Ingersoll Rand

AIR SEPARATION AND INDUSTRIAL GASES

MSG® Centrifugal Compressors

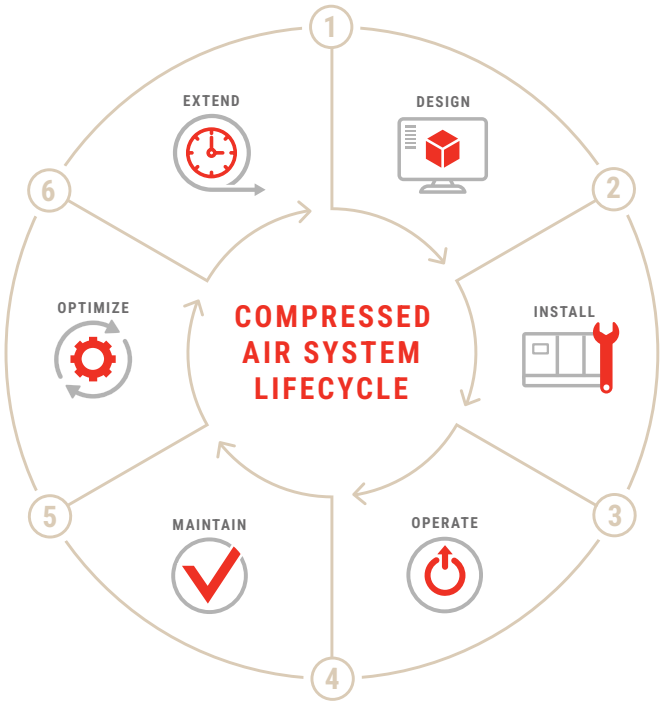
Your Trusted Partner in Compressed Air

Staying ahead of your competition with advanced compressed air systems and services that boost productivity, lower operating expenses and extend equipment life is critical to your success.

No matter the industry or application, you can count on Ingersoll Rand® as a trusted partner for centrifugal compressed air technologies and services. By focusing on you and your business, we provide collaborative solutions that make you successful, offering a total system approach to maximize efficiency and performance.

Take a Systems Approach

Delivering reliable compressed gas to your process goes well beyond the compressor itself. To maximize performance, it is imperative to manage the entire lifecycle of your compressed gas system. Your system can be optimized at many points—from design to operation to overhaul. Your operation will benefit from Ingersoll Rand's partnership through our extensive experience and global expertise to ensure reliability, lower maintenance costs and ease of service.



Let's Get Started...Together

Watch the Ingersoll Rand Contracting Services Video

A History of Innovation

1955
Joy Manufacturing Co. established facility in Buffalo, N.Y.

1987
Cooper Industries Inc. purchases Joy Manufacturing Co.

1995
Cooper Cameron Corporation established

2015
Ingersoll Rand acquires Cameron's Centrifugal Compression division

What Makes Our MSG Centrifugal Compressors Unique?

Compare the MSG's innovative centrifugal compressor technology to others—the advantages are clear.

	MSG TURBO-AIR COMPRESSORS	OTHER COMPRESSORS
LOW MAINTENANCE	• Long-life stainless-steel compression elements • Accessible horizontally split gearbox for quick inspection • Removable intercooler and aftercooler bundles for easy cleaning	• Require regular maintenance, such as replacing piston rings, gland packing and valve plates, or periodic air end replacement • High operating expenses and significant machine downtime
OIL-FREE AIR	• 100% oil-free gas • Prevents system contamination • Eliminates expense and complexity of oil separation system	• Oil separators must be installed at discharge • Potential for oil carryover to foul the valuable process equipment • Oil-free claim is dependent on uninterrupted seal gas supply
RELIABILITY	• Centrifugal compressors have industry-leading 99.7% MTBF • Conservative high-quality gear design • Highly resilient to surge events	• Contacting compression elements are subject to wear • Limited rotating element life • Designed-in wearing items to generate aftermarket revenues • Require costly surge control systems to avoid seal and bearing damage
OPTIMUM CONTROL	• Inlet guide vane control and bypass for consistent gas delivery • Automatic operation and precision control • State-of-the-art controls, including PLC systems	• Expensive variable-frequency controls may be required to adjust capacity • Cylinder unloading for stepped flow control can result in complicated process control due to sudden changes in capacity
COMPACT INSTALLATION FOOTPRINT	• Single-lift skid or maneuverable modules • Simple foundation requirements • Reduced floor space and accessible components • Virtually pulsation and vibration-free	• Require additional external speed-changing gearbox for drivetrain input • Require pulsation dampers to reduce pressure fluctuations • Large and deep foundations to handle heavy weight and unbalanced forces • Precautions must be taken to prevent vibration transmission to other equipment

