

**James Walker**<sup>®</sup>

# HydroSele<sup>®</sup> total sealing systems for Water Turbine Shafts

Issue 3



## **Innovative rotary sealing cartridge systems that offer**

- Greatly reduced turbine downtime
- Minimal leakage
- Major cost savings
- Full system compatibility

High Performance Sealing Technology





## What is HydroSeal® ?

**HydroSeal® is James Walker's family of innovative cartridge seals for the shafts of water turbines. It is the result of over 12 years of design, development and operational experience on Francis and Kaplan equipment working under a wide variety of conditions.**

Our sole objective has been to produce cartridge seals of superior reliability that greatly improve a turbine's

- Cost efficiency, and
- Operational performance.

Field trials, backed by commercial operations since 2006, show that our HydroSeal systems offer the best long-term value for money of any shaft sealing arrangement for many Francis and Kaplan turbines.

### **Our HydroSeal offer**

We will:

- Custom-manufacture the seal from modular components to suit your specific application.
- Install the seal on site for you.
- Fully support your HydroSeal system with worldwide technical advice and refurbishment services.

## Extended family

We are constantly developing our HydroSeal® family to provide a total shaft-sealing service to OEMs and operators of water turbines. Current family includes:

**HydroSeal® S** — the innovative rotary cartridge seal for turbine shafts (p3-7).

**HydroSeal® MS** — S type plus maintenance seal (p8).

**HydroSeal® RS** — S type with reversed inner element (p8).

**HydroSeal® W** — cartridge containing a single Walkerseal® radial lip seal (p9).

**HydroSeal® WT** — cartridge with two Walkerseal lip seals in tandem (p9).

**HydroSeal® WB** — cartridge with two Walkerseals back-to-back (p9).

**HydroSeal® Total Service** — ancillary equipment and services (p10).

Other variants and combinations of HydroSeal can be custom-designed, including 'floating' versions to cater for higher levels of shaft eccentricity.

## The innovative HydroSele® S



*HydroSele® S offers many unique financial and operational benefits over other sealing systems used on Francis and Kaplan turbines*

### Why fit HydroSele® S?

#### **Swift payback on investment**

Our innovative HydroSele® S offers significant cost savings by being retrofitted and fully operational in half the time of a traditional mechanical seal.

**In less than two years**, it should have paid for itself in terms of maintenance costs, turbine downtime and power absorption.

**At four years**, your total investment in cash and downtime could be just one-quarter of that for an equivalent mechanical seal.

#### **Long & reliable service**

HydroSele S prototypes are still running trouble-free after 12 years of operation. This outstanding reliability enables you to schedule your maintenance with absolute confidence.

#### **Simple to install & adjustment-free**

HydroSele S is one of the easiest sealing arrangements to fit on a turbine shaft. With our technical expertise, your downtime is cut to a minimum — and the cartridge sealing unit is totally adjustment-free once installed.

#### **Economical refurbishment**

It takes just hours rather than days to refurbish our innovative HydroSele. You no longer need to hold expensive standby sealing units in stock.

#### **High efficiency sealing**

HydroSele's unique method of operation gives a very low and controlled level of leakage. This greatly reduces the risk of flood damage to plant caused by uncontrolled leakage past sealing faces.

#### **Low power consumption**

HydroSele S has an exceptionally low torque requirement compared to traditional mechanical seals.

#### **Worldwide technical support**

Every HydroSele installation is fully supported by James Walker's global network of specialists in high performance sealing technology.



*HydroSele® S is a fully split cartridge assembly, containing two sealing elements working back-to-back with flush water introduced between them*



## HydroSele® S in operation

### Shaft diameter

Surface finish: 0.4 to 0.8 $\mu$ m Ra (CLA 16 to 32 $\mu$ in)

Surface hardness: 33 HRC minimum

Diameter tolerance: ISO 286-2/BS EN 20286-2 h8

Maximum permissible shaft runout: Please consult James Walker.

