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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 ■

FOXTHREE

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Rafale **Combat Success**

HARMATTAN SPECIAL

Editorial

In the 15th issue of Fox Three,

The Rafale Team is proud to explain how the Rafale has demonstrated its true omnirole capabilities at war. The fighter successfully and autonomously carried out over Libya the whole spectrum of high-intensity combat operations ranging from air-superiority to precision strikes, from tactical and strategic reconnaissance to dynamic targeting, and from destruction of enemy air-defences to buddy-buddy refuelling. It easily plugged into a complex command and control structure and flew demanding combined air operations alongside other allied air assets. After similar achievements in Afghanistan since 2007, the new fighter is now firmly rated as combat-hardened and battle-proven. Such is the success of the Rafale that it has attracted a lot of favourable comments from French users and foreign observers alike.

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RAFALE KICKS THE DOOR DOWN

The Rafale has proved, in action, that it is the best all-round fighter in service anywhere. Operating from air bases in Corsica and Sicily and from the *Charles de Gaulle* nuclear-powered aircraft-carrier, the omnirole fighter has managed to bring down enemy air-defences and, more importantly, protect civilian populations.



On 19 March 2011, French Air Force Rafales carried out the very first strike missions against forces loyal to Libyan Leader Colonel Gaddafi. With tanker support, the fighters flew extremely long-range sorties from their base in Saint-Dizier, in the North-East of France. The daring, seven to eight hour-long raids against heavily defended targets were entirely successful: the Rafales quickly achieved un-

contested air-supremacy and used their Armements Air-Sol Modulaires (AASMs, or Air-to-Surface Modular Armaments, also known as SBU-38 Hammer under the new NATO designation) to bring down air defences and destroy units that posed a direct and immediate threat to the besieged city of Benghazi and to civilian lives. Simultaneously, other Armée de l'Air Rafales flew the first reconnaissance missions to start

gathering up-to-date intelligence with the Pod Reco NG (New Generation Reconnaissance Pod, also known on the export market as AREOS, for Airborne REconnaissance Observation System). They undertook reconnaissance missions over points of interest, using their pod to photograph numerous tactical and strategic targets at stand-off distances.

Destroying enemy air-defences

Such was the confidence of the French aircrews in their new mount that all missions were conducted without any support from dedicated electronic warfare and SEAD (Suppression of Enemy Air Defences) assets: thanks to its Spectra state-of-the-art electronic warfare/self-defence suite, the Rafale was able to operate at

operating base on the island of Corsica. The Rafale's low logistical footprint was a decisive advantage for the move from Saint-Dizier to Solenzara, the large number of Transall and Hercules airlifters being mainly needed to transport the huge amount of ammunition required for the combat operations. For air-to-ground missions, the Rafales are equipped with either four to six GBU-12 Paveway 2 laser-guided bombs or four to six AASM precision weapons, plus a

far mostly been fired against high-value and well-defended military targets, such as ammunition dumps, air-defence systems and hardened shelters. Operation Harmattan is the first time the Rafale has used the Damoclès laser designation pod 'in anger'. The pod is indifferently fitted to aircraft armed with the GBU-12 or the AASM and is used for target identification at long distances, for the guidance of GBU-12s or to determine the precise



will in a dangerous environment, against a dense network of deadly surface-to-air missile systems. Even more significant is the fact that the Rafale was able to accurately locate enemy air-defence systems and engage them. As early as 20 March 2011, Armée de l'Air Rafales started operating from Solenzara, a forward

full load of flares and chaffs and of MICA (Missile d'Interception, de Combat et d'Autodéfense, Interception, Combat and Self-Defence Missile) air-to-air missiles. The GBU-12 is mainly used for 'dynamic targeting', a kind of close air support, but without any forward air controller on the ground. The AASM has so

coordinates of a target before engaging it with an AASM. The Damoclès is a valuable addition to the Front Sector Optronics, an internal system mounted above the nose of the Rafale. The FSO is composed of a powerful TV sensor, a laser rangefinder and an infrared search and track system. ■



Enter the Navy

The Rafale was designed from the start to operate from the pitching deck of an aircraft-carrier and, from 23 March 2011, French Navy Rafales flying out of the *Charles de Gaulle* joined the fight. For over four months, French Navy Flottille 12F Rafale aircrews performed the whole spectrum of conventional offensive combat operations from the carrier (except anti-ship attacks with Exocet missiles, even though surface combatants were destroyed by Rafales in Libyan harbours using laser-guided bombs).

