

# SANDWICH NOZZLES



Volvo Aero has developed a new rocket engine technology, the Sandwich concept, which constitutes a considerable improvement over today's actively cooled nozzles. This high-pressure regeneratively cooled Sandwich nozzle is based on our patented laser-welded channel wall technology. It offers shorter lead-time, versatility, greater robustness, low weight and low cost.

Our Sandwich nozzle has undergone an extensive testing program, including two hot gas demonstrators and a full-scale unit for the Pratt & Whitney Advanced Rocket Technology Demonstrator Engine. It has also been chosen for a European booster nozzle demonstrator for the Vulcain 2 engine.

**VOLVO AERO**

# VOLVO AERO SANDWICH NOZZLE PROGRAMS

Program	P <sub>CC</sub> bar	P <sub>Inlet</sub> bar	T <sub>Inlet</sub> K	Medium	Material	L/D m	Q <sub>CC I/F</sub> MW/m <sup>2</sup>
1998 demonstrator	100	200	90	LH2	In 625	0.12/0.15	~11
Pratt & Whitney Advanced Rocket Technology Demonstrator Engine	80	280		LH2	Nitronic 40	0.8/1.2	
2003 demonstrator (CALO)	130	30	300	GH2	In 600	0.08/0.17	~18
Advanced Nozzle Technology Demonstration	125	~30	~30	LH2	Haynes 230	2.3/2.1	~12-13
SSME (Reference)	~200	~450	~40	LH2	A286	2.3/2.1	~22

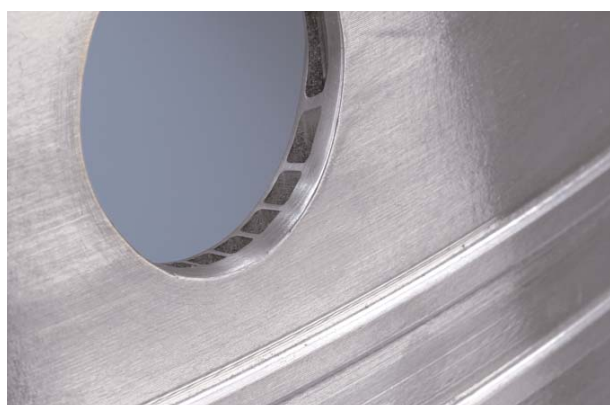
## Related Technologies

Volvo Aero is developing the process of Metal Deposition (MD) as a means to reinforce and attach manifolds, etc. This minimizes contour distortions as well as the heat affected zones in the base material thanks to the limited heat input of the laser-based MD process used.

## Volvo Aero responsibility

Volvo Aero is a partner in Pratt & Whitney's **Advanced Rocket Technology Demonstrator Engine (ARTDE)** program where the company is responsible for the development and manufacture of the regeneratively cooled Sandwich nozzle.

For the European **Advanced Nozzle Technology Demonstration**, Volvo Aero is responsible for the development and manufacture of the Sandwich demonstrator nozzle. This program is being carried out in cooperation with Snecma and EADS Space Transportation. In addition,



*Detail of Sandwich nozzle reinforced with MD, outer jacket thickness 3 mm.*

the Swedish National Space Board is supporting Volvo Aero in both of these programs.

## Similar assignments

- Development and production of the Vulcain and Vulcain 2 nozzles for the Ariane 5.
- Production of the Viking 4, 5 and 6 thrust chambers for the Ariane 4.

## Volvo Aero Corporation

Volvo Aero develops and manufactures components for aircraft and rocket engines with a high technology content in cooperation with the world's leading producers. Service and maintenance are an important part of our operations. The company offers an extensive range of products, including

sales of spare parts for aircraft engines and aircraft, sales and leasing of aircraft engines and aircraft, and overhaul and repair of aircraft engines. Volvo Aero also develops and services gasturbines for propulsion and power generation.

# VOLVO AERO

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