



SIEMENS

With
Rolls-Royce
Aero Engine
Technology

Industrial RB211 Gas Turbines

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Industrial RB211 gas turbine

Over 750 Industrial RB211 gas turbine systems sold with over 34 million operating hours

Siemens industrial gas turbine systems have been supplied to the worldwide oil and gas and power generation industries for five decades. During this time close to 4,000 gas turbine systems have been sold with over 200 million hours of operation to date.

The Industrial RB211 Gas Turbine Package

Siemens provides advanced aero-derivative gas generators, combined with proven industrial power turbines and the packaging know-how to create Industrial RB211 gas turbine drive systems. These systems are combined with compressors, pumps or electrical generators to create complete machinery solutions for many applications, both onshore and offshore.

The Industrial RB211 gas turbine package matches a Siemens Industrial RB211-G or Industrial RB211-GT gas generator to either a Siemens RT62 or RT61 power turbine. Auxiliaries such as intake air filtration, acoustics, lubrication, starting and wash systems are all part of the scope of supply.

Performance in the Field

Siemens gas turbine systems have been refined through experience, including remote and offshore applications where availability and reliability are of crucial importance. With superior performance retention and relative ease of overhaul, Industrial RB211 systems provide an ideal solution for today's applications. Total system efficiency can be enhanced by adding exhaust heat recovery equipment to produce steam or hot liquid for local area heating or process needs.

A primary factor in the success of the Industrial RB211 is our dedication to excelling in complete aftermarket support. Encompassing worldwide parts inventory, skilled service technicians and the on-going development of performance-enhancing upgrades, the Siemens commitment to integrated solutions continues throughout the equipment life cycle.



“A primary factor in the success of the Industrial RB211 is Siemens’ dedication to excelling in complete aftermarket support.”

Offshore Applications

Being an aero-derivative gas turbine, the Industrial RB211 is ideal for offshore applications. Its low weight minimizes the cost of offshore structures and makes it possible to quickly and easily remove the gas generator for transport to shore where overhauls can be performed in a controlled environment dedicated to that purpose. During the overhaul, a spare or lease gas generator can be installed to ensure maximum availability of the machinery train.

Close to 280 Industrial RB211 gas turbines are currently in offshore service driving electrical generators, compressors and pumps. They operate in challenging environments such as the North Sea, West Africa, Russia, Brazil, Caspian Sea, North America and South East Asia. Special product features are available for offshore applications, including materials and air filters designed for marine environments, as well as three-point-mounted baseplates to ensure proper equipment alignment in applications where deck deflections are a concern. Lubrication systems and other components in the package are specially designed to be tolerant of topsides pitch and roll on FPSOs and other floating structures. Control systems can be configured with Equipment Health Management (EHM) technology to enable equipment diagnostics and trouble-shooting from Siemens onshore service centers.

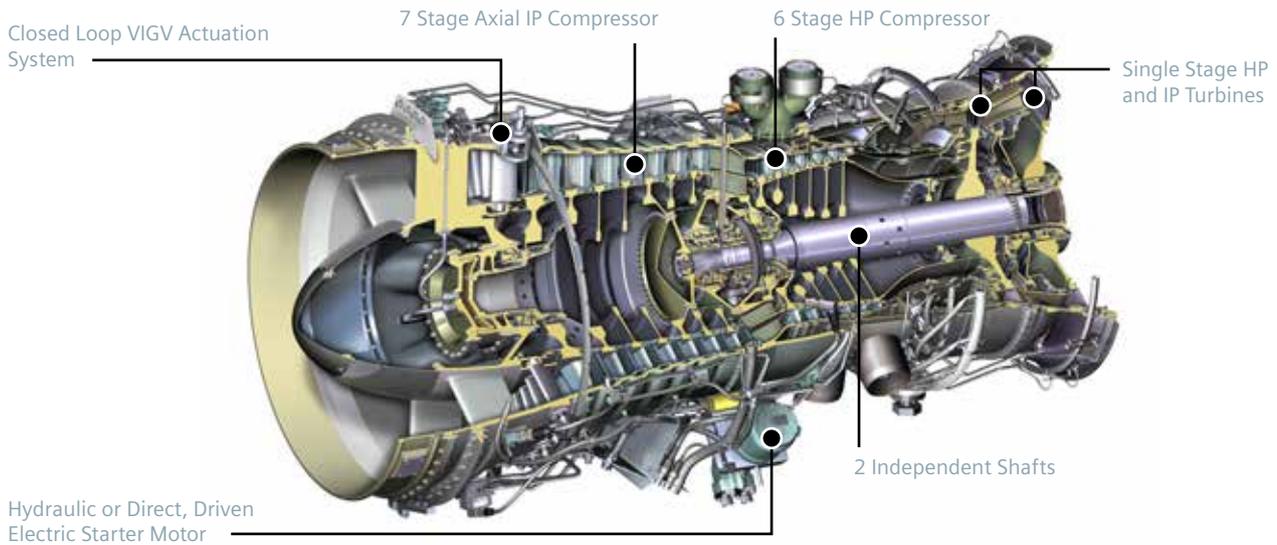
Gas Pipeline Mechanical Drive Applications

