

## Compressor Seal Replacement and Upgrades

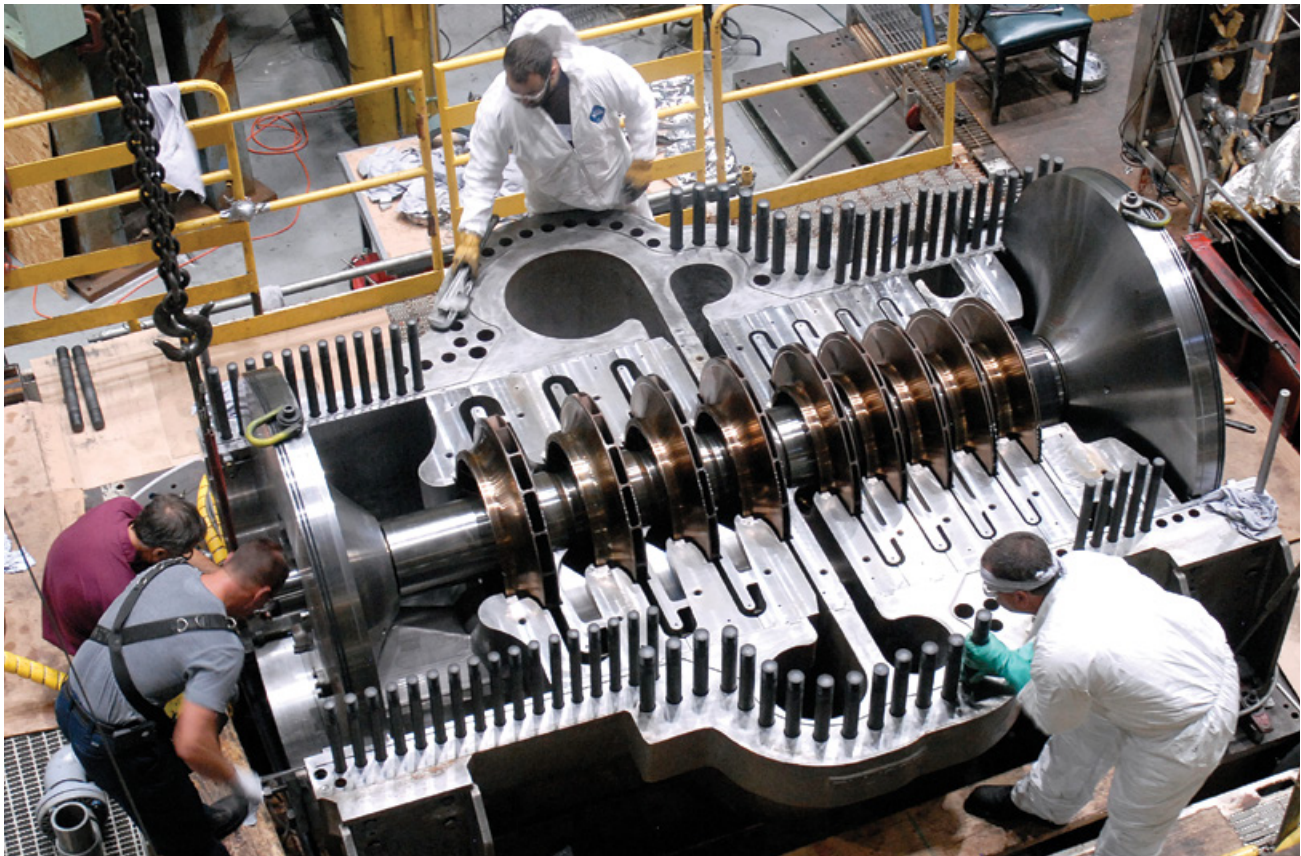
## ■ COMPRESSOR SEAL UPGRADES

An Elliott Group compressor seal upgrade increases seal reliability and reduces process gas leakage to improve overall efficiency. Optimal seal performance depends upon proper selection for the process application, operating conditions, process gas composition, and design specifications. For example, if a compressor is operating at off-design conditions, premature wear of critical components can cause increased gas leakage, oil contamination, reduced efficiency, increased downtime, and adverse environmental consequences. In addition to increased efficiency and reliability, an Elliott seal upgrade reduces operating and maintenance costs, and increases safety. These benefits can quickly offset the costs associated with a seal upgrade.

