THE WORLD’S
HEAT EXCHANGER
SPECIALISTS

POWER

We are shaping the future

ALSTOM
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.
Outstanding and unrivalled experience of Alstom Heat Exchange, providing flexibility, reliability and efficiency to his customers worldwide.

Leadership, partnership and expertise

Alstom’s 100 years of experience in power generation enables us to develop and continuously improve our products to meet changing customer demands. That unrivalled expertise is reflected in the installed base of over 450 GW and heat exchange equipment sizes of up to 1700 MW electrical output.

We have broad experience in local manufacturing, with high-quality carefully selected suppliers worldwide to be close to customers and to understand and meet their needs. Our expertise enables us to offer comprehensive services and solutions to comply with the specific requirements of each project.

Alstom’s integrated design, procurement, manufacture, erection and commissioning processes are tailored to meet present and future requirements for:

- Operational flexibility
- High reliability
- High efficiency
- Cost effectiveness.

Customer satisfaction, our top priority

In addition to power generation turbines and turbogenerators, Alstom also offers an extensive range of heat exchange equipment for all kinds of power plants, steam, combined cycle, nuclear. The Alstom Heat Exchange offering comprises four major product clusters:

For Turbine Island:
- Surface condensers
- Moisture separation/reheating equipments (Moisture Separator Reheater, Moisture PreSeparator, Special Cross-Under Pipe Separator)
- Heater systems (LP and HP heater, feedwater tank with deaerator, district heater, water-water heat exchanger, once-through cooler).

For Nuclear Island:
- Liquid purification systems (gas stripper, stripper condenser, evaporator and boric acid column)
- Multi-venturi scrubber system.

Alstom is a globally well-known supplier of heat exchange equipments and services. A full range of services, from consulting and field support to component supply and turnkey retrofit is available to our customers. Their purpose is to raise the efficiency, safety and environmental-friendliness of power plants, as well as to improve the final cost of your power plants.
The condenser is a crucial element of any power station. It is the interface between the water/steam cycle and the heat sink. Condenser performances have a direct impact on the power station’s output and the availability of electric power.

Alstom’s condensers meet sustained high-performance requirements, since any increase in pressure at the turbine exhaust will cause a substantial power loss. And clearly, they are perfectly water-tight, whatever the quality of the on-site cooling water supply.

**Key advantages:**

**HIGHER PLANT PERFORMANCE**
- Higher part-load efficiency
- No condensate subcooling for high plant performance
- Low venting flow to reduce auxiliary power consumption
- Optimised water boxes.

**HIGHER RELIABILITY**
- Excellent deaeration
- Downstream components protected against corrosion
- Low loading of the turbine foundation
- Adapted tube materials
- Low oxygen content of the condensate.

**PRE-ASSEMBLED MODULES FOR**
- Rapid installation
- Shorter time-to-operation.

For each project Alstom Power condensers are specifically adapted to operate on any kind of steam power station, fossil-fired, nuclear, combined cycle as well as certain industrial plants such as petrochemical refineries or paper mills. They are robust and designed to withstand turbine and steam generator overloads and variations in cooling water temperature.

Alstom Power designs its condensers taking into consideration the specifics of each installation.

**Tube bundle designs**

The tube bundle is the main component of the condenser. That is why Alstom has invested heavily in tube bundle research and development over the past 50 years. The resulting tube bundle designs take into account each particular client situation. They are highly efficient.

The Alstom tube bundles are suitable for any turbine hall configuration. The tube and tubesheet materials have been selected according to a series of physical and chemical parameters such as salinity, suspended solids, chloride content.
Therefore the tubes themselves are made of copper-nickel, stainless steel or titanium. The tubesheets are made of carbon steel, copper alloy, stainless steel or titanium. Stainless steel-clad or titanium-clad carbon steel tubesheets are also possible. Alstom provides two bundle designs:

- Daisy (radiant) is a compact design that meet HEI requirements
- Church Window is a modular design.

The choice of the best tube bundle will be made upon the 3 main following criteria:

- Whether HEI is required or not
- Whether space is limited or not
- Costs comparison on a case by case basis.

