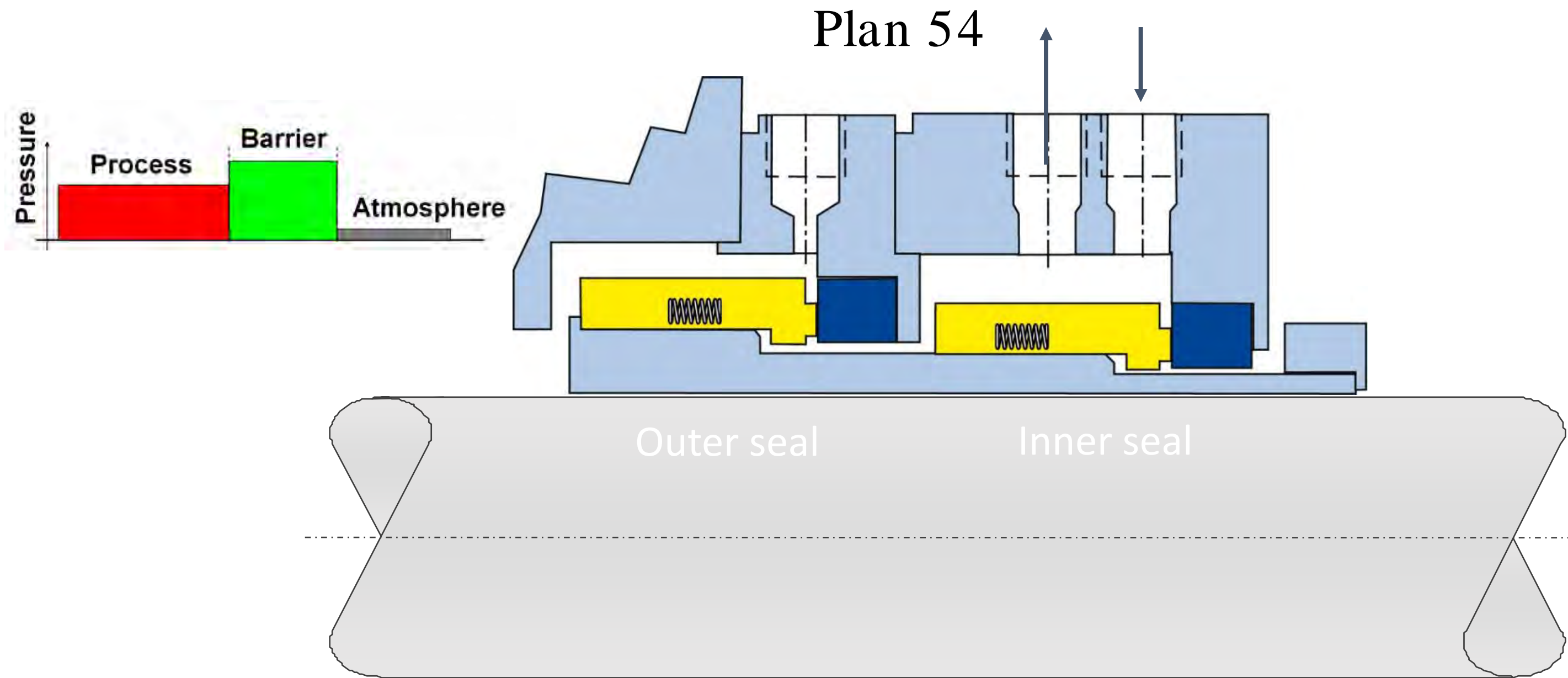


- Pressure / Level re-charge (re-fill) and decay
- Pressure / Level decay due to normal leakage of mechanical seal
- ‘Saw Tooth’ profile
- Pitch = Hold up time





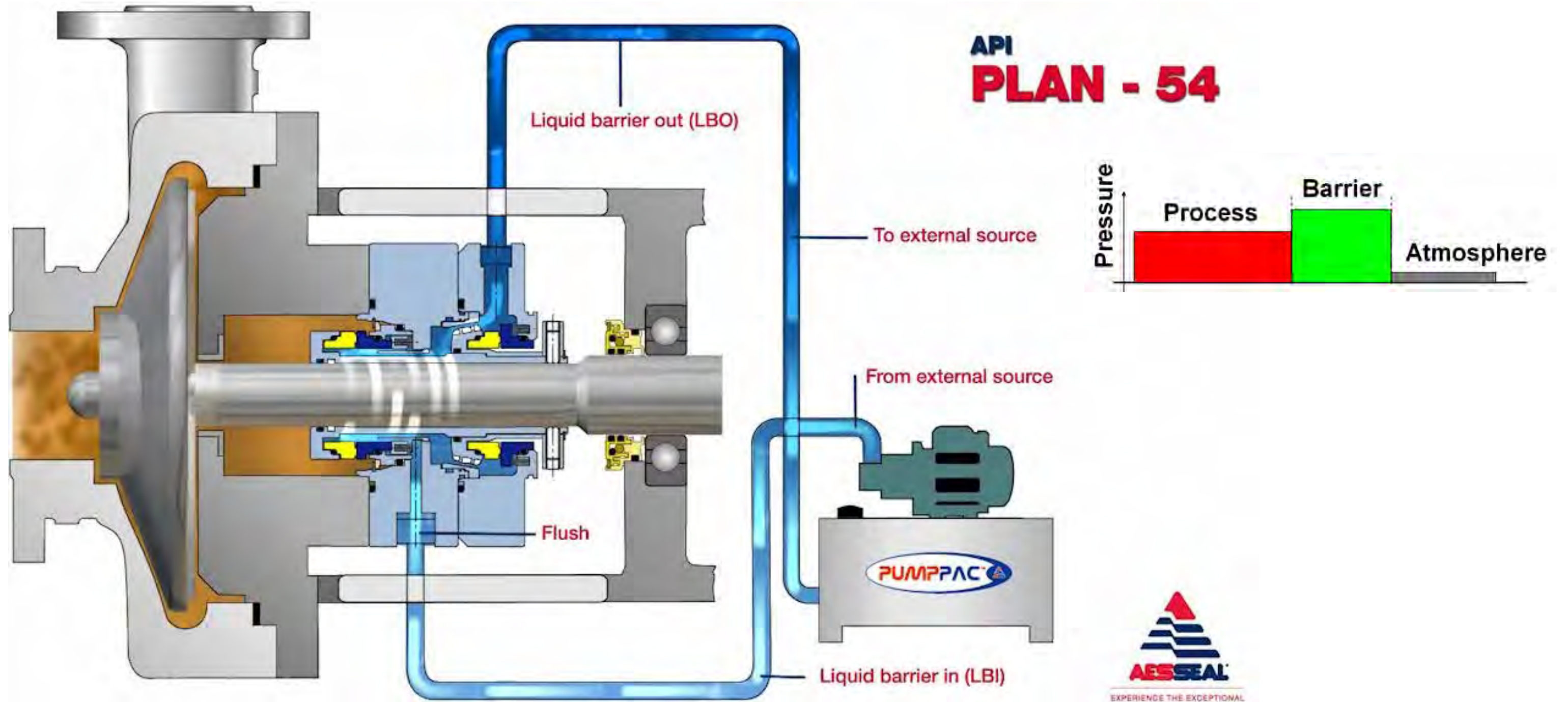
# LDAR Exceptions



*Piping Plan 54 is used with Arrangement 3 liquid seals and the barrier liquid is maintained at a pressure greater than seal chamber pressure. Barrier liquid is circulated by an external pump or pressure system.*

