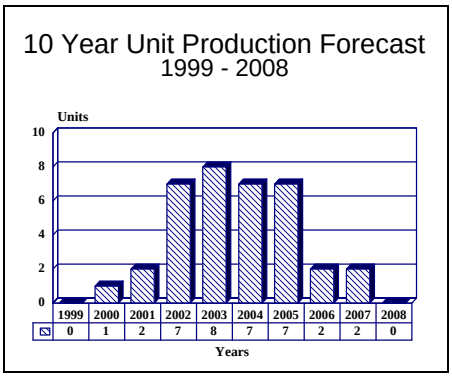
Signaal APAR - Archived 4/99

Outlook

- APAR system currently in final testing
- Germany to receive the first production unit in 2000
- Canada has still not awarded an APAR contract but is expected to do so



Orientation

Description. Active phased-array multifunction radar operating in the I/J band (8-20 GHz) frequency.

Sponsor

Ministerie van Defensie
Plein 4
PO Box 20701
NL-2500 ES The Hague
Tel: +31 70 318 8188
Fax: +31 70 318 8401
Telex: 31337

Department of National Defence Canada
Asst Deputy Minister of Supply and Services
Place du Portage
Hull PQ
Ontario K1A 055
Canada

Bundesamt für Wehrtechnik und Beschaffung (BWB)
Konrad-Adenauer-Ufer 2-6
Postfach 7360
D-56057 Koblenz
Germany
Tel: +49 261 4001
Fax: +49 261 400 7630; 400 7964
Telex: 862661 bwb d

Contractors

Hollandse Signaalapparaten (Signaal) BV
PO Box 42
NL-7550 GD Hengelo Ov
The Netherlands
Tel: +31 74 488111
Telex: 44310
(overall system engineering, program management, data processing and antenna design)

Daimler Benz Aerospace (DASA)
Sensor Systems Division
Sedanstraße 10
Postbox 1730
D-7900 Ulm
Germany
Tel: +49 731 392 4058
Fax: +49 731 392 5247
(design and manufacture of the front-end processing chain: signal processing and radar wavecom generators)

Nortel North America, a subsidiary of Northern Telecom Ltd
2920 Matheson Blvd East
Mississauga, Ontario L4W 4M7
Canada
Tel: +1 416 238 7000
Fax: +1 416 238 7350
(production of the transmit/receive modules)

TNO Defence Research
TNO-FEL (Physics & Electronics Laboratory)
PO Box 96864
NL-2509 JG The Hague
The Netherlands
Tel: +31 70 326 4221
Fax: +31 70 328 0961
(design consultant for systems integration, responsible for applied scientific research)

Lockheed Systems Canada
(antenna interface unit, beam steering equipment, control and monitoring)

Thomson Systems Canada
(track management unit)

Com Dev
(switch matrix)

Stork Canada
(system cooling and supply unit)

Licensee. No production licenses have been granted.

Status. Prototype finishing acceptance tests; series production of APAR subassemblies have begun

Total Produced. One prototype (EMD-1) manufactured.

Application. APAR is designed to act as the fire control component of an integrated air warfare system, capable of target detection, tracking and missile guidance functions.

Platform. The system is to be included as a self-contained module within existing or planned warship designs. The initial platforms will be the new Dutch De Zeven Provincien class, the German F-124 Sachsen class and the Canadian Halifax AAW or new frigates of another design. Retrofits on existing frigates are foreseen as well.

Price Range. At this point, cost estimates remain highly speculative, but a unit value of US$9.6 million can be projected. However, this will depend on the unit cost of the individual transmit-receive modules.

Technical Data

Specifications

Frequency band:	I/J band
Spatial coverage:	360^o x 70^o
Instrumented range:	
Surface	32 km
Horizon	75 km
Air search	150 km
Target capacity:	250+ tracks
Weight	
Top side	10 tons
Antenna	2 tons per antenna
Total System	20 tons
Minimum Ship Class	2,000+ tons

Design Features. APAR is the third and final sensor component of the ARTIST anti-air warfare system. In designing this equipment, Signaal has made the smart decision to design the entire weapons/sensor/command system as a single portable block with transparent interfaces. This means that it is compatible with virtually any command system currently in service or under development and can, thus, be used to convert any existing frigate design to an AAW destroyer role.

The APAR consists of four active phased arrays, each with a 90^o field of view, mounted on the sides of a fixed rectangular housing. Each array consists of 3,200 transmit/receive elements mounted in groups of four to form Transmit/Receive (T/R) modules. These modules are, in turn, grouped into 32 column assemblies, each of which has its own data distribution and power converter assemblies.

