

# ARCHIVED REPORT

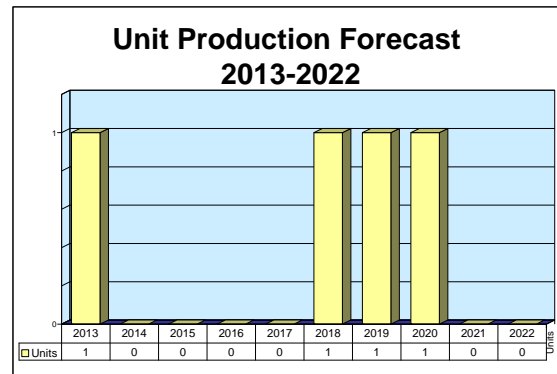
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## APAR

### Outlook

- Thales produces an AAW suite that consists of APAR and SMART-L radars, and one fire control cluster
- Final Danish APAR expected for delivery in 2013
- No further orders are on the books, but additional sales are possible. Deliveries will not commence for four to five years, following a contract award



### Orientation

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

#### Sponsor

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**Licensee.** No production licenses have been granted.

**Status.** In production and service.

**Total Produced.** 12 APAR systems will have been produced by the end of 2013, including two prototypes.

**Application.** APAR is designed to act as the fire control component of an integrated anti-air warfare (AAW) system; it performs target detection, tracking, and missile guidance functions.

**Platform.** APAR's three platforms are the Dutch De Zeven Provinciën class, the Danish Ivar Huitfeldt class, and the German F-124 Sachsen class. Primary platforms are destroyers and frigates.

**Price Range.** The price of an APAR system has not been publicly released. Therefore, Forecast International can only provide an approximate price range of \$10 million to \$12 million.

## APAR

## Contractors

## Prime

<b>Thales Nederland BV</b>	<a href="http://www.thalesgroup.com/netherlands">http://www.thalesgroup.com/netherlands</a> , Haaksbergerstraat 49, Hengelo, 7554 PA Netherlands, Tel: + 31 74 2488111, Fax: + 31 74 2425936, Email: <a href="mailto:info@nl.thalesgroup.com">info@nl.thalesgroup.com</a> , Prime
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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; [rich.pettibone@forecast1.com](mailto:rich.pettibone@forecast1.com)

## Technical Data

<b>Specifications</b>	<b><u>Metric</u></b>	<b><u>U.S.</u></b>
Frequency band	I/J-band	
Spatial coverage	360° x 85°	
Instrumented range		
Surface	32 km	19.9 mi
Horizon	75 km	46.6 mi
Air search	150 km	93.2 mi
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.** The APAR consists of four active phased arrays, each with a 90° field of view, mounted on the sides of a fixed rectangular housing. Each array consists of 3,200 transmit/receive (T/R) elements, mounted in groups of four, to form T/R modules. These modules are grouped into 32-column assemblies, each of which has its own data distribution and power converter assemblies. The T/R modules are capable of generating 500 pencil beams per second scanning over a 120° arc.

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

For ease of construction, repair and retrofitting, the APAR system comprises three clusters:

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

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

The I/J-band was selected for APAR because of its superior horizon detection capability and its compatibility with the Evolved SeaSparrow Missile (ESSM) and SM-2 missiles. Susceptibility to clutter is overcome using FFT Doppler processing.

APAR is able to handle multi-target tracking out to 150 kilometers against more than 250 air and surface targets, including helicopters. It also offers weapon control support, including missiles and guns, and can perform search functions, including horizon search out to 75 kilometers, surface search out to 32 kilometers, and helicopter searches. The system is capable of providing guidance for the RIM-7P and RIM-7M SeaSparrow, Evolved SeaSparrow, and Standard SM-2 missiles.



Germany's F-124 Class Frigate *Sachsen* Mounted with the APAR Multifunction Radar

Source: German Navy

## Variants/Upgrades

**SEAPAR.** A lighter and reduced-cost derivative of APAR is SEAPAR. In some of its literature, Thales refers to SEAPAR as the Scaled ESSM APAR, or the Scheduling and Evaluation of Active Phased Array Radar. SEAPAR's reduced weight will permit it to be installed on board smaller vessels, such as corvettes.

