


PLANT AIR PACKAGE



**P/P**  
**PAUS**<sup>®</sup>

RELIABLE 100% OIL-FREE ENGINEERED AIR



**ELLIOTT**<sup>®</sup>

A World Leader for Centrifugal Compressors

# PAP PLUS® – WORLD CLASS COMPRESSORS

## FS-ELLIOTT DELIVERS THE WORLD'S MOST RELIABLE SOURCE OF ENGINEERED AIR TO YOUR INDUSTRY.

Wherever there is a requirement for engineered air, PAP PLUS® centrifugal compressors from FS-Elliott offer an exclusive, purpose-built package of unparalleled benefits.

In addition to the traditional air applications, FS-Elliott is the leader in providing API 672 compressor packages. With our experienced engineering staff and vast installation base, we customize our compressor package designs to meet client specifications and demanding conditions. These compressor packages can be found in oil and gas production facilities, oil refineries, and petrochemical plants around the globe. The API 672 compressor package is yet another example of FS-Elliott providing true engineered air where it really counts.

Our energy efficient machines not only save power, they save manpower – with reliability and ease of maintenance that let you stay focused on your business. And because PAP PLUS® compressors deliver clean, oil-free engineered air, you can rest easy knowing your air lines, instruments and processes will remain uncontaminated.

From the smallest to the largest compressor models, the FS-Elliott design philosophy is simple and consistent: we combine unyielding reliability with leading-edge technology to ensure that your vital operations will never be interrupted or compromised. This philosophy, along with comprehensive, full life-cycle service, has made FS-Elliott a world leader in engineered air technology.

PAP PLUS® CENTRIFUGAL AIR COMPRESSORS COMBINE EFFICIENCY, ECONOMY, AND RELIABILITY IN MODELS FROM 1,500 TO 18,000 CFM (2,520 TO 30,600 m<sup>3</sup>/hr); AND 350 TO 3,500 HP (260 TO 2,600 kW).



# COMMITMENT TO RELIABILITY



## 10 WAYS FS-ELLIOTT ENSURES RELIABLE ENGINEERED AIR

### 1 HIGH BASE-LOAD AND PART-LOAD EFFICIENCY

- Precision state-of-the-art impeller designs provide for highly efficient air compression.
- Optimized aerodynamic stage matching and intercooler efficiencies minimize power requirements.
- Backward-leaning impeller designs can effectively be controlled for optimum air flow.

### 2 OPTIMIZED OPERATIONAL EFFICIENCY THROUGHOUT THE ENTIRE YEAR

- PAP PLUS® inlet control adjusts to changing ambient conditions and plant load variations to conserve energy.

### 3 MINIMUM NUMBER OF MOVING PARTS

- No major sliding or rubbing parts to wear.
- No coating on rotating elements to wear.

### 4 ROBUST AND RELIABLE INDUSTRIAL DESIGN

- High-precision AGMA Quality 13 / ISO-DIN 4 helical gears to minimize noise and vibration.
- Self-adjusting tilt or flex pad journal bearings adapt to load changes, providing superior stability compared to fixed geometry bearings.
- Double-acting thrust capability to accommodate all load conditions.
- Stainless steel impellers resist corrosion and erosion.
- Precision component balanced rotors.

### 5 SUPERIOR PACKAGE DESIGN

- An “all-inclusive” designed package.
- Reliable and efficient trouble-free operation.
- Package is designed to assure low vibration levels.
- Self-contained, low-pressure lubrication system.
- Controls are easily accessible on the unit for local operation.
- Highly efficient intercoolers are built into the package and designed to provide ease of maintainability and reliability.

### 6 SIMPLE, LOW-COST INSTALLATION

- Package is designed to minimize the number of external connections.
- Compact design minimizes foundation and floor space required.
- Quiet operation.

### 7 ELIMINATION OF AIR LINE OIL CONTAMINATION

- PAP PLUS® is designed to be oil-free.
- Cleanliness certification available.
- Oil contamination is eliminated.

### 8 EASE OF OPERATION

- Simple and easy-to-use menu driven controller operated via the newest technology displays.
- Controller handles automatic start-up and shutdown sequence and prompts appropriate operator actions.
- Real time monitoring of temperature, pressure, and vibration.

### 9 EASE OF MAINTENANCE

- Equipment components are easily accessible.
- Horizontal-split gearbox, pinion bearings, bull gear bearings, and seals permit easy inspection and service.
- Intercoolers may be cleaned in place by rodding.
- Bull gear and pinion gears can be replaced individually (i.e., not matched sets).

### 10 PROFESSIONAL SERVICE

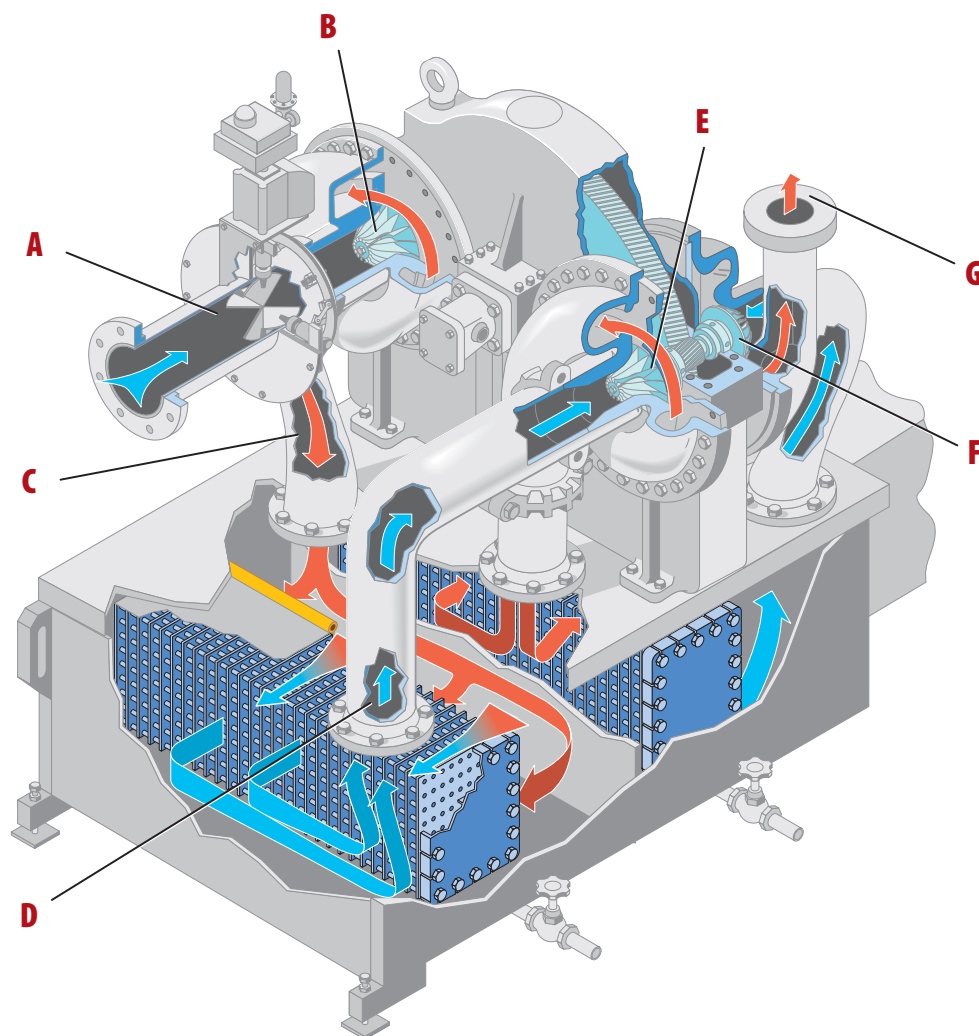
- Reliable assistance available upon request.
- 24/7/365 responsiveness.
- Decades of professional service experience.
- Global service network.
- Complete service packages available, including operation and maintenance training.

