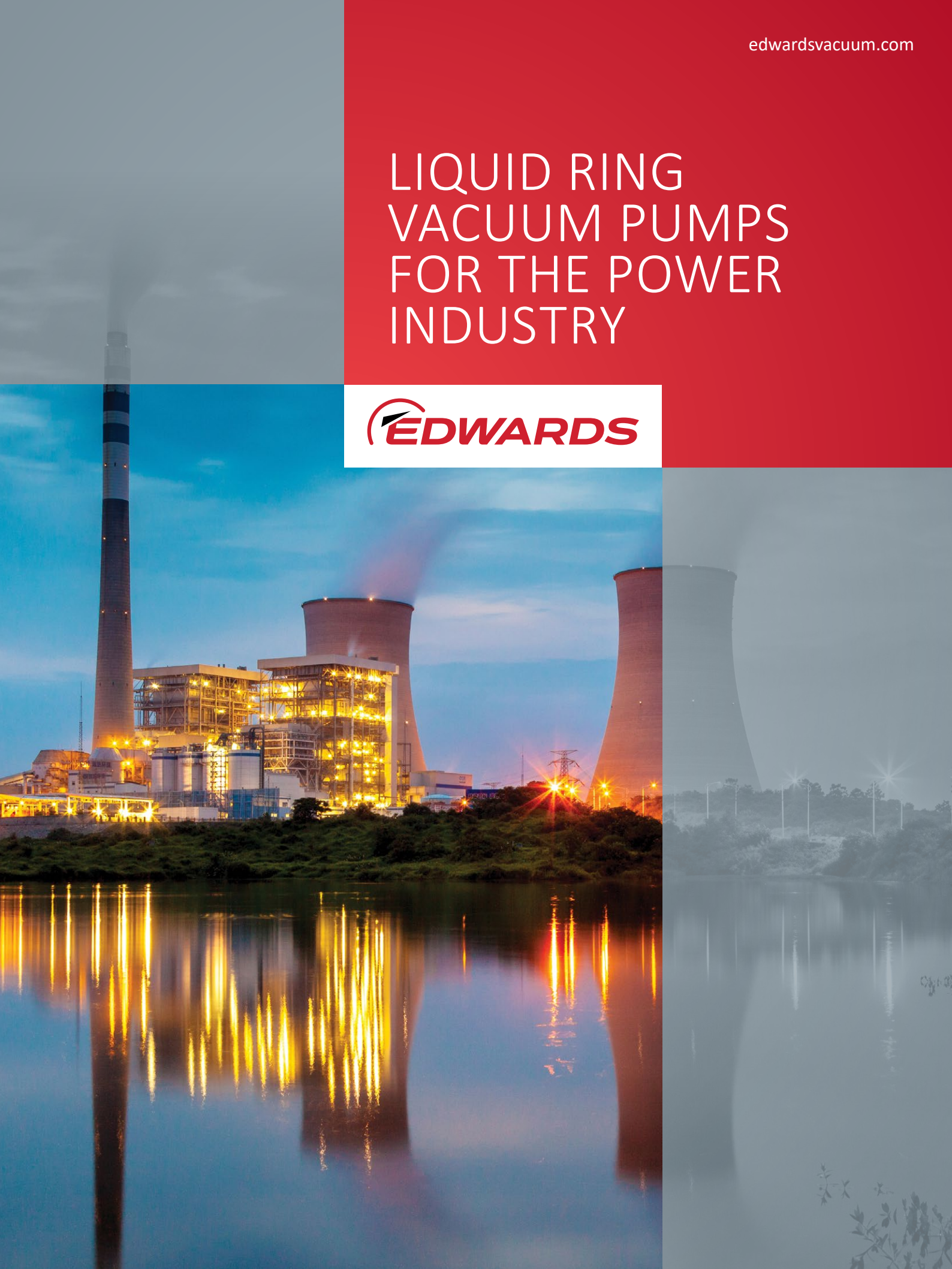
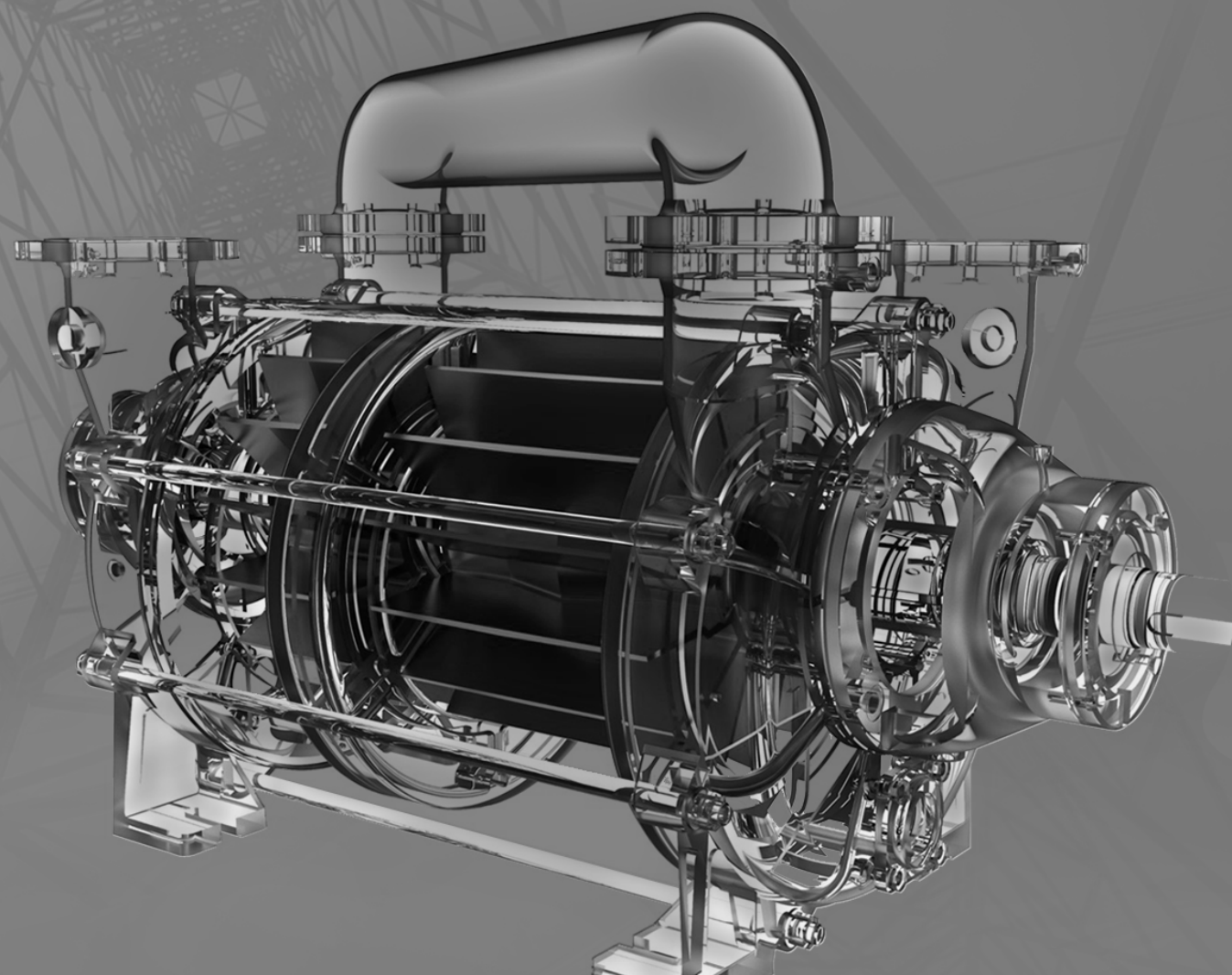


