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M A R I N A B A Y S A N D S



Dry gas seal failure and trouble shooting

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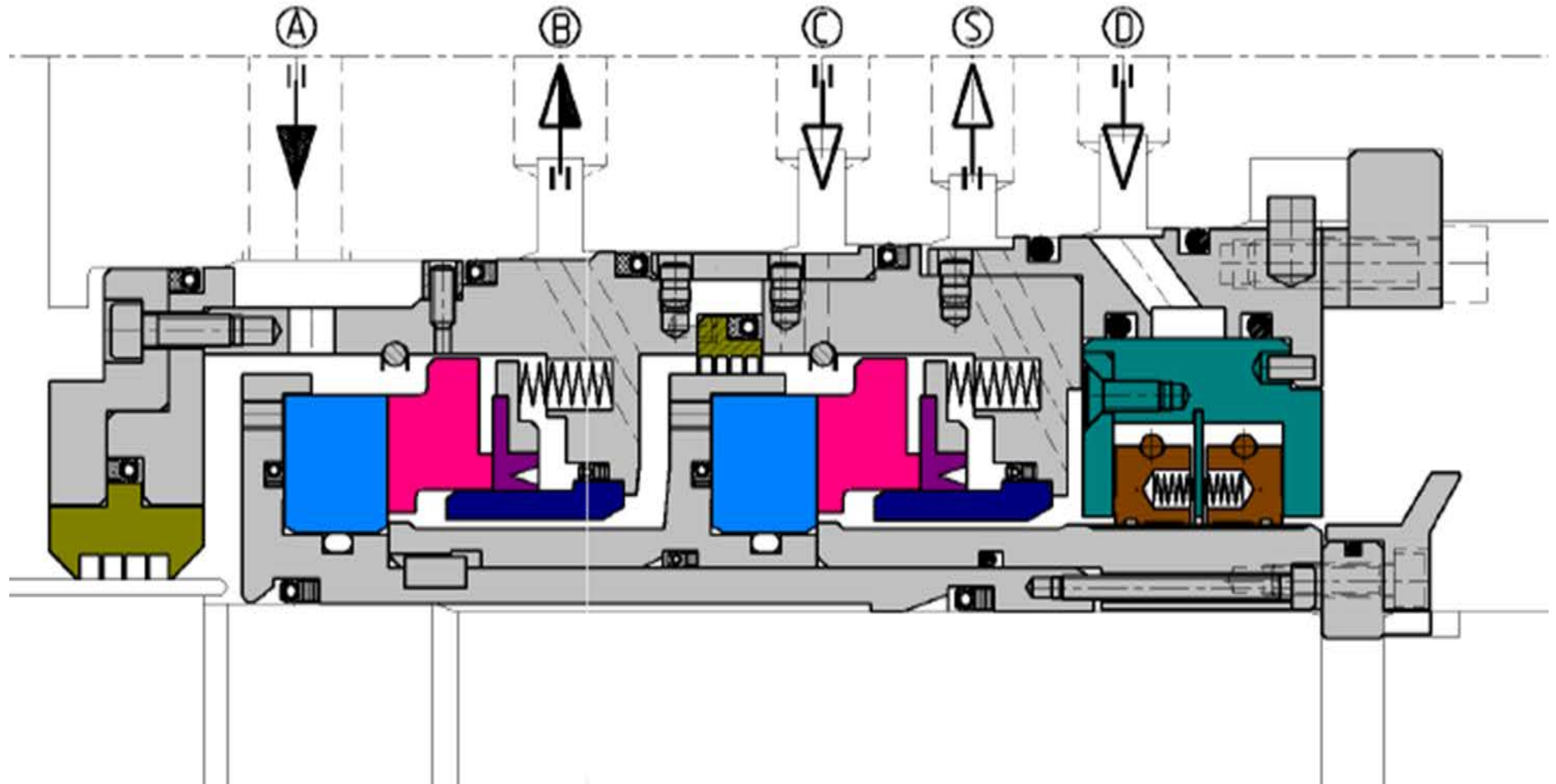
Introduction

