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



*Do you have Mechanical
Seal Refurbishing Shop in
your complex?*

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ABSTRACT

Author intends to convey:

Importance of having Mechanical Seal Refurbishment facility in a refinery complex, supported by interesting case studies on critical mechanical seal failures. Minimum set up required for In-house Mechanical Seal Refurbishment facility.

The success story of having a Mechanical Seal Refurbishment facility at 9MMTPA Grass Root Refinery, which proved a major factor in timely project completion and vital during the safe and successful refinery commissioning and steady state operations.

At what stage the Mechanical Seal Refurbishment facility should be functional in the project ?

Importance of mechanical seal refurbishing facility:

Seal Testing Philosophy

Answers to the following questions, explains the importance of having In-house facility:

What's our conventional seal testing practices?

- Should we test the seal on pump itself?
 - Is it safe to test the Mechanical seal on-site with hydrocarbon?
 - What's my seal arrangement whether cartridge or alternate?
 - Should I test my seal by pressurizing casing with buffer fluid or nitrogen?

- Do we need the seal testing facility in the plant?
 - Will it be good to test the mechanical seal in a dedicated facility?
 - Will it be fine to test the mechanical seal with air or water?
 - Can I rely on shop testing?
 - Does API accepts mechanical seal test with air?
 - What is recommended pneumatic test pressure for shop testing.

Case study- Success of Mechanical Seal Refurbishment facility in a typical 9MMTPA refinery

Some interesting details of the typical 9MMTPA grass root refinery:

- Number of Pumps/equipment with mechanical seal: 1200
- Total number of mechanical seals at refinery: 1500
- Number of equipment single mechanical Seal: ~20%
- Number of equipment with double mechanical seal: ~80%
- Number of mechanical seals shipped as loose with equipment: ~10%
- Number of mechanical seals tested during commissioning stage prior to installation: ~80%
- Number of seals refurbished during commissioning stage: ~5%
- Average annual mechanical seals refurbished in steady state operation: 15-18% of installation
- Was it good to have a seal repair facility during commissioning ??

Common failures reasons during commissioning

- Foreign particles ingress in seals due to improper flushing.
- Overheating - cooling water lines to seal coolers choked/not charged/ blinded.
- Flare header line up discontinuity.
- Seal flushing plan not adequate, wrong size orifices installed - burnishing of seal faces.
- Inadequate design of temporary strainer, resulting into collapsing of strainer in trial run and piping debris ingress into equipment.
- Inadequate preservation of equipment and mechanical seal during project stage.
- Soiling of seals due to poor storage practices.
- Standard operating procedure lacking/ not followed.

With the support of seal room experts at the stage of pre-commissioning such problems are identified and resolved. All the seal room persons - trained and certified at OEM's training Centre.

Case Study-1: Usage of Seal Refurbishment facility during CDU commissioning

Crude Distillation Unit (CDU) is the very first unit of any crude oil refinery and commissioned prior to any other unit. Following are the experiences on pump mechanical seals during commissioning of CDU-VDU of a 9MMTPA Refinery.

- Total rotary equipment : 146 (pumps : 87 nos.)
- Mechanical seal leakages experienced in 10 Nos. of Pumps

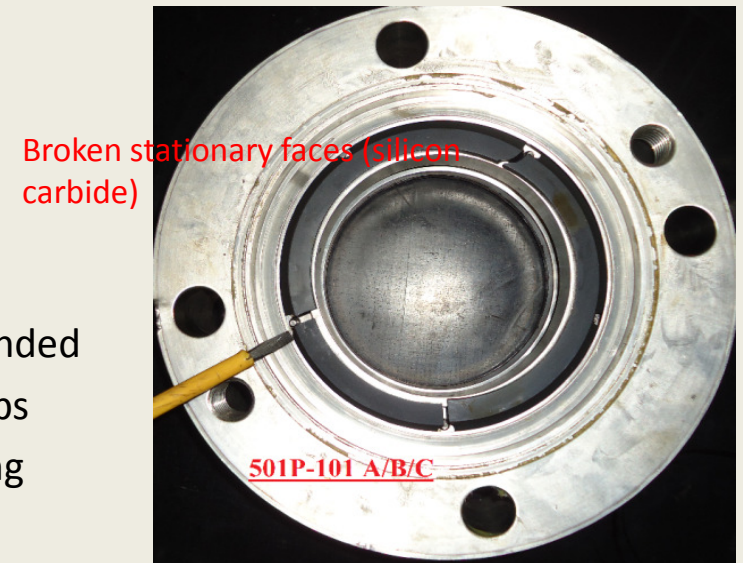
Observation in the leaked seals:

Mating ring found broken .