Low Total Cost
of Ownership

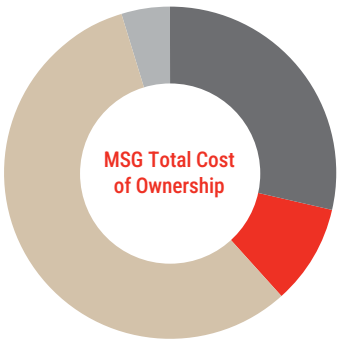
Energy use is the biggest long-term cost of running a compressed air system, especially with today's changing energy prices. To understand your return on investment, consider the full lifecycle cost—including the purchase price, energy use, and maintenance.

Installation
- Commissioning services

Energy
- Aerodynamically efficient to reduce electrical power or steam consumption
- IGV control

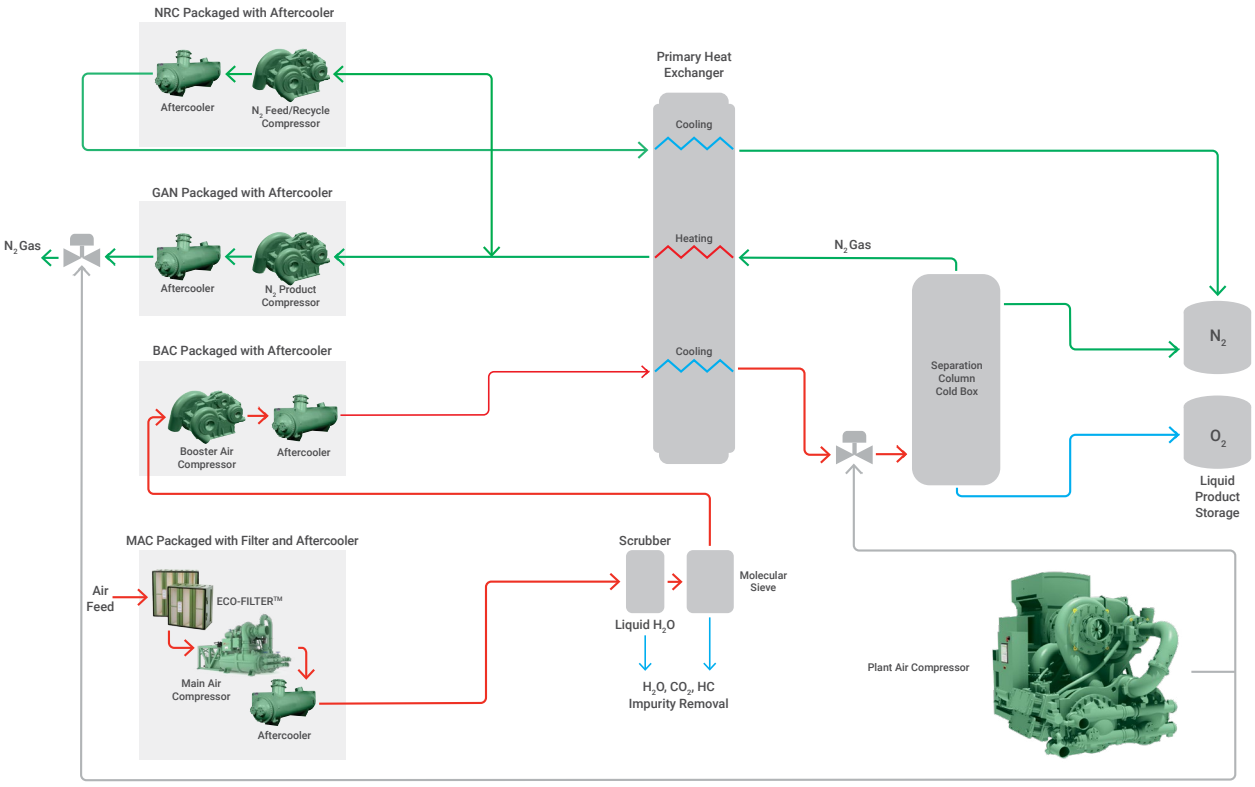
Maintenance
- Global service tech network
- OEM parts
- Diagnostic and repair services
- Remote monitoring

