EPRI

TECHNICAL BRIEF



Seal Face Flatness

Potential Distortion Due to Installation Errors and Out-of-Specification Holders

FLATNESS METROLOGY

Changes in available metrology technology have enabled utilities to identify previously undetected issues.

Traditionally, seal face flatness is validated when the seals are not assembled into their seal face holders. Recently, laboratory testing identified that seal faces that meet flatness specifications during inspection can be distorted, becoming out of tolerance when assembled in the seal face holder.

Holders typically are not replaced parts. Current operating experience found some holders that were out of tolerance, affecting the flatness of the assembled seal face. For example:

- Holders can deform over time
- Deformed holders impact assembly
- Inadequate critical dimension checks
- Final flatness in holder out-of-specifications for operation
- Reduced MRP seal life

High standards during assembly and installation will result in longer-lasting and more reliable seal assemblies.

MAIN REACTOR PUMP SEAL FACES.

Seal Face Flatness

Seal flatness measurements are difficult to acquire and subject to user error. For many years, using a monochromatic light with an optical flat was the only way to measure the flatness of the seal faces. This method may result in different interpretations when used by different people. Repeatability of readings is possible; however, it is more likely that the results will differ between users.

Mechanical seals for all applications rely on a degree of flatness to perform optimally (see Figure 1). The larger the seals, the more critical the tolerances become. Even seals with tapered faces are subject to increased leakage when the faces are out of tolerance. Seal face flatness is a “Critical Dimension,” with each specific seal design having a unique geometry.



Figure 1. *Optical comparator flat with monochromatic light*

Metrology instrumentation technology has improved over the years, and equipment that digitally measures critical dimensions of seal face flatness with repeatable results now exists. Other critical part dimensions, such as ID and OD of seal holders and other parts, such as shaft sleeves, can be obtained with current technology. Instruments like the Mahr MarForm MMQ 400 or Talyrond 585 (see Figure 2) can provide digitally repeatable measurements.



MarForm MMQ 400



Talyrond 585

Figure 2. *Measuring devices with seal face stand*

FINDINGS

Seal face flatness has been distorted by installation errors and holders that have fallen out of tolerance. During recent laboratory testing, the repeatable MarForm measuring equipment determined seal faces to be flat. When placed in the seal holders, they were found out of tolerance.

For example, in 2023, a root cause investigation at a nuclear power station found 20-year-old seal face holders that were out of tolerance which, in turn, impacts the flatness of the seal face and holder assembly.

Laboratory testing in 2024 using an optical flat and MarForm equipment noted that seal face flatness (with seals not in the holder) was measured at 32.13 µin (2.77 Helium [He] light bands, 0.8155 µm) when on the measuring fixture (see Figure 3).

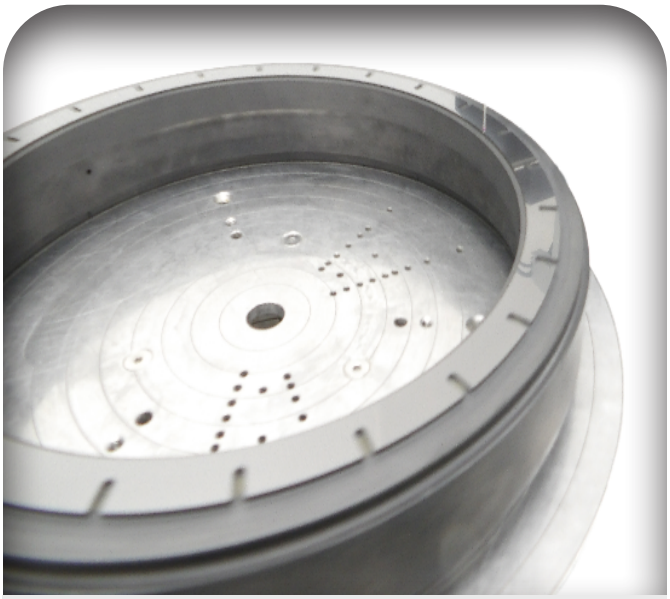
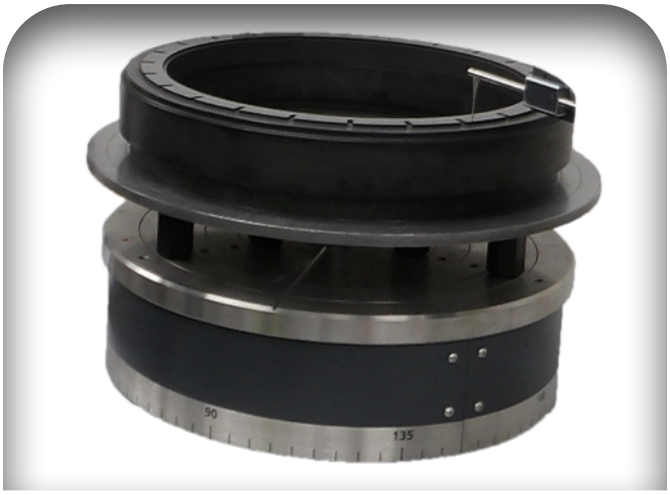


