

ARCHIVED REPORT

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R.440/R.460/VT-1

Outlook

- Production complete
- Crotale air defense systems will remain in service despite the end of missile fabrication
- VT-1 the last missile built to equip the Crotale
- China may be manufacturing a version of the VT-1 missile with or without a license from France
- Fabrication of the R.440 and R.460 missiles ended many years ago

Orientation

Description. Short-range surface-to-air missiles.

Sponsor. The French Ministry of Defense through the French Air Force.

Status. Production of the R.440 and R.460 missiles ceased many years ago. Thales more recently ended manufacture of the VT-1 missile.

Total Produced. Approximately 5,071 R.440, 4,088 R.460 (Sica), and 974 VT-1 missiles were built.

Application. Low-altitude air defense missiles capable of meeting land-based and shipborne needs.

Price Range. The R.460 missile costs about \$135,900 in FY93 dollars. The VT-1 has a per-unit price of \$341,000, although some put it at \$520,000.

Contractors

Prime

Thales Air Defence Ltd	http://www.thalesgroup.com/Countries/United_Kingdom/UK_Home/ , Alanbrooke Rd, Castlereagh, Belfast, BT6 9HB Northern Ireland, United Kingdom, Tel: + 44 0 2890 465 200, Fax: + 44 0 2890 465 201, Prime
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Subcontractor

EURENCO, Head Office	http://www.eurenco.com , 12, quai Henri IV, Paris, 75004 France, Tel: + 33 1 49 96 7400, Fax: + 33 1 49 96 7401, Email: eurenco@eurenco.com (Cast PBX Charges)
Roxel France	http://www.roxelgroup.com , Ave Gay Lussac, Saint-Médard-en-Jalles, 33167 France, Tel: + 33 556 70 50 50, Fax: + 33 556 70 75 22 (Rocket Motor)
TDA Armements SAS	http://www.thalesgroup.com , Route d'Ardon, La Ferté Saint-Aubin, 45240 France, Tel: + 33 2 38 51 63 63, Fax: + 33 2 38 51 63 97, Email: dpt.communication@tda.thalesgroup.com (Warhead)

R.440/R.460/VT-1

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Technical Data

	<u>Metric</u> R.440	<u>Metric</u> R.460	<u>Metric</u> VT-1	<u>U.S.</u> R.440	<u>U.S.</u> R.460	<u>U.S.</u> VT-1
Dimensions						
Missile Length	294 cm	300 cm	229 cm	9.65 ft	9.84 ft	7.5 ft
Missile Diameter	15 cm	15.54 cm	16.5 cm	5.9 in	6.12 in	6.5 in
Missile Finspan	54 cm	59 cm	N/A	1.77 ft	1.94 ft	N/A
Missile Weight	80 kg	105 kg	75 kg	176 lb	231 lb	165 lb
Performance						
Speed	Mach 2.3	Mach 2.5	Mach 3.5	Mach 2.3	Mach 2.5	Mach 3.5
Altitude	4,500 m	4,500 m	6,000 m	14,760 ft	14,760 ft	19,680 ft
Range	500-8,500 m	14,000 m	11,000 m	1,640-27,880 ft	45,920 ft	36,080 ft
Maneuverability at 8 km	15g	20g	35g	15g	20g	35g

N/A = Not Available

Propulsion. The R.440 has a single-stage, extruded double-base solid-propellant rocket motor, designated Lens. This motor is rated at 48.015 kN (10,670 lbt) and is produced by PROTAC. Fuel was provided by Société Nationale des Poudres et Explosifs (SNPE). The R.460 motor is a two-stage, extruded double-base solid type having approximately twice the thrust of the R.440 motor.

Control & Guidance. Pitch and yaw are controlled by canard fins; the missile is roll-stabilized by rear control surfaces. Servo motors operate the control surfaces. Thales manufactures the Ku (J)-band monopulse radar, which tracks and guides the missiles to the target. Command guidance is provided by a digital radio link.

Launcher Mode. The R.440 and R.460 missiles in the land-based Crotale and Cactus systems are fired from a four-round launcher mounted on a Hotchkiss-Brandt wheeled chassis. In 1984 it was announced that the Crotale system had been integrated with the MOWAG Shark vehicle and called the LLAD (Low Level Air Defense) MOWAG. This development

was aimed at the ongoing evaluation in Canada for a new low-altitude defense system. This system was not short-listed by Canada.

