Visby – Archived 4/2011

Outlook

- Construction completed, and no new orders projected
- Modifications continue, with ships not due for full operational service until 2012
- Exports seem unlikely at this time
- Future of Swedish surface combatant construction unclear
- Design appears to have been unfortunately timed and is unsuited to demands of today's market

Orientation

Description. A multipurpose ASW/ASuW corvette (FFL) with exceptionally low radar cross-section.

Status. In limited service.

Total Produced. Five ships completed

Sponsor

Royal Swedish Navy
Marinstaben
Lidingövägen 24
S-10450 Stockholm
Sweden

Pennant List

Number & Name	Builder	Launch Date	Commission Date
K-31 *Visby*	Kockums, Karlskrona SY	6/2000	5/2006
K-32 *Helsingborg*	Kockums, Karlskrona SY	6/2001	4/2006
K-33 *Harnosand*	Kockums, Karlskrona SY	6/2002	5/2006
K-34 *Nykoping*	Kockums, Karlskrona SY	9/2004	8/2006
K-35 *Karlstad*	Kockums, Karlskrona SY	8/2006	8/2007

Mission. The Visby class corvette is a multirole platform designed for wartime roles that include anti-surface warfare; guarding against hostile landing and destruction teams; and laying, hunting, and detecting sea mines. Peacetime duties include coastal patrol and maritime policing. The first four ships of the series are specifically tasked for mine clearance and ASW roles, while the remaining ship is oriented toward anti-surface warfare.

Price Range. The contract for the first two ships was originally pegged at SEK1 billion ($150 million), excluding the weapons and combat information center equipment. Fully equipped, their price later went up to about SEK1.8 billion ($270 million). However, due to the cost increases, the order for the last ship was converted into an option, with the remaining five ships priced at the same amount as the previous six. This raises the estimated unit cost to $324 million.

Visby

Contractors

Prime

Kockums AB Karlskronavarvet	http://www.kockums.se, Amiralitetsgaten 25, Karlskrona, 371 30 Sweden, Tel: + 46 455 68 30 00, Fax: + 46 455 179 34, Email: information@kockums.se, Prime

Subcontractor

BAE Systems Land & Armaments, Armament Systems Division	http://www.baesystems.com/Businesses/LandArmaments, 4800 E River Rd, Minneapolis, MN 55421-1498 United States, Tel: + 1 (763) 571-9201, Fax: + 1 (763) 572-9826 (Mark 110 57mm Gun)
Cincinnati Gear Co	http://www.cintigear.com, 5657 Wooster Pike, Cincinnati, OH 45227-4120 United States, Tel: + 1 (513) 271-7700, Fax: + 1 (513) 271-0049 (Gearbox & Clutch)
Filtronic Components Ltd	Airedale House, Acorn Park, Shipley, BD17 7SW Bradford, United Kingdom (RF Components)
Kamewa AB	PO Box 1010, Kristinehamn, 68129 Sweden (Waterjets)
Maersk Data Defense	http://www.maerskdata-defense.com, Ellegaardvej 25, Sonderborg, 6400 Denmark, Tel: + 45 3638 3000, Fax: + 45 3638 3010 (Data Processing)
MTU Friedrichshafen GmbH	http://www.mtu-on-line.com, Maybachplatz 1, Postfach 2040, Friedrichshafen, 88040 Germany, Tel: + 49 7541 90 0, Fax: + 49 7541 90 2724, Email: info@mtu-on-line.com (Diesel Engine)
Polyamp AB	http://www.polyamp.com, PO Box 925, Sollentuna, 19129 Sweden, Tel: + 46 835 9390, Fax: + 46 896 1897 (Data Processing)
Rheinmetall Waffe Munition GmbH	http://www.rheinmetall-defence.com, Heinrich-Ehrhardt-Strasse 2, Unterlüss, 29345 Germany, Tel: + 49 5827 80 0, Fax: + 49 5827 10 90, Email: info-wm@rheinmetall.com (Pyrotechnic Countermeasures)
Rolls-Royce North America	http://www.rolls-royce.com/northamerica, 14850 Conference Center Dr, Suite 100, Chantilly, VA 20151 United States, Tel: + 1 (703) 834-1700, Fax: + 1 (703) 709-6086 (TF-50A)
SaabTech, Head Office	http://www.saabtech.se, Nettovägen 6, Järfälla, 175 88 Sweden, Tel: + 46 8 580 840 00, Fax: + 46 8 580 322 44, Email: info@saabtech.se (Command & Control System)
Telefonaktiebolaget LM Ericsson	http://www.ericsson.com, Torshamnsgatan 23, Stockholm, 16483 Sweden, Tel: + 46 8 719 0000, Fax: + 46 8 719 1976 (Sea Giraffe Radar)
Thordon Bearings	http://www.thordonbearings.com/, 3225 Mainway, Burlington, L7M 1A6 Ontario, Canada, Tel: + 1 (905) 335-1440, Fax: + 1 (905) 335-4033 (Bearings)

