

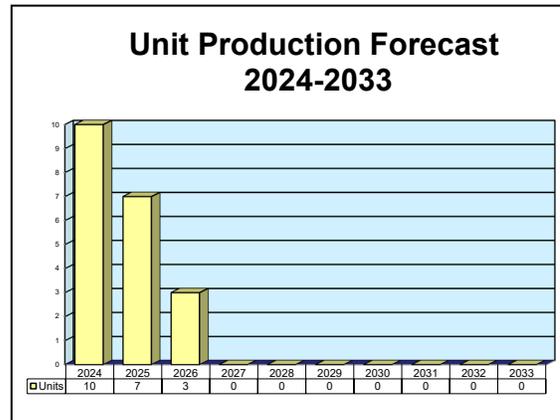
ARCHIVED REPORT

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RDY

Outlook

- Continued production of the RDY-3 radar is linked to upgrades of aging Mirage aircraft
- Sales prospects are limited, as many customers who operate RDY platforms have either already committed to upgrades or will transition the Mirage aircraft out of their fleets without upgrading
- Delays in India's Mirage upgrade program have pushed the expected conclusion of the program to 2024 or 2025



Orientation

Description. RDY is a family of X-band, multifunction/multimode, mechanically scanned radars with first-generation VHSIC-programmable signal processing and low, medium, and high pulse-repetition frequency.

Licensee. No production licenses have been granted.

Status. In service and ongoing maintenance.

Application. The RDY was designed for the Mirage 2000-5, initially supporting air-to-air missions only.

The RDY-2 was produced in support of Mirage 2000-5 Mk 2 aircraft and enhances the radar with multifunction

and multimode capabilities, performing air-to-ground, air-to-sea, and air-to-air missions.

The RDY-3 is an update to the RDY-2, marketed as a cost-effective radar for combat aircraft modernization. Targeted aircraft include older Mirage variants and the MiG-29.

Price Range. Because the cost of the system has not been broken out in aircraft orders, a specific price cannot be determined. Through the RDY's production run, comparable systems have ranged in price from \$1.8 million to \$2.8 million.

Contractors

Prime

Thales Aerospace	http://www.thalesgroup.com/en/aerospace , Tour Carpe Diem, 31 Place des Corolles CS 20001, Paris, La Defense Cedex, France, Tel: + 33 1 57 77 80 00, Fax: + 33 1 57 77 87 70, Prime
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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 75 Glen Road, Suite 302, Sandy Hook, CT 06482, USA; rich.pettibone@forecast1.com

RDY**Technical Data**

	Metric	U.S.
Characteristics		
Waveband	X-band	
Architecture	Modular	
Maximum detection range	111 km (lookdown at 37 km)	60 nm (lookdown at 20 nm)
Beamwidth	3.6°	
Antenna diameter	Variable, including 655mm flat slotted array	Variable, including 25.8-in flat slotted array
RDY-3		
Total system weight	<120 kg	<265 lb
LRUs	4	
Average transmitter power	400 W	
Power consumption	3.5 kVA	
Interface bus	MIL-STD-1553	
ECCM	Yes	
Modes		
	All-aspect, look-up/look-down	
	IFF	
	ISAR (optional)	
	Moving target indicator and tracking	
	Multitarget automatic lock-on	
	Multitarget TWS	
	Simultaneous multitarget fire control	
	Single target track	
	Spotlight SAR	
	Target track	
	Terrain avoidance	

Design Features. The RDY features multiple-range gating, with high, medium, and low pulse-repetition frequency (PRF) selectable within a single system. The appropriate waveform is software selected, depending on range, height, and target approach angle. The RDY includes a compact, dual peak power transmitter operating over a wide frequency. The radar uses a low-inertia, mechanically scanned flat-plate antenna with low sidelobes. A programmable signal processor (PSP) with a 1-Gflop capacity is at the heart of the system's flexibility, though it is relatively small (38 liters) in volume. The small size is attributable to the use of a first-generation VHSIC (very high-speed integrated circuit). The programmable arithmetic unit (PAU) data processor for the RDY is not as quick as the PSP, but it is quicker than that of the Radar Doppler Impulse (RDI) or Radar Doppler Multifunction (RDM) systems. Spare capacity in both PSP and PAU units enables growth, and modes can be added at a later date. The PSP computes by fast Fourier transform in the high-repetition frequency, using up to 32,000 Doppler filters.