Thanks to its huge experience, Alstom Power product supply covers the whole spectrum from design to commissioning, as well as spare parts, replacement or rehabilitation and maintenance, even of third-party heat exchange equipment.

### Efficient venting

The steam side of the condenser must be continuously vented to maintain the vacuum in the condenser. Alstom has engineered a venting system that provides efficient venting under all load conditions based on the optimised tube arrangement in the tube bundle and one or two air coolers installed in each bundle. This helps to reduce capital investment and operating costs.

### Retrofit

Over the past 35 years Alstom has retrofitted more than 100 condenser tube bundles establishing a record of 23 days for a complete unit retrofit.
Alstom has invested exceptional effort in the research and development of its moisture separator reheaters (MSRs). They can be horizontally or vertically mounted in the turbine hall – horizontally on the turbine floor or vertically on the cellar floor underneath the turbine floor.

**Key advantages:**

- Optimum performance
- Maximum cycle steam reheat temperature at minimum pressure loss (for MSR)
- Adaptability to all existing reactor outputs
- Proven design for a long lifetime
- High reliability
- Low maintenance
- Optimum integration into the thermal cycle, since Alstom Power’s nuclear activity can handle both MSR and steam turbine as a single package.

In nuclear power plants with wet steam turbines, the steam at the high-pressure turbine exhaust has a moisture content of up to 15%. To improve plant efficiency and to avoid erosion corrosion and droplet impingement in the low-pressure turbine, the moisture is removed by the moisture separator through chevron separating elements. In most cases, the steam is also superheated in the reheater; this is done by live steam and/or condensing extraction as heating steam inside the reheater tubes, where the cycle steam flows in cross-counter flow on the shell side of the tube bundles.

The Alstom chevron separator design guarantees a very low pressure drop, with the result that the overall arrangement of the MSR minimises the shell-side pressure loss. To ensure efficiency of separation and that the wet steam is correctly distributed along the moisture separator panel, a pre-separator component is installed in the cross under section of the steam inlet pipe.
reheaters
for your nuclear power plant

Expertise in figures: 200 units in commercial operation,
40 years of trouble free operation,
more than 200,000 operational hours at 1550 MW

Horizontal MSR

The 2-pass tube bundle consists of finned U-tubes, which are expanded and welded into the tubesheet. The steam chamber is divided into two internal chambers to ensure distribution of the heating steam to the tubes and collection of the steam and condensate leaving the tubes.

A design goal is to ensure a sound fluid flow inside the tubes and to avoid condensate sub-cooling.

The steam box is designed for evacuating the condensate and is permanently scavenged.

To minimise U-tube sub-cooling, a perforated plate is installed in front of the tube bundle inlet.

For Erection and Maintenance operation this is the preferred Alstom Design.

Vertical MSR

In the vertical MSR, drainage of the heating condensate in the tubes is ensured by gravity.
By giving greater access around the turbogenerator floor level, this design allows the size of the turbine island building to be reduced.

HIGH VELOCITY MOISTURE SEPARATORS

In conventional moisture separator designs, water separation takes place at vapour speeds of less than 5 m/s. That is why Alstom has developed several High Velocity Separators (HVS) by using multi-vortex cells. These components – MOPS and SCRUPS – achieve a very high efficiency of separation. HVS is already used on the heating steam extraction of HP heaters on NPP.
Heater systems
High reliability

High pressure heaters for thermodynamic efficiency

The high pressure feedwater heaters are used in a regenerative water-steam cycle to improve the thermodynamic gain of the plant and to reduce the thermal pollution.

Alstom’s family of HP feedwater heaters are of shell and U-tube type and for supercritical cycles header type can also be used. The feedwater passes through the tubes heated by steam on the shell side. The U-tubes are welded in the tubesheet and the tube coils are welded onto the header nipples.

High Pressure heaters generally have a desuperheating, a condensing and a drain sub-cooling zone.
The high pressure heaters can be installed horizontally or vertically channel down or channel up.

Key advantages:
- High heat transfer
- Optimal partition of the heat exchange area
- Optimal thermodynamic and economic integration into the water/steam cycle
- High reliability
- Channel partition very resistant to temperature stresses.