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Technical Data

	Metric	**U.S.**
Dimensions		
Length, Overall	72 m	235 ft
Length, Waterline	61.5 m	201 ft
Beam	10.4 m	34 ft
Draft	2.4 m	7.8 ft
Displacement		
Full Load	620 tonnes	

	Metric	U.S.
Performance		
Maximum Speed	70 km/h	38 kt
Crew	43 (approx 6 officers)	
	Type	**Quantity**
Armament		
Main Gun	Bofors 57mm L70 SAK Mk III	1
Missiles – SSM	RBS15 Mk 2	8
Missiles – SAM	Umkhonto-IR	8
Torpedoes	400mm 43X2 (anti-submarine)	4
Helicopter	AB-206A JetRanger	1
ROV	CelsiusTech Double Eagle	1
Boat	RIB	1
Electronics		
Radars		
Air/Surface	Ericsson Sea Giraffe agile multibeam 3-D	1
Search	CelsiusTech Pilot I/J-band FMCW	1
Fire control	CEROS 200 Mk 3	1
Electronic Warfare, ESM	Condor CS-701	1
Decoy/Chaff Launchers	MASS	2
COMINT	INFOCOM ICS-2000 derivative	1
Sonar System	CDC Hydra multi-sonar system (TAS, VDS, HMS, sonobuoys, ROV sonars)	1
C4I System	9LV CETRIS	1
Propulsion		
Gas Turbines	Allied-Signal TF50A	4x 4,000 kW
Diesel Engines	MTU 16V2000 N90	2x 1,300 kW
Waterjet Units	KaMeWa 125 SII	2
Gearboxes	Cincinnati Gear MA-107 SBS	2

Design Features. The Visby class is a multipurpose corvette with exceptionally low radar cross-section, thanks to the design's extensive use of stealth technologies.

The design of the Visby is intended to minimize the optical and infrared signature, above-water acoustic and hydro-acoustic signature, underwater electrical potential and magnetic signature, pressure signature, radar cross-section, and actively emitted signals. Stealth acts to delay detection, identification and target acquisition by hostile forces, enhancing both the first strike capability and survivability.

Signature Reduction. The concept of a stealthy (reduced radar cross-section) craft was tested by the Royal Swedish Navy during the 1990s on the KSS *Smyge* surface effect ship (SES), which acted as a small-scale pre-prototype testbed for the YS-2000 class of boats. Because the *Smyge* was not an actual production prototype, it was possible to minimize the size (length 30.4 m, beam 11.4 m, and a dead weight of 140 tonnes) of the vessel without significantly sacrificing its ability to provide a platform for meaningful and reliable testing and evaluation of the general principles at issue.

Several of the stealth properties are immediately evident upon visual inspection of the vessel. On the other hand, an observer cannot easily determine the ship's mission because the armament and sensors are concealed. Especially important is the fact that every piece of external equipment contributing to the ship's total radar cross-section has been moved away from exposed locations on the weather deck to the inside of the hull. This configuration allows the general outline of the ship to be adjusted for very low monostatic radar reflections. Extensive theoretical calculations have been employed in optimizing the surface, and great pains have been taken to introduce new technology in critical applications.