The high simple cycle efficiency of the Industrial RB211 makes it ideal as a driver of pipeline compressors, barrel compressors and pumps. Its low weight and the ability to quickly remove the gas generator for transport and maintenance is another key feature for these applications, which are often located in remote locations far from maintenance facilities.

Over 560 Industrial RB211 gas turbines are operating in mechanical drive applications, including locations such as North America, Europe, China, India, North Africa, Russia and South East Asia. Most of the pipeline applications have the Industrial RB211 paired with a highly efficient Siemens compressor designed specifically for gas pipeline duty.

Power Generation

The Industrial RB211 generating set is engineered for cost effectiveness, complementing the gas turbine driver. It can be accommodated within a site area of less than 250 square meters for a 32MW simple cycle plant. The Industrial RB211 generating set is available in a wide variety of configurations to meet individual project requirements offering operators fast start up times and can meet current emissions requirements. It is well suited to co-generation or to simple and combined cycle operation. Over 180 Industrial RB211 gas turbines are currently installed in power generation applications boasting over 5 million operating hours.



Industrial RB211 gas generator

The most advanced, most reliable and the easiest to maintain industrial gas generator available

The Industrial RB211 gas generator is a two-spool design derived from the Rolls-Royce RB211 aircraft engine, with a performance lineage founded in Boeing 747, 757, 767 and Tupolev TU204 applications.

Trusted Performance

The Dry Low Emissions (DLE) version of the Industrial RB211 offers the same reliability and maintainability as units with conventional combustion systems. Today the Industrial RB211 DLE is one of the most experienced aero-derivative low emission gas generators available.

The Industrial RB211 is less than 3 meters (10 feet) long and weighs just over 2.5 metric tonnes (2.75 US tons).

The DLE version maintains the overall length of the standard engine so it can be retrofitted into existing installations.

Maximum Efficiency

A single row of variable position inlet guide vanes in the low pressure compressor module, combined with bleed valves and the two-spool design, allow for lower power starting and optimum performance over the engine speed range. Guide vane position is automatically adjusted to provide maximum efficiency.



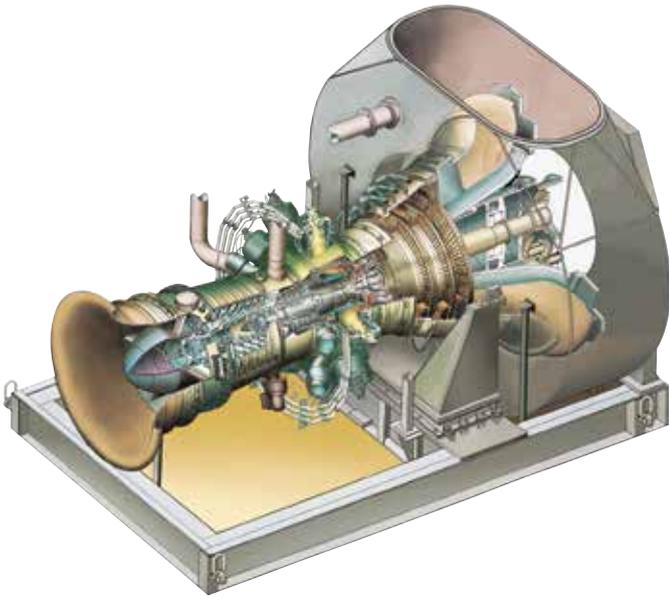


“The Dry Low Emissions (DLE) version of the Industrial RB211 offers the same reliability and maintainability as units with conventional combustion systems.”