From the Gulf of Sirte, the *Charles de Gaulle* launched waves after waves of fighters which dropped hundreds of precision weapons (GBU-12s, AASMs and Scalps) against a wide variety of targets. Flottille 12F Rafales mainly operated in three types of configurations: reconnaissance, attack and buddy-buddy tanker. Although

the air-threat was considered very low and the surface-to-air threat had been significantly reduced by air strikes, the Navy Rafales usually flew with a full load of flares and chaffs and of MICA air-to-air missiles on top of their air-to-surface weapons or of their recce pod. For air-to-ground

missions, they usually carried four GBU-12 laser-guided bombs or four AASM precision weapons, these loads being increased to six weapons when required. About half of all missions conducted by Navy Rafales were flown at night.





Scalp attack

Although all numbers were still classified at the time of writing, it can already be revealed that Navy and Air Force Rafales have destroyed hundreds of targets, ranging from armoured personal carriers to main battle tanks, from

artillery positions to long-range missiles, from parked aircraft to air-defence radars, from hardened ammunition storage facilities to deeply buried command posts...

Among the Rafale's weapons, the Scalp stealth cruise missile was singled out for long-range strike missions against hardened targets very deep inside Libyan

territory. Strikes were conducted by a combination of French Navy Rafales and Armée de l'Air Rafales and Mirage 2000Ds. It is understood that the first target for the Scalps was a heavily-defended high-value target deep inside Libya, where a strike with close range weapons would have proved unnecessarily dangerous.



Extreme range

A key advantage of the Rafale compared to the other French and foreign fighters is its very long range. «French Air Force Rafales initially flew with two 2,000-litre external fuel tanks under the wings on top of their MICA air-to-air missiles and of their air-to-surface ordnance, reveals the Armée de l'Air Rafale detachment commander. When the availability of tankers became an issue, a third 2,000-litre drop tank was added to the Rafale based in Solenzara, thus helping minimise the pressure

on the Allied tanker force.» The Rafale then carried 6,000 litres of external fuel on top of the 4,700 kg of internal fuel for the single-seat Rafale C, and 4,400 kg for the two-seat Rafale B, giving an outstanding range and an extended time on station.

Endurance was a crucial parameter for Rafales operating from the *Charles de Gaulle* too: «we typically flew missions lasting over two hours without tanker support, stresses the Commanding Officer of French Navy Flottille 12F. With tanker support, either from a Rafale configured for buddy-buddy tanking, a C-135FR, a KC-135R or from any other coalition tanker, we flew 4-hour long sorties with two refuellings. Our 'playtime'

was excellent, with relatively short transits to and from Libya. In fact, out of 4 hours airborne, we remained 2 h 20 min on station, ready to strike any target of opportunity.» Usually, two of the ten Rafales onboard the carrier were configured as buddy-buddy tankers, each with an in-flight refuelling pod under the centreline pylon and two to four drop tanks under the wings. One of them was systematically launched prior to any recovery cycle, ready to give away fuel to any fighter which might have encountered difficulties when attempting to trap back onboard the carrier. Another one was ready to be catapulted away, should the situation have got worse. ■



Datalink

The Rafale is the first French fighter equipped with the L16 datalink which is fully integrated into the fighter's weapon system. Through the L16, pilots share surveillance and targeting data, and give and receive orders. *«To boost flight safety, we use our L16 for de-confliction, without speaking on the radio, explains the Armée de l'Air Rafale detachment commander. We are assigned block levels by the NATO Air Tasking Order and, by just looking at a screen,*

we know what the flow looks like. The Rafale's man-machine interface has been cleverly designed. For example, there are some modes that declutter the displays, allowing the pilot to concentrate on the target. You prioritise things: tasks, Desired Mean Points of Impact, air targets... If the AWACS decides that there is something more important happening, the system will just show it to you. Pretty neat... Nearly everything can be done without any radio coms. The Rafale has got a very silent cockpit and I like silence in my cockpit during combat missions. I tend to have Damoclès

imagery on the right lateral display, with a fuel page on the left display and the tactical situation on the centre screen. If needed, Damoclès imagery can be expanded on the head-level display for better quality.»

