MIDDLE EAST TURBOMACHINERY SYMPOSIUM

Separation Seal Upgrade to overcome Repetitive Failures

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Objectives

- Trouble shooting of Separation seal failures.
- Reference for DGS design selection at Project stage.
- Share experience with audience for improved DGS performance (in certain applications).

Contents

- ✓ Problem
- ✓ Events' Summary
- ✓ Observations & Findings
- ✓ Root Cause Failure Factors
- ✓ Solutions
- ✓ Selection & Implementation
- ✓ Conclusion

Problem

- Repetitive failures of Separation Seal (Contacting Design type).
- Flooding of main gas seal with lube oil.
- Excessive leakage of lube oil from DGS cavity drains.
- Lube oil accumulation at Primary & Secondary vent lines.
- Lube oil & vapors mixture seepage to buffer gas skid filters.

Events' Summary

- Frequent seal failures in Fuel Gas Compressors, experienced over 12 years of operation.
- 9 sets of DGS were replaced on 4 units in last 4 years.
- Lube oil migration is monitored for quantity, color, and debris.
- Separation Seal Gas supply Nitrogen pressure was increased gradually from 0.45 (design) to 0.9 barg.
- About 50 to 150 ml/day accumulated lube oil being drained on daily basis from seal cavity.

Equipment Details

Compressor

- Service : Fuel Gas Compressors
- Type : LP (MCL) & HP (BCL)
- Model : MCL 9H-7C (LP Compressor)
  BCL 5V-8B (HP Compressor)
- Max working pressure : 7 barg (LP) & 26 barg (HP)