**Sea Master 400/SMILE.** The Sea Master 400 (known domestically as SMILE) has been designed by Thales as a successor to APAR. It incorporates aspects of the APAR and SMART radars. More information on the system can be found in the *Integrated Mast* report located in FI's *Land & Sea Based Electronics Forecast* and *Radar Systems Forecast* books.

## Program Review

**Background.** APAR development originated from the Experimental X-band Phased Array Radar (EXPAR) demonstrator program. The EXPAR program, which started in Holland in 1989, led to the award of a two-year contract from the Royal Netherlands Navy (RNLN) for module design of the APAR in 1993. EXPAR was run by Signaal (now Thales Nederland) and TNO-FEL (Physics and Electronics Laboratory).

In 1991, a contract was awarded to Signaal and TNO-FEL to study Advanced Radar Techniques for Improved Surveillance and Tracking (ARTIST). This project studied data processing for air defense systems. The aim was to design a fully integrated air warfare system, initially based on the Evolved SeaSparrow Missile (ESSM) but capable of expansion to the Standard Missile - 2 (SM-2). The ARTIST air defense system was to integrate with the SMART-L and SMART-S radars, a phased-array version of the STING fire control radar system, infrared sensors, and anti-aircraft missiles.

### *Canada, Germany, and the Netherlands*

In 1992, Canada, Germany, and the Netherlands agreed to the joint development of an active phased-array radar to provide the fire control element of a new air warfare system. The Memorandum of Understanding (MoU) was signed in early 1993 and, as a direct result, the RNLN and Signaal signed an \$18 million contract for APAR development. 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 on the existing Dutch Jacob van Heemskerck and Canadian Halifax class frigates.

In 1993, Spain showed interest in APAR for its F-100 class destroyers. Interest in APAR continued, with Australia considering APAR as part of its FFG-7 upgrade program, and Taiwan contemplating a similar upgrade to its FFG-7s. The German and Dutch navies reaffirmed their faith in the radar by pre-funding APAR development with a \$13 million contract to Signaal.

## APAR

**EMD Contract Award.** In 1995, an MoU related to APAR was signed by the Netherlands, Germany, and Canada. At the same time, Signaal signed an engineering and manufacturing development (EMD) contract worth \$125 million with each partner agreeing to buy APAR systems. Initial plans indicated that four De Zeven Provinciën class ships in the Netherlands and three German F-124 Sachsen class ships would receive APAR systems. Originally, Canada said that it would install APAR on four of the existing Halifax class frigates. Canada has since decided not to purchase APAR (see below).

In December 1999, the APAR engineering development model (EDM), consisting of one array, was installed at the RNLN Land-Based Test Site (LBTS) in Den Helder. The EDM underwent operational testing and was subsequently integrated with the SMART-L long-range volume search radar and command & control system.

**Three-Phase Evaluation.** The LBTS evaluation was divided into three phases. The first phase, successfully completed in May 2000, incorporated a series of live flying tests focusing on search, detection, extraction, and track functionalities. The second phase utilized new software and evaluated helicopter and surface functionality. The final phase tested electronic counter-countermeasures and was supported with naval gunfire. The third phase was completed in September 2000.

Prior to the LBTS evaluation, the APAR Qualification and Reference System (QRS) underwent assessment in February 2000. Using a variety of equipment, including the Northrop Grumman ALQ-131 Block II electronic countermeasures (ECM) pod, the APAR QRS was subjected to jamming signals.

**Sea Trials.** APAR series production ran parallel to radar testing. Four antenna arrays, four radar waveform generators, and two missile waveform generators were installed on the first mast module, which was delivered to Blohm + Voss in Hamburg, where the German F-124 frigates were being built.

APAR installation on the *Sachsen* began in January 2001. In July 2001, the first APAR was delivered for installation on the first De Zeven Provinciën class frigate, which was commissioned in 2002. APAR sea trials on board the *De Zeven Provinciën* and the *Sachsen* began in the summer/fall of 2001.