The power turbine

The Industrial RB211 package includes RT62 or RT61 power turbines. The turbines are mature products that provide high efficiency over a broad speed range. The two-stage RT62 was introduced in the mid 1980's. The RT61 is the latest-generation high efficiency three-stage power turbine.





Low emissions over a wide operating range – less than 25 vppm NO_x and CO simultaneously.

One of the most experienced aero-derivative low emissions gas generators available, with over 4 million operating hours.

Designed for simple retrofit of existing non-DLE engines.

Flexible and modular

Industrial RB211 features fuel flexibility, DLE option and modular construction

Fuel Flexibility and DLE Option

The standard Industrial RB211 gas generator employs an annular combustor fitted with multiple fuel injectors. The combustion system can be configured for gas, liquid or dual fuel capability. The combustion chamber is lined inside and out allowing for the introduction of air for cooling and dilutions. A version of the Industrial RB211 with a gas fuel DLE combustion system is available, with or without liquid fuel capability for more flexible operation.

The DLE combustion system is comprised of nine combustors spaced radially around the engine casing. Thanks to the Industrial RB211 modular design, the replacement of only one of the five engine modules is the only engine modification required to retrofit an engine with a conventional combustion system to one with DLE combustion.

The DLE canister combustors also offer simplified maintenance of the combustion system. Each combustor can be removed individually in less than an hour for inspection or repair without removing the engine from its berth.

Modular Construction Simplifies Maintenance

The Industrial RB211 gas generator is constructed of five pre-balanced modules that can be removed or replaced individually. The design reduces downtime and maintenance costs by allowing an individual module to be

replaced at a local maintenance base with a new or leased module while the original module is repaired or overhauled.

Low Emissions Technology

As the innovator of Dry Low Emissions (DLE) technology, Siemens has remained steadfast to the original design concept: lower emissions without sacrificing the respected Industrial RB211 reliability and ease of maintenance.

Through a pre-mix, lean-burn series staged combustion system, the Industrial RB211 DLE lowers emissions while offering the proven dependability of the standard Industrial RB211. The Siemens fuel control system provides the precise fuel management necessary to ensure consistent lower emissions levels. This system includes only four fuel valves for fuel scheduling, assuring high reliability.

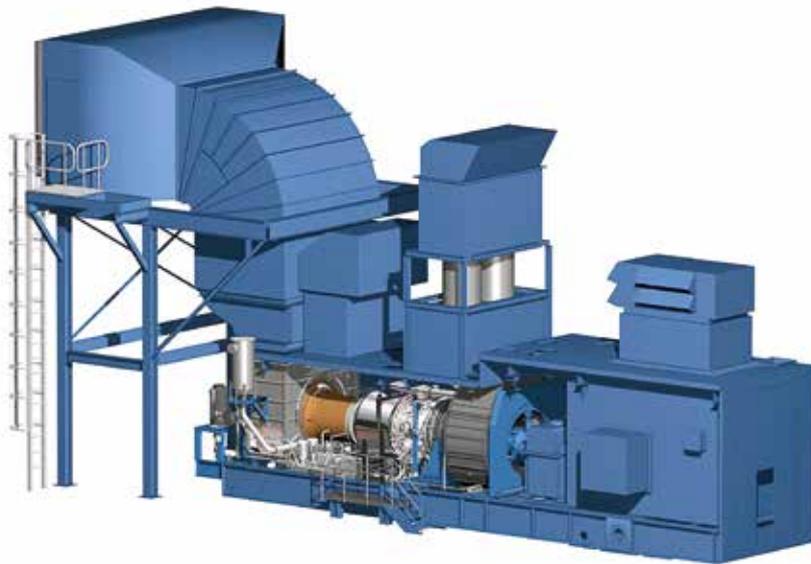
- Low emissions over a wide operating range – less than 25 vppm NO_x and CO simultaneously
- One of the most experienced aero-derivative low emissions gas generators available, with over 4 million operating hours
- Designed for simple retrofit of existing non-DLE engines
- Replacement of only one module required for DLE system
- Same overall length to fit existing installations
- Liquid fuel operation available on the DLE, enhancing operational flexibility



“Each DLE canister combustor can be removed individually in less than an hour for inspection or repair without removing the engine from its berth.”