Figure 3. *Seal face flatness testing*

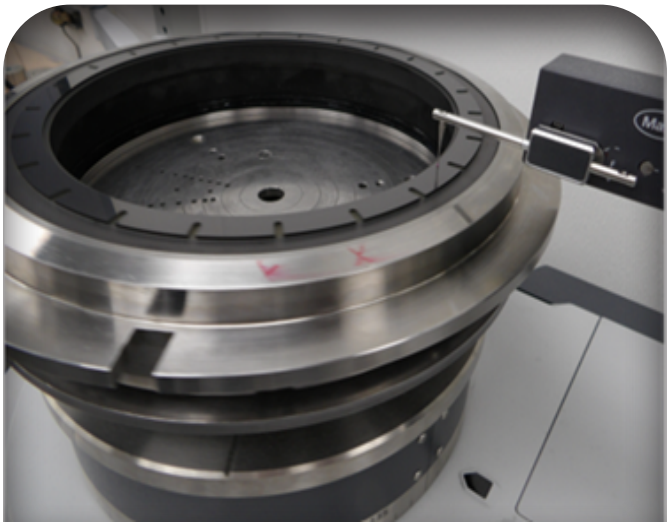
However, when the same seal face was placed in the holder, the flatness measurement was 200.01µin (17.25 He lightbands, 5.082µm). During the measurement of the seal face flatness while in the seal face holder, it was identified that the care with which the O-Ring was placed affected the flatness readings, at one point resulting in a reading of 243.6µin (21 He light bands, 6.19µm) (see Table 1). Ultimately, the holder was out of tolerance (see Figure 4).



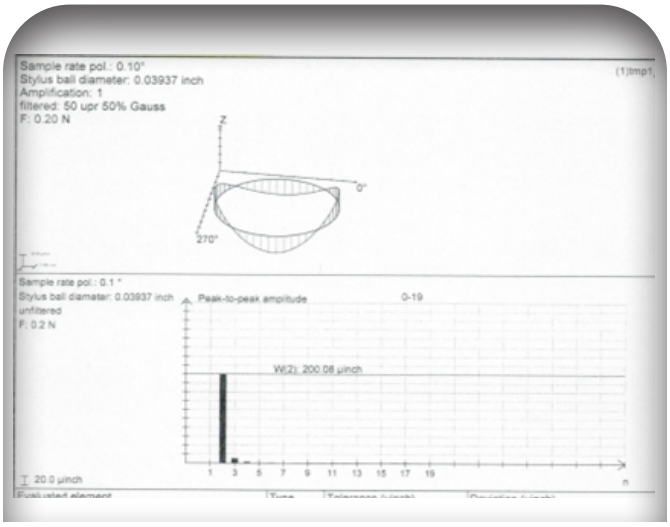
Flatness testing with no holder



Holder with face



Face in holder testing



Face in holder testing results

Figure 4. *Seal face testing*

It is worth noting that measuring the seal face flatness in the holders is not usually performed when building and assembling the seal. Readings are normally only taken on the face when not in the holder. Additionally, digital measuring equipment is not currently a standard tool at most utility seal rebuild stations.

REQUIRED DEFINITIONS

Flatness – The degree of flatness (peak-to-valley amplitude) of the seal faces, normally expressed in helium light bands (1 helium light band = 11.6 micro-inches (0.29 µm)).

Light Band – Refers to the wavelength of helium light (= 11.6 micro-inches, (0.29 µm) used to measure the seal faces' flatness.

Table 1. *Test data*

DESCRIPTION	MICRO METERS/MICRO INCHES	HELIUM LIGHT BANDS
Face Not in Holder	0.8155µm/37.16µin	3.20 He light bands
Face in Subassembly/4 Bolts/Manually Pinched Loaded O-Rings	6.250µm/248.07µin	21.22 He light bands
Face in Subassembly/All Bolts/Manually Pinched Loaded O-Rings	6.18µm/243.30µin	20.97 He light bands
Face in Subassembly/All Bolts/O-Ring Loaded with Tool	5.08µm/200.08µin	17.25 He light bands

RECOMMENDATIONS

Based on the potential impact and reduced life expectancy of installing MRP seals when the face flatness is significantly out of tolerance the seal face should be checked for flatness before and after seals are placed in holders. With the seal face installed in the holders, the flatness is considered by vendors/seal experts to be acceptable when the readings are 116µin (10 He light bands, 2.95µm) or less.

Utilities should consider updating their metrology capabilities to ensure that reusable parts meet the critical dimensions required for their application. Digital instruments, like the MarForm MMQ 400 and Talyrond 585, can validate dimensions (IDs, ODs, etc.), roughness, waviness, and contour measurements. Seal holders, carbon faces, and other seal components can also be measured using digital meauring devices.

For additional information on Main Reactor Pump Seal Best practices please see EPRI Report 3002029184, Main Reactor Pump Seal Best Practices.

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