

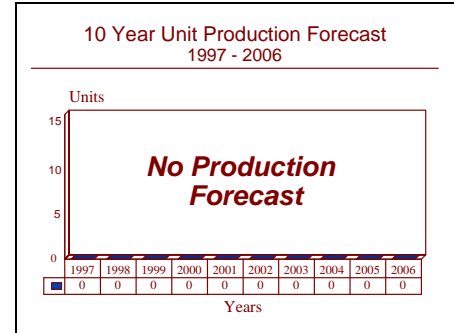
ARCHIVED REPORT

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Type 2400 Upholder Class - Archived 1/98

Outlook

- Construction curtailed at four hulls
- Existing Royal Navy boats up for sale or lease



Orientation

Description. Diesel electric torpedo attack submarine.

Sponsor

Ministry of Defence
 (Procurement Executive)
 CB/Admin 3
 St. Georges Ct
 14 New Oxford St
 London WC1A 1EJ
 United Kingdom

Platform

Ship

S40 *Upholder*
 S41 *Unseen*
 S42 *Ursula*
 S43 *Unicorn*

Builder

Vickers, Barrow
 Cammell Laird, Birkenhead
 Cammell Laird, Birkenhead
 Cammell Laird, Birkenhead

Contractors

Vickers Shipbuilding and Engineering (VSEL)
 Barrow-in-Furness
 United Kingdom

Licensee. There are no licensees at the present time.

Status. In reserve.

Total Produced. Four submarines of the class have been completed.

Ordered

11/1983
 1/1986
 1/1986
 1/1986

Commissioned

7/1990
 6/1991
 5/1992
 6/1993

Application. The Upholder class were originally designed to provide training facilities against diesel-electric submarines. Their role has since been expanded to cover anti-submarine warfare and covert operations.

Price Range. The lead ship, *HMS Upholder*, cost US\$606 million at November 1992 rates of exchange. The remaining three ships cost a total of US\$585 million on the same basis. Thus the average cost per hull is US\$297.75 million.

Technical Data

Characteristics

Speed (surface):	12 kts
Speed (snorting):	12 kts
Speed (submerged):	20+ kts
Range:	8,000 nm at 8 kts
Design diving depth:	200+ m/656+ ft
Patrol length:	49 days
Crew:	7 officers, 40 enlisted

Dimensions

	<u>Metric</u>	<u>US</u>
Length:	70.3 m	230 ft
Beam:	7.6 m	25 ft
Draft:	5.5 m	17.7 ft
Displacement, surface:	2,185 tons	
Displacement, submerged:	2,400 tons	

Armament

	<u>Type</u>	<u>Quantity</u>
Torpedo tubes:	21 in	6
Torpedoes:	Mark 24 Tigerfish	18
Mines:	Mark 5 (replace torpedoes)	36

Electronics

Sonars:		
Bow active/passive:	Type 2040 Argonaute	1
Passive ranging:	Type 2041	1
Towed array:	Type 2046	1
Intercept:	Type 2019 PARIS	1

Radar:

Navigation	Type 1007	1
ESM:	Outfit UAP	1
Periscopes:		
Search:	Barr & Stroud CK35	1
Attack:	Barr & Stroud CH85	1

Command & Control:

Command System:	Ferranti Outfit DCC	1
TDHS:	BAeSEMA Outfit DCG	1
Underwater telephone:	Type 2008	1

Propulsion

Main Propulsion:		
Diesels:	Paxman Valenta 16SZ	2x3,620 shp
Electric:	GEC	1x5,400 shp
Battery:	Lead/acid	2x240 cell
Propeller:	Fixed-pitch 7-blade	1

Design Features. The Upholder class submarines are covered with acoustic tiles to improve stealthiness. All machinery is raft-mounted to reduce noise and vibration while all internal features have the maximum practical level of silencing. The Upholder class submarines are reputedly the quietest in the world.

The pressure hull is cylindrical and contains three decks, the lowest of which contains the batteries, fuel bunkers and other ship service functions. The two upper decks contain the crew quarters, command and operations spaces and weapons storage/discharge compartments. Separate officer and enlisted accommodation is provided and messing/recreation areas is kept separate from sleeping accommodation. Individual

bunk and locker space is provided for each crew member. In theory, accommodation is available for up to 11 trainees but in Royal Navy service, this is used to house additional members of the crew required for operational reasons. The hull is fitted with two pressure-tight bulkheads and two connection points for a DSRV.

The weapons suite consists of six bow mounted 21-inch torpedo tubes. The maximum load is 18 torpedoes, with six in the tubes and 12 reloads. The Mark 24 Mod 2 Tigerfish torpedo is carried. Contrary to published reports, there is currently no provision for the Upholder class to carry Sub-Harpoon missiles. Mines can be carried on a two-mines-per-torpedo replacement basis. There is a new hydraulic mechanical interlock system to prevent the outer torpedo tube doors from being opened simultaneously with the inner torpedo tube doors. Previous Royal Navy submarines used a mechanical interlock system. The torpedo room is reloaded via a new mechanical system that marks a considerable advance in operational safety over that used in previous submarines.