LIQUID RING VACUUM PUMPS FOR THE POWER INDUSTRY





EDWARDS THE PARTNER OF CHOICE

Edwards is a world leader in the design, technology and manufacture of vacuum pumps for industrial applications with over 100 years' history.

We believe in delivering results that bring value to our customers by using our breadth of industry experience to identify and apply solutions. Using the most innovative and up-to-date modelling techniques, we can optimise the pumping configuration for customers to provide a system design giving the maximum performance in the most reliable and cost-effective way.

COMPLETE VACUUM PUMPING SOLUTIONS FOR YOUR POWER PLANT

As a global leader in vacuum technology, today Edwards has grown within the power industry from pioneering work in developing equipment for the traditional power stations, to the supply of sophisticated vacuum systems for combined cycle, geothermal, thermal, nuclear and solar-powered power plants.

By working with power sector engineers and operators, Edwards is able to challenge the limits of vacuum system design, creating solutions to meet the demands of increasingly challenging applications.

The efficiency of steam turbines is an important part of electricity generation. Edwards' liquid ring vacuum pumps play a vital role in maximising efficiency by removing excess air from the system. On exiting the turbine, steam is condensed either by a water or an air-cooled condenser, creating a vacuum inside the turbine and therefore increasing efficiency. To maintain this vacuum, air and other non-condensable gases that leak into and build up within the condenser must be extracted. Liquid ring vacuum pumps are used worldwide in this critical application.

Waterbox priming is an important application to optimise condenser efficiency. Edwards' liquid ring vacuum pumps are used for condenser waterbox priming, to ensure that they deliver optimum cooling performance; the pumps also perform a deaeration duty, continuing to remove accumulated air and non-condensable gases from the condenser cooling water line.

Edwards' liquid ring vacuum pumps are also used for gas treatment processes such as fly ash handling, flue gas desulphurization and carbon recovery, mainly to address environmental concerns and to use economical solutions.

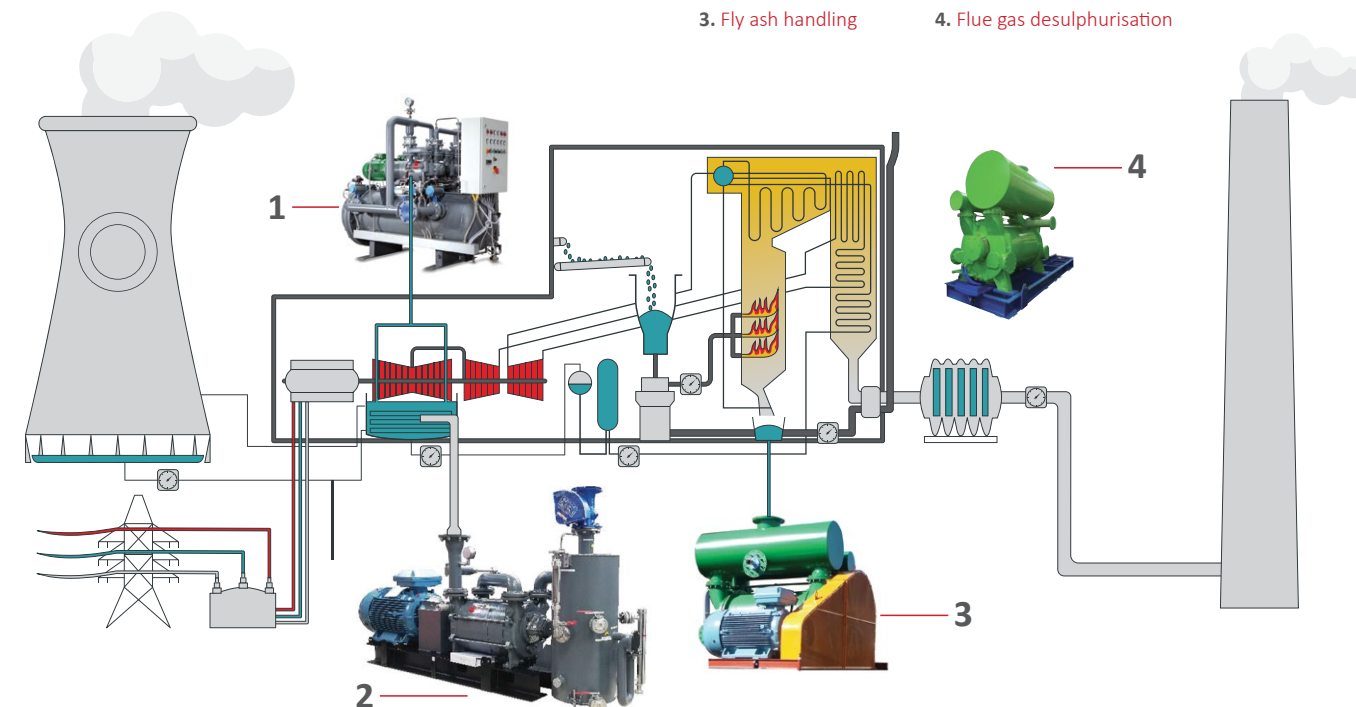
Liquid ring vacuum pumps in a power plant