Operational Characteristics. In the air defense role, the RDY radar features automatic lock-on and has been integrated with the built-in 30mm cannon on the Mirage 2000, Magic, Super R-530, and MICA missiles. In the air-to-air function, RDY provides multitarget search, detection, and identification at all ranges and altitudes. It features continuous-wave illumination. Originally, RDY tracked up to eight targets, and interception and firing data were calculated for the four priority targets. RDY-2 will track 24 targets while displaying track-while-scan (TWS) data for the top eight targets. Additionally, RDY-2 will calculate interception and firing data for the four priority targets. In air-to-sea mode, the range is said to be 296 kilometers, even in high sea states. Integration with the AM39 and Kormoran 2 missiles is possible. In the air-to-ground function, RDY's TWS function enables low-level penetration, with real-beam, synthetic aperture radar, Doppler sharpening, and terrain-avoidance mapping modes. Static target and moving target indicator modes are included as well.

Variants/Upgrades

RDC. The RDC radar is a compact, pulse-Doppler, airborne fire control and target designation radar designed specifically for retrofit to older fighters without the nose volume required by the RDY radar. RDC exploits much of the RDY technology. Test flights began in 1995 on a Mystère 20 testbed. The estimated price of the RDC is \$1 million.

Vigil. This variant was abandoned in 1993, but it had been proposed for use as an airborne early warning sensor. A technical evaluation prior to trials revealed that it was unable to fulfill the requirements; therefore, the program was terminated.

RDY. The original RDY became available in 1991 with the introduction of the Mirage 2000-5. In this iteration, the RDY functions only in air-to-air mode.

RDY-2. The RDY-2 upgrade became available in the late 1990s as part of the Mirage 2000-9 and Mirage 2000-5 Mk 2 packages. It adds air-to-ground capability to the original RDY, while allowing increased range, more targets, and lower power consumption. Additionally, the radar offers the ability to engage with naval targets and provide surveillance/targeting through an SAR mode.

The RDY-2 displays up to 24 tracks rather than the eight tracks of its predecessor. The system consists of six units: the exciter, the transmitter, the antenna, the receiver, the signal processor, and the data processor.

RDY-3 / RC-400. The RDY-3 (also known as the RC-400) is the most advanced model in the RDY range. This is a modular, lightweight, power-efficient radar that has air-to-air, air-to-ground, and air-to-sea operational capabilities.

The RDY-3 is designed to upgrade several types of aircraft, including the Mirage F1, the MiG-29, the F-16, the F-5, the EADS Mako supersonic advanced trainer/light combat aircraft, and the Hindustan Aeronautics Ltd (HAL) Light Combat Aircraft.

It is believed that the name "RDY-3" could denote a version of the RC-400 that is specialized to function with Dassault's Modular Data Processing Unit (MDPU) mission computer. Several antenna sizes are available for the RDY-3. Its package is composed of four line-replaceable units (LRUs): the processing unit, the exciter/receiver, the transmitter, and the antenna unit.

Program Review

Background. In 1981, Thomson-CSF (now Thales) began the Radar de combat aérien et d'attaque au sol (RACAAS) – a "radar of aerial combat and attack on the ground program" – to develop next-generation technology. The new RDY radar was introduced at the 1987 Paris Air Show as a follow-on to the RDI radar. At the time, the RDY radar was entering production for the French Mirage 2000. In 1988, the RDY underwent flight tests in a modified Dassault Mystère 20.

First Contract Award

In July 1992, Dassault Aviation announced that it would halt development of the Mirage 2000-5 and its associated RDY radar unless orders were received by the end of the year. Shortly afterward, the French government announced that the country's defense budget for 1992-1994 included a financial provision for the upgrade of 37 Mirage 2000C-RDM aircraft to the Mirage 2000-5 configuration. This decision was confirmed by an \$830 million contract in November 1992 for the rebuild of the Mirage 2000-Cs. Deliveries of the first 15 rebuilt aircraft started in 1994.