Seals are complex assemblies that require precise clearances to minimize gas leakage. For decades, Elliott has been a leader in the design and manufacture of self-contained cartridge seals that simplify the procurement and installation of complete seal assemblies for a wide range of operating pressures. Elliott also designs and manufactures complete dry gas seal systems to ensure optimal functionality, including gas seal cartridges, separation seal cartridges, process side labyrinth seals, and buffer gas systems. Elliott tailors every seal upgrade to a customer's specific needs for a reliable installation, regardless of the original equipment manufacturer (OEM).

### *Oil Seals*

Configuration	Application	Sealing Pressure
ISO-CARBON® cartridge seal	Low pressure	750 psig
ISO-SLEEVE™ cartridge seal	High pressure	4,200 psig

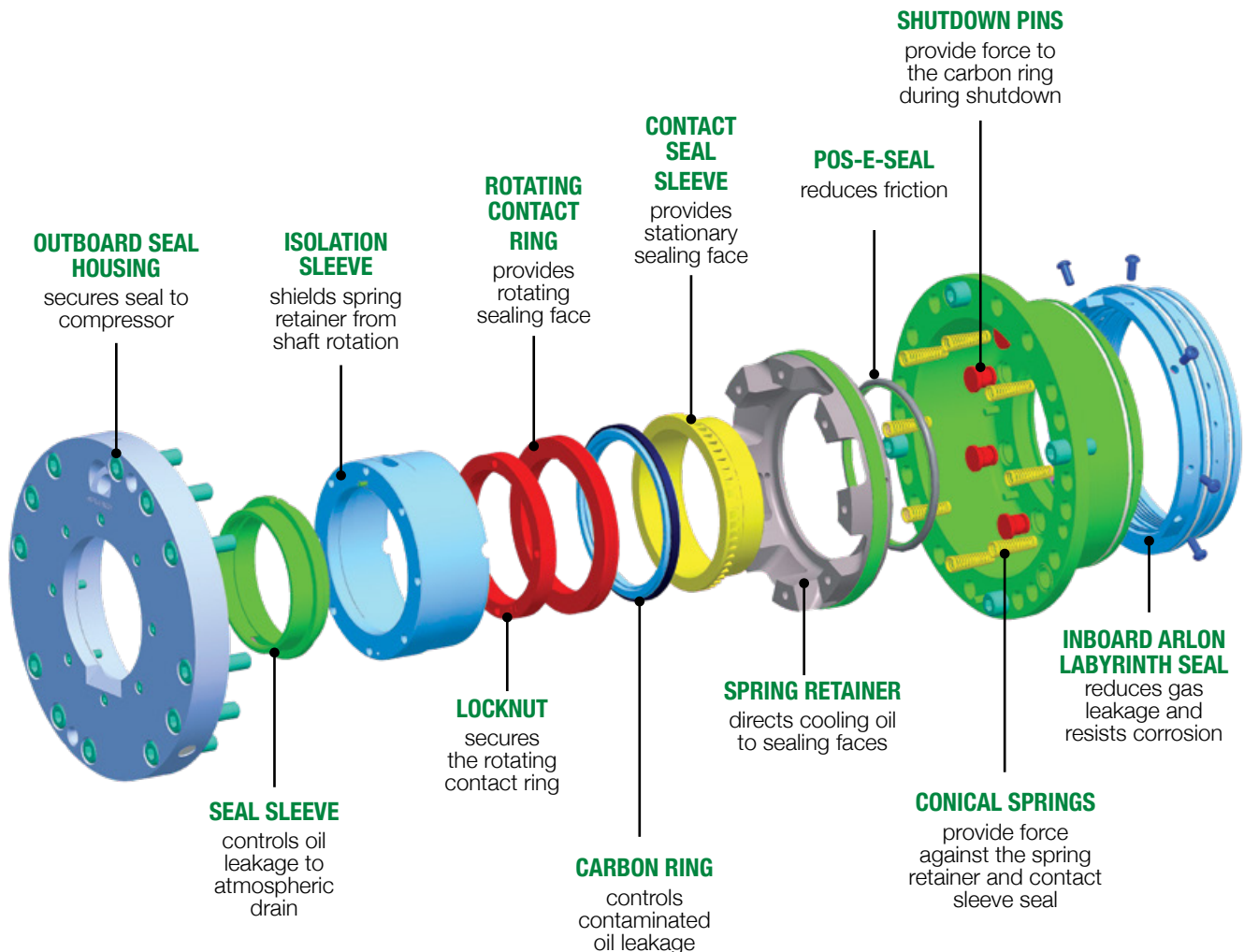


## ■ ISO-CARBON® CARTRIDGE SEALS

Elliott ISO-CARBON® cartridge seals are mechanical contact oil seals that use stationary and rotating components in conjunction with a stainless steel backed carbon ring to create a sealing surface. Oil lubricates, cools, and flushes the mechanical contacting surfaces. A thermoplastic labyrinth seal with rub-tolerant teeth replaces the traditional aluminum labyrinth to create a tighter seal, reduce the risk of oil ingestion, and resist corrosion and chemical attack from the process gas. The cartridge assembly is installed into a compressor as a single component, simplifying installation and maintenance. The Elliott ISO-CARBON cartridge seal offers:

- ♦ Pre-assembly of all parts for protection during storage
- ♦ Static leak testing to verify proper assembly before installation
- ♦ Simple installation of cartridge assembly
- ♦ Drop-in replacement without modification of the seal housing or rotor removal
- ♦ Elliott Pos-E-Seal included as a secondary seal to reduce friction
- ♦ Fail-safe design maintains the seal in case of seal oil pressure loss

ISO-CARBON cartridge seals are used in applications with sealing pressures up to 750 psig.

