astrium

VINCI
Thrust Chamber
Cryogenic Upper Stage

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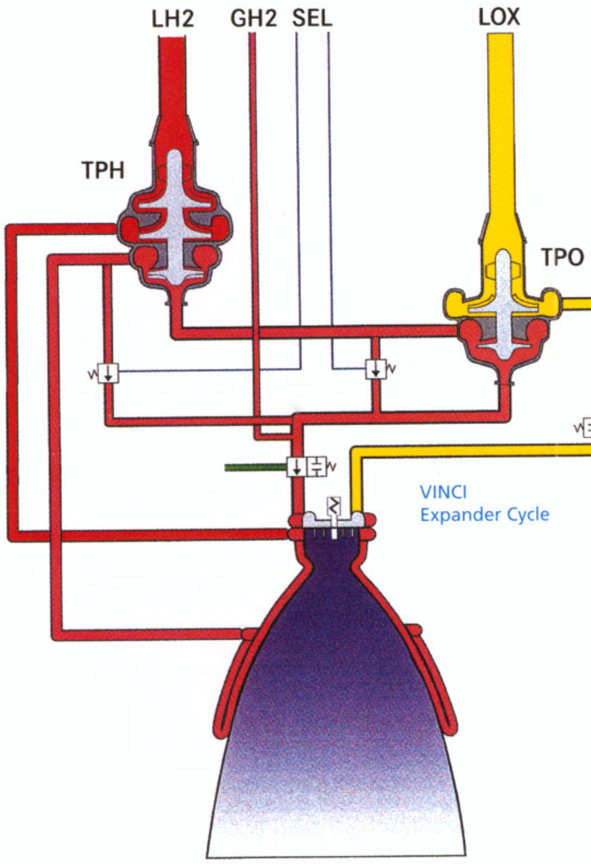


The European Ariane 5 architects (ESA, CNES, Arianespace, Aerospatiale) have started to utilize the growth potential of their new heavy lift launcher. In order to meet future market demands for heavier payloads and lower launch cost, various improvements are under development which will increase Ariane's payload capability to GTO stepwise from 5.9 tons to finally 12 tons. Amongst other improvements a cryogenic upper stage will contribute to this powerful launcher capability from the year 2006 onwards. VINCI will be the new cryogenic engine for this stage.

Astrium is responsible for the development of the VINCI cryogenic thrust chamber, under contract to Snecma, which is managing the entire cryogenic propulsion system.

VINCI is characterized by four sophisticated features:

Expander cycle:

VINCI is an expander cycle engine. The very first in Europe. It operates with the propellant combination liquid hydrogen / liquid oxygen. The liquid hydrogen is also used as an engine coolant. First flowing through the cooling jacket the hydrogen is then fed to the turbines to drive the propellant pumps. Downstream of the turbines the coolant is injected into the combustion chamber. VINCI will offer substantial advantages compared to other engine cycles:

- high specific impulse
- engine simplicity, compared with gas generator cycle engines consequently lowering production cost together with a higher thrust level

The challenge for injector and chamber designers is to provide high combustion efficiency along with maximum heat transfer from the hot gases to the coolant fluid, since the coolant has to pick up sufficient heat to propel the turbines.

This will be achieved by

- coaxial element injector
- integral chamber design (copper alloy liner with galvanic nickel jacket)
- co-flow coolant routing with U-turn
- rectangular cooling channels with high aspect ratio.