Below decks, the unit will consist of a data processing and signals control cabinet and an interface with the warship's integrated command system. The SEWACO FD protocol is used for this, making the assembly suitable for installation in most frigate-sized warships.

For ease of construction, repair, and retrofitting APAR the system is composed of three "clusters" for each face as follows:

- Cluster A- Antenna array
- Cluster B- Signal and data processing units
- Cluster C- Tracking and management unit; combat direction system interface

Operational Characteristics. APAR's main functions are designated as being continuous horizon-range search, multi-target tracking and missile guidance support including midcourse guidance uplink, programmable autopilot command and terminal illumination.

Signaal has stated that the I-band was originally selected for APAR due to superior horizon detection as opposed to range capabilities. This band also gives compatibility with the ESSM and SM-2 missiles. Susceptibility to clutter is overcome by using FFT Doppler processing, which Signaal has extensive experience with through the development of this processing for the STIR radar and Goalkeeper CIWS.

APAR is able to handle multi-target tracking out to 150 km against more than 250+ air and surface targets including helicopters; weapon control support (including missiles and guns); and search functions (including horizon search out to 75 km, surface search out to 32 km, and helicopter search modes). The system is capable of providing guidance for RIM-7P and RIM-7M Sea Sparrow, Evolved Sea Sparrow, Standard SM-2 as well as a number of future missiles.

The multifunction APAR can fulfill many tasks, including simultaneous detection and tracking of low-altitude targets by searching the horizon, detecting and tracking all targets within a given range, and guidance and support of all modern missiles. It consists of four one meter square arrays that are composed of transmit/ receive modules capable of generating 500 pencil beams per second scanning over a 120° arc.

Below decks are the four tracking and management units (TMUs) connected to the combat system database which constitutes the main control center of the system. Included are two missile waveform generators (MWGs) for missile uplinking and mid-course corrections as well as four radar waveform generators (RWGs).

Variants/Upgrades

EDM-1. A pre-prototype/technology demonstrator Engineering Development Model 1 (EMD-1) that will be used to verify the basic design parameters of the proposed radar.

QRS. The pre-production Qualification & Reference System (QRS) system that will follow the EDM-1. The QRS will be outfitted to a German vessel as a working testbed, and will consist of a single antenna array. While the QRS will have full APAR performance, it will have limited coverage, flexibility and ECCM capabilities. Upon beginning serial production the QRS will be upgraded to a full APAR system.

Program Review

Background. APAR can trace its developmental roots back to active-array technology developments from the 1989 TNO-FEL/Signaal EXPAR (Experimental X-band Phased Array Radar) demonstrator program. The EXPAR program, which had its start in Holland, eventually led to the Royal Netherlands Navy (RNLN) awarding a two-year contract for the system and module design of the APAR radar in 1993.

A November 1991 contract was awarded to Signaal and FEL-TNO to study the feasibility of the ARTIST (Advanced Radar Techniques for Improved Surveillance and Tracking) program. This was intended as a research project to study the latest technological developments in the field of data processing for air defense systems. The aim was to design a fully integrated air warfare system, initially to be based around the Evolved Sea Sparrow Missile, but capable of expansion to handle Standard SM-2MR.

The ARTIST program was to run for 42 months and involve Signaal as main contractor and TNO-FEL (Physics and Electronics Laboratory) as subcontractor. The air defense system emerging from ARTIST will integrate the SMART-L and SMART-S radars, a phased-array version of the STING fire control radars, infrared sensors and anti-aircraft missiles.

In 1992, Canada, Germany and the Netherlands reached an agreement for the joint development of a new active phased-array radar to provide the fire control element for the new air warfare system. Signature of the appropriate MoU was delayed for almost a year by a German defense funding freeze, but was completed in early 1993. As a direct result of this MoU, the Royal

Netherlands Navy and Signaal signed an US$18 million contract for the development of the APAR radar. The new radar, with its associated air warfare system, was scheduled for installation on the new German F-124 and Dutch LCF destroyer designs as well as the existing Dutch Jacob Van Heemskerck and Canadian Halifax class frigates.

In late 1993, Spain announced that it would be joining the new development program and would be installing the new air warfare system on its F-100 class destroyers. Interest in the APAR system has continued to grow, with Australia considering installing the equipment as part of its FFG-7 upgrade program and Taiwan contemplating a similar upgrade to its FFG-7s. However, reports surfaced during 1994, alleging development problems with APAR.