Fine particles between faces & O ring.

Cooling water line to seal flushing coolers were not charged/ blinded

- During CDU commissioning, mating ring of all three crude charge pumps got damaged during trial run itself. These seals were opened and mating ring found loose with excess clearance on anti-rotation pins. These seals were installed with modified stuffing box bore and rubber grommets on anti-rotation pin. After which the pumps could run without any problem.
- These seals were modified and tested in-house at seal refurbishment facility without hampering the unit commissioning activities.



Case Study-2: Usage of seal refurbishment facility for testing of mechanical seals shipped loose with pumps

- During erection and installation stage of a crude oil refinery around 110 pumps supplied by a specific vendor were shipped with glands and mechanical seals were supplied as loose.
- These pumps were supplied at critical stage of erection, when piping erection was on peak stage.
- The pumps were installed and piping alignment was done to make them stress free. The pumps were aligned with motors and later it was observed that these pumps had come without mechanical seals fitted and these seals were supplied loose.
- The loose seals were lying at contactors yard and were soiled.
- Mechanical seal of all these 110 pumps were opened and lapped after which these were tested and installed at In-house Seal Refurbishment facility with a short span of 20 days.
- Such a quick and quality job could be done due to availability of mechanical seal refurbishing facility in the complex.
- These pumps were installed on site without hampering other scheduled activities and commissioning was done well within schedule
- In absence of availability of in-house mechanical seal refurbishing facility these had to be sent to OEM shop , which could have taken long time and could have resulted in delay in commissioning

Case Study-3: In-house refurbishment of Poly Propylene unit

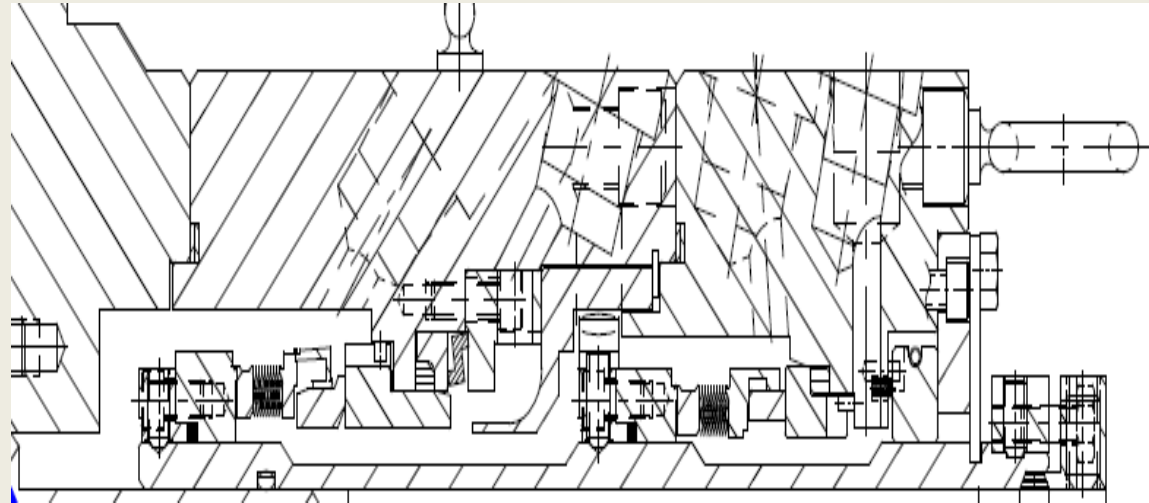
Recycle Gas Compressor

- Recycle Gas Compressor of Poly Propylene unit equipped with dry gas seal
- Repeated failures were observed due to ingress of poly propylene powder into separation gas housing.
- Refurbishment at vendor works takes 3 months.
- In order to save the outage of PPU for such a long period, challenge taken to refurbish the damaged dry gas seal at in-house Mechanical Seal Refurbishment Facility.
- The repair was successful.
- Although the dynamic testing could not be performed at in-house facility, it was static tested and installed on compressor.
- On this event only, Mechanical Seal refurbishment facility justified its investment and continued the PPU and refinery operation activity.