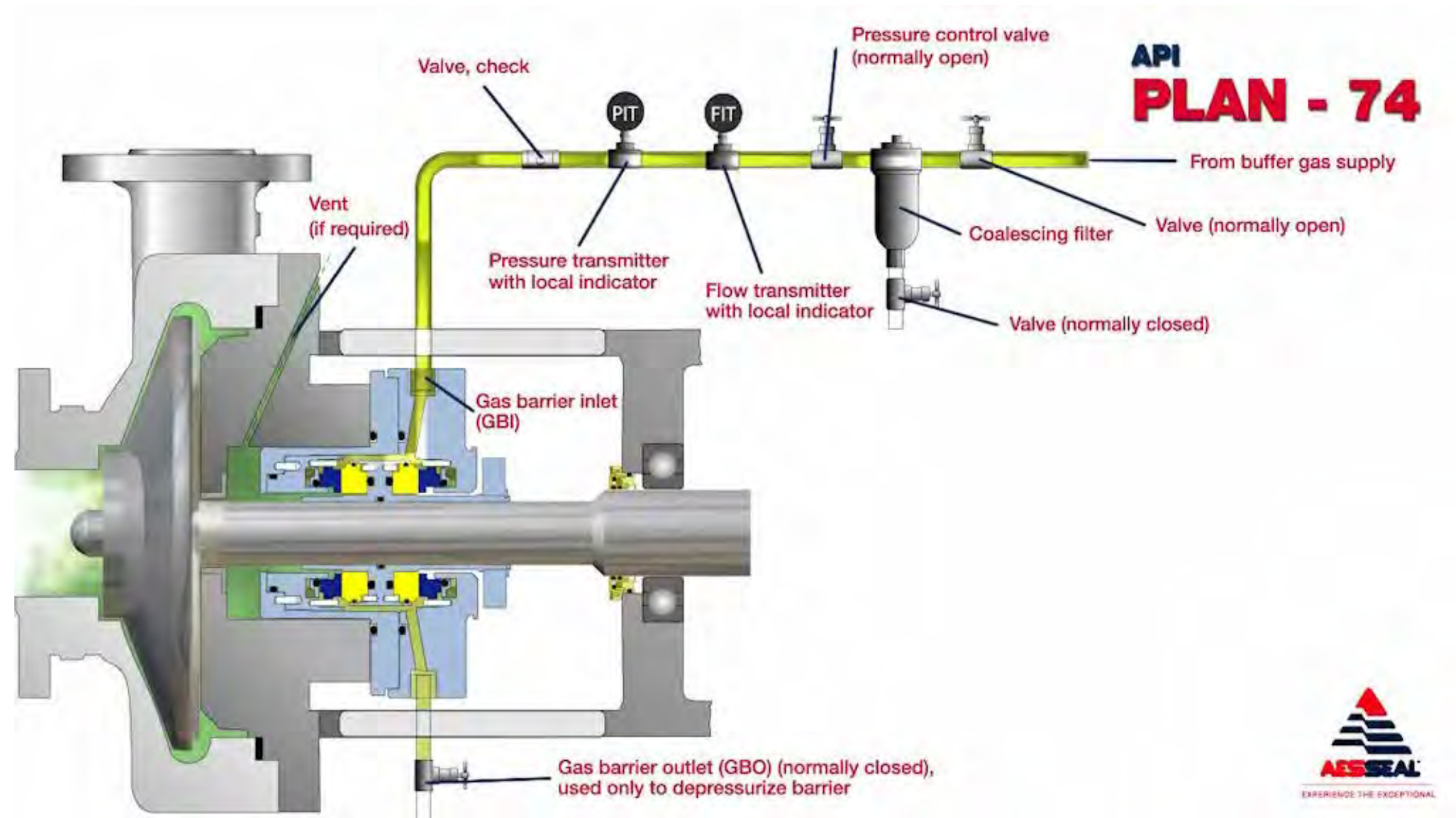
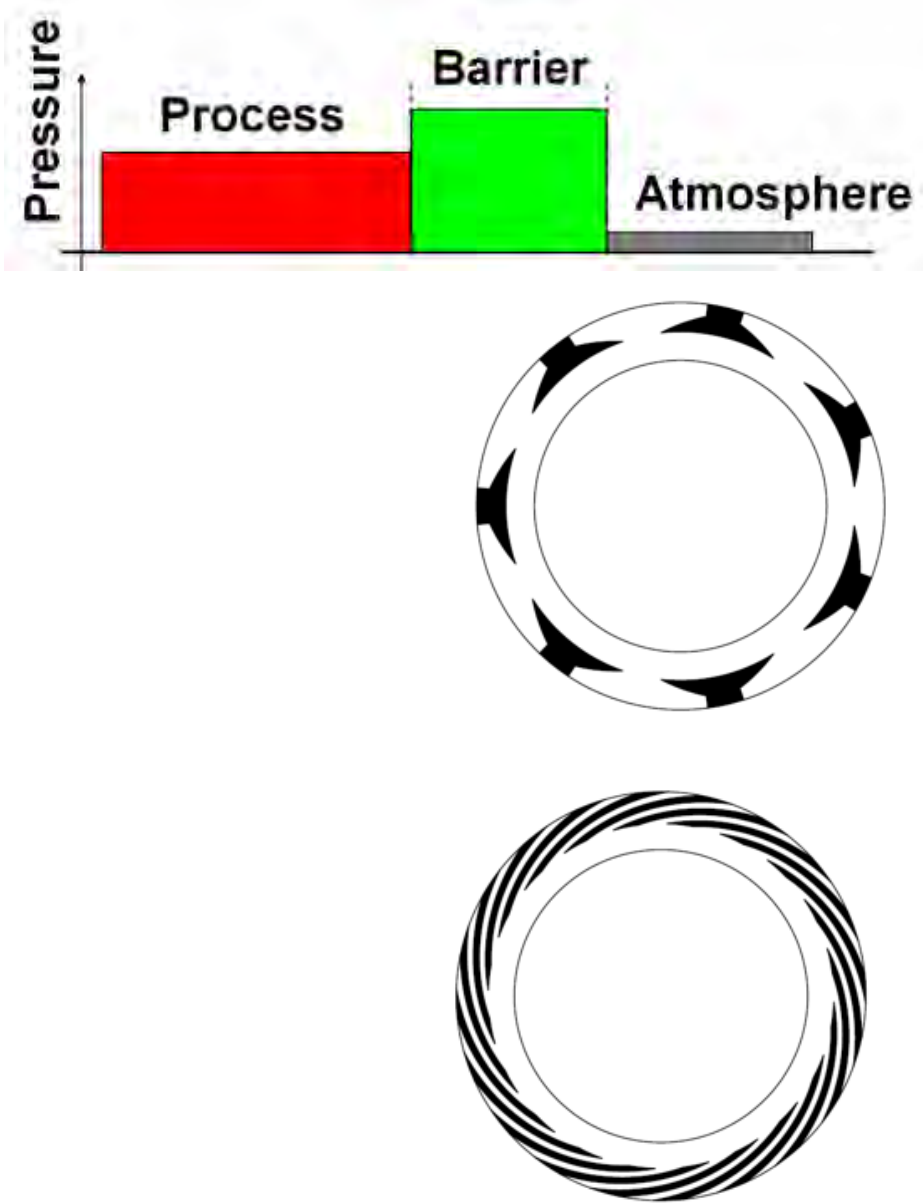