### Inlet flush requirements

Pressure: To be maintained at a minimum of 0.2MPa (2bar) above maximum system pressure. A through-flow flush system is generally recommended.

Filtration: 100 $\mu$ m (0.004in) or better

### Equipment surface or adapter plate

Surface finish: 0.4 to 0.8 $\mu$ m Ra (CLA 16 to 32 $\mu$ in)

Flatness: Within 0.05mm (0.002in)

### Cartridge outside diameter

Cartridge to be located in a counter-bored recess 5.00mm (0.197in) deep with a fit based on ISO 286-2/BS EN 20286-2; H9/f8 on cartridge outside diameter

### HydroSele® S operating capabilities

Shaft diameters: 250 - 1000mm (9.84 - 39.37in)

Please consult James Walker if your shaft diameter exceeds 1000mm (39.37in).

Maximum pressure at gland: 1MPa\* gauge (10bar)\* gauge

Maximum shaft speed: 20m/s\* (3937fpm\*)

Maximum temperature: 50°C (122°F) at seal/flush water interface

Flush water pressure: 0.2MPa (2bar) above system pressure.

(\*These values will be size dependent and may not necessarily be applied simultaneously)

# HydroSele® S

## Standard sizes for HydroSele® S

| Metric sizes in mm (apart from G in inches) |       |                   |                       |                 |                 |                  |  |
|---|-------|-------------------|-----------------------|-----------------|-----------------|------------------|--|
| Shaft (A)                                   |       | Overall depth (B) | Location diameter (C) | Bolting details |                 |                  | Flush pipe fitting (G)<br>DIN ISO 228 Parallel |
| Equal to or above                           | Below |                   |                       | Number of bolts | Bolting PCD (E) | Thread depth (F) |  |
| 250   | 500   | 88.0              | A+140                 | 8               | A+97            | 30               | G3/8   |
| 500   | 700   | 120.5             | A+160                 | 12              |                 | 40               |  |
| 700   | 1000  | 123.0             | A+180                 | 16              |                 |                  | G3/4   |

Tolerances ± 0.1 except where shown

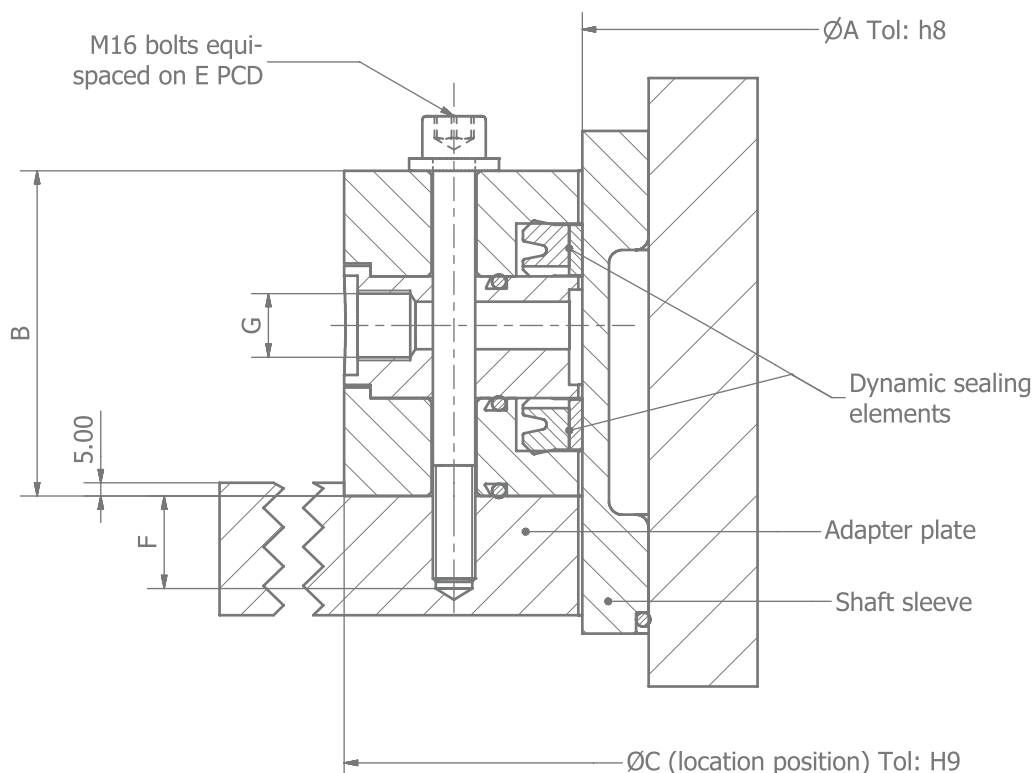
| Inch sizes        |        |                   |                       |                 |                 |                  |  |
|-------------------|--------|-------------------|-----------------------|-----------------|-----------------|------------------|--|
| Shaft (A)         |        | Overall depth (B) | Location diameter (C) | Bolting details |                 |                  | Flush pipe fitting (G)<br>DIN ISO 228 Parallel |
| Equal to or above | Below  |                   |                       | Number of bolts | Bolting PCD (E) | Thread depth (F) |  |
| 9.843             | 19.685 | 3.465             | A+5.512               | 8               | A+3.819         | 1.181            | G3/8   |
| 19.685            | 27.559 | 4.744             | A+6.299               | 12              |                 | 1.575            |  |
| 27.559            | 39.370 | 4.843             | A+7.097               | 16              |                 |                  | G3/4   |