The power train is a standard diesel-electric (not direct-drive diesel) configuration with the diesels charging the batteries which then run the electric motor. Propulsion power comes from two 4-stroke 16-cylinder Paxman Valenta diesel engines, each developing 2,035 bhp for a top speed of 12 knots surfaced. Each diesel drives a 1.25-MW AC generator. A GEC twin armature generator with a 2,500 kW output feed a GEC 5,400 shp electric motor. It draws on two banks of lead acid batteries, each with 240 cells. The batteries have an operating range of 6,080 amp/hr at one-hour rate or 8,800 amp/hr at five-hour rate. The top submerged speed is 20 knots. The submarine has a range of 8,000 nautical miles at eight knots snorkeled.

Operational Characteristics. The main sonar aboard these submarines is the Type 2040 Argonaute, a British version of the French Eledone system. The Royal Navy modified the Eledone by adding a third transducer tier, for a total of 48 staves. The Type 2040 includes a command/display console with a large scope screen, the large circular passive transducer array, a 360-degree sonar intercept array, and the transmitter. The passive transducers can track up to 12 targets automatically and

simultaneously. The intercept array gives 360-degree coverage and warning against any sonars it might encounter, from low frequency long range to high frequency acoustic torpedo sonars. The command display console uses color coding to differentiate information received from the different arrays.

The second sonar system is the Type 2019 Passive/Active Range and Intercept Sonar (PARIS), which will serve as a warning and threat detection system. Type 2019 is the result of a collaborative effort among Britain, France and the Netherlands. The last sonar is the Type 2046 passive towed array, which provides long-range target detection and tracking.

A Kelvin Hughes Type 1007 radar is carried. Primarily navigational, it can provide target bearing and range when the submarine is running at periscope depth. The Barr & Stroud CK35 and CH85 periscopes offer several new twists on the submarine's oldest sensor. A split eyepiece allows binocular observation and simple adaptation for photography. Target designation information can be displayed on the eyepiece. Both this information and the periscope view can be displayed on the SAWS (Submarine Above Water Sensor) video display. A built-in estimator can take the range and transmit it to the fire control system. The periscopes have a thermal imaging facility with highly impressive capabilities including the ability to determine the internal structure of a ship using the heat differentials caused by bulkheads and strength members.

The primary command and control system is a Ferranti Outfit DCC, an AIO/FCS (Action Information Organization/Fire Control System), based on the DCB system used by Britain's nuclear submarines. It uses two FM 1600E minicomputers. It takes information from all the sensors, performs target motion analysis on 35 contacts simultaneously, and guides four torpedoes independently to their targets. It also permits salvo firing of mines or submarine Harpoon missiles and remote control of torpedo firing. Due to processing power limitations, Outfit DCC is supplemented by the Outfit DCG Tactical Data Handling System (TDHS) which provides additional weapons control and tactical picture facilities.

Variants/Upgrades

Originally eight Upholder class submarines were to be built in two batches; Batch 1 as described above and Batch 2 which would have the new Type 2075 sonar and SMCS command system. Later the Batch 1 boats were to have been brought up to Batch 2 standard. However, the four Batch 2 boats were canceled in 1991.

Type 2400E. The basic export derivative of the Royal Navy Type 2400 Upholder design in which costs have been reduced by the deletion of Royal Navy specific systems without compromising key performance characteristics. This design provides a baseline for optimization to specific customer requirements.

Type 2495/1. An advanced derivative of the Type 2400E, the Type 2495/1 is a fuel-cell powered submarine in which an advanced propulsion system replaces the diesel engines. This uses fuel cells designed by Ballard Power Systems of Canada in combination of Lithium Aluminum Iron Sulphide (LAIS) batteries. The new technology batteries provide a two-fold increase in power: volume ratios over lead acid cells. Type 2595/1 remains an air-breathing submarine

in that it has to snort to operate its fuel cells. It has major advantages over Type 2400 in that the elimination of reciprocating machinery greatly reduces noise levels and thermal emissions.

Type 2495/2. A fully air-independent version of Type 2495/1 in which the provision of liquid oxygen tanks removed the need for snorting while operating the fuel cells.

Program Review

Background. The Type 2400 Upholder class submarines are the Royal Navy's first conventional diesel electric submarines in over 20 years. The last conventional class, the Oberons, were designed in the late 1950s and commissioned between 1962 and 1967. The Upholders are designated SSKs, hunter/killer submarines, as opposed to SSNs, nuclear powered fast attack submarines. This reflects their intercept and ambush role rather than patrol function. The Upholder class are intended to serve as open ocean and coastal patrol submarines, inserting covert operations groups and antiship and antisubmarine warfare. Originally they were to have served as training submarines for surface ships and nuclear submarines in antisubmarine warfare and retain this role as a secondary function.