# LDAR Exceptions





# LDAR Exceptions



*Not suited for services containing sticky or polymerizing agents or where dehydration of the pumpage causes solids buildup, Piping Plan 74 systems are not generally recommended.*

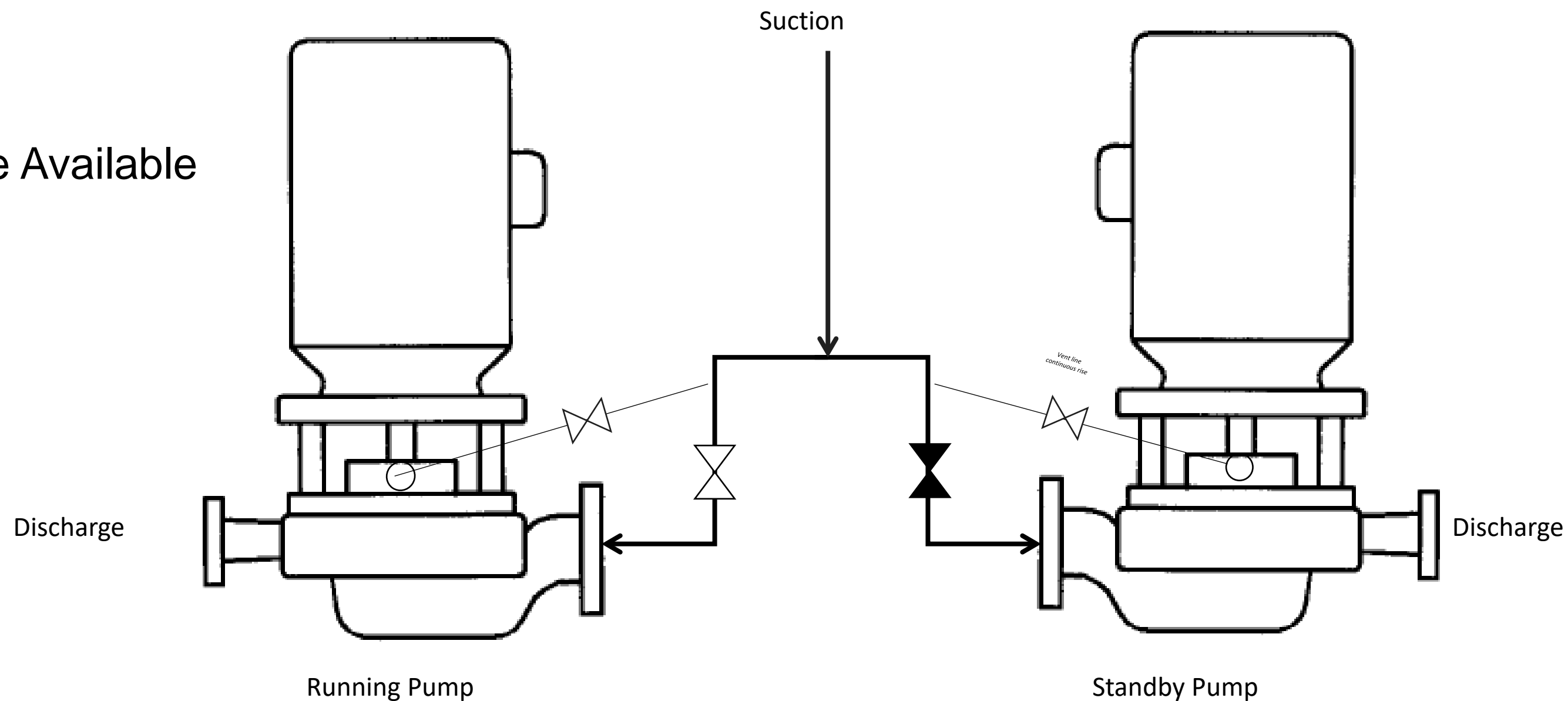


# LDAR Exceptions

- Advantages
  - Simple
  - Low Cost
- Limitations
  - Nitrogen
    - Pressure Available
    - Security