The Crotale Navale uses an eight-round, deck-mounted launcher. Thales and Fakel of Russia conducted a feasibility study on developing a vertical launch system for the VT-1 to be used with the Crotale Navale NG. The study found it was feasible without modification of the VT-1, beyond the addition of a pitch-over control module.

The Shahine system uses launchers that can be mounted on a wheeled vehicle, a towed trailer, or an AMX-30 tank chassis. Meanwhile, the Sica system can be mounted on a variety of wheeled or tracked platforms.

Warhead. A high-explosive, focalized fragmentation type, weighing 14 kilograms (30.8 lb) and detonated by an infrared proximity fuze. The high-velocity burst is effective to a radius of 8 meters (26.25 ft). At its La Ferte-Saint-Aubin facility near Orleans, Thomson-Brandt Armement developed a splintering-type, proximity fuze warhead for the R.440 for use in the Crotale missile system.



R.460 Shahine

Source: Bayern-Chemie

Variants/Upgrades

The following is a listing of the various system configurations and missiles associated with the Crotale:

Cactus. Modified version of Crotale provided to South Africa.

Crotale. Main designation for this air defense system.

Crotale NG. Enhanced fire unit, equipped with the new VT-1 missile. Also called the Crotale Next Generation.

Liberty. LTV Aerospace/Thomson-CSF entry in the U.S. Army's Forward Area Air Defense System competition (see Crotale NG/VT-1).

Crotale Navale Modular. Modular follow-on to Compact Crotale said to be particularly suited for vessels of 500 tons or less.

R.440. Missile associated with original Crotale air defense system.

R.460. Missile developed as part of the Saudi Shahine air defense system program.

Shahine/Sica. A new modular design for acquisition and firing control units. It allows for quick installation and removal on the battlefield. The new missile battery is able to control 24 missiles instead of 18.

Shahine 2. The R.460 missile integrated with greatly improved fire-control components, including a new pulse-Doppler acquisition radar highly resistant to electronic countermeasures. The Shahine 2 is mounted on an AMX-30 tank chassis and is similar to the Shahine 1.

Shahine-S. This is the name given to the shelter-mounted version of Shahine. The system is based on pallets, a fire unit, and a radar unit. These can be transported on a three-axle, cross-country trailer that can be split in two for air transport by aircraft or helicopter.

The system has secure radio links between individual units and can coordinate several acquisition units. The Shahine-S weighs a maximum of 20 tons and has the ability to attach very short-range guns. The Shahine-S also carries the designated Shahine Air Transportable Towed System (ATTS) and is designed to be loaded on board transport aircraft such as the C-130 Hercules or Transall.

Sirocco. Sirocco is the designation of the Shahine system mounted in the P6R vehicle, a six-wheeled variant of the P4R Hotchkiss-Brandt chassis used with Crotale.

TSE 1000. This was the original Crotale air defense missile system produced by France in 1969.

TSE 2000. The TSE 1000 was followed by the TSE 2000 (also referred to as the 2000 series) in 1973.

TSE 3000. In 1975, the TSE 3000 entered production. The crew was required to connect the fire and acquisition units together with standard cabling.

TSE 4000. The TSE 4000 entered production in 1983 and is equipped with a Liaison InterVehicule Hertzienne (LIVH) radio link and mast.

TSE 5000. The TSE 5000 entered production in 1985 and included additional improvements that allowed the installation of two Matra SATCP (now known as the Mistral) missiles on either side of the container-launcher canisters.

TSE 5100 Shahine. This modernized, more sophisticated system, mounted on the AMX-30 tank chassis, uses an enhanced version of the R.440 missile designated the R.460.

TSE 5500 Naval Crotale. The French Navy selected a version of the Crotale system to replace 100mm deck guns aboard several ships, and for installation on several

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new classes. The Naval Crotales uses an eight-round launcher, but the actual R.440 missiles will be the same as the other systems.

VT-1. Hypervelocity missile developed by LTV Aerospace for the U.S. Army's Forward Area Air

Defense program. Loral Vought Systems has been contracted to develop a maritime version of the VT-1 for deployment with the Crotales Navale NG system.