# OPERATION

## IT'S SIMPLE:

**PAP PLUS® COMPRESSORS DELIVER OIL-FREE ENGINEERED AIR RELIABLY AND EFFICIENTLY**

Simplicity means reliability, and the design of the PAP PLUS® compressor is simplicity defined. The only moving parts are a gear and the rotors. And, because this is a centrifugal design, there are no lubricated parts in the air passage – so you can count on getting oil-free, engineered air.



## Typical Operation

- A** Ambient air enters the first stage through the inlet control device.
- B** The first stage impeller accelerates the air. A radial diffuser converts the air's velocity into pressure before the air enters an efficient scroll casing.
- C** The air is ducted through interstage piping into the first intercooler.
- D** The cooled air then flows into the second stage inlet piping.
- E** The compression process is then repeated through a diffuser, into a scroll casing, and then into the second intercooler.
- F** Air from the second intercooler then moves through a third impeller, diffuser, and scroll casing.
- G** Air is discharged into the aftercooler and air system.



# AERODYNAMIC PERFORMANCE

## IMPELLERS...

### BACKWARD-LEANING FORWARD THINKING

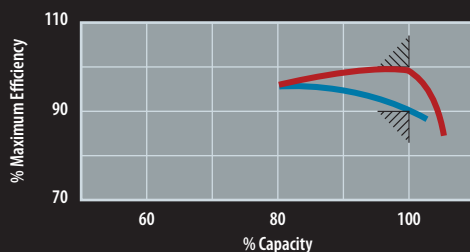
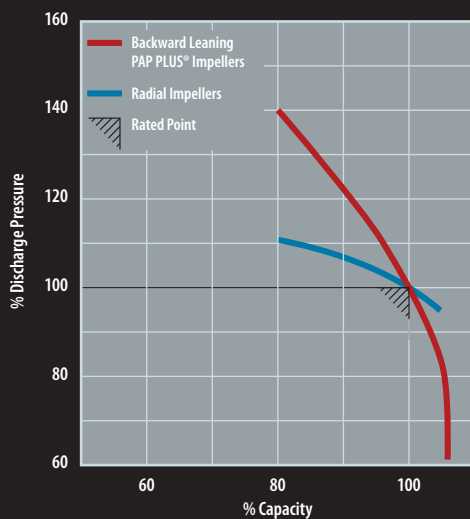
The impellers of the PAP PLUS® compressor are constructed from high strength stainless steel. The precipitation hardened, stainless steel material resists the corrosive and erosive action of atmospheric contaminants and water vapor that may pass through the inlet air filter.

The state-of-the art backward-leaning impeller design provides superior overall aerodynamic performance characteristics. Three important benefits are shown in the graphs below.



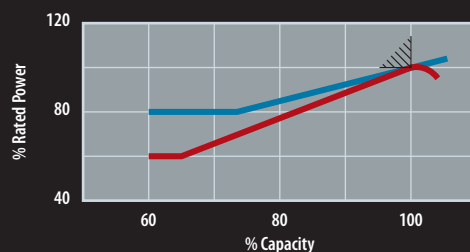
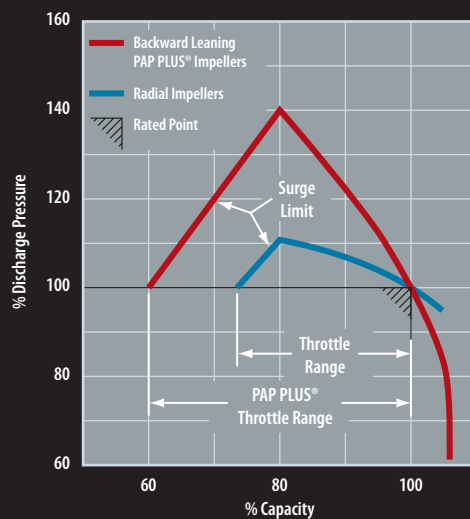
## PAP PLUS® – LEADING-EDGE TECHNOLOGY

PAP PLUS® – HIGHER EFFICIENCY AT RATED POINT



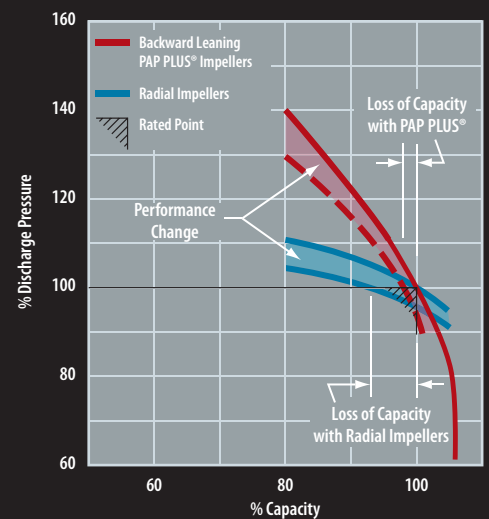
Backward-leaning impeller designs place the optimum compressor efficiency at the rated point.

PAP PLUS® – HIGHER EFFICIENCY AT PART LOAD



Backward-leaning impeller designs produce a higher pressure rise over the entire compressor operating range. This inherent design characteristic makes it possible to reduce power consumption by throttling the compressor at part load. Radial or quasi-radial impeller designs do not yield as large a throttle range as the backward-leaning design.

PAP PLUS® – HIGHER OFF-DESIGN POINT EFFICIENCY



The inherently greater pressure rise to surge of the backward-leaning impeller naturally provides for a more tolerant operation, especially when the actual site conditions differ from the original design parameters. High air or cooling water temperatures will reduce the output of a compressor. The backward-leaning impeller design experiences a smaller reduction in output. Overall, a backward-leaning impeller design provides excellent efficiency and is the most forgiving impeller design known today for centrifugal compressors.

# MECHANICAL DESIGN

## Every component designed with your needs in mind

The PAP PLUS® compressor is derived from using current codes and industry standards as well as state-of-the-art technology for bearings, gears, and rotor dynamic design.

The compressor cut-away view depicts the typical PAP PLUS® internals. The compressor driver is connected to the main drive shaft end of the bull gear through a flexible coupling. The single helical bull gear is supported by two horizontally-split sleeve journal bearings, while the thrust is absorbed in either direction by flat-land thrust bearings. The bull gear drives two pinions with mounted impellers. The pinion shafts are designed to operate at the optimized rotational speed for the best efficiency.

The aerodynamic configurations include an impeller mounted on one of the pinions and two impellers mounted on the other pinion. Each pinion and impeller assembly comprises a rotor, which is supported by two tilt or flex pad journal bearings. Two tapered-land thrust bearings absorb the residual thrust force transmitted through two thrust faces on the pinion.

A shaft seal located at each impeller seals oil in the gear-box and out of the compression chamber.