The design philosophy for the outer hull is to collect incident radar radiation and scatter it in a few non-hazardous directions. In areas where functional limitations restrict the external shaping, radar-absorbing materials have been applied. Particular attention has been paid to a variety of design details, using computerized calculations and simulations as well as measurement on scale models. As a result of the theoretical and experimental work, the following principles were adopted:

Visby

- The hull was configured with a small number of flat plates that are inclined so that any reflections are directed in a controlled fashion.
- A gun turret of special design was adopted, minimizing the radar cross-section.
- All traditional main deck equipment and procedures that are traditionally performed on the weather deck were moved inside the hull.
- Special materials were used where necessary to control radar reflectivity.
- Extreme care was employed when locating open cavities, such as air intake and exhaust ducts.
- The number of exposed antennas was minimized by encasing them in protective cladding or flush-mounting, or by using pop-up techniques.

Reducing radar cross-section often implies preventing radio-frequency energy from entering the interior of the hull. Great care was taken to prevent undesired leakage through imperfectly closed hatches, doors, and other openings. These efforts work synergistically with corresponding activities related to the reduction of EMI/ EMP hazards. These threats are largely concentrated in the frequency region of 10 kHZ to 300 MHz, where the radars take over. A Faraday cage enclosing vital parts of the ship has beneficial effects against all types of radiation and thus fulfills a double purpose.

The various magnetic signatures normally generated by the vessel have been reduced by the extensive use of carbon-fiber-reinforced plastic sandwich panels on the exterior surfaces, galvanic interruption in frames for doors and hatches, galvanic interruption in pipe systems, stainless steel exhaust ducts, composite (carbon-fiber) propshafts, and the high placement of magnetic sources.

Anti-ship missile seekers hone-in on their targets by means of what is known as the midrange infrared (MIR) window. A far infrared (FIR) window, on the other hand, is used for surveillance. Because they would be detectable in the MIR window, all point heat sources must be eliminated. Warm sources, i.e., at or around room temperature, show as radiation, mainly in the FIR window. To avoid detection in the FIR window, the vessel has to have an IR signature that corresponds as closely as possible to the surroundings. The techniques used to avoid hot spots include encapsulating and isolating the hot spots, or cooling them with air or water.

A hull built of fiberglass sandwich automatically gives good heat insulation and prevents heat bridges between the two laminates. The selection of hull material is dominated by the requirement for stealth, strength, and weight constraints, oceangoing characteristics, and cost. The hull material is a sandwich construction consisting of a PVC core with a carbon fiber and vinyl laminate. The material provides high strength and rigidity, low weight, good shock resistance, low radar signature, and low magnetic signature. The flat panels are manufactured using a vacuum injection process. The panels are then joined to form larger hull sections. The research and development of the hull material and construction technology was undertaken by FMV, KkrV, the Royal University of Technology, and the National Defense Research Establishment.

The exhaust ducts and the air conditioning outlets still need to be suppressed. On the *Smyge* testbed, the exhaust ducts were water-cooled, and the exhaust could also be routed to the air cushion under the vessel, which obviously is not an option on the monohull YS-2000. In the Visby class, the exhaust emission outlet for the engines is concealed in a duct under the water surface, at the center of the stern.

The most difficult task was reportedly dealing with the bridge windows, since they have to fulfill different and sometimes conflicting requirements, including radar reflection, de-icing, and infrared emission reduction. In addition, they must be resistant to static and dynamic loads from heavy seas and gun blasts.

Machinery. The YS-2000 series has a CODAG (combined diesel and gas turbine) main propulsion arrangement coupled to waterjets. Four TF 50A AlliedSignal gas turbines are used for medium- and high-speed maneuvers and transit operations, generating a top speed of at least 35 knots. The low-speed operations and loitering are handled by the two MTU 16V2000 N90 diesel engines (total output 2,600 kW), with a top speed of about 15 knots. They are connected to two gearboxes that run two KaMeWa waterjet propulsors. Additionally, the ship has rudders and bow thrusters for slow-speed maneuvering in harbors.

