

# GIGATOP 4-pole

Hydrogen and water-cooled turbogenerator  
the solid investment for the future



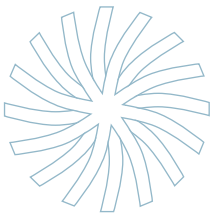
POWER

*We are Shaping the future*

**ALSTOM**

# GIGATOP 4-pole

## Your nuclear solution



In today's competitive power market, nuclear power plants need to operate at maximum performance and availability.

**GIGATOP 4-pole** is the most efficient 4-pole turbogenerator for the nuclear market, making it a solid long-term investment.

**GIGATOP 4-pole**, the turbogenerator behind Alstom's proprietary ARABELLE™ steam turbine, sets the benchmark for reliability and efficiency. Covering an output range from 900 MW to 2,000 MW, in both 50 and 60 Hz markets, the world largest turbogenerators in operation today are **GIGATOP 4-pole**, with a power output of 1,550 MW.

Alstom is the world's most experienced turbogenerator supplier for nuclear application, with worldwide operational experience since the 1960s. About one third of the world's nuclear fleet are today equipped with Alstom turbogenerators. Recent orders include Flamanville 3 in France, and Hong Yan He in China as well as orders from UniStar in the USA.

Whatever your needs, Alstom has the solution.

### Right technology, right products



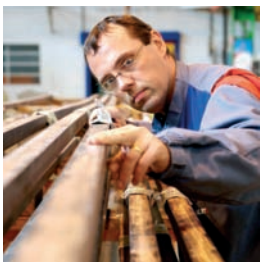
The Alstom Turbomachines group (TMG) designs, manufactures, markets and commissions the key equipment that is at the heart of power plants, namely:

- ✦ Gas turbines
- ✦ Steam turbines
- ✦ Steam turbines retrofit and integrated retrofit solutions
- ✦ Conventional islands for nuclear power plants
- ✦ Turbogenerators

Alstom has more than 100 years' experience in designing and manufacturing turbogenerators. Our pioneering work includes the world's first turbogenerator in 1898, the first 2-pole turbogenerator in 1901 and the invention of the Roebel bar in 1912. We have a comprehensive range of products and retrofit solutions, from 40 to 2,000 MW in 50/60 Hz markets, covering all applications for both Alstom and non-Alstom turbines.



## GIGATOP 4-pole: the benefits



### **A robust product**

Alstom's close co-operation with nuclear power plant operators means that we have unique feedback from operational experience of the installed GIGATOP 4-pole units. This enables us to continuously improve the product design and the technology that goes into it to adapt to changing market requirements.



### **Unrivalled efficiency**

Alstom's GIGATOP 4-pole is the most efficient 4-pole turbogenerator for the nuclear market. This is largely the result of its optimised cooling systems. The stator winding is water cooled, while the rotor and stator core are directly hydrogen cooled. At the same time, the efficient hydrogen sealing system maintains high hydrogen purity, which sustains the equipment's efficiency over long operational periods.