Tolerances ± 0.004 except where shown

*Simple in concept yet ingenious in operation, HydroSele® S relies on engineering excellence for its outstanding sealing performance*

## Compact cartridge

*HydroSele® S is a compact bolt-on sealing unit that can readily be installed where housing space is limited.*



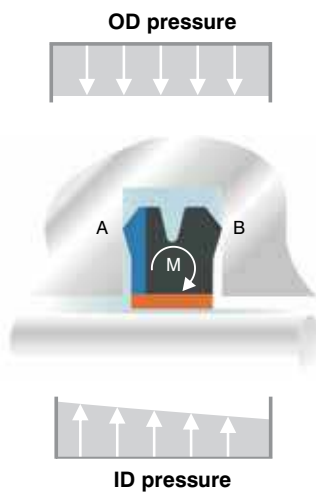


## How HydroSeal® S works

### HydroSeal® S relaxed

The ported pressure face (A) allows fluid to the outside diameter of the housing. The un-ported atmosphere face (B), however, forms a static seal that prevents the fluid from continuing around the back of the seal to atmosphere.

Because the sealing element is manufactured to have a small clearance on the shaft, the fluid can also pass between the shaft and the running sleeve of the sealing element.



If the sleeve were rigid, the pressure would drop almost linearly along this route, and leakage would be high. Instead the pressure distributions on the outside and inside of the seal produce a turning moment (M) that tilts the seal to bring the 'atmosphere' edge of the seal sleeve into close proximity to the shaft, stemming the leakage.

The under-sleeve pressure then backs-up to produce a distribution approximating to that shown — with most of the pressure drop occurring near the atmosphere edge of the seal sleeve.

## HydroSele® S construction



## Modular concept

*HydroSele® S is modular in concept, with each component designed and precision manufactured to fit together perfectly around the turbine shaft without stripping down the housing.*

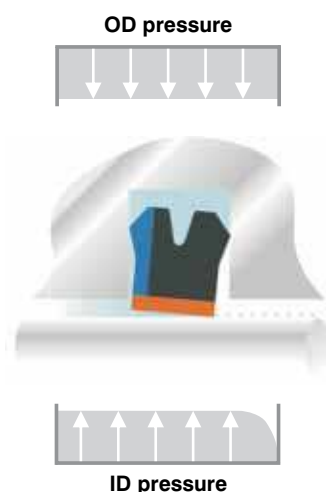
Each of the three metal rings is fully-split and fitted with locator pins for accurate realignment. The two sealing elements and three 'O' rings have single splits.