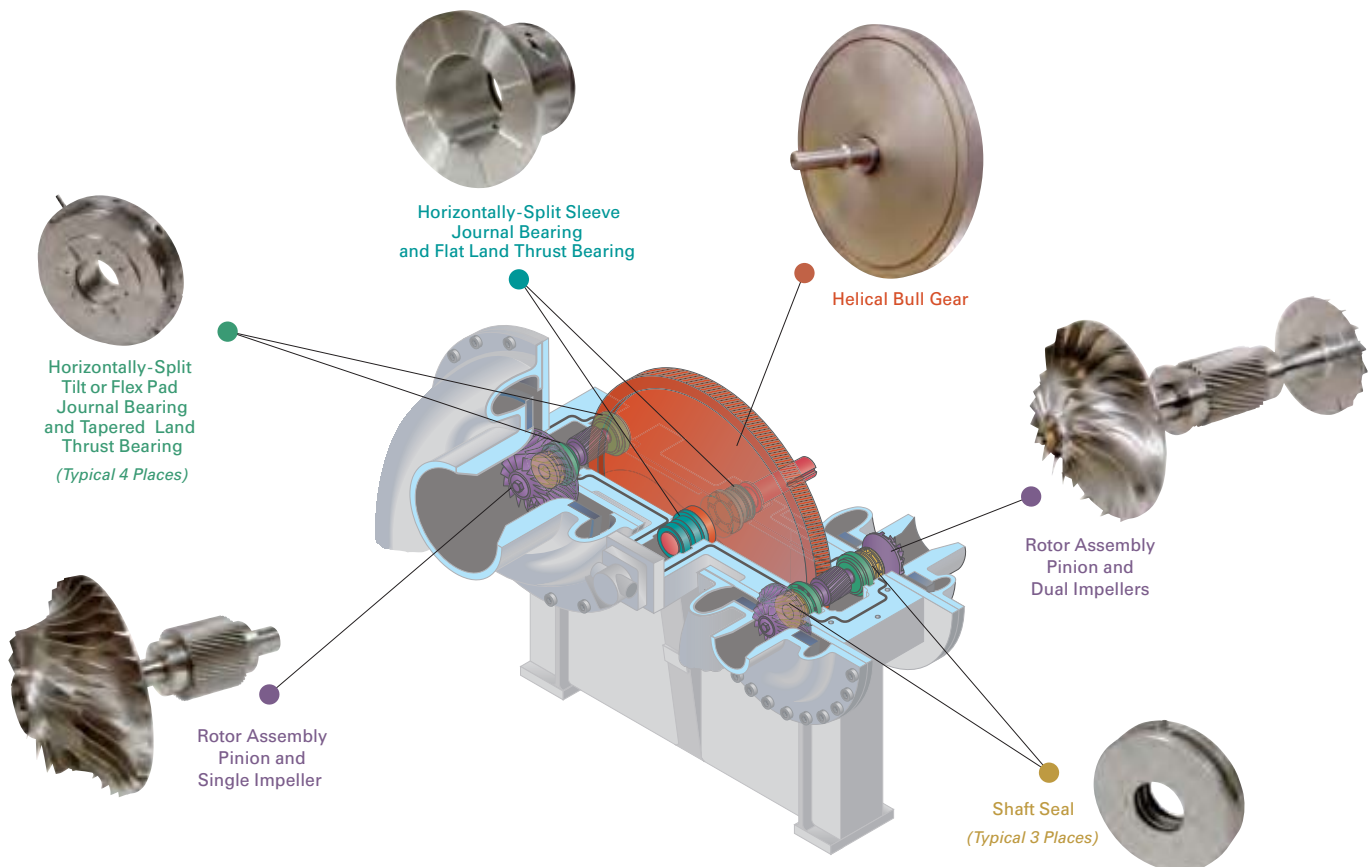
PAP PLUS® rotor dynamic characteristics have been meticulously analyzed to arrive at the ultimate design that assures smooth, reliable and lasting compressor operation. The most sophisticated software tools were utilized to derive the rotor system configuration, which was then prototype tested and verified in the laboratory. Take note of the following features:

- Short rotor length. The compact shaft seal design of the PAP PLUS® permits extremely short shaft lengths, which means that centrifugal forces are not amplified through a long lever arm.
- Rotors are supported by self-centering, horizontally-split tilt or flex pad journal bearings for best stability through the entire operating range of loads and temperatures.
- The net resulting thrust forces imposed by the helical gears and the air pressure distribution on the impellers are analyzed over the entire operating



range. Any remaining residual thrust forces are absorbed by the tapered-land thrust bearing.

- For added reliability, each PAP PLUS® rotor has its own thrust bearing system to absorb thrust where it is created, rather than transmitting the thrust forces through the bull gear to a single bearing.
- During running periods, the helical gear thrust force remains relatively constant while the pressure forces on the impeller can vary with operating conditions. Good design practice dictates that thrust is absorbed in both axial directions. All PAP PLUS® rotors have thrust capability in either axial direction via tapered-land thrust bearings.



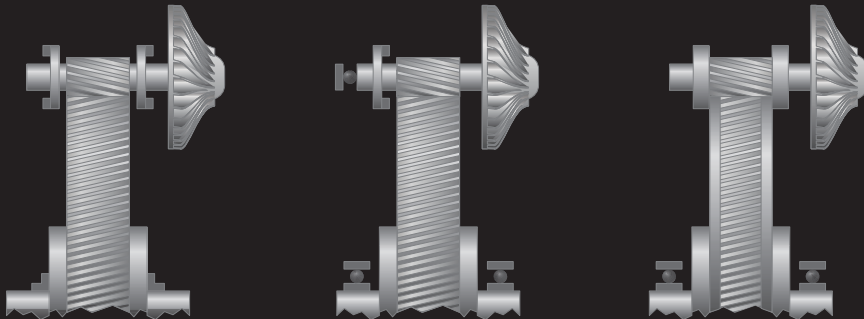
# BEARINGS AND SEALS

## JOURNAL BEARING FUNDAMENTALS



OPTIMUM PERFORMANCE FEATURES	PAP PLUS® TILT OR FLEX PAD	LOBE OR TILTED PAD	HYDRODYNAMIC SQUEEZE FILM
Load Carrying Capacity	Superior	Good	Superior
Stability and Low Vibration	Good	Modest	Good
Self Centering	Yes	No	Yes
Low Oil Supply Pressure	Yes	Yes	No
Accommodates Shaft Radial Movement/Eccentricity	Yes	Moderately	Low
Friction Losses	Low	Low	Low
Sensitive to Damage by Foreign Matter	Low	Moderately	High
Inspection Time / Costs	Low	High	High
Replacement Costs	Low	Low	High

## THRUST BEARING FUNDAMENTALS



PAP PLUS® DOUBLE-ACTING	SINGLE ACTING	RIDER RING
Thrust Absorbed at Each Rotor	Thrust Absorbed at Each Rotor	Thrust Transmitted Through Drive Gear
Bearings Absorb Thrust in Both Axial Directions	Bearings Absorb Thrust in One Axial Direction	Bearings Absorb Thrust in Both Axial Directions
Lightly Loaded	Lightly Loaded	Heavily Loaded
Babbitt to Metal Construction	Babbitt to Metal in One Bearing	Steel to Steel – Sensitive to Damage by Foreign Matter
Can Operate Safely Under All Conditions	Rotor Must Be Loaded in One Direction Only	Must Operate Under Clean Conditions



Horizontally-split pinion bearing assemblies combine tilt or flex pad journal bearings and tapered land thrust bearings. These precision-designed packages assure smooth and stable operation over the entire compressor operating range (i.e. from low load to full load conditions).



PAP PLUS® rotor design features extremely short shaft lengths. Every PAP PLUS® rotor assembly is dynamically balanced.



PAP PLUS® pinion shaft seal technology is the result of years of design and operational experience. The carbon ring seal assures oil-free air.



Bull gear bearings are horizontally-split for easy inspection and maintenance. The combination flat-land thrust bearings and sleeve journal bearings are made of steel with babbitt lining.

# PRESSURE LUBRICATION SYSTEM

## LUBRICATION WITHOUT CONTAMINATION

The PAP PLUS® oil lubrication system has proven its reliability through many years of successful operating experience. The system is self-contained within the compressor package and is designed for easy access and maintenance. Every lubrication system is factory assembled and tested prior to shipment. This PAP PLUS® system provides for all of the package's needs, which include continuous oil flow to all bearings and gears, as well as the driver when required.

The oil lubrication system is designed with ease of inspection and maintenance as one of its primary goals. Therefore, all of the oil connections are positioned in the lower half of the gear case for quick and simple access to the bearings, gears, and pinions.

The oil reservoir is located within the package's baseplate. The reservoir interior is conveniently accessible through an oversized cover. Each reservoir has fill and drain connections and an easy-to-view oil level gauge.

