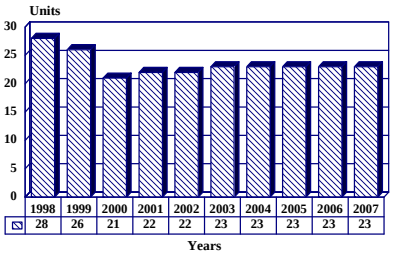
Condor Mk II 9600 MSSR - Archived 8/99

Outlook

- Most identified contracts will be delivered the end of 1999
- Sales of Condor Mk II MSSR systems are increasingly linked to fully integrated ATC packages
- System sales will remain relatively high as long as the US DoD and FAA exercise all options to procure MSSRs for various programs

10 Year Unit Production Forecast
1998 - 2007



Orientation

Description. The Cossor SSR family are monopulse secondary surveillance radars for air traffic control.

Sponsor

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Licensee. No known production licenses have been granted.

Status. In production and in service.

Total Produced. An estimated 243 radars have been produced through 1997.

Application. An advanced air traffic control radar family developed to overcome signal interference problems which occur with existing SSR systems in high traffic densities.

Price Range. Contract cost averaging from the 1996 order from the FAA and US DoD indicates that a single Cossor Condor Mk II 9600 system, including installation and a shelter, is priced at approximately US$2.9 million per unit (1996 dollars).

The earlier Mark I models which are no longer produced, were priced around US$750,000 per unit.

Technical Data

Design Features. The Cossor SSR 950 system is made up of the CRS 512 antenna, the SSR 950 interrogator and the CVP 250 plot extractor.

The CRS 512 is a large vertical aperture secondary surveillance antenna which was designed to replace the familiar linear array which has been the standard SSR antenna since the radar's first introduction. The large vertical aperture (measuring five feet) contains a vertical array of radiating elements which permits more flexibility in controlling transmit and receive patterns and also improves performance. This system surmounts the disadvantages of linear array antennas, which sometimes cause gaps in radar coverage and generate false replies because of reflections from local terrain and buildings, caused by the narrow aperture in linear arrays.

New techniques have been used to construct the radiating elements to minimize weight while retaining strength. The open array format also lowers wind resistance and is capable of withstanding a wide range of environmental conditions. Specific areas of application for the CRS 512 include airfields, where reflection problems can be quite severe, and also long-range surveillance missions in which superior coverage at low elevation angles is a primary requirement.

The SSR 950 interrogator was developed specifically for monopulse operation while at the same time meeting the requirements of ICAO Annex 10. The interrogator includes two matched logarithmic receivers for monopulse operation and also a third receiver for receiver sidelobe suppression. The SSR 950 also features improved sidelobe suppression (site selectable), programmable gain time control in range and azimuth, a digital plot extractor interface and a computerized management system interface. The interrogator has been designed to be readily extendible for Mode S operation as it becomes fully operational.

The CVP 250 plot extractor uses advanced microprocessor technology and includes extensive self-test and fail-soft features. Monopulse data from the SSR 950 are used to compile target reports. The plot extractor is built into the same cabinet as the SSR 950.

Cossor Condor 9600 The Condor Mk II Monopulse Secondary Surveillance Radar (MSSR), succeeding the highly successful Condor Mk I, has a Mode-S performance with the addition of modules to prewired locations. It uses 486 processors on Multibus II and custom-designed VLSI chip technology. All system functions may be exercised remotely. Condor II is a third generation MSSR, which provides Modes A, C, and S operations. It combines the proven performance of previous Cossor MSSRs with the latest hardware technology benefits.

