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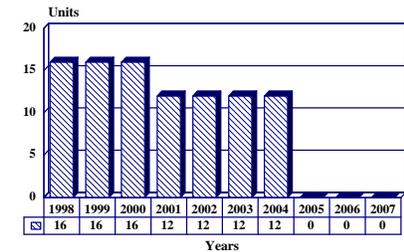
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Orion - Archived 6/99

Outlook

- In production and service, on naval surface units of all types
- Firm grip of the market
- Other major players Signaal WM-28, Thomson-CSF Castor III
- License production in China to boost production in the late 1990s
- Large family of radars, each with different character

10 Year Unit Production Forecast
1998 - 2007



Orientation

Description. A family of naval tracking radars tasked with the acquisition and tracking of airborne and surface targets for naval weapon systems.

Sponsor

Orion RTN-10X: Italian Navy
Orion RTN-20X: company private venture
Orion RTN-25X: company private venture
Orion RTN-30X: Italian Defense Scientific Committee
Type 912: defunct UK Royal Navy designation for the RTN-10X

Contractors

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Status. In production and service.

Total Produced. About 430 Orion RTN series radars have been supplied to date, with additional systems on order. This includes licensed production in China.

Application. Naval surface vessels of all types.

Price Range. Based on the known costs of comparable systems, it can be assumed that the Orion family has a unit cost of between US\$1.5 and US\$3.5 million depending on the functions built into the specific system on order.

Technical Data

Characteristics	<u>RTN-10X</u>	<u>RTN-20X</u>	<u>RTN-25X</u>	<u>RTN-30X</u>
Frequency band:	I-band	J-band	J-band	I-band
Range:	20 km	10 km	15 km	25 km

Design Features. All members of the Orion family of fire control systems can scan in three modes: automatic blindfire, operator-assisted blindfire, and area. All are designed for one-man operation.

Operational Characteristics. Although the Orion RTN series radars are capable of autonomous deployment as primary tracking/secondary surveillance systems aboard naval surface units, each type within the family is optimized for a particular fire control system.

Variants/Upgrades

Orion RTN-10X. This is a conical scan pulse radar for tracking and fire control, operating in the I-band (8-10 GHz). It has been specifically configured for effective one-man operation. The RTN-10X radar is often deployed with the NA 10 MoD 2, NA 10 MoD 3, and NA 21 fire control systems (ELSAG). It is also used with the SEN-100 (Alenia-ELSAG), Albatros (ELSAG), WS-400 and WS 420 series (Ferranti) of fire-control systems. The Italian Navy designation is SPG-70.

The radar's operational range is about 40 km. The antenna consists of a slatted parabolic reflector and feed with integral trunnion box, mounted on an elevation over train director. Elevation is +90 degrees to -30 degrees. The trunnion box contains the feed drive motor for high-speed conical scanning and the assembly which performs the target acquisition scanning mode. The unit is fitted to accept a CCTV camera and camera control unit. Target acquisition is initiated by the ship's primary surveillance radar and the RTN-10X is switched to tracking mode, continuing automatically upon target detection.

It can also perform an autonomous search program complementing the overall air defense system utilizing its good low-level detection performance to advantage. The equipment is of modular design with extensive Built In Test Equipment (BITE). RTN-10X is suitable for installation on ships of any size from fast-attack craft (FAC) upwards.

Sirio RTN-12X. A continuous wave radar specifically designed to act as a target illuminator for semi-active homing missiles. It is deployed with the RTN-10X radar in the Albatros weapon system.

Orion RTN-20X. This equipment is intended for close-in weapon systems (CIWS) and operates in the J-band (10-20 GHz), derived from the RTN-10X. When configured

with the Dardo close-in weapon system (Alenia-ELSAG), it is used for the automatic acquisition of air targets and spotting of rounds. RTN-20X performs automatic acquisition of low and fast flying targets either by designation from the related surveillance radar or at closer range in an autonomous surveillance mode. In the surveillance mode, the equipment detects targets at low elevation angles either in assigned sectors or through a 360-degree scan with automatic lock-on of targets within a selected range gate. The radar then carries out automatic tracking with automatic spotting of rounds or bursts of rounds fired at the target.