At that time, there was no independent evidence to support these suggestions and they may well have been nothing more than the normal intricacies of developing a highly sophisticated system. However, Spain pulled out of the trilateral program in June 1995 in favor of adopting either the SPY-1F or the US Navy/ Lockheed-Martin Distributed Advanced Naval Combat System (DANCS). There was some speculation that this decision may have been related to the reported technical problems with APAR. The German and Dutch navies reaffirmed their faith in the APAR system by prefunding APAR development with a US$13 million contract to Signaal for advanced work on the new radar. Germany also specified APAR for the upgrade of its existing Type 122 frigates.

On December 29, 1995, Signaal signed an engineering, manufacturing and development (EMD) contract worth US121 million. This locked in place a revised time schedule for introducing the product now in the year 2000, in lieu of the earlier planned service entry in 2002. The first production radar should be ready by July 2000. It will be installed in a diamond-shaped masthead module and the complete assembly should be lifted on the first frigate of the trilateral cooperation program by October that year. For Signaal, this contract has major significance both technologically and strategically, despite the monetary value which is not a new all-time high for the company.

The EMD contract is a direct consequence from a government-level Memorandum of Understanding between the Netherlands, Germany and Canada, entered earlier in the fall. Under the EMD contract, each partner has agreed to buy four APAR systems, the first forming the AAW cornerstone for the new trilateral program frigates. This comprises the first two ships of the De Zeven Provincien class in the Netherlands and the F-124 Sachsen class in Germany. The second Dutch pair will be used for either modernizing two Jacob van Heemskerck class frigates or for additional De Zeven Provinciens, depending on the availability of funding. Canada said originally it would install theirs on four of the existing Halifax class frigates. More recently, however, it has been estimated that the decision of the platform is less certain and will depend on what the successor for the Halifax class hull is.

The EMD contract also entails that Signaal will be working with a number of international partners on the project, including Germany's DASA (Daimler-Benz Aerospace) Sensor Systems Division and STN-Atlas Elektronik, Hughes Missile Systems of the US, and Canada's Northern Telecom and Spar Aerospace.

In 1997 it was reported that Signaal had offered both APAR and SMART-L technology to the US Navy in hopes of capturing some of the USN programs for multi-function self defense and surveillance radars. It is believed that Signaal teamed with Hughes for this offer. However, as no other information regarding these offerings has been released in the following years, the systems most probably did not make the first tier of the USN programs.

Additionally in March 1997, Signaal began preliminary beam forming measurements using a prototype array incorporating four column assemblies (out of 64), but containing fully compliant transmit-receive (T/R) modules slotted behind the waveguides.

In early 1998, Signaal began testing the APAR EMD prototype on their new Compact Antenna Test Range (CATR) located at Signaal's main plant in Hengelo, the Netherlands. This test used the first complete APAR array and is scheduled to be concluded in July 1999. After this testing concludes the APAR test unit is scheduled to be to a land-based test site at the Dan Helder Naval Base, the Netherlands.

As of mid-1998 the APAR system had been proposed to equip a number of ships including the Turkish TF2000, South Korea's KDX-3, and the Australia ANZAC Warfighting Improvement Program (WIP). Of these the KDX-3 has apparently opted for the Signaal LW.08 and MW.08 systems. A slim chance exists that the US Navy could adopt the system as part of its Project Akcita- a series of studies to determine the direction that the next anti-air self-defense systems will take. Project Akcita is known to be favorable disposed towards I-band phased array radars.

During the same time frame Signaal reportedly began looking at designing a smaller, three-face APAR

derivative using a half-array sized unit. This system would be used primarily to control missiles and guns on ships having a displacement weight of less than 2,000 tons.

Funding

Development of APAR is a joint effort by a consortium of the Dutch, German, and Canadian governments, involving the companies listed above.

Recent Contracts

Contractor	Award ($ Millions)	Date/Description
Signaal	38.4	Late 1997- German Navy issues a pre-contract for three APAR systems with an option for a fourth. The first unit is expected to be delivered by December 2000.