- On 19th Nov 2014 the Compressor was tripped due to high leakage in the NDE side Dry gas seal primary vent. The NDE primary vent high pressure indicated the high leakage of the Dry gas seal.
- Compressor was stopped and performed static test with low pressure Nitrogen to confirm the NDE seal health condition before change out as the last Dry gas seal was changed one year back due to the same problem.
- Checked the static pressure test at 5 BarG. using nitrogen and still primary leakage line pressure transmitter indicated high leakage pressure (Equivalent to the Compressor casing pressure). The customer decided to change the Dry gas seal in NDE side only as the DE side dry gas seal was performing well at all time.

Background

- # The process gas high pressure centrifugal compressors used in oil & gas industries requires highly safe and reliable operating requirement.
- # The dry gas seals are used to prevent the gas leakages from the compressors and plays roles as critical component. Hence the proper design and monitoring of dry gas seals are most important.
- # This case study represents the frequent failure of Non Drive End(NDE) dry gas seal in Recycle Gas Compressor which tripped due to very high primary leakage pressure of 3.2barg (set pressure 2.5bar)

Dry Gas Seal



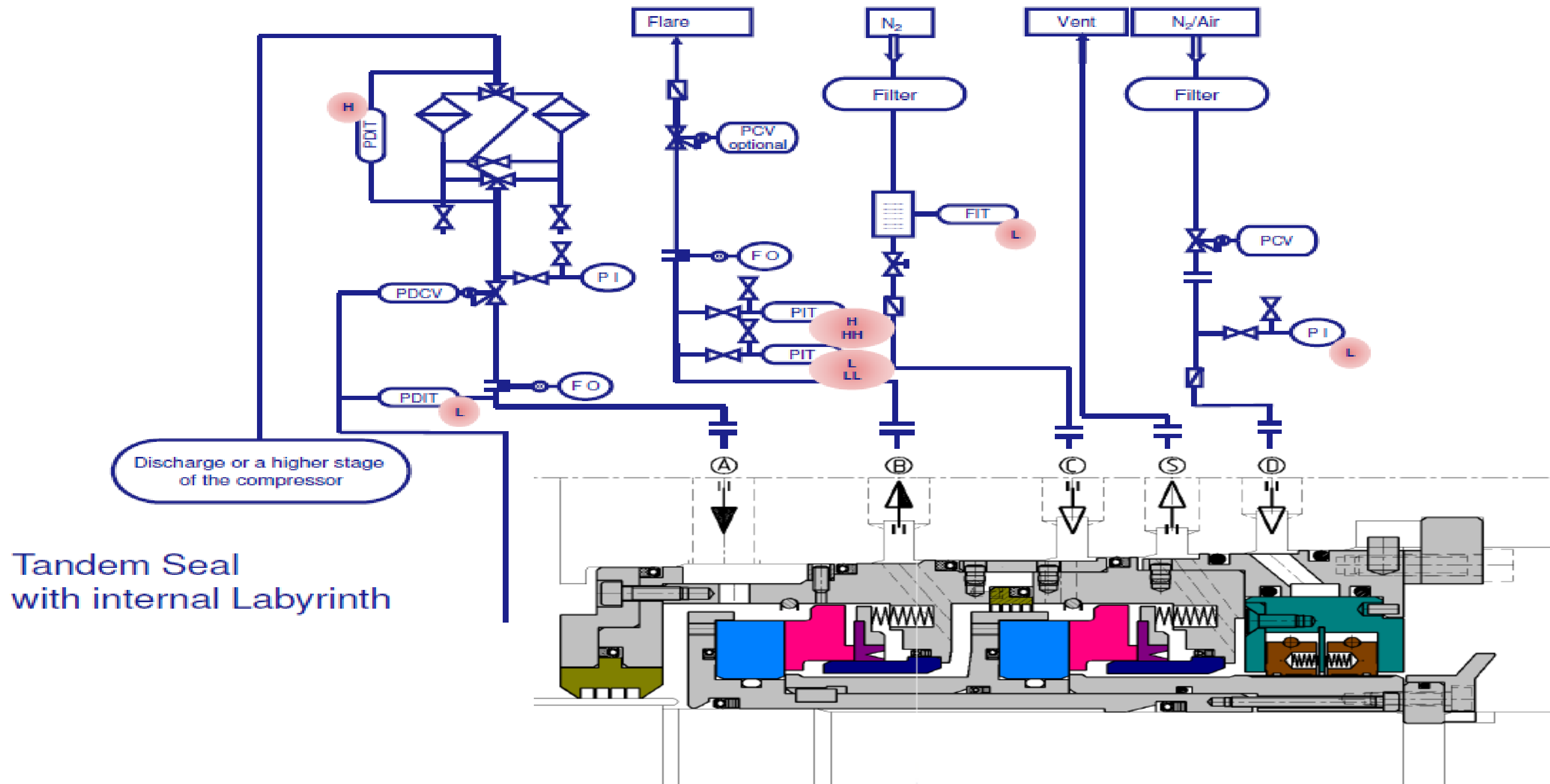
Dry Gas Seal control system

- Dry Gas Seal and barrier gas control systems are specially designed to supply gas, at the correct pressure and flow, to the dry gas seals. These systems are panel-mounted and installed adjacent to the compressor skid.
- The DGS will have reliable operation only if the gas is clean. The seal gas filter is installed to filter the contaminants.
- Ingression of foreign material into the running gap of the seals leads to degrade sealing performance (increased gas leakage) and eventual failure of the seal.

