# INDEPENDENCE

PEMA 2b - Photo F. Robineau - Dassault Aviation

RAFALE INTERNATIONAL

When a single country makes your aircraft from nose to tail, you know exactly what you're getting into. Rafale is not subject to multinational controls. It also offers unrestricted access to key weapon systems technologies, spare parts, and know-how. Rafale offers superior operational effectiveness and failsafe worldwide support, yet isn't delivered wrapped in red tape. Or with strings attached. *Rafale.* The *OMNIROLE* fighter■

RAFALE INTERNATIONAL

FOXTHREE

DASSAULT AVIATION - SNECMA - THALES N°9

# Editorial

In this latest issue of Fox Three, the magazine dedicated to the Rafale Omnirole fighter, you will find features on the latest development in the Rafale programme, including the first trials with the acclaimed Exocet missile, the Rafale production, and the Rafale Simulation Centre, plus updates on the French Air Force Rafales and the Link 16 datalink.

Enjoy!

The “FOX THREE” Team

# Summary





# *FIRST EXOCET TRIALS*

The first stage of the integration trials of the combat-proven AM39 Exocet antiship missile has successfully been completed by a production Rafale from the Dassault facility in Istres, the fighter carrying a single AM39 on the centreline pylon.
To this date, more than 3300 Exocet sea-skimming missiles have been sold to 34 customers. For increased commonality, the Exocet is available in three variants : surface-to-surface (MM38 and MM40), air-to-surface (AM39), or submarine-to-surface (SM39). The 1,475 lb (670 kg) air-launched missile has a range of between 27 and 38 nautical miles (50 and 70 km) depending on launch speed and altitude, and its 363 lb (165 kg) blast fragmentation warhead is powerful enough to disable a frigate or a destroyer. Over the years, the AM 39 Exocet has progressively been updated, with the successive improvement programmes concentrating on radar seeker counter-countermeasure capabilities, thus limiting vulnerability to jamming and decoying while increasing lethality.
Flight envelope expansion was carried out by Rafale M1, with three sorties only being required to validate the normal operating envelope: 600 knots / Mach 0.9 maximum speed, 5.5 g maximum g-load and 4 m/s vertical sink rate for carrier landings. The aircraft and missile combination will be tested at sea onboard the *Charles de Gaulle* carrier in December 2005. During these trials, the vertical sink rate will be cleared up to 5 m/s. The first separation tests are planned for early 2006.

# *FRENCH AIR FORCE RAFALES:*
# FAST FORWARD

***Today, Mont-de-Marsan Air Base is a hub of activity as the CEAM (Centre d'Expériences Aériennes Militaires), the French Air Force Evaluation Centre, conducts a rigorous operational evaluation of the Standard F2 Rafale omnirole fighter. The CEAM is currently evaluating the performance of the Rafale and of its weapon system, including the RBE2 electronic scanning radar, the Spectra electronic warfare suite, the Front Sector Optronics, the data fusion system and all the various missiles and precision weapons.***

## Link 16 and Mica IR missiles

«In the last few months, the Rafale evaluation and the Rafale aircrews conversion training have been carried out concurrently, explains General Rouzaud, CEAM Commander. So far, thirteen crews - each composed of one pilot and one weapon system operator - have completed their conversion process, nine of them belonging to EC 1/7 'Provence', the first Rafale fighter squadron. The Rafale is planned to enter operational service around Summer 2006 and, for us, the timetable is extremely tight. That means that our experts don't have time to conduct the two phases one after the other as it is usually the case. However, the Rafale is a very flexible aircraft and we have no difficulties mixing the two missions.»

All French Air Force Rafales are fitted with the Link 16 datalink system and new tactics are already being developed to take advantage of this revolutionary system. «We regularly work with E-3 AWACSs to test information exchanges and to validate new tactics, says Colonel Rondel, the CEAM Evaluations Manager. With the Link 16, we now have a 360 degree vision around the Rafale and we can clearly see 'hostile' fighters attacking us from the sides or from the rear. The operational evaluation of the infrared-guided Mica IR missile has also begun, and the first results are nothing short of astounding. The Mica IR missile can be utilised either for a dogfight or for a long-range interception. When used in conjunction with the Link 16, we can conduct silent interceptions at extreme range, and we can even shoot Micas off-boresight for self-defence with an external target designation, either from another Rafale or from an AWACS.»