SPECIFICATIONS

Cossor Condor MK II 9600

Antenna

Gain:	27dBi
Horizontal beamwidth 3 dB:	2.45 +/- 0.25 degrees
Horizontal sidelobes:	-26 dB below peak
Roll-off rate (underside):	1.9 dB/degree at -6 degrees point
High angle cut-off:	-4 dBi at +65 degrees
Wind survival 40 mm radical ice:	200 km/hour
Temperatur:e	-30 degrees Celsius to +70 degrees Celsius

Transmitter

Frequency:	1030 +/- 0.01 MHz
Output Power:	32 dBW
Duty Cycle:	Up to 2%, optional 6%
Operating modes:	1, 2, 3/A, B, C, D(S and 4 as options)
Suppression: (Improved ISLS (IISLS) option)	Interrogator SideLobe Supression (ISLS)

Log Receivers

Frequency:	1090 +/- 0.2 MHz
Sensitivity:	-90 dBm tangential
Bandwidth (3dB):	9 MHz
Dynamic range:	-16 to -86 dBm
Suppression:	Receiver SideLobe Supression (RSLS)

Extractors/Plot Processor

Multibus II:	80486 processors
VLSI technology:	Monopulse Azimuth Range Code Assembler
Target Load:	Average 600/scan (120/s) (900/scan option) Peak 350/s
Standby readiness:	Software coupled (hardware option)

Extractors/Plot Processor

Video clock I/P:	16 MHz
Decode:	Up to 4 overlapping replies
Antenna check:	Built-in antenna HPD plotter
Built-in monopulse consistency check:	Continuous
Reflection suppression:	Fixed and dynamic files
Output formats available:	Radar Data Interface Format (RDIF), Asterix

Variants/Upgrades

ASR-11. This is the FAA designation of the Condor Mk II system that will be employed in the Digital Airport Surveillance Radar (DASR) program.

Condor 9600 (Mk II). The Condor 9600 represents the newest generation of Cossor SSR. It is evolved from the SSR 955. This variant includes dual monopulse interrogators and plot extractors, control and fault isolation systems, as well as a large vertical aperture antenna. The associated display equipment features the newest high-resolution technology with image memory techniques, as well as a CRT that consumes less power and lasts as much as 10 times longer than existing softer phosphor types. The Condor 9600 can be combined with a wide variety of primary radar. It is also fully Mode S compatible.

DASR. The Digital Airport Surveillance Radar (DASR) is both the name of a cooperative FAA/DoD ATC upgrade and the designation of the Condor Mk II system that will be procured by the US DoD.

SSR 955. In 1985 Cossor introduced the SSR 955, a fully solid state version of the SSR 950 that includes a modular transmitter with a driver module that provides outputs to two identical high-power RF amplifiers. This new version is available with the LVA antenna and can also be easily adapted to the Mode S selective address system which was scheduled as a required capability in the US after January 1, 1992. The main application for the SSR 955 is in the Canadian RAMP program.

Program Review

Background. Cossor Electronics developed its monopulse system in order to attack three problems that were encountered with standard SSR. These shortcomings became increasingly evident as air traffic became denser and a heavier reliance was placed on processed secondary radar data for air traffic control, thanks to its being able to provide positive height and identity data.

The identified problems associated with the display screen were: (1) track wander (caused by signal interference), (2) garbling of close flying aircraft which makes it difficult to make separate identifications, and (3) false targets caused by nearby objects reflecting the radar signals. As a result of these problems, air traffic control operations had to provide large aircraft flight path separations which, in turn, meant longer times spent in loiter prior to landing, and correspondingly higher fuel consumption.

The track wander problem is overcome by the SSR monopulse system implementation concept. Instead of ascertaining bearing by relying on the average of a number of replies, the monopulse concept typically needs only one pulse of a single transponder reply. This largely eliminates the risk of distortion from an interruption of the reply pattern.

The other two problems are addressed by the CVP 250 plot extractor. The extractor can differentiate the replies of each aircraft by the differences in their signal strengths and arrival angles. The extractor is also able

to detect and eliminate false signals by reviewing a number of quality measurements such as signal strength, the multiple assignment of codes, length of track and the location of known reflectors.

Cossor received the 1985 Queen's Award to Industry for Technological Achievement for the development of its monopulse SSR system. Cossor had received orders for 92 SSR 950s by mid-1985. The company is now addressing Thomson-CSF's turnkey ATC system capability by making the Condor 9600 available as part of a total ATC system, which is likely to be dubbed System 2000. System 2000 will take advantage of Raytheon's radar design capabilities and previous experience and will include the latter's ASR-9000 G/H-band primary radar. Innovations being developed for the Canadian RAMP program also will be included.