The unit is installed simply by fitting each component in sequence around the shaft, with the bolt holes aligned through the metal rings.

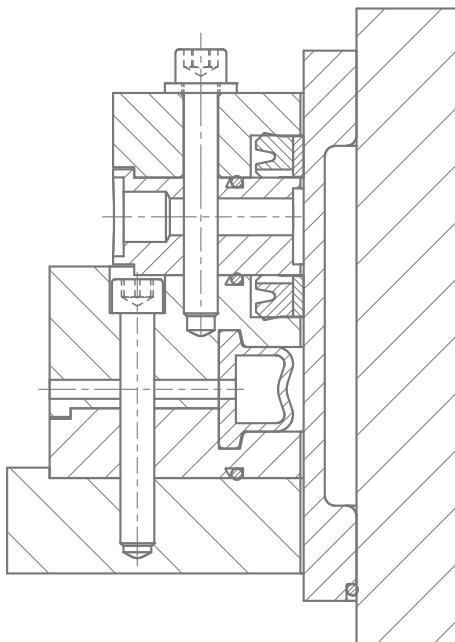
**HydroSele® S energised**

Loaded contact between the sealing element and shaft is prevented by the hydrodynamic pressure generated in the thin fluid film that is created by shaft rotation. Equilibrium is therefore set up between the closing and opening forces acting on the sealing element.

This results in a seal that is virtually pressure balanced (providing high pressure capability) and running on a hydrodynamic film (providing high speed capability), with a low level of controlled leakage.



All modules of the fully assembled HydroSele are held accurately and firmly in position by the bolts that fasten the cartridge to the adapter plate or equipment surface beneath.

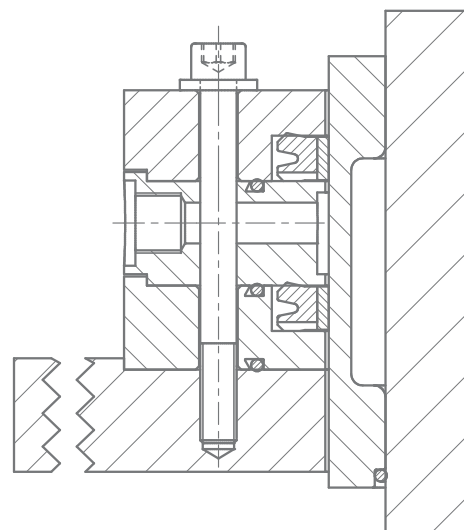


### HydroSele® MS

This enhanced version of HydroSele® S allows maintenance of the primary sealing elements to be carried out safely and swiftly with the cartridge in situ.

The inner housing ring is adapted to incorporate an externally energised maintenance seal that sits well clear of the shaft sleeve while the turbine is running. During turbine shut-down the maintenance seal is energised to make intimate contact with the shaft sleeve and provide high-efficiency static sealing.

The maintenance seal is energised either by automatic diversion of the cartridge flush water, or by separate pressurised water or air supplies.