### **Ease of transportation and installation**

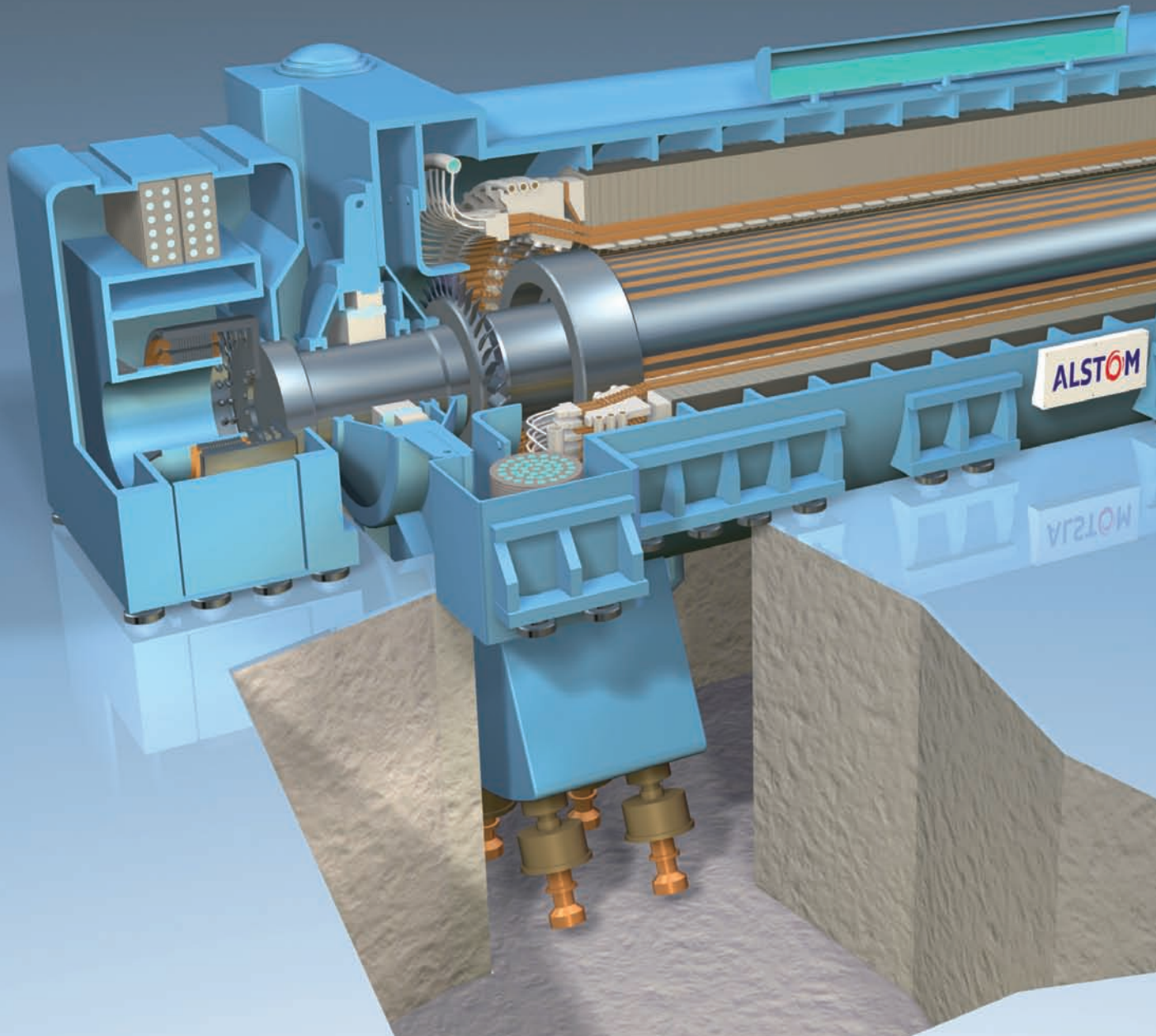
The GIGATOP 4-pole turbogenerator is designed for rail and road transport, making delivery much easier and smoother. The stator is transported within the casing as a single unit, so cleanliness of the core is ensured during transport. The result is that only a small number of individual, separately packaged pieces are transported, which considerably speeds up installation time and brings you on power and making revenue more rapidly.