## Maintenance training

As part of the wider conversion effort, French Air Force engineers have been busy learning how to maintain and repair the Rafale. «We have already trained about 100 Rafale engineers, which is quite good considering that we have no spare airframe just for maintainers, stresses General Rouzaud. Thanks to our exchange programme with the French Navy, we have been capable of fielding the new type without major problems. The French Air Force has set up here the Rafale Formation Centre which handles all Rafale training courses, including those of the Air Force, the Navy, the French Flight Test Centre, and the industrial partners. We are also ready to accommodate any potential export customers.»

The operational evaluation of the omnirole Standard F2 Rafales is expected to be thorough enough to allow the operational release of the type at Saint-Dizier Air Base next summer. From 2008 onwards, the CEAM will switch its attention to the improved Standard F3 Rafales which will offer expanded capabilities in the fields of reconnaissance, nuclear deterrence and anti-ship strikes

# VIRTUAL REALITY

*A new, state-of-the-art Rafale Simulation Centre is being put together by Dassault and Thales to train future Rafale aircrews. Taking advantage of their respective fields of excellence, the two companies have created a new concept of a fully integrated training simulator network. Dassault Aviation is in charge of the global system architecture, the visual system, the network environment, the high-fidelity flight model and the building. Thales develops the cockpits, the simulator architecture and the weapon system modelisation (RBE2 electronic scanning radar, Front Sector Optronics, Spectra electronic warfare suite). Acting as co-contractors, Dassault Aviation, through its Military Customer Support Division, and Thales ensure the global management of the programme.*

*Three Instructor Operating Stations (IOS) manage the four Cockpits*

## High-fidelity

The first two Rafale bases, Saint-Dizier Air Base and Landivisiau Naval Air Station, will each be equipped with a complete Rafale simulation facility, with four cabins at Saint-Dizier and two at Landivisiau. If needed, the two facilities can be coupled in order to simulate complex missions with up to six Rafales 'flown' simultaneously. The two facilities can even be interconnected with off-site simulators in order to conduct real time cooperative training mission with other assets: aircrews at different locations will then be able to train together in the same threat environment via a high-level architecture protocol (HLA) which ensures that the simulators can talk to each other and share data over the network.

The new full-mission Rafale simulators will be extremely high-fidelity devices using the real Modular Data Processing Unit borrowed from the fighter. As such, they will accurately replicate the performance of the Standard F2 Rafale omnirole fighter. Pilots will be able to practise demanding scenarios, including interceptions, dog-fights, precision attacks and even carrier landings at night. To augment the value of the training, more than 200 friendly or hostile virtual entities (50 aircraft, 40 missiles, 20 warships, 20 moving surface targets and 100 SAM sites) can be simulated during each session, allowing extremely complex missions to be rehearsed. Other innovative capabilities such as the voice control of the virtual friendly aircraft or the use of Night Vision Goggles will be implemented.

For increased flexibility, each cockpit can be easily reconfigured from one version to another in less than an hour, for example from the Air Force to the Naval variant, or from the single-seat to the two-seat version (four cabins can be utilised to simulate two two-seaters). Additionally, the two Rafale Simulation Centres will be equipped with dedicated debriefing facilities, allowing missions to be replayed to increase experience and enhance training value.
With their new, full-mission, reconfigurable, networked simulators, the French Armed Forces will soon get the tool they need to train Rafale aircrews for the future. The simulator centres will be declared operational at Saint-Dizier in April 2007, and at Landivisiau in May 2008.

# *RAFALE PRODUCTION IS* **NOW IN FULL SWING**

***With the Rafale fighter, Dassault Aviation has pioneered new design and production methods which are progressively being adopted by the rest of the world, from famous automotive companies to most major aircraft manufacturers. The sweeping changes introduced for the Rafale programme have helped streamline manufacturing techniques in order to reduce both fabrication costs and delays from order to delivery.***