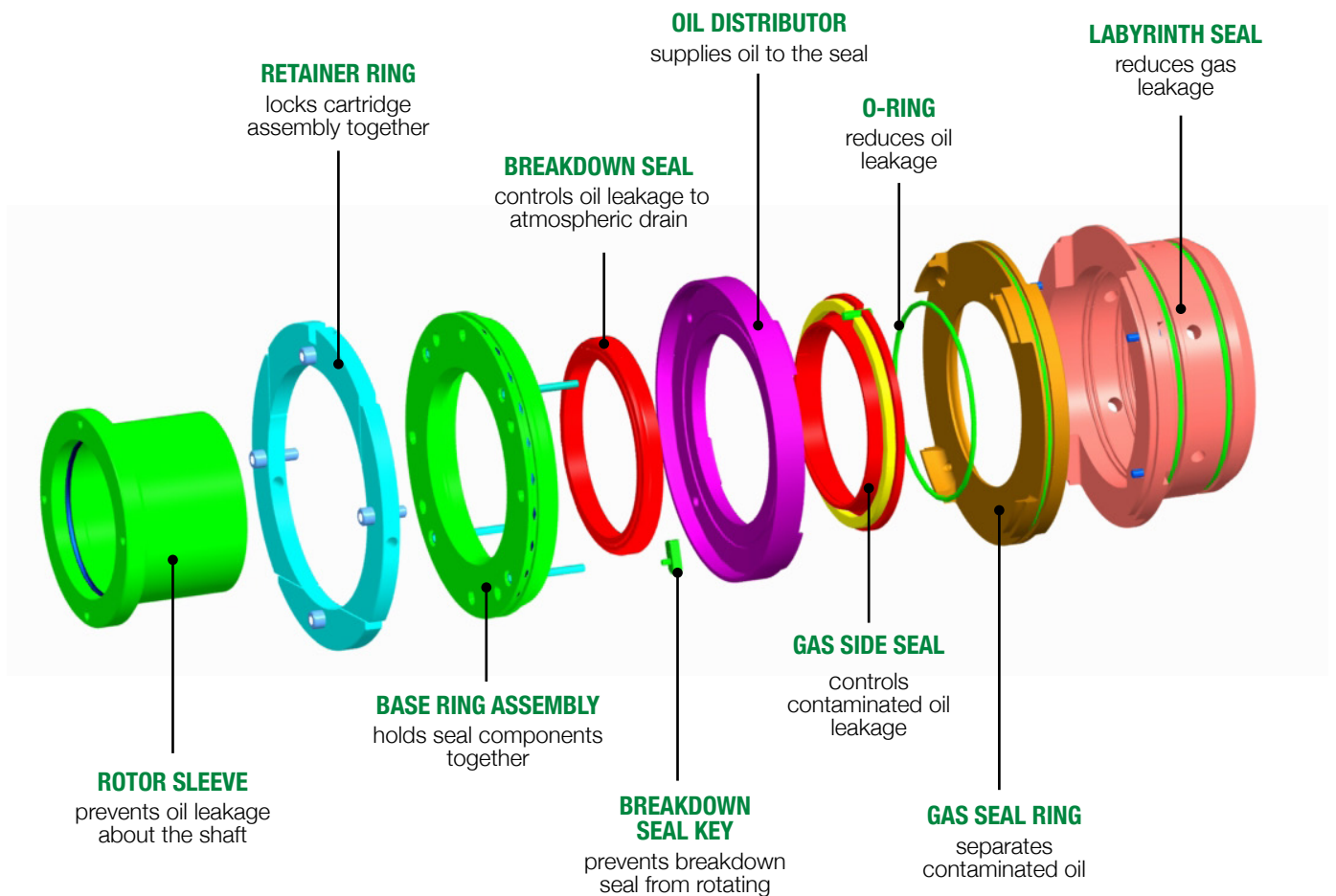


## ■ ISO-SLEEVE™ CARTRIDGE SEALS

The Elliott ISO-SLEEVE™ cartridge seal is designed for applications that exceed the pressure limitations of a mechanical seal and where gas leakage cannot be tolerated. The ISO-SLEEVE cartridge seal creates a liquid film seal by injecting oil between stationary bushings at a pressure higher than the process pressure. A thermoplastic rub-tolerant labyrinth seal and a gold babbitt coating on the breakdown bushings provide improved resistance to harsh sulfides and chlorides in process gases. The ISO-SLEEVE cartridge seal offers:

- ♦ Pre-assembly and protection during storage
- ♦ Cartridge assembly for reduced installation time
- ♦ Installation and maintenance without removing the bundle and the rotor of a barrel compressor
- ♦ Tungsten carbide coating on the rotor sleeve to minimize wear
- ♦ Rub-tolerant thermoplastic inboard labyrinth seal for increased chemical resistance and reduced buffer gas consumption
- ♦ A buffer gas connection for applications that require complete separation of process gas and seal oil

ISO-SLEEVE cartridge seals are used in applications with sealing pressures up to 4,200 psig.



## ■ DRY GAS SEALS

Dry gas seals are non-contact, dry running mechanical face seals that use a sealing gas to create a barrier between the process gas and the atmosphere. They have less mechanical loss than oil seals, improving efficiency. With no contacting surfaces, dry gas seals are extremely reliable, reducing downtime and unplanned maintenance expenses. Dry gas seals do not require a seal oil system, eliminating both the adverse environmental impact of contaminated oil and the maintenance costs associated with oil seals. Compared to oil seals, Elliott dry gas seals offer several benefits:

- ◆ Reduced process gas leakage
- ◆ Less complex support systems
- ◆ Increased reliability with fewer shutdowns and reduced maintenance
- ◆ Greater efficiency as a result of less mechanical loss