Initial Capital Expense



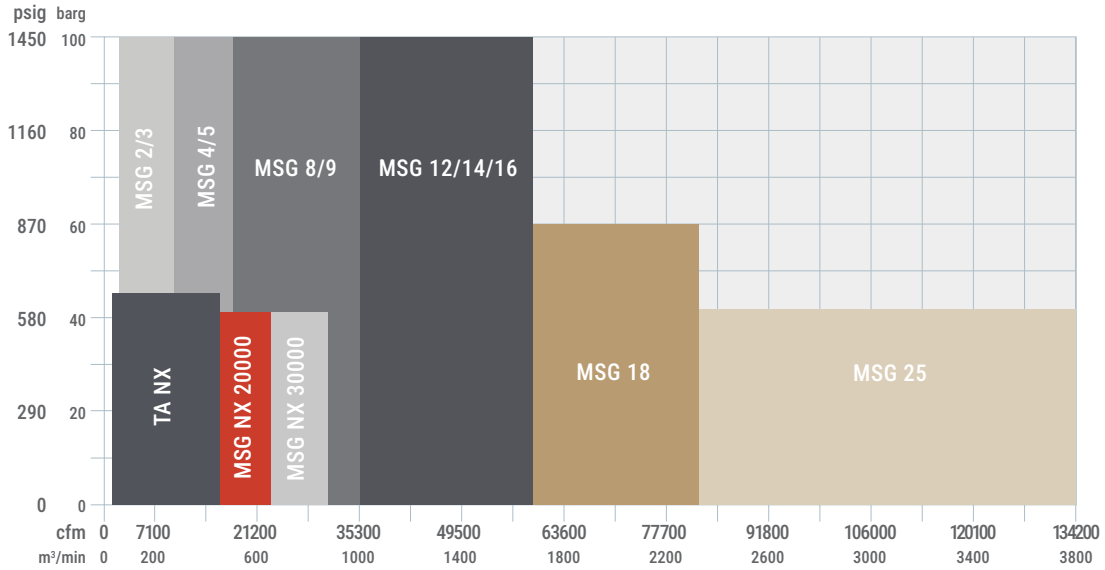
Comprehensive Solutions for Air Separation

MSG compressors are used for many purposes in the air separation process, including the main air compressor, booster air compressor, nitrogen gas compressor, nitrogen recycle compressor and argon gas compressor.



MSG Performance Ranges

See Our Portfolio MSG centrifugal compressors



Superior Centrifugal Design

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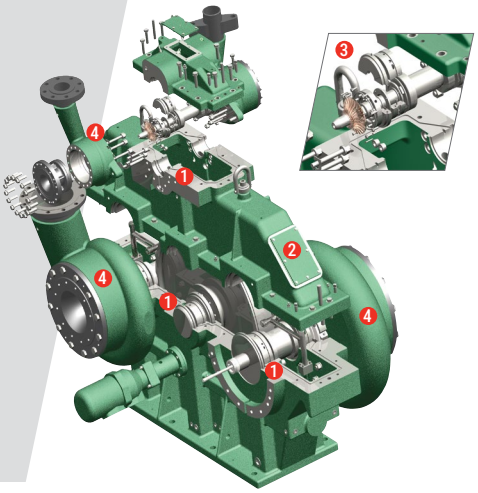


Independent Compression Stages

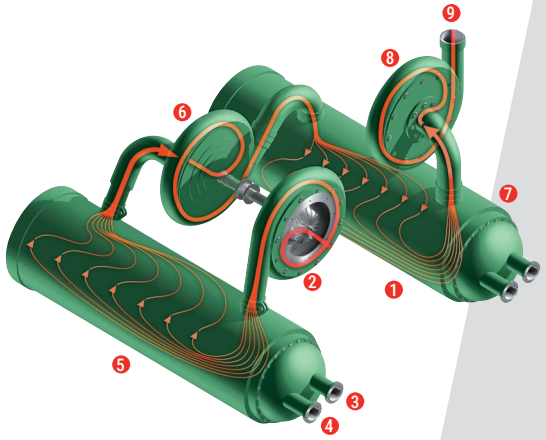
MSG technology separates each compression stage as its own "mini-compressor", improving performance.