The RTN-20X employs coherent MTI for fixed echo cancellation and RFD transmission using a Traveling Wave Tube (TWIT) amplifier. Other features include high Pulse Repetition Frequency (PRE), frequency agility, and staggered PRE and digital processing of the video inputs.

The radar can be situated remotely from the related weapons, eliminating problems due to vibration and allowing unrestricted arcs of fire. RT-20X is a digital coherent monopulse radar featuring high resistance to EM and good sub-clutter visibility. Autonomous automatic tracking occurs at ranges from 5-12 km, depending on the target size and relative altitude.

Fully automatic target tracking takes place using monopulse techniques. Among the radar's features are nodding free operation during tracking and automatic target launched missile tracking. The equipment has been designed for rapid fault tracing and ease of maintenance.

Orison RT-25. This is an improved version of the RT-20X which uses the same antenna and transmission chain, but with greater radiating power. Two operating modes are available, a long pulse/coded waveform and a short, single pulse. In both modes the receiver is

comprised of a multi-canceler MTI and a data processor, enabling the radar to continue accurate tracking in conditions of severe weather and ECM. The radar can be used with different fire control systems to direct guns firing at short and medium range. No contracts have been placed for this variant.

Orion RTN-30X. This is a monopulse acquisition and tracking radar operating in the I/J-band and optimized for the low/very low altitude air threat. It is often deployed as an integral part of the Albatros Mk 2 or NA 30 missile and gun fire control system (ELSAG). Intercept range is said to be 15 km maximum against targets at radial speeds of up to Mach 3. The radar remains effective even in the presence of adverse weather, sea clutter and ECM. The fully stabilized antenna consists of a cassegrain type twisted polarization reflector which avoids aperture blocking, thus optimizing antenna gain while reducing sidelobe level.

The extended range and high tracking accuracy is obtained by the use of monopulse techniques. The good anti-clutter performance is achieved by the use of a coherent chain for Radio Frequency (RF) generation and operation using frequency agility with simultaneous MTI processing.

An improved version of the RTN-30X radar is under development. It is a combined surface and air surveillance radar specifically intended for small and medium-sized ships. It will have a cylindrical parabolic reflector and three feed systems. RF power is divided between these on a time-sharing basis to give three vertically stacked beams. The feed horn for the upper beam will be capable of tilting by remote control to achieve different elevation angles. The new equipment will have a variable antenna rotation rate and a dual mode transmitter. This will operate on either fixed frequency or in a frequency agile mode.

Other features will include generation and pulse compression and frequency agility with adaptive Moving Target Indication (MTI) processing. Software controlled search and acquisition patterns will be performed automatically. After radar lock-on, automatic computer regenerated tracking will be automatically implemented.

Alenia-Elsag Argo. The Argo NA 10 Mod 2/3 Fire Control System is designed to control a number of short- and medium-range weapons and incorporates the RTN-10X tracking radar.

Albatros. An all-weather missile and gun shipborne weapon system designed for defense against aircraft and anti-ship missiles, particularly steep diving or sea skimming types. The system is also capable of carrying out surface action fire control. The associated radar is the RTN-10X system.

Alenia-Elsag NA-21. It is developed from the NA 10 system for the direction of guns, surface-to-surface and surface-to-air missiles against air and surface targets. The system utilizes the RTN-10X tracking radar.

Alenia-Elsag NA-30. This system provides good rapid reaction to high-speed air threats. It is able to control a surface-to-air missile system and medium-/short-range guns for up to three weapon outputs of two different calibers. The RTN-30X radar is employed in this system.

Alenia-Elsag Dardo. A close-in weapon system (CIWS) for defense against steep diving or sea skimming missiles, the system employs a Breda compact twin 40-mm L/70 naval gun combined with an RTN-30X radar. A Chinese derivative of this system uses 37-mm guns.

SEN-300. This system is designed for FACs and corvettes and utilizes the RTN-30X radar.

Type 912. UK Royal Navy designation for the RTN-10X radar. This version now exists only in Pakistani service, so the designation is defunct.

EL/M-2221. Israeli designation for the RTN-10X systems equipping the SAAR class FAC. It is believed that EL/M-2221 differs from RTN-10X only in that it is modified to provide target acquisition and designation for Gabriel SSM missiles.