This new system has been ordered by the UK and Norway to form the basis of their modern military ATC networks. In the former case, the deployment is in partnership with Watchman primary radar; in the latter they are apparently used in conjunction with Giraffe primary search systems. Both applications appear to be relatively small procurements.

The first of the 9600 Mk II radar was delivered to the UK in 1992. Since that time Raytheon/Cossor have secured several lucrative contracts for the equipment. Recent customers have included Australia, Cyprus and China. In particular the Australian contract, at US$100 million, was for the setup of the Royal Australian Air Force' ATC system designated the Australian Defense Air Traffic System (ADATS). This contract called for seven primary radars, eight radar and flight data processing centers, eleven ATC switches, and seven Condor Mk II secondary radars.

In December 1996, the US Air Force's Materiel Command Electronics Systems Center ordered an indefinite quantity/indefinite delivery contract for up to 213 radars including the Digital Airport Surveillance Radars (DASR) and the Cossor-provided MSSRs. Final signing of the contract was delayed until December 1996 due to protests lodged by Raytheon's competitors. In December, the US General Accounting Office (GAO) upheld the contract which was then signed with deliveries to begin in 1997.

In 1997, the Cossor radars garnered additional orders from China and Norway. The Chinese order will be deployed at the airport located in the Guangzhou province of the Peoples Republic of China. The Norway order will see Condor Mk II MSSR's linked to not only a new ATC center, but also to Norway's four major airports and its flight database.

Raytheon also announced in late December 1997 that a new company– Raytheon Systems Ltd.– had been created. This new company would be further split into two divisions– Electronic Systems and Systems Integration. Of these the Raytheon Cossor Harlow and Hughes Microelectronics Glenrothe operations were combined to form the Electronic Systems division.

No additional program activity has been detected regarding the Cossor ATC systems in 1998.

Funding

The Cossor family of air traffic control systems was developed as a private venture using corporate funding. Cossor is a subsidiary of the Raytheon Corporation.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Raytheon/Cossor	100.0	Aug 1995 – Contract for seven solid-state primary radars and seven monopulse secondary surveillance radars (MSSR), eight radar and flight data processing automation systems with controller workstations and eleven ATC switches in support of the Australian ADATS program. Cossor is providing the MSSR units.
Raytheon/Cossor	2.0	Aug 1996 – Contract awarded by the Cyprus Telecommunications Authority to provide a MSSR for Lara, near Paphos, in southwestern region of Cyprus.
Raytheon/Cossor	619.9	Dec 1996 – Contract from the US Air Force's Materiel Command, Electronic Systems Center, for the DoD/FAA Digital Airport Sur-

Contractor	Award ($ millions)	Date/Description
		veillance Radar (DASR) program. This is an indefinite quantity/ indefinite delivery contract for up to 213 radars and will extend through 2007. An unspecified number of MSSRs will be supplied by Cossor.
Raytheon/Cossor	29.0 (Estimate)	Apr 1997 – Contract for 10 MSSR radars to Norway's Civil Aviation Administration.
Raytheon/Cossor	4.0	May 1997 – Contract to provide a modern ATC radar system valued at US$4 million for a new airport development at Guangzhou P.R.C. The total project includes primary and secondary surveillance radars, communications, training and spares.