Communications. The Karlskrona shipyard is the system integrator of the communications system. Central to the system is a high-capacity digital communications switch that interconnects the voice and data communications channels. The Denmark-based company INFOCOM, together with Karlskrona, developed the digital communications switch. The system provides internal communications using point-to-point communications or open conference lines. Radio links and land-based networks are used for external communications. The switch also provides frequency management and remote control of tactical radio and peripheral equipment.

A demountable mast is provided for peacetime operation.

The CETRIS combat management system was selected. The Swedish Defense Materiel Administration, FMV, issued an Invitation to Tender in the spring of 1997.

Operational Characteristics. The primary roles of the first four ships of the YS-2000 series are mine countermeasures (MCM) and anti-submarine warfare (ASW) operations. The second series of corvettes, originally planned to consist of six ships but now reduced to one, is primarily tasked with the attack and anti-surface warfare (ASuW) roles. A helicopter can land, take off, and refuel on the rear deck. Preparation has been made for the installation of a hangar on the ship. Both series of corvettes have patrol and reconnaissance capabilities and can perform command and communications functions. The corvettes can also be equipped for minelaying, and are capable of fulfilling a role in international operations. They can operate year-round in the variable and harsh conditions of the Baltic, Kattegat, and North seas.

The Visby class is equipped with hull-mounted sonar for mine detection, and remotely operated vehicles (ROVs) for minehunting and mine destruction. For ASW, it has a suite of 127mm rocket-powered grenade launchers, depth charges, and lightweight torpedoes. Active hull-mounted sonars, variable depth sonars, and passive towed array sonars provide underwater reconnaissance and tracking. There are three fixed 400mm torpedo tubes.

In the minehunting role, the corvette runs on diesel engines at low power for long periods. Surface attack missions require high-speed capability and will use the four gas turbines. In the submarine hunting role, which requires high flexibility in speed and duration, the corvette can run on diesel engines or one gas turbine per shaft.

Air defense is carried out with an air defense command system, artillery, and electronic countermeasures. The countermeasures include chaff launchers. The Visby is equipped with a Bofors 57mm 70 SAK Mk III general-purpose gun with a new, low-signature cupola. The gun has a range of 13.9 kilometers (8.6 mi) and a firing rate of 220 rounds per minute.

The preferred candidate for the surface-to-air missiles is reportedly a naval version of the medium-range Bofors RBS23 BAMSE. These missiles were to be fitted on the Batch 2 ships during construction, whereas the first four would probably receive them as retrofits. No close-in weapon system (CIWS) gun was to be installed on any of these ships.

The second batch of the YS-2000 was also to carry the latest version of the RBS15 anti-ship missile – probably the Mk III – since the primary mission of these ships was to be anti-surface warfare. The RBS15 has a range of 80 nautical miles and is equipped with an active radar homing guidance system.

The integrated communications system is operated and managed from a commercial personal computer using a Windows-based graphical user interface. The operator using the PC has the choice of using the automatic communications route management system or manually selecting the communications path. The digital communications switch has three independent and parallel processors for built-in redundancy. The communications system and the combat management system are connected via a local area network using an open system structure, and built to international standards.

Variants/Upgrades

KSS Smyge. The Visby class corvettes are derived from the original catamaran-hulled vessel KSS *Smyge*, which was a testbed for new stealth technologies between 1991 and 1993 (see **Program Review**).

YS-2000. This was the interim designation, or project name, for the class used prior to the establishment of the class name Visby. The designation is derived from the Swedish word "ytstridsfartyg" (surface combat vessel) plus the year 2000. The class name Visby is now more commonly used.

YS-2000, Batch 2. In 1999, plans for Visby class construction were trimmed down to comprise a total of only six ships in two batches (four plus two). While both batches are basically the same vessel, boats in Batch 1 are intended for mine countermeasures (MCM) and anti-submarine warfare (ASW). The second batch was to specialize in attack and anti-surface warfare (ASuW) and carry the latest version of the RBS15 anti-ship missile; a second fire control radar would be installed aft. This batch was first reduced to a single hull and then canceled completely.

