SKYLON

Potentially the new big thing in LEO transport

Space planes could very well be the ultimate aerospace engineering machine. These space planes are vehicles that function both as an aircraft when flying or gliding through the atmosphere, and as a spacecraft when orbiting around the earth. Well known examples of space planes are NASA's space shuttle, which launches as a rocket, but re-enters as a glider, and XCORs Lynx, which takes off horizontally with four rocket engines, reaching suborbital flight. Since the twenty-first century, there is a new competitor on the market: Reaction Engines Limited (REL), with their space plane called Skylon.

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SKYLON INTRO

The ultimate goal for the Skylon is to replace all inadequate launcher systems that are used today with a more practical transport system. As current launchers are very expensive ($150M/launch) and unreliable (5% loss rate), a future launch vehicle as Skylon will require a low specific launch cost and should be genuinely easy to operate. This means that Skylon has to meet the following criteria: single stage in order to reduce development and operational costs; as reusable as possible; computer controlled as qualifying a vehicle for piloted flights increases development costs; simple launch and recovery procedures to minimize turnaround time; capable of aborted landing during ascent; an engine that uses existing aero-thermodynamic techniques and materials; minimum maintenance between flights; provides an interface with other elements as it has to become part of an efficient transport system and the vehicle use environmentally friendly propellants to avoid atmospheric pollution. All these criteria can be met with the engine and structure concept for Skylon, described below. The REL company already received $350m in funding for the project as the first static tests of the newly designed engine's precooler were successful.

SKYLON PERFORMANCE

Skylon is designed to bring a payload of fifteen tonnes to Low Earth Orbit, without any pilots. It has a gross take-off weight of 275 tonnes, of which 220 tonnes propellant. The payload bay is 12.3m long, and 4.5m in diameter. Designed to be reusable for 200 flights, REL aims to provide a cheap solution for bringing payload into orbit. This payload may include either a standardized payload container, and passenger compartment. Control during atmospheric flight is provided by the moving tailfin, delta canard wings and ailerons along the wing trailing edge. Reaction control thrusters are present for the space flight phase.

A retractable landing gear is attached to the fuselage, packed closely to save space and weight. Water tanks are used to dissipate of the heat caused by emergency braking during take-off. After successful take-off, the water is thrown out.

SABRE ENGINES

The SABRE (Synergistic Air-Breathing Rocket Engine) is a hybrid engine, containing two operational modes. In both modes, liquid hydrogen is used as propellant. The air breathing mode takes oxygen out of the atmosphere, where the rocket mode uses its stored liquid oxygen. This is advantageous, because this eliminates the need for bringing oxygen as a first stage oxidizer, and with it the need for a heavy oxidizer container. SABRE is able to reach a thrust over weight ratio of 3 at burnout. Specific impulses of 3500 seconds atmospheric, or 450 seconds exoatmospheric are standard.

A precooler, consisting of thousands of small thin-walled tubes is present between the intake and turbocompressor. In air breathing mode, this precooler is used to cool the air down from 1000°C down to -150°C in 1/100th of a second [4], by cooling it with a closed helium loop, that is cooled again by the liquid hydrogen fuel. This is done to allow compression to the required 140 atmospheres without the need for extreme temperatures. The air-breathing mode can be used up to Mach 5, after which it is inefficient, so the intake will close and the rocket mode will take over.

A major problem for pre-cooled engines is water vapour in the atmosphere. Lowering the temperature of the intake air will freeze the water, blocking the engine. A major testing programme has shown that this can be prevented, with provision made to stop the build up of ice.