Program Review

Background. The Crotales air defense missile system has its technological roots in a joint program effort between Thomson-CSF (now Thales) and the Republic of South Africa. Development of Crotales was initiated in 1964 by Thomson-CSF and Matra (now Aerospatiale Matra) to fill a South African requirement. Pretoria provided 85 percent of the funding, with the remainder paid by France. Deliveries of the South African systems, known as Cactus, began in 1971. Seven platoons were delivered to South Africa, with an additional unit arriving in 1973. It has long been suspected that as part of this arms package, South Africa acquired the capability to indigenously produce the R.440 missile. The Cactus system has also been sold to Chile.

South Africa produced the R.440 missile, and Egypt may have signed an agreement to coproduce the R.440 or R.460. The Hellenic Arms Industry also assembled/produced fire units and missiles.

French Deployment. Crotales is deployed by both the French Air Force and Navy. The 20 Crotales batteries for airfield defense ordered by the French Air Force in 1973 were delivered late in the decade.

The French Navy fitted the Crotales Navale to three F67 class and seven F70 class destroyers, and to the aircraft carriers *Clemenceau* and *Foch*. In 1987 it was learned that France was basing a Crotales battery in French Guiana to protect the Arianespace launch facility located at Kourou.

By 1997, both the French Air Force and Navy had adopted the Crotales NG and the VT-1 missile. The French Navy is deploying the VT-1 on its La Fayette class frigates.

Naval and Land-Based Versions Developed

Missile/Fire Unit Models. The R.440 missile has proved to be extremely adaptable to various launching and guidance and control technologies. The R.440 is a highly maneuverable missile, due to its canard configuration. The missile attains a speed of Mach 2.3 within 2.3 seconds of launch, and requires 16 seconds for an 8-kilometer (5-mi) flight. There are a number of missiles, fire units, and deployment configurations associated with this program. Below is a discussion of these missiles and fire unit systems.

Crotales. The original Crotales air defense missile system entered production in 1969 under the designation TSE 1000, and was equipped with the R.440 missile.

The Crotales complete system consists of three launch/command wheeled vehicles, plus a fourth fitted with surveillance radar. Launch vehicles each carry four ready-to-fire missiles and a monopulse fire-control radar that can guide two missiles simultaneously. The system's acquisition unit, mounted on a separate vehicle, consists of a pulse-Doppler E/F-band surveillance radar incorporating sufficient anti-clutter performance to detect targets at very low altitudes. This radar features an automatic target evaluation system that permits a typical reaction time of six seconds from initial target detection until missile launch. The acquisition unit can provide command and control functions for up to three launch vehicles, or for a mix of launch vehicles and conventional gun systems. This flexibility allows the Crotales/Cactus to be integrated into larger air defense command and control systems.

Aside from the four missiles and fire-control radar, the launch vehicle is also fitted with an X/Ku (I/J)-band command transmitter, an infrared gathering system, an integrated electro-optic tracking mode as a backup should radar tracking fail, a real-time digital computer, an operating console, and a digital datalink.

Identified purchasers of the Crotales/Cactus systems include Abu Dhabi, Chile, Egypt, France, Kuwait, Libya, Morocco, Pakistan, Saudi Arabia, the Republic of South Africa, and Spain. Greece is offering the shelter-based Apollo system, based on the R.440/Crotales, with its Artemis 30 air defense system.

Crotales Navale. The French Navy selected a version of the Crotales system to replace 100mm deck guns aboard several ships, and for installation on several new classes. The Crotales Navale, also called TSE 5500, uses an eight-round launcher, but the actual R.440 missiles are the same as on the other systems. The shipboard system consists of a deck-mounted launcher and DRBV51-C radar direction center. Crotales Navale is fitted with a new infrared guidance technology called EDIR (Ecartometrie Differentielle Infra Rouge, or differential infrared angle tracking). This technology complements the shipboard radar; it can monitor

incoming sea-skimming missiles without any image effect resulting from reflections off the water's surface. SAT developed and produces the EDIR. Conventional radar tracking is used until the target drops below 50 meters altitude, at which time the system automatically switches to infrared tracking. The electromagnetic proximity fuze is activated just before the missile intercepts the target.