Case Study-4: Whether Secondary Plan testing is good enough for cartridge seal

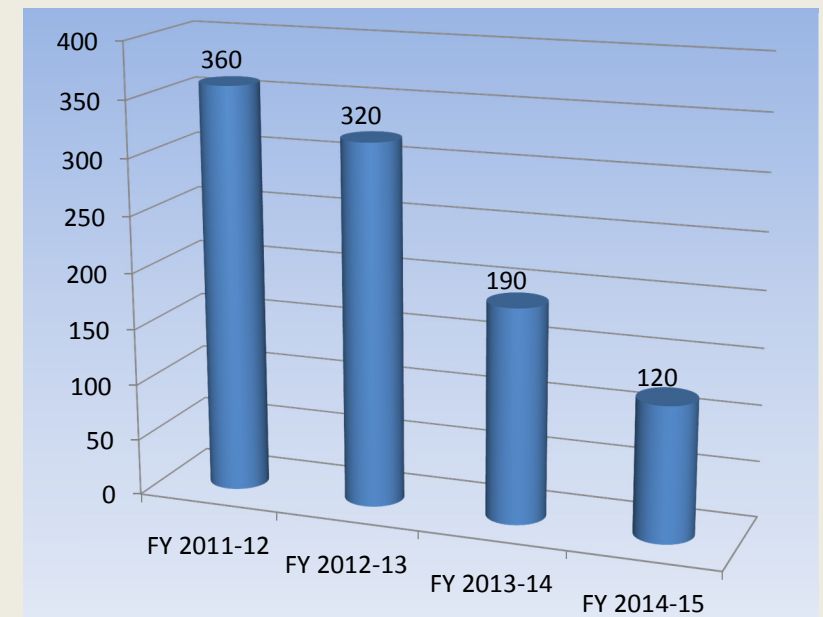
- Usually pneumatic testing plan-52 at $\sim 1.5-1.8$ Kg/Cm²G Pressure is done
- Whether it is acceptable to test through secondary plan or we need to pressurize through primary seal plan also!
- During maintenance of a slurry pump, the seal found OK during secondary plan testing leaked after installation at site. This seal is one of the biggest cartridge seal with 4.875" shaft size operating at 350 Deg C.
- In order to test with primary seal plan, Mandrel was prepared and the primary seal was tested at seal repair shop itself.
- Being an special engineered seal, Primary Mating ring gasket was not getting covered during secondary plan testing.
- Availability of seal refurbishment shop at your refinery can contribute in multiplier of its investment for testing and refurbishment of such engineered seals.