Live missile firings were conducted in November 2003 from the *De Zeven Provinciën*, using APAR's interrupted continuous-wave illumination (ICWI) technology. Unlike other systems, ICWI permits multiple missiles to be controlled with one APAR. Raytheon RIM-162 Evolved SeaSparrow Missiles (ESSMs) and SM-2 Block IIIA Standard missiles were

fired at high-speed drones during the tests. APAR was able to acquire the targets and guide the missiles well within the specified kill range.

Further testing was performed during August 2004. The *Sachsen* successfully completed a series of live firings at the U.S. Naval Air Warfare Center/Weapons Division Sea Range in California. Eleven ESSMs, 10 SM-2 Block III missiles, and two Boeing Harpoon missiles were utilized in several increasingly complex scenarios.

In March 2005, an APAR system successfully guided two ESSMs and two SM-2s simultaneously to various targets, destroying all of them. The APAR engaged two drones by guiding four missiles concurrently to the targets, using only one of its four faces. The face did not reach its maximum capacity, leaving room for more engagements. The tests were conducted on board the *De Zeven Provinciën*.

### *SPY-1 Wins Three*

A key component of the Lockheed Martin AEGIS weapon system is its SPY-1 radar. In 2000, Lockheed Martin completed the first AEGIS system for Spain's F-100 frigates. In 2002, APAR was rejected in favor of AEGIS for the Republic of Korea's new KDX-3 destroyer program. A more recent potential sale was for the Royal Australian Navy's three new air warfare destroyers (AWDs). Nevertheless, U.S. ship designer Gibbs & Cox selected the AEGIS SPY-1D(V) radar in September 2005.

### *Canadian Navy Says No to APAR*

The Canadian Navy did not consider APAR for its Halifax upgrade program. According to Brett Johnson, marketing and sales director of Thales Canada, APAR was rejected owing to its weight, space, and cost. This assessment concurs with a report on the Canadian American Strategic Review news site that Canada decided not to purchase APAR owing to its need for ballast and also because of its weight, which is 20 tons. Johnson said the Canadian Navy investigated SEAPAR as an option, but that it was eliminated due to the program's limited budget.

### *Thales Markets AAW Suite*

In December 2006, the Royal Danish Navy and Thales Nederland signed a contract for the delivery of three Thales anti-air warfare (AAW) suites. Each suite consists of the APAR and SMART-L volume search radars, plus one fire control cluster. The suites will be installed on the new frigates, each displacing about 6,000 tons.

The lead ship, *Ivar Huitfeldt*, was deployed in early 2011 without its APAR radar. In April 2011, Thales reported that the first APAR had passed its factory acceptance test (FAT) at the Thales facility in Hengelo and was being installed on the *Peter Willemoes*, the second Ivar Huitfeldt frigate. The FAT for the second APAR was scheduled for August 2011, and the third for early 2012. Integration on the two frigates was to be completed in 2012 and 2013, respectively.

### **2009 Loss - Hellenic Navy**

Military Procurement International (MPI) reported in February 2009 that the Defence Ministry in Athens was seeking to procure up to six French DCNS FREMM frigates. Construction would take place at Greece's Neorion-Elefsis shipyard. FREMM frigates from France are equipped with the Thales Herakles radar, while FREMM vessels from Italy sail with the SELEX Sistemi Integrati EMPAR (European Multifunction Phased Array Radar). Losing bidders included the Netherlands' De Zeven Provinciën class frigate equipped with APAR/SMART-L radars. According to *Jane's International Defence Review*, one combination that the Hellenic Navy favored was the Thales APAR/SMART-L radars sailing on a FREMM design.

### **Reusing Technology**

In April 2009, Thales signed an agreement with the Australian Department of Defence granting it a license to use Thales' Mid-course Guidance and Sampled Data Homing function, which is based on ICWI technology. Thales developed ICWI technology as part of the APAR program. Australia will be applying this function as a part of its anti-ship missile defense upgrade of the ANZAC class frigate. ANZAC will be sailing with a competitor's radar.

### **Missile Defense Capability**

In other news, Raytheon announced in September 2011 that the company had completed testing of a prototype dual-band datalink that will enable interoperability between the Standard Missile family of interceptors and a wider variety of radars and ships. Raytheon reports that its dual-band datalink will allow ships that use AEGIS and SMART-L/APAR variants to employ the full range of Standard Missiles. Raytheon's datalink is a follow-up to the joint U.S.-Netherlands study in 2009 that concluded SM-3 could be integrated on SMART-L/APAR platforms, providing non-AEGIS ships with a viable missile defense capability.