1. Waterbox priming

2. Condenser air extraction

3. Fly ash handling

4. Flue gas desulphurisation





TAILORED SOLUTIONS FOR YOUR APPLICATION

More complex systems include special recirculation systems with combinations of liquid ring vacuum pumps, air or steam ejectors. These hybrid systems can significantly extend the liquid ring vacuum pump performance.

In addition to the standard range of liquid ring vacuum pump systems for various power applications such as condenser air extraction, waterbox priming, fly ash handling, flue gas desulphurisation, Edwards offers bespoke systems designed to meet your specific requirements, including:

- Hybrid ejector/liquid ring vacuum pump systems
- Large capacity single-stage hogging systems suitable for air-cooled condenser
- Stainless steel pump construction for geothermal applications
- Custom-designed seal water cooling systems
 - multiple heat exchanger for low quality cooling water
 - air blast coolers for applications with limited water supply

We have the expertise to deliver powerful dry pump and booster combinations for emerging applications such as CO₂ recovery and recycling. Please get in touch with your local Edwards representatives for a bespoke system.

Condenser air extraction packages



CONDENSER AIR EXTRACTION (CAE)

In order to increase the availability, operational performance and reliability of turbine condenser vacuum units, the dynamic relationship between the vacuum pumping system, condenser performance and turbine back pressure is an important factor in the design requirements and needs careful appraisal when considering overall plant performance.

Edwards condenser air extraction packages, based on liquid ring vacuum pumps, are designed to remove system air leakage across common sizes of turbine generator steam condensers. This is achieved by reducing the pressure in the turbine which enables more heat from the steam to be converted to mechanical energy. This increases the overall efficiency of the power plant.

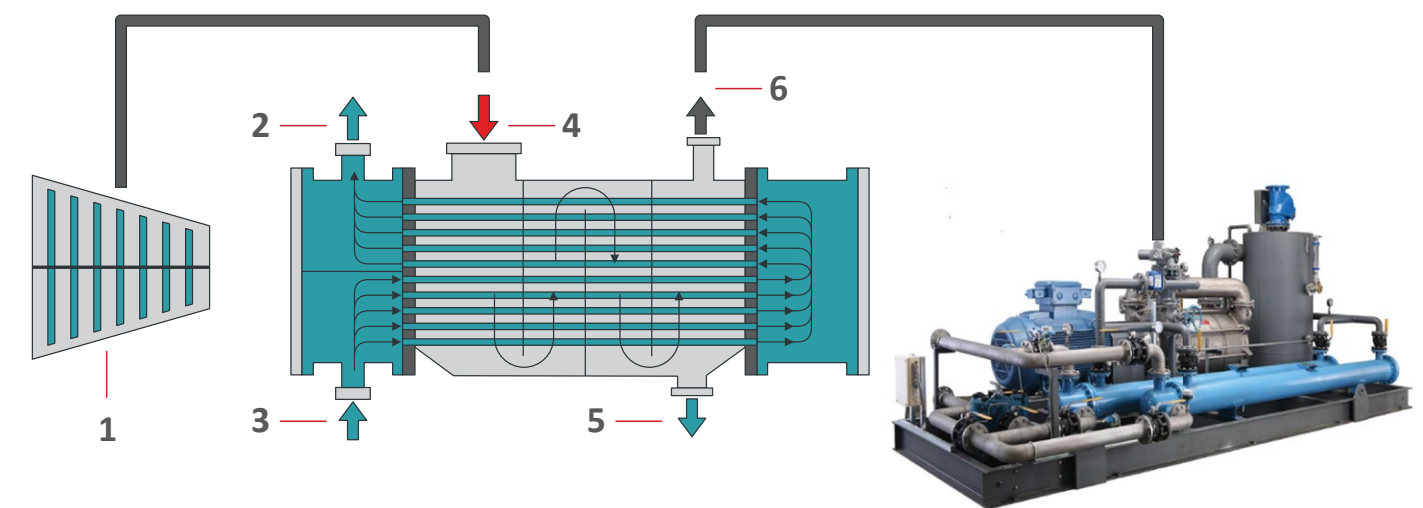
The air load from a turbine condenser system is saturated with vapour. Liquid ring vacuum pumps are ideal for handling high vapour loads as much of the vapour will be condensed at the pump suction (by the direct condensing action of the inlet water spray or contact with the pump seal water).