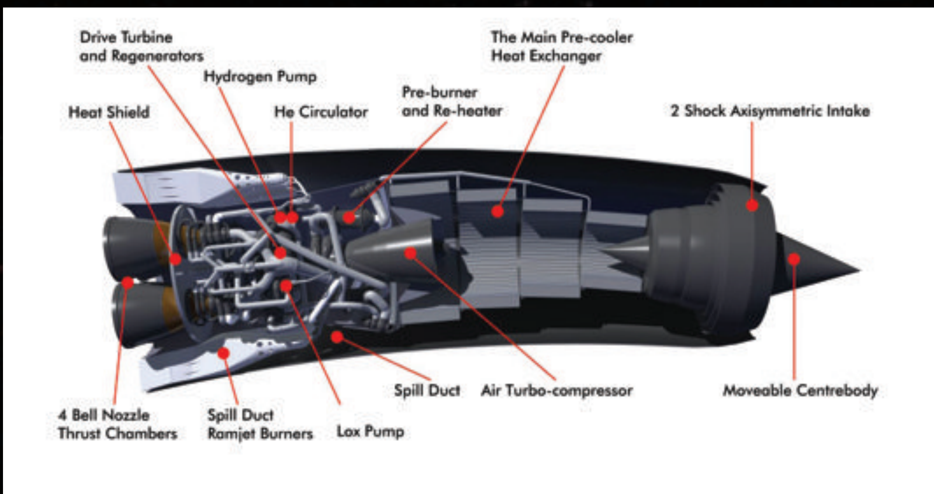
FUSELAGE & STRUCTURE

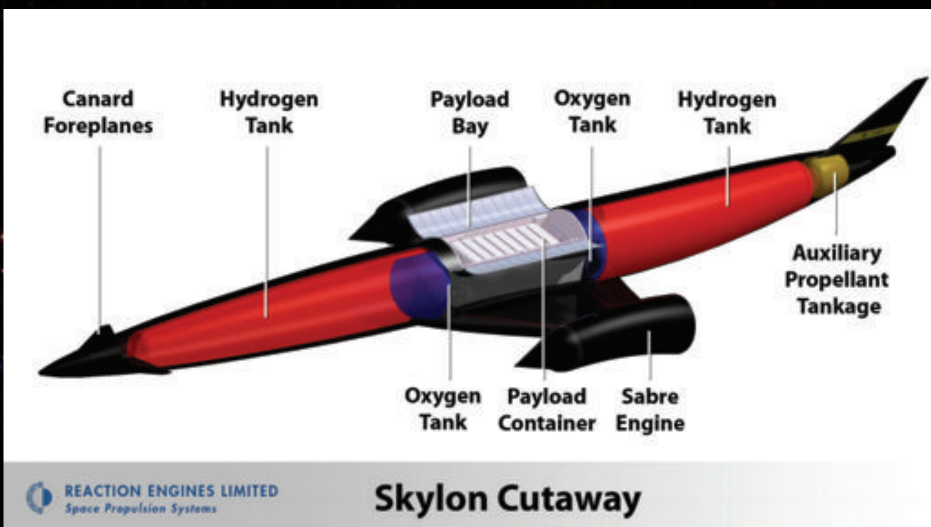
Skylon consists of a slender fuselage containing the propellant and payload bay, with a delta wing located midway along the fuselage with the engines mounted in the wingtips. The design evolved from the HOTOL airframe, which was derived from conventional rockets. The propulsion system is installed in the nacelles on the wing tips. This makes it possible to place the empty center of gravity on the hypersonic re-entry center of pressure. The payload bay is also coincided with the center of pressure, over the wing. This is to avoid disrupting trim with varying payload masses.

RE-ENTRY

Re-entry occurs at relatively high altitude (approximately 10km higher than the Space Shuttle) due to the lower ballistic coefficient (mass per unit plan area). Temperature during this re-entry is kept down to 1100K by controlling the trajectory via active feedback of measured skin temperatures. As Skylon has an aerodynamic configuration that comprises a definite wing plus body, the wing does not fit within the body bow shock wave during re-entry, giving a rise to a localized heating problem addressed by actively cooling the wing.

Though will Skylon be the final breakthrough in Spaceplanes? Or, as can be concluded about all past Spaceplane projects from the 20th century, will it be postponed to our next generation. For now we will just have to wait and see.





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SPACE DEPARTMENT

The Space Department promotes astronautics among the students and employees of the faculty of Aerospace Engineering at Delft University of Technology by organizing lectures and excursions.