This system also incorporates a guidance transmitter antenna, an infrared angular deviation measurement system, an electro-optic viewing system, and the fire control room. The entire Crotale Navale system, including the turret assembly, fire control equipment, and missile storage and loading system with 18 rounds, weighs about 33.2 tonnes (36.59 tons). The system has a range of 13 kilometers.

The first Crotale Navale shipboard installation was completed in 1978 aboard the trial ship *Ile d'Oleron*. Operational firing evaluations were completed in 1979. The first production Crotale Navale missile system was installed on the French corvette *Georges Leygues*. The frigate *Duguay Trouin* was subsequently fitted with the missile. The acceptance trials were completed in 1980, with 12 consecutive successful launches.

Crotale Navale Modular. France developed a follow-on to the Crotale Navale for installation on smaller warships, with the following specifications: 250 tonnes, 46 meters in length, a 2,000-horsepower engine, a 20-knot cruise speed, and a crew of 10. The Crotale Navale Modular weighs only 6.5 tonnes (7.17 tons) and is available in an eight- or four-round launcher configuration. Operation and performance are similar to the basic Crotale Navale. With this modular design, the fire-control system and launcher are separated. This gives it a great deal of flexibility in its installation, thus making it particularly well-suited for retrofit programs. The system uses the Ku-band Doppler radar and an infrared camera. Two of the 12 fire units ordered by the French Navy will be installed on the aircraft carriers *Foch* and *Clemenceau*.

Crotale NG/VT-1. The VT-1 hypervelocity missile was originally developed by LTV for the French entry in the U.S. Army's Line-of-Sight Forward Heavy competition. The system was known as Liberty. Although the Liberty lost the competition to the Air Defense Anti-Tank System (ADATS), France decided to incorporate this missile into its Crotale family. That decision eventually resulted in the development of the new Crotale NG (next generation) system.

One of the main improvements to the Crotale NG is the ability of its fire coordination system to take account of the widened scope for interception resulting from the adoption of a hypervelocity missile. Another

improvement is the ability of the VT-1, which can attain a speed of Mach 3.5, to maneuver under load factors of 35g. The VT-1 intercepts tightly maneuvering targets up to distances of 10 kilometers.

Market Opportunity Missed

Guidance for the Crotale NG is entirely radar-controlled via an E-band Doppler surveillance radar and a Ku-band monopulse radar. In its control system, the Crotale NG is actually very similar to the Crotale Modular Navale system. Missile guidance for the VT-1, like its predecessors, is provided by a deviation-measurement system or a radar beam, but the manufacturer has adopted the multisensor guidance principle incorporated in the Crotale Navale. Each sensor sends its data to a computer that processes the information and determines guidance orders after filtering interference (clutter, decoys, or jammers). In normal operation, therefore, both radar and optical modes operate together and check each other constantly.

The tracking devices define an observation window that displays the target, the missile to be tracked, and the false targets already detected. Inside the observation window are measuring windows associated with each target to be tracked. The physical measurements made by different sensors are correlated in each measuring window. All the data collected are sent to a two-dimensional digital filter, and the best estimate of target and missile positions is extracted.

The Crotale NG system consists of the following major subsystems:

- The turret, developed by Thales, is electrically driven. Its homing speed is 5 rad/s in azimuth and 1 rad/s in elevation. The turret weighs about 4 tons, and includes a surveillance radar, an associated Identification Friend or Foe (IFF) system, a cupola housing a tracking radar and electro-optical equipment, and eight ready-to-fire missiles divided into two groups of four each.
- The standard surveillance radar previously offered by Thales was the TSM 2630 frequency-agile pulse-compressed Doppler model. It operates in the S-band and has a 40-rpm planar antenna with a small minor lobe. The radar has a range of 18 kilometers and can track up to eight targets simultaneously while evaluating the threat. For the Dutch program, Hollandse Signaalapparaten is developing a new surveillance radar operating in the C- and X-bands. With a range of some 20 kilometers, this new radar, called Varibeam, has an average power of some 200 W (10 times more than the TSM 2630) and a far greater anti-jamming capability. This radar is capable of processing up

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to 20 targets, and can monitor eight tracks simultaneously.

