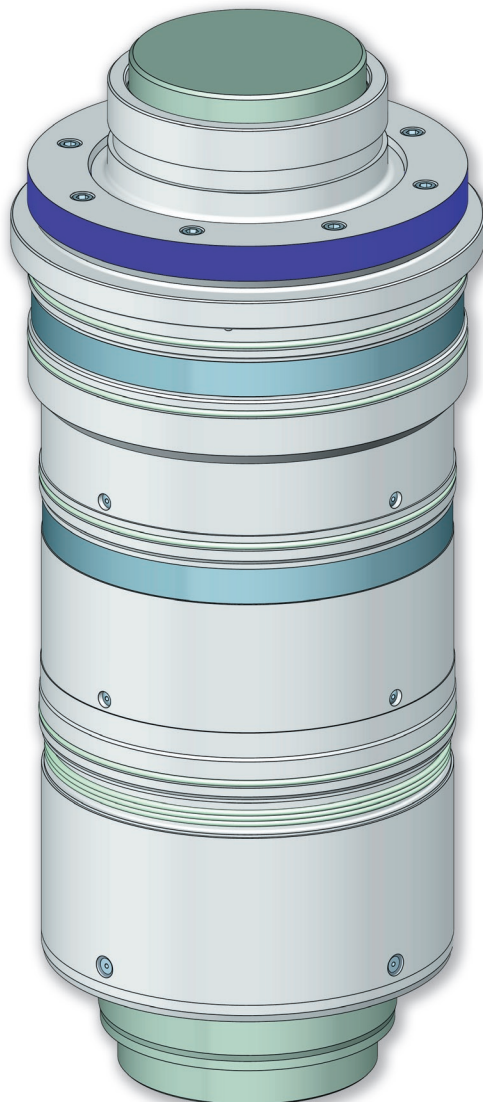


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SULZER

Balanced Stator™ Seal for Reactor Coolant Pump Retrofits



The **Heart**
of Your
Process

Sulzer Pumps

Sulzer Pumps is a leading global supplier of reliable products and innovative pumping solutions for end users. Our active research and development, detailed process and application knowledge together with a comprehensive understanding of market demands keeps us consistently at the leading edge of technical development. Our global network of modern manufacturing and packaging facilities together with sales offices, service centers and representatives located close to major markets provide fast responses to customer needs.

Sulzer Pumps is active serving business partners in the following industries:

- Oil & Gas
- Hydrocarbon Processing
- Pulp & Paper
- Power Generation
- Food, Metals & Fertilizers
- Water & Wastewater



Balanced Stator™ Seal for Reactor Coolant Pump Retrofits

In the nuclear power generation industry, safe operation, plant reliability and the technology to ensure productive operation are of paramount importance. At Sulzer, our focus is on providing the service, expertise and proven, tested product to meet the needs of this critical industry.

The Stator™ Seal – Fully Evolved Product Technology

Sulzer's Balanced Stator™ seal is a proven product, ready to solve seal reliability, maintenance, and cost problems. Unlike other suppliers of reactor coolant pumps, Sulzer's seal development and testing experience dates from 1961, and our seal's field-proven performance through all types of transients is a matter of record. Both our on-site services and product development capabilities make us uniquely proficient at providing retrofit solutions.

Unparalleled Seal Performance

The Balanced Stator™ seal is an ultra-high-performance cartridge unit that provides lifespan and leakage control unmatched by conventional seals. Employing patented flexible stator geometry, the Balanced Stator™ seal automatically compensates for pump shaft deflections. Leakage is predictably controlled to less than 0.03 gpm (0.11 liter/min). Maintenance-free periods extend from four to eight years. The hydrodynamic Balanced Stator™ seal has three stage redundancy and a proven track record that the competition's hydrostatic or hydrodynamic seal simply cannot match.

Versatile for Any Retrofit

The Balanced Stator™ seal is available for any reactor coolant or recirculation pump. Sulzer provides

replacement mechanical seals for other manufacturer's reactor coolant pumps (RCP) and installs the Sulzer Balanced Stator™ seal in RCPs from all the major original equipment manufacturers (OEMs).

