

THE ARIANE 5 PROGRAMME

The Ariane 5 programme, financed by the ESA (European Space Agency), was started in the early 1980s to respond to market needs for better performance.

The Ariane 5 launcher is designed for payloads up to 10 t at GTO; a growth version of the launcher for payloads up to 12 t is currently in the development phase. Avio has been working on the Ariane launcher family since the 1970s, when it designed, developed and manufactured boosters and stage separation motors for Ariane 3.

Avio later designed and built the Ariane 4 boosters, the growth version with 10 t of solid propellant.

The total number of boosters produced for Ariane 3 and Ariane 4 was more than 180 units.



AVIO FOR ARIANE 5

The boosters

Avio has a major share in the production of the P230 launch motor, which carries 237 t of solid propellant and delivers 90% thrust to the launcher at take-off for 130 sec.

The S1 forward segment

The S1 segment is one of three segments for the Ariane 5 booster and is fully manufactured at the Colferro plant (Rome, Italy).

The manufacturing process is:

- application of thermal protection
- inspection of forward and back chicanes
- after machining
- ultrasonic inspection
- loading with 30 t of solid propellant
- endoscopic controls
- x-ray inspection

The loaded segment is then shipped to French Guyana, where it is assembled to the S2 and S3 segments. So far, Avio has produced 106 units, of which 94 have already been successfully utilised in flight. The booster igniter is also manufactured at the Colferro plant.

The S2 and S3 segments

The S2 and S3 segments, once thermally protected (at Colferro), are then shipped to French Guyana where they are each loaded with 100 t of propellant by the Regulus company (60% Avio and 40% SME); they are then integrated by the Europropulsion company (equally shared by Avio and Safran).



Main characteristics of the booster

Motor length	27.8 m
Motor diameter	3.07 m
Total weight	269 t
Propellant mass	237.8 t
Vacuum thrust (max)	6,709 kN
Total impulse	641,500 Ns
Combustion time	130 s
Nozzle expansion ratio	11

Main characteristics of S1 segment

Segment length	3.5 m
Diameter	3.07 m
Total weight	27.2 t
Propellant mass	23.5 t

Main turbopump characteristics

	V1 LOX TP	V2 LOX TP
Inlet pressure (bar)	3	7
Inlet temperature (°K)	91	90.6
Flow rate (kg/s)	207.6	274
Outlet pressure (bar)	133	168
Rotor speed (rpm)	12,712	12,660
Power (MW)	3.2	5.2
Weight (kg)	185	240

The LOX turbopump

In 1985, continuing its long history and vast experience in aero-engine design and construction, Avio was commissioned by the ESA to develop the liquid-oxygen turbopump (LOX TP) for the Vulcain 1 motor of the Ariane 5 launcher.

Avio developed and tested several key technologies: the axial stage, bearings, and Dynamic Seal Package (DSP), which physically separates the hot gases feeding the turbine (+600°C) from the liquid oxygen on the pump side (-180°C), and the Active Balancing System (ABS), which compensates the axial forces generated by the turbine.

For the development of its LOX turbopumps, Avio uses a variety of dedicated facilities and test benches, such as the clean room for integration and assay, the bearing and seals test bench in LOX, and the water test bench.

The stator parts of the turbine and the disk blades are developed and built by Volvo Aerospace Co.

Volvo Aero's Space Propulsion Division is specialised in partnerships in the product areas of turbo machinery and combustion chambers/nozzles. Since 1985, Volvo Aero has been responsible for the development, qualification and production of the LOX turbines for the Ariane programme. Since 1995, a total of 47 units have been built and accepted.

Avio developed and also produces an improved version of the LOX TP for the Vulcain 2 motor (45 built and accepted). The V2 LOX TP has a higher LOX flow rate and outlet pressure than the Vulcain 1. The LOX turbopump for the Vinci motor of the cryogenic upper stage of the Ariane 5 Plus is currently under development.