

Space Launchers

Cryogenic, gas-related equipment and engineering solutions for launchers and launch pads infrastructures



Launcher equipment

Cryogenic propulsion enables a significant increase of space launchers performance, when compared to storable propellant solutions

Air Liquide provides the cryogenic tanks used to store liquid oxygen, liquid hydrogen, liquid helium and associated equipment.



Cryogenic tanks

- Design of liquid hydrogen, oxygen and helium tanks: functional, thermal and structural aspects
- Cryogenic pressurised tanks manufacturing
- Integration of thermal insulation, propellant management devices, instrumentation...

Instrumentation for cryogenic tanks

Temperature measurement

Different types of sensors chosen to meet your specific needs: liquid or gaseous measurement, temperature range, reactivity, sensitivity...

Pressure measurement

A choice of probes and sensors depending on the pressure levels to be measured: absolute or relative.

Level gauge

Design and manufacturing of capacitance or super conductive probes (flexible or rigide), to determine the mass of the cryo fluids remaining in the tank.

Cryogenic camera

An innovative tool to visualize the behaviour of propellants during the different phases of the flight, or during ground phases and qualification tests.

Pressurization systems and regulation platines

Cryogenic feed lines

Propellant management devices

Anti-sloshing

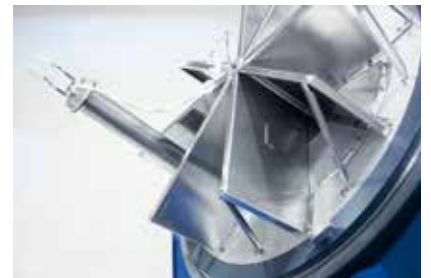
To reduce liquid ingestion in the pressurisation line, ullage pressure variations and solicitation of the attitude control system. Our device breaks slosh motion during the launcher ascent.

Anti-wetting

To limit propellant losses by vaporization during transient and ballistic phases.

Anti-vortex

To prevent premature gas ingestion in the engine turbo pumps. The anti-vortex device minimizes unusable propellant mass.



Propellant management

To maintain the right positioning of the propellant for the main engine reignition after the ballistic phase.

Insulation

Low density, low thermal conductivity and easy shaping insulation, resistant to aerothermal flux and that can be bonded straight onto the aluminium structure.

- Dacron™ felt
- Closed-cell foam
- Vacuum honeycomb common bulkhead
- Multi Layer Insulation (MLI)
- High performances multi-layer thermal protection systems (FMLIF, open cell...)
- High performances LH₂ insulation system compatible with nitrogen venting



Engineering solutions and tests for launchers

Air Liquide carefully investigates the needs of its customers. Working with you, our teams and experts find innovative solutions that deliver the best technologies, products and services for space launchers.

Air Liquide supports you throughout the different phases of your project, from design to operation, carrying out studies and analysis, in order to optimize the dry mass of launcher stages, maximize the embarked propellant and reduce the thermal inputs. We approach each solution, project globally, using a procedure that combines advice, solution design and cost control.



Design and engineering

Consulting

Definition of specifications

Engineering studies to optimize:

- Propellant tank architecture
- Propellant management system
- Cryogenic propellant tank thermal protections
- Propellant pressurization system

Analysis:

- Thermal and structural
- Propellant behaviour prediction inside tank during different flight phases. Prediction through accurate CFD (Computational Fluid Dynamics) analysis and in-house qualified software

Control of fluids and interfaces specifications and management



Qualification, simulation and testing

A large range of tests

Thanks to a unique test center and clean rooms, Air Liquide can provide a large range of tests to analyse, control and validate components, materials and products under representative space conditions. It can also be used for assembly or integration.

Specimen cryogenic and gas tests

To characterise material, to calibrate sensors, thermal cycling of material or components...

Large scale tests

To test large structures or propellant tanks under static loads and pressure, functional tests on piping and instruments, thermal simulation tests under representative space conditions...