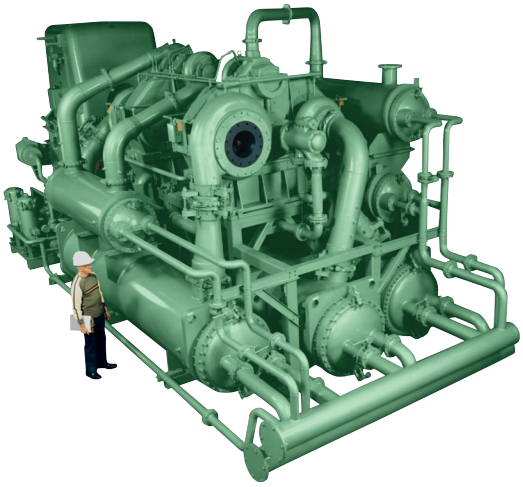
1. One, two or three rotors with up to six independent stages per gearbox with optimized speed to match impeller/diffuser design
2. Horizontal split line(s) provide easy access to parts for inspection and maintenance
3. Each stage is independently sealed
4. Scrolls and aerodynamic components are selected and engineered for each specific stage process requirement

Intercooling

Gas may be cooled after every stage to assure a high isothermal efficiency and better gas flow.

1. Compressor inlet
2. 1st stage compressor volute
3. Coolant in
4. Coolant out
5. 1st stage intercooler
6. 2nd stage compressor volute
7. 2nd stage intercooler
8. 3rd stage compressor volute
9. Compressor discharge





Multiple Process Capability

Integrating multiple processes into a single compressor reduces energy consumption, shrinks the installation footprint, and lowers overall maintenance costs.

In the air separation industry, MSG compressors are trusted for various multi-process applications, including:

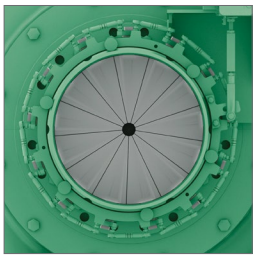
- MAC/BAC (main air compressor/booster air compressor)
- MAC/GAN (main air compressor/nitrogen gas compressor)
- Nitrogen feed and recycle services

The Right Compressor for
Your Application

With experienced design teams and numerous available configurations, our MSG compressors are application engineered to deliver the performance and quality you need.

Custom Engineered
- Optimized performance for specific conditions
- Tailor-made to include critical features

Robust Components
- Rotating components
- Reliable lubrication system
- Multiple seal options



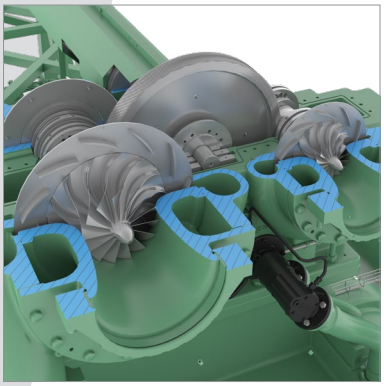
Power-Saving Designs
- Variable inlet guide vanes
- Efficient tapered thrust collars

Simplified Operation
- Intuitive control
- Easy maintenance heat exchangers

Industry-leading Features

Our entire portfolio of compressors for air separation and industrial gas solutions include unique features that provide this performance and quality specific to your application. **Learn more on the following pages.**