Installation Efficiency

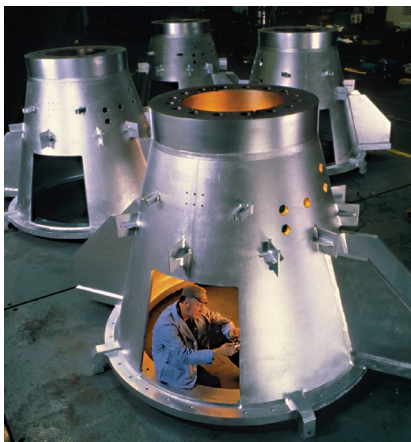
Main coolant pump (MCP) seal performance often hampers plant availability by causing forced outages and requiring frequent change-outs. Because we recognize the cost in downtime and hot-shop work to modify existing pump components, Sulzer approaches retrofits by implementing an absolute minimum of modifications to existing hardware. Two, three, or four stage seal cartridges with internal staging coils can be retrofitted into existing pumps with virtually no plant impact. Existing cooling water and injection systems can remain unchanged.



Stator™ Seal Features and Benefits

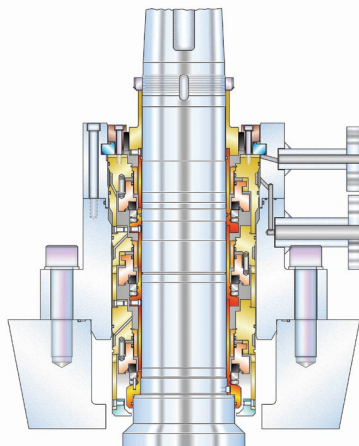
Rotating Seal Ring and Support Ring

One of the unique features of the patented Balanced Stator™ seal is the support mechanism for the rotating seal ring. During temperature and pressure transients the seal sleeve deflects at a different rate than the rotating seal ring. The carbide rotating support ring isolates this effect so it is not transmitted to the sealing face. This is accomplished through the similar rates of expansion of the two rings and the narrow support nose on the seal sleeve and rotating seal ring. The location and shape of the support nose – determined by the finite element analysis – eliminates moments and deflections which would cause leakage during transients in other designs.



Transient Sensitivity Eliminated

The patented Balanced Stator™ seal, unlike other seals, has been designed to perform under all known transient conditions. The basic Balanced Stator™ seal arrangement was developed as a refinement of the balanced end-face seal in which all the balance diameters are on the non-rotating seal parts. This configuration is utilized for its ability to tolerate pump shaft tilt without subjecting the floating member and secondary seal to axial cycling.



Cost Effective Results

Retrofit of your reactor coolant or recirculation pump seals is not a project entered into lightly. Conversely, it is costly for maintenance and repair of poorly performing seal packages in a 'hot' environment (as well as dealing with the cost of lost generating capacity). We think you will find a Balanced Stator™ retrofit package has an amazingly short payback period. Sulzer is ready to bring a team of seal professionals to explain the benefit of the Balanced Stator™ seal for your facility. Find out what the possibilities are for your application by contacting one of our representatives.



Comprehensive Service and Support

Purchase of a Balanced Stator™ seal retrofit buys much more than a shipment of parts. It also entitles your utility to become a valued recipient of the Sulzer support system. Support options and features include:

Field Change Support

Sulzer provides support including instructions, procedures, tooling, training and factory assistance necessary to make a seal conversion within one normal maintenance outage. Our experienced seal engineering team also facilitates any necessary change to plant licensing documentation resulting from the RCP seal change.

Optional Training Programs

This can be instrumental to fully prepare your operations and maintenance personnel in the important basics of servicing and operation of the Balanced Stator™ seal.

Field Service Capability

Our experienced field engineers can ensure immediate attention to your operating needs, backed by reliability/maintainability programs to monitor seal performance on a continual basis.

Containers for Shipping and Storage

Specialized containers are available for complete spare seals or separate parts. These provide a sealed, controlled environment for delicate O-rings and seal faces and ensure indefinite shelf life.

Optional Fitness Fixture

This allows an assembled seal cartridge to be fully pressure checked, including staging pressure, before installation. This proven procedure assures proper seal assembly before installation in your pump.

PWR Balanced Stator™ Seal Retrofit Installation List

RCP manufacturer	NSSS	RPM	Original install	Quantity
Sulzer Pumps	B&W	1190	1980	8
Byron Jackson	CE	900	1985	8
Byron Jackson	CE	1190	1990	8
KSB	CE	1190	1996	12
Westinghouse	B&W	1190	2000	4

Note: Total retrofit run time experience to date: over 3 million hours.