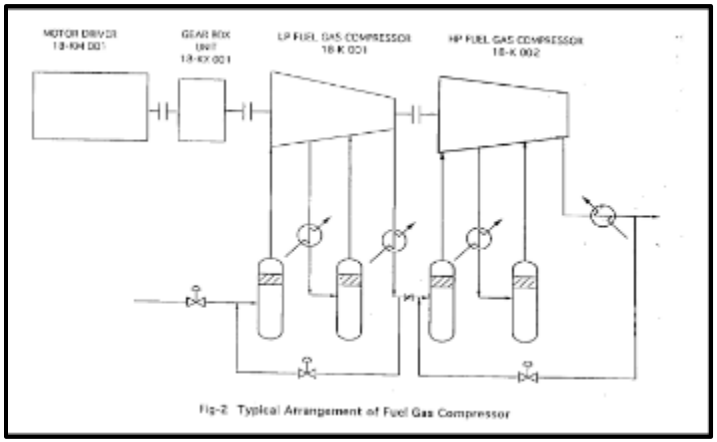
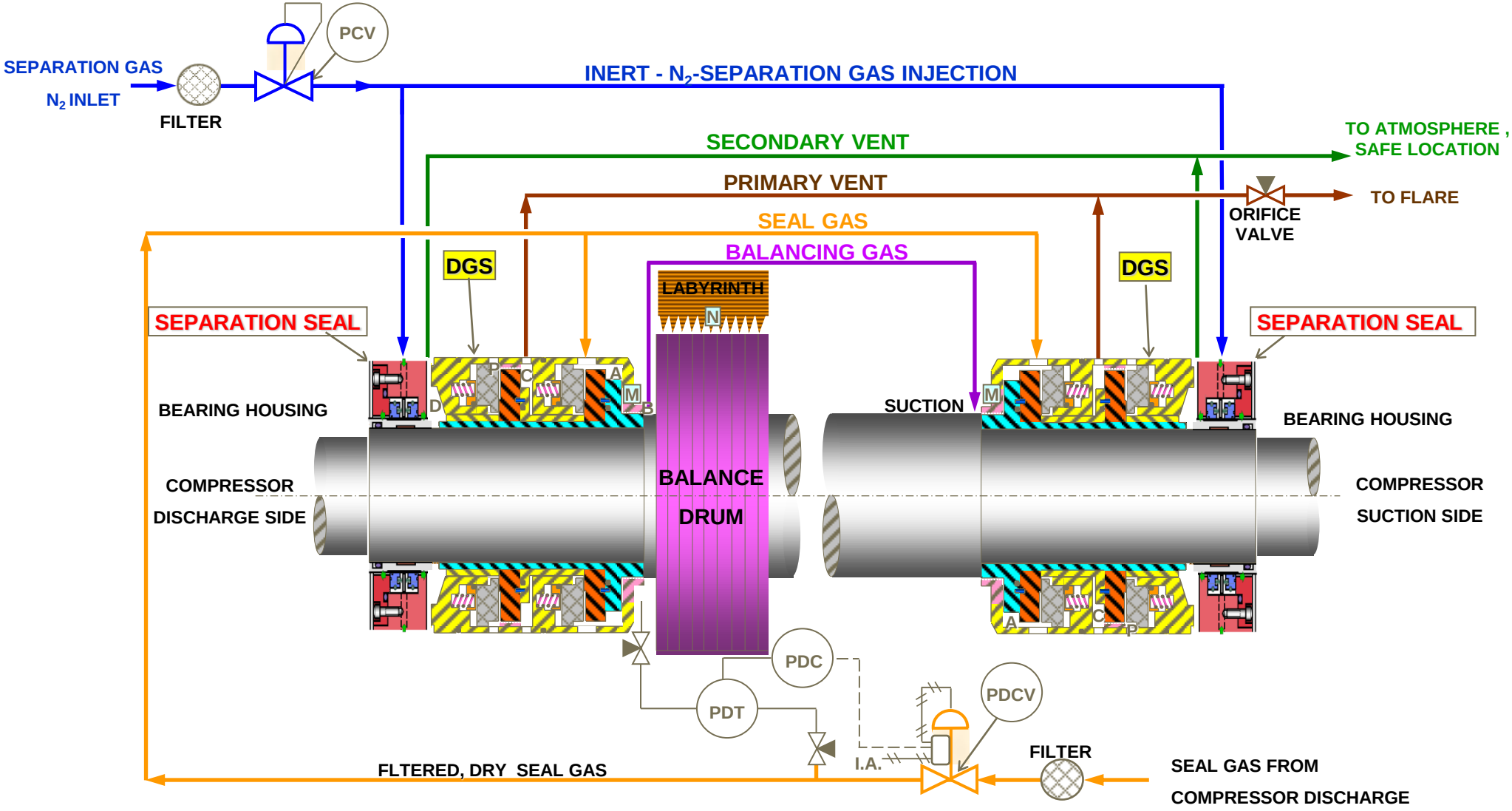


Fig-2 Typical Arrangement of Fuel Gas Compressor

Dry Gas Seal

- Gas seal : Tandem 28AT Model
- Separation seal : Contacting type, (T82)
- Size : 7.625” (for LP) , 6.625” (for HP)