Extendable Nozzle:

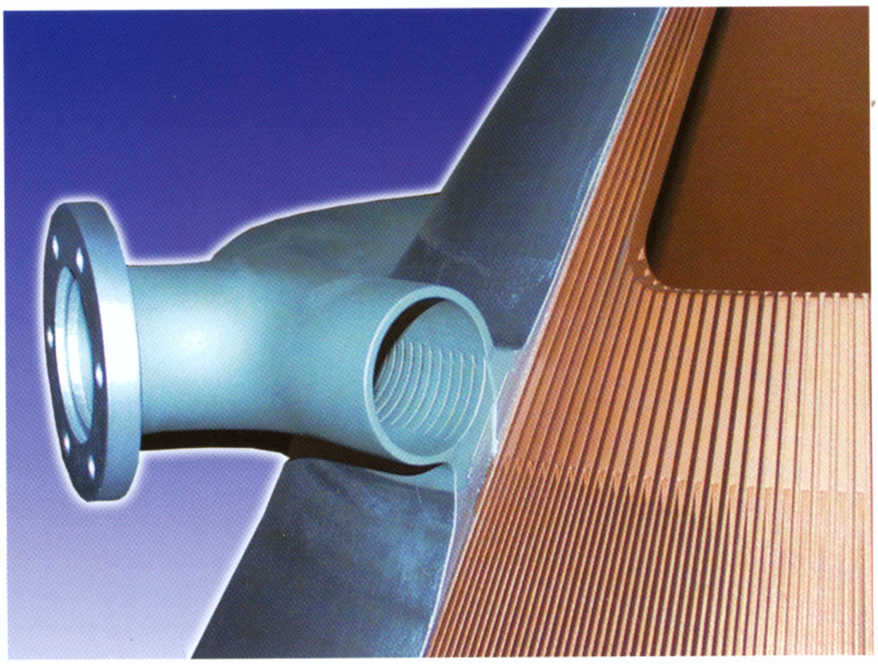
A major part of the nozzle extension is extendable. It is stowed during the launch phase and is deployed into its operational position only after separation of the upper stage.
This allows the use of a large nozzle extension bringing maximum engine efficiency with minimum length and weight of the stage.

Composite Nozzle Material:

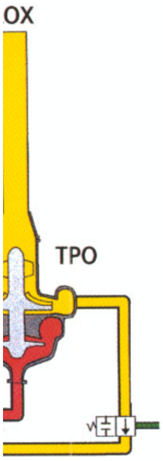
Both the fixed and the extendable nozzle sections are made from carbon ceramic material. Astriums new C/SiC material is a high priority candidate for this application.

Ignition System:

VINCI is equipped with a re-ignition system allowing multiple engine ignitions during the stage's flight. The reference configuration is an independent high pressure ignition system operation with gasous hydrogen and oxygen.



Integral Copper Liner
228 Cooling Channels



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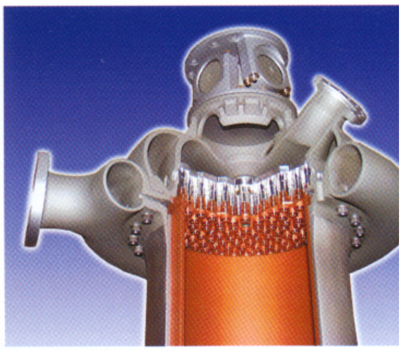
VINCI
at Reference Operation Point

Vacuum Thrust	155 kN
Vacuum Specific Impulse	467 s
Propellant Mixture LO_2 / LH_2	5.84
Propellant Flow Rate	33.7 kg/sec
Chamber Pressure	60.8 bar
Injector Inlet Conditions	
H_2 Pressure	72 bar
H_2 Temperature	225 K
O_2 Pressure	73 bar
O_2 Temperature	94 K
Mass w/o Ceramic Nozzle	160 kg
Overall Length, Nozzle stored	2.3 m
Overall Length, Nozzle deployed	4.2 m
Nozzle End Diameter	2.15 m



122 Co-axial Injection Elements

The design of the VINCI thrust chamber combines Astrium's cryogenic engine technologies, well proven by VINCI's predecessors HM 7, (Ariane 4) Vulcain and Vulcain 2 (Ariane 5). New technologies including expander cycle and multiple ignition of cryogenic engines are challenging steps.
Astrium is currently on schedule with the thrust chamber design phase in line with Europe's plans for the Ariane 5 cryogenic stage development. Hot firing testing will start in 2001, ground qualification will be completed in 2005 and maiden flight is planned for 2006.

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