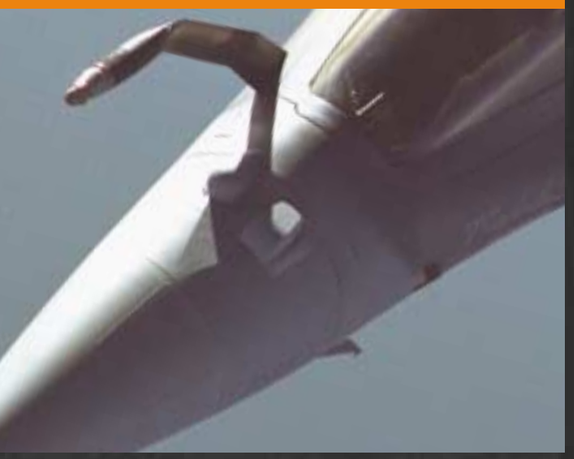
A TRULY ***PASSIVE RADAR***

To complement its multisensor avionics suite that includes the RBE2 multimode electronic scanning radar and the Spectra electronic warfare system, the Rafale is fitted with the Front Sector Optronics (FSO), a state-of-the-art passive system. Operating in different infrared wavelengths, the FSO provides discreet long-range detection, multi-target angular tracking and range-finding for air and surface targets, considerably enhancing the Rafale's stealthiness as the fighter can covertly detect, track and identify enemy aircraft without using its own radar which would betray its presence. Additionally, the entire system is immune to radio-frequency jamming.



The FSO comprises two modules mounted on top of the Rafale's nose, ahead of the windshield, to offer an unobstructed view of the forward sector: the infrared sensor (Infra-Red Search and Track), and the TV sensor coupled with an eyesafe laser rangefinder. The functions of the two modules are clearly complementary:

- surveillance and high-accuracy, multi-target automatic tracking by the starboard IR surveillance module
- target tracking, identification and ranging by the port TV/laser module.

The latest 3rd generation matrix detector technology has been chosen for future versions of the FSO to ensure extended detection ranges, and the IR module is fully capable of operating in hot and humid climate/conditions.

The TV sensor has an exceptional long-range identification capability, allowing a high-resolution image of the target to be displayed on any of the cockpit's three screens. Target counting for raid assessment is also a key advantage of the FSO, and tracking of low radar cross-section aircraft is a distinct possibility. Similarly, hostile fighters performing a defensive 'beam' manoeuvre will be tracked easily. In the air-to-surface mode, targets can be pinpointed at stand-off ranges thanks to the outstanding angular accuracy and resolution of the TV/identification channel, and target designation can be performed for air-to-ground weapons.

The FSO is an integral part of the Rafale's mission system as it is closely integrated with the other primary sensors, the RBE2 radar and the Spectra Electronic Warfare suite. As such, it considerably improves pilot situational awareness: all sensors' data is fused into a single tactical picture displayed on the central wide-angle colour screen, offering the pilot a clear image of the evolving tactical situation. This smart data fusion significantly increases mission success rates through better understanding of enemy tactics.

Whatever the rules of engagement, the FSO minimises the risks of fratricides (blues on blues) in both air-to-air and air-to-surface modes, and it allows instantaneous battle damage assessment to be performed. This unique surveillance and identification system has been thoroughly tested on board various testbeds and Rafale prototypes M02 and B01, plus two-seaters B301 and B302 production aircraft. The FSO will be introduced into F2 Standard Rafales.

PEMA **2b** - Photos F. Robineau - Dassault Aviation - K. Tokunaga.

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FOX THREE

N°5

THE FIRST PRODUCTION ***SINGLE-SEAT AIR FORCE RAFALE FLIES***

On 16 April 2003, Rafale C101, the first production single-seater for the French Air Force, made its maiden flight from Mérignac with test pilot Frédéric Lascourreges at the controls. During the 1 h 15 min flight, the fighter performed aggressive combat manoeuvres and flew at high supersonic speed.

Rafale C101 is the first aircraft to be equipped with the new avionics core of the omni-role F2 Standard which encompasses major improvements over the F1 Standard currently in service. The main features of the F2 Standard include the Front Sector Optronics (although it is not yet fitted to C101), the MIDS-LVT (Multifunction Information Distribution System - Low Volume Terminal) Link 16 data-link, specific air-to-ground modes for the RBE2 electronic scanning radar, additional modes for the Spectra self-defence/electronic warfare suite, and a wide range of weapons: Scalp EG cruise missiles, the AASM (Armement Air-Sol Modulaire) air-to-surface modular armament with INS / GPS reference and imagery guidance, plus long-range infrared-guided Mica IR missiles which supplant the long-serving Magic 2. Moreover, a high-resolution 3D digital database permits automatic terrain-following at low-level. Finally, an in-flight refuelling pod will be adopted for naval aircraft.

At the core of the F2 Standard increased capabilities is the Modular Data Processing Unit (MDPU) composed of line-replaceable modules, including commercial off-the-shelf elements. The MDPU enhances avionics/armament integration thanks to its redundant, open and modular architecture. The system is highly flexible, allowing the integration of new avionics and future weapons. It has been conceived with growth in mind to facilitate the incorporation of new capabilities from one standard to another. C101 is the first Rafale equipped with the MDPU straight from the production line, although both M02 and B302 have been retrofitted with the system.

The first Rafale B/Cs will be delivered to the French Air Force test and evaluation unit (CEAM squadron) which will deploy to Saint-Dizier Air Base in 2005. Escadron de Chasse 1/7 'Provence' will then become the second Rafale front-line unit after French Navy Flottille 12F which stood up in May 2001.