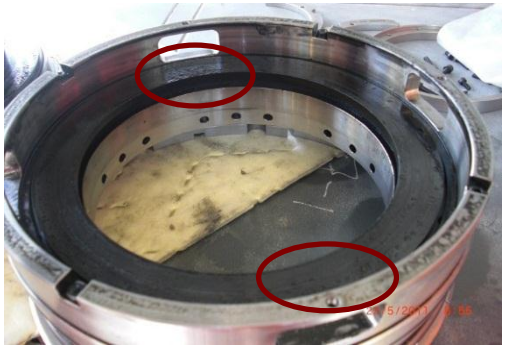
DGS Schematic



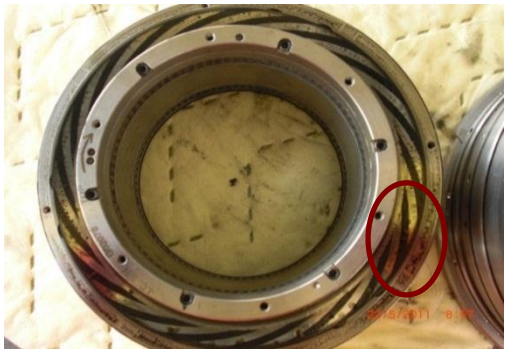
Observations & Findings

- Lube oil accumulation inside seal bore

- High/hard spots
- Sharp edge / Irregularities

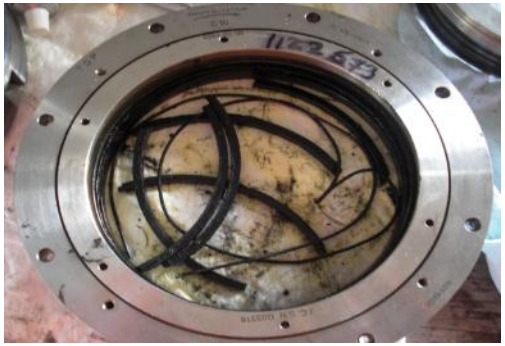


- Oil film on Secondary seal ring faces



Observations & findings

- Separation seal carbon segments in damaged and dislocated condition



- Worn out seal rings

- Carbon deposit

Observations & Findings

- Excess oil collected from both Primary & Secondary drain line

- Oil reached up to primary vent line

- Oil collected from vent line drain points

Observations & Findings

- Lube Oil migration issue found more severe at NDE (Thrust Bearing) relative to DE (Non Thrust) DGS assembly.

Root Cause Failure Factors

Dusty climate effect on breather element function. (Equipment Strategy)

Location of the oil - vapor extraction point from bearing housing

Lack of physical restriction like baffle/ deflector /labyrinth between bearing and separation seal.

T-82 separation seal design does not work properly for compact Bearing Housing, where extraction of oil-vapor mixture is ineffective

Solution

Available Options

Option-1

Compressor / system retrofit

- Bearing housing modification:
- Maintenance Strategy upgrade
- Improving QA / QC for the new spares

Considered secondary for implementation

Option-2

Separation seal upgrades

Sequence of schemes considered:

1. Original seal (T-82) with oil deflector
2. Enhanced seal design (T-83)
3. T-83 with oil deflector.
4. Labyrinth seal design.
5. Non-contacting seal design (T-93FR).
6. T-93FR with oil slinger/deflector.