MSG NX 30000 Centrifugal Compressor

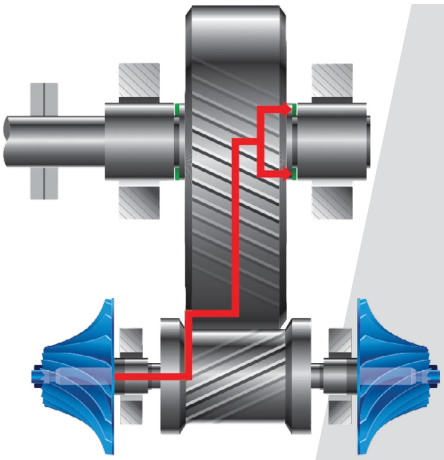


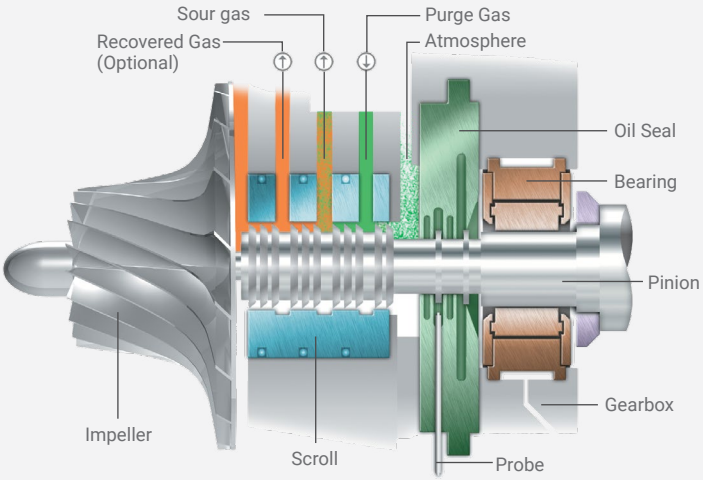
Robust Rotating Component Design

- High-efficiency AGMA 13 gearing
- Five-axis milled impellers
- Split seal and bearing design for simplified inspection
- Non-contacting gas and oil seals
- Stainless steel rotation compression elements

Tapered Rider Ring Thrust Collars

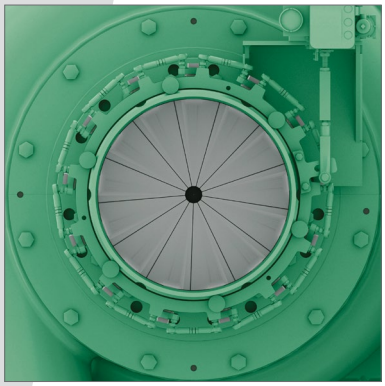
- Symmetrical design cancels power-robbing thrust loads
- Small remaining net thrust transferred by oil wedge from tapered thrust collar to bull gear
- Net thrust absorbed by low-speed thrust bearing
- Balanced design saves power while maximizing mechanical integrity





Reliable Gas Seal Design Options

- Plain labyrinth-style
- Abradable (babbitted) labyrinth-style for low leakage
- Buffering and educting arrangements for process gas recovery
- Dry-face seals for maximum sealing
- Tandem and backup seal arrangements for added protection

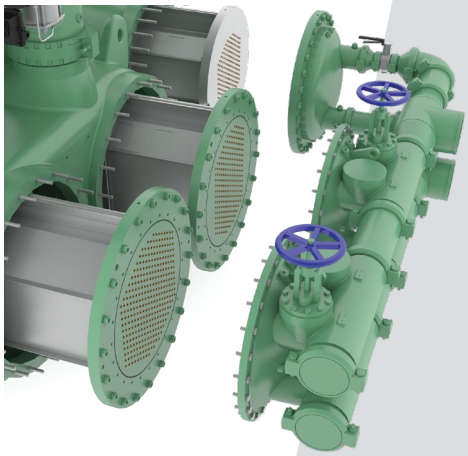


Cost-saving Variable Inlet Guide Vanes

- Up to 9% power savings compared to alternative throttling technology
- Pre-rotate the gas stream in the same direction
- Power savings in turndown or during cold temperature days

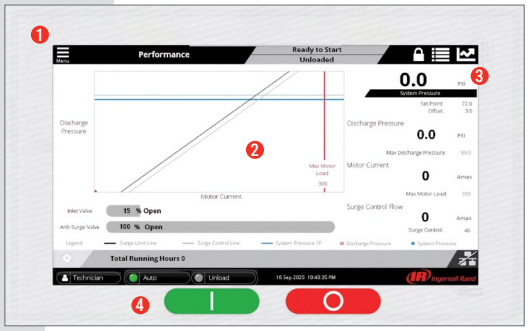
Efficient, Accessible Heat Exchangers

- Extended-surface, plate-fin design provides increased heat transfer with reduced space requirements
- Water-in-tube cooler designs allow for easy cleaning in areas with poor water conditions
- Accessible, smooth-bore tubes are easily rodded with bundles in place
- Compliant with global pressure vessel regulations (ASME, PED, GB, CU TR, KOSHA and more)