Header type feedwater heater:
The header type feedwater heater is a tube bundle heater (three or four passes) with multiple bent tubes (S or W shape) with the ends connected to an inlet header on one side and outlet header on the other. It is especially suited for “supercritical” high efficiency thermal power plants, because they are more robust than tube sheet heaters at high pressure and in transient conditions (frequent starts and shutdowns). They allow much greater power plant operation flexibility with a large number of load changes and a life time up to four times longer.
Alstom can supply an exhaustive range of heater systems depending on the power station needs, from low and high pressure heaters to district heaters and water-water heat exchangers. They are robust, reliable and deliver excellent performance.

Low pressure heater with a great reliability

The low pressure feedwater heater in a steam or nuclear power plant is used to fine-tune its water-steam cycle. It improves thermodynamic efficiency, resulting in a reduction of fuel consumption and thermal pollution. Alstom low pressure feedwater heaters are tubular heat exchangers with U-shaped tubes fixed in a tubesheet. The design of the tube bundle and the steam and condensate flow paths in the different heater zones minimise shell-side pressure losses. Alstom has patented a removal device for the non-condensable gases, which ensures a high heat transfer rate.

Low Pressure heater can be horizontal, vertical channel up or vertical channel down. The low pressure feedwater heaters are custom manufactured by Alstom. After commissioning and tuning of the control system, the low pressure heaters are maintenance-free.

Key advantages:
- High heat transfer
- Easy inspection
- Long life time.
District heaters for sound heating economics

Alstom has been providing district heaters for over 50 years. They offer very good heat transfer coefficients, with optimum steam transfer surfaces. They are also extremely reliable, even under transient conditions.

District heaters are normally installed close to the steam turbine to provide heat for consumers external to the plant, i.e., for residential or industrial heating needs. They make a major contribution to maximising fuel utilization.

Alstom district heaters are of the shell and tube type with the tubes fixed in a tubesheet. They are designed either as straight condensing heat exchangers or with an integral drain cooler zone. Depending on the process and layout plan, horizontal or vertical installation is possible. If softened or demineralised district heating water is used, the tubes are U-shaped, otherwise straight tubes are used.

**Key advantages:**
- Proven design
- Optimisation of heater to turbine and generation
- Excellent fuel re-utilisation, and therefore sound economics
- Ease of maintenance
- High reliability
- Ease of accessibility to waterboxes for inspection
- High heat transfer
- Optimal thermodynamic and economic integration into the water-steam cycle.
Feedwater storage tank and deaerator

The Alstom direct contact deaerator and its associated storage tank form a single, combined unit. It achieves high operating reliability due to its simple and robust concept, based on many years of experience.

Alstom has also developed an integrated deaerator for nuclear power stations. Its function is the same, however, the deaerator is placed inside the storage tank. Thanks to this arrangement, the overall dimensions of the equipment are reduced.

The deaerator provides a triple function:
- It eliminates all oxygen so as to avoid any damage to the steam generator
- It heats the feed water to as high a temperature as possible with the steam pressure available
- It provides a reserve of deaerated and heated water necessary for proper operation of the feed heating equipment and its associated pumps.

The feedwater storage tank and deaerator can operate in over pressure and/or vacuum mode, both modes being equally effective for oxygen removal. The deaerator can be installed vertically or horizontally above the storage tank, or integrated within the storage tank.

Key advantages:
- Optimum thermodynamic exploitation
- High operating reliability
- Steam extraction lines not submerged in the feedwater, hence no steam and water induction into turbine during transient conditions
- Good deaeration over the entire load range
- Very low heat losses through venting
- Spray nozzles with low pressure loss, hence saving in pump energy
- Easy adjustment of feedwater outlet temperature depending on the sulphur content in the fuel
- Feedwater storage tanks and deaerating direct-contact heaters are largely maintenance-free.
Water-water heat exchangers for improved reliability and heat recovery

There are several fields of application for water-water heat exchangers, such as:
- Water-water coolers for auxiliary cooling circuits
- Water-water heat exchangers for flue gas heat recovery
- Water-water heat exchangers in district heating systems.

Alstom can supply all these shell and tube type water-water heat exchangers, mounted horizontally or vertically.