Implemented Successfully

Design Features of selected T-93FR

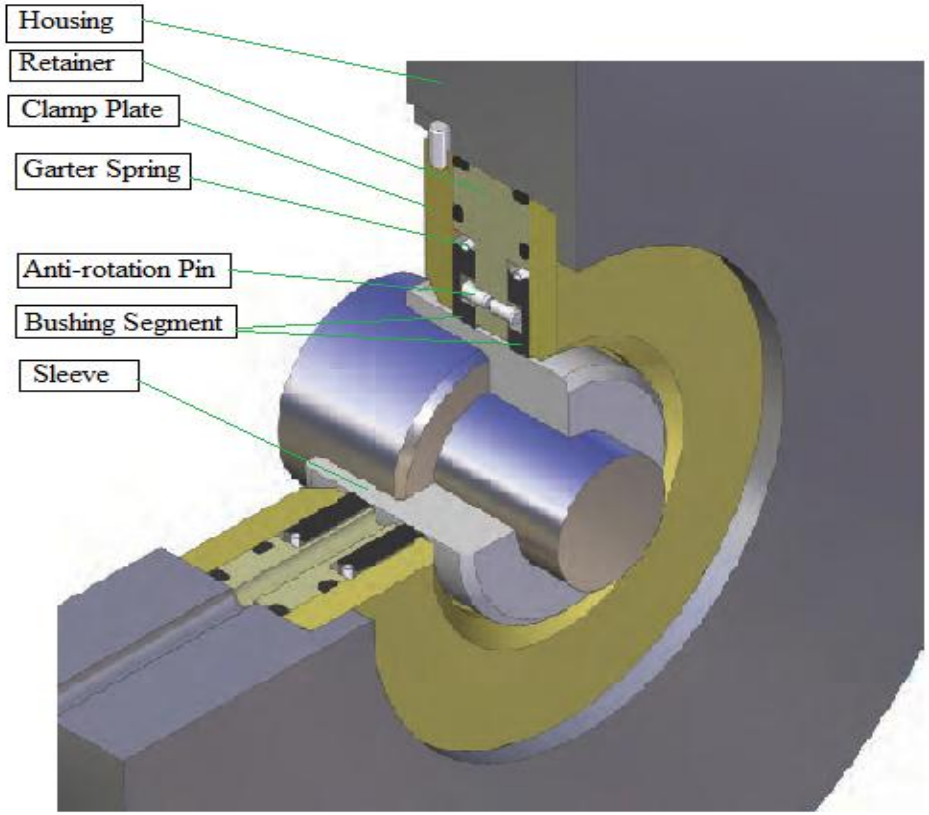
- Non-contacting for longer life and improved reliability.
- Bi-directional.
- Suitable for running with N2 separation gas irrespective of dew point.
- Self-centering design minimizes wear even during upset conditions.
- Robust cartridge design.
- Eliminate ‘Fallback’, ‘Hang-on’ phenomenon.
- Low heat generation, hence reduce coking.

Selected Option

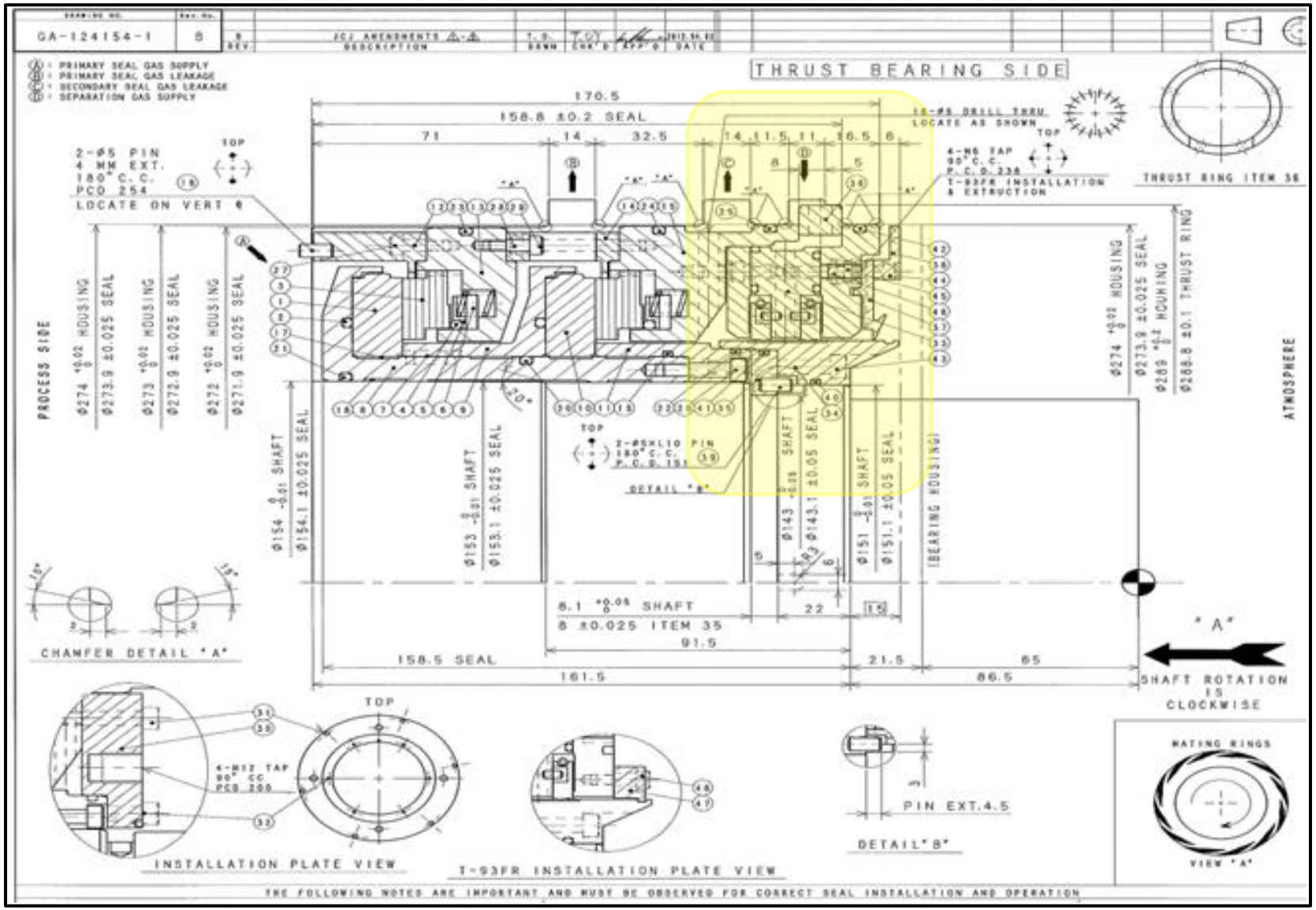
"Upgrade existing DGSs to available technology of Non contacting type Separation Seal (T-93FR) with Oil Slinger / Deflector provision followed by related modifications in Main Gas Seal"