Customizable Lubrication System

- Includes an oil reservoir, mechanical oil pump, electric full-flow auxiliary oil pump, fixed-bundle oil cooler, full-flow oil filter, safety devices, and instrumentation for safe compressor operation
- Welded interconnecting piping in carbon steel or stainless steel
- Can be designed to meet custom specifications, such as API 614



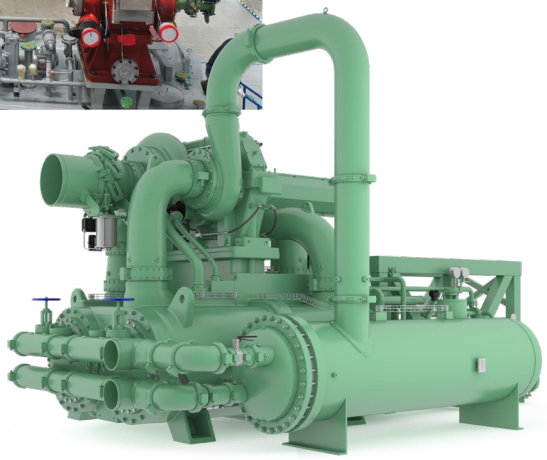
See our portfolio of compressor controls

Intuitive Compressor Controls

The MXS Controller, part of the MAESTRO™ family, delivers next-generation performance for centrifugal compressors. Built for demanding industrial environments, it combines intuitive operation, robust connectivity and advanced logic to maximize uptime and efficiency

1. Intuitive 10.1 inch, 16:9 industrial touchscreen display
2. Real-time discharge pressure and motor load performance graphs for proactive adjustments
3. Factory-standard IoT cloud access enables remote monitoring and predictive maintenance
4. Easy start/stop control

Compressor Quality Assured



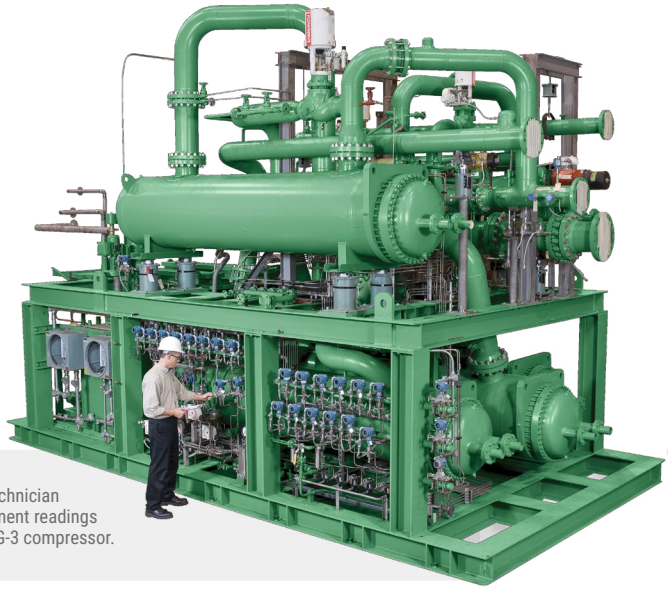
- Critical quality certifications, including ISO 9001, ISO 14001 and OHSAS 18001
- Robust engineered-to-order (ETO) process to create custom engineered machinery
- Advanced manufacturing capability including both assembly and package fabrication
- Comprehensive test laboratory with large scale test benches capable of full-load and closed-loop testing with various test gases

Field Service

Ingersoll Rand's field service team provides the technical expertise necessary to ensure seamless compressor operation and process integration. Our factory-trained technicians specialize in the on-site coordination of essential services, including:

- Installation and startups
- Vibration analysis and field balancing
- Turnaround and diagnostic inspections
- Control system services
- Performance evaluation and preventative maintenance

Find out about our field service capabilities



A field service technician evaluates instrument readings on a 5-stage MSG-3 compressor.

