# ARCHIVED REPORT

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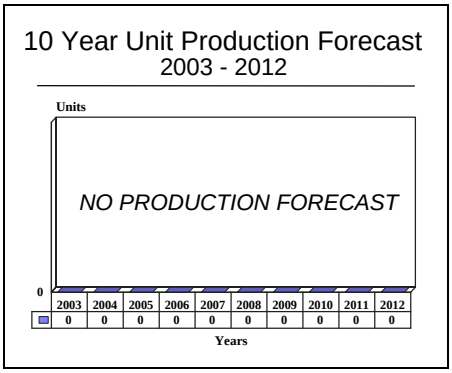
# BSY-2 - Archived 10/2004

## Outlook

- No further production expected
- Technology may be used as basis for Virginia class combat system
- This report will be archived next year




## Orientation

**Description.** The BSY-2 is the advanced combat system for the SSN-21 Seawolf class submarine.

### Sponsor

US Navy
Naval Sea Systems Command
Washington, DC USA
(Program management, development and procurement)

Naval Sea Combat System Engineering Station
Norfolk, Virginia (VA) USA

Naval Training Systems Center
Orlando, Florida (FL) USA

Naval Underwater System Center
Newport, Rhode Island (RI) USA

Naval Weapons Support Center
Crane, Indiana (IN) USA

David Taylor Naval Research and Development Center
Bethesda, Maryland (MD) USA

### Prime Contractors

Lockheed Martin Corp
Naval Electronics & Surveillance Systems - Syracuse
Electronics Park
Syracuse, New York (NY) 13221-4840
USA
Tel: +1 315 456 0123
Web site: http://www.lockheedmartin.com/syracuse
(Prime contractor production)

### Secondary Contractors

Analysis & Technology Inc
Middletown, Rhode Island (RI)
USA
(Engineering services)

Bicoastal Corp
Librascope Division
Glendale, California (CA)
USA
(Combat situation display console for common display and work station)

Chromatics Inc
Tucker, Georgia (GA)
USA
(CX2000 high-speed, graphic engine technology for combat situation display consoles)

Computer Sciences Corp
Moorestown, New Jersey (NJ)
USA
(Software)

Charles Stark Draper Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts (MA)
USA
(Program monitor)

Dynamics Research Corp
Andover, Massachusetts (MA)
USA
(Engineering services)

EG&G
Washington Analytical Services Center
Rockville, Maryland (MD)
USA
(Hull array support)

General Dynamics Corp
Electric Boat Division
Groton, Connecticut (CT)
USA
(Hull array support)

Lockheed Martin Corp
(formerly Loral Federal Systems Corp, formerly IBM Federal Systems)
Manassas, Virginia (VA)
USA
(Active transmit system)

Lucent Technology
(formerly AT&T Technologies)
Greensboro, North Carolina (NC)
USA
(UYS-2 EMSP)

Raytheon Co
Naval and Maritime Systems
Portsmouth, Rhode Island (RI)
USA
(Developing active transmit system for acoustic sensors; hull array support; design and development of the Combat Team Trainer)

Systems Engineering Associates Corp
Newport, Rhode Island (RI)
USA
(Testing and evaluation)

Unisys Corp
Paramax Systems Corp
Electronic Systems Division
Eagan, Minnesota (MN)
USA
(UYK-43 computers)

Verdix Corp
Chantilly, Virginia (VA)
USA
(BSY-2 Ada code)

Vitro Corp
Groton, Connecticut (CT) 06340
USA
(Technical support)

**Status.** Operational. The first system was for testing aboard SSN-710; the remaining three were for the SSN-21 Seawolf class submarines.

**Total Produced.** Four (including the original prototype) have been produced.

**Application.** Combat system for the US Navy's SSN-21 Seawolf class attack submarine.

**Price Range.** The price of the first BSY-2 system has been estimated at US$280 million (FY93 dollars). The price appears to come down to about US$250 million with subsequent buys.

# Technical Data

**Design Features.** The main components of the BSY-2 are the following: TB-12X Long Thin Line Towed Array (TARP), TB-16BQ Digital Towed Array, BQG-5 Stand-alone Wide Aperture Array, Large Spherical Array, Horizontal Large Screen Display (HLSD), Vertical Large Screen Display (VLSD), Transmit Group (TG), Multi-Purpose Consoles (MPC), modified Combat System Display Consoles (CSDC), Tactical Situation Plotter, Weapon Launch System (WLS), the Multi-Array Signal Conditioner (MASC), UYS-2 Enhanced Modular Signal Processors (EMSP), and UYK-43 standard computers.

The BSY-2 has two major subsystems: the acoustic (sensor) subsystem and the combat control (fire control and weapons launch) subsystem. Since the system uses a wide aperture array and enhanced information management, it is expected to provide the Seawolf class attack submarines with the improved response time, operability, and firepower capabilities needed to counter the quieter Russian submarines now making their appearance on the world market as the former Soviet republics sell off their fleets for much-needed hard currency.