### HydroSele® RS

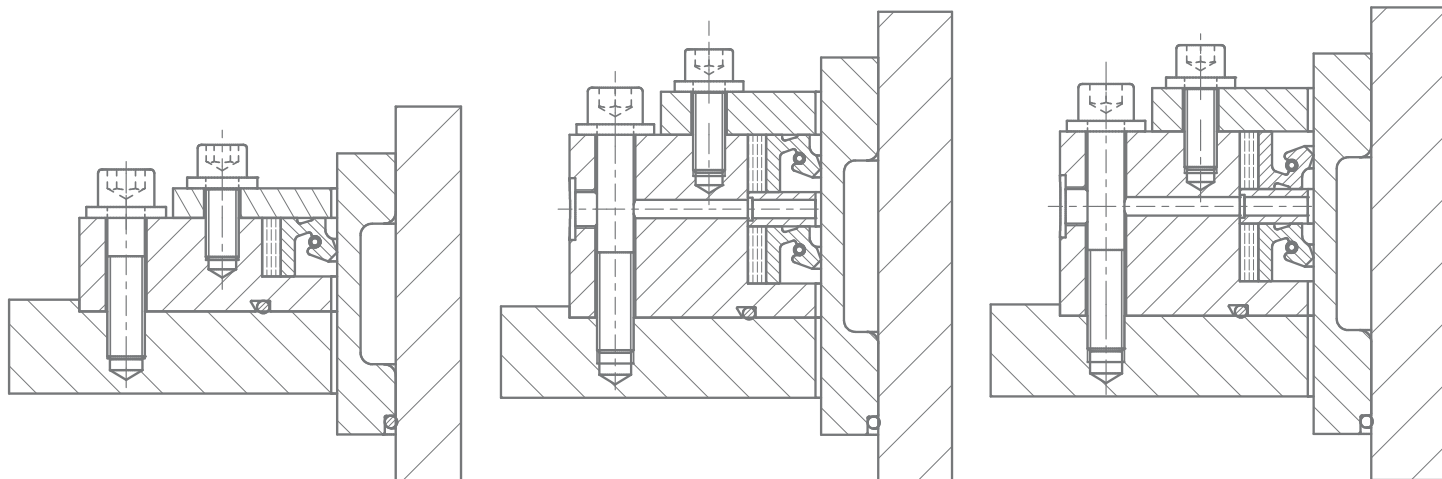
This is designed for situations where a water-lubricated bearing is located immediately inboard of the HydroSele®.

The inner dynamic sealing element is fitted in the reverse direction, and energised by pressurised clean water within the bearing. The same water as supplied to the bearing is also fed to the HydroSele flush ring at lower pressure to lubricate and cool the seal assembly.

The result is an exceptionally stable sealing system with very low leakage and minimal additional pipework.



## HydroSele® variants



## HydroSele® W

Our HydroSele® W range comprises split cartridges that house James Walker's renowned Walkersele® D7 rotary shaft lip seals. This standard version has a single sealing element in the cartridge.

Moulded in tough, water resistant elastomers, Walkersele D7 is ideal for lower pressure Kaplan turbine duties.

Although HydroSele W is recommended for smaller turbines, it can be supplied in diameters up to 2000mm (78.74in) if required.

The Walkersele is supplied in spilt form for ease of installation. It is then joined to form an endless ring using our patented OSJ® (On-Site Joining) technique.

## HydroSele® WT

This version comprises a fully split cartridge unit containing two Walkersele® D7 On-Site Joining lip seals working in tandem. Both Walkerseles face the pressurised water to provide increased sealing integrity.

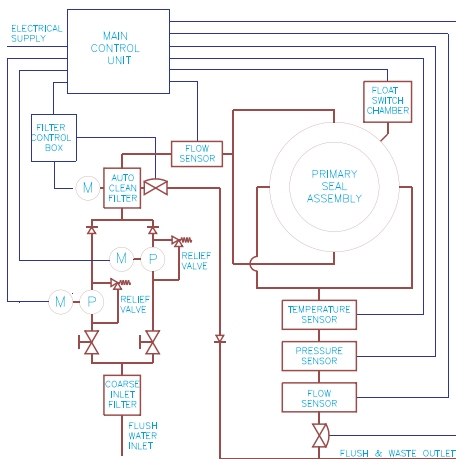
The space between the two lip seals is normally packed with grease during assembly. A port is incorporated to allow additional greasing to improve the lubrication of the seal lips and to extend seal life.

## HydroSele® WB

Our HydroSele® WB is particularly suitable for protecting bearings in submerged applications such as bulb turbines.