The Rafale's participation in the NATO operation is an uncontested success. It has confirmed, in action, that all the choices made a few years ago by French Air Force and Navy decision makers were the right ones. The fully omnirole fighter once envisioned has now come of age and is fully operational, as demonstrated by the current operations in Libya. ■

Outstanding reliability

At the time of writing, French Rafales had logged over 6,000 combat flying hours in close to 2,000 sorties in support of the Harmattan operation with outstanding reliability. Flying out from forward operating bases, Solenzara, on the island of Corsica, and Sigonella, in Sicily, and from the *Charles de Gaulle* carrier, the omnirole fighter has demonstrated, in action, that the maintenance and support concept designed by Dassault Aviation fully fulfils the stringent requirements decided by the French Armed Forces when the programme was launched. The Rafale's inherent reliability and its ease of maintenance have significantly contributed to a very high dispatch rate that has helped bring down operational costs while maximising military efficiency.

Recce

Very early into the mission, the Armée de l'Air started using the AREOS pod for pre-strike reconnaissance, battle damage assessment and video reconnaissance. The French Navy soon started doing recce missions too, from the *Charles*

de Gaulle, and Air Force and Navy Rafales then became one of the main providers of airborne imagery for the whole coalition. *«We broadcast all the recorded imagery on the way back to base, explains the Armée de l'Air Rafale detachment commander at Solenzara Air Base. We have also transmitted French Air Force AREOS imagery to the Charles de Gaulle while on*

our way back to base so that all data can be processed more quickly to shorten the OODA (Observation Orientation, Decision, Action) loop. The system is highly flexible, with remarkably sharp images. We have mainly used the AREOS in high level mission profiles, but we could also have chosen low-level high-speed runs, with a 'pop up' to take imagery.» ■

Air superiority

On the first few days of the Allied air operations, Rafales in air-to-air configurations flew Offensive Counter Air (OCA) missions to achieve air-superiority over Libya, preventing Libyan loyalist fighters from taking off from their own bases. They also escorted strike fighters and were ready to protect them against any airborne threat.

Rafales flying their recce or strike missions over Libya remain fully capable of providing air-to-air support with their MICA missiles. On several occasions, they have been re-tasked in flight to investigate and identify air targets detected in the vicinity of their working areas. The air-to-air threat is assessed by NATO as very low or negligible, but Rafale pilots could still have found themselves engaged against a last ditch attempt to regain air supremacy. *«Rafale strike and recce missions*

are always conducted without any dedicated escort, our RBE2 radar, our Link 16, our FSO and our Spectra electronic warfare suite helping us maintain a very good all-round situational awareness, explains the Armée de l'Air Rafale detachment commander. Nevertheless, we stand ready to strike back and engage enemy fighters at all times. If intercepted, we could have destroyed any airborne threat with our MICAs during the very same missions.»







RAFALE TACTICAL NODE **AND ISTAR TOOL**

The conflict in Libya has clearly demonstrated that the Rafale, with its state-of-the-art sensor suite, has become a key tool for ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) missions.



Without any forces on the ground to provide them with up-to-date intelligence, NATO commanders have to rely on airborne assets to build up an unambiguous tactical picture. Ongoing operations have shown that, thanks to an unmatched combination of powerful sensors, Link 16 datalink and intuitive man-machine interface, the Rafale is a decisive airborne asset in the ISTAR role and key provider of vital intelligence.

Comprehensive sensor suite

French Air Force and French Navy Rafales fly over Libya with a fully operational sensor suite that includes the RBE2 electronic scanning radar, the Spectra internal electronic warfare suite, the Front Sector Optronics, the Pod Reco NG (New Generation Reconnaissance Pod, also known on the export market as AREOS, for Airborne REconnaissance Observation System), and the Damoclès laser designation pod. Among all the allied aircraft engaged over Libya on a daily basis, the Rafale is the only one to boast such a large array of internal and

external sensors. As a result, the pilots have at their disposal all the systems required to detect and locate hostile activity. For instance, they can use their radar high-resolution mode to look at an area of interest from extreme distances before cueing their Damoclès pod to precisely identify a target and find its coordinates. Alternatively, the radar high-resolution mode can be utilised to keep a sharp eye on enemy activity through a thick cloud layer. With its Link 16 datalink, the Rafale omnirole fighter readily plugs into the complex NATO command and control networks. All collected intelligence is easily transmitted back to the C² assets, the

Rafale thus becoming a node within a much larger C² structure. *"With the Rafale, we are part of the network centric warfare loop and we can easily engage time sensitive targets,"* explains the Armée de l'Air Rafale detachment commander at Solenzara Air Base. *The Rafale has become a gathering platform for information and we are continuously fed with data. We also scatter information to our wingmen and to other assets."* It should be noted here that the Rover system, fully operational on the Rafale, has not been utilised in Libya due to lack of forward air controller on the ground.