Visby-Plus. A variant of the Visby design being prepared by Kockums in response to the Swedish Navy's requirement for a major surface combatant to follow the Visby class. The Visby-Plus is a 1,500-ton light frigate based on an 88-meter hull built of GRP sandwich. The beam is 15 meters. The ship will be powered by four 7.2-kW diesel engines to give a speed of 30 knots. The design features a full helicopter hangar

and replenishment-at-sea facilities. Armament will consist of 16 vertical launch tubes for air defense missiles, eight anti-ship missiles, a RAM launcher, a medium-caliber gun, mine rails, and four torpedo tubes. The sensor suite will include surveillance radars, IR sensors, and both hull-mounted and towed sonars.

Missile Boat 2010. There was a suggestion in the late 1990s that some of the principles used in designing the YS-2000 could be applied to the Missile Boat 2010. A smaller surface effect ship was envisioned, weighing 200 to 300 tonnes with a top speed of 40 to 45 knots. The proposal specified a separate lift motor to create an air cushion between the hulls. Manning requirements were expected to be very low. The design was expected to have a low radar signature, and employ a number of intelligent sensors integrated in the vessel's surface structure. This proposal now appears to be defunct, and has been replaced by the plan for the new light frigates.

KSS *Visby & Helsingborg (*note spray clouds*)*

Source: Royal Swedish Navy

Program Review

Background. The Swedish Navy's research and development efforts regarding naval stealth technology applications have been ongoing since the late 1970s. The bulk of the work has been conducted by the Swedish Defense Materiel Administration (FMV), with consultative support from the Royal Institute of Technology and the Swedish Defense Research Establishment.

Testbed Comes First

Two separate tasks were addressed, resulting in an interim operational coastal corvette (Stockholm and Göteborg classes) and an advanced test vessel, KSS *Smyge* (the word "smyge" in Swedish means having stealth properties). The two slightly differing corvettes were basically conventional designs, although considerable effort had been put into reducing their hydro-acoustic signature. The *Smyge*, on the other hand, was to exemplify a construction technique where signature reduction is given absolute priority.

In 1987, FMV launched a comprehensive research and development program aimed at building a test platform for naval stealth techniques. Limitations in time and budget necessitated a concerted, carefully planned effort involving industry and research organizations, as well as government agencies. In June 1989, a contract for building an experimental surface effect ship (catamaran hull) was signed. The KSS *Smyge* was launched on March 14, 1991.

The Staff requirements for the test program were to:

1. Implement stealth techniques on naval ships

2. Integrate new technology for weapons, communications, and sensors
3. Implement general surface effect ship technology

This test program was started in December 1991 and continued into mid-decade. The trials were specifically designed to provide guidance for the design and construction of future ships of this nature. Following its launch, the *Smyge* was involved in extensive testing of its radar cross-section properties, with very satisfactory results.

Building on Trials Results

In August 1993, following the successful trials, Vice-Admiral Dick Börjesson (Commander-in Chief of the Royal Swedish Navy) announced that the Navy was planning to acquire two new classes of ships exploiting the technology developed. These were referred to as the YSM-2000 corvette and the YSB coastal patrol/mine countermeasures craft. Four of each type were to be built initially, with two more YSM-2000 corvettes and eight more YSB minehunters to follow.

Following this announcement, the Swedish government, in January 1994, granted approval for the first batch of four YSB class minehunters. An order for four was placed on February 11, 1994. The YSB mine warfare vessel has since taken a slightly more conventional approach, while still employing some of the principles of stealth.

Conventional Hull Adopted

The growing size of the YSM-2000, meanwhile, began to cause doubts about the viability of the surface effect ship concept, and pressure was growing to revert to a conventional monohull design. As a result, in August 1994, the SES design was abandoned and replaced with a vee-shaped monohull design of 63 to 70 meters in length, displacing about 420 tons. The deciding factors were presumably the more limited area of operation and higher cost of the SES versus the more traditional monohull design. Because of this change in plans, the first orders were delayed until the third quarter of 1995.