International Sales

This decision was followed by a Taiwanese order worth \$3.8 billion for 60 Mirage 2000-5 aircraft, together with air-to-air missiles. The first of the new aircraft were delivered in 1995. Dassault also won a contract for 12 aircraft from Qatar in 1994. In 1998, a contract was finalized with the United Arab Emirates that specified 33 new Mirage 2000s and the upgrade of the UAE's existing 30-plus Mirage 2000s.

In 1999, Greece announced its decision to acquire 15 new Mirage 2000-5 Mk 2 aircraft equipped with Thomson-CSF radar and countermeasures from Dassault Aviation. In addition, Dassault would upgrade 10 Greek Mirage 2000s to the same configuration. In 2000, a \$1.4 billion contract was signed for this deal. Deliveries of the newly built aircraft began in 2003, and the last upgraded aircraft was delivered in 2007. In addition to these orders, India signed a contract for 10 Mirage 2000-H fighter aircraft in 2000. It is assumed that the RDY radar would be fitted to these platforms.

RDY

Thales announced its involvement in the UAE order for new Mirage 2000-9 aircraft and Mirage 2000 aircraft retrofits to the -9 standard at the time of aircraft deliveries in November 2007. Thales was responsible for supplying and upgrading several systems, including the RDY-2 radar. The UAE Air Force and Air Defense ordered 32 new Mirage 2000-9 aircraft, plus the upgrade of 30 Mirage 2000 aircraft to the -9 standard.

Mirage Production Enters History Books

In 2006, Dassault Aviation decided to halt Mirage production and focus on its Rafale aircraft.

Peru Fighter Modernization Contract

Dassault disclosed in June 2009 that the Peruvian vice minister of defense had met with representatives of the French DGA, Dassault, Thales, and Snecma to discuss the upgrade of the country's Mirage 2000 fleet. Peru intended to allocate \$140 million for the modernization work. The contract would encompass Peru's 10 Mirage 2000Ps and two Mirage 2000DPs.

In May 2012 it was revealed that Peru had decided to proceed with the upgrade. The fighter modernization effort, which also included a selection of MiG-29s, had a total estimated cost of \$266 million. The final modernization contract involved all 12 Mirage aircraft. Work was expected to be completed by the end of 2014.

Thales Teams Up for Moroccan Job

Safran announced in January 2006 that 28 Moroccan Air Force Mirage F1 aircraft were being upgraded by the Astrac joint venture of Thales and Safran's Sagem Défense Sécurité (SDS) division. The upgrade includes the SDS Armement Air-Sol Modulaire (AASM), the Thales RDY-3 radar, and other equipment. No information on the delivery schedule or cost has been released.

In April 2010, *Arabian Aerospace* revisited the Moroccan modernization, providing an update on the program. The report noted that the prototype aircraft first flew in October 2009 and that flight tests and certification were expected to continue throughout the spring and summer of 2010. Also detailed was the cost: Morocco will spend \$420 million to upgrade 27 Mirages to the MF2000 standard under the F1 Renovation program. These modifications included updating to the RDY-3 radar.

Pakistan and China Team Up

China and Pakistan collaborated to produce a single-engine, single-seat attack aircraft known in Pakistan as the JF-17 Thunder and in China as the FC-1. The Pakistan Aeronautical Complex (PAC) was the main contractor for the program in Pakistan. PAC held talks

with France about obtaining MBDA MICA air-to-air missiles and Thales RC-400 (RDY-3) radars to support the JF-17 aircraft.

The SELEX Galileo (later Selex ES and now Leonardo) Grifo radar was also a contender for the radar portion of the JF-17 program. However, because of trade issues, the first 50 JF-17 aircraft were fitted with the Nanjing Research Institute of Electronic Technology Type 1478 radar (also known as the KLJ-7) instead of the Grifo or RC-400.