Sharp-eyed Rafale

Reconnaissance is one of the Rafale's main missions. With the advent of the AREOS, which entered service in late 2010, the French Navy and Air Force are equipped with one of the best recce systems in the world. Thanks to the AREOS's powerful dual band infrared/visible sensor mounted in a swiveling turret at the front end of the pod, the Rafale can remain outside the range of enemy air defences while taking incredibly sharp pictures from stand-off distances, day and night. Similarly impressive is the capability to transmit back in real time all imagery taken during the mission via a broadband datalink system that offers a

360-degree coverage. The highly directive data beam would prove very difficult to intercept, and all data can be encrypted for additional security. *"The AREOS is a superb system for both day and night operations, and the High Command is extremely happy with all the imagery we provide,"* explains French Navy Flottille 12F Commanding Officer. *Onboard the Charles de Gaulle aircraft-carrier, naval photo interpreters process all data which is sent back to the French and Allied headquarters in near real-time. Everything is done to cut down the time required to process the information in order to shorten the intelligence gathering cycle and accelerate the tempo of operation, and the AREOS, with its high-speed datalink,*

is a key enabler. The new reconnaissance mode of the Damoclès pod has also proved tremendously useful, helping us gather imagery during a larger number of sorties." ■



Ease of use

Like all the Rafale systems, the AREOS has been optimised to reduce aircrew workload: "reconnaissance missions are conducted day or night by two aircraft equipped with one AREOS pod, four MICA air-to-air missiles and two 2,000-litre drop tanks, and dozens of targets are photographed in the course of the flight, reveals the Flottille 12F Commanding Officer. The pod is highly automated and our state-of-the-art mission planning tools allow us to precisely program the system prior to the flight. During the sortie, all is done to minimize the pilot's workload and the pod automatically points its main sensors at areas of interest. As



a consequence, we can cover huge areas in a very limited amount of time while concentrating on the tactical situation and on the surface-to-air and air-to-air threats. We also have at our disposal a user-friendly target of opportunity mode that proves ideal in some circumstances. The pod is equipped with large data recording systems and we have never experienced any capacity issues, even when the AREOS is 'on' during the whole sortie."

Neither the Air Force nor the Navy would give any precise details on the tactics being used but we can ascertain that the main advantage of flying as a two-ship is that each aircraft can photograph the same target from different angles or directions and/or from different altitudes. Alternatively, the route of the aircraft can be adjusted so that each fighter within the patrol will photograph widely separated targets on each side. ■



Dynamic targeting

The Damoclès laser designation pod has also proved highly successful over Libya. The ongoing NATO operation is the first time the pod has been used in anger against real targets by Rafale aircrews. The pod provides the Rafale with extremely valuable ISTAR capabilities, especially for

dynamic targeting, i.e. the engagement of moving forces without any guidance from a Forward Air Controller. "The lack of FACs on the ground has forced us to use new tactics and we rely on our onboard sensors to locate and positively identify our target, says Commanding Officer of Flottille 12F. This is why the Damoclès proved essential to sort out targets and accurately determine their coordinates. We also have excellent all weather capabilities and we use our radar high-resolution mode to find and designate targets, even in the worst conditions, when the wind is blowing sand for instance. The Damoclès arrived at a crucial moment, and we can now autonomously 'spike' without resorting to buddy-lasing. The Damoclès now incorporates a number of ameliorations which have benefited both the Super Etendard Modernisé

and the Rafale communities: laser pointer, laser spot tracker and recce mode. The Damoclès is optimised for the air-to-surface role and the FSO for the air-to-air mission: we constantly switch from one to the other depending on the conditions, day, night, sand storm... In very bad weather, when we can't see the ground at all, we can still 'paint' radar images of the target areas thanks to the RBE2 high-resolution mode." ■







DESTROYING ENEMY AIR DEFENCES

For the French Armed Forces, the operation in Libya offered a unique opportunity to improve new tactics and to prove in action that the Rafale omnirole fighter could perform an extremely wide range of missions, including the Destruction of Enemy Air Defences, which eventually led to the collapse of the Libyan Air Force air-defence network.

Inherent flexibility

With its intuitive and easy to use man-machine interface and its wide array of systems and weapons, the Rafale can perform an incredibly large number of missions. «The Rafale's sensor and armament suite has proved extremely effective and remarkably flexible, explains the Commanding Officer of French Navy Flottille 12F. I will take one example: the Rafale's weapon system has not been specifically designed for the DEAD role, the Destruction of Enemy Air Defences. With all our sensors - the radar high-resolution

mode, the Spectra suite and the Damoclès and Front Sector Optronics systems - we were, however, fully capable of detecting, localising and engaging enemy surface-to-air missile sites and we destroyed SA-3 and SA-6 SAM systems with our AASMs, including some mobile, time sensitive systems. This was a significant achievement. I would like to insist on the fact that Flottille 12F is one of the very few units in the world which can carry out such a large array of missions from a carrier deck, from reconnaissance to nuclear deterrence, from DEAD to anti-ship attacks, from close air support to air-defence.»