SPG-70. Italian Navy designation for RTN-10X

SPG-74. Italian Navy designation for RTN-20X

SPG-76. Italian Navy designation for RTN-30X

Program Review

Background. Development of these radars began in the early 1960s with series production starting in 1972. They are derived from the 250 kW Orion-250 which formed part of the original NA-9 fire-control system. This was, in turn, a derivative of the Nuova san Giorgio

MLT-4 fire control system, a clone of the US Mark 39 with an open-work antenna.

The RTN-12X radar system is no longer produced. It was replaced by the RTN-20X radar, four of which were installed on each of the two new destroyers of the

De la Penne class. Other new construction to be fitted with Orion RTN series radars included the eight light frigates of the Minerva class. The first of these commissioned in 1986 was fitted with two RTN-20X radars for Dardo GFCS. The Cassiopeia-class patrol vessels are equipped with the RTN-20X radar controlling a single 76-mm OTO Melara gun.

In 1992, a senior Chinese Admiral addressed a group of naval officer cadets on present and future Chinese naval programs. A translation of this address revealed that the Chinese Navy has already adopted the Breda 40-mm L70 Dardo system (chambered for Chinese 37-mm ammunition) as equipment for the Luda III-, Jianghu IV- and Jiangwei-class frigates. It was also revealed that this equipment was being produced under license in China. The information has been subsequently confirmed by examination of photographs of the Jiangwei-class frigates fitting out. These clearly showed the 40-mm L70 turrets and the Orion fire-control radar.

In April 1995, the Brazilian navy awarded Alenia-Elsag Sistemi Navali a US\$160 million contract for the upgrade of the six Niteroi-class frigates. The order covers a substantial modification of the command control system and the installation of a new point defense anti-air warfare missile system. Hardware to be supplied includes six Aspide eight-round box launchers, seven RAN-20S target acquisition radars and 13 RTN-30X fire control radars for the Aspide missiles.

This suggests that one RAN-20S and one RTN-30X radar will be retained as a shore-based trials, training and system reference set. Alenia was selected for the upgrade program in 1993 with the contractual terms being agreed in 1994. However, Senate approval was not achieved until March 1995. The Brazilian Esca company will be assisting in the upgrade program, which is expected to continue overall until 2001-2002.

The RTN series has benefited from a series of upgrading exercises as new technology became available, and barring major developments in the radar field, this process will continue. Sales of the Orion RTN series have been assisted by the export orders for Italian warships, but have also achieved considerable success in being specified for non-Italian-built hulls. Its continued sales success will thus be independent of the overall success of the Italian shipbuilding industry, a point demonstrated by the recent sale to Brazil.

The Orion RTN series of acquisition and tracking radar is associated with several weapon systems. These include the successful Albatros (Aspide) surface-to-air missile and the Dardo CIWS. The Aspide missile system is achieving significant export success as a reliable, effective and easily installed point defense missile system suitable for most types of warships. It is likely that Aspide installations, both on new construction and by retrofit, will continue throughout the forecast period.

The apparent Chinese adoption of the Dardo system is interesting and opens up a potentially very large market. Up to this point, Chinese warships have been deficient in anti-missile defense, with little in the way of either hard-kill or soft-kill protection. This reflected the role of the Chinese Navy as a largely coastal force.

Now that the Chinese fleet is moving increasingly into blue-water areas, though, such defense has become essential. It appears that Dardo is being produced under license in China, although the 40-mm cannon have been rechambered for traditional 37-mm caliber ammunition. By taking this route, Chinese warships have jumped straight from being virtually defenseless to having a highly capable anti-missile system.

There is no doubt that Dardo is a highly effective point defense gun system (close-in weapon system). Unlike the Mk 15 Vulcan Phalanx and Goalkeeper systems, Dardo does not work by direct kills but by laying down barrages of fragments. This is a more effective and efficient option than trying for direct hits on a small, fast-moving target, but 40 mm is the smallest caliber for which it is, at present, practical. In turn this will involve considerable work on the intended platform if Dardo is to be installed as a retrofit. A number of such retrofits have been performed, particularly in the Italian Navy.