Timetable

Month	Year	Major Development
	1989	Development of EXPAR demonstrator
	1991	Development of ARTIST AAW system initiated
Nov	1992	Germany and Canada enter negotiations
	1993	Joint Canadian/German/Dutch development MoU
Jul	1993	Development contract awarded
Oct	1993	Spain joins program
	1995	Spain leaves program; elevation to advanced development stage
Dec	1995	EMD contract for the Trilateral Frigate Cooperation program
Dec	1997	Pre-contract issued by German Navy for up to four systems
	1998	Contract issued by the Royal Netherlands Navy for four systems
	1999-2000	Trials scheduled to begin on TFC (De Zeven Provincien class)
	2000	Installation on Dutch DZP and German F-124 frigates projected
	2001	Harbor and sea acceptance tests scheduled for Dutch AAW system
	2003	Retrofit to Jacob van Heemskerck class
	2005	Retrofit to Halifax, F-122 class

Worldwide Distribution

Two prototypes produced.

Installations foreseen for **Canadian**, **Dutch** and **German** fleets.

Forecast Rationale

The Active Phased Array Radar (APAR) system is a tri-nation joint venture whose ultimate goal is the production of an integrated surveillance and fire control radar for use by AAW frigates. The system uses the I/J-band not only for its excellent horizon detection rate, but do to its compatability with the ESSM and SM-2 missiles. The I-band is considered to be the leading candidate for surveillance and AAW functions in the future as evinced by the US Navy Akcita study. This study has identified I-band radars as the preferred system for future AAW and self-defense purposes on USN ships.

I-band systems, and APAR in particular, are designed to act as the fire control component of an integrated air warfare system, capable of target detection, tracking

and missile guidance functions. The system is one of increasingly more sophisticated multi-function radar units. While comparatively expensive when compared to non-multifunction radars, APAR is able to replace two or even three older radars – making it a real bargain for modernization.

APAR is currently undergoing its final land-based testing in Holland prior to being outfitted on a German Navy vessel. Interestingly, it appears that no actual sea-based testing will occur. The inference is that the first system, which is due to become operational in 2001, will serve a dual purpose as both an operational and test system.

In late 1997/early 1998 both the German Navy and the Royal Netherlands Navy signed a procurement contract for a total of three and four systems, respectively. Germany also has an option to procure a fourth system. Canada, which has been behind the program since 1993 has continued to vacillate on awarding a production contract. This delay is not the fault of the system, but whether Canada wants to upgrade the *Halifax*-class frigates, which are fast approaching the end of their operational life, or wait to until a decision is made on a more modern hull, or a combination of both (i.e. upgrading a minimum number of the Halifax's while its successor is chosen).

The ten-year forecast detailed below is based primarily on the orders and potential orders of the Canadian, Australian, Dutch and German orders. While the Dutch and German orders can be considered solid, the same cannot be said for Canadian and Australian procurement.

Of the two Canada is the most likely to forge ahead with the procurement of APAR. Canada's main problem in delaying a decision to procure this system rests not with the system, but rather its inability to decide whether upgrading its Halifax-class frigates is worth it or whether they should wait to install the system on the Halifax's replacement. The entire Canadian forecast should be treated as "Good" overall.

Australian orders for APAR is rather tenuous at this time. The radar system is currently in a contest with three other systems to be used in the Australian Warfighting Improvement Program (WIP) which should be decided by the end of 1999. The winner of the WIP will be retrofitted to at least eight Australian frigates. Due to the uncertainty of APAR winning this competition, the Australian line should be treated as "Speculative" until a winner is determined.

On the generic export market it is felt that at least some systems will be procured by those nations wishing to modernize their navies. As stated previously, the systems estimated US$9.6 million price tag is about three times higher than the equipment it will replace. However, the system's very high processing capacity means that a single APAR system can replace two or even three dedicated fire control radars as well as, if necessary, take over many of the functions of a target acquisition radar. The economies resulting from such concentration of function may offset the higher purchase price by lowering the overall fit cost.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level			Good Confidence Level				Speculative			
Designation	Application	thru 98	99	00	01	02	03	04	05	06	07	08	Total 99-08
SIGNAAL APAR	DD/FFG (CANADIAN NAVY)	0	0	0	0	3	3	3	3	0	0	0	12
SIGNAAL APAR	DDG/FFG (EXPORT)	0	0	0	0	0	1	1	2	2	2	0	8
SIGNAAL APAR	DDG/FFG (ROYAL AUSTRALIAN NAVY)	0	0	0	0	2	2	2	2	0	0	0	8
SIGNAAL APAR	FFG (GERMAN NAVY)	0	0	1	1	1	1	0	0	0	0	0	4
SIGNAAL APAR	FFG (RNLN)	0	0	0	1	1	1	1	0	0	0	0	4
SIGNAAL APAR	Prior Prod'n:	2	0	0	0	0	0	0	0	0	0	0	0
Total Production		2	0	1	2	7	8	7	7	2	2	0	36