Testing and Field Operation Record

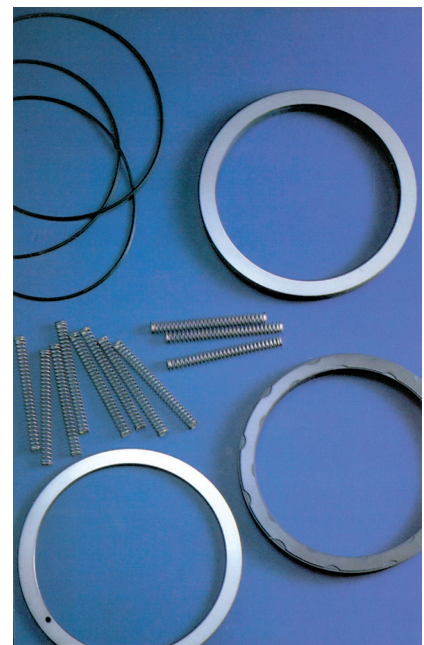
Seal Fully Tested

The Balanced Stator™ seal has been qualified for reactor coolant pump service by tests both in seal testers and in the reactor coolant pump test facility at Sulzer. Seal testers have repeatedly been used to perform continuous tests from 100 hours to 9,000 hours duration.

The Balanced Stator™ seal has also logged an impressive operational record – 54,000 hours in our own test facilities and more than 3 million hours in OEM and non-OEM service. In addition to the design verification this testing and operational field experience supports, it provides a

fully documented track record, making additional performance testing on the existing seal design unnecessary. Consequently, customer time and money can be saved. Every seal package is also thoroughly tested to assure proper assembly and staging pressure behavior prior to shipment.

Each seal stage utilizes common replacement components which duplicate original seal parts precisely, drastically reducing inventory requirements.



Pump Operation In-House Testing

In-house procedure	Model	Total hours
Eight separate pump tests	RDV 950 B-3	506
Four separate pump tests	RQV 875 B-2	207
Pump development test	BV 450 B-3	303

Seal Testers

Seal tester	Test type	Model	Hours tested
Initial seal development			3059
Two-stage seal	Endurance		1052
Three-stage seal	Endurance/qualification		3021
BWR two-stage seal	Qualification		1107
PWR (913 MW) three-stage seal	Qualification	RQV 875 B-3	3034
Three-stage seal	Special tests	RQV 875 B-3	14014
Larger diameter three-stage seal	Development	RDV 950 B-3	432
PWR (1260 MW) three-stage seal	Qualification	RDV 950 B-3	9422
Special seal tests	Special tests	RDV 950 B-3	13661
Boiler circulator three-stage seal	Development	BV 450 B-3	3657
In-house seal tester test			Total hours 52459

Balanced Stator™ Seal Design Features

Seal Springs

- Special tests conducted to determine secondary seal friction and the required spring load.
- Springs designed to provide necessary force for the seal to function even with large shaft displacements and low RCS pressure.

Secondary Seal

- Ethylene propylene O-ring and backup ring located on the carrier – assures the pressure loading around the carrier will be constant as shaft position changes.
- Backup ring prevents O-ring extrusion in event single seal stage becomes subjected to full system pressure.
- The surface on which the O-ring rides is coated with a wear-resistant chrome oxide ceramic overlay.