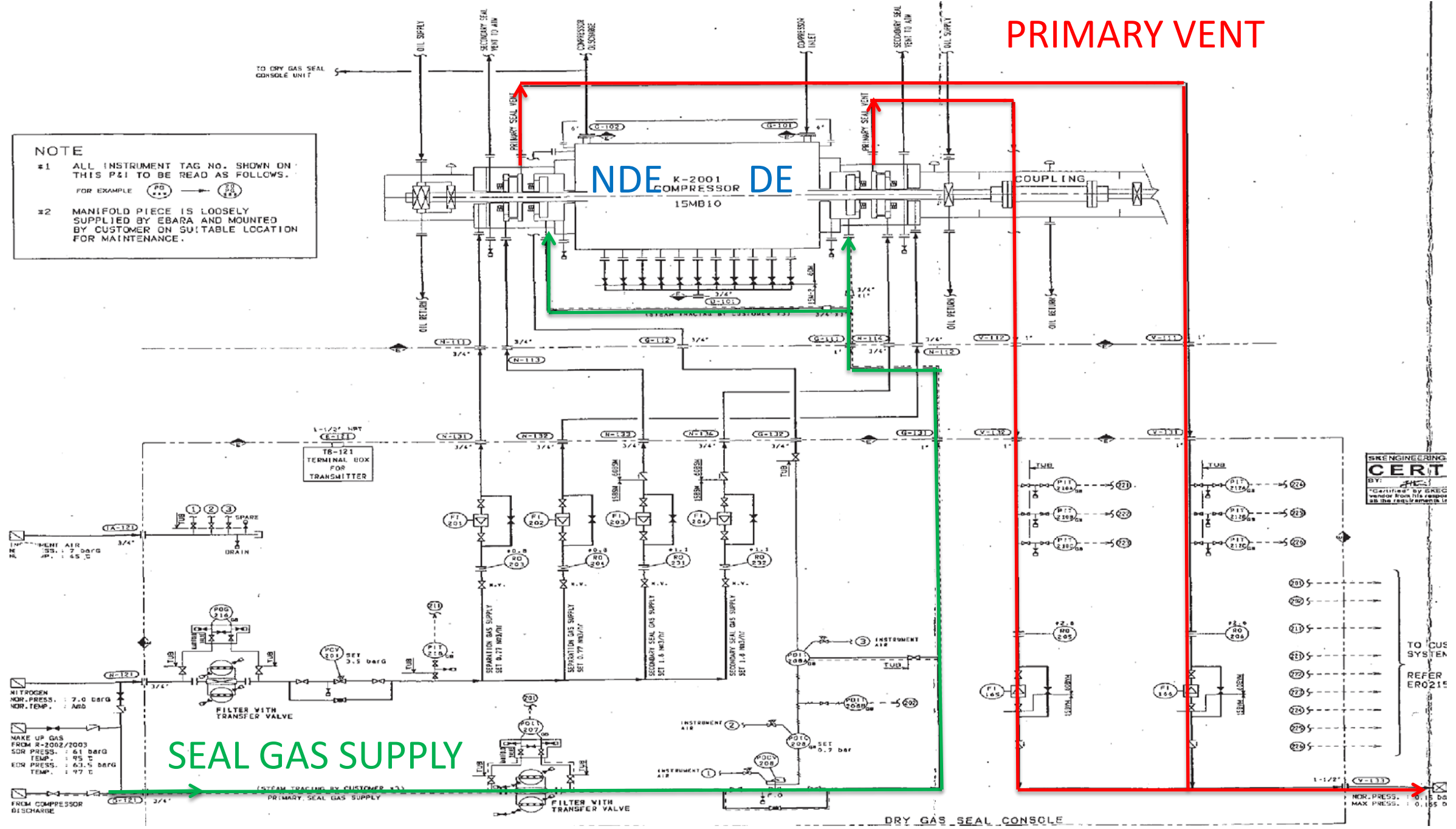
Dry Gas Seal control system

- Provides three main functions:
 - **Filtration of Seal gas & Buffer Gas**
 - **Regulation of Seal gas & Buffer Gas**
 - **Monitoring of seal Performance**
- Design is simple to operate and user friendly with minimum maintenance requirements

Dry gas seal control system Layout



Control System P&ID



NOTE

#1 ALL INSTRUMENT TAG NO. SHOWN ON THIS P&I TO BE READ AS FOLLOWS:
 FOR EXAMPLE $\text{PO} \rightarrow \text{201}$

#2 MANIFOLD PIECE IS LOOSELY SUPPLIED BY EBARA AND MOUNTED BY CUSTOMER ON SUITABLE LOCATION FOR MAINTENANCE.

SKENGINEERING
CERT
 BY: [Signature]
 "Certified" by SKENGINEERING vendor from his responsibility as the requirement is in

TO GUS SYSTEM
 REFER ER0215

SEAL GAS SUPPLY

PRIMARY VENT

DRY GAS SEAL CONSOLE

NOR. PRESS. : 0.15 bar
 MAX. PRESS. : 0.195 bar