SIGNIFICANT MILESTONES

In the last few months, the Rafale has passed numerous and significant milestones in its development programme. The trials of the air-defence Standard F1 have been completed, and various new configurations have been tested with Standard F2 and F3 external loads. New internal and external systems are also under active development and testing.

"At the moment, we are concentrating on the trials of the F2 omni-role standard, says Pierre-Cyril Delanglade, Engineer in Charge of Rafale Flight Tests at Istres. We are busy expanding the flight envelope with new external stores in heavy configurations. We are also performing weapons releases to make sure there are no adverse effects on the stores or on the aircraft during the release."
Internal systems trials have followed a similar path, and progress has been quick: Dassault Aviation test pilots and flight test engineers have been very active developing and testing the Front Sector Optronics (FSO), the Link 16 Multifunction Information Distribution System-Low Volume Terminal (MIDS-LVT) datalink, the Modular Data Processing Unit (MDPU), and the Direct Voice Input system.

New external loads

The range of missions which can be performed by the Rafale is constantly being expanded, and the integration and trials of the Intertechnique buddy-buddy refuelling pod have now been completed. This pod is due to be used by the French Navy from its aircraft-carrier to provide an organic in-flight refuelling capability to the carrier battle group. "To date, Rafale M1, the first production naval Rafale, has successfully refuelled other Rafale and Super Etendard fighters, clearly demonstrating the inherent flexibility of the design, explains Pierre-Cyril Delanglade. The pod itself has been cleared up to Mach 0.9 / 580 knots IAS, and in-flight refuellings have been conducted - with transfer rates of 530 litres/minute - at 280-350 knots at altitudes up to 20,000 feet, but this could be expanded to 30,000 feet without any problem." Even for countries with no naval air arms, a Rafale equipped with this refuelling pod could increase the combat capabilities of a strike package as it boasts a significant self-escort capability with its Mica air-to-air missiles, allowing a raid to penetrate deep into hostile territory while still having an embedded tanker force.
Similarly, the Rafale has successfully flown with a New Generation Reconnaissance Pod (NG Recce Pod), a new configuration which is representative of the Standard F3 fighter. The NG Recce Pod will significantly boost the capabilities of reconnaissance units. It will be fielded by Rafale units from 2007, and will progressively supplant Mirage F1CR and Super Etendard reconnaissance aircraft currently in service with the French Air Force and Navy. The NG Recce Pod has been flown at Mach 0.9 / 580 knots IAS with two 2,000 litre external fuel tanks and four Mica missiles. Supersonic speeds have been demonstrated too, the fighter reaching Mach 1.4 with the NG Recce Pod on the centreline pylon and two Mica air-to-air missiles at the wingtips. It has been determined that the NG Recce Pod has negligible impact on aircraft handling.

New weapon configurations

The improved Standard F2 for the French Armed Forces will allow air-to-ground attacks to be performed with advanced weapons such as the powerful and stealthy MBDA Scalp EG cruise missile and the low-cost Sagem AASM (Armement Air-Sol Modulaire, Modular air-to-surface armament). "The new weapons are already being tested at Istres and Cazaux, and Scalps were recently dropped from the wing pylons of the Rafale, a more demanding scenario than releases from the fuselage centreline hardpoint, says Pierre-Cyril Delanglade.

Full-scale guided firings are expected to be carried out in late 2003."
A new triple ejector rack for staggered carriage of GBU-12 laser-guided bombs has now been tested, allowing six GBU-12s to be carried, along with three 2,000 litre drop tanks and four Mica missiles. Taking advantage of what had been done with the GBU-12s, the first flights of a Rafale fitted with six AASM GPS/INS/Imagery-guided bombs have been performed too.
The first separation firings of the infrared-guided, long-range, multi-target MBDA Mica IR air-to-air missile have also been conducted with the firing envelope now opened at supersonic speeds. Fully guided missiles are planned to be fired in late 2003.
Flight test engineers have taken advantage of the ongoing programmes to clear the normally subsonic 2,000 litre drop tank up to Mach 1.6 when two fuel tanks are fitted to the aircraft. The obvious advantage of this flight envelope expansion is that a Rafale in an air-to-ground fit could accelerate to high-supersonic speed after weapon delivery, either to escape a threat or to carry out an interception without dropping its fuel tanks.

Carrier trials

In late 2002, the fighter participated in a three-week trial campaign on board the Charles de Gaulle to validate various weapon/external load configurations at heavy weights. For instance, Rafale M1 was catapulted at a weight of 21,4 tonnes (47,137 lb.) with a Scalp on the centreline pylon, two 2,000 litre drop tanks on the inboard wing pylons, and four Mica missiles at the wingtips and under the fuselage. During another test, it was recovered at a weight of 15,7 tonnes (34,581 lb.) with six AASM 300 kg bombs (plus empty 1,250 litre drop tanks), clearly demonstrating its huge 'bring back' capability.
Perhaps even more significant is the flight testing of the NG Recce Pod in an aircraft-carrier environment to make sure that the pod/Rafale airframe combination could withstand the shocks and vibrations associated with carrier operations.
The Rafale flight test programme is continuing at an unabated rate and it is expected that, in 2003, more than 450 Rafale sorties will have been carried out from Istres and Cazaux by the Air Force / Test Centre / Dassault integrated test team. In 2004, other important events will be recorded, such as the first firing of a Scalp pre-strategic cruise missile from a Rafale launched from the Charles de Gaulle carrier.