It uses the same cartridge design as HydroSele® WT, but the outer Walkersele® is reversed.

In operation, the outer seal acts as a protective barrier to prevent the ingress of water and external contaminants.



## HydroSeal® Service

We offer a full service package to support all HydroSeal® installations. Our applications engineers will assist and advise on all aspects of turbine sealing.

They are complemented by our site personnel who are fully safety trained and available to carry out pre-contract surveys — plus all levels of on-site work, from supervision and system installation, to commissioning and customer training.

## HydroSeal® Adapter

An adapter plate enables the HydroSeal® unit to be retro-fitted to a turbine casing, usually via the bolt circle of the previous sealing system. Sufficient detail is provided on page 5 to enable a customer to design and manufacture the plate.

Alternatively, we will custom-design and supply a precision-machined adapter plate that provides the perfect base for optimum HydroSeal performance.

## HydroSeal® Condition Monitoring

All HydroSeal® units are designed to give a long trouble-free working life, with their elastomeric sealing elements performing perfectly for several years before on-site replacement is needed.

To gauge the operational efficiency of an installation, we can supply our HydroSeal® Condition Monitoring system.

This monitors major parameters, such as temperature, pressure and flow rates. It gives prior warning of changes that affect the efficiency of a HydroSeal unit, thus enabling on-site maintenance to be scheduled well in advance.

The system is particularly suitable for use at plants that are not permanently manned, and can submit its reports automatically via email or text messaging, if required.

## HydroSeal® Shaft Sleeve

We can provide precision manufactured split sleeves that protect the turbine shaft from wear, and present the optimum running surface for HydroSeal® elements.

These are manufactured in corrosion resistant steel, and will be supplied with hard surface layers, if required. A taper-wedge location/locking system ensures perfect alignment of the split halves.

## HydroSeal® FlushPak

Our compact skid-mounted FlushPaks are custom designed to provide the clean, cool and uninterrupted supply of flush water needed for efficient HydroSeal® operation.

They contain all the fluid handling and automatic control systems required to ensure the minimum of operator intervention and maintenance.

## Case studies

Here are a few examples of the many successes achieved with HydroSele® S during development, testing and commercial operations.



## HydroSele® case studies

**Case study 1**

**Application:** Two Francis vertical turbines with 410mm (16.14in) diameter shafts running at 750rpm and 0.3MPa (3bar) operating pressure.

**Previous seal type:** Both turbines were fitted with spring-retained carbon rings.

**HydroSele success:** In December 1996 the turbine shafts were fitted with prototypes of the HydroSele S cartridge unit.

In March 2008 both units were still working precisely to the customer's requirements, with the original elastomeric sealing elements in place.

**Case study 2**

**Application:** Kaplan vertical turbine with 380mm (14.96in) diameter shaft running at 428rpm and 0.3MPa (3bar) operating pressure.

**Previous seal type:** The turbine was originally fitted with a famous brand of mechanical seal that lasted about two years, but suffered performance problems.

**HydroSele success:** In February 1998, a prototype HydroSele S was installed.

In July 2007, the total leakage from the HydroSele S was measured at 2 litre/min (0.53USgal/min). The original elastomeric sealing elements were still in operation, and the unit was continuing to meet the customer's specifications.

**Case study 3**

**Application:** Two Francis vertical turbines with 480mm (18.9in) diameter shafts, running at 375rpm and 0.25MPa (2.5bar) operating pressure.

**Previous seal type:** Both these turbines were formerly fitted with conventional mechanical face seals that leaked heavily.

**HydroSele success:** In June 2001 each turbine was fitted with a HydroSele S, with immediate dramatic reductions in leakage rates.

In 2008, the leakage rate was measured at 2 to 4 litre/min (0.53 to 1.06USgal/min), which was fully acceptable to the customer.

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To ensure you are working with the very latest product specifications, please consult the relevant section of the James Walker website: [www.jameswalker.biz](http://www.jameswalker.biz).

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