The amount of work required implies that the system should be designed into the hull at an early stage if it is to be deployed to maximum efficiency. It will also consume a significant proportion of the available weight, which could well be allocated to other characteristics. This is probably a price worth paying for a capable gun-based CIWS in situations where CIWS missiles are inappropriate.

Funding

Development of the RTN-10X radar was carried out on behalf of the Italian Navy under a Defense Ministry contract. RTN-20X was developed as a company private venture. The RTN-30X was the result of a research and development program commissioned by the Italian Defense Technical Scientific Committee within a wider program for a new Gun Fire Control System (GFCS).

Recent Contracts

<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
AESN	160.0	<i>April 1995</i> – Brazilian Navy contract for the upgrade of six Niteroi-class frigates, including the supply of seven RAN-20S and 13 RTN-30X radars.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1962	Development of the Orion series begins
	1970	Development of the Orion RTN-10X begins
	1972	RTN-10X enters series production
	1972	RTN-10X refitted to Israeli Saar FAC
	1972	RTN-10X fitted to Italian Arditto destroyers
	1973	Development of the RTN-20X radar begins
	1974	Type 912 in service on RN Type 21 frigates
	1975	RTN-10X in service on Israeli Reshev FAC
	1976	Development of the RTN-30X radar begins
	1976	RTN-10X in service on Brazilian Niteroi frigates
	1977	RTN-10X in service on Italian Lupo frigates
	1977	RTN-20X in service on Italian Lupo frigates
	1978	RTN-10X in service on South African Minister FAC
	1978	RTN-10X refitted to Italian Doria cruisers
	1978	RTN-20X in service on Venezuelan Lupo frigates
	1979	RTN-10X refitted to Libyan Dat Assawari frigate
	1979	RTN-10X in service on Libyan Assad corvettes
	1979	RTN-20X ordered for Peruvian Lupo frigates
	1979	RTN-30X ordered for Peruvian Lupo frigates
	1980	RTN-10X in service on Danish Niels Juel frigates
	1981	RTN-10X in service on Israeli Aliyat FAC
	1982	RTN-10X in service on Ecuador Esmeraldas corvettes, RTN-20X in service on Ecuador Esmeraldas corvettes
	1982	RTN-10X subject of a design upgrade
	1983	RTN-20X in service on Italian Maestrале frigates
	1983	RTN-30X in service on Italian Maestrале frigates
	1984	RTN-10X refitted to Vittorio Veneto cruiser
	1985	RTN-10X fitted to Iraqi Lupo frigates, RTN-20X fitted to Iraqi Lupo frigates (not delivered)
	1986	RTN-10X fitted to Iraqi Assad corvettes (not delivered)
	1987	RTN-10X refitted to Greek Gearing destroyers
	1987	RTN-30X fitted to Giuseppe Garibaldi aircraft carrier
	1989	RTN-10X in service on Brazilian Inhauma frigates
	1991	RTN-30X operational on Italian Animoso destroyers, RTN-20X operational on Italian Animoso destroyers

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1992	RTN-10X and RTN-20X seen on Chinese Jiangwei-class frigates, as part of Dardo point defense system
Mar	1995	Brazil contract for upgrading six Niteroi-class frigates with RAN-20S and RTN-30X radars

Worldwide Distribution

Brazil. (Sixteen RTN-10X on four Inhauma-class frigates and six frigates of the Niteroi class, the latter having two RTN-10X each which are now being replaced by RTN-30X.)

Chile. (Four RTN-10X on two SAAR-2- and two SAAR-4-class FAC purchased from Israel.)

China. (Four RTN-10X and two RTN-20X on Luda III FF, two RTN-10X and one RTN-20X on Jianghu IV FF, four RTN-10X and two RTN-20X on Jianghu III FF, four RTN-10X and two RTN-20X on Jiangwei FF.)

Denmark. (Three RTN-10X on the three corvettes of the Niels Juel-class.)

Ecuador. (The six CNR missile corvettes of the Ecuadorian Esmeraldas class are fitted with both RTN-10X and RTN-20X radars. These ships were delivered to Ecuador between 1982 and 1984.)