The BSY-2 in the Seawolf class submarines does not use the CCS Mk 2, but instead has its own combat

control system, which has been developed to improve existing combat systems to meet the expanded operational needs of the Seawolf class.

EMSP. The BSY-2 was also one of the first systems to use the US Navy's Enhanced Modular Signal Processor (EMSP), although Congress expressed concern about the Navy's commitment to maximum use of the EMSP. The House Armed Services Committee recommended the development of a total system software package that used at least 50 percent Ada code, along with procurement of at least four units of EMSP. The BSY-2 includes computer programs and equipment that allows it to carry out command and control as well as acoustic detection, tracking, classification, weapon presetting, torpedo and missile targeting, and launch control. The human interface element is also emphasized.

**Operational Characteristics.** The development requirements for the BSY-2 included the following: develop an architecture that facilitates tactical enhancements and future growth, and provide computer processes that improve response time from initial threat detection to weapon launch. Among the characteristics of the BSY-2 that enhance Navy attack submarine capabilities are new acoustic arrays that have better detection performance and self-noise characteristics; a partitioned system architecture that facilitates tactical improvements, future growth, and high availability; computer aids to assist operators in sensor, contact, and weapon management; and finally, the employment of the most advanced submarine weapons.

US Navy BSY-2 Advanced Combat System for Seawolf class submarines

Source: U.S. Navy

# Variants/Upgrades

Due to the developmental nature of the system, no variants or upgrades have been introduced. The BSY-2 is still evolving. One example of a modification is the decision to include the SEM-E version of the UYS-2 EMSP.

# Program Review

**Background.** The BSY-2 (originally called the FY89 SCS) replaces the former SUBACS B, which was to be the ultimate SUBACS configuration. It is fielded on SSN-21 Seawolf class nuclear attack submarines. The FY89 SCS was developed in response to the problems encountered with (then) IBM's (now Lockheed Martin) sole-source contract for the original SUBACS. In January 1986, RCA Corp (Missile and Surface Radar Group) was awarded a US$20 million contract to begin development of the FY89 SCS. RCA and its partners, (then) General Electric (which subsequently became the parent corporation of RCA) and Singer Librascope (now part of the Bicoastal Corp), brought significant experience to the project. RCA was able to call on its experience with the AEGIS battle management system, General Electric's experience with sonars and submarine systems, and Singer Librascope's expertise in the area of submarine torpedo fire control and submarine combat systems.

BSY-2 Contract Award. The winner of the competition was the RCA/Lockheed Martin team, with a preliminary developmental contract awarded in December 1987. By this time Lockheed Martin (then GE) had bought RCA, and the actual team leader was Lockheed Martin's (then Marietta) Undersea Warfare Department. Lockheed Martin's bid of US$1.6 billion was believed to be about US$200 million below that of the Loral team.

Lockheed Martin received a US$945 million follow-up contract in April 1988.

As work on the BSY-1(V) dwindled, Loral began pressing a reluctant Lockheed Martin to give Loral a larger BSY-2 role. Loral Federal Systems had been mandated by Congress to have a 15 percent share of the BSY-2 development job as a prelude to becoming a second source. Loral had only been awarded a US$90 million contract, under which it developed the receiver portion of the active transmit system (Raytheon developed the transmit portion), conducted the software integration for a number of key subsystems, including the hull array and towed array passive sonar sensors as well as the EMSP, and provided engineering support for the BSY-2 system qualification program.

The first BSY-2 was delivered to the Navy in December 1993, after completing a two-year system integration test of the unit's acoustics and combat control hardware and software. The first Seawolf class submarine, USS *Seawolf* (SSN-21), was commissioned in July 1997. The second of the Seawolf class, USS *Connecticut* (SSN-22), was commissioned in December 1998. In August 1995 a decision was made to procure the third Seawolf class submarine, the USS *Jimmy Carter* (SSN-23). It is expected to be commissioned in 2005 after undergoing "Special Projects" mission modifications.

BSY-2 Platform. Original planning called for the BSY-1(V) to be installed on Los Angeles class submarines authorized from FY83 through FY88. The BSY-2 was to be carried by the last eight Improved Los Angeles class submarines (FY89 to FY91) and the boats in the Seawolf class. However, now only the Seawolf class is equipped with the BSY-2.

BSY-2 Team Trainer. In March 1991, Raytheon was awarded an US$80.9 million contract to design and develop the BSY-2 combat team trainer. Raytheon's Submarine Signal Division built a full-scale engineering development model of the Submarine Combat System Team Trainer for initial training of Navy personnel. An option in the contract covered the building of an additional trainer for the US Navy Submarine School (Groton, CT) in 1996, as well as relocating the full-scale model to the Navy Underwater Systems Center (Newport, RI) in 1997.

BSY-2 Development Activity. The Chief of Naval Operations established the SSN-21 Seawolf class and the BSY-2 combat system Top Level Requirements (TLR). The development objectives for BSY-2 are to meet the Seawolf combat system-related TLR, develop an architecture that facilitates tactical improvements and future growth, and provide computer processes that improve response time from initial threat detection to weapon launch.