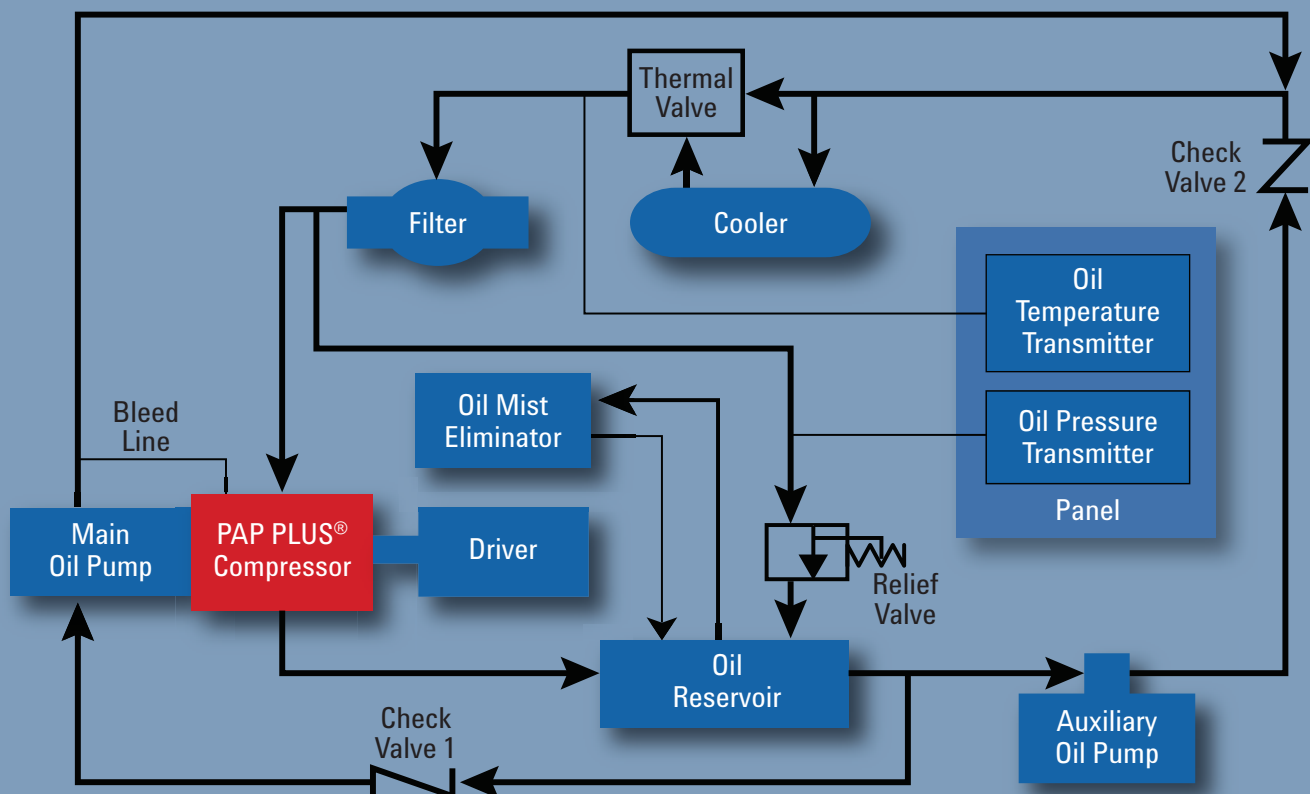
The oil cooler is sized to provide cooling under design and off-design conditions. The full-capacity oil filter eliminates contaminants 10 microns or larger, and its mounting location was selected for easy access to allow changing the filter without draining the reservoir.

The full-flow auxiliary oil pump, with electric motor drive, operates automatically during start-up, shutdown, and in emergency situations to provide additional overall package protection.

The positive-displacement main oil pump is directly driven by the bull gear or driver shaft. The pump is oversized and will continue to provide lubrication to the system during coast-down to a safe stop.

The system includes temperature and pressure control valves. Sensors continuously monitor the inlet oil pressure and temperature, and provide machinery protection. Alarm or trip functions activate in the unlikely event they are required.

The gearbox and reservoir operate slightly above atmospheric pressure. Venting of the oil mist is done through a mist eliminator, which returns all of the coalesced oil to the reservoir.





# CORONA™ BRAND LUBRICANTS



## SUPERIOR PERFORMANCE IN A VARIETY OF ENGINEERED LUBRICANTS

FS-Elliott recommends the use of our exclusive selection of Corona™ lubricants for optimum operation and maximum service life. These premium fluids are specifically engineered for use in centrifugal compressor applications. All new FS-Elliott compressors are supplied with Corona™ lubricants. In addition, these lubricants can be easily retrofitted into existing installations.

### • BENEFITS

- Extended lubricant life
- Minimize build-up of lacquer, varnish and resins
- Excellent wear protection
- Superior resistance to foaming
- Reduced downtime
- Free oil analysis program

## NO COST LUBRICANT TESTING

FS-Elliott provides a free lubricant analysis service to all compressor operators that utilize our Corona™ lubricants. This service is also available to any end users that retrofits their existing equipment with our premium Corona™ lubricants.

Lubricant sampling and testing should be a part of every turbomachinery user's preventative maintenance practices. FS-Elliott recommends that a quarterly lubricant analysis be part of the maintenance regimen. For convenience, FS-Elliott provides an easy-to-use lubricant sample kit which contains the following items:

- Lubricant sample bottle
- Identification label
- Plastic bag
- Lubricant sample datasheet
- Self-addressed mailing container



*The FS-Elliott Corona™ Brand lubricants are available in three container sizes: 330 gallon tote, 55 gallon drum and 5 gallon pail.*

# REGULUS® CONTROL SYSTEM

## REGULUS® CONTROL SYSTEM... ...PUTTING YOU IN CONTROL

FS-Elliott's control systems have been a fundamental part of our equipment packages since the very first compressor was shipped more than half a century ago. Thousands of our control systems are operating at high levels of excellence in facilities located around the globe. It is this incredible depth of experience that has earned FS-Elliott the reputation as the premier provider of reliable control technology for centrifugal compressors. Today, every FS-Elliott air compressor has at its heart

one of our advanced REGULUS® Control Systems. With this easy-to-use, multifaceted system, plant operators are empowered to master one of their facility's highest operating expenses – energy costs. Savings are achieved through the REGULUS® operating system's superior pressure control capability, thereby eliminating excessive air blow-offs to the atmosphere while efficiently responding to the facility's changing air demands.



### The REGULUS® Control System Series Consists of Four Models – R150, R200, R300 and R400

The REGULUS® product line provides the broadest selection of control systems in the centrifugal compressor marketplace. REGULUS® features an Industrial and Engineered Series to economically focus on specific application requirements. The unique REGULUS® design flexibility includes an extensive complement of optional features that can accommodate any site.

## All the Right Stuff

The REGULUS® Control System includes a comprehensive group of standard features. In addition, FS-Elliott offers an extensive number of hardware options that enable you to configure the system to accommodate your specific needs. These features have been pre-engineered to maintain standardization and minimize the cost and delivery impact.

- NEMA 4 and NEMA 4X control cabinets are available in carbon and stainless steel materials of construction.
- The REGULUS® Control System is driven by the most current Siemens and Allen Bradley Programmable Logic Controllers (PLC).
- Control panel cooling modes can be provided with single or dual vortex and air conditioning units.
- Large touch screen HMI's for operator ease-of-use.
- Communication capabilities include Modbus®, Profibus, LonWorks®, Ethernet and Teleservice. Remote diagnostic options are also available.
- Available heater devices ensure cabinet component reliability in the harshest environments.
- The REGULUS® has expansive Input / Output (I/O) module capabilities. Sensing instrumentation input is processed to provide precise output signals to control devices located in the main air and auxiliary systems.