## API Plan 74

Vent line (Plan 13) For use in conjunction with plan 74





# LDAR Exceptions - Challenges

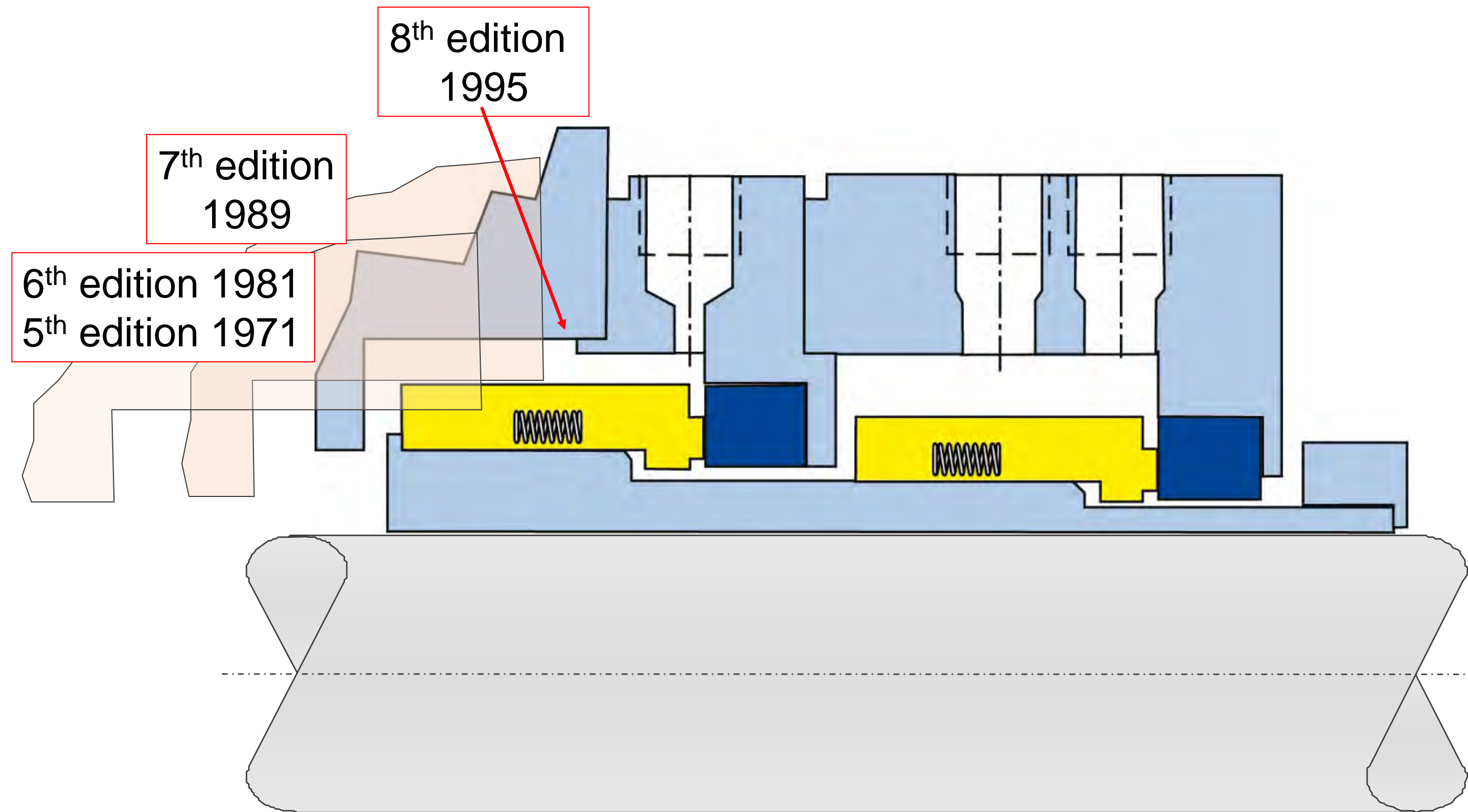
Regulatory Body – Clarification Required?

Revised wording in line with internationally accepted industry terminology ?

- Section 6 Inspection — equipment components
  - 3(a)(i) the dual mechanical seal system is
- (A) **For light or heavy liquids** operated with a barrier fluid system in which the fluid is at all times at a pressure that is greater than the stuffing box pressure, **as per API Plans 53A,B,C Plan 54, Plan 74**
- (B) **For light liquid** equipped with a **barrier buffer** fluid degassing reservoir **as per API plan 52** that is connected by a closed-vent system to a process gas system, a fuel gas system or a control device, or
- ~~(C) equipped with a system that purges the **barrier buffer** barrier fluid into a process gas system **as per API plans 72 & 76** and prevents the release of any VOCs into the environment,~~

