Volvo Aero
-important supplier for the launching industry

With the successful launch of Ariane ECA in February this yea, Volvo Aero proved that the parts to the launcher engines that were delivered from the company met the necessary demands of quality the launcher industry expects. From the very beginning of the Ariane launcher era, Volvo Aero has supplied parts to the engines. Firstly, Volvo Aero produced nozzles and combustion chambers for the Viking engines used in the first models of Ariane, secondly, in recent years they supplied nozzles and turbo pumps for the Vulcain and Vulcain 2 engines. Additionally, like other innovative companies, they look to the future. Volvo Aero currently participates in the development of the next generation of engines, for the first time, developing the Vinci engines for the Ariane ECA-B. The company specialises in the production of nozzles and turbines for rocket engines, and these experiences have provided them with the title of "Centre of Excellence" in Europe for nozzle and turbines.

Production of nozzles for Vulcain 2 and the Ariane 5 ECA-B at the production plant in Trollhättan, Sweden.
Photo: Volvo Aero

Successful tests of the new Vinci engines last summer gave Volvo Aero the green light for analysis of the test results, in addition to the continuous development of the two turbines the engine is going to have, something which Volvo Aero is responsible for. The Vinci engine will be very applicable and can be used both for Ariane 5 and Vega. For Ariane, Vinci will provide possibilities for higher flexibility, and Europe can offer new types of satellite injecting orbit launches, like the new super GTO.

Developing for the future

Together with Safran, previously named Snecma, Volvo Aero also participates in the development of turbo pumps for the next generation of rocket engines. These demonstration programmes that have now begun are going to be fully and completely tested in 2007. It is the French CNES ant he Swedish National Space boardthat finance the project. Volvo Aero is responsible for the development of the turbine, and Safran is responsible for the pump itself and for the integration and testing of the complete turbo pump, TPX. Through different research and

The nozzle is an upgraded version of the main engine for Ariane 5, but develops considerably more thrust. The main technical challenge for the nozzle team was to keep a low surface mass density while reinforcing the hot tube wall (1000K) and the lower, even hotter, film cooled wall (1350 K). The new nozzle is considerably larger than its predecessor and uses the world-first technology for supersonic film cooling. Two layers (re-injected turbo-pump exhaust and dumped hydrogen) ensure highly efficient cooling of the lower part of the nozzle. The upper part is made up of a spiralling tube wall. Photo: Volvo Aero

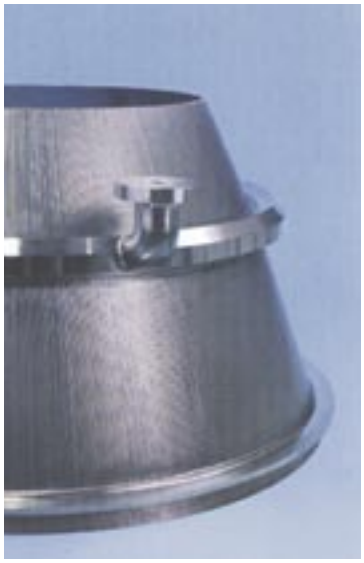
development programmes Volvo Aero has previously developed and patented several critical cost effective turbine technologies. TPX is a continuance of the successful TP2-programme and will demonstrate the BLISK-technology (Blade Integrated Disk), a technology which provides possibilities of countersining the turbine rotor from one piece, instead of the mounting of lose blades on a dish. The BLISK-technology will provide a decrease in costs, shorter production time, and higher reliability.

New and advanced production technology

In addition to further development of the BLISK-technology, Volvo has used and will continue to spend large resources on the development of the "Sandwich-technology" for production of the next generation of engine nozzles. The basis for the technology is a laser welding production method that can meet the commercial demands for active cooling of engine nozzles. Through financing from the Swedish National Space Board, Volvo Aero has started a demonstration programme for the technology within the frames of the "Advanced Nozzle Technology Programme", where the company is responsible for the construction and production of a full scale nozzle at 2.5 metres produced with the new techniques, and where the first tests can be carried out during 2007.

The technology will be useful for all types of engine nozzles and will provide higher reliability, shorter development and production time, increased design flexibility in addition to decreased weight and production time. Demonstrations have been carried out in parts several times, but in 2007 there will be full scale tests for the first time. The programme was carried out in cooperation with Safran and EADS ST. Both these companies have previously been partners with Volvo Aero through the development of the Vulcain engines.

