EMERGENCY DIESEL GENERATORS
NUCLEAR SAFETY FIRST
Welcome to **Alstom Power**

Alstom is a global leader in power generation with a portfolio of products covering all fuel types. From fossil and biomass to nuclear and renewables, close to 25% of the world’s power production capacity depends on Alstom Power technology and services. Whether in design, manufacture, procurement or servicing,

Alstom Power is setting the benchmark for innovative technologies that provide clean, efficient, flexible and integrated power solutions. Alstom can supply anything from single components to complete turnkey power plants. Our Plant Integrator™ approach and power automation and control solutions ensure the optimisation of all elements to derive the maximum lifetime value from all our customer’s investments.

Alstom Power has more than 100 years of experience in engineering, procurement and construction (EPC) of new power plants. But our engineers are also experts in retrofitting, modernising and servicing existing plants. With operations in 70 countries, Alstom Power is close to customers all over the world, ensuring rapid responses and service excellence at all times.

With our recognised expertise all over the power generation market, we are able to find solutions to the challenges of today.

**CLEAN POWER TODAY!®**
We recognise the need to improve the environmental balance of legacy plants while increasing adoption of new clean energy solutions.
Alstom is the **global leader in EDG installation**, providing 50% of the world’s EDG packages in the last decade alone.

**Leadership and Expertise**

**Alstom EDGs – defining excellence**
Designing integrated Emergency Diesel Generators (EDGs) requires an exceptional level of expertise. With a history of 35 projects on 50 reactor units, Alstom’s specialist engineers boast a total of 124 installations of EDGs and stand-by diesel generators. We use integrated calculation tools to define the optimum configuration for each project, designing individual packages that include all the systems and components necessary to make your project a success.

**Experience that counts**
Alstom has 30 years’ experience supplying EDGs for all reactor types across the globe including major nuclear power plants in China, Korea, India, Africa and Europe. In fact, in the last 10 years alone we have installed over 50% of the world’s integrated EDG packages for nuclear reactors, making Alstom the world leader.

Our success is the result of a long-established partnership with the leading diesel engine manufacturer and is backed up by Alstom’s worldwide network of customer service facilities.

**Safety: our number one priority**
When it comes to safety, there can be no room for error. Alstom EDGs have a track record of over 300 starts without a single failure. If a reactor loses power, they start their first load after just 10 seconds, providing vital emergency power to cool the reactor core fast. They even operate without auxiliary power in what is called a ‘Black Start’.

As you would expect, all our equipment undergoes a thorough and systematic quality assurance test cycle. Every single product involved in our emergency power range is certified according to the most stringent criteria.
Delivering reliability

Alstom EDGs have been designed specifically for emergency situations. They operate either as stand-alone emergency generating units or as back-up generating units for other EDGs. They deliver safety to nuclear power plants in two key ways:

1. If there is a power failure or an accident, they provide a reliable electrical supply to the emergency reactor core cooling system.

2. If the reactor needs to be shut down, they have the emergency power supply and auxiliaries to do it safely.

100% available. 100% reliable.

Alstom EDGs come complete with redundant starting devices (air starting lines and fuel-oil transfer pumps) to ensure availability when it counts. They are also designed for a 10% overload for two hours every 24 hours.

Other benefits include:
- A reliable and qualified complete EDG package
- Rated speed and voltage within 10 seconds after start-up
- Direct engine/generator coupling
- Redundant engine auxiliary systems
- Two independent air start-up systems
- Excitation based on a permanent magnet generator
- Redundant features of the microprocessor-based distributed control system with self-checking
- Black Start capability

Alstom sets the global benchmark for both engineering and customer service.
Working with the specialists

For your project to be successful, you need the most talented and experienced engineers. We hire only the very best in the industry, providing them with continuous training and development throughout their careers. Once assigned to your project, Alstom engineers will:

- Define generator technical data (in accordance with engine technical data).
- Study the EDG installation needs.
- Calculate for certification: load sequence, short circuit, transient generator voltage and motor frequency recovery, and transient load stability.
- Verify the equipment vibration and seismic constraints.
- Perform equipment environmental qualifications.
- Perform inspections and tests.
- Ensure the interface to civil works.
- Assist the erection and commissioning on-site.
- Provide complete training programs for your staff.
- Deliver after-sales services.

Meeting your goals

We understand what it takes to deliver projects on time and to plan. We make sure you meet your goals, not only in terms of safety but also profitability, ensuring punctual delivery on every project. Our reputation for project support is also outstanding, thanks to our worldwide network of customer service facilities.
Your specifications – our packages

Alstom EDGs cover the whole emergency power range, from 3 to 10 MW. These EDGs reflect our in-depth expertise in power plant technology and our extensive experience in plant engineering.

**EDG package based on a high speed engine**
- 3-7 MW
- High-speed (900 to 1,000 rpm)
- 12-20 cylinders Vee 280 mm bore
- Generator up to 7 MWe (50 or 60 Hz)
- 110% for two hours every 24 hours

**EDG package based on a medium speed engine**
- Up to 15 MW
- Medium-speed (500 to 750 rpm)
- 12-20 cylinders Vee 400 mm bore
- Generator up to 9MWe (50 or 60 Hz)
- 110% for two hours every 24 hours
Experts in integration

Our specialist engineers will create an individually-tailored EDG package specifically for your plant. We will determine which diesel engine, generator and excitation system best suit your requirements before using a complex set of integrated calculations to fulfill your requirements including:

- Starting time engine torque and dynamics
- Voltage and frequency drop & recovery time
- Transient stability
- Environmental resistance
- Site conditions
- Seismic resistance.