Timetable

Month	Year	Major Development
	1970	Cossor first demonstrated a monopulse SSR
Jun	1983	First foreign order for SSR, to Saudi Arabia
	1983	SSR entered service with the Civilian Aviation Authority (CAA) in the United Kingdom, the first authority in the world to specify the system
Jan	1984	SSR ordered for 22 Royal Air Force airfields
Jun	1984	Cossor chosen to supply 41 SSR for the Canadian Radar Modernization Project (RAMP)
Oct	1984	Royal Navy selected three SSR for Royal Navy air stations
	1985	Cossor won a Queen's Award to Industry for Technological Achievement for the development of its SSR system. Cossor introduced the first fully solid state version of its monopulse SSR. UK CAA SSR installation completed
	1986	First Canadian RAMP SSR delivered. PRC, Australia and Greece ordered SSR. Omani and Dubaian SSR installed
Jan	1987	First RAF SSR went operational at RAF Scampton
Feb	1987	Cossor won order from Radio Suisse to supply Geneva Airport with a second SSR Cossor announced that it had won a contract from Sweden for an initial three SSR (with as many as 14 possibly to be procured)
Oct	1987	Delivery of two SSR for Zurich International Airport
Nov	1987	Cossor completed installation of Australia's first monopulse SSR at Brisbane Airport
May	1988	Delivery of first SSR of Swedish order, installed at Romele
Feb	1989	Fourth Condor 9600 radar ordered by Sweden for Umea airport
May	1989	Second SSR of Swedish order delivered for installation at Lulea
Oct	1989	Cossor 8600 low-cost ATC radar introduced
May	1990	Delivery of third SSR of Swedish order for Ostersund
Dec	1990	Installation of ATC system at Mount Catherine in Trinidad/Tobago
	1991	Completion of deliveries of SSR for the RAMP program
Apr	1991	Completion of installation of Condor 9600 at Umea airport in Sweden
Sep	1993	Completion of four optional sites for the Swedish order
	1995	Contract issued by Australia for seven Condor Mk II units as part of the ADATS program
Aug	1996	Contract awarded by US DoD and FAA foe the supply of up to 213 Condor radars
Aug	1996	Cyprus contract awarded and delivered
Apr	1997	Norway contracts for 10 Condor Mk II MSSR's as part of a new nationwide ATC system

May 1997 A Condor system was emplaced at the new Guangzhou province airport in the P.R.C.

Worldwide Distribution

Selected in open competition by the United Kingdom, Norway, India, Sweden, Oman, People's Republic of China, Hong Kong, Lebanon, Australia, Switzerland and The Netherlands. Mode-S MSSRs have also been delivered to India.

Australia. In August 1995, Raytheon, Cossor's parent company, was selected by the Royal Australian Air Force to supply new ATC equipment for the Australian Defense Air Traffic System (ADATS) project. The seven monopulse secondary surveillance radars, (MSSR), being provided by Raytheon, are third generation products from Cossor Ltd.

Bahrain. Co-sited with Plessey Watchman primary radar.

Canada. The first customer for the SSR 955 was the Canadian Department of Transport, for the Canadian Radar Modernization Project (RAMP), in which Cossor is a team member along with its parent company, Raytheon's Canadian subsidiary. Cossor will supply 41 dual-channel SSRs systems, 24 of which will be interfaced with primary surveillance radars being supplied by Raytheon Canada Ltd, which is the primary radar contractor for the RAMP program. Eighteen of the SSR were located in remote sites across Canada as stand-alone systems for en-route monitoring of air traffic. The RAMP project is significant in that it represents the first time that the primary radar is not being re-equipped, with en route radar coverage to be provided by the SSR alone. The company also emphasizes that the SSR is easily adapted to the Mode S selective address secondary radar system which is expected to be brought into international service in the late 1990s.

China. A Cossor SSR is located at Xiamen International Airport in Fujian Province, co-sited with a Plessey Watchman primary radar. In 1997, Raytheon won a contract to provide a modern ATC system for a new airport development at Guangzhou. Cossor is supplying an unspecified number of Condor MSSRs for the project. The Guangzhou award is the ninth Raytheon ATC system to be installed in China.

Dubai (UAE). Co-sited with Plessey Watchman primary radar at Dubai International Airport.

Greece. The Greek order was for an autonomous station consisting of a dual channel transmitter/receiver/extractor with a large LVA antenna. The order came from the Hellenic Civil Aviation Authority via Hollandse Signaalapparaten BV (the Netherlands), which was the main contractor for the system. The system has been installed at Mount Himittos (near Athens) and feeds monopulse SSR data to the Athens area control center.

Cyprus. The Cyprus Telecommunications Authority ordered one Condor MSSR in 1997 to enhance their national ATC system. The radar will be installed at Lara, near Paphos, in the southwestern region of Cyprus.

Norway. Ten Condor 9600 Mk II radars have been delivered to the Norwegian Air Force for military air traffic control. Another system was delivered to Statoil.