- ◆ Reduced contamination of process gas and bearing oil
- ◆ Environmental benefit of no contaminated seal oil



### *Dry Gas Seal Configurations*

Dry gas seal assemblies are available in single, double-opposed, and tandem configurations to suit all applications. The single seal arrangement is used for moderate pressure applications, where small amounts of inert, non-toxic, or non-flammable process gas leakage into the atmosphere do not present a problem. The single seal configuration is seldom used in oil and gas applications. Double-opposed seals are used primarily in toxic or hazardous gas applications, or to protect the process gas from outside contaminants if the suction pressure is below atmospheric pressure. An inert buffer gas is maintained at a higher pressure than the sealed process gas, resulting in leakage toward the process gas and preventing process gas from escaping to the atmosphere.

The tandem seal configuration is the most common in the oil and gas industry. Primary and secondary seal modules are oriented in the same direction, with or without an integrated intermediate labyrinth seal. The primary seal (process gas side) handles the full pressure drop, and the secondary seal (atmosphere side) serves as a backup and as an additional barrier between the process gas and atmosphere. The benefits of the tandem seal configuration include:

- ◆ Prevents process gas from entering the secondary seal, allowing it to vent to atmosphere
- ◆ Directs cooling gas to secondary seal faces, which typically run hotter than the primary seal

### *Dry Gas Seals*

Configuration	Application	Sealing Pressure
Double opposed seal	Low pressure, hazardous gas	< 250 psig
Single seal	Low pressure	< 400 psig
Tandem seal	Most popular, multiple arrangements	< 1,200 psig
Single seal, high pressure*	High pressure applications	<1,800 psig
Tandem seal, high pressure	Higher pressure applications	<2,900 psig

\* Seal design and component materials can be tailored to specific higher pressure applications or corrosive processes.