The technology may also be a basis for cooperation between Volvo Aero and the American "Vision for Space Exploration". The programme, intended at some point in the future to carry humans to Mars, needs new launchers, one of the Saturn-class with 100 tonnes lifting capacity, and one type somewhat larger than Arian, with 35 tonnes of capacity. Both types need engines with actively cooled nozzles, and the Swedish production method will be very useful for the production of the nozzles. Volvo Aero has already one foot within the American market through the cooperation agreement with Pratt & Whitney Rocketdyne and NASA, for preliminary studies and building demonstration engines with the new technology. Volvo Aero is previously chosen as strategic partner for Pratt & Witney in developing their RL60 engine. All the engines that actually can be used in the new launchers, have nozzles that can be produced based on the Sandwich-technology.



The new production method, the Sandwich concept, which constitutes a considerable improvement over today's actively cooled nozzles. The high-pressure regenerative cooled Sandwich is based on Volvo Aero's patented laser-welded channel wall technology. It offers shorter lead-time, versatility, greater robustness, low weight and low cost.
The Sandwich nozzle has undergone an extensive testing programme, including hot gas demonstrators and full-scale unit for the Pratt & Whitney Advanced Rocket Technology Demonstrator Engine. It has also been chosen as a European booster nozzle demonstrator for the Vulcain 2 engine.
Foto: Volvo Aero

The Ariane Flight Recovery Programme.

In December 2002 Volvo Aero went through a nightmare. The new Ariane 5 ECA went down in the ocean outside Kourou for reasons closely connected to the engine nozzle.

Immediately after the accident Volvo Aero, together with Safran (main responsible for the Vulcain engine) and EADS (responsible for the combustion chamber), started the common Flight Recovery Programme aimed at getting the launcher ready for a new launch as quickly as possible. Volvo Aero basically sought to design new load specifications for a more robust nozzle in a very short time. The work, conducted under an enormous amount of stress, was almost a complete reconstruction of the nozzle.

A group of about 50 people worked on the programme, in which much of the work consisted of analyses and verifications of the new construction. The result was that the launcher now is able to meet the very complex load specifications from the customer. In addition, the temperature loads have decreased through increased cooling in the pipes, and coating with a "temperature barrier layer" on the inside of the nozzle.

The result of this intensive reconstruction is an agreement about producing a series of the Vulcain 2 engine.

Volvo Aero has participated in the development of this engine since the beginning of the 1980s, and has now signed a contract with the French Safran, previously known as Snecma, for serial production of nozzles and LH2-turbins for about 30 Ariane-5 launchers. The contract is worth about 30 million Euros and will run for a five-year period.

The LH2 turbine for the Vulcain and Vulcain 2 engines is a 2-stage transonic turbine that powers the liquid hydrogen pump of the Vulcain Engine. As a GG-cycle engine, the Vulcain uses hydrogen-rich gases to power its turbines. For the upgrades version, the Vulcain powering the Ariane ECA launcher, the LH2 turbine is of similar configuration but develops more power, operating at higher speed and pressure. The turbine, with a blade mean- line diameter at 240 mm, has an operating speed at 31 800-39 800 rpm, an inlet pressure at 52-105 bar and has an inlet temperature at 770-960 K.
Photo: Volvo Aero

The LOX turbine powers the liquid oxygen pump at the Vulcain 2 engine. This is a one–stage axial supersonic turbine with a working speed between 11 300-13 700 rpm, an inlet pressure at 40-101 bar, inlet temperature at 770-960 K and has a mean-line diameter at 320 mm.
Photo: Volvo Aero

The Volvo Aero history

Volvo Aero dates back to the 1930s, during the formation of a national air force in Sweden. Through Sweden's independent and neutral foreign policy the following few decades, the company developed a string of engine models for the air force, as well as for civilian use. Today, Volvo Aero is still recognised as a high quality supplier of parts to civilian and military engines, in addition to being a supplier of complete engines for the Swedish Gripen fighter. It is the techniques from the aircraft production that have laid the basis for the success of Volvo Aero's development and production of engine parts to the space industry.

Photo: Volvo Aero