- The tracking radar is a frequency-agile and pulse-compressed Doppler model. It detects hovering helicopters or aircraft flying at over Mach 2 up to a range of 18 kilometers. The electro-optical equipment consists of a TRT Castor double-field thermal imager and a J3 single-field television camera. In optimal visibility conditions, these have maximum acquisition ranges of about 15 kilometers and less than 10 kilometers, respectively.
- The VT-1 missile, formerly produced by LTV, weighs 75 kilograms (95 kg for a complete shot) and is 2.4 meters long. The missile has a maximum range of 11 kilometers at an altitude of 6,000 meters and has a maximum speed of Mach 3.5. It is capable of maneuvering under load factors of 35g at a range of 8 kilometers, whereas Crotales NG can withstand 20g at the same range. The VT-1 carries a focused load of 13 to 14 kilograms, which is effective within a radius of 8 kilometers. The explosion is controlled by a pseudo randomly pulse-modulated broadband electromagnetic proximity fuze. Its transmission is controlled in flight by the processor between 0.2 seconds and 0.5 seconds before target interception.
- A color console displays alphanumeric data on targets, television, and infrared thermal images, video images from the tracking radar, the surveillance radar scope, and available missiles. All the operator has to do is follow the computer-generated menu displayed on the console. The operator selects the desired functions by pressing various buttons. By contrast, target engagement from detection to interception is entirely automatic. The operator is required to press the function buttons twice to ensure the safety of friendly aircraft. Reaction time is very short (a maximum of 5 seconds), since a total engagement duration is estimated at 15 seconds for target interception at 8 kilometers. Re-engagement reaction time is limited to 1 or 2 seconds, depending on whether targets are patrol or isolated aircraft. Thus, a single firing unit can theoretically counter attacks from two patrols of four aircraft each and shoot down all of them located between 0.5 and 2 kilometers away.

The Crotales NG uses an integrated multisensor approach (radar, FLIR, laser rangefinder). Unlike its predecessors, all elements (missiles, sensors, guidance antenna) can be mounted on the same pedestal.

The first production deliveries of the VT-1 to the French armed forces were made in 1992. These missiles were

for deployment by the French Air Force on France's new La Fayette class frigates. The initial batch of 1,000 missiles was manufactured by LTV (now part of Lockheed Martin). Once this contract was completed, production was to be quickly restarted in Europe. However, unspecified problems surfaced during subsequent firing trials in Europe, leading to finger-pointing by Lockheed Martin and Thales over which company was responsible for correcting the missile's shortcomings.

In 2000, Thales was urgently seeking a company to manufacture the VT-1 missile. Despite previous reports, production of the VT-1 in Europe never commenced, and this is said to be hurting the system's export sales. All sales of the VT-1 have been of those missiles built by LTV (now Lockheed Martin). However, most of these missiles have now exceeded their shelf life.

Candidates to manufacture the VT-1 included Aerospatiale Matra, Lockheed Martin, Raytheon, and Shorts Missile Systems. BAE Systems decided not to bid for this contract. In January 2001, Thales announced that Thales Air Defence Ltd, formerly known as Shorts Missile Systems, had been selected to manufacture the VT-1 missile.

Meanwhile, Aerospatiale Matra (now part of MBDA) completed technical studies of a VT-1R missile, intended for use from the Roland air defense system. The Roland is in service with both France and Germany.

Shahine/Sica. During 1976, in response to the rapid cooling of Egyptian-Soviet relations, Cairo ordered a modified version of the Crotales system for its air defense requirement. The Egyptian air defense system technicians have incorporated more than 20 modifications into the basic R.440 missile and Crotales system. These modifications resulted in a variant that was originally called the Arab-Crotales and carried the designation TSE 5100. The French accepted the changes and agreed to incorporate them into all production missiles and systems. Egypt was awarded a coproduction contract and healthy financial offsets for its research efforts. The modifications enabled an increase in speed and range, and enhanced maneuverability. From 1981 to 1983, Matra / Thomson-CSF built on these basic changes and incorporated them into the Shahine system.

The Shahine, a modernized and more sophisticated system mounted on the AMX-30 tank chassis, uses an enhanced version of the R.440 missile – the R.460. Originally, this missile was designated SA-10, then R.460, and finally Sica, to avoid confusion with a former Soviet surface-to-air missile system of the same nomenclature. The overall system is known as Shahine.