### **Easy to maintain**

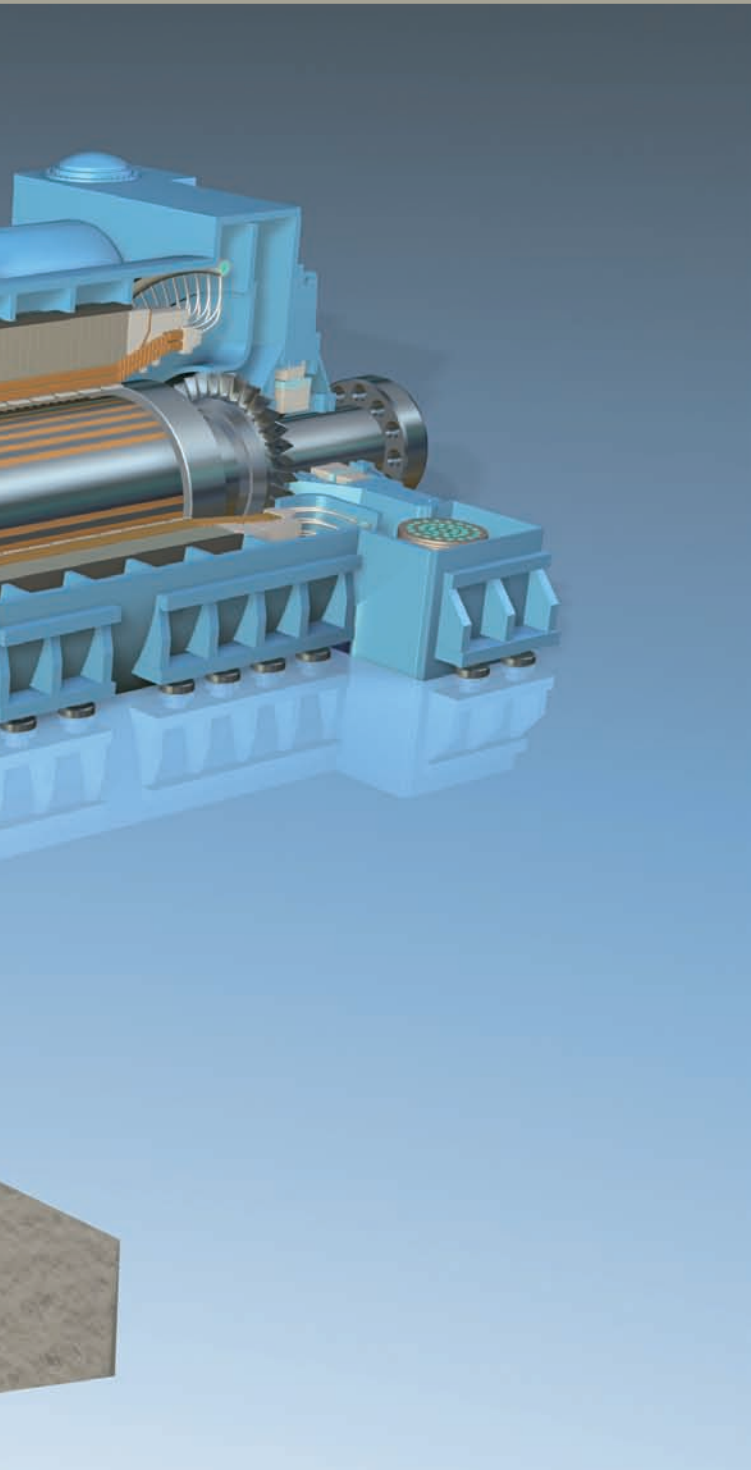
The inner parts of the machine are easily accessible, making maintenance much easier. For example, the stator end winding can be re-tightened during a major overhaul, quickly and simply. Also, the cooling tubes are made of stainless steel instead of copper, so there is no risk of corrosion and clogging from copper oxides. This adds to the reliability of operation.

# GIGATOP 4-pole: designed to perform



## Water-cooling system in the stator winding

The water-cooling system in the stator winding is designed to deliver the highest reliability. De-ionised water flows through the stainless-steel cooling tubes to remove the heat dissipated by the stator winding. The corrosion-resistant nature of stainless steel ensures that there is no clogging within the cooling tubes, whatever the water quality, so that losses are minimised and efficiency enhanced. The tubes themselves are welded to water clips located at both ends of each bar, next to the brazed lugs. The electrical and cooling circuits are therefore kept separate, further improving reliability.



### **Stator end-winding support structure**

This truly unique design feature reduces the maintenance effort and increases availability of the GIGATOP 4-pole. It is axially flexible to allow thermal expansion, and rigid in the radial and tangential directions to withstand high electromagnetic forces. The end-winding can be re-tightened easily during a major overhaul, which accelerates maintenance operations.

### **Hydrogen sealing system**

Alstom has gone the extra mile with the safety of the GIGATOP 4-pole, by designing a triple-circuit hydrogen sealing system. This ensures very low hydrogen consumption, which also helps to reduce operational costs. It also maintains the hydrogen at very high purity levels, meaning that the GIGATOP 4-pole's outstanding efficiency is sustained over the long term.

### **MICADUR® insulation system**

One of the key features to boost the reliability of the GIGATOP 4-pole is Alstom's MICADUR® insulation system, the result of continuous development that started in the 1950s. The insulation consists of a glass-fibre tape incorporating mica flakes. The taped bars are vacuum-impregnated with a solvent-free epoxy resin and thermally cured. The surface is finally coated with a corona-protection varnish. MICADUR® meets all the requirements of thermal class F (155°C), while GIGATOP 4-pole operates in thermal class B (130°C), meaning that it has an intrinsic safety margin for reliable operation. The MICADUR® insulation system exhibits outstanding mechanical and electrical properties, resulting in excellent long-term durability under all operating conditions.

### **Accessibility for inspection and maintenance**

The special Alstom design ensures fast and easy access to the stator and rotor components to speed up the maintenance process and add to the remarkable availability of the GIGATOP 4-pole. For example, the rotor can be removed without disassembling the end casing.

For the 50 Hz market, the GIGATOP 4-pole comes complete with an Alstom unique brushless excitation system. This makes it maintenance-free, since there is no longer any need to change brushes. It also leads to a more compact design, so the hall length can be much shorter than conventional designs.



