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Development of a success-
ful dual-role powerplant is
crucial to the success of the
Hotol concept. Rolls-Royce is
working on a hybrid engine
which uses atmospheric
oxygen and on-board liquid
hydrogen to accelerate the
craft in the lower, denser
atmosphere, transitioning to
pure rocket propulsion using
the liquid hydrogen and a
supply of on-board liquid
oxygen. Conchie says that
technical problems have
hitherto prevented this ap-
proach, but that a "potential"
propulsion breakthrough

occurred concurrently with
BAe's studies of an advanced
launcher which renders the
idea practical. Proof-of-con-
cept work on the engine is ex-
pected to begin in the autumn.
An important element of
Hotol is the use of a ground
trolley at take-off. The craft
weighs five times as much at
the beginning of a mission as
it does at the end, which
means that an excessively
heavy undercarriage would
have to be carried into orbit.
Conchie says that the trolley
"should be regarded simply as
a second undercarriage"
which is left behind. Other
take-off ideas are being
studied, but the trolley is at
present seen as the best
system.

As now configured, Hotol's
fuselage cross section is simi-
lar to that of Shuttle's, but
optimised for satellites weigh-
ing around 7 tonnes "which is
a popular size," says Conchie.
The chosen Concorde-type
wing planform combines the
required lift/drag and
stability characteristics with
good structural efficiency.
The wing is rear-mounted,
since Hotol's e.g. is a long way
aft owing to a "relatively
heavy" powerplant and liquid
oxygen storage, the latter
accounting for over half of
take-off mass. The liquid
hydrogen tank is stored ahead
of the payload bay and
occupies considerable volume,
since hydrogen is used in all
phases of the climb to orbit.

Because of the rearward e.g.
and consequent short tail
moment arm, Hotol will need
actively controlled horizontal
and vertical canards to main-
tain stability. These can also
be used to trim aerodynamic
moments during transonic
flight, says BAe.
A major advantage claimed
for Hotol is the very good

Payload bay (7 tonnes)

Canard Hydrogen
controls ——*f\

«0

Engines

Re-entry
thermal
protection

Intakes-

Hotol's fuselage is largely taken up by liquid hydrogen and oxygen tanks. The dual-mode engine means that the oxygen tank can be much smaller than in conventional rockets

crossrange ability conferred
by a hypersonic lift-to-drag
ratio "twice that of Shuttle's".
This means that the craft
would be able to return to a
European base from an equa-
torial orbit, saving turnround
time. For geostationary
launches, with a perigee boost
motor aboard, Hotol would fly
a sub-orbital trajectory to a
suitable airfield near the
equator (Ascension Island
would be one possibility, the
Ariane launch centre at
Kourou another), refuel, and
climb to orbit.

Apart from the engine,
Hotol does not require
dramatic technology ad-
vances, according to BAe. The
vehicle is more lightly loaded
than Shuttle on re-entry and
temperatures are sufficiently
low to use metallic thermal
protection instead of ceramic
tiles. Titanium would be the
principal material used in
construction, with composites
where possible. One area in
which there might be prob-
lems, however, is the insu-
lation of liquid hydrogen and
oxygen tanks, which will form
part of the outer structure.

Technology input for Hotol
is derived from Concorde, and
from experience in rocket
technology going back to the
1950s, when the UK worked

on the Blue Streak ballistic
missile. This eventually be-
came the first stage of a Euro-
pean civil launcher called
Europa, which failed because
of management problems and
rising costs. The UK also
shares in the Ariane pro-
gramme, with responsibility
for guidance, launch release
gear and, on Ariane 4, the
satellite mounting capsule.

British Aerospace claims
that Hotol could reduce
launch costs to low-earth
orbit by a factor of five and
halve the cost of launch to
geostationary orbit, enabling
it to compete realistically for
about 75 per cent of the
commercial market from the
beginning of the next century.

Development cost of Hotol
is roughly estimated at £4,000
million, taking the project up
to 1997 with a single oper-
ational vehicle. Funding is
currently very limited, but the
UK Government will be asked
to contribute to the pro-
gramme later this year. BAe
and Rolls-Royce would match
Government contribution
pound for pound. The UK
avionics industry will not
become involved until proof-
of-concept trials are com-
pleted in two years time.
Avionics would be derived
from systems in civil airliner

Secrecy surrounds the details ofHotol's engine. This diagram suggests that oxygen separation occurs in a device placed in front of the turbopump stage

Liquid hydrogen i Liquid
^Hydrogen l^ge n

Air£>

SPACEFLIGHT

use in the 1990s, possibly
making considerable use of
fly-by-light control tech-
nology.
In the long term, Hotol's
future will rest on continued
support from the UK Govern-
ment, which would have to
agree to increased spending
on launcher development, an
area which is currently
outside the UK frame of refer-
ence within ESA.

Conchie promotes Hotol as
a way of ensuring Europe's
long-term competitiveness in
the satellite launch business.
He says that the French
understand the eventual need
for a single-stage to orbit
vehicle, "but not within the
Ariane timescale". He notes,
however, that Ariane 5 has yet
to win full ESA approval, and
that Hermes remains a
French-only project, with no
ESA funding.

SPACESHOTS

Within its normal framework
of scientific exchanges with
the Soviet Union, ESA is
discussing the flight of one or
two experiments on the two
Soviet Mars Orbiters due to
be launched in 1988. One of
these probes will rendezvous
with the Martian moon
Phobos.

Nasa and the Chilean
Government are discussing
the use of Easter Island (Isla
de Pascua) in the Pacific
Ocean as an emergency land-
ing site for Shuttles launched
from Vandenberg AFB. The
island's Mataveri airfield
could be used as a trans-
Pacific landing site in the
event of a launch abort and
also as an additional con-
tingency landing site. If agree-
ment is reached, Nasa will pay
Chile to increase the length of
the present runway from
2,900m to 3,350m. Another
Pacific abort site is at Hao, a
French island which already
has a 3,350m runway built to
support France's nuclear test
programme.

Nasa has ordered a
Honeywell-developed space
vehicle guidance system from
Orbital Sciences (OSC). The
laser inertial navigation
system using three ring laser
gyros is being developed by
Honeywell for OSC's private-
venture transfer orbit stage,
with space qualification
scheduled for May 1986. The
Nasa contract is worth almost
$270,000.

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