This condensing reduces the total volume to be handled by the pump, which is a significant advantage when compared to other pumping technologies.

- Condenser air extraction packages for holding and hogging
- Designed to meet HEI specifications
- Local service and site commissioning support



- | | | |
|-----------------|----------------|--|
| 1. Turbine | 3. Water inlet | 5. Condensate |
| 2. Water outlet | 4. Steam | 6. To condenser air extraction package |





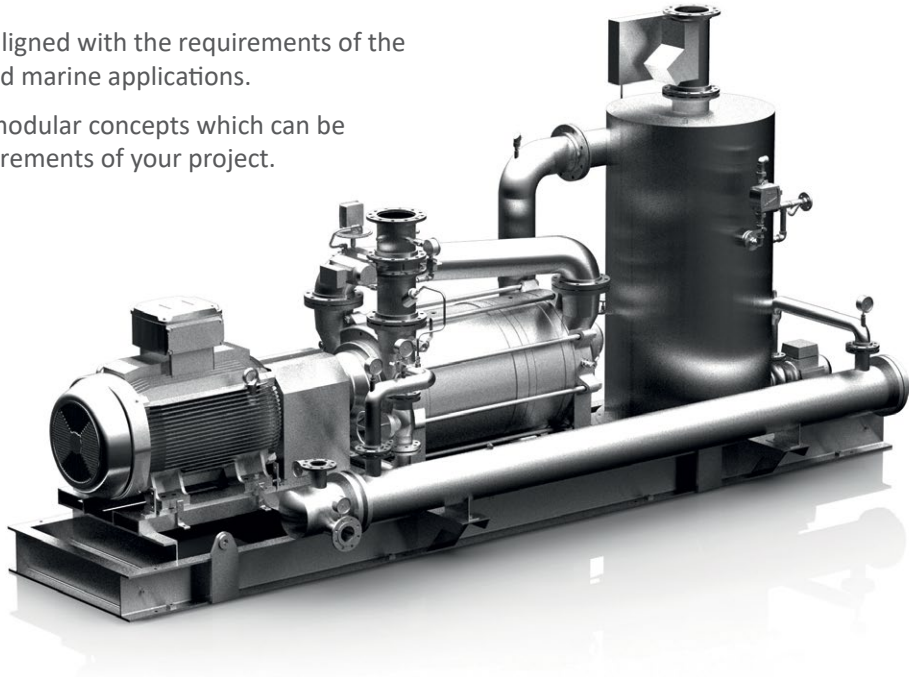
CONDENSER AIR EXTRACTION PACKAGES

Edwards offers two types of packages to meet the differing market requirements for condenser air extraction systems.

Fully automated CAE packages are designed to meet the typical specifications and requirements for larger steam turbine plants which are developed by the major utility companies.

Small Condenser Packages (SCP) are aligned with the requirements of the lower capacity plants for industrial and marine applications.

Both these packages are based on a modular concepts which can be customised to meet the specific requirements of your project.



FULLY AUTOMATED CAE PACKAGES

Two stages liquid ring vacuum pump sizes
SHR2400–SHR23500

Single stage liquid ring vacuum pump sizes
LR1A200–LR1A26000

Features

- Simplex design with dedicated seal water circuit
- Fully automatic operation
- Inlet water spray for inlet volume reduction
- Inter-stage anti cavitation device
- Recirculation pump to facilitate optimum seal water flow rate
- Level control with multiple set points
- Pump discharge temperature switch to detect operational problems
- Discharge air flow meter
- Shell and tube heat exchanger with stainless steel tubes
- Option for plate type heat exchanger as alternative to shell and tube type



SMALL CONDENSER PACKAGE

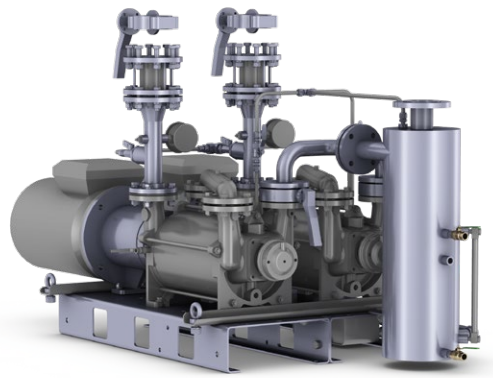
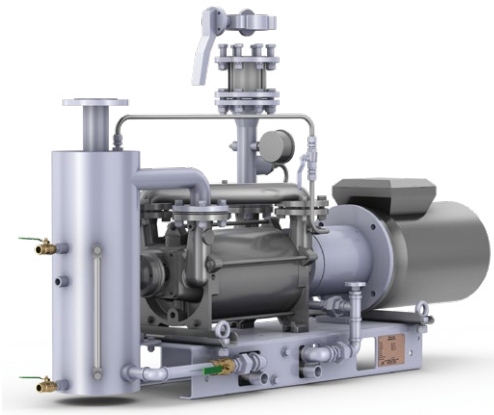
The SCP Packages are designed to meet the requirements of industrial installations where manual operation is the preferred solution. There are three design options to select from all including integrated seal water recirculation using a stainless steel plate type heat exchanger.