The Type 2400 submarine developed out of two schools of thought. During the 1970s, Vickers Shipbuilding and Engineering Ltd (VSEL) began design studies for a conventionally powered submarine to export as a replacement for foreign Oberon submarines. At the same time, the Royal Navy was having second thoughts about its rapidly increasing reliance on nuclear submarines. In 1975, when the Outline Staff Requirement was issued, the two schools had major differences. The Navy envisioned a 1,850-ton design, while VSEL had a 2,700-ton model. The added tonnage allowed increased range and added weapons loadout which was thought to be desirable for export.

However, the Royal Navy began to have doubts about its design at this time. Although it had planned the submarine for coastal defense and training, the Navy decided it needed a submarine capable of carrying a towed array sonar and undertaking lengthy patrols in the GIUK (Greenland, Iceland, United Kingdom) Gap. Another reason for this change of heart was the announcement that Australia would shortly be looking for a replacement for its Oberons and was interested in the Vickers design.

The Operational Requirements Committee endorsed the Naval Staff Outline in early 1979 and issued the requirements that July. VSEL submitted its initial

outline in September. While similar, VSEL's design had more torpedoes, and at 2,770 tons, it was 500 tons heavier than the Royal Navy's design. After much discussion, the Type 2400 design was submitted in early 1980 as a compromise candidate. VSEL spent the next three years on engineering design, using its CODEM (Computerized Design from Engineering Models) system. The 1981 Defence White Paper slowed the design program, due to the declining naval budget.

On November 2, 1983, the Ministry of Defence (MoD) placed a £100 million order for the first submarine, *HMS Upholder*. Assembly of the first sections began in November 1983, and it was launched on December 2, 1986. On March 1, 1986, after competitive bidding between Cammell Laird Shipbuilders in Birkenhead and VSEL, the MoD placed a US\$450 million order with Cammell Laird for three submarines.

The MoD was concerned that VSEL's submarine construction facilities were at capacity, with three nuclear submarines and *HMS Upholder* being built. Cammell Laird had built five diesel submarines and three nuclear submarines in the 1960s but had nearly closed before receiving the Type 2400 contracts. VSEL agreed to take over Cammell Laird as part of the privatization of British shipyards. Construction of *HMS Unseen* began in August 1987, and *HMS Ursula* in January 1989.

In 1983 the MoD and VSEL began a major effort to export the Upholder design. VSEL had designed the submarine with the Royal Australian Navy in mind, but the Australians did not place the Upholder in the final short list of contenders for their program. Canada considered the design before announcing plans in 1987 for nuclear-powered submarines. In mid-1987 the Saudi Arabian Navy announced that it was considering an order for eight Type 2400s. The Saudis also were considering the Dutch Walrus design and a West German submarine. *HMS Upholder* began sea trials in the late Summer of 1988.

During *HMS Upholder's* sea trials, the submarine experienced several problems. As a result, *HMS*

Upholder entered service with its torpedo tubes sealed shut, due to a fault in the hydraulics system. According to the MoD, "During the rigorous setting to work which took place before sailing for sea trials, testing of the torpedo discharge hydraulic system revealed a problem when water was admitted to the torpedo tubes, due to the inadvertent opening of an outer door. As a precautionary measure, the torpedo tube outer boundaries have been locked shut until the design, production and testing of a system modifications have been completed."

Another problem occurred during a dive in July 1989, when there was a temporary loss of power. According to VSEL officials, the submarine was rising at the time, and the boat's crew blew all ballast tanks, allowing the submarine to surface with normal trim. Reports that the submarine experienced an out-of-control dive to 1,000 feet were completely erroneous. These problems caused a delay in the trials, and a postponement of the submarine's commissioning. In early August 1989, the British undersecretary of state for defence procurement, Tim Sainsbury, told Parliament that *HMS Upholder* would not be delivered to the Royal Navy until December 1989.

HMS Upholder commissioned on July 9, 1990, approximately 18 months later than originally scheduled. As usual with a new design, it returned to the shipyard for post-commissioning refit. By June 1993, all four submarines were in service when *HMS Unicorn* joined the fleet. Forecast International were guests on board this submarine shortly afterwards.