Prototype

Manufacturing, assembly and tests of prototypes in order to obtain the space qualifications required before producing flight models.

Air Liquide support

To define and select the most appropriate tests according to your specific needs.



Launch pads equipment and engineering

With more than 40 years of experience in space launch pads infrastructures (Kourou, in French Guiana – for Europe, Cap Canaveral – US, Tanegashima – Japan), Air Liquide offers ground support devices and engineering solutions to meet the infrastructures needs and logistic requirements of space launch pads, by developing a range of cryogenic and gas-related ground support equipment and associated services.



Ground support equipment

- On the ground launch pad equipment: cryogenic storage, specific equipment and facilities
- Cryolines
- Test equipment for launchers and satellites: space simulation chambers, test benches

Ground engineering

- Consulting
- Design and specifications
- Interfaces between the launch pad and the launcher
- Design of specific test benches



Gas production and supply

- Hydrogen and helium liquefaction systems
- Helium vaporization station
- Nitrogen compression station
- Supply of bulk and cylinders gases
- Distribution and storage



Air Liquide at the heart of the Ariane launch vehicle

Pressure control component



Pressurised helium storage



Level gauges, propellant management devices (anti-vortex...), insulation



Cryogenic feeding lines



ESC-A*: liquid hydrogen tank



ESC-A*: liquid oxygen tank



EPC**: liquid hydrogen and oxygen tanks

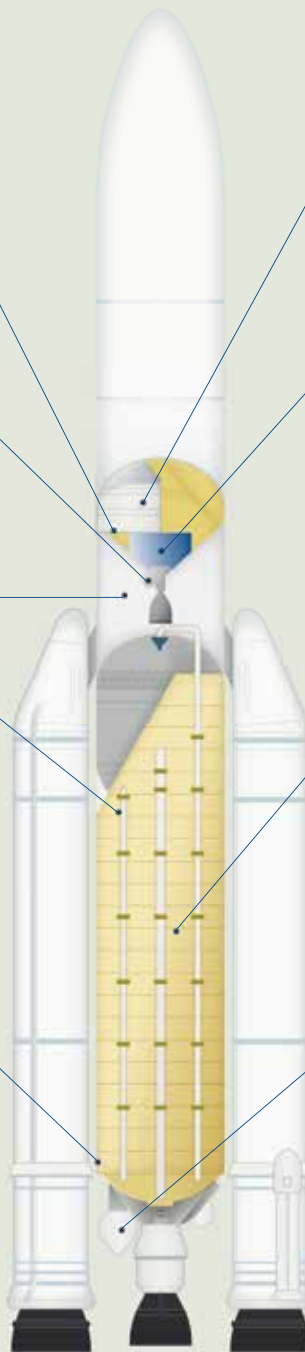


Pressurised liquid helium storage



* ESC-A: Cryogenic upper stage "A"

** EPC: Main cryogenic stage



Through Air Liquide advanced Technologies and the GIE Euro Cryospace, Air Liquide designs and implements all of the cryogenic tanks for the Ariane 5 launcher and the related equipment.

Air Liquide is also the partner of the future launcher Ariane 6 for onboard and on the ground cryogenic systems (ELA4 launch pad).

Air Liquide is particularly proactive in the search for new technologies alongside space stakeholders, using science and technology to innovate and push back the frontiers of knowledge.

Examples of this approach include its involvement in the HX space program and the Cryofenix mission.





Our strengths

- Recognized experience in the space adventure for more than 50 years
- Solid expertise in space cryogenics and in gas production and storage (Air Liquide core business)
- A global space launcher offer: from the ground to the launcher
- Dedicated teams providing support
- Unique cryogenic test center simulating space environment
- Resources of an international group

Air Liquide and Space

Since the beginning of cryogenic launchers in Europe more than 50 years ago, Air Liquide has been a major partner, bringing to the space community its pioneering spirit, its innovation capacity, its expertise and its technical excellence.

Air Liquide is a key partner for launchers, satellites and space exploration.

Contacts

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