Two stage liquid ring vacuum pump sizes
EHR2190-SHR2750

Single stage liquid ring vacuum pump sizes
LR1A300-LR1A1600

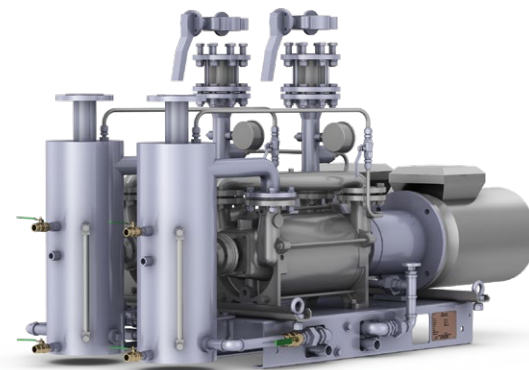
Features

- Simplex, Duplex and common separator design options
- Manual operation
- Inlet water spray for inlet volume reduction
- Interstage anti-cavitation device
- Plate type heat exchanger



▲ **Simplex** - A single pump model complete with a dedicated total seal water recirculation system, multiple units can be arranged alongside

▲ **Duplex** - Duty/standby pumps each with a dedicated total recirculation system, used when initial evacuation requires multiple pumps or when extra capacity is required to specific operating conditions



◀ **Common** - Duty/standby pumps with a common recirculation system, also used to meet additional specific operating conditions, with the added security of independent seal water recirculation systems



CONDENSER AIR EXTRACTION PUMP SELECTION TO HEI STANDARDS

Edwards’ condenser air extraction packages are designed to meet or exceed all applicable HEI performance specifications. The venting equipment is selected to operate at 1” Hgabs (33.86 mbara). The ITD (Initial Temperature Difference) is an important consideration in optimum pump sizing. As the ITD increases the capacity of the venting equipment also increases.

Edwards two stage liquid ring vacuum pumps are an ideal solution for handling liquid carryover, condensate and large volume of water vapour, and eliminates cavitation at high vacuum levels. As the ITD decreases at low level, Edwards offers ejectors with single or two stage liquid ring vacuum pump systems to maintain the main condenser pressure. Edwards has vast experience to help you select the best condenser air removal equipment for your specific requirement.



Single stage pump	Two stage pump													
LR1A8000	SHR23500													
LR1A5500/LR1A8000	SHR22500													
LR1A4000/LR1A5500	SHR21850													
LR1A2500/LR1A4000	SHR21200													
LR1A1600/LR1A2500	SHR2950													
LR1A1200/LR1A1300/ LR1A1600	SHR2750													
LR1A700/LR1A800	SHR2400													
LR1A400/LR1A500	EHR2390													
LR1A300	EHR2190													
Capacity (in SCFM)		3	4	5	7.5	10	12.5	15	17.5	20	25	30	40	



WATERBOX PRIMING

Waterbox priming serves two functions: to create a siphon effect reducing the amount of power required to start the main Cooling Water pumps (CW pump); and to ensure maximum condenser cooling efficiency by preventing accumulation of air in the upper parts of the cooling tube bundle. The ability to handle wet gases without any detrimental effect makes liquid ring vacuum pumps ideal for condenser waterbox priming applications. The pumps are used initially to carry out priming of the main condenser water boxes and CW pump; once this is complete they are used to maintain vacuum in the water box at the required level.

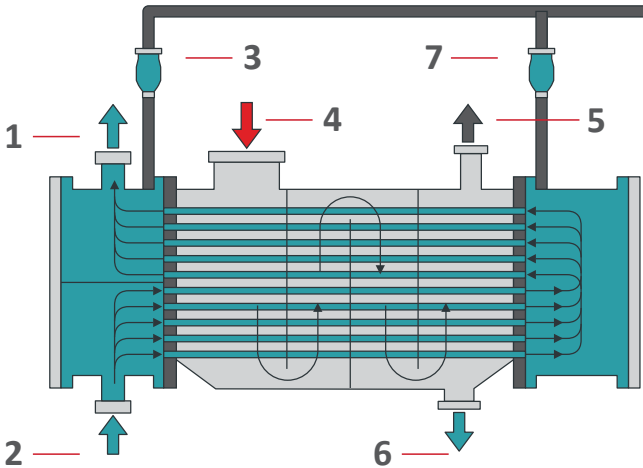
The Edwards priming system is a modular design comprising three component parts: vacuum pumps, vacuum receiver and priming valves with accessories, which are supplied as required to meet customer specifications. The vacuum pump system comprises of a single stage liquid ring vacuum pump complete with a total seal water recirculation system, sized to meet the process duty requirements. If duty and standby pumpsets are required, two systems are provided, giving true standby capability including the seal water recirculation system.

The vacuum receiver vessel is equipped with a pressure transmitter to control the pump operation and can include an automatic drain tank arrangement to remove any water carry-over from the system, therefore avoiding corrosion. If required, a priming valve and associated accessories can be supplied for each condenser vacuum connection.

The priming valve helps to prevent cycling of the vacuum system and minimises carryover of cooling water.

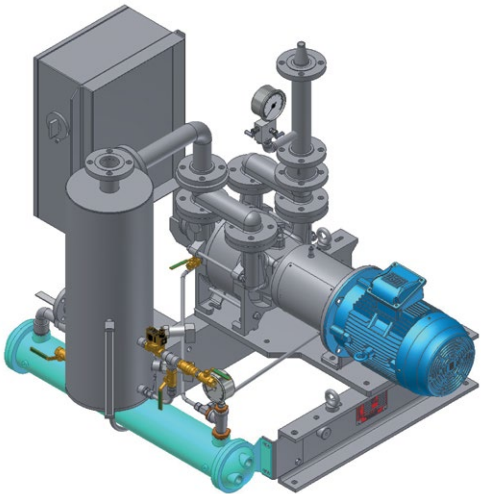


1. Water outlet
2. Water inlet
3. Priming valve
4. Steam
5. To condenser air extraction package
6. Condensate
7. Priming valve
8. Waterbox priming package