- Air system operational information and set point data is easily stored on a large capacity memory flash card for future reference and downloading to a computer.
- A conveniently located USB port is provided to access the REGULUS® Control System.

## Precise System Control with Energy Savings & Simplicity

### Energy Savings

Experience the REGULUS® Control System's energy saving features and realize the profitability benefits from day number one.

- Precise air system pressure control
- Maximizes turndown capability and energy savings
- Advanced adaptive controller permits protected operation closer to actual surge resulting in energy savings
- Innovative adjustable inlet guide vane design maximizes efficiency at off design operations
- Suction Throttle and Auto-Dual control modes add operational flexibility and efficiency
- Multiple compressor unit energy management capability

### Simplicity

Discover the simplicity of the REGULUS® Control System together with the outstanding operational benefits it delivers to your facility.

- All control set points from one interface
- Numerous language display capabilities
- Multiple choices of communication protocols with interfacing systems
- Supervisory capabilities include monitoring the entire air system from one location
- Data storage and trend viewing are instantaneously available with the touch of the finger
- The compressor can virtually run unattended at optimum efficiency through various plant air demand conditions

# HEAT EXCHANGERS

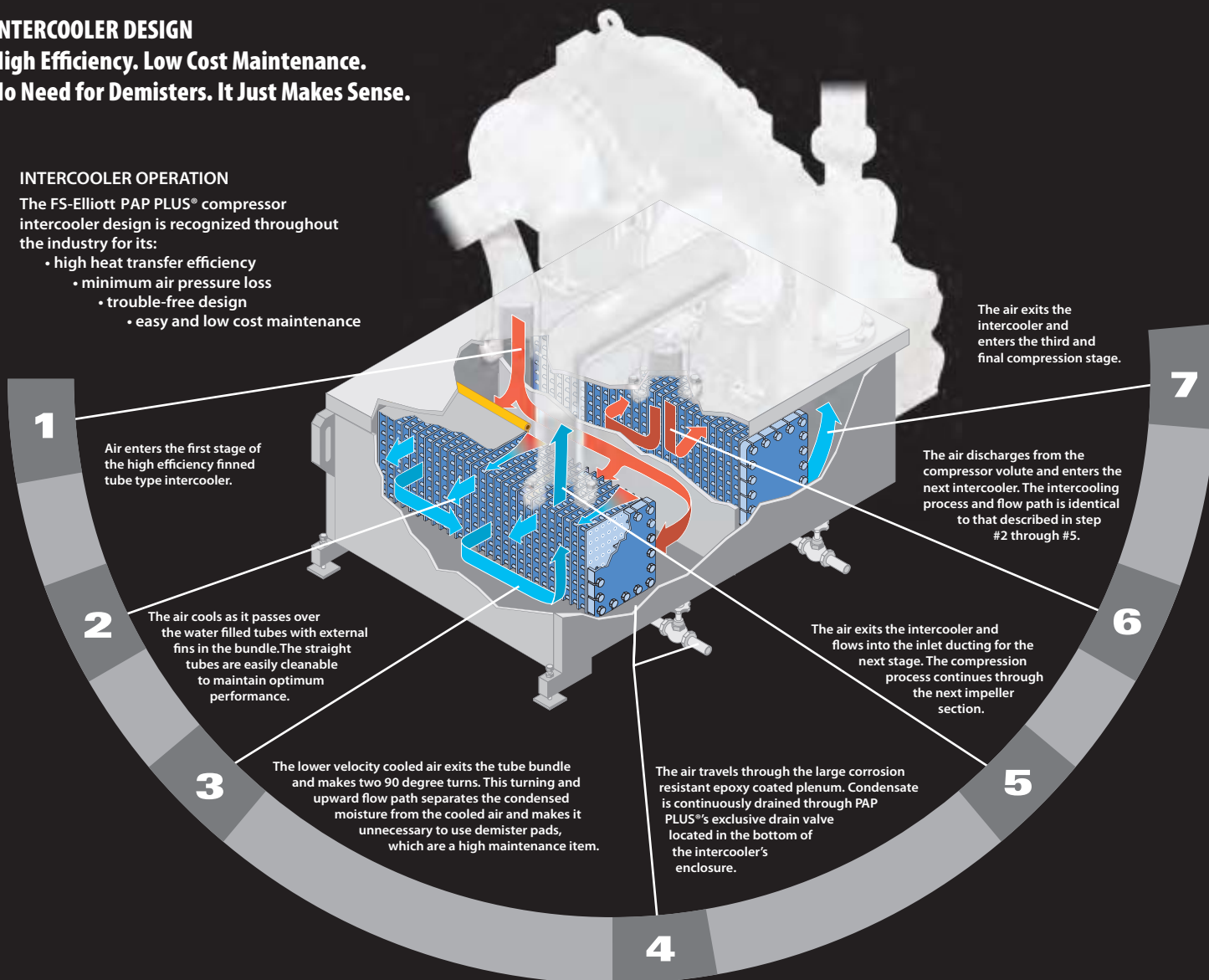
## INTERCOOLER DESIGN

**High Efficiency. Low Cost Maintenance.  
No Need for Demisters. It Just Makes Sense.**

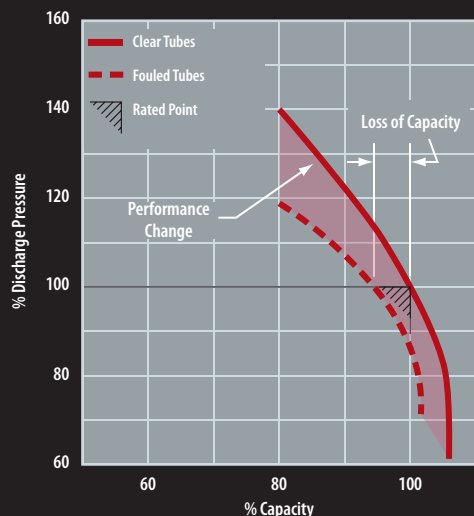
### INTERCOOLER OPERATION

The FS-Elliott PAP PLUS® compressor intercooler design is recognized throughout the industry for its:

- high heat transfer efficiency
- minimum air pressure loss
- trouble-free design
- easy and low cost maintenance



### INTERCOOLER FOULING IMPACT ON PERFORMANCE



The compact, highly efficient PAP PLUS® heat exchangers are the result of decades of design expertise and actual operating experience.

What are the characteristics of an ideal heat-exchanger?

- Long periods of operation at high heat-transfer efficiency.
- Minimum loss of air pressure through the intercooler.
- Simple, low-cost maintenance.