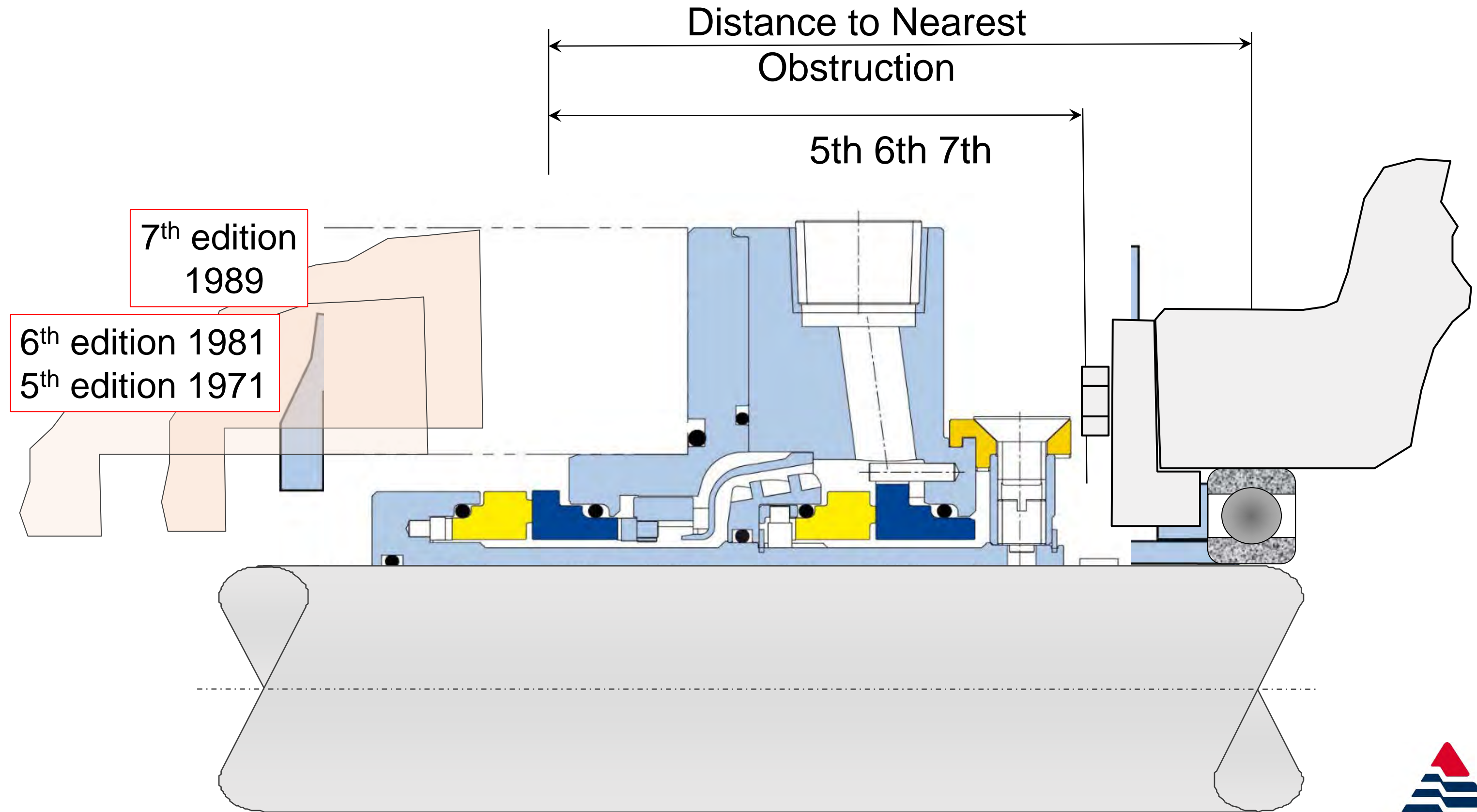


# LDAR Exceptions - Challenges






# LDAR Exceptions - Challenges




# LDAR Exceptions - Challenges

## API Standard 682 4th edition – Manufacturers Qualification Testing



### Mechanical Seal Qualification Test Form



1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T4/4/PT00API 8 Revision: 08/23

Manufacturer: AESSEAL plc Seal Type / Model: CAPI Type A Dual

Seal Type: A  B  C  ES

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide Secondary Seal Faces\*: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer Metal Hardware: 316 SS

Seal Size: 50mm Seal Code: 3CW-FB Piping Plan: 11 & 53 Shaft Speed: 3600rpm

Pumped Fluid (Table 1.2): Nonhydrocarbon (water, caustic acid) Nonflashing Hydrocarbon  Flashing Hydrocarbon

Shaft Runout (Figure 19): 0.025mm Sleeve Runout (Figure 19): \_\_\_\_\_ Chamber Concentricity (Figure 12): 0.1mm Seal Chamber Face Runout (Figure 14): <0.1mm

Test Fluid: Mineral Oil Base-point Temperature °C (°F): 20 (68) Base-point Pressure MPa (bar) (psi): 0.7 / (7) / (102)

Relative Density (SG): 0.873 Vapor Pressure: N/A Solids: None Particle Size: N/A \*Dual Seals


DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m <sup>3</sup> /h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day (ppm)	Nonhydrocarbon Leakage cm <sup>3</sup> /min	Circulating Device m <sup>3</sup> /h (U.S. gal/min)
Date	Time														
	Start	Stop													
28-07-2002	15:00		6.85 (99)	19.93 (68)	18.11 (65)	18.6 (65)	0.3 (1.32)	18.17 (65)	7.76 (113)	21.5 (71)	39.5 (103)	0.84 (1.13)	0	N/A	0.15 (0.66)
31-07-2002		10:13	6.89 (100)	20.1 (68)	19.82 (68)	18.44 (65)	0.35 (1.54)	18.85 (68)	7.83 (114)	25.9 (79)	44.1 (111)	0.84 (1.13)	0	N/A	0.18 (0.79)
STATIC TEST 4 h minimum															
31-07-2002	10:13		6.89 (100)	20.07 (68)	19.78 (68)	18.4 (65)	0.35 (1.54)	18.85 (68)	7.82 (113)	25.7 (78)	40.9 (108)	0	0	N/A	0
31-07-2002		14:43	7.04 (102)	19.56 (67)	18.97 (68)	17.29 (63)	0.29 (1.28)	17.62 (64)	8.13 (118)	20.7 (69)	20.8 (69)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
31-07-2002	14:55		6.87 (100)	19.84 (67)	18.95 (68)	17.9 (64)	0.29 (1.28)	17.83 (64)	7.94 (115)	23.8 (74)	41.8 (107)	0.85 (1.14)	0	N/A	0.18 (0.79)
01-08-2002			7.14 (104)	19.57 (67)	17.89 (64)	18.73 (68)	0.29 (1.28)	18.37 (66)	8.37 (121)	25.8 (78)	44.2 (112)	0.88 (1.18)	0	N/A	0.2 (0.88)
02-08-2002		10:05	7.23 (105)	19.52 (67)	17.54 (64)	17.6 (64)	0.3 (1.32)	17.56 (64)	8.52 (124)	25 (77)	37.2 (99)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Notes:

- Conducted to latest version of API 682 at time of test; 1st edition.
- API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
- Average outer seal leakage barrier fluid measured at less than <0.2g/hr
- kW / HP are calculated theoretical values.