## Digital revolution

From the early stages of the Rafale programme, the widespread use of digital technology for the development considerably facilitated the elaboration of digital blueprints that were later transferred to production plants. For production engineers, the advent of the automated conception with the Catia 3D tool meant that new production methods could be adopted. Huge investments in new tooling were made to reduce costs and increase flexibility, the staff undergoing specific training to adapt to the new techniques. Traditionally, fitters and riggers were key employees in a Dassault plant. Now, everything fits perfectly and complex rigs are not required anymore. This is a real cultural revolution. New, large, automated production machines have been introduced in the last few years and, for maximum flexibility and adaptability, they are utilised to fabricate parts for both the fighters and the Falcon business jets. With these machines, the level of production accuracy has been boosted to unprecedented levels. This means that parts taken from one aircraft will fit another, without any adjustment or modification as was common practice on previous aircraft. «With the Rafale, there is no adjustment required, such is the quality of the construction, explains Etienne Prévost, Rafale Programme Manager. Everybody - from the design office to the production engineers working in our factories - utilises a common, unique digital reference that considerably facilitates production. For the time being, all assembly instructions are still printed on paper fact sheets but we will eventually switch to computer instructions with 3D graphics.» Today, all major Dassault Aviation production plants are already heavily involved in the Rafale programme. For instance, Seclin, in Northern France, specialises in the fabrication of large primary parts. The Rafale's fuselage is assembled at Argenteuil, near Paris, from components delivered from Biarritz (in the south-west of France) and from various partners' facilities. The Biarritz plant also specialises in composite materials. At Martignas, close to Bordeaux, the wings are assembled from elements coming from Seclin. Rafale final assembly and acceptance testing is carried out at Bordeaux-Mérignac. It should be noted that, from the production people's point of view, only two Rafale versions exist, the Air Force single-seater being produced by mating up the forward fuselage of the Naval single-seater to the rear fuselage of the Air Force two-seater.

# *MIDS/LINK 16* **ON THE RAFALE**

***The Rafale new-generation multi-mission combat aircraft now has MIDS/Link 16 capability to ensure full interoperability with the major NATO and allied platforms for joint and/or allied operations.***

Link 16 is NATO's most recent interoperable datalink standard and is defined in STANAG 5516. It is a real-time tactical link for the exchange of digital multi-service data across multi-user networks that can comprise several hundred platforms.
L16 is a tri-service datalink (air, land, naval) and supports a broad range of operational services, including tactical situation awareness, command, control, electronic warfare, mission execution, anti-surface warfare and anti-submarine warfare.
L16 enables real-time exchange (in the order of seconds) at tactical level. In other words, the information it carries is considered valid at the moment it is sent and the moment it is received via the communication network. The information itself is fully standardised. Messages are structured into fields to avoid any possible misinterpretation. Exchange procedures and protocols are also strictly defined in the NATO standard.
MIDS is the waveform that supports Link 16 and is itself defined in STANAG 4175. Located in L band, the MIDS waveform is highly protected (TRANSEC and COMSEC) against jamming and intrusion, and enables basic bit rates up to around 100 kilobits per second.
Until recently, the relatively big and heavy MIDS terminals could only be integrated with large platforms: special-mission aircraft, surface ships, ground centres, etc. However, the latest generation of the terminal, called MIDS-LVT (low-volume terminal) is smaller and lighter, so MIDS/L16 capabilities can be implemented on smaller aircraft, including combat aircraft and helicopters. These new terminals are now in production.
On the Rafale, the MIDS-LVT is fully integrated with weapon systems via the aircraft's databus (1553 and BHV high-speed bus). The L16 management function is performed by the aircraft's mission computer, and the human-machine interfaces are incorporated with the existing cockpit displays.
The Rafale will use Link 16 for air-to-air and air-to-ground/surface missions for all mission phases, from alert to landing, and for two main classes of services: external cooperation (with other participants in the engagement) and internal cooperation (within the aircraft's own patrol).
For external cooperation, the Rafale will automatically receive tactical situation information, i.e. the representation of its operational environment with the positions of other players (friendlies, hostiles, neutrals, etc.) in the theatre of operations. It will also have a direct connection with its control centre (ground, surface or air) for the exchange of mission-specific information such as flight plans, navigation and refuelling waypoints, guidance to target, engagement orders, acknowledgements and reports.
For internal cooperation, MIDS/L16 will be used to exchange data on the relative positions of aircraft within the patrol, their statuses, detection data (e.g. one aircraft using its radar to provide tracks for other aircraft), coordination data and target distribution data.