Water-water cooler for auxiliary cooling circuits

The purpose of the water-water cooler is to cool the closed cooling water circuit used for the plant auxiliaries. Normally there are two water-water coolers installed indoors for each unit, one in operation and one in standby. This intermediate cooling water system is filled with clean, fully desalinated water. It emits waste heat into the auxiliary or main cooling water circuit.
Our heaters are cost-effective and highly reliable because we choose, arrange and design them to fit the requirements of your nuclear power plant.

Water-water heat exchanger in district heating systems

The recovered heat – from any source – can be transferred by this water-water heat exchanger to a district heating system.

Water-water heat exchanger for flue gas heat recovery

Another water-water cooler application is for flue gas heat recovery. These closed cooling water systems transfer the recovered flue gas heat to the water/steam cycle at the temperature level of the low pressure heaters.

Key advantages:

- Avoids fouling and corrosion of the plant equipment by using an intermediate closed-loop cooling system
- Wide Range on rating, medium pressure and mass flow
- Continuous sponge ball cleaning system to reduce cleaning costs to a minimum
- Improved reliability and reduced maintenance on the main cooling circuit.
Cutting edge technology in Liquid Purification Equipment

Alstom is a leader in nuclear Liquid Purification Equipment using evaporation and degassing technologies, thanks to its long experience and the continuous upgrading of equipment, including development of turnkey systems adapted to the latest generations of pressurized water reactors.

Various types of liquid radioactive effluent result from the operation of a Nuclear Steam Supply System (NSSS). Alstom provides treatment equipment and processes in order to restrict the discharge of radioactive liquid effluent to the environment and to improve the process loop performance.

Their design is in accordance with the principle of waste minimisation, focusing on reduction at source, collection and separation, treatment and reuse/recycling. Finally, residual decontaminated products are monitored and discharged to the environment, within regulatory discharge limits.

In particular, Alstom benefits a great experience in following systems:

- The primary coolant treatment system, performing:
  - The separation of reactor coolant discharged during plant normal operation into a concentrated boric acid solution (7000ppm) and distillates (distilled water and any volatile constituents issued from the distillation process)
  - The degassing of distillates from evaporation prior to reuse in the primary circuit or release from the plant
- The primary coolant degasification system, taking in charge:
  - The removing of dissolved gases in the reactor coolant such as fission products (Krypton, Xenon...) and Oxygen
  - The treatment system, dealing with the processing of radioactive liquid wastes of different types (process drains, chemical drains, floor drains) non reusable in the primary system and performing:
    - The separation of effluents into a concentrated solution (which contains almost all the activity of the dissolved salts & suspended matters) and demineralised water.
Key advantages:

Nuclear Liquid Purification Equipment are crucial elements in any nuclear power plant, since they contribute significantly to safety and the protection of the environment. Consequently, the availability and reliability of Alstom solutions respond to customers’ current and future concerns and needs:

- Optimal materials selection with regard to the aggressive nature of radioactive fluids
- Maintainability and compactness
- High efficiency in separation, degasification and decontamination as well as in heat exchange processes
- Integration in the design of measures for smooth process and preservation of the best efficiency level (erosion and corrosion resistance, fouling mitigation)
- Integration in the design of safety measures for radiation protection and operator security (equipment tightness, instrumentation selection, access and inspection according to client requirements and good practice in radioactive environment)
- Quality of the demineralised water which, after purification, meets all the requirements for reuse in the primary circuit or release from the plant in compliance with discharge regulations.
Alstom is committed to supporting its customers throughout the lifetime of their power plants, with the objective of maximising their return on investment and minimising the environmental impact. With its wealth of experience and feedback from such plants, Alstom assesses the project from the high ground, covering design and manufacturing, installation, operation, maintenance, as well as upgrading existing assets and retrofitting state-of-the-art technology.

Whether you are building a new power plant or refurbishing existing assets, Alstom has developed leading-edge technologies that optimise efficiency, output and sustainability. For maximum return on investment, all heat exchange equipment needs to be adapted to fit the specifics of the project. Similarly, every retrofit or upgrade is a customised project that needs to be designed to deliver optimum results.