Oman. Cossor SSR co-located with Plessey Watchman primary radar on Masirah Island.

Saudi Arabia. The Saudi order for a Cossor SSR for installation at the new King Khaled International Airport represented the first overseas order for the SSR 950. The SSR 950 interfaces with a Phillips LAR II primary surveillance radar.

Sweden. The most significant more recent order came from Sweden, which issued an initial contract for three SSR (US$3.7 million) in early 1987, and a follow-up contract in 1989 for one more SSR. The total order may eventually be for as many as 14 SSR. The program is known as Project Score (Swedish Condor Radar Equipment) and called for the completion of the first three sites by 1990, with four optional sites to be completed by 1993. The Swedes chose the Condor 9600 since they required a high level of availability and ease of maintenance in extreme weather conditions. The antennas will not have radome protection.

Switzerland. Two of each Cossor SSR at Geneva airport and Zurich International Airport.

Trinidad/Tobago. Cossor SSR 955 to be co-located with Raytheon primary radar on Mount Catherine on Trinidad Island. Financing assistance for the project is being provided by the Canadian government, and the configuration for the turnkey ATC project closely resembles the equipment being provided for the Canadian RAMP program.

United Kingdom. The UK has been the biggest customer for the Cossor SSR line. The Civil Aviation Authority in the UK originally ordered 22 Cossor 950s, with deliveries completed in 1985. The UK Ministry of Defence ordered a total of 27 for Royal Air Force airfields and Royal Navy air stations, for use in the UK and West Germany. The first of these became operational in early 1987 (RAF Scampton) after successfully completing a nine-month on-site testing program. The remaining 26 systems were installed over a five-year period, with 25 to be operational and the remaining two to be used for engineering and training applications. Some of these, reportedly the final five sets and a training set, were re-ordered as Condor 9600 Mk.2.

United States. In 1996, Raytheon won an indefinite quantity/indefinite delivery contract for up to 213 radars from the US Air Force's Material Command Electronic Systems Center, for the DoD/FAA Digital Airport Surveillance Radar (DASR) program. The radars will be delivered through 2007. An unspecified number of Condor MK II MSSRs will be supplied by Cossor. If all 213 radars are delivered, the contract could be worth up to US$619.9 million.

Forecast Rationale

Raytheon, Cossor's parent company, continues to see relatively successful sales of the Cossor produced Condor Mk II monopulse secondary surveillance radar (MSSR) system. Within the last few years Raytheon has been aggressively marketing integrated, turnkey ATC packages that have typically included a primary radar, ATC switching gear, training facilities, and secondary radars (the Condor Mk II). The company appears to push the digital aspects of their ATC package to nations with older, less sophisticated systems that badly need to be upgraded. This strategy has worked well in the past as seen by integrated ATC packages being procured by Australia, China, Norway and other countries.

However, the most lucrative contract by far was the signing of the Digital Airport Surveillance Radar (DASR) program with the FAA and US DoD in December 1996. This contract has a potential value of US$619.9 million over a 12-year period stretching through 2007 if all 213 radars are procured. It should be noted that this contract is only for the supply of the Condor Mk II and is not part of an integrated ATC package. The radars are destined to be installed in the most heavily used civil, military, and joint controlled airports.

Within the last few years Raytheon has been pursuing opportunities in the Far East. One of the most successful breakthroughs was the initial contract to China in the early 1990's. This has led to nine additional contracts over the years and continues with the awarding of a US$4 million, turnkey modern ATC radar system for deployment at the Guangzhou province airport. The total project is an integrated system that will include the primary and secondary surveillance radars, communications, training and spares.

The ten-year forecast given below indicates a rather comfortable manufacturing schedule for the Cossor system through 2007, but this can be misleading. All of the firm non-US orders will have been delivered by 1999. This leaves the time period of 2000-2007 highly dependent upon speculative orders as well as the continued procurement of Condor Mk II by the FAA/DoD. If the FAA/DoD cooperative were to face budget constraints, it is possible that the amount of systems procured could be significantly reduced or even eliminated.