Progress
on the
SKYLON Reusable Spaceplane

7th Appleton Space Conference
8 December 2011

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SKYLON C1

12 tonnes to LEO
10 tonnes to ISS
200m$^3$ payload bay
4.6m diameter payload

Being revised to D1
Payload 15 tonnes to LEO
Company Structure (April 2011)

Headquarters
Design and Test Facilities
Culham Science Centre

Experimental production
Abingdon

Sheet metalwork & fabrication
Wantage

Precision engineering
Newbury
Progress on SABRE
SABRE-3 Engine

- Air Intake
- Precooler
- Compressor
- Turbine
- Bypass Duct
- Thrust Chambers
The SABRE Engine Cycle

A helium loop provides the intermediate cycle.

In rocket mode LOX replaces the air fed to the combustion chamber.
Experimental Contra-rotating Stator-less Turbine Installation
STRICT Thrust Chamber
E-D Nozzle Test Program (STERN)

(Joint program Uni. of Bristol and Airborne Engineering)
STERN Thrust Chamber Firing
J-site at Westcott
Joint programme with Airborne Engineering

Thrust stand for Low-NOx and Strict Programmes
Strict Engine Test Firing – June 2011
Test LCT-T01-4 @ pc=70 bar 8kg/s LOX cooling
Test bench P8, Lampoldshausen Germany
DLR Film Cooling Test Facility at P8 Lampoldshausen

nozzle

measurement segment

supply line GH2

supply film injector
Precooler Geometry
The prototype pre-cooler will be made from over 16,000 thin-walled Inconel tubes.
- All incoming tubes are inspected and processed prior to module assembly.
Pre-Cooler Construction

A production module under construction

Vacuum brazing

Header/matrix tube brazed joints

Header tube installation
Precooler Modules
Pre-Cooler Testing at Reaction Engines B9

Helium Flow
- $T = 96\,\text{K}$
- $P = 150\,\text{Bar}$

Air Flow
- $T = \text{ambient}$
- $T = 260\,\text{K}$

Pre-Cooler
- $T = 130\,\text{K}$

LN$_2$ Reservoir
- $T = 130\,\text{K}$

Circulator
- $T = 260\,\text{K}$

LN$_2$ Reservoir
- $T = 260\,\text{K}$

Pre-Cooler By-Pass
- Temperature Control Bypass

Pre-Cooler Stop Valve
The Pre-Cooler will be tested at REL’s B9 test site using a VIPER 522 jet engine.

REL’s B9 installation with VIPER and ‘dummy’ pre-cooler assembly.
High Pressure Helium Loop at B9
Progress on SKYLON
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
Re-entry Modelling
with DLR Braunschweig using TAU CFD code

Aeroshell Material
with Lateral Logic and Pyromeral

Titanium Matrix Composite Struts
with TISICS Ltd (TSB supported Research)
The Phase 3 Objectives
(30 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).
Nacelle Flight Test Vehicle

Length ≈ 9m
Span ≈ 3.5m
Mass ≈ 1000kg
Phase 3 Cost Estimate

- Total Engine Programme (with NTV) £220m

Which is comprised by:

- Airframe requirement studies £6
- Preparation for Phase 4 £30m
- Engine technology demonstration £30m
- SABRE4 design £134m
- NTV £20m

The engine is the long lead item but the vehicle system design must begin soon in order to meet entry to service in 2021-2022
UK Space Agency independent review

ESA providing technical support

Almost 100 invitees attended two day workshop (Sept 2010)

Part of wider review including on site audit by ESA

REVIEW CONCLUSIONS

‘no impediments or critical items have been identified for either the SKYLON vehicle or the SABRE engine that are a block to further developments’.