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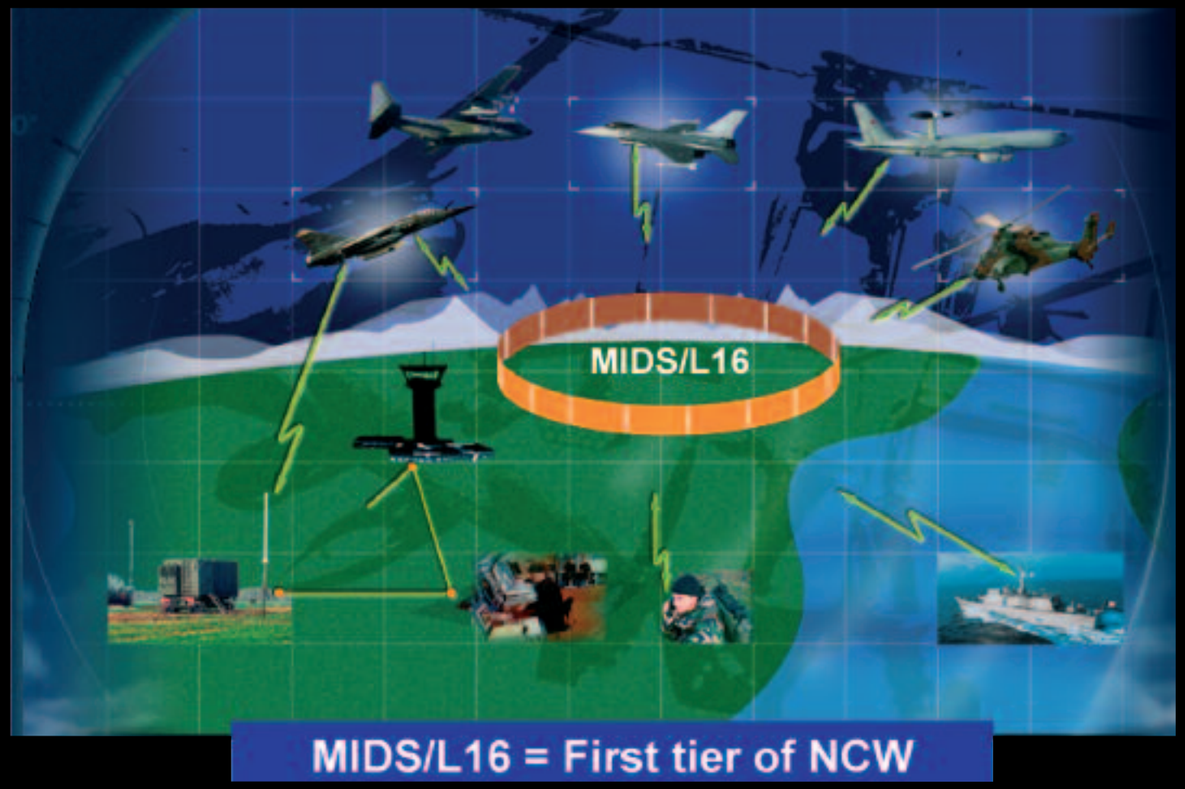
***MIDS = Multifonctional Information Distribution System***
***NCW = Network Centric Warfare***




## Link 16 capability gives the Rafale multiple operational advantages:

- First, it enables the aircraft and its crew to receive real-time information automatically:

  o broad spectrum of data on the operational environment, mission, etc.
  o data is extremely reliable and accurate (e.g. on targets — absolute or relative position, route, speed, altitude, etc.)
  o no crew saturation (data is stored, then displayed on request or automatically, according to the phase of the mission)
  o updates (instant or periodic).

- Second, it gives the aircraft full interoperability:

  o with French forces:

  - as part of the SCCOA* air command and control system, with its fixed and deployable components, SDCA** airborne detection and command system (equivalent of AWACS) and (in the near future) tanker aircraft, Mirage 2000 combat aircraft and SAR helicopters operated by the French Air Force

  - the French Navy's air arm, with the *Charles de Gaulle* aircraft carrier, anti-air frigates, carrier-based airborne early warning aircraft (French Hawkeyes) and (in the near future) multi-mission frigates

  - the Martha system (ground-based air and area defence) and helicopters operated by the French Army

  o with NATO forces, particularly the Air Command & Control System (ACCS) with its fixed and deployable components, airborne early warning (AEW) assets, other allied command systems (including combat aircraft) and (in the near future) the Alliance Ground Surveillance (AGS) system.

The Rafale is one of the first combat aircraft to be equipped with an advanced real-time and fully interoperable tactical datalink. This new capability will enhance the aircraft's operational effectiveness as part of broader force structures and will enable it to play a critical role in future network-centric warfare operations.