- ✓ Options considered at RasGas to phase out the existing T82 Separation Seal with T93FR Separation Seal, but with Oil Slinger / Deflector provision to solve this oil migration issue.

- ✓ This enhanced design was so far running successfully at RG.



New seal T-93FR drawing



T-93FR Upgrade Requirement

1. **N2 Pressure Regulator:**

   T-93FR is designed to operate at low N2 pressure from 0.02 – 0.25 bar, while the old T-82 was in operation with higher range from 0.25 – 0.75 bar.

2. **N2 Gas Flow Meter:**

   With T-93FR seal system, N2 flow rate consumption will increase as per followings:-

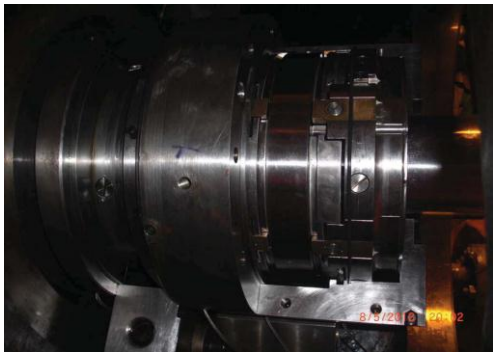
- Original T-82 range : 2 - 5 NM3/HR
- T-93FR, cold static Range : 8- 12 NM3/HR
- T-93FR, hot dynamic : 2 – 4 NM3/HR

