Liquid Hydrogen and the SABRE Engine

Alan Bond
Founder & Chief Engineer
SKYLON’S PURPOSE

“The SKYLON launch system has the primary purpose to achieve the lowest cost access to space possible with both current technology and commercial feasibility.”
SKYLON’S MISSION PROFILE

THE SKYLON SPACEPLANE
Origins of LH$_2$ Rocket Fuel in the UK

DeHaviland proposal 1960 by Denis Hurden

Proposals for practical work by:
- Rolls- Royce APR/R4  Aug 1963
  (heavily dependent on RPE work)
- Bristol Siddeley RR 76 29 July 1963
  (domestic facility using Screamer components)
RPE Westcott Lox/LH$_2$ 20kN Chamber (1962)

Built by BAJ Banwell
RPE chamber on A site
The R-R 70kN Engine RZ20

Rolls-Royce very sensibly built heavily on the Wescott experience.

They moved to vacuum furnace brazing instead of hand layup as was still used on the RZ2 and was very expensive.

Pressurised thin stainless steel ‘balloons’ were used to hold the tubes and braze alloy in place during brazing.
Test firing at R.P.E. Westcott, full-size coarse showerhead injector.
R-R liquid hydrogen test stand at Spadeadam

Built with Company investment

Pressure fed facility (700psi)

Liquid hydrogen supplied by RPE Westcott and tanked to Spadeadam
RZ20 Test 1
8 September 1969 20sec
RZ20 post test hardware

Shell burn-through
collapsed dip pipe from hydrogen tank
Simplified Sabre Cycle
PRE-COOLER HEAT EXCHANGER

THE SKYLON SPACEPLANE
LOX cooling
Test bench P8, Lampoldshausen Germany
DLR Film Cooling Test Facility at P8 Lampoldshausen

- nozzle
- measurement segment
- supply film injector
- supply line GH2
Strict Engine – first test firing June 2011
The Phase 3 Objectives
(36 month Programme)

• Raise engine technology to TRL 6 through ground testing.
• Complete the design of the SABRE4 to manufacturing drawings.
• Ensure that the vehicle requirements and SABRE4 engine design are compatible.
• Flight test the nacelle design (desirable).
The B9 Area, Culham Science Centre
D1 requirements are now established and validated.

Configuration revision proceeds: a fully trimmed solution has been found, but it will require further study before it can be finalised.

External contributions to D1 design (expand available skill base):

- Aerodynamic modelling
- Structure loads analysis
- Payload interface
- Avionics and electrical power
Length ≈ 9m
Span ≈ 3.5m
Mass ≈ 1000kg
Thank you!

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