PROJECT

CHATT

Cryogenic Hypersonic Advanced Tank Technologies

**Funding:** European (7th RTD Framework Programme)
**Duration:** Jan 2012 - Jun 2015
**Status:** Complete with results
**Total project cost:** €4,237,231
**EU contribution:** €3,225,681

**Call for proposal:** FP7-AAT-2011-RTD-1
**CORDIS RCN:** 100271

**Background & policy context:**
Cryogenic propellant management and advanced tank design for hypersonic and advanced future aviation systems. In future aviation and particularly in hypersonic systems new propellants will be used, such as liquid hydrogen, liquid methane and possibly even liquid oxygen. These systems will require complex technology, ultra light-weight, and reusable propellant tank systems.

**Objectives:**
Challenging technological developments are required for such systems. New materials and design concepts are required such as fibre composites in order to reduce the tank weight and to increase the structural performance. Propellant management is imperative for achieving reliable and efficient vehicle operation. The sloshing of cryogenic fluids close to their boiling conditions in tanks of horizontal take-off vehicles is not yet mastered.

**Methodology:**
Proposed work tasks are:

- Design, manufacturing, and tests of 4 different scaled cryo-tanks in CFRP material including and w/o liner;
- Screening of future cryogenic insulation systems not only lightweight and long lasting but also resistant to the high thermal gradients experienced in hypersonic flight. New cryogenic insulation concepts and materials will be addressed, such as e.g. aerogels;
- The following propellant management technologies will be studied by simulation or experiment: tank pressurization, fuel location/retention, horizontal sloshing, analytical and experimental study of stratification, nucleation, and boiling in cryogenic fuel tanks subject to surface heat transfer;
- Design of a small ceramic heat exchanger to assess the safe generation of gaseous propellants used for improved tank pressurization, attitude control and cabin oxygen supply. A prototype Rankine cycle cabin air-conditioning system, utilising a cryogenic working fluid is designed;
- All cryo-tank technologies will be driven by system requirements of advanced passenger vehicles (e.g.LAPCAT A2 and the SpaceLiner) and results will at the study end be assessed on impact.

**Parent Programmes:**
FP7-TRANSPORT - Transport (Including Aeronautics) - Horizontal activities for implementation of the transport programme (TPT)

**Institute type:** Public institution
**Institute name:** The European Commission
**Funding type:** Public (EU)

**Lead Organisation:**
Deutsches Zentrum Fr Luft Und Raumfahrt E.v

**Address:**
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**Organisation Website:**
http://www.dlr.de

**EU Contribution:** €859,586

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**Partner Organisations:**

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**EU Contribution:** €249,375

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**Swerea Sicomp Ab**

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**EU Contribution:** €413,055

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**EU Contribution:** €188,280

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**Orbspace Aron Lentsch**

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**EU Contribution:** €272,825

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<td><strong>Address:</strong> 22 Empress Avenue Farnborough GU14 8LX United Kingdom</td>
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<td><strong>EU Contribution:</strong> €151,734</td>
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<td><strong>EU Contribution:</strong> €216,150</td>
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**Technologies:**
- Fuel cells and hydrogen fuel
- Development of new Fuel Cells and Hydrogen (FCH) technologies

**Development phase:** Research/Invention

**Key Results:**
- Advanced tank technology for flying faster

Long restricted to the realms of sci-fi, hypersonic passenger planes could come a step closer to reality.
by developing lightweight cryogenic fuel tanks.

Cryogenic liquid propellants, including liquid hydrogen, methane and oxygen, are a cornerstone of the vision for hypersonic intercontinental or sub-orbital passenger transport.

Although hypersonic rocket propulsion is run-of-the-mill, getting the technology to work with air-breathing planes is another story. While past studies have advanced vehicle aerodynamic design, none have addressed in sufficient detail the critical question of cryogenic fuel storage and usage on an airliner.

Aeroplanes this fast will require new designs, materials and propulsion technologies. These topics are being investigated by the EU-funded project ‘Cryogenic hypersonic advanced tank technologies’ (http://www.chatt.aero/ (CHATT)).

The project’s ultimate aim is to increase the technology readiness level of cryogenic tank design and associated technologies to level 5. In addition to liner design, health monitoring, propellant management and sloshing modelling, ceramic heat exchanger design is necessary to ensure reliable and efficient vehicle operation.

Given that light weight is of critical importance to attain hypersonic speeds, researchers are designing carbon fibre-reinforced plastic cryogenic fuel tanks in various configurations. Specifically, four different prototypes driven by future vehicles under study will be manufactured and tested.

Scientists made excellent progress on tank designs. They employed sophisticated analytical methods and finite element simulations to evaluate options in geometry and materials. Furthermore, they thoroughly investigated the impact of propellant sloshing on vehicle flight dynamics and aeroelastic behaviour.

Regarding health monitoring, a leak detector was manufactured, with initial testing already performed. Researchers also conducted extended research into new cryogenic insulation concepts and materials such as aerogels and cryogels.

Another project achievement was the development of an analytical sloshing model. The mechanical interfaces and the sloshing facility for the slosh experiments are ready.

Researchers improved the design of the ceramic heat exchanger to lessen the impact of thermal stress. Production dummies that sub-cool liquid nitrogen are under investigation because of detected fractures.

Aeroplanes that travel at several times the speed of sound could change the way people see long-haul travel. Except for hypersonic flights, project results may also impact on conventional sub-sonic passenger transport by proposing a means for lower or even zero greenhouse emissions air traffic.

**STRIA Roadmaps:** Transport electrification, Low-emission alternative energy for transport

**Transport mode:** Air transport

**Transport sectors:** Passenger transport

**Transport policies:** Deployment planning/Financing/Market roll-out

**Geo-spatial type:** Other