New Seal T-93FR – Few Snap Shots

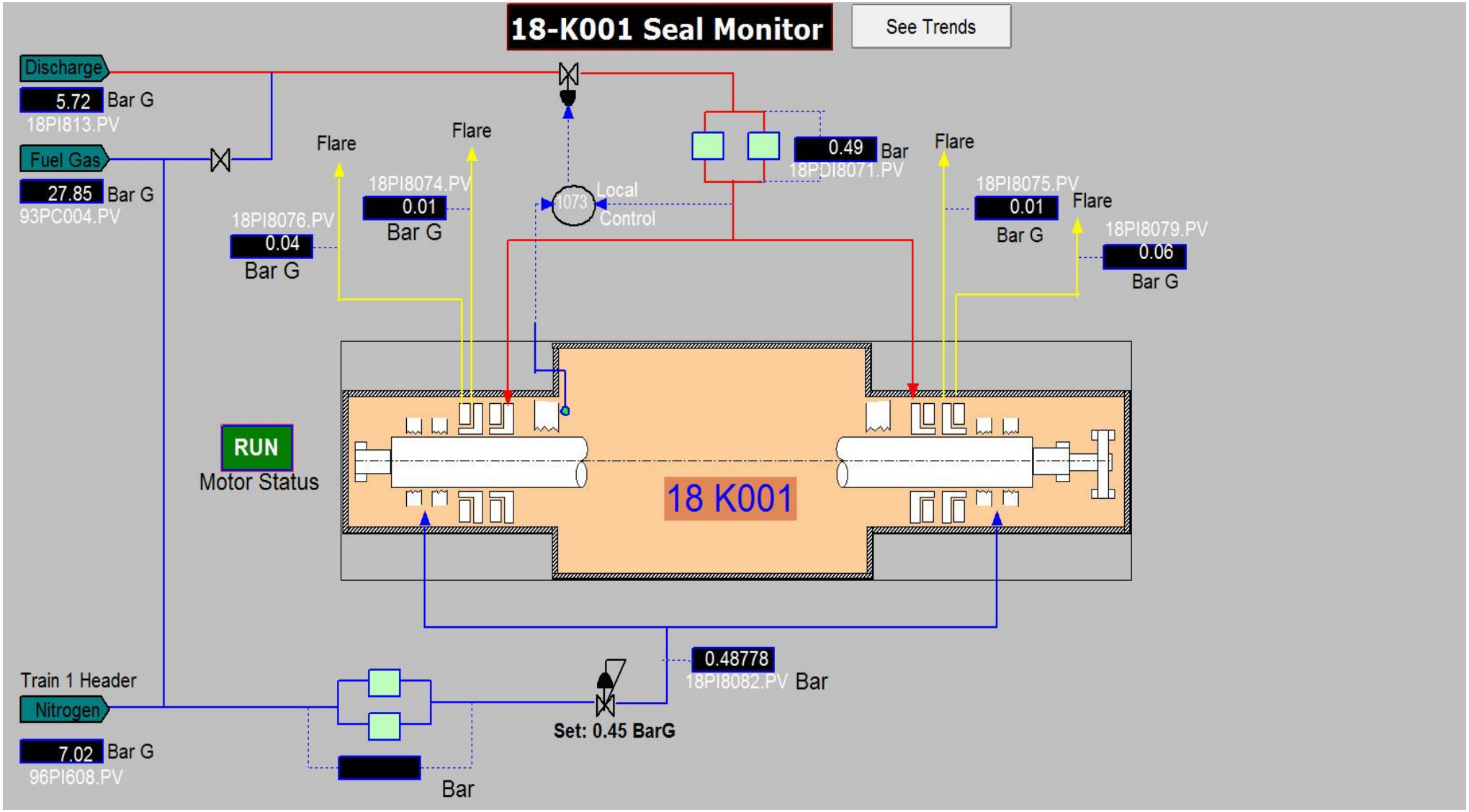
- Oil slinger (deflector)