The orders for the first two units were placed in October 1995, with the option for the next two exercised at the keel-laying of the first ship, in December 1996. At that time, it was stated that the program could involve up to 14 ships for the Royal Swedish Navy. The subsequent decision by the Swedish Parliament and government to cut back future defense budgets, however, placed question marks on these plans.

Selecting Subsystems

In the summer of 1997, it was reported that the Danish company INFOCOM had won a contract for its ICS-2000 integrated communications systems to be fitted on the Visby class. On the Danish Niels Juel class frigates, the system comprises four work stations integrated with an automated message-handling system in a Windows NT environment. Whether that solution will be carried over to the Swedish ships is not yet known. The deliveries for the Visby class units began in 1998.

On September 30, 1997, FMV signed a contract with Computing Devices Canada Ltd in Ottawa for the procurement of four ASW and MCM sonar systems for the corvettes under construction at Karlskrona. This order also included the procurement of a complementary sonar system for the Göteborg class corvettes already in service. The contract value exceeded $65 million.

The order included the following systems for integration into the most technically sophisticated and complete underwater surveillance system in the world, named Hydra MSS (Multi-Sonar System):

- TAS (Towed Array Sonar)
- VDS (Variable Depth Sonar)
- HMS (Hull Mounted Sonar)
- Sonars for mounting in ROV sonobuoys

Proposals for this procurement were invited in spring 1996 and succeeded in attracting 15 of the world's leading sonar manufacturers and system integrators to vie for the contract seven months later.

The Hydra sonar system has already aroused interest in the naval communities on both sides of the Atlantic, since it represents a very capable and all-new system for a platform whose mission is decidedly different from that of some of its predecessors in the same size range.

CETRIS, the ship's C^4I system, is another subsystem that is being observed with interest due to how it supports the role of these ships and their mission. Bids were invited in the spring of 1997 from potential suppliers for four such suites for the Visby class. A contract for 9LV CETRIS was awarded to CelsiusTech on March 24, 1998, covering the first four boats of the series.

Bids were also invited for medium-range surface-to-air missiles in 1997, to be fitted on the second batch. Bids were expected from not only Bofors (RBS23 BAMSE), but also Eurosam (FSAF, with Aerospatiale VL Aster missiles), Matra BAe Dynamics (VL Seawolf), and Raytheon (VL Enhanced SeaSparrow). The invitations for bids suggested that the contract would involve arming six to 10 ships between the years 2000 and 2007.

Visby

Meanwhile, the original stealth technology demonstrator vessel, HMS *Smyge*, reportedly has been converted into a public relations and recruitment center for the Swedish armed forces.

Construction Cut Back

In 1999, the Navy trimmed down its plans to a total of only six ships in two batches (four plus two). Although both batches would have basically the same vessel, the hardware would be based on their respective missions. The boats in Batch 1 would be mainly intended for mine countermeasures (MCM) and anti-submarine warfare (ASW), while the second batch would specialize in attack and anti-surface warfare (ASuW).

The two units of Batch 2 were ordered in August 1999. The main tasks of these boats were to be ASuW and to deflect attacks from the air, mainly from rotary-wing aircraft. Instead of carrying helicopters on board, these two follow-on ships were expected to house RBS15 anti-ship missile batteries on the rear deck, where the first four ships have the landing facilities for the helos.

The first-of-class was launched on the birthday of the King of Sweden, June 8, 2000, and underwent on-water trials that lasted until the ship's commissioning in March 2001. At the time of the launching ceremony, the FMV joint procurement director, Rear Adm. Bertil Bjorkman, announced that the next generation of Swedish surface combatants would enter service in the 2010 to 2012 period, and would be much larger than the Visby class. He said that the minimum size of the next-generation ships would be in the 110-meter bracket, suggesting a displacement in excess of 2,000 tons. This plan appeared to be a replacement for the suggested Missile Boat 2010.

In late 2001, the Visby construction contract was re-negotiated to take into account the rising cost of these ships. The order for the last of the six ships was converted into an option, leaving the remaining five ships to be built for the same cost as the original six – effectively representing an increase in unit cost of approximately 20 percent. Interestingly, orders continued to be placed for subsystems for the sixth hull, suggesting that its procurement was still contemplated. However, the option on this ship expired in September 2003.