Once these are completed, we move on to selecting the mechanical and electrical auxiliaries. These include protection and control systems, low-voltage distribution switchboards, tanks, valves and pipes for fuel oil, air intake, exhaust, lubrication, preheating, water cooling and compressed-air start-up systems. Every component used is individually qualified, and then the resulting package will be qualified as well.
Quality – the essentials

Alstom’s nuclear activities have been awarded ISO 9001:2008 certification by Lloyd’s Register Quality Assurance.

Nuclear specialists from Alstom conduct all qualification processes. When required, EDG projects can be managed in accordance with specific quality requirements, such as IAEA 50-C-QA and 10 CFR 50 Appendix B.

Alstom EDGs are classified for nuclear safety and comply with the most stringent requirements and regulations applicable in nuclear power plants for all types of reactors – PWR, BWR, VVER, CANDU, PHWR, etc. They are certified for nuclear applications in leading nuclear power production countries such as China, USA, France, India, Japan and Korea.

Specific qualifications include:

- IEEE standards (USA)
- ASME (USA, India, China)
- RCCE and RCCM codes (France, China)
- CSA (Canada)
- KTA (Germany)
- GOST, ROSTEKNADZOR (Russia)
- YVL (Finland)

Alstom EDGs have been qualified according to the IEEE 387 standard, covering 300 consecutive hot and cold starts of the diesel generator unit and requiring a less than 1% failure rate. They are also seismically qualified according to the IEEE 344 standard, and IEEE 1E qualified for their electrical components and control systems.
At Alstom, we are dedicated to continuous, rapid improvement in quality, lead-time, customer value and innovation.

We continually strive to meet both customer expectations and the highest quality standards and our culture of continuous improvement is supported by specific policies and objectives. We monitor our achievements on a regular basis and, by benchmarking and sharing best practice, our quality remains unrivalled.

Throughout Alstom, we apply Six Sigma methodologies to analyse, measure and reduce any kind of variation in our processes. Guided by our strategic objectives, values and culture, Alstom employees willingly take ownership of our improvement projects.

Working internationally, delivering locally – China

We are proud to supply the full line of EDG solutions to the growing nuclear industry in China, having sold 51 EDGs across 8 sites, with 14 under commercial operation. Such is our success, that we have been awarded the HAF604 qualification for our exceptional delivery.

Our engineers in Europe work in close collaboration with colleagues in Wuhan, China to design and deliver each system. This way of working enables the Alstom team in China to source the mechanical and electrical auxiliaries needed, and closely manage each project.
Emergency Diesel Generators in action

Alstom EDGs can be installed in all types of nuclear reactors. The following is a snapshot of some of the major Alstom EDG installations and current projects:

**CPR 1000**

*HongYangHe 1-4, Ningde 1-4, Fangchenggang 1+2; China*
*Customer: China Nuclear Power Engineering Co. Ltd. (CNPEC)*

Alstom’s qualified EDGs were commissioned for installation in China Nuclear Power Engineering Company’s CPR 1000 nuclear reactors - a total of 23 x 6 MW with PA6-B engines. Alstom’s facilities in Wuhan are developing an excellent reputation in this market, delivering the project localisation required by Chinese customers.

**EPR**

*Olkiluoto 3, Finland*
*Customer: Areva NP*

Alstom is delivering an integrated EDG package with 4 x 6.3 MW PA6-B engines for the first EPR nuclear reactor.

*Flamanville 3, France*
*Customer: EDF*

Alstom is delivering an integrated EDG package with 4 x 7.3 MW PC2-6B engines.

*Taishan 1+2, China*
*Customer: CNPEC*

Alstom is delivering an integrated EDG package with 8 x 9.1 MW PC2-6B engines, these will be the largest EDGs in the world.

The three references above demonstrate how Alstom is providing EDGs to every one of EPR’s current projects. Alstom is also actively collaborating on new EPR projects around the world.

**OPR 1000, APR 1400**

*Shin Kori 3+4, South Korea*
*Customer: KHNP*

5x8 MW with PC2-6B Shin Kori 3+4 was the first APR 1400 project. It delivers the largest amount of power of any nuclear reactor in Korea and is now exported around the world. Alstom has installed 19 EDGs in nine nuclear reactor units in Korea. It has delivered 8 EDGs for Shin-Kori and Shin Wolsong power plants. Together with the five EDGs at Shin Kori, this makes a total of 32 Alstom EDGs operating in Korea.

**PWR & CANDU**

*Qinshan, China*
*Customer: NPOJVC*

4 x 6.0 MW PC2-5 engines for the PWR nuclear reactor
4 x 8.2 MW PC2-6 engines for the CANDU nuclear reactor

Alstom delivered two integrated packages in 2003. The qualified EDG packages are still used as references for new projects.

**ABWR**

*Lungmen 1+2, Taiwan*
*Customer: TPC*

6 x 7.5 MW with PC2-5 engines
1 x 7.5 MW with PC2-6B engines

Alstom is delivering these integrated packages in accordance with the ASME standards required for both the Korean and US markets.

**VVER**

*Tianwan 1+2, China*
*Customer: Atomstroyexport, Russia*

Alstom delivered 4 x 5 MW with PA6-B engines in 2003. The nuclear power plant has been operating since 2007.

*Kudankulam 1+2, India*
*Customer: Atomstroyexport, Russia*

Alstom delivered 10 x 6.3 MW with PA6-B engines in 2006.

*Leningrad II, 1*
*Customer: Alstom-Atomenergomash, Russia*

Alstom is delivering 5 x 6.3 MW with V32 engines for the nuclear power plant Leningrad II,1.
## ALSTOM POWER WORLDWIDE REFERENCES

Emergency Diesel Generator packages in Nuclear Power Plants

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* Estimated commissioning date