Global Service Centers

Servicing centrifugal compressors requires high levels of expertise and precision to maintain tight manufacturing tolerances and ensure compressor performance. Ingersoll Rand has the facilities, equipment and experience strategically located throughout the globe to provide a complete range of services from simple parts inspections to complete compressor overhauls.

Benefits of Our OEM Service Centers

- Access to original design specifications
- Complete service history to ensure accuracy
- In-house rework performed with proper equipment
- Full mechanical and aerodynamic testing capabilities
- Globally located: North Carolina, United States; Milan, Italy; Ahmedabad, India; Shanghai, China

OEM Replacement Parts and Accessories

Whether your compression requirements have changed, or you are looking for increased efficiency, Ingersoll Rand offers a variety of performance-enhancing solutions that can improve your operation.

As the MSG compressor OEM, Ingersoll Rand provides exact replacement parts for all maintenance and service needs, from bull gears to missing bolts. We maintain detailed records for every compressor built and offer extensive global inventory backed by our OEM guarantee.

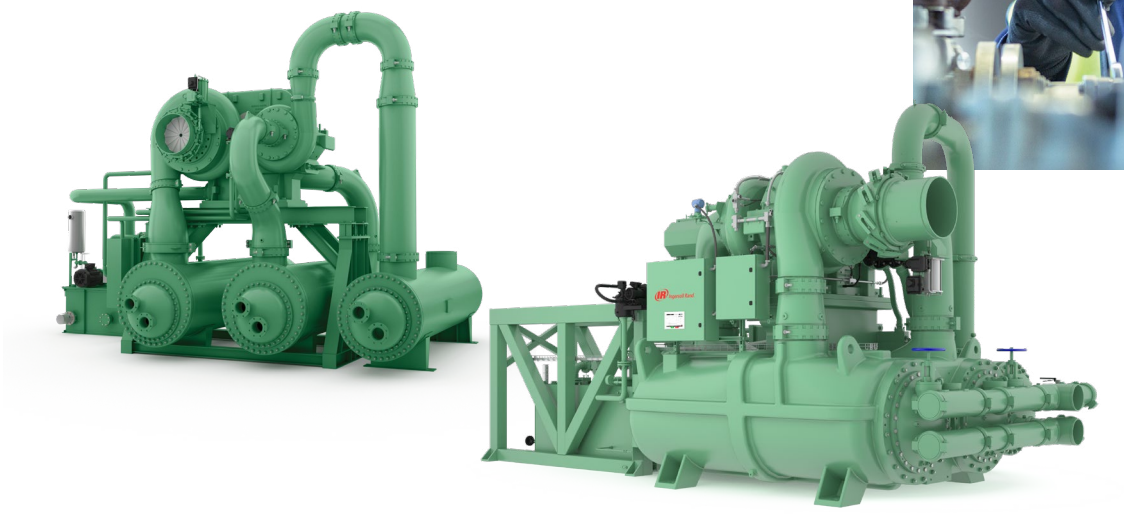
See our portfolio of OEM parts & accessories

Performance Enhancing Upgrades

Beyond standard maintenance, we also help you adapt to shifting operational demands. Ingersoll Rand offers aerodynamic modifications to optimize your existing performance for current process gas requirements. This includes re-rates for new pressure and flow levels, air-end upgrades for expanded turndown and rise to surge, and custom 5-axis milled impellers for enhanced performance.

Excellence in Engineering

Maximize your total cost of ownership with Ingersoll Rand's extensive knowledge of compressor system design, applications, technologies and services—**we are your trusted partner in air separation and industrial gas systems.**



About Ingersoll Rand Inc.
Ingersoll Rand Inc. (NYSE:IR), driven by an entrepreneurial spirit and ownership mindset, is dedicated to Making Life Better for our employees, customers, shareholders, and planet. Customers lean on us for exceptional performance and durability in mission-critical flow creation and life science and industrial solutions. Supported by over 80+ respected brands, our products and services excel in the most complex and harsh conditions. Our employees develop customers for life through their daily commitment to expertise, productivity, and efficiency. For more information, visit www.IRCO.com.

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