* SCCOA: Système de Commandement et de Contrôle des Opérations Aériennes
** SDCA: Système de Détection et de Commandement Aéroporté

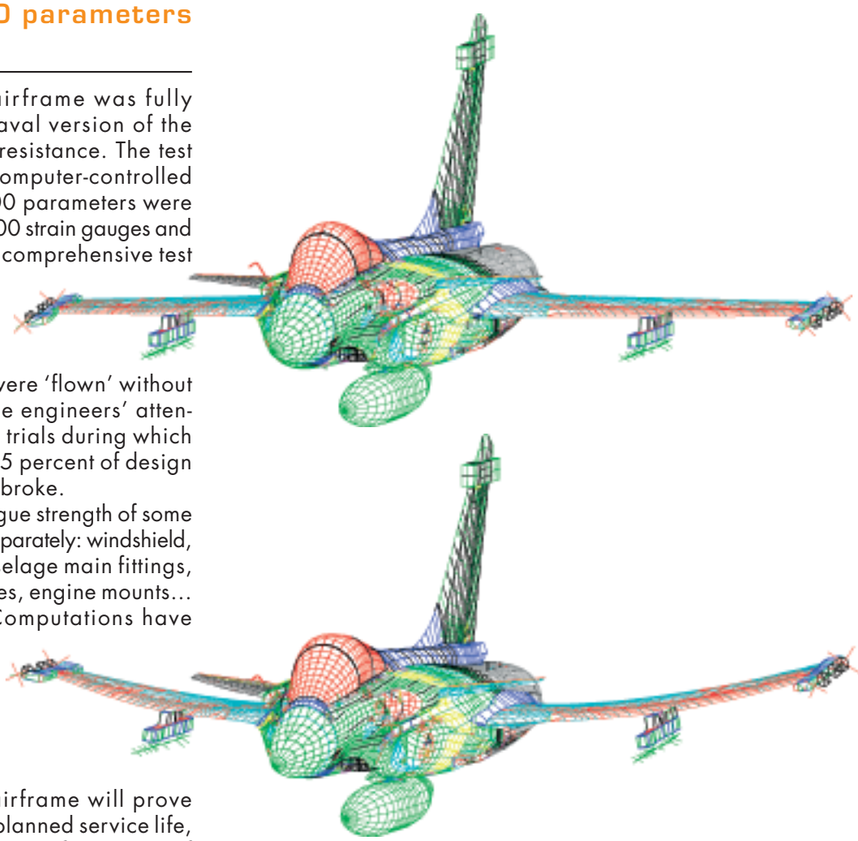


# *RAFALE :* "AN EXTREMELY STRONG" AIRFRAME

***Between 1992 and 1999, a test airframe was used to validate the Rafale's design structural service life. The fatigue and static tests were based on a demanding flight spectrum representing expected flight usage, with data drawn from Mirage 2000 service experience.***

## No fewer than 3,000 parameters recorded

The Rafale static/fatigue airframe was fully representative of the real Naval version of the aircraft in terms of structural resistance. The test installation comprised 110 computer-controlled actuators and more than 3,000 parameters were recorded simultaneously by 3,000 strain gauges and 50 displacement sensors. The comprehensive test programme initially concentrated on fatigue trials and two aircraft lives - equivalent to 2 x 5,000 flying hours and 2 x 3,500 flights - were 'flown' without sustaining major damage. The engineers' attention then switched to the static trials during which the Rafale was tested up to 185 percent of design limit load before the airframe broke.



Additionally, the static and fatigue strength of some crucial components was tested separately: windshield, canopy, wing attachments, fuselage main fittings, landing gear, canard foreplanes, engine mounts... Additional Finite Elements Computations have beeen performed whenever needed to demonstrate the strength of components that have not been tested.

«Having completed all this substantiation process, we are fully confident that the airframe will prove problem-free for well over the planned service life, stresses Philippe Delaage, an aircraft engineer of the Rafale Management Team. Moreover, in-service aircraft are entirely monitored in real-time by a Health and Usage Monitoring System integrated into the mission computer, thus allowing the operator to precisely follow up the actual use of each aircraft through fatigue indexes.»

French MoD initial design specifications for the Rafale are 5,000 flying hours/3,000 landings with a severe usage spectrum, but studies have shown that the expected economical life (that is without any major structure component replacement) is 7,000 hours and 5,300 landings.