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Versions Developed for Foreign Customers

The Shahine (Arabic for "falcon") was developed specifically for Saudi Arabia; its acquisition and firing control units have a modular design that allows for quick installation and removal on the battlefield. A tactical limitation of the Crotale radar vehicle is that it must measure the relative positions of its fire units prior to launching missiles, whereas the Shahine acquisition unit controls its fire units via a radio link, maintaining a continuous check on their positions through a localizer. Thus, the radar vehicle can issue firing instructions as soon as all vehicles have halted, providing a significantly shorter reaction time than that offered by Cactus/Crotale. The Shahine has a range of 12 kilometers and can control 24 missiles instead of 18. The Sica (R.460) missile is longer and heavier due to a larger but more efficient engine, which has increased speed and range. Additionally, the system's six-round launcher reduces reload time.

Saudi Arabia ordered 12 Shahine systems of the original design in 1975 for use in conjunction with the twin-barreled 30mm cannon also fitted to the AMX-30 chassis. The missile system deliveries for this order began in early 1980 and were completed in late 1984.

Around 1988 it was announced that Thales had subcontracted to Egypt's Arab Organization for Industrialization for the production of 320 launch containers for the Shahine missile system. The containers would be manufactured to fill an order from Saudi Arabia.

Shahine 2. In March 1984 it was announced that Thales and Saudi Arabia had signed a contract for the Saudi purchase of two new versions of the Shahine mobile air defense system. Although the quantities of missiles and launchers were not revealed, it was stated that the contract was worth about \$4.1 billion. Subsequent news releases revealed Saudi Arabia had financed the development of the new system, which is greatly enhanced over the original Shahine; the newer system is designated Al-Thakeb or Shahine 2. The R.460 missile is integrated with greatly improved fire-control components, including a new pulse-Doppler acquisition radar highly resistant to electronic countermeasures.

Two types of platforms are being used for the launchers: the AMX-30 tank for the Shahine 2 and the Shahine-S (see entry in **Variants/Upgrades**), which is a

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shelter mounted on a towed trailer. The Shahine 2 systems, as well as the existing four batteries of Shahine 1, will be integrated into the overall Saudi air defense structure; Litton Industries is responsible for this effort. Eventually, the existing Shahine 1 systems will be brought up to Shahine 2 status (see **Contracts/Orders & Options**). The Royal Saudi Air Defense Force had some 40 Shahine 2 acquisition and 100 fire units in early 1991.

Because Saudi Arabia financed the development of Shahine 2, it is considered a proprietary Saudi weapon

system. Any export of the system, and even procurement by France, requires approval by Saudi Arabia. This contract was fulfilled some six years after its signing in 1990. A spokesman for the Saudi Defense Ministry stated that the system might be made available to other members of the Gulf Cooperation Council: Bahrain, Kuwait, Oman, Qatar, and the United Arab Emirates. Despite the Saudi restrictions on the sale of Shahine, it is known that France has bid to supply a similar system to Algeria, although no sale was ever recorded. The Algerian deal had a potential value of about \$2.33 billion.

Funding

The French Ministry of Defense continues to supply funding to support the Crotale air defense systems. No figures are currently available.

Shahine has been developed with Saudi Arabian funding. The most recent order, for the supply of 24 Shahine 2 acquisition units and 48 firing units, totaled FRF40,000 million (\$4 billion) in 1984. The value of the Finnish contract is FIM800 million (\$182 million).

Contracts/Orders & Options

In Aug 2004, MBDA received a EUR340 million (\$410 million) contract from Saudi Arabia to provide logistics support over five years for its 141 Shahine and 40 Crotale air defense systems. The contract also included the upgrade of the systems' missiles.

In Mar 2001, Saudi Arabia awarded Thales a EUR230 million (\$206 million) contract to upgrade its Shahine air defense systems. This contract covered technical assistance and renovation, and provision of replacement parts, for the Shahine SAMs. This contract followed one awarded in January 2001 worth EUR140 million (\$129 million) to upgrade and support Saudi Arabia's Crotale SAMs.