Authorised By:  
Stephen Shaw  
Group Engineering Director



**AESSEAL**  
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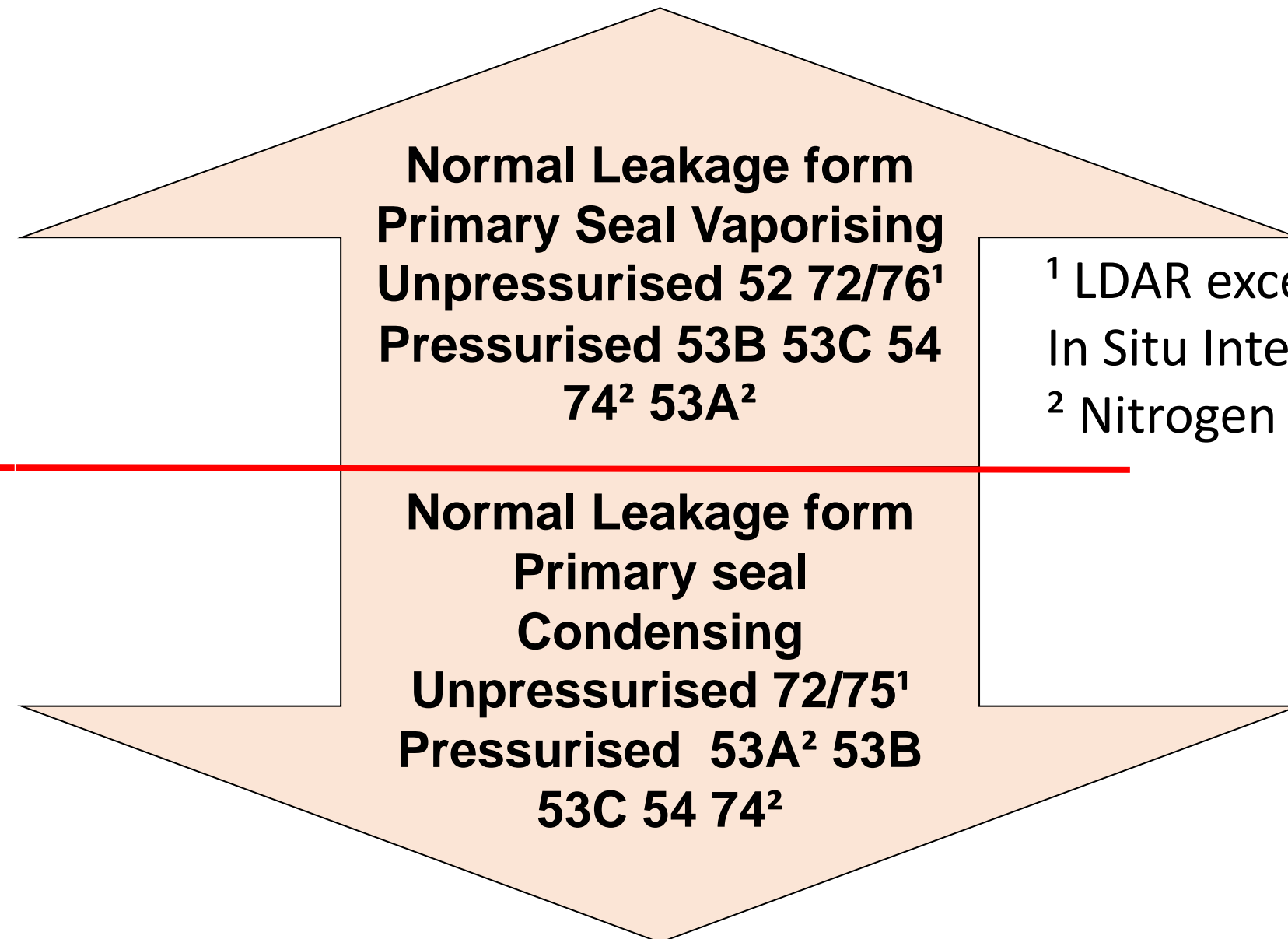


# LDAR Exceptions - Solutions

**METH C1**  
**ETH C2**  
**PROP C3**  
**BUT C4**  

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**PENT C5**  
**HEX C6**  
**HEPT C7**  
**OCT C8**  
**NON C9**  
**DEC C10**



<sup>1</sup> LDAR exception compliance?  
In Situ Integrity Testing Required  
<sup>2</sup> Nitrogen Pressure



# LDAR Exceptions – Potential Solutions

Seal Vendor	Seal Arrangement	User - Contractor Scope					\$ Costs
		Other Parts	Number of Instruments	Hook Up / Tie In			
Aux System				N2	Water Cooled	Flare	
52	2	No	2	No	Normally	Required	52 Hardware   Flare Connection
53A	3	Regulator	2	Yes	Normally	No	53A Hardware   N2 Connection
53B	3	No	1*	No	Air / Water	No	53B Hardware
53C	3	No	2	No	Air / Water	No	53C Hardware
54	3	No	2	No	Air / Water	No	54 Hardware
72 / 75	2	No	3	Yes	No	Required	72/75 Hardware   Flare Connection & Drain
72 / 76	2	No	3	Yes	No	Required	72/76 Hardware   Flare Connection
74	3	No	2	Yes	No	No	74 Hardware   N2 Connection

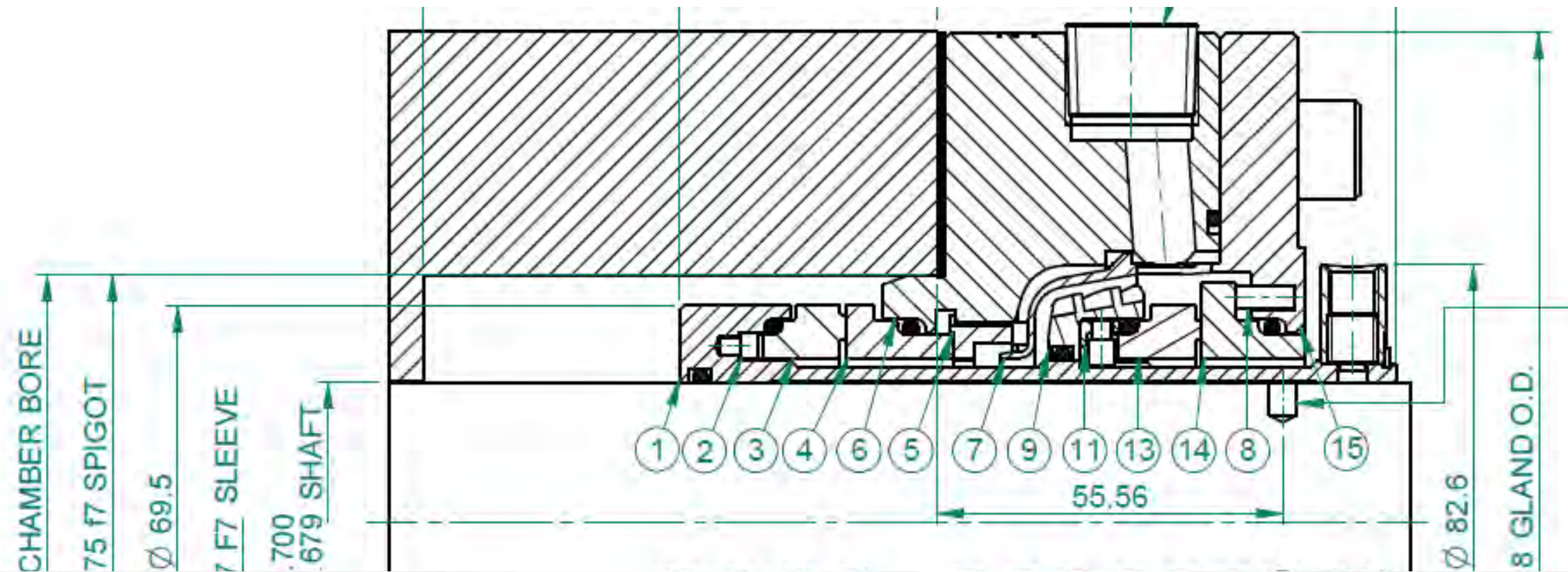
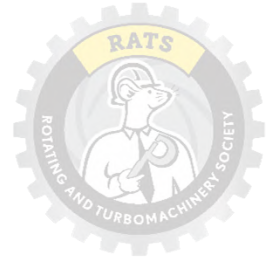