At this point in the aircraft's deployment, Forecast International believes that all JF-17 aircraft were fitted with the KLJ-7 radar. There is, however, a slight possibility that Pakistan could have used the RDY-3 in later production aircraft.

India's Mirage Upgrade

In July 2011, Thales and Dassault Aviation signed a contract for the upgrade of the Indian Air Force's Mirage 2000 fleet. *Flight International* reported that India's 51 Mirage 2000H fighters would be upgraded to the Mirage 2000-9 standard. The first two aircraft would be upgraded in France, and the rest of the fleet would be upgraded in India by HAL.

As part of the new configuration, the Indian Mirages would be upgraded with the RDY-3 radar.

Aviation Week reported that the first two Mirage aircraft to be updated left India for France in December 2011. It was reported that the first of the modified aircraft flew in October 2013. In March 2015, the first two upgraded aircraft were delivered.

By 2021, the combination of technical issues at HAL, a temporary grounding of the Mirage fleet, and complications from the COVID-19 pandemic resulted in only about 50 percent of upgrades being reported as complete. As of January 2023, 33 Indian aircraft were thought to have completed their upgrade, but the actual figure could be lower.

Considering these factors, upgrades are expected to be completed in 2024, but the timetable could be pushed back even further.

UAE's Mirage Upgrade

Originally, Forecast International projected that the country would install the RDY-3 radar and TALIOS EO (electro-optical) pod. However, it later became known that the country had selected Lockheed Martin's Sniper pod. It is possible that the UAE also selected an alternative radar, and with the situation still unclear, RDY-3 production in support of the country should be considered somewhat speculative.

In December 2021, news emerged that the UAE planned to sell or donate its fleet of Mirages following acquisition of new Rafales, thus complicating the country's upgrade even further. Rumors indicate that Egypt or Morocco are the most likely countries to take possession of the UAE's Mirages. Greece has also emerged as a potential destination.

Considering the contract that the UAE signed with Dassault in 2019, Forecast International believes that upgrades will be completed before any transfer occurs.

Taiwan's Mirage Upgrade

Amid delays in receiving 66 new F-16C/D Block 10 jets from the United States, the Taiwanese Air Force signed a \$4.8 million deal to extend the life of some of its Mirage 2000-5 fighter jets. As of August 2023, Taiwan is working with Dassault Aviation to assess whether the jets in question can serve an additional 20 years. It is unknown at this time if the Mirage upgrades will include the RDY radar.

Worldwide Distribution/Inventories

Known customers of the RDY radar include **France, Greece, India, Morocco, Peru, Qatar, Taiwan,** and the UAE.

Forecast Rationale

Thales' RDY line of multimode radars is designed to bring a range of air-to-air, air-to-ground, and air-to-surface capabilities to fighter jets.

The RDY-3 – the only model of the RDY range still in production – is designed as a cost-effective modernization option for operators of Dassault Mirage fighter aircraft, a line that has been out of production since 2007. Previously, the RDY-2 supported the upgrade of the Mirage 2000-5 to the Mirage 2000-5 Mk 2, whereas the RDY-3, with its various antenna options, is more flexible and can be applied as an upgrade to both Mirage 2000 and Mirage F1 aircraft.

Many aging Mirage aircraft continue to fly – each one representing potential sales opportunities for Thales.

Some of these aircraft, as they are transitioned out of the fleets of higher-profile militaries, will be resold to countries with lower-spectrum military budgets that may wish to update the existing radar. Other countries that currently operate the aircraft could upgrade their fleets.

Other than a handful of existing and potential Mirage upgrade programs, no other RDY deliveries are projected. RDY production will most likely end with the Indian Air Force's final Mirage upgrade, which is expected in 2025. Nevertheless, there remains a small possibility that RDY production could continue a few years longer if additional countries seek to upgrade the aging Mirage aircraft.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			Total
	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
Thales Aerospace												
RDY Military <-> RDY-3 Upgrade <-> Mirage 2000												
	40	10	7	3	0	0	0	0	0	0	0	20
Total	40	10	7	3	0	0	0	0	0	0	0	20