In Feb 2001, Thales Air Defence Ltd won a \$72.4 million (GBP50 million) contract for production of the VT-1 missile. The contract covered research, development, and production of a more capable version of the VT-1 missile.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1964	Research initiated
	1965	Prototype development started
	1968	Series production begun
	1968-71	Operational evaluation begun
Nov	1971	Deliveries of Cactus to South Africa
	1972	Initial Operational Capability
	1974	Initial Saudi Arabian request to Matra
Late	1977	Shahine development begun
Dec	1978	First firing of SA10 (Shahine) missile
Jan	1980	Delivery of first Shahine to Saudi Arabia
Apr	1980	Naval Crotale operational
Late	1981	IOC, Shahine system
Late	1981	IOC, Sica missile
Early	1983	Production of Shahine 1 variant terminated
Jun	1983	Introduction of Shahine-S
Mar	1984	Major order for Shahine 2 announced
Mid-	1985(a)	Production begun of Vertical launch Naval Crotale
	1989	Final deliveries of Saudi Shahine 2
	1989	VT-1 selected by French armed forces

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<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Late	1989(a)	VT-1 production begun in United States for export orders
Aug	1990	Iraq invades Kuwait
Late	1990	Saudi R.460/Shahine upgrade contract awarded
	1991	Production of the R.440 concluded
	1992	VT-1 production concluded by Lockheed Martin (LTV)
	1997	France orders VT-1 for Navy Crotale systems
	1998	Greece places major Crotale/VT-1 order
	2001	Thales Air Defence Ltd selected as European VT-1 producer
	2003	Production of VT-1 to be restarted
	2012	Production to conclude

(a) Estimate

Worldwide Distribution

Technology from the Crotale may be part of the **Iranian**-built Shahab Thaqeb. However, this missile is actually a version of the Chinese HQ-7 series. The new Shahin SAM built by Iran is a copy of the Raytheon-designed MIM-23 HAWK. This new Shahin SAM entered production in 2009.

User Countries. Identified users of the R.440/R.460 in various systems include **Abu Dhabi** (Crotale Navale), **Bahrain** (Crotale), **Chile**, **People's Republic of China** (Crotale Navale), **Egypt**, **Finland** (Crotale NG and the VT-1), **France** (both the Air Force and Navy operate the VT-1), **Greece** (Crotale NG and VT-1), **Iraq**, **Republic of Korea** (Chun Ma), **Kuwait**, **Libya**, **Morocco**, the **Netherlands** (Crotale NG - purchase delayed), **Oman** (Crotale NG on warships with the VT-1), **Pakistan**, **Saudi Arabia** (Shahine 1 and 2, and Crotale NG on La Fayette), **Singapore** (Crotale NG on La Fayette; unconfirmed), **South Africa** (Cactus), **Spain**, **Taiwan** (Crotale NG on La Fayette), and **Thailand** (Crotale NG).

Forecast Rationale

The Crotale air defense system first came into service in the early 1970s. France sold ground-based and shipborne versions to customers around the world. By introducing improvements and new missiles, the Crotale remained a competitive system on this market for decades.

Nevertheless, all good things come to an end. The development of new air defense systems slowly undermined demand for Crotale. The introduction of a new missile in the late 1980s could not stop this system's slow market slide. Furthermore, the creation of MBDA, the European tactical missile megacorp, left Thales Air Defence Ltd at a competitive disadvantage. Eventually, top company officials at Thales began considering selling this business unit to MBDA. In return, Thales could gain a stake MBDA.

VT-1 Could Not Save Crotale

The VT-1 had a potentially bright future, with some predicting thousands of VT-1 missile orders. Thales had hoped to capitalize on the wide deployment of the

Crotale air defense system. The VT-1 did offer a significant upgrade in capability.

Then, a series of program delays occurred. These delays sapped market demand for the VT-1. Potential VT-1 customers sought and acquired alternatives. Little by little, the potential market for VT-1 slipped away. Thales never planned for VT-1 to propel it to the top of the surface-to-air missile market, but it did lose a good opportunity for additional earnings.

Production of the VT-1 is complete. The orders needed to keep this production running just didn't appear.

China might be manufacturing a version of the VT-1. Beijing is desperately trying to modernize the People's Liberation Army (PLA). The Chinese government views itself as a world power and wants a strong military to help it fulfill its global ambitions. However, France is reluctant to sell weapons to Beijing. China might be manufacturing a version of the Crotale, the HQ-7. Sources say France is not involved in this program, but others are not so sure.

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