# LDAR Exceptions - Solutions

## Case Study - UK Refinery Benzene



CUSTOMER DETAILS				APPLICATION DETAILS	
CUSTOMER				PRODUCT	BENZENE
END USER	-			TEMPERATURE	100°F / 37.78°C
TAG No.	P570			SEAL CHAMBER PRESSURE	-
PO No.	-			DISCHARGE PRESSURE	290-450psig / 20-31 barg
RE-ORDER	AZT04584001---20201			SUCTION PRESSURE	64-100psig / 4.4-6.9 barg
EQUIPMENT DETAILS				VISCOSITY @PT	0.06 cSt
MAKE	DAVID BROWN			SPECIFIC GRAVITY @PT	0.88
MODEL	2x3x8 3/4 A- MSC 5 STAGE	SPEED	2950 RPM	VAPOUR PRESSURE @PT	-





# LDAR Exceptions - Solutions

**From:** [REDACTED]

**Sent:** 25 March 2022 08:35

**To:** Andrew Harrison <Andrew.Harrison@aes seal.co.uk>

**Subject:** [EXT] RE: 53B trends

**This message originated outside your organisation's email system.**

Andy

After sending the first email I have just looked at P570. It is now running a dual seal with 53 system. This pump previously had single seals with single springs, it would suffer leaks whenever there was any kind of unit upset, or even bring the unit back on line. It's the main benzene charge pump for the unit and is un-spared so is an LPO whenever it leaks, added with that the fact it leaks benzene means its quite dangerous.

Since fitting the CAPI TXS 53 system in May 2018 there have been no seal failures 😊

Note, the trend dips you can see are from corrective work on the instruments.