### **APAR Successor**

Thales has designed a new radar for the offshore patrol market that will become the successor to APAR. The Sea Master 400 incorporates features and software from both the APAR and SMART series of radars, providing a non-rotating, four-face active phased-array volume search radar that simultaneously provides air surveillance, helicopter control, surface surveillance, and weapon control functions.

The system detects at short and long ranges, and has been especially designed to allow defense against asymmetrical threats.

Sea Master 400 is the nomenclature for international contracts; SMILE, for domestic sales. More information on the system can be found in the *Integrated Mast* report located in the *Land & Sea Based Electronics Forecast* and *Radar Systems Forecast* books.

## **Contracts/Orders & Options**

<b><u>Contractor</u></b>	<b><u>Award (\$ millions)</u></b>	<b><u>Date/Description</u></b>
Thales Nederland	N/A	Dec 2006 – Contract with Royal Danish Navy for the delivery of three Thales AAW suites. The AAW suite consists of an APAR multifunction radar, a SMART-L volume search radar, and one fire control cluster.

N/A = Not Available

## **Timetable**

<b><u>Month</u></b>	<b><u>Year</u></b>	<b><u>Major Development</u></b>
Dec	1997	Pre-contract issued by German Navy for up to four APAR systems
	1998	Contract issued by the Royal Netherlands Navy for four APAR systems
	2000	Land-based EDM testing
	2001	Delivery of first production model to shipyard

## APAR

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Aug/Sep	2001	Sea trials aboard De Zeven Provinciën and Sachsen class ships
	2002	APAR loses bid for the Korean KDX-3
Nov	2003	First live firings with the APAR-equipped <i>De Zeven Provinciën</i>
Jan	2004	Delivery of last of seven APAR systems
Aug	2004	Live test firing aboard the German Type F-124 frigate, the <i>Sachsen</i>
Mar	2005	Live test firing aboard the Netherlands' <i>De Zeven Provinciën</i> frigate
Sep	2006	APAR combined with SMART-L chosen for Dutch Navy patrol frigate program
	2014	Third and last Ivar Huitfeldt frigate scheduled to join RDN fleet

## Worldwide Distribution/Inventories

The **Royal Dutch Navy** has four systems on its De Zeven Provinciën frigates, and Thales is producing APAR for the three new **Danish** Ivar Huitfeldt class patrol frigates. The three Sachsen class (Type 124) frigates of the **German Navy** are each equipped with an APAR system.

## Forecast Rationale

Thales Nederland is starting to shift its marketing strategies away from the APAR system, which has its foundation in the 1990s, and toward newer, successor systems. Going forward, Thales will more strongly market its Integrated Mast, which features the Sea Master 400/SMILE and Sea Watcher 100/Seastar radars. Notably, the Sea Master 400 is a direct descendant of the APAR, incorporating features and software of both the APAR and SMART radars in a more modern, capable package.

Other than competition within the company, there is also strong outside competition in the naval multifunction radar market, including the BAE Systems

Sampson, Lockheed Martin SPY-1 AEGIS, SELEX Sistemi Integrati EMPAR, and Thales Herakles.

At this time, Thales Nederland is continuing to pursue future markets for APAR and SEAPAR. The primary focus is on those destroyers and frigates expected to require a multifunction radar capability. Still, with competition from the outside and alternative options available within the company, sales options for APAR appear weak.

If further orders are won, deliveries of the new APAR systems will not commence for another four to five years, potentially in 2018.

## Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			
	Thru 2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
<b>Thales Nederland BV</b>												
<b>APAR &lt;&gt; Denmark &lt;&gt; Navy &lt;&gt; Ivar Huitfeldt Class</b>												
	2	1	0	0	0	0	0	0	0	0	0	1
<b>APAR &lt;&gt; Worldwide &lt;&gt; Navy</b>												
	0	0	0	0	0	0	1	1	1	0	0	3
<b>Subtotal</b>	2	1	0	0	0	0	1	1	1	0	0	4
<b>Total</b>	2	1	0	0	0	0	1	1	1	0	0	4