Performance data for Industrial RB211–GT61





Efficiency of auxiliary systems

Engineered to meet the demands of operating in diverse environments

Air Intake Systems

The air intake system provides a clean, uniform airflow to the gas turbine. It is comprised of a filter assembly, silencer and flow direction geometry to properly condition and direct the incoming air. Careful site design assures that the filter house is located to minimize disruptions of inlet air flow.

Gas turbine filtration systems are configured to suit the demands of specific operation environments, whether offshore, onshore or coastal. Filtration requirements vary significantly with systems ranging from single to multiple stages. Self-clean pulse filter systems can offer an effective, low-maintenance alternative for high dust load environments.

High-efficiency, multi-stage systems are engineered to combat corrosion in offshore and coastal installations. In cold climates, icing and frost conditions are controlled using a pulse type filter. In hot climates, an evaporative intake cooler or intake chiller can be added to lower intake air temperatures for improved performance.

The Gas Turbine Enclosure

Acoustic enclosures are available to meet a wide range of requirements, from weatherproof outdoor structures to enclosures customized to fit within existing buildings. Construction features include sound absorbent materials to meet occupational noise level requirements.

Lubricating Oil Systems

The gas generator uses synthetic oil, which is provided by an on-skid oil console, to lubricate the bearings and dissipate heat. The console incorporates two identical pumps, one for active and the other for standby duty.

The power turbine, gear (where applicable) and driven equipment share a separate mineral oil lubricating system. This system can be placed within the skid or on a separate console.

Oil cooling is accomplished with either a forced air radiator, plate coolers or shell and tube heat exchangers. Overcooling is avoided by using thermostatic controls that maintain proper oil temperatures by means of bypassing oil around the cooler.



“Wash systems prevent the build-up of contaminants in the gas generator compressor that could cause deterioration in performance.”

Automation and control systems

Equipment Coupling

Dry flexible couplings are the preferred method for transmitting power between the power turbine and the driven equipment. These couplings require no lubrication and do not impose excessive axial or radial loads on the power turbine or driven equipment. Torque metering couplings can be supplied as well.

When applications require an increase or decrease of shaft speed that exceeds the standard speed range, a gear is introduced into the power train to assure the output speed matches the requirements of the driven equipment.

Gas Turbine Starting

Starting the Industrial RB211 requires only approximately 200 HP. Starting options include gas and electro-hydraulic systems, which are incorporated into the base. When self-sustaining speed is achieved, the starter is automatically shut off. It also has the capability for Hot Restart without lock out periods which can further improve availability.

Gas Generator Wash System

Wash systems prevent the build-up of contaminants in the gas generator compressor that could cause

deterioration in performance. The wash system consists of storage tanks, pressure gauges, valves, piping and either a pump or compressed air supplied by others. The wash cycle can be run during either a starter driven crank soak cycle or during gas turbine operation.

Siemens provides complete automation solutions for gas turbines. The control algorithms are coded using programmable logic controllers. With decades of experience in designing control systems, Siemens engineers are uniquely qualified to offer solutions for any mechanical drive or power generation application. The basis of the control system is state-of-the-art, programmable, logic controller technology and hardware, along with a variety of communication options, that provide reliable performance with ease of maintainability and flexibility.

The system provides real time monitoring and control of turbine critical functions including: sequencing, speeds, guide vane positioning, firing temperature limiting and data event logging.

The gas turbine controls offer either local or remote modes of operation. Viewing of the operating parameters is available locally or remotely. Easy to use software allows programming for initial operation and provisions for future changes.



Factory testing and technical training

Testing and training maximize performance in the field

Siemens has dedicated facilities for both testing and training to ensure the best performance from both the equipment in the field and the operators running it.

Testing

Siemens has extensive test facilities to ensure that each unit conforms to performance objectives. Each gas turbine undergoes an API 616 mechanical running test prior to shipment.

Optional tests are available on request, including complete package full load string testing and ASME PTC-22 performance testing using either liquid or gaseous fuel.