# LDAR Exceptions - Solutions



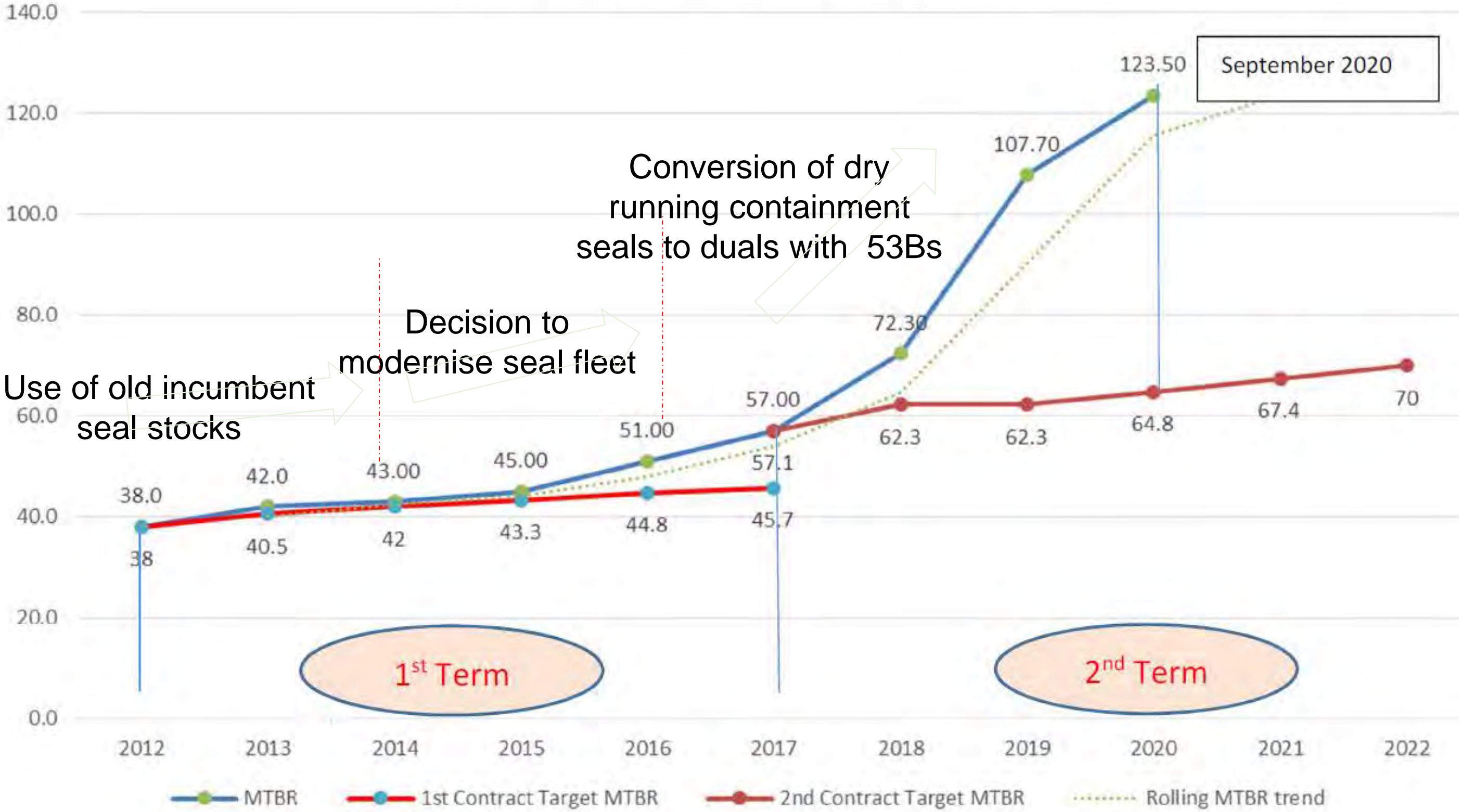
Case Study - UK Refinery Benzene





# LDAR Exceptions - Solutions

Historical 12 Month Rolling MTBR





# LDAR Exceptions - Solutions

**Case Study Reliability  
2 Refineries – Europe  
Commissioned 1965**

**Upgraded unpressurised dual seals  
Predominantly dry containment type  
MTBR < 60 months**

**Upgrades pressurised dual seals  
Predominantly Plan 54 and 53B  
MTBR > 125 months**





# LDAR Exceptions - Solutions

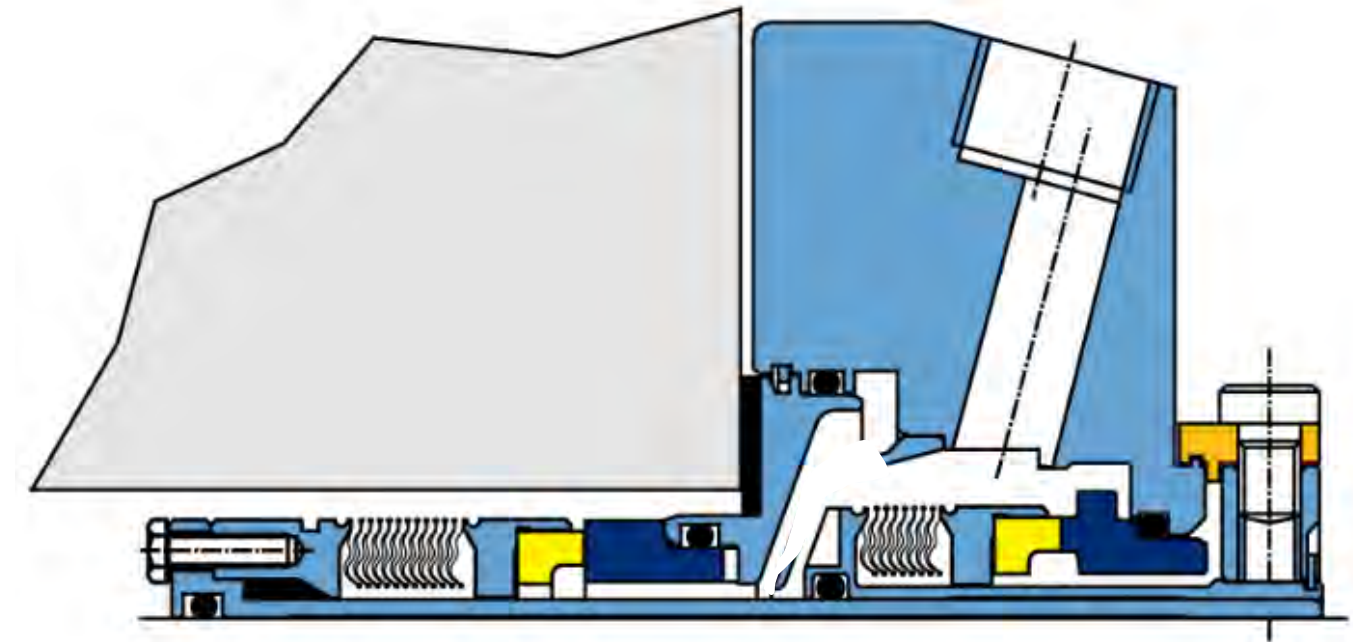
## Case Study US Refiner - Plan 52 – VOC Emissions H<sub>2</sub>S Stripper Overheads



# LDAR Exceptions - Solutions

## Case Study

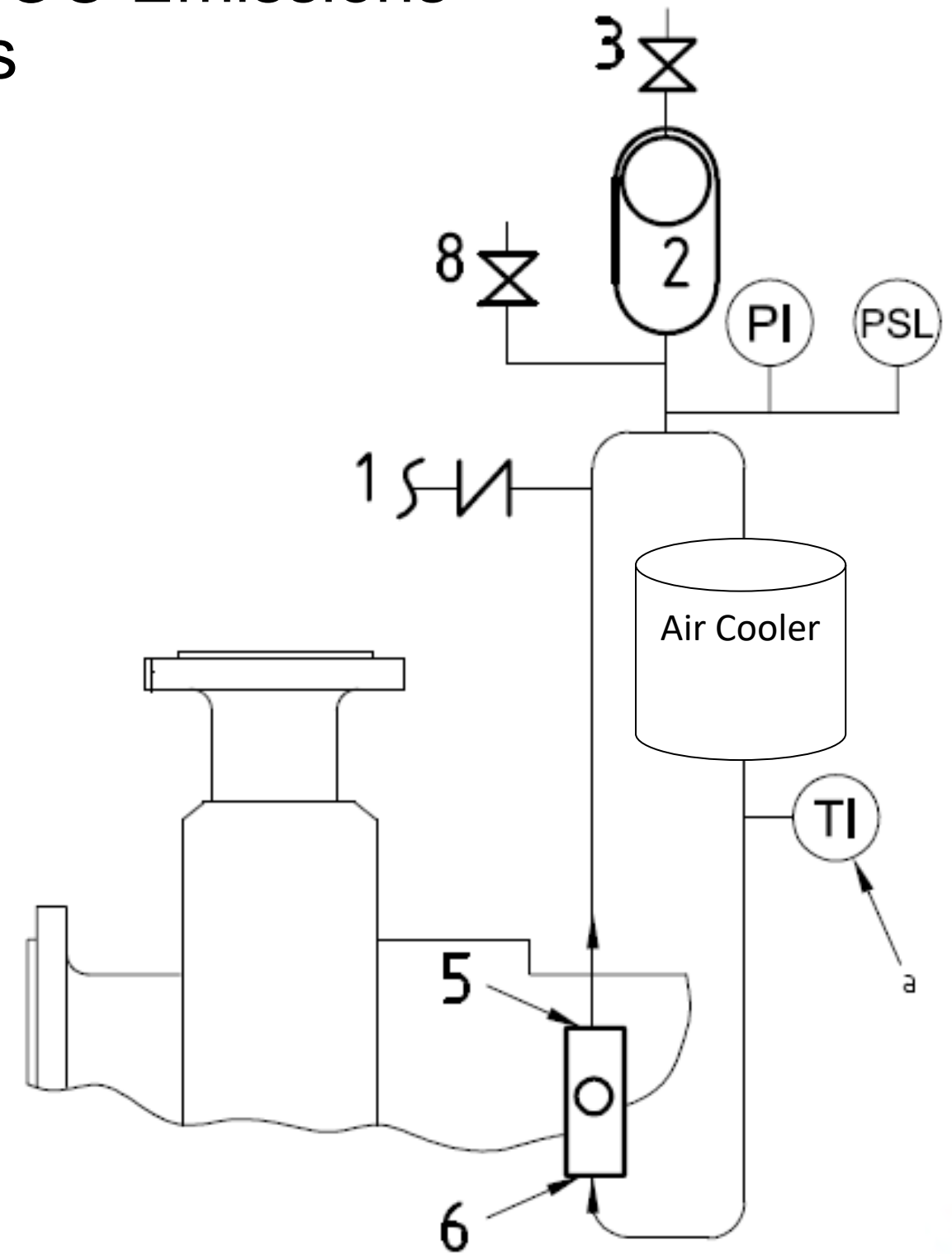
- Naptha (4% H<sub>2</sub>S) 145°F Plan 52
- H<sub>2</sub>S. Contaminated plan 52 system
- Seal chamber vapor pressure margin insufficient
- Seal pot contamination needed regular drain down
- Drain down releasing H<sub>2</sub>S to the atmosphere.
- MTBF Low
- System replace by plan 53 pressurized seal
- Pressurized seal Reliability increased X 6 still running
- No Barrier Contamination





# LDAR Exceptions - Solutions

## Case Study US Refiner - Plan 52 – VOC Emissions H<sub>2</sub>S Stripper Overheads





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