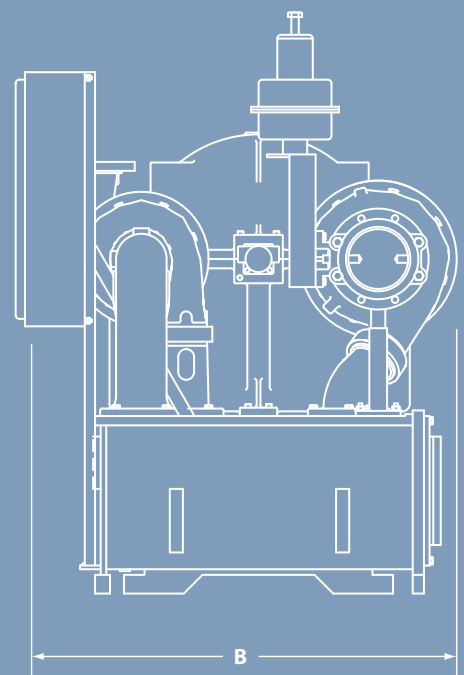
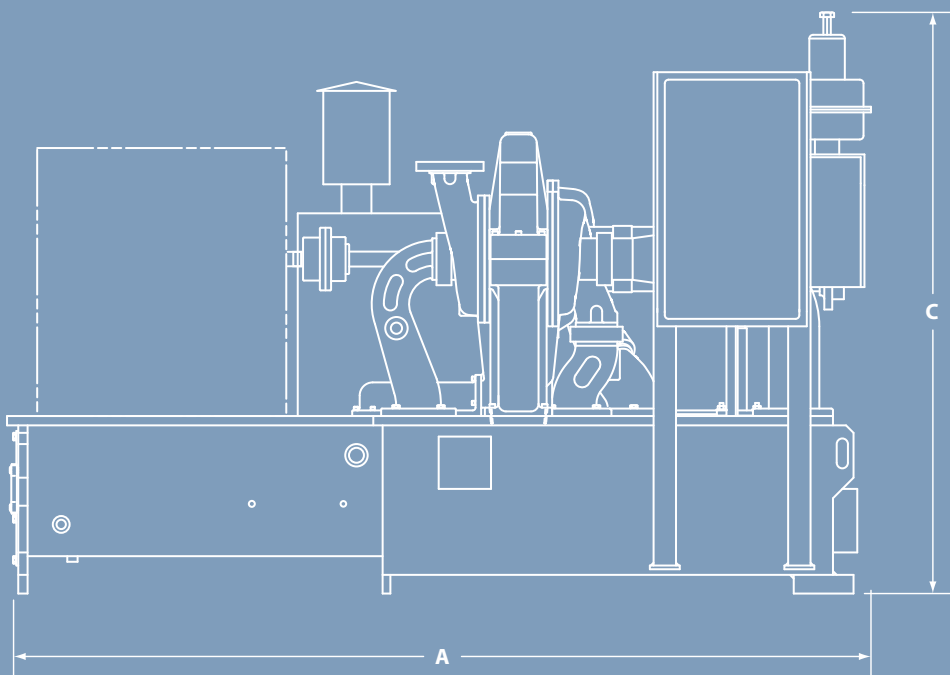
You get all these characteristics – and more – in a PAP PLUS® air compressor.

Why are easily cleanable intercooler tubes important?

Because any compressor's performance (and energy consumption) depends on the effectiveness of its intercoolers. The intercooler effectiveness is largely dependent on the absence of mineral scale formation on the transfer surfaces of the heat exchanger. Fouling reduces the compressor's performance by reducing the heat exchangers ability to transfer heat and results in a lower discharge pressure. This effect is demonstrated in the performance curve. Cleaning will restore the heat transfer efficiency and the rated discharge pressure.



# MODEL RANGES



PAP PLUS® Compressor Frame	Nominal Capacity		Nominal Driver Power		Overall Dimensions						Approximate Weight	
					A		B		C			
	ICFM	m³/min	HP	kW	in	mm	in	mm	in	mm	lb	kg
A1	1,500–3,400	42–96	350–700	260–520	124	3,150	61	1,549	81	2,057	14,000	6,350
BH	3,500–5,700	100–161	800–1,250	597–932	174	4,420	75	1,905	96	2,438	27,000	12,245
CH	5,500–11,000	156–311	1,000–2,000	746–1,492	195	4,953	152	3,861	120	3,048	38,000	17,235
D	10,000–18,000	283–510	2,000–3,500	1,492–2,600	252	6,401	134	3,404	153	3,886	70,000	31,750

## MINIMAL MAINTENANCE – MAXIMUM SIMPLICITY

Centrifugal air compressors are popular because they operate reliably for long periods of time with minimal maintenance. This is made possible by a combination of features:

- Inherently low vibration
- No rubbing or direct wearing parts
- Optimum clearances between rotating and stationary parts
- No oscillating load
- Integrated engineering package design approach

The PAP PLUS® compressor package design not only includes all of these features but also provides for easy access to critical components – thus simplifying and encouraging good preventative maintenance practices. PAP PLUS® compressor construction permits fast, efficient inspection and maintenance during off hours and at scheduled intervals. Unexpected shutdowns and

production interruptions are virtually eliminated. All scheduled maintenance work can be performed by your plant personnel, or FS-Elliott can provide a maintenance plan to fit your specific needs.

The gearing, intercoolers, aerodynamic parts, lubrication system and control system are all independently accessible. Maintenance of any one of these items does not require the disassembly of other components or the exchange of large assemblies. Inspection and maintenance of the bearings and seals is another example of the PAP PLUS® Ease-Of-Maintainability philosophy. There is no need to disassemble intercoolers or impellers/diffusers, or interstage piping and casings, or to disconnect the air or cooling water piping. The photos below show that by simply lifting the cover, these components are totally accessible.

A complete maintenance operation, including removing the gear case cover, inspecting gears, bearings and seals,

and reassembly can be accomplished within 3–8 hours, depending on the specific site situation. This procedure can be done without disturbing impellers, diffusers, air or water piping, or other components. Unlike other compressors, the unique PAP PLUS® horizontal-split design was meticulously conceived to provide quick and easy local maintenance. There is no need to send components back to the factory. Compare this time-efficient procedure with some other compressor designs that require days to perform the same tasks.



*Easily accessible bolting facilitates the removal of the gear case cover.*



*Gear case cover lifts off easily, exposing gears, bearings, and seals – without removing any other components.*



*The bearing top half can be taken off after removing two screws. The bottom half of the bearing can be rolled out and removed from the casing for inspection. The two-piece seal assembly can be removed by sliding it into the bearing cavity area; then follow the same procedure that was utilized for removing the bearing.*

## INTERCOOLER DESIGN MINIMIZES MAINTENANCE TIME AND TROUBLE

The PAP PLUS® intercooler tube bundles are a straight-through design with water in the tubes. The tubes are easily accessible without disturbing other components. This straight-through heat-exchanger design with external fins can be maintained at high efficiency with fast and simple cleaning by rodding. This is a quick and low-cost procedure compared to the time and expense needed to chemically clean an intercooler designed with water on the outside of the tubes.



## SEAL AND BEARING INSPECTION TIME COMPARISON

Typical time for inspection procedures, as represented by the table below, establishes the PAP PLUS® compressor as the lowest time and cost leader.

Inspection Procedure	Horizontally-Split Centrifugal Compressor		Vertically-Split Centrifugal Compressor	Screw Compressor
	PAP PLUS®	Brand "X"		
Remove Inlet Piping, Valve & Filter	Not Required	¾ Hour	1 Hour	Not Permitted.  Voids Warranty.
Remove Interstage Piping	Not Required	½ Hour	½ Hour	
Remove Oil Piping to Bearings	Not Required	¼ Hour	Not Required	
Remove Main Oil Pump	Not Required	¼ Hour	Not Required	
Disconnect Main Drive Coupling	Not Required	¼ Hour	Not Required	
Open Intercooler Casing	Not Required	Not Required	3 Hours	
Remove Intercooler Bundles	Not Required	Not Required	4 Hours	
Remove Impellers	Not Required	Not Possible	4 Hours	
Remove Gearbox Cover	½ Hour	½ Hour	½ Hour	
Pull Bullgear	Not Required	½ Hour	Not Required	
Remove Bearing Assemblies	½ Hour	Not Possible	2 Hours	
Remove Shaft Seal Assemblies	½ Hour	Not Possible	1 Hour	
Remove Casing & Diffusers	Not Required	1 ½ Hours	¾ Hour	
Remove Complete Rotor Assemblies with Bearing Attached	Not Required	1 Hour Return Rotor Assemblies with Bearings Attached to OEM for Bearing Replacement and Rotor Rebalance to Maintain Warranty	Not Required	
Reverse Above Operations	1 ½ Hours	5 ½ Hours	16 ¾ Hours	
Total	3 Hours	11 Hours + Weeks for OEM to Return Rotor Assemblies and New Bearings	33 ½ Hours	

Note:

Not all horizontally-split centrifugal compressors are designed the same. The PAP PLUS® horizontally-split compressor design allows inspection of all bearings and seals without removing the complete rotor assembly.