Trial s Period Started

In December 2001, first engineering and sea trials of the KSS *Visby* were conducted. At the same time, details were released of the new Visby-Plus design that appears to be Kockums' response to the requirement announced by Rear Adm. Bertil Bjorkman. Visby-Plus is somewhat smaller than the requirement announced by Admiral Bjorkman, and may be an intermediate step in that direction.

Following these trials, the *Visby* was handed over to the Swedish Navy on June 10, 2002. The announced schedule for the new ship included equipping her with the planned combat management system, weapons, and sensors in 2003, prior to an extensive series of trials in 2004.

At the end of October 2002, Northrop Grumman signed an exclusive cooperation agreement with Kockums that would enable the Visby design to be used as the basis of the Northrop Grumman bid for the U.S. Littoral Combat Ship and its Focused Mission Vessel precursor study. This agreement also allowed for the exploitation of Kockums' foam-cored glass-fiber construction technology by Northrop Grumman in its LCS proposals.

FIRE!

However, shortly after this agreement was signed, a fire broke out in the area of the lifting fans near the engine-room of the Norwegian Alta class air-cushion catamaran minesweeper KNM *Orkla*. The fire took only seven minutes to engulf the bridge; apparently the flames had spread through the funnel. Although it was believed that the fire had been brought under control, it later flared up again. The fire proved impossible to put out, as it had spread to the composite hull itself, and in time, to the entire ship. While the burning composite materials in the hull were the primary source of the problem, the vessel's partial aluminum construction was also to blame. The minesweeper had been burning steadfastly for 24 hours when she capsized early on the morning of November 20. The rapid loss of the *Orkla* is currently attributed to the use of a sandwich material, which appears to act as a fire accelerant, as well as giving off large clouds of choking smoke and toxic gas.

The schedule for the full operational service of the Visby class was confirmed during the course of 2003. This envisioned that the first pair of ships would be commissioned in 2005, with the second pair following in 2006 and the last entering full service in 2007. By

the end of 2006, the first four ships were commissioned, with the last due to follow in 2007, although the Swedish Navy later admitted that none of the class would be available for full operational service until 2008. The Swedish Navy revised this estimate in 2007, stating that the Visbys had been delayed and would not be delivered until 2009-2010. By early 2010, this program had been delayed still further, with the first of the operational ships to be delivered in late 2010 and the remainder at six-month intervals. The last operational ship will be delivered in 2012.

Funding

The *Smyge* and YS-2000 programs were both funded by FMV on behalf of the Royal Swedish Navy. Funding was first provided for the initial batch of four, whose construction began in December 1997. Defense budget cuts reduced number of second batch to only two ships, and subsequent cost overruns compelled a further reduction to a single ship before this batch was canceled outright.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Computing Devices Canada	42.0	Jun 2001 – Three Hydra underwater warfare systems, two for installation on the fifth and sixth Visby class corvettes and the third for use as a shore-based training system.
Comrod A/S	1.2	Dec 2002 – Five intelligent antenna systems for Visby class corvettes.
SAAB	23.0	Dec 2003 – Development of a planning and combat management system for the RBS15 anti-ship missile system on the Visby class corvette.
Rheinmetall	9.9	Oct 2004 – 11 shipsets of the MASS decoy system for Visby and Goteborg classes.

Timetable

Month	Year	Major Development
	1987	*Smyge* testbed designed
	1989	*Smyge* construction started
Apr	1991	*Smyge* launched
Dec	1991	Trials started
Sep	1993	First RBS15 missiles fired off the *Smyge*
Oct	1995	Orders for two YS-2000s, with option for two more
Apr	1996	Bids invited for four sonar systems from potential vendors
Oct	1996	CelsiusTech exhibits new C^4I workstation aimed at YS-2000 program
Dec	1996	Keel laid on first ship, option for two more exercised
Feb	1997	Request for Proposals for SAMs starting with the second batch
May	1997	Bids invited for four CETRIS C^4I systems
Jul	1997	Contract for 57mm guns for the first batch, with option for the second
Jun	1998	Fourth ship laid down
Mid-	1998	Deliveries of ICS-2000 communications system begun
Aug	1999	Order placed for a follow-on batch of two
	2000-2002	Deliveries of 57mm guns for first batch
Jun	2000	Projected launch of the first ship
Dec	2001	Engineering trials of first ship commence
Dec	2001	Sixth ship reduced from order to option
	2010	All five ships expected to be in full operational service

Worldwide Distribution/Inventories

Sweden. Five units in nominal service.