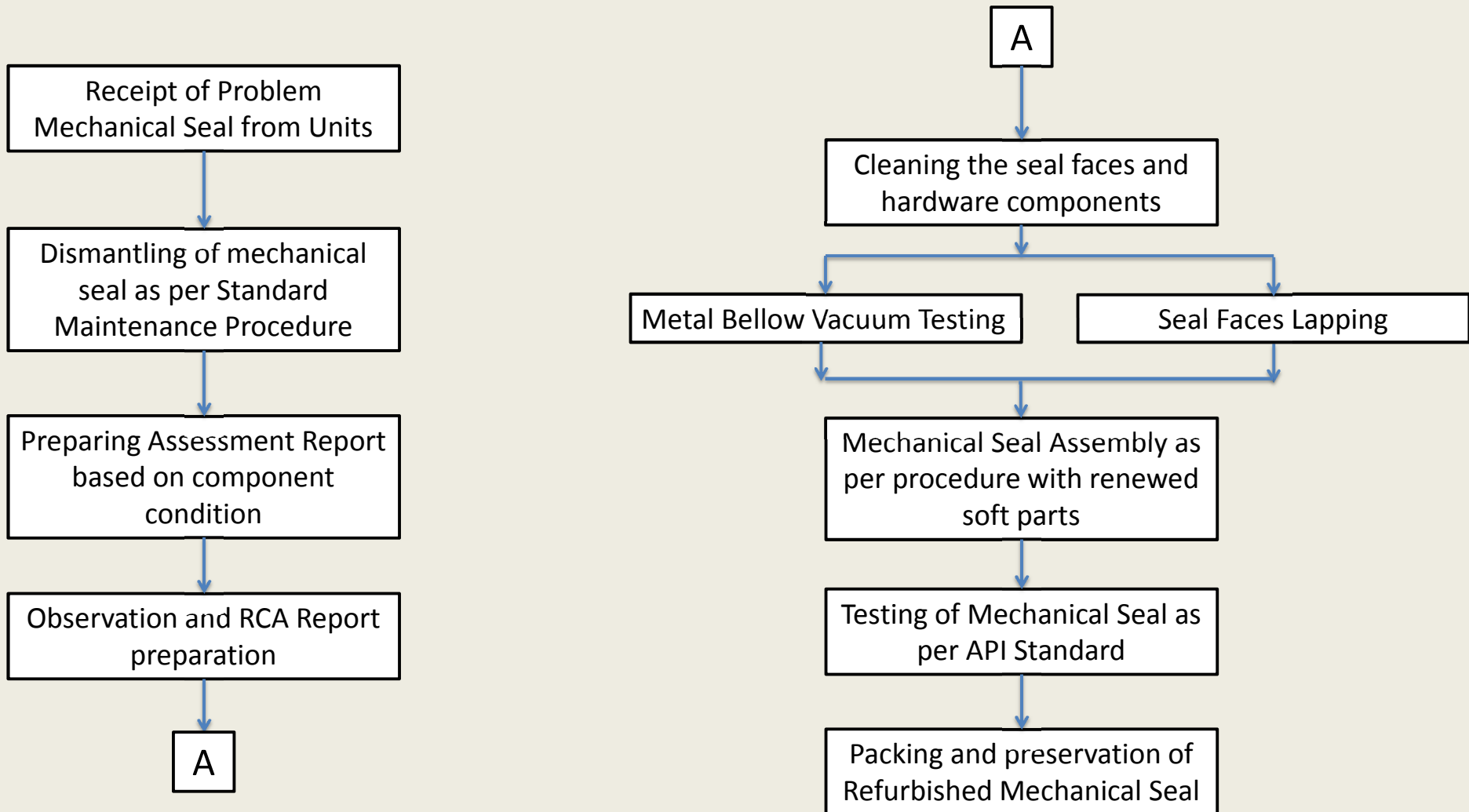
Case Study-5: Continuous reduction of seal failure after commissioning

- This graph shows the continuous reduction in mechanical seal failure after commissioning, resulting into increase in Mean Time Between Failure as well as reduction in Mean Time to Repair.
- This has been achieved by:
 - Field rounds (LLF – Look Listen Feel) by Seal Room Staff
 - Training to operators and maintenance teams by Seal Room Experts
 - Supervision of Dismantling and assembly of mechanical seals by Seal Room
 - RCA for repetitive failure and damage cause finding for every failure by Seal Room Experts to avoid reoccurrence.

Number of Seal Failure



Flow-chart for Mechanical Seal Refurbishment Activity



When to have a Mechanical Seal Refurbishment Facility

- Appropriate to have the seal test/ refurbishment facility ready during the last phase of project completion prior to commissioning.
- With number of seal up-gradation and their refurbishment experience, availability of seal repair shop had proven as a good investment at project phase itself.
- With this facility, we managed to test around 80% mechanical seal prior to installation and commissioning.
- It reduced repair time drastically by saving on transit time as well as hold up time at vendor works.
- With the experience of CDU-VDU commissioning, flushing plans for seals were reviewed by seal experts and mechanical seal repair facility was further strengthened to gear up for smooth and uninterrupted commissioning of other downstream units.
- Seal OEM and experts also utilized the facility to best and appreciated the availability of repair shop for quick resolution of problems with quality and testing of repaired seals.

Minimum setup for Mechanical Seal Refurbishment facility!!

- Lapping machine- Single side lapping machine with VFD and Abrasive supply system
- Lapping Plates
 - CI Plates for Soft faces
 - Copper Plates for Hard faces
- Vacuum Testing machine for bellow testing: Range up to 350-400mm Hg.
- Monochromatic Light Testing facility to check the flatness by light bends.
- Pneumatic testing facility for cartridge seals
 - Test Mandrel Size: Typically 10 mm to 150 mm.
 - Mandrel (Dummy Shaft) size is to be decided based on installed pumps shaft/ Sleeve diameter



Monochromatic Light Flatness Testing Unit

Minimum setup for Mechanical Seal Refurbishment facility!!