BSY-2 provides new acoustic arrays that have improved self-noise characteristics and better detection performance. It provides computer aids to assist in sensor, contact, and weapon management, and to support employment of the most advanced submarine weapons from eight torpedo tubes. Software development is being conducted by dividing the total software into six "threads" to be built and tested in phases throughout the development. The system architecture is partitioned to facilitate tactical improvements, future growth and high availability.

In FY93, the BQG-5 8902 and 8903 arrays were delivered; the BQG-5 8901 outboard array was installed on SSN-710, and Thread 3 (BQG-5) testing and integration were completed. During FY94, the BQG-5 8901 was delivered to SSN-710, Threads 4 and 5 were tested and integrated, and the BQG-5 Self Design Certification Test (SDCT) was conducted. In FY95, Thread 6 testing and integration was completed, and the BSY-2 8903 system was delivered to SSN-21.

The third BSY-2 was delivered to the second Seawolf, SSN-22, the USS *Connecticut*, during FY96. The fourth BSY-2 supports SSN-23, which was approved in August 1995. A BSY-2 system Post-Shakedown Availability was originally slated to start in FY97, but was delayed due to rescheduling of the *Seawolf* (SSN-21) delivery.

In FY96, SDCT 2 integration was completed, as were all test reviews certifying system readiness for formal testing. Also, the sea trial delivery system received Combat System Installation Certification (CSIC), and sea trials were begun.

During 1997, the Weapon System Accuracy Trial (WSAT) II was initiated, and all Navy testing certified that the final delivery system and technical documentation fully supported weapon firing. Also, Post-Shakedown Availability was initiated to coordinate the installation of the Joint Maritime Command Information Strategy (JMCIS) and resolve system problems. Finally, by the end of FY97, both the JMCIS and the system's Advanced Capability Torpedo (ADCAP) shallow water capability had been fully integrated and certified.

The agenda for FY98 called for providing software and engineering support to resolve system discrepancies identified during WSAT, developmental testing, and early technical evaluations. Also, testing and integration of the BSY-2 Block 2.2a upgrade were completed, and the BSY-2 Block 3 upgrade was further developed and tested. Meanwhile, continuing support was provided for the BQG-5A(V) 1 Standalone Wide Aperture Array development efforts.

In FY99, further efforts were made to resolve system discrepancies identified during development testing. The program schedule also called for Block 3 integration testing to be completed and for the initiation of Block 4 development and integration efforts. In another effort, an Engineering Development Model common acoustic processor was being tested in FY99 in support of an EMSP replacement in FY00 or later.

The program agenda for FY00 focused on TECHEVAL and OPEVAL (excluding Arctic operations), with continued development of Block 5. Engineering support to backfit the UYQ-70 displays on submarines was also initiated. All development and testing was completed by the end of FY01.

**Note:** For detailed information on the submarine platforms, please refer to the report "SSN-21 Seawolf Class" in Forecast International's *Warships* Forecast.

# Funding

**U.S. FUNDING**

| | FY02 | | FY03 | | FY04 | | FY05 | |
|---|---|---|---|---|---|---|---|---|
| | QTY | AMT | QTY | AMT | QTY | AMT | QTY | AMT |
| **RDT&E (US Navy)** | | | | | | | | |
| PE#0604503N Submarine Sys Equip Dev: Project F0219[a] Submarine Sonar Improvement | - | 38.8 | - | 71.9 | - | 65.0 | - | 40.3 |

| | FY06 | | FY07 | | FY08 | | FY09 | |
|---|---|---|---|---|---|---|---|---|
| | QTY | AMT | QTY | AMT | QTY | AMT | QTY | AMT |
| **RDT&E (US Navy)** | | | | | | | | |
| PE#0604503N Submarine Sys Equip Dev: Project F0219[a] Submarine Sonar Improvement | - | 27.5 | - | 43.6 | - | 51.1 | - | N/A |

All US$ are in millions.

Source: US Department of the Navy FY2004/2005 RDT&E Project Justification (R-2a)

[a] This project delivers block updates to sonar systems installed on Los Angeles, Improved Los Angeles, Seawolf, and Trident class submarines to maintain clear acoustical, tactical, and operational superiority over submarine and surface combatants in all scenarios through detection, classification, localization, and contact following. Current developments are focusing on supporting littoral warfare, regional sea denial, battle group support, diesel submarine detection, surveillance, and peacetime engagement. ARCI is a multi-phased development effort geared toward addressing acoustic superiority issues through the rapid introduction of interim development products applicable to US Navy submarines. ARCI Phases I and II introduce towed array processing improvements. ARCI Phase III introduces spherical array processing improvements. ARCI Phase IV is a standalone program that introduces high-frequency upgrades to the BSY-1 system on the Los Angeles-Improved class and Seawolf class submarines only. ARCI Phase V focuses on development efforts for the BSY-2 as well as delivering a CCS Mk 