Forecast Rationale

All five Visby class ships have now been nominally completed, although the Swedish Navy has delayed their full introduction to service until 2012. This is now seven years behind schedule, and the number of ships built is only a fraction of the original plan. Perhaps the Visby program can best be described as an interesting effort that failed.

In a general sense, the Visby and her sisters are a response to the rapid decline in military credibility of the missile-armed fast attack craft that started in the late 1980s and picked up steam throughout the next decade. Sweden was an early convert to the idea behind these craft and, in common with many other niche products, quickly acquired a clique of determined supporters. Despite growing appreciation of the shortcomings of these craft, in particular their extreme vulnerability to air attack, restriction to coastal waters, and dependence upon shore-based command and control systems, these supporters continued with their dedication to the concept when the first-generation fast attack craft came due for replacement.

The Visby class was a direct result of the efforts of FAC-M supporters to overcome the shortcomings of their favored concept. It was originally believed that by exploiting the (then) new arts of signature reduction, the new class would revitalize the prospects of small surface combatants. The lack of air defense was partially solved by the addition of anti-aircraft missiles, the command control problems by providing an on-board battle management system and facilities for operating a helicopter.

As it happened, none of these objectives have been fulfilled. As they actually emerged, the Visbys offered no significant capability gain over previous missile-armed fast attack craft and shared the disadvantages of all members of that class: limited flexibility, limited air defense capability, and restricted operational portfolio. The Visbys were not fast attack craft with their deficiencies corrected, they were frigates seriously compromised by being compressed into a hull that was far too small to accommodate the required systems.

In addition to those limitations, it appears that the great efforts to reduce radar cross-section do not offer the benefits once hoped for. One reason why is shown in the picture printed on page 6 of this report. Most photographs of the Visbys show them moving at relatively low speed where their operational discretion is displayed, but this picture tells a different story. At speed, the Visbys throw up prominent water clouds that generate a large radar reflection (interestingly, the Norwegian Skjold class – another design placing great emphasis on radar image reduction – suffered the same problem).

It would appear that a covert attack with a Visby is possible, but the craft would have to execute such an attack by drifting in slowly, reducing profile and disturbance to a minimum. This is, of course, how all successful fast attack craft commanders have carried out their attacks; the idea of streaking in at high speed to launch weapons is a "Hollywood movie" tactic that just does not work in real life. The Visby is really too large to carry out the sort of covert attack that really works.

Timing was also very bad. Conceived in the dying days of the Cold War, by the time the Visby class entered service, the world had changed completely. The prospect of heavy fighting against Russian forces in the Baltic had vanished and, instead, the emphasis was on peacekeeping and equivalent missions far abroad. The ships are too small to be seaworthy for long transits to the scene of operations. Their crew facilities are cramped and minimalist; their stores capacity is quite inadequate.

Faced with a ship that lacked the endurance and crew support facilities required for deployed operations, the Swedish Navy concluded that it needed a new class of ships, reflecting the same general approach as the Visby class, but larger, more capable, and with greater endurance. This is emerging as a new logistics support ship that bears more resemblance to an LPD than a surface combatant.

Thus, the five ships of the Visby class are likely to represent the total production for this class. The class has not succeeded in attracting export orders, having been squeezed out by the La Fayette class and MEKO-A class frigates, so it seems most unlikely that any additional ships of this class will be built. Because all the ships have been delivered, no production forecast is provided. These ships have been completed and are undergoing extensive trials that will last until the last ship is re-delivered in 2012.

Ten-Year Outlook

Construction of this class is complete and no orders are outstanding.

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