Vacuum Leak Testing Unit



Air Leak Testing Unit

Some facts

- It is not merely a setup of certain testing and refurbishment equipment. It's a group of experienced trained personnel preferably OEM service engineer supported with on-site refurbishment and testing facility.
- With a population of 1500 Mechanical seal, an average 3-4 seal experts are required with minimum 2 service engineers.
- To start with new set-up at project stage, seal experts should be hired from OEM, preferably the one having maximum seal installation.
- On later stage, in-house expertise can be developed with proper hands-on training and certification programs from OEM.
- With a structured approach and vision for seal refurbishment facility, this facility can be utilized to:
 - Reduce the logistic timing for repair
 - Development of In-house capabilities
 - Minimizing emergency purchase orders to OEM and associated opportunity costs
 - Possibly catering to nearby industries as per company policy

Factors behind Success for in house Seal Room facility

AA - Trained Staff

BB - Setup with machinery/ testing facility

CC - Spare Availability

- What to have!
- How Much is required!
- Are there duplicates – E-SPIR

E-SPIR - Spare Part Interchangeability Report - Benefits

- Suppliers create the SPIRs
- Standard data formats and standard review process
- Automatic identification of duplicate spare parts against other SPIRs and existing stocks
- Duplicate items can be compared on one screen
- Efficient Tag number reviews against the Asset register, for upload to SAP
- Facilities for automatic coding (new)
- Progress & budget reporting during the project
- Import facilities of SAP suppliers details as Vendor code, full and abbreviated Vendor name
- Facilities to creation of Equipment BOM titles and short BOM list descriptions for SAP (new)
- **It saves up to 50% on the review process;** Due to the controlled and efficient review process, the program provides you with the time to deliver savings.
- **It saves 90% on the spare parts data input;** Entering the data into an ERP system and creating the link between the spare parts and the equipment takes nearly as much time as the complete review of the SPIRs.

What To Have and How Much to Have!!

Typical Spare Philosophy for Mechanical Seals

* INCLUDING STANDBY / SPARE EQUIPMENT																				
S. No.	SPARE PART DESCRIPTION	SPARE PART CLASSIFICATION			N= TOTAL NO OF INTERCHANGABLE PARTS INSTALLED *							FORMULAE	V / E / D ANALYSIS			A / B / C ANALYSIS			REMARKS	
		UOM	I	C	M	1 & 2	3	4	5	6 & 7	8 & 9		10 & MORE	V	E	D	A	B		C
						RECOMMENDED SPARE PART QUATITY BASE ON 'N'														
			(I) INSURANCE	(C) COMMISSIONING	(M) OPR. & MAINT.															
1	Complete Seal Cartridge	Set	√			1	1	1	1	2	2	2	0.2 N	√			√			Very costly items and required to be judiciously selected for purchasing
2	Rotating ring	Nos.			√	1		1	2	3	4	5	0.2N	√			√			
3	Stationary face	Nos.			√	1		1	2	3	4	5	0.2N	√			√			Long lead Special tailor made items
4	Soft packings (rotary , static & gasket)	SET	√	√		2	3	4	5	7	9	10	N	√			√			

Take away points

- In-house Mechanical Seal Refurbishment Facility has proved as bliss at various stages of refinery during commissioning as well as steady state operation.
- The seal facility is not only limited to facility inside a room but a lot of activities like: availability of trained persons , various facilities to repair and test seals, trouble shooting, RCA of seal failure , audit at site, training, reliability improvement of rotating equipment.
- The average annual savings at site: 150K USD (direct saving by seal refurbishment onsite instead by sending to OEM works)
- Although the annual saving on refurbishment of seals is reducing due to reduction in seal failure yet it signifies to improvement of equipment reliability and reduced spare cost.
- No Pump seal has gone out to OEM or outside Shop since commissioning.
- Seal room facility is to be initially started with OEM and later gradually train your technicians.
- After successful operation of seal refurbishing facility, one can plan to convert the facility in profit center by extending this service to nearby industry for mechanical seal refurbishment/testing.