Jamming the enemy

Such is the quality of the Spectra electronic warfare suite that the Rafale literally disappeared from the radar screens of the Libyan Air Force while performing 'soft kills' on the enemy radar systems. Spectra relies on advanced jamming modes and jamming techniques to defeat hostile weapon systems and to hide the progression and whereabouts of the fighter. With its state-of-the-art antennas and sub-systems using the latest technology, Spectra is also incredibly precise, with an amazing angular accuracy. This proves essential



to accurately locate a threat and significantly enhance aircrew situational awareness. Rafale pilots and weapon system operators can also rely on fine-tuned data-fusion to 'rise above the fog of war', all electronic warfare data being fused with radar, L16 and Front

Sector Optronics information to produce a single, unambiguous tactical picture. Finally, the Rafales always fly with a full-up load of decoys, chaffs and flares, and are thus ready to instantly react should they be engaged by a Libyan surface-to-air system. ■

Stand-off accuracy

The Armement Air-Sol Modulaire (AASM, or Modular Air-to-Surface Armament), also known as the SBU-38 Hammer (standing for Highly agile and manoeuvrable munition extended range), has proved to be one of the most effective stand-off precision weapons in service anywhere.

Thanks to the advanced technologies chosen by Sagem during the development programme, the AASM offers a large number of

operational advantages over more traditional precision weapons. The AASM's main advantage is its range, and targets have been struck in Libya at distances more than 50 km away from the release point. The second advantage is the multiple target release mode, when up to six widely separated DMPIs (Desired Mean Points of Impact) can be hit with deadly accuracy in one run. The third advantage is the weapon's ability to strike a target at a precise angle (from the horizontal to the vertical) to achieve the largest amount of destruction for the largest

military effect or, on the contrary, to minimise the risk of collateral damages. The AASM's final advantage is its modularity, with numerous warheads available. For example, the Armée de l'Air relies on standard Mk 82 bomb bodies whereas the French Navy fielded insensitive BANG-series (Bombe Aéronavale Nouvelle Génération, or new generation naval aviation bomb) warheads as prescribed for use on the French aircraft-carrier. In the future, heavier and lighter bomb bodies could be adopted for the AASM.





Hammering the enemy

The AASM has been used by the Rafale throughout the campaign, the weapon proving totally successful in a large number of scenarios, including strikes against highly defended targets such as air-bases. In fact, such was the accuracy of the new munition that the AASM is now considered as the Rafale's main offensive weapon for conventional strikes

and DEAD missions. «During the conflict, we flew air-to-surface missions with AASMs to bring down the Libyan air-defence / command and control network, reveals the Armée de l'Air Rafale detachment commander at Solenzara Air Base. The obvious advantage of the weapon is that we can hit six distant or widely separated targets with only one trigger press. This means that a Rafale two-ship can destroy twelve targets in one pass, at stand-off ranges. This is a really impressive fire power that

clearly minimises the required number of sorties to disable a given target. Later in the campaign, we opted to have one aircraft of a two-ship fitted with AASMs while the second one carried up to six laser-guided GBU-12s, giving enhanced tactical flexibility. The AASM is user-friendly and targets coordinates can be fed into the weapons in three different ways: manually, from the Damoclès targeting pod, or from data sent from the AWACS via datalink.»

GPS/INS and IR versions

The GPS/INS-guided variant of the AASM bore the brunt of the French Air Force and

French Navy effort and was fired in massive numbers. The infrared variant of the AASM (known as the SBU-64) has also been utilised operationally by both Navy and Air Force Rafales, scoring hits with clinical surgery too. This variant is fitted, in addition to the INS/GPS guidance kit, with an advanced passive infrared IR imagery homing head that is activated during the final target approach. Automatic target recognition algorithms compare the actual scene with the memorised scene, identify the designated target, and select the impact point in order to hit with outstanding precision. The AASM IR has proved essential in some demanding conditions. For instance, the weapon was fired at military buildings that required hits with extreme accuracy to obtain a significant military effect. A laser-guided



variant of the AASM is planned to enter service in 2013, thus bringing another useful capability to the Rafale.