# MANUFACTURING AND PACKAGING

## DESIGNED, BUILT, AND TESTED IN THE FS-ELLIOTT QUALITY TRADITION.

By the time a PAP PLUS® compressor arrives at your site for installation, it has undergone a rigorous execution process covering the product design, manufacture and inspections governed by our ISO 9001:2000 Certified Quality Management System.

FS-Elliott's ISO 9001:2000 Certified Quality Management System encompasses the entire lifecycle of the product line, which includes the sales, marketing, engineering, purchasing, manufacturing, testing, and shipping. This quality process also assures that our suppliers are qualified and continuously monitored to the same high standards that we demand of ourselves. All PAP PLUS® impellers meet rigorous quality requirements before being assembled into rotors that are then dynamically balanced to exacting standards that assure smooth operation. Pressurized components are hydro tested and every compressor is then given a thorough functional test.

Every PAP PLUS® compressor embodies the know-how resulting from over fifty years of experience in designing, manufacturing, and testing quality centrifugal compressors.



*High performance five axis milled impeller profiles are authenticated with a digital coordinate measuring machine.*



*Precision built high-speed rotor assemblies are dynamically balanced and documented in accordance with API 672 standards.*

### PACKAGING FACILITY

The Packaging Facility is the location where all of the components and sub-systems come together and collectively emerge as a world renowned PAP PLUS® compressor system. A variety of compressor packages are

routinely processed through the facility that range from essentially standardized units for industrial applications to highly engineered systems that are customized to the client's exacting requirements. Highly experienced and talented assemblers, welders and technicians start the packaging process by mounting the compressor air end onto the baseplate skid.

Next, the skids are outfitted with the major auxiliaries including the driver, controls, intercoolers, instrumentation, lubrication system, electrical conduit, air and water piping to name a few. These quality built packages are routinely required to operate for up to three years uninterrupted operation while maximizing efficiencies and minimizing unplanned downtime.

*Craftsmen with years of experience skillfully assemble the PAP PLUS® packages to our exacting standards.*





# TESTING

## TEST FACILITY

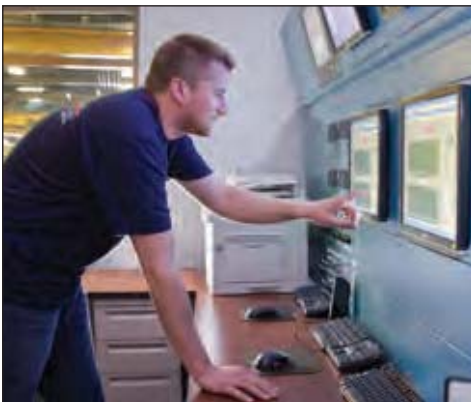
The final stop in the manufacturing process for every FS-Elliott compressor is the ultra modern test facility that is equipped with the most progressive test equipment, instrumentation and control systems that are available. This spacious 16,000 ft<sup>2</sup> building includes eight fully automated test cells that enable the simultaneous testing of three complete compressor units. The variable speed drives provide 50 and 60 hertz capabilities up to 4,000 horsepower and 6600 volts. Wide ranging resources include mechanical testing in compliance with API 672 standards and Performance Testing in accordance with the ASME Power Test Code.



*All PAP PLUS® compressors are tested and monitored to the demanding standards of API 672. FS-Elliott has the distinction of working with our customers to meet additional requirements that can accommodate project specific testing requirements.*



*FS-Elliott's advanced test facility is another testimonial of our pledge to the marketplace to aggressively invest in facilities and technology for the advancement of oil-free air compression systems.*



## CONTROL ROOM

The Control Room is located high above the test facility and is outfitted with the most modern data acquisition, control, monitoring and analysis systems. The test technician has the ability to operate from either the main drive control PLC situated in the Control Room or from a PLC located at each test stand control cabinet. The state-of-the-art data acquisition system collects the mechanical and aerodynamic information for analysis and storage. The integrated control system instantly processes test data and displays the results in user friendly formats.

Additional Control Room features include the automatic sequencing of the oil pump operation and system valve setting positions for the compressor start-up. All of the compressor package safety systems are continuously monitored and automated safeguards are prepared to take corrective measures should such actions be required.

*With the touch of the finger, experienced technicians have complete automated control, monitoring and data acquisition capability to ensure accurate and customer compliant testing.*

# AFTERMARKET PRODUCTS AND SERVICES

## YOU CAN COUNT ON US – FROM THE FIRST DAY TO THE LAST DETAIL.

The PAP PLUS® compressor is highly engineered and carefully crafted to provide years of reliable operation that is second to none. The PAP PLUS® compressor is known to be the most robustly built and reliable compressor in the industry. Nonetheless, when service is needed, the FS-Elliott name is your assurance that all of your needs will be taken care of quickly, professionally and completely. We have the local people, the experience, the parts, and the facilities to handle your every service need. Selection of an Original Equipment Manufacturer (OEM) and its Service Organization is a critical factor in your decision-making process. Make it easy – FS-Elliott is the right choice every time.

### INSTALLATION AND START-UP

Our services range from qualified direction and assistance for your own installing and commissioning team to providing the total turnkey installation – including project management, supervision and all of the craft labor and tools to handle the complete job.

### MAINTENANCE

Maintenance programs can be customized to your specific needs. The programs can be as straightforward as necessary to coincide with and support your scheduled outages, or can comprise a comprehensive, long-term maintenance program for your air compressor. We can also provide schedule visits by local service personnel. This service provides the peace-of-mind that comes from knowing your air compressor is being cared for by qualified service personnel.

### REPAIRS

ISO-certified authorized shops are fully capable of performing repairs. The experienced FS-Elliott service team is dedicated to ensuring that emergency situations will be handled with urgency 24/7/365.



*The absolute best service is just a telephone call away. The experienced FS-Elliott TEAM is dedicated to ensuring that emergency situations are handled locally with urgency 24 / 7 / 365.*



*FS-Elliott's service TEAM members are fully qualified to handle a wide range of services quickly and professionally thus ensuring years of reliable operation. These services can range from qualified advice or, as an example, include on-site optical alignment resources as shown in the above photograph.*





### RERATES

Rerating of an existing compressor to a new set of operating conditions is often the most economical means to meet a system's changed compressed air demands. We can also provide new design modifications and upgrades that enhance an air system's reliability and reduce life cycle costs. As the Original Equipment Manufacturer (OEM), FS-Elliott is in the unique position to have direct access to the authentic manufacturing drawings, material specifications and assembly clearances. End Users can have total confidence and peace of mind that by using genuine OEM parts for their rerates and upgrades their project will perform as intended the first time and every time.

### PARTS

The correct replacement parts and the access to them on a timely basis are critical issues to compressed air users. FS-Elliott can provide these parts to the exacting dimensions, material specifications, quality standards and up-to-date technology. FS-Elliott maintains a large inventory of quality-made OEM parts to assure quick delivery. Many of the high usage components such as bearings, seals, gaskets and O-Rings, to name a few, can be shipped within twenty-four hours.

### TRAINING

FS-Elliott offers a wide range of operator and maintenance training programs. The training can be performed at one of our facilities or conducted at your location. We can offer a variety of standard self-contained packages or can customize a program to suit your specific needs..



*Our programs include an excellent mix of cut-away models, hardware elements, and textbook to develop and train individuals in a wide range of oil-free compressor system subjects.*

Call 724-387-3215 for  
information on training classes held  
at the FS-Elliott Service Center  
in Export, Pennsylvania.