Seal Gas loop

- Seal gas must be dry and free of particles less than 3 micron. Sealing gas injected between the inner labyrinth seal and the Dry gas seal.
- The majority of this gas flows across the inner labyrinth seal and into the compressor or process side of the Compressor. A very small amount of the sealing gas passes through the primary seal and out the primary vent which is normally connected to the user's flare system.

Findings & Analysis

Problem statement:


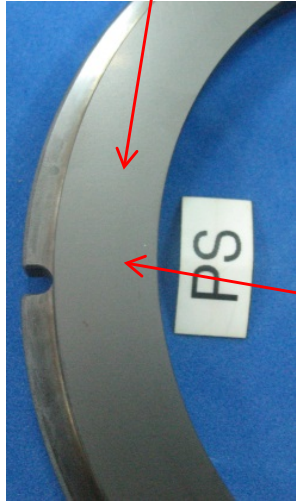
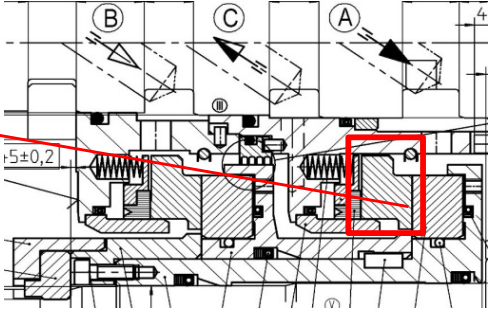
The site had repeated high alarm in the NDE primary leakage line within three years of operation. The DGS were removed out and found traces of hydrocarbon contaminants near the primary side. The primary side seal faces were covered with fine traces of liquid/hydrocarbon . DE dry gas seal was found normal