Controlled Full-fluid Film

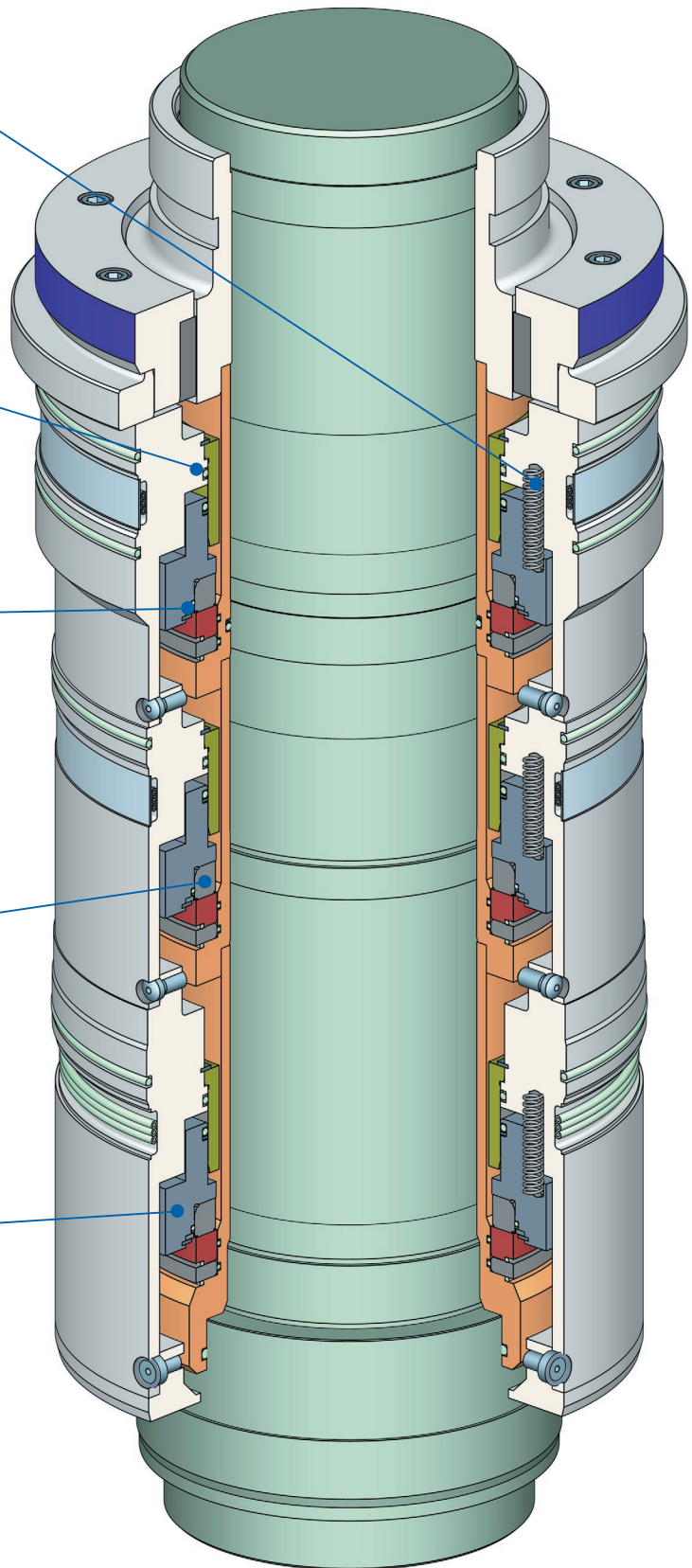
- Seal is designed to develop controlled full-fluid film lubrication between rotating and stationary seal faces – allowing a minimum amount of leakage.
- Tests show actual leakage rates with the seal to be substantially less than 0.03 gpm (0.11 liter/min), compared to leakage rates many times higher for other mechanical seal designs.