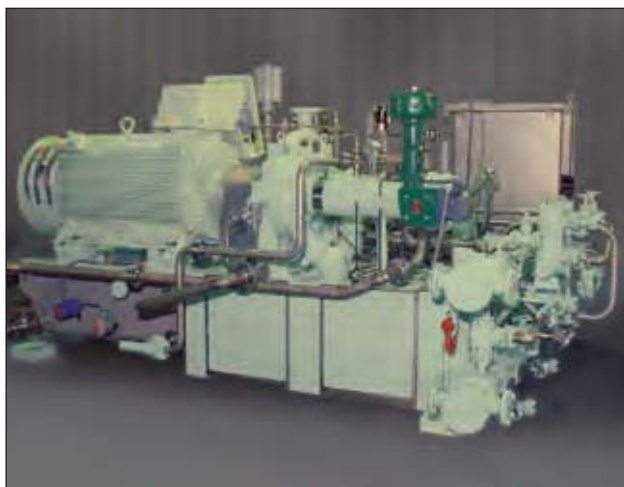
# CUSTOM CONFIGURATIONS

**FS-Elliott has the experience and the expertise to design and deliver the best system to meet unique user requirements.**

The wide range of FS-Elliott's compressor models will meet most air application requirements. In addition, many end users have specialized needs which require customized solutions. Our PAP PLUS® engineering staff has the depth and know-how to meet the simplest to the most complex requirements; from a simple twin oil filter which permits filter change while the compressor is running to complete packaged air systems. The base design for these applications includes API 672 and can accommodate additional detailed client specifications. Here are some examples of FS-Elliott's capabilities.







*Installed in an Asian oil refinery, this Engineered Air system is utilized in the production of Clean Fuels. The compressor package inlet air flow is 2,585 CFM (4,390 m<sup>3</sup>/hr). The end product for this refinery upgrade project is unleaded gasoline.*



*This Engineered Air, 2,670 CFM (4,540 m<sup>3</sup>/hr) system was designed for a Middle East Oil refinery. This air package design was based on API 672 plus comprehensive EPC and End User specifications. This compression unit is applied for the production of unleaded/low sulfur gasoline.*



*This Engineered Air compressor package is part of a major petrochemical plant capacity expansion project in Eastern Canada. The 2,760 CFM (4,690 m<sup>3</sup>/hr) is utilized in the production of ethylene.*

# PAP PLUS® – THE BEST CHOICE

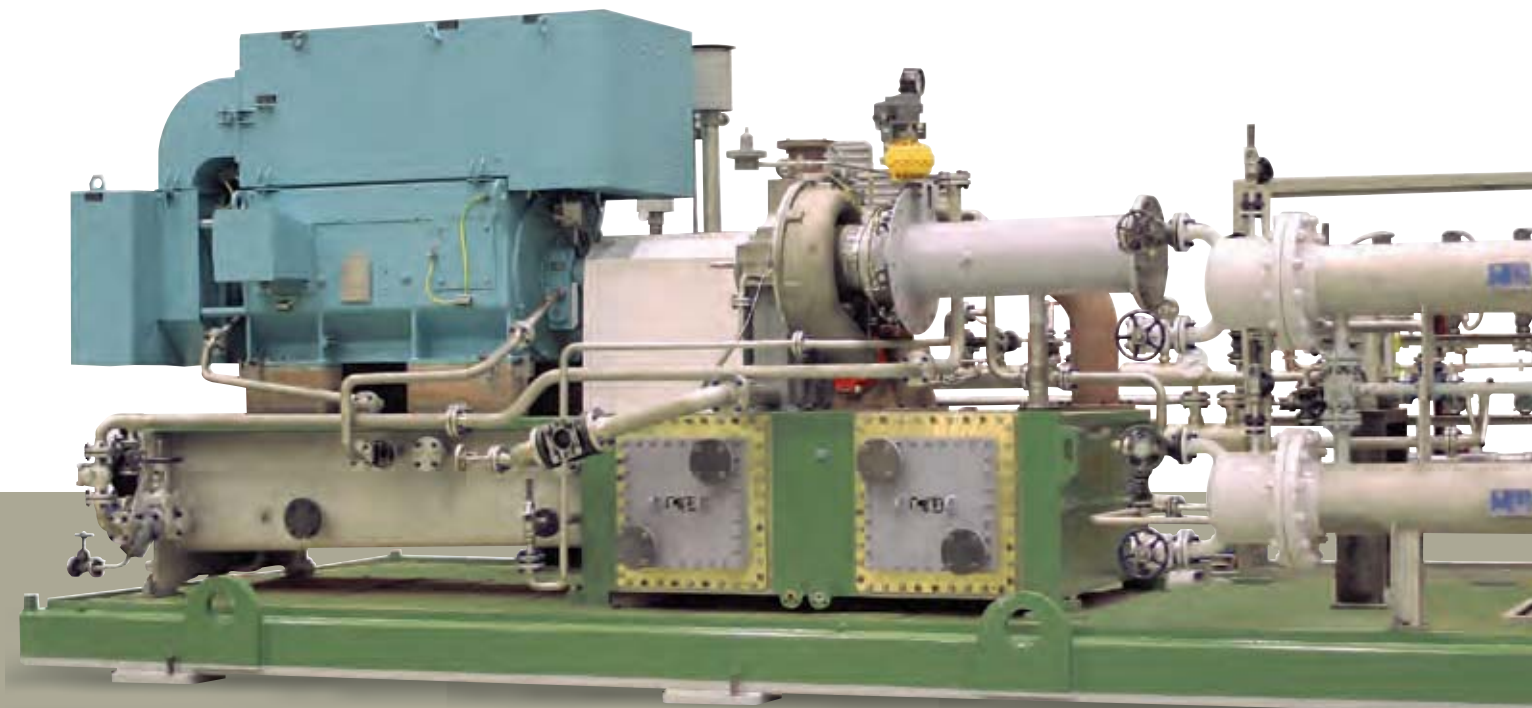
## THERE ARE MANY REASONS WHY THE PAP PLUS® FROM FS-ELLIOTT IS THE ONLY CHOICE FOR ENGINEERED AIR APPLICATIONS

FS-Elliott is the preferred source for 100% oil-free, particulate filtered, reliable engineered air. Engineered air is tailored to meet your specific industry needs, providing the right type of air for the right application.

In diverse and demanding fields such as food and beverage processing, the automotive industry, pharmaceutical manufacturing, electronic component fabrication, and mining operations, our customers have learned what sets FS-Elliott and the PAP PLUS® apart. Our design and manufacturing processes are based on more than fifty years of experience in the centrifugal compressor business. Our reliability and quality standards deliver years of trouble-free operation under the most demanding conditions, including API 672 applications. We offer comprehensive, full life-cycle services and simple, economical maintenance.

In short, we offer the things you need when engineered air is an essential part of your operation. We know that if your engineered air fails for even a single day, it can result in an unplanned facility outage. That is why we build the PAP PLUS® for long-term reliability with features you can count on. Features such as:

- Easy accessibility for low-cost maintenance. The gearcase is split horizontally for simplified access to internal parts. Remove the cover and service the seals, bearings and gears. All major components – gearing, intercoolers, aero components, lubrication system and control – are packaged to facilitate independent servicing.
- Fewer rotating and stationary parts for high reliability. The only moving parts include two rotors and a gear. Each rotor has two high-speed bearings and seals.



**FS-Elliott's PAP PLUS® compressor combines high reliability with easy servicing in ratings from 1,500 to 18,000 CFM (2,520 to 30,600 m<sup>3</sup>/hr); and 350 to 3,500 hp (260 to 2,600 kW).**

- Rotors that can be removed and reinstalled without rebalancing the components.
- Unitized construction that simplifies installation.
- Standardized designs that allow for easy uprating. Uprating hardware to meet new operating conditions is a simple job.
- Noise levels that meet or exceed the OSHA compliance standards.

*The PAP PLUS® from FS-Elliott. Your best choice for reliable oil-free air. Engineered for the way you do business.*



*For complete details, specifications and pricing, contact one of the representatives from the FS-Elliott network of worldwide authorized distributors.*





*FS-Elliott's Corporate Headquarters - located in Export, PA USA*



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REPRESENTED BY:



ISO 9001 – Certified for  
design and manufacture of  
centrifugal compressors.



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