- Bearing installation

- Bearing assembly



DGS Performance Monitoring



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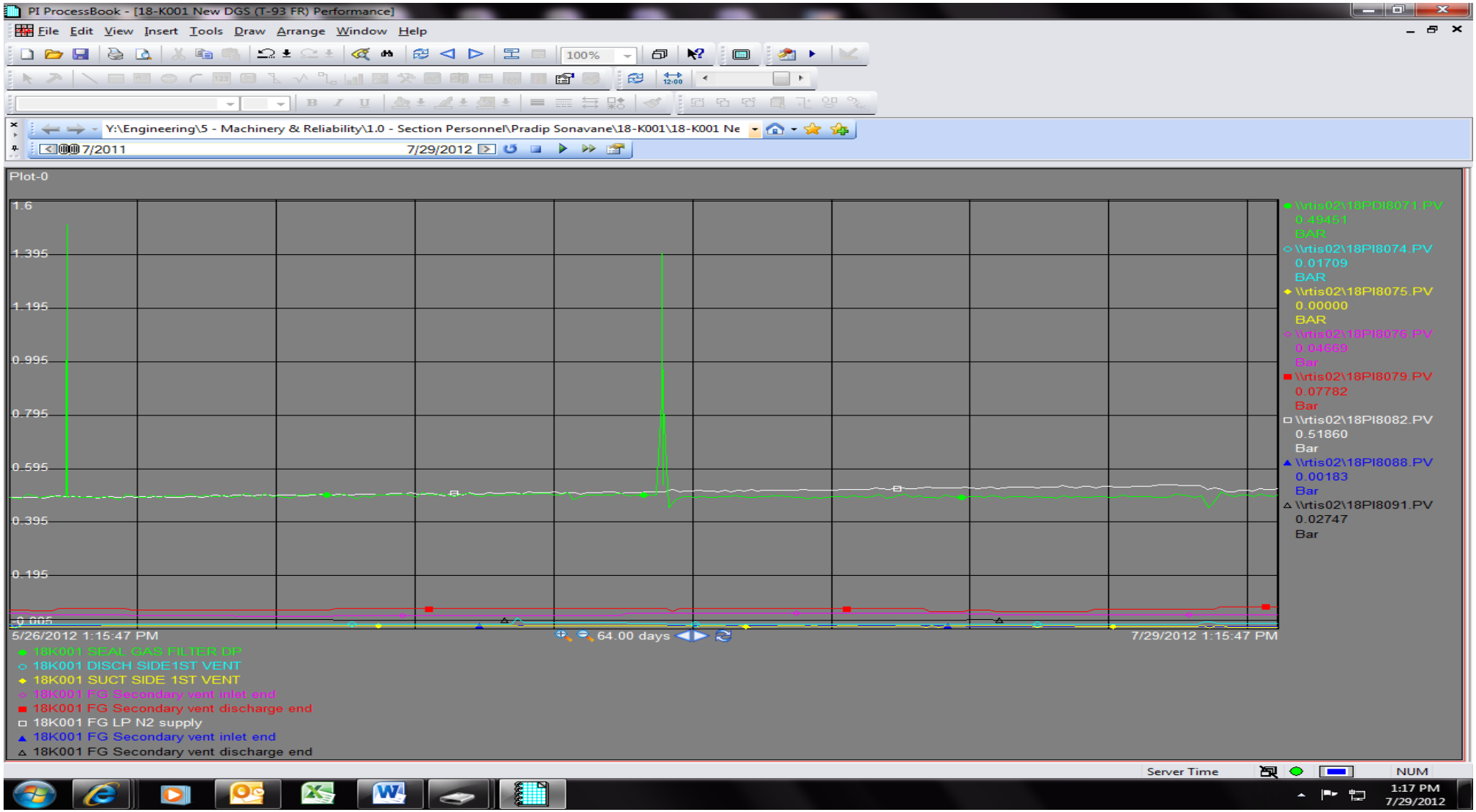

Conclusion

- DGS Upgrade with Floating Ring / Non Contacting Type T-93FR Separation Seal has so far successfully solved the Lube Oil Migration / Ingress issue.
- Oil Slinger provision along with Dual Segmented Floating Carbon Ring T-93FR Cartridge Assembly has proven as effective barrier between Main Gas Seal and Bearing Housing.
- This upgrade was carried out without any modification works on Compressor side.
- T-93FR Non contacting Type Separation Seal performance observed to be significantly better in comparison with T-82 and T-83 contacting type Separation Seals.
- Successful prototype implementation based on full OEM and End User contribution

Thank you ! !

Questions ? ?