DEFENCE

display, flat screen liquid-
crystal eye-level display
collimated at infinity to avoid
refocussing the eyes from the
Hud presentation, two lateral
colour multifunction shadow-
mask CRTs, and a head-down
flat display. Active voice
control will be used exten-
sively to change displays or
call up information.
Rafale will also demon-
strate the general integration
of all flight systems. In addi-
tion to the flight control
system, all aircraft systems
and circuits—fuel, electrics,
hydraulics, air conditioning,
engine controls, navigation,
and communications—are
broadly based on digital tech-
nology. All information from,
and orders to, these systems
will be transmitted and
exchanged through two
centralised digibus lines.

Health monitoring

The pilot will not have to
bother with monitoring these
systems in normal operation.
He will be aurally warned (but
only if strictly necessary)
about a system failure. The
pilot will then automatically
be provided with the informa-
tion he needs to rectify a
system fault. Systems per-
formance is automatically
recorded for subsequent
replay by groundcrew to

identify any shortfalls.
Rafale's construction uses
a high proportion of new
materials and new manu-
facturing techniques. Com-
posites of carbon, boron, Kev-
lar, or mixes of these, allow
weight to be reduced by about
20 per cent from similar all-
metal structures. Composites
are used to form the front
fuselage section (cockpit and
equipment bay), the fuselage
centre section, and its integral
fuel tank, and the rear-lower
fuselage. The wings, canards,
rudder, elevons, and leading-
edge flaps are also of com-
posite construction, as are the
gear doors and numerous
access panels. The radome
and wing-to-fuselage fillets
and fairings are of Kevlar.
Overall, composite materials
account for about a quarter of
Rafale's weight.

To this weight saving must
be added the savings from
using aluminium-lithium
alloys. On Rafale allithium, or
"alii", is used for the fin and
wing to fuselage attachment
frames, fuselage skinning, and
fuel tank walls. Alii offers a
7-8 per cent weight reduction
over conventional aluminium
alloys and could eventually
replace 60-70 per cent of
conventional alloys in future
aircraft. Lithium is a low-
,density metal with a mass of
0 • 6gm/cm3

compared with

Left View to the rear is good and the all-moving canards are unobtrusive to the pilot's downward field of view. Below Basic structure of Rafale

lgm/cm3

for water and alumi-

nium's 2-7gm/cm3

. Added to
aluminium, lithium decreases
the metal's density and,
unusually, increases its stiff-
ness while the strength stays
the same and fatigue behavi-
our is better. A typical alii
alloy would have 2 • 5 per cent
lithium by weight (10 per cent
by volume).

Superplastic metals

When conventional materi-
als and metals remain the best
solution for some specific
parts, Dassault has progressed
in the manufacturing tech-
niques used with these
materials. An example with
Rafale is the use of super-
plastic forming and diffusion
bonding of titanium pieces.

Superplasticity is the prop-
erty of some metals to become
highly ductile at high
temperature and thus be
stretched into most intricate
shapes. With most of today's
alloys a stretch of 20 per cent
is possible before the metal
tears. With superplastic alloys
the stretch factor can be as
high as 1,000 per cent. Dass-
ault has used titanium sheet-
ing tack welded into a mould
which is then heated and has
pressure applied to form it
into the shapes required. The
Rafale programme has
allowed the company to fine-

tune this technique for
reduced-cost fabrication of
complex parts.
Rafale's fly-by-wire system
draws heavily on company
experience gleaned from the
neutral-stability Mirage 2000
programme, but has much
higher performance because
of increased computer power,
complete digitalisation of the
system and more functions.
In addition, the unstable
Rafale's flying canards offer
more inherent manoeuvra-
bility, approaching control-
configured vehicle standards.

Rafale's flight control
surfaces consist of the rudder,
three elevons on each trailing
edge, which can be moved
identically or differentially,
plus automatic leading-edge
flaps which can be combined
with elevon droop to alter
wing camber and provide high
lift. The active canards allow
the introduction of direct-lift
control principles. For
instance, it will be possible to
increase or decrease lift at
will, by using the canards and
elevons together, without
changing aircraft attitude or
angle-of-attack.

At present Rafale has an
electronically signalled fly-by-
wire system, but ACT/ACM
will use fibreoptics for data
transmission; a fly-by-light
system is currently being test
flown in a Mirage 2000.

FLIGHT INTERNATIONAL. 4 January 1986