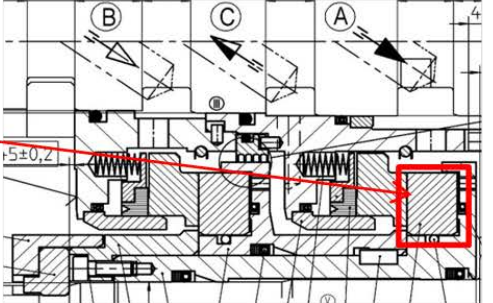
History:

The NDE DGS were replaced 3 times in last three years and every time the same type of behavior were found. During the first 2 failures the seal chamber, seal gas filter were inspected and found with no traces of contamination. The seal gas composition was verified and confirmed that the seal gas used is as per specification. So the site team replaced the DGS cartridge without any further investigation in each failure.

Finding & Analysis

Inboard/Process side (PS) Seal Face & Seat

<p>Before cleaning</p> 	<p>After cleaning</p> 	<p>PS Seal face Pos-2: Traces of black sticky liquid observed on the sliding surface. Seal face found to be in re-usable condition after cleaning.</p>
		

<p>Before cleaning</p> 	<p>After cleaning</p> 	<p>PS Seat Pos-1.1: Traces of black sticky liquid observed on the sliding surface. Seat found to be in re-usable condition after cleaning.</p>
		

Findings & Analysis

Observation during 3rd time failure:

During the trip, the alarm and trip was verified and the trend indicated that the seal failure was gradual in time and real issue. The investigation was performed on dry gas seal panel. The seal gas filter and N2 filter were found normal. There is no liquid present on the seal gas filter drain.

Nitrogen purging was performed and the unit was restarted. The unit tripped again due to high pressure on primary vent within few minutes of operation. The vibration readings of bearings were found normal

Site intervention:

The NDE dry gas seal cartridge was removed out from the compressor and inspected. The inspection on DGS cartridge confirmed that the seal faces were contaminated with traces of condensate in the process gas.

The seal gas supply line, suction drum and PDCV functions were verified. Functionality of steam tracing in seal gas inlet was also verified. No abnormalities were found.

Findings & Analysis

Root cause analysis:

The root cause analysis was performed as per the

Design consideration Vs Site condition

The root cause for all the previous failure was suspected to be due to the similar cause as the DGS cartridge inspection confirmed that the location of contamination was in same primary faces and the type of contamination was due to hydro carbon deposit.

The Root cause was analyzed as per the cause & effect diagram.

Cause –Effect Analysis of the failure

Operation

Installation

workmanship

↓ *Low Seal Gas Temperature*

↓ *Incorrect dry gas seal assembly*

↓ *Improper installation of O-rings*

↓ *Seal gas Steam tracing not working*

↑ *Piping cleanliness not verified*

↓ *Insufficient skill*

Dry gas seal contamination

↔ *Improper sealing of barrier seal*

↓ *DGS cartridge pre installation checks*

↑ *NDE Primary vent orifice location*

↔ *Primary seal faces integrity*

↓ *DGS – shaft - casing position*

↔ *Seal face selection vs Gas*

Material

Measurement

Design

↓ UNLIKELY

↔ LIKELY

↑ MOST LIKELY

Conclusion

The source of contamination was identified as due to the condensing happening in the seal gas system primary vent line. The primary vent line cleanliness and presence of orifice plate location was not checked in all the previous occurrences.