## ■ DRY GAS BUFFER SYSTEMS

Dry gas seals require a buffer gas system to supply a sealing gas between the mechanical face seals. Elliott dry gas buffer systems consist of a primary and separation gas supply to ensure that the gas face seals have a sufficient amount of filtered gas at all operating points. These systems support an ideal sealing environment to maintain optimum performance of the gas face seals. Elliott dry gas buffer systems are designed to American Petroleum Institute (API) 614 standards.



## ■ BOOSTER PACKAGES

Gas booster packages provide a positive flow of clean, dry gas to the seal during periods of low differential pressure across the compressor. A booster package provides a small amount of gas flow when the compressor is in a static, settled-out condition or at initial startup or shutdown when the pressurized gas within the compressor must be contained. Elliott booster packages are typically used in “wet gas” and natural gas applications to help eliminate process contamination, the leading cause of dry gas seal failures. The benefits of Elliott gas booster packages include:

- ◆ No power source required
- ◆ Robust standard system based on proven Elliott designs
- ◆ Piston-type positive displacement pump for ease of maintenance



## ■ GLOBAL SERVICE

### *Comprehensive Quality Service*

With a century of turbomachinery experience and a tradition of excellence, Elliott Group offers comprehensive service and support for all types of rotating equipment. Customers everywhere turn to Elliott because our resources are global and our response is local.

### *Elliott Engineered Solutions*

Elliott Engineered Solutions has one focus – to help customers obtain the highest value from their critical rotating equipment. Elliott Engineered Solutions specializes in the following areas:

- ◆ The modification and rerate of turbomachinery to increase the operational life and value of your investment
- ◆ On-site audits of rotating equipment to evaluate efficiency, determine potential reliability improvements, and maximize the performance and minimize the downtime of existing equipment
- ◆ Comprehensive analytical studies such as lateral and torsional rotor analysis, root-cause failure analysis, mechanical evaluation analysis, finite element analysis (FEA), and aerodynamic analysis
- ◆ Reverse engineering of rotating equipment from any manufacturer

### *Repair Centers*

Elliott's global network of full-service repair centers provides a complete range of service for Elliott and non-Elliott rotating equipment, 24 hours a day, 7 days a week. Our service teams include experienced, dedicated engineers, metallurgists, technicians, welders, machinists, and mechanics. Standard service procedures include:

- ◆ Repair and remanufacture of all rotating and stationary components including blades, impellers, diaphragms, shafts, seals, and bearings
- ◆ Weld repair, including sub arc, TIG, MIG, flux core, and stick
- ◆ Machine overhauls
- ◆ Rotor balance & storage

### *Field Service*

Elliott Field Service is recognized worldwide for its technical expertise and hands-on experience with turbomachinery of all types and manufacturers. Elliott Field Service crews overhaul, repair, and upgrade turbomachinery at customer sites in every region of the world with an excellent record of safety and on-time performance.





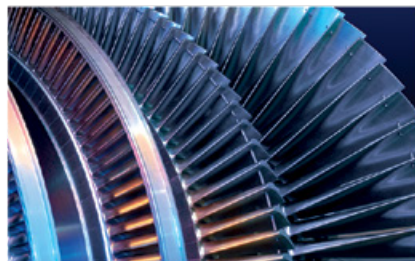
Elliott Group is a global leader in the design, manufacture, and service of technically advanced centrifugal and axial compressors, steam turbines, and power recovery expanders used in the oil & gas, petrochemical, refining, and process industries, as well as in power applications. Elliott Group is a wholly owned subsidiary of Ebara Corporation, a major industrial conglomerate headquartered in Tokyo, Japan.



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T H E W O R L D T U R N S T O E L L I O T T



C O M P R E S S O R S ■ T U R B I N E S ■ G L O B A L S E R V I C E