Ling Ao, China

# GIGATOP 4-pole: a success story

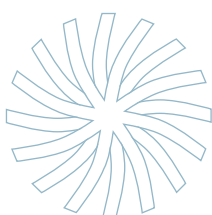
With global operational experience since 1960, Alstom has the world's largest turbogenerator in operation today, with an output of 1,550 MW.

## Ling Ao & Hong Yan He / CHINA

### Recent successes in China

Alstom designed, delivered and supervised the erection of the complete integrated turbine island at Ling Ao I (2 x 990 MW). A power plant extension is now under construction. It includes two additional ARABELLE™ 1000 steam turbines, with two GIGATOP 4-pole turbogenerator, each delivering 1,080 MW.

Alstom will also supply 4 x 1,000 MW-class steam turbine-generator packages for the conventional island of a new nuclear power plant to be built at Hong Yan He, in close co-operation with local manufacturers. The order comprises an ARABELLE™ steam turbine, a GIGATOP 4-pole turbogenerator, a condenser and moisture separator/ reheaters.



## Oskarshamn 3 / SWEDEN

### Plant asset optimisation with integrated retrofit

Alstom is carrying out an integrated retrofit project at Oskarshamn 3, whose power output is being up-rated from 1,200 MW to 1,450 MW. The complete electrical system is being upgraded with a new GIGATOP 4-pole turbogenerator, together with new or upgraded auxiliaries, to provide a fully integrated retrofit solution. This project demonstrates Alstom's competence in large complex nuclear plant modernisation programmes.

## EPR projects for UniStar / USA

### Nuclear renaissance in North America

Alstom is supporting UniStar Nuclear Energy to strengthen its position as a leader in the US nuclear renaissance. Alstom is to supply Baltimore-based UniStar Nuclear Energy with a minimum of 4 turbine-generator packages for a planned fleet of advanced-design nuclear power plants in the United States. The target for completion of the first power plant is end 2015.

## Flamanville 3 / FRANCE

### Alstom breaking its own record

The nuclear power plant started commercial operation in 1985 with two 1,350 MW units. Alstom designed, delivered and erected the turbine-generator package, plus the bulk of the turbine island mechanical and electrical auxiliaries. A power plant extension is now under construction. It will include an additional ARABELLE™ 1750 steam turbine and a GIGATOP 4-pole turbogenerator delivering 1,750 MW. When commissioned in 2012, this will be the highest output in the world from a single turbine-generator package. Alstom will design, deliver and erect the complete turbine island for Flamanville 3.





# Alstom Power, a world leader in power generation

Alstom is a global leader in power generation designed to meet the needs of customers and end users across the world. For over 100 years, Alstom has been helping to satisfy the growing need for electricity.

Today, we deliver power generation solutions in over 70 countries. Our innovative, environmentally-friendly technologies have made Alstom a by-word for efficiency, reliability and performance.

## Alstom Power R&D

Alstom Power R&D focuses on creating innovative technologies to be applied at all stages of a product's life cycle. We aim for the best utilisation of the customers' investment, the earth's materials and the fuel used, through efficiency, availability and cost reduction.

Across over 20 development centres and more than 10 laboratories worldwide, Alstom R&D activities focus mainly on the improvement of plant performance and efficiency and on the reduction of environmental impact.

## Quality manufacturing

Alstom's 100-year manufacturing experience gives customers special advantages. Our worldwide plant network, all ISO 9001/14001 certified, ensures that high quality standards are consistently met through continuous quality improvement initiatives. A key focus area of our R&D effort is new manufacturing technology and processes. Laser cutting of core laminations as well as automatic stator bar and rotor coil manufacturing are some of the innovative methods that keep us at the technology forefront.

In accordance with IEC and ANSI/IEEE standards, every turbogenerator is subjected to a series of tests over and above the material and manufacturing checks.

## Extensive service experience

Through our 200 Local Service Centres in 70 countries, you have direct access to Alstom Power Service's full range of maintenance and emergency repair services.

Our services include performance improvement, lifetime extensions and consultancy packages for Alstom and other OEM turbogenerators. Alstom can also advise you on the economics and risks associated with different maintenance and repair strategies.

Upgrades offer a very economic opportunity to benefit from Alstom's latest technology. Various upgrade packages have been developed to match your operating strategy. Increased power output, improved operational flexibility or reliability are the major aims of an upgrade.

Alstom service packages to re-wind and repair major components, coupled with new design techniques and modern materials, help improve plant performance.

Alstom's long-term service contracts will meet your unique requirements. You can choose from traditional Purchase Order Contracts, Service Agreements, and Operations and Maintenance Contracts.

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