Following a very long, bitter and detailed debate, the British 1993 Defense White Paper "Defending Our Future" announced that the four Upholder class submarines were to be withdrawn from service by the end of 1994 for sale or lease to other navies or to be mothballed and kept in reserve. The announced reason behind this decision was that the future long-term funding estimates for the Royal Navy did not permit the maintenance of both nuclear and diesel-electric submarines and that one or the other would have to be sacrificed. In this environment, the superior strategic mobility and striking power of the nuclear-powered boats was considered more valuable than the covert

operating characteristics of the Upholder class and the latter were therefore selected for disposal. By October 1993, several candidates for the four submarines had emerged including Canada and Saudi Arabia as lessees and Chile as a direct cash purchaser.

In September 1993, VSEL announced that it had entered into an agreement with RDM of the Netherlands for the joint development and marketing of the Moray class submarine design. This would appear to end VSEL's plans to market the Type 2400/Type 2495 designs and probably reflects the adverse effects of the Royal Navy withdrawal of the ships on export prospects.

The first pair of Upholder class submarines, *HMS Upholder* and *HMS Unseen* were decommissioned in early 1994, with the remaining pair following suite by the end of the year. All four submarines were officially offered for sale in April 1994. Additional prospective customers emerged, including Brazil, Thailand, Singapore, Pakistan and India but all these failed to materialize and some sections of the British defense industry were criticizing the UK Defence Export Sales Organization (DESO) for their handling of the disposal.

By early 1995, Canada and the UK were in detailed negotiations over the acquisition of the four Upholder class submarines. The leading proposal was a no-money arrangement by which the lease fees for the Upholders would be credited against the payments due from the UK for the use of Canadian bases. This deal fell through when the state governments in Canada obstructed passage of the necessary legislation in an attempt to force the federal government's hand in other matters. At that point the British government severed further discussions.

Canada was then replaced by Portugal as the leading candidate for the Upholders, using NATO funding to procure them as a replacement for the existing, very old Daphne class boats. Further prospective purchasers continue to be reported while disquiet has grown over the cost of maintaining the four submarines in storage. The most recent proposal was that two submarines would be sold to South Africa (in return for the reinstatement of the Simonstown naval base agreement and two to Chile).

Funding

This program is funded by the UK Ministry of Defence for the Royal Navy.

Recent Contracts

<u>Contractor</u>	<u>Award</u> <u>(US\$</u> <u>millions)</u>	<u>Date/Description</u>
VSEL	4.5	March 1991 - Design support for the tactical weapons system.
Marconi	1.5	July 1991 - Provide new towed submarine communication antenna system.

Timetable

Dec	1975	Initial Naval Staff outline requirement raised
Jul	1979	Naval Staff Requirement raised
Sep	1979	Proposals announced by Vickers
Nov	1983	Ministry of Defence ordered first Type 2400
Feb	1986	Keel laid
Jan	1986	Ministry of Defence ordered three additional Type 2400s
Dec	1986	<i>HMS Upholder</i> launched
	1988	<i>HMS Upholder</i> began sea trials
	1990	<i>HMS Upholder</i> commissioned
May	1993	Decision to withdraw Upholder class announced
Jun		<i>HMS Unicorn</i> commissioned

Worldwide Distribution

Royal Navy. (4 in reserve)

Forecast Rationale

The decision to prematurely withdraw the Upholder class submarines from service dealt a crippling blow to what otherwise was a very promising design family. Removing four virtually unused submarines from service is bad enough; the accounts of technical failures circulated gives the impression that the decommissioning of the boats was due to design faults rather than being purely financial in nature. These accounts vary from problems with the torpedo tubes (true but greatly exaggerated) to design faults with the diesel-electric power train (completely untrue).

The decision to remove the Upholder class from service is particularly sad since, after a very troublesome development period and a number of starting problems, the Type 2400 submarines proved to be extremely dangerous adversaries. A combination of inherently quiet power system, scrupulous attention to detail engineering and some highly classified silencing technology makes them the quietest submarines in the world. Their capabilities place them in the leading rank of diesel-electric submarine designs with only the Dutch Walrus class, Japanese Harushio and Russian Project 636 being their equals in operational service. Only when the next

generation of submarines start to enter service in the medium term will their capabilities be exceeded.

The US experience has shown that, once diesel-electric submarine construction expertise has been lost, it cannot be recovered. The fund of design knowledge and operator skills is quickly degraded. The possibility of export orders has now, in our opinion, vanished and there are growing questions as to the probable sale of the existing four hulls. The current state of the competitive market strongly implies that when *HMS Unicorn* commissioned, it represented the last diesel-electric submarine to be built in a British yard.

Following the decision to withdraw these boats from Royal Navy service, we have terminated all forecasts for new construction of the design. It is possible that, if purchased by a new user, additional submarines of this type may be ordered. It is also possible that the Royal Navy may return to the diesel electric arena with an order for one or two Type 2495/2 boats to act as experimental AIP platforms. Neither prospect seems likely and we now believe that this program has come to an abrupt end.

Ten-Year Outlook

**** No production is forecast ****

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