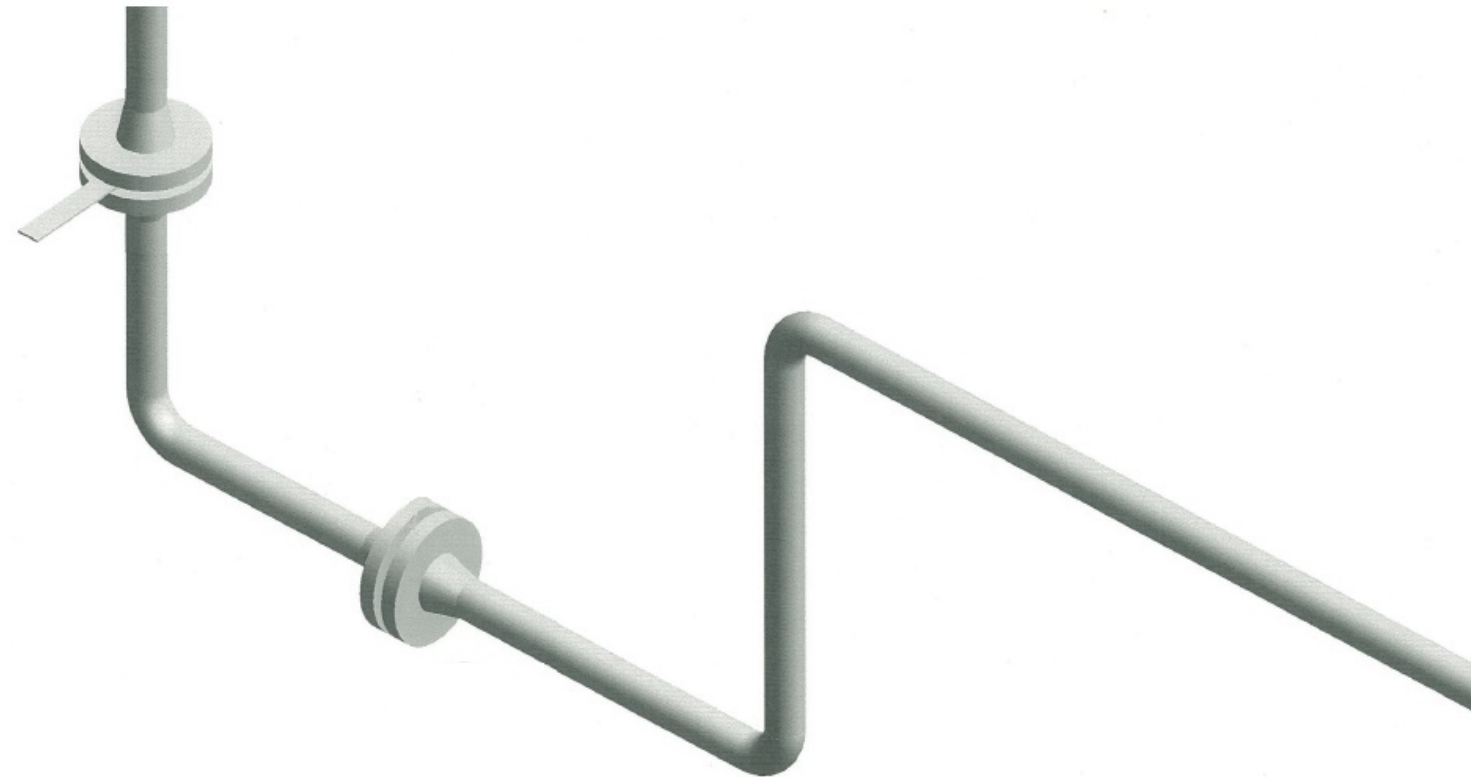
The orifice plate installed at the NDE primary vent line was lower than the center line of the compressor. It makes the primary vent gases turn to liquid at the orifice plate due to pressure drop. The condensates started accumulating over the period of time in the loop and blocked the orifice plate hole for further escape of the gases which leads to back pressure in the line. But the DE primary vent orifice was found already at the height of 1.5m as per the design from ground level.