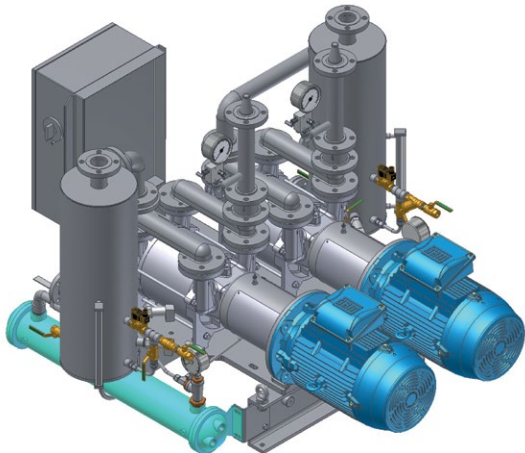


Edwards waterbox priming system has a modular design with three components: vacuum pump, vacuum receiver and priming valves, supplied as required to meet the customer specifications. The complete duplex package includes two liquid ring vacuum pumps, each with an independent seal water recirculation system, a vacuum receiver, interconnecting pipework and local control panel. Alternatively, pumps can be supplied as a Simplex package, or as a Common package with a combined recirculation system. All three package options are available with or without the vacuum receiver and can be mounted on a separate baseplate or on top of the vacuum receiver.

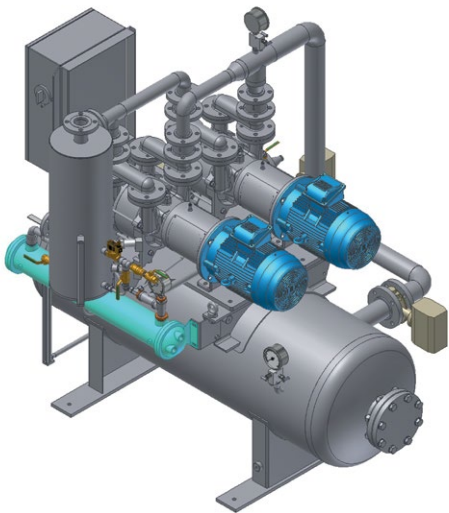
For waterbox priming system that requires higher capacities, different configuration or other accessories such as plate and frame type heat exchanger or drain tank are available. Edwards offer customised solutions.



▲ **Simplex** - A single liquid ring vacuum pump complete with a dedicated seal water recirculation system



▲ **Duplex** - Two liquid ring vacuum pumps, each complete with a dedicated seal water recirculation systems



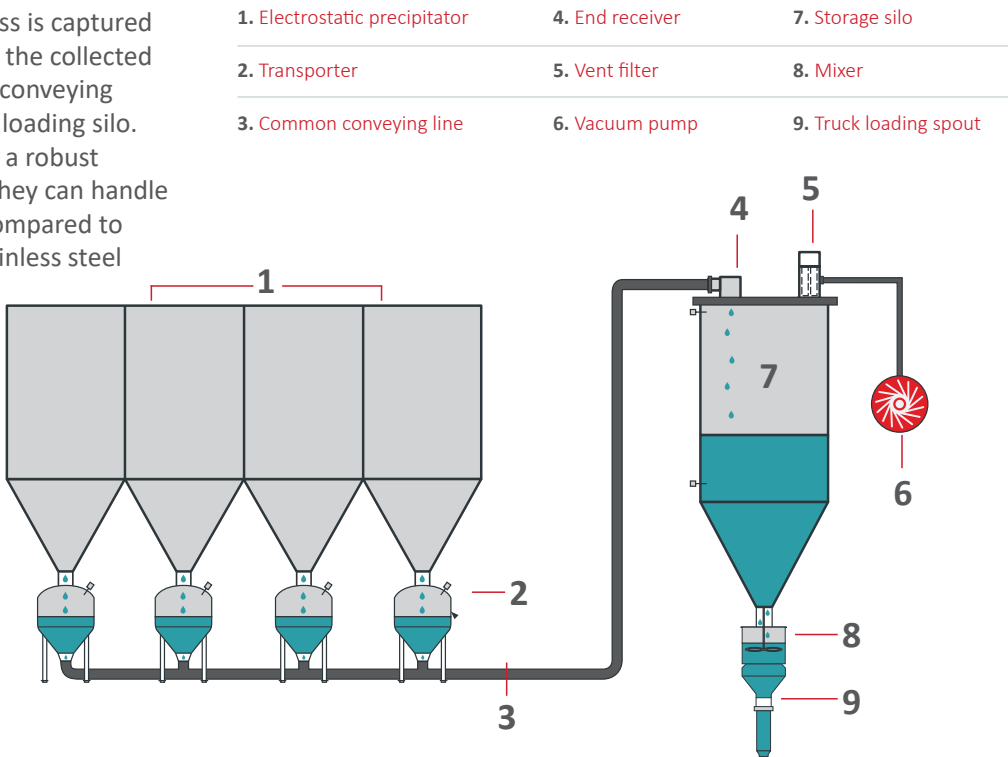
◀ **Common** - Two liquid ring vacuum pumps with a common seal water recirculation system mounted on a vacuum receiver



FLY ASH HANDLING

Ash from the combustion process is captured in the electrostatic precipitator; the collected ash is transported by a vacuum conveying system to the storage facility or loading silo. Liquid ring vacuum pumps offer a robust solution for this application as they can handle the particulates effectively as compared to other vacuum technologies. Stainless steel impellers are often utilised.