Technical Training

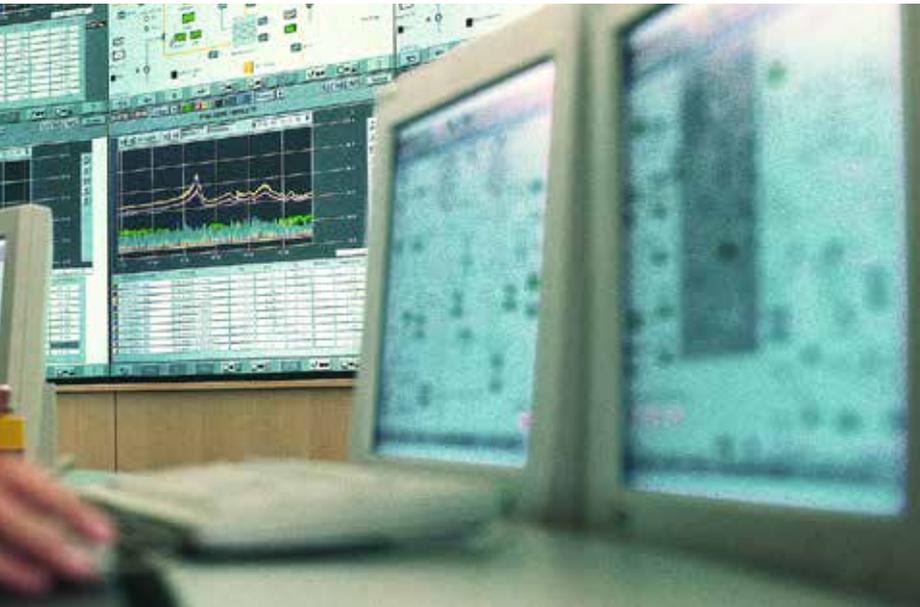
From the first day of start-up, the expertise of operating and support personnel is central to the productivity of every major equipment installation. Through the years, Siemens operators, mechanics, technicians, engineers and supervisory support personnel have been trained to achieve the safe and economical operation/maintenance of Industrial RB211 packages. Measurable benefits include reduced downtime, increased fuel savings, reduced liability risk and extended equipment life cycle.

In addition to OEM expertise, our professional instructors offer the insight of real-world experience. A professional training consultant is also available to evaluate individual training needs and develop customized curriculum for application-specific training.

Siemens dedicated training facilities feature fully-equipped classrooms, equipment models and control systems simulating working conditions for in-depth, hands-on training. On-site training, based on the proven learning strategies used in our training facilities, is also available.

From the moment you become a valued Siemens customer, you enter into an ongoing partnership that is totally focused on maximizing your profitability and unit availability.

Siemens has earned the reputation as a leading supplier capable of sustaining optimum performance as a result of our commitment to integrated solutions.



“Siemens dedicated training facilities feature fully-equipped classrooms, equipment models and control systems simulating working conditions for in-depth, hands-on training.”

Solutions are delivered through Siemens global resources to satisfy individual needs:

- Project management begins with a detailed activity network and schedule to determine the “critical path” for project completion. A complete activity manual, updated through periodic project reports, keeps the customer informed of project status. Computer-based projections can accommodate unforeseen contingencies to keep activity on track.
 - Siemens global resources, including multi-national manufacturing facilities, ensure that tight delivery schedules are met. Installation and commissioning are carefully monitored so the proper people, tools and equipment are onsite when needed.
 - Quality replacement parts and expert maintenance service. Inventories of critical parts, as well as skilled service personnel, are located among the world’s energy capitals to assure prompt service. Sophisticated tracking systems also provide access to complete parts inventories worldwide.
 - Experienced, highly trained, technical field personnel are backed by the world’s most respected engineering staff to provide expertise on unit design, application, repair and field modification as required. Also, our experienced instructors offer technical training for efficient and safe equipment operation.
 - Service agreements are designed to control your maintenance budget while increasing the availability of your equipment. Benefits include early problem diagnosis for lower maintenance costs, decreased fuel and lubrication oil consumption, increased availability and reliability, and extended unit life.
 - Engineered Solutions include upgrades based on comprehensive system history and key performance indicators established in our technical support networks. The result is a retrofit investment that improves the customer’s operation as promised.
 - Technical training from experienced instructors, based on proven hands-on methods, assures operating and support personnel positively contribute to productivity.
- Perhaps the most important question when making a choice among capital equipment suppliers is, “Does the supplier have the commitment and financial resources to provide sustained, comprehensive service?” At Siemens, we have demonstrated that the answer is “yes.” Most importantly, we are working today to increase the range and scope of customer service solutions in order to meet tomorrow’s challenges. A prime example of this commitment to the future is our online service community at www.energymanager-online.com, which provides customers with access to our technical documentation every second of every day.

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