Greece. (Seven ex-US Navy FRAM I/II Gearing destroyers of the Themistocles class are fitted with Orion RTN-10X FCR. In addition, Alenia-ELSAG won a contract to carry out an electronic refit on two of the above vessels, plus three ships of the Aspis (Fletcher) class. This will involve the fitting of either an NA 21 or NA 30 FCR. The Aspis refit appears never to have been carried out, and since these ancient ships are now in reserve, further re-equipment seems improbable.)

Iraq. (Four Lupo-class frigates were ordered from Italy with Orion RTN series radars and six CNR missile corvettes fitted with both RTN-10X and RTN-20X systems. Due to the Iran-Iraq war, none of these ships have been delivered, and they are presently laid up in Italian shipyards. Negotiations for their delivery were under way, but the ships were once again embargoed as a result of the Iraqi invasion of Kuwait and subsequent outbreak of the Gulf War. The four Lupo-class frigates are being acquired by the Italian Navy while the four of the six corvettes are up for sale. Two were sold to Malaysia in late 1995.)

Israel. (The Orion RTN-10X radar is standard equipment on board the Saar-class fast-attack craft of the Israeli Navy, 24 of these craft being so equipped. A further group of four ships, the Saar 5 Lahav-class, is under construction. It is reasonable to assume these will be similarly equipped.)

Italy. (Virtually every major Italian surface unit is fitted with one or more members of the Orion RTN family of radars. These include the aircraft carrier *Giuseppe Garibaldi* (three RTN-20X Dardo and two RTN-30X Albatros), the light aircraft carrier *Vittorio Veneto* (two RTN-20X Dardo), the two cruisers of the Andrea Doria class (four Orion Argo), the two destroyers of the Audace class (three RTN-10X NA 10), the two destroyers of the Impavido class (three RTN-10X Argo), the eight frigates of the Maestrale class (one RTN-3 X for MM 59, two RTN-20 Dardo), the four frigates of the Lupo class (one RTN-10X Argo, two RTN-20X Dardo), the two frigates of the Alpino class (two RTN-10X Argo) and the seven Spaviero-class missile hydrofoils (RTN-10X Argo).)

Libya. (The Libyan frigate *Dat Assawari* was refitted by CNR in 1982 at which time two RTN-10X radars were installed. The Libyan Navy also operates four CNR missile corvettes fitted with NA 10 MoD 2 FCR including RTN-10X radars. These were delivered between 1979 and 1981.)

Malaysia. (Two acquired with purchase of ex-Iraqi corvettes.)

Pakistan. (Twelve Type 912 on six Type 21 frigates purchased from the UK.)

Peru. (Four modified Lupo-class frigates were purchased, and deliveries are continuing. These ships are equipped with two RTN-30X (Albatros) systems and two RTN-20X (Dardo) systems each.)

South Africa. (RTN-10X radars may have been acquired as part of the refit equipment aboard the frigate *President Pretorius* during 1977. The radars are fitted to the 9-12 Israeli-designed Minister-class fast-attack craft.)

United Kingdom. (Sixteen Type 912 radars purchased to equip eight Type 21 frigates. Two of these sank in action during the Falklands War; the rest were sold to Pakistan.)

Venezuela. (Six Lupo-class frigates were acquired from Italy during the period 1980-82. These were equipped with Orion RTN series FCR. In addition, the Venezuelan Coast Guard operates two ex-frigates of the Almirante Clemante-class which were fitted with RTN-10X radars during refit in Italy in 1983.)

Forecast Rationale

The following forecast is based upon known and projected orders for warship hulls using RTN series radars. It has been increased over last year's, to allow for Chinese production. The great flexibility and proven efficiency of the Orion family should guarantee that it remains in production throughout the forecast period.

Orion is one of three mid-range integrated fire control systems that dominate this market sector; the other two are the Signaal WM-28 and Thomson-CSF's Castor III. Their established position will make it very difficult for any new system to enter this particular area. In order to do so, the new system would have to offer some very substantive benefits over the existing trio.

Ten-Year Outlook

		ESTIMATED CALENDAR YEAR PRODUCTION												
Designation	Application	thru 97	High Confidence Level				Good Confidence Level				Speculative			Total 98-07
			98	99	00	01	02	03	04	05	06	07		
ORION	CVH/DD/FF/FAC-M (VARIOUS)	430	16	16	16	12	12	12	12	0	0	0	96	