Alstom Power offers an integrated approach to address all plant equipment, including the assessment and optimisation of moisture separator reheaters (MSRs), feed heating, condensers, and liquid purification systems. This can be extended to encompass project management, engineering, logistics, installation and start-up such that risk management is optimised.

Performance for the long haul

Alstom can offer a wealth of power generation expertise, whether you opt for our OEM, EPC or O&M solutions. The systems that are running today feed a huge amount of input into the development of those for tomorrow. This makes a noticeable difference to your plant performance, reliability and, ultimately, profitability.

The Alstom O&M goals are simple: to maximise plant availability, improve energy efficiency and extend component and system lifetime through planned maintenance operations and appropriate upgrades and retrofits. At the same time, concerns about the environment and the health and safety of employees and local communities are always high on our list of priorities.

Consulting and support

Alstom Power helps its customers to maximise plant performance, availability and reliability through a comprehensive palette of innovative services:

- Performance and lifetime assessments.
- Design studies
- Inspection technologies
- Emergency response planning
- Monitoring and diagnostics
- Training.
A full service range

Alstom’s 50 years of experience servicing heat exchange equipment mean that we can offer a complete range of services – traditional spare parts supply, performance upgrades, lifetime extensions, right up to full operation and maintenance. The result is enhanced efficiency combined with reduced emissions and less impact on the environment, according to new regulations.

Outages: Alstom is a major provider of outage services, from turnkey outages through technical advisors and specialist services. Processes cover both planning and execution, ensuring on-time delivery with optimum quality.

Exhaustive component supply: Alstom offers the full portfolio of components required for heat exchange equipment installations. Our parts management is handled through a sophisticated database, with full parts traceability and data accessibility. Centralised warehousing means fast delivery and competitive pricing.

Quality built in

Alstom is dedicated to continuous, rapid improvement in quality, lead time, customer value and innovation. The company in its entirety continuously strives to meet both customer expectations and the highest quality standards.

Alstom Power operates world-class facilities certified to the ISO 9001 international quality standards as well as to ISO 14001 environmental management and OHSAS 18001 occupational health & safety management standards.

Policies and objectives for continuous improvement are set and deployed throughout the company and supported by the Six Sigma programme. Achievements are monitored and reviewed on a regular basis. Benchmarking and sharing of best practices support the efforts to sustain unrivalled quality.

We help you to maximise power output and profitability – from design and engineering studies to plant configuration and from commissioning to maintenance.

of your power plant
Alstom heat exchangers in action

FLAMANVILLE 3,
EPR™ NUCLEAR POWER PLANT, FRANCE
Customer: EDF
Power output: 1750 MW
Scope: vertical MSR, low pressure feedheaters, feedwater tank with integrated deaerator, high pressure split-flow feedheaters, CCWHE, ATD regenerator

TAISHAN 1&2,
EPR™ NUCLEAR POWER PLANT, CHINA
Customer: TSNP/JV (EDF 30% + CNPE 70%)
Power output: 1750 MW
Scope: vertical MSR, low-pressure feedheaters including duplex arrangement, feedwater tank with integrated deaerator, high pressure full flow feedheaters, CCWHE, ATD regenerator

LING AO 3&4:
NUCLEAR POWER PLANT, CHINA
Customer: CGNPC
Power output: 2x1080 MW
Scope: Liquid Purification equipment successfully commercially operating since 2010

OLKILUOTO 1&2:
NUCLEAR POWER PLANT RETROFIT, FINLAND
Customer: Teollisuuden Voima Oy TVO
Power output: 2x860 MW
Scope: complete MSR replacement in 19 days

PEMBROKE
GAS POWER PLANT, UNITED KINGDOM
Customer: RWE
Power output: 5x400MW
Scope: Condenser, feedwater tank with associated deaerator, atmospheric drain vessel

SOSTANJ
SUPERCRITICAL STEAM POWER PLANT, SLOVENIA
Customer: Termolektrarna Šoštanj d.o.o. (TEŠ)
Power output: 1x600 MW
Scope: Condenser, High Pressure and Low Pressure heaters, Feedwater Tanks
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