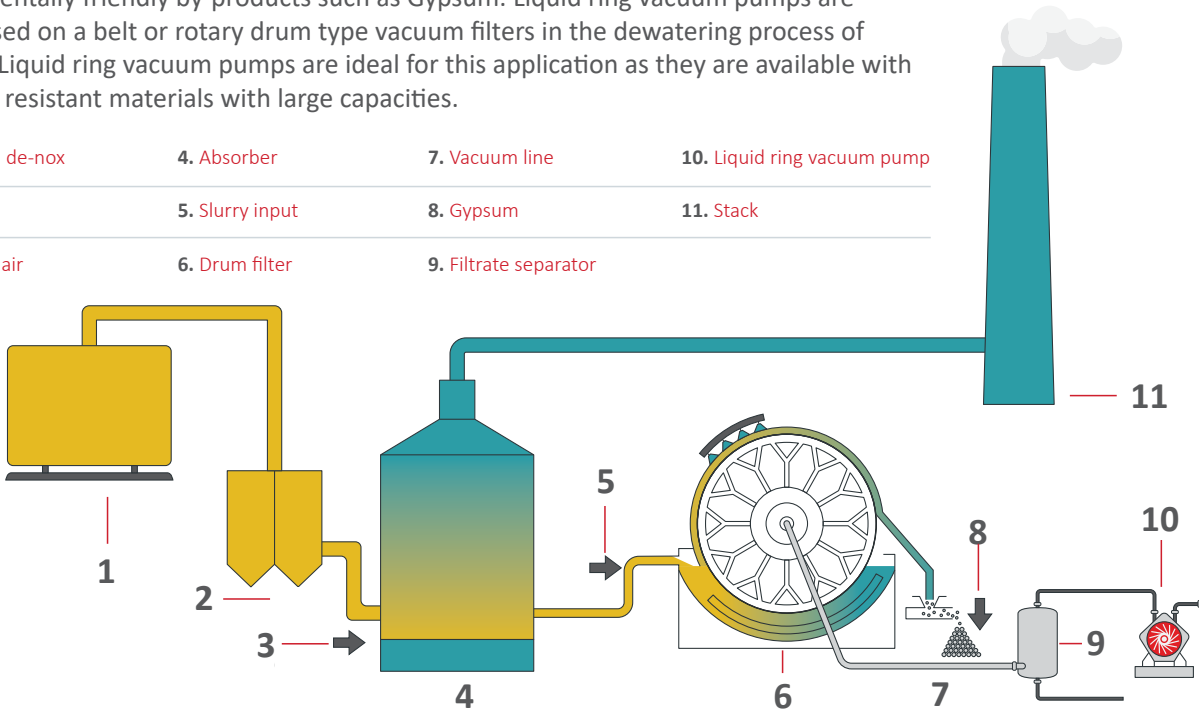
- Pump capacities up to 8000 m³/h
- Corrosion/erosion resistant materials available
- Systemised to meet project requirements
- Once-through or partial recirculation seal water



FLUE GAS DESULPHURISATION

Flue gas desulphurisation technology removes poisonous gas components from untreated gas discharge in coal or oil-fired power stations etc. These gases are converted into environmentally friendly by-products such as Gypsum. Liquid ring vacuum pumps are usually used on a belt or rotary drum type vacuum filters in the dewatering process of Gypsum. Liquid ring vacuum pumps are ideal for this application as they are available with corrosion resistant materials with large capacities.

- | | | | |
|----------------------|-----------------|-----------------------|-----------------------------|
| 1. Boiler and de-nox | 4. Absorber | 7. Vacuum line | 10. Liquid ring vacuum pump |
| 2. ESP | 5. Slurry input | 8. Gypsum | 11. Stack |
| 3. Oxidation air | 6. Drum filter | 9. Filtrate separator | |





EDWARDS PRODUCTS FOR POWER INDUSTRY



LR1C - Lantern

- Small single stage liquid ring vacuum pumps, compact structure with less footprint for easy installation and service
- Best efficiency with vacuum 600 to 100 mbar abs
- Capacity of 25 m³/hr to 500 m³/hr with vacuum to 33 mbar abs



EHR/SHR

- Integral two stage liquid ring vacuum pumps, peak efficiency and stable operation at high vacuum levels, designed to handle large amounts of liquid carryover without difficulty
- Capacity of 190 m³/hr to 7500 m³/hr with vacuum to 33 mbar abs

LR1D

- Single stage liquid ring vacuum pumps, made in USA, ASTM/ANSI standard compliance
- Capacity of 25 m³/hr to 1700 m³/hr with vacuum to 33 mbar abs



LR1A - Lantern

- Single stage liquid ring vacuum pumps, best efficiency with vacuum 600 to 100 mbar abs with corrosion resistant material option, top discharge capability with less footprint
- Capacity of 200 m³/hr to 26000 m³/hr with vacuum to 33 mbar abs



Air ejectors

- Efficient vacuum pump with no moving parts and utility consumption
- Size range from 25 mm to 250 mm inlet
- Ultimate pressure under no load is 8 mbar abs



LR1B - Lantern

- Large liquid ring vacuum pumps, robust operation at rough vacuum with corrosion resistant material option, best efficiency with vacuum 800 to 300 mbar abs
- Top discharge capability with less footprint
- Self-recirculating seal water, reducing external seal water supply
- Capacity of 3000 m³/hr to 40000 m³/hr with vacuum to 160 mbar abs