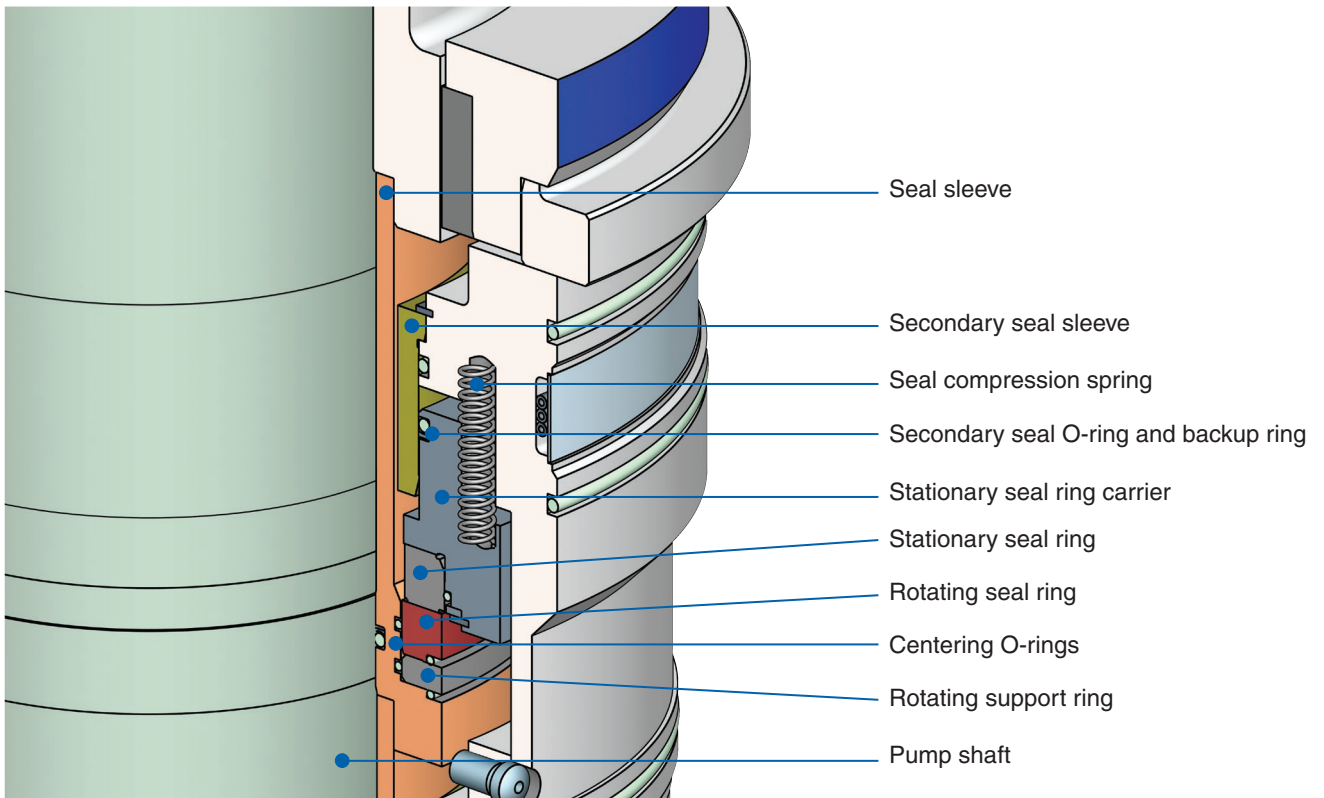
Stationary Seal Ring

- Configuration determined by FEA analysis and verified by development testing.
- Various balance ratios, face widths, and cooling notch configurations were evaluated in the process of optimizing the design.
- Carbon material receives non-destructive examination to assure it's internal integrity. Front and back faces are lapped flat.

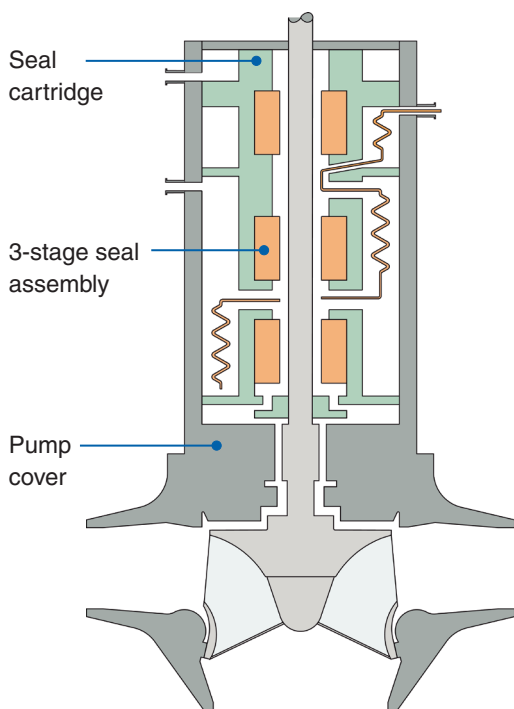
Stationary Seal Ring Carrier

- Provides necessary support and isolation for the stationary seal ring.
- This critically important part was designed using FEA analysis.
- A single anti-rotation lug located over the secondary seal prevents carrier rotation and allows the carrier to track shaft deflection without restriction.
- Location of the anti-rotation lug near the secondary seal minimizes relative motion and wear that would otherwise occur on the mating surface.
- Backseat surface which supports the stationary ring is lapped flat within two helium light bands (.000023 in) (0.00058 mm).



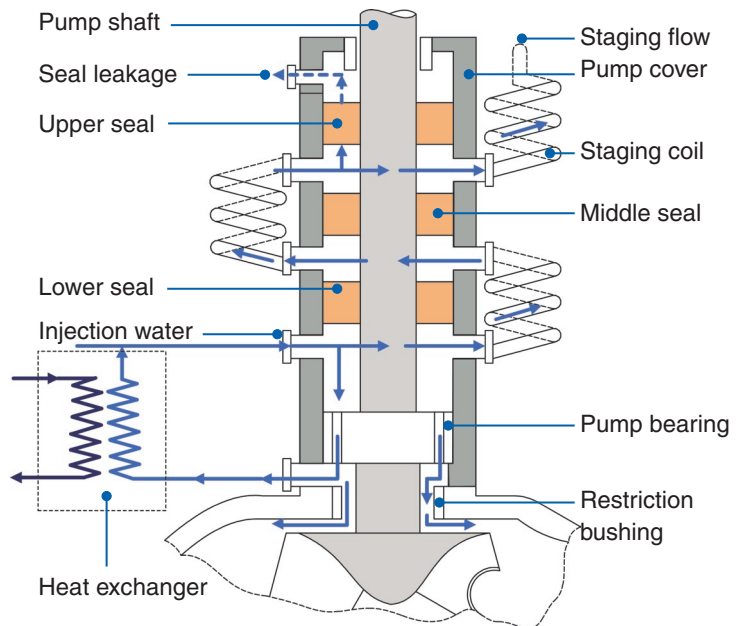


Typical Retrofit Installation



Seal Staging Flow

Schematic showing direction of flow through seal stages. Staging coils are illustrated away from the seal holder for clarity.



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