NDE DGS primary vent orifice arrangement

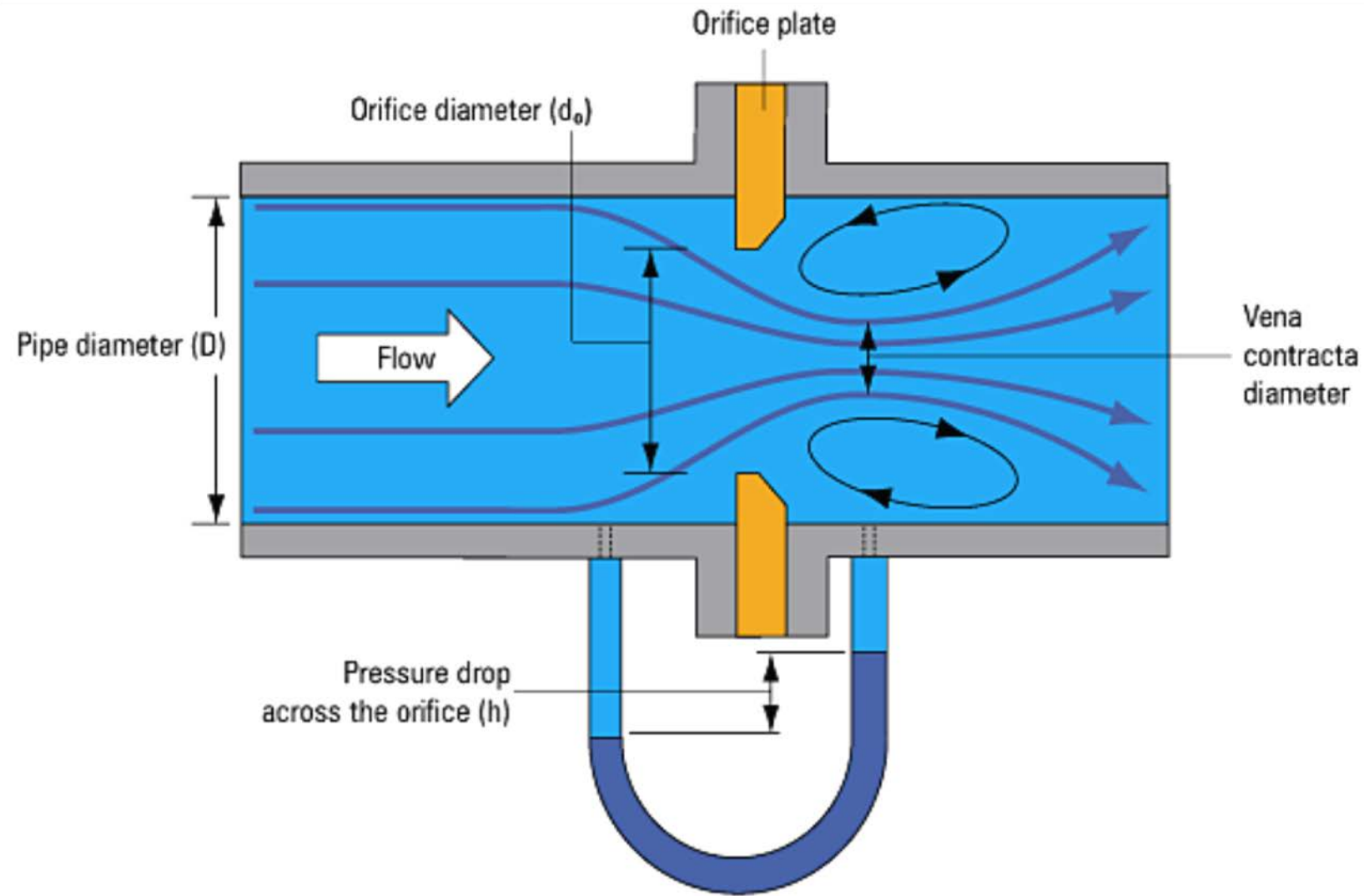
Original as per design



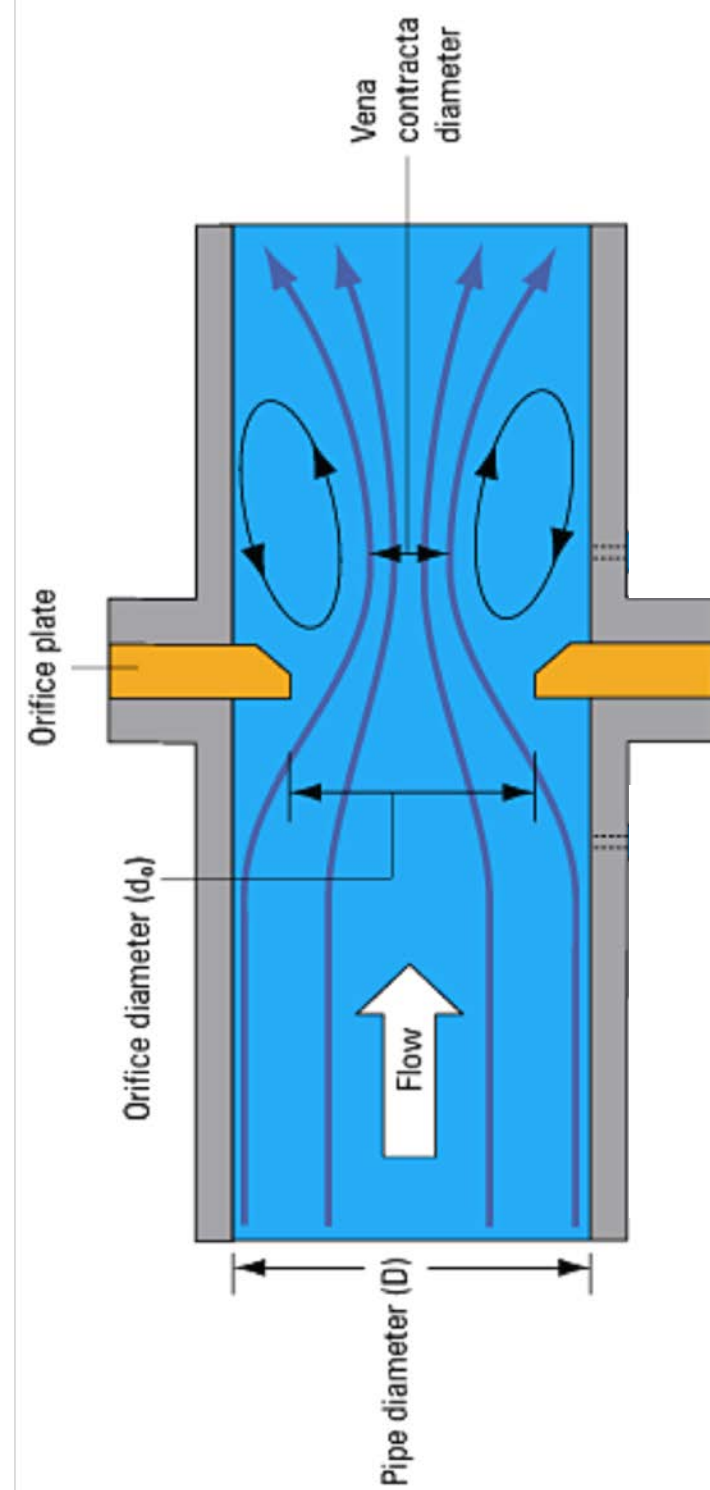
Modified



Orifice Arrangement



Horizontal Position



Vertical Position

Recommendation

The orifice was removed from the original location and moved at the height of 1.5meter from the ground level. This eliminated the possibility of condensate formation and proper exit for primary vent leakage. The unit was started and the primary vent leakage pressure was found as 0.036barg at NDE and 0.04barG and DE which was just above the minimum leakage requirement.

The system was verified after 6 months of operation and no abnormalities found.

Lesson learnt

- The orifice plate location is a key element in the seal gas system.
- Inspection and blowing of primary vent line is mandatory during the DGS replacement

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THANK YOU