PRODUCT FEATURES AND CUSTOMER BENEFITS

Product features	Customer benefits	CAE	WBP	FAH	FGD
Heavy duty bearings mounted external to the pumping chamber	No contamination to process	✓	✓	✓	✓
Low operating noise	Environmental, safety and health benefits	✓	✓	✓	✓
Low vibration level	Long period of stable operation	✓	✓	✓	✓
Operate across entire vacuum range	Flexible working conditions			✓	✓
Low tempertaure operation and big clearance	Harsh duty handling capability	✓	✓	✓	✓
Rugged, robust construction, no oil replacement	Less maintenance required, trouble-free life	✓	✓	✓	✓
No lubrication in working chamber	No extra exhaust contamination	✓	✓	✓	✓
Mechanical seal as standard	Reliable processing	✓	✓	✓	✓
Water as seal liquid	Capable of handling saturated gas mixtures and small amount of liquids	✓	✓	✓	✓
Flat sided pumps	Reduce condensables, volume and require smaller capacity	✓	✓	✓	✓
Anti-cavitation design	Pump protection and endurance	✓			
Automatic design and operation	No local operator required	✓	✓		
Choice of construction materials	Customised design for different applications	✓	✓	✓	✓
Single stage liquid ring vacuum pump	High efficiency at rough vacuum levels	✓	✓	✓	✓
Two stage liquid ring vacuum pump	Stable operation and peak efficiency at high vacuum levels	✓			
Full factory acceptance test	Quality assurance	✓	✓	✓	✓
Standard packages and bespoke solutions	Optimum solution for different requirements	✓	✓	✓	✓
Saturated air test capability	Simulate real process condition	✓			
Compliance to global and industry standards	Reliable and trustworthy	✓	✓	✓	✓
Extended Warranty option	Peace of Mind	✓	✓	✓	✓
Worldwide local applications expertise and service support	Edwards representatives available in your region	✓	✓	✓	✓

CAE: Condenser Air Extraction WBP: Water Box Priming FAH: Fly Ash Handling FGD: Flue Gas Desulfurisation

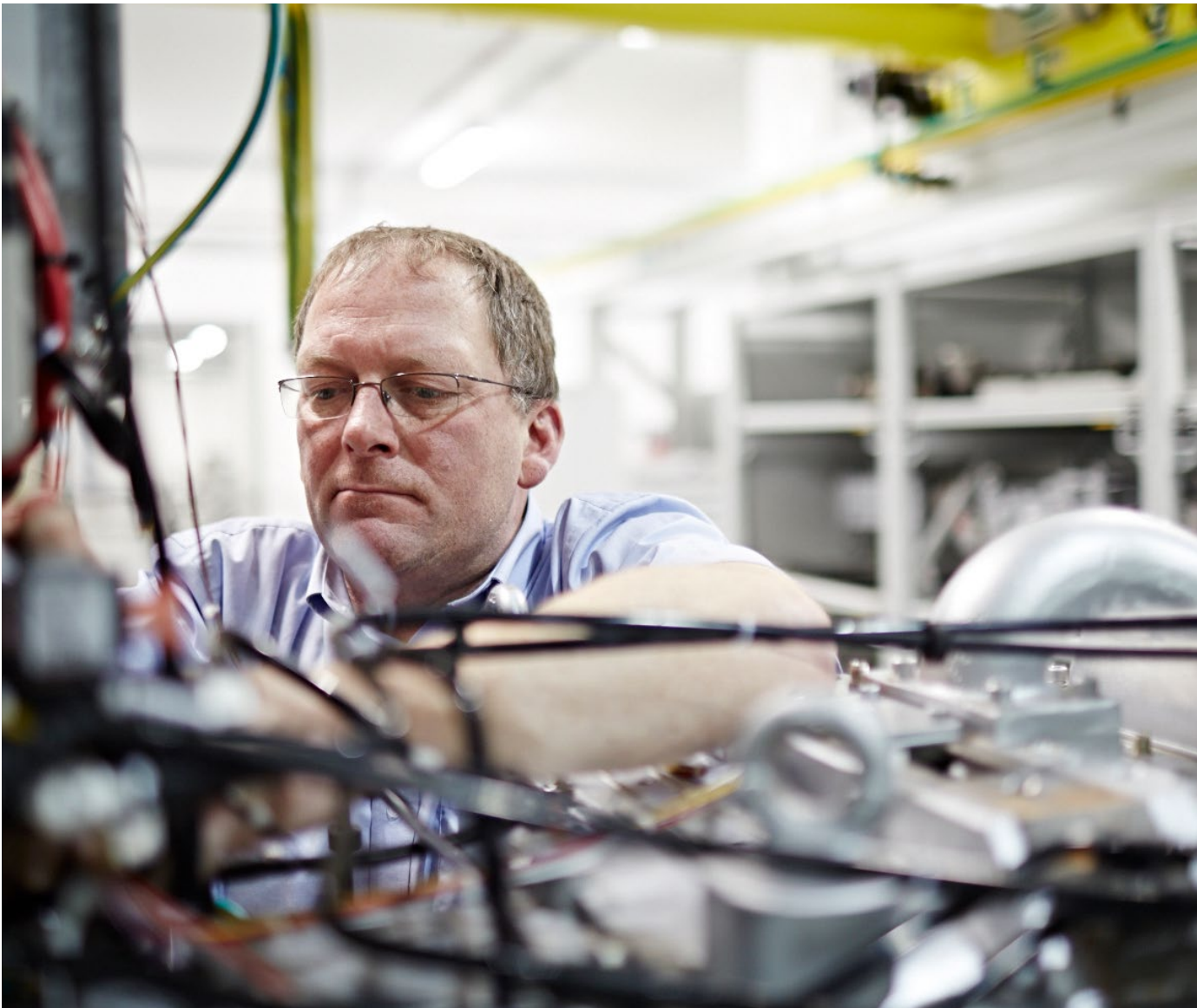


SERVICE AND SUPPORT

To ensure your pump maintains optimal performance and reliability, we offer a wide range of service solutions, tailored to meet your needs. From Field Service intervention to Managed Maintenance agreements, we will take care of your pump to ensure that it continues to deliver clean, consistent, efficient performance, with lower running cost and optimum total cost of ownership for its entire operating life.

Selecting original spare parts, maintenance kits and grease, means that every critical part performs as it was intended. Form, fit and function are guaranteed. Our services engineers only fit 100% genuine parts to ensure you receive the best result from each and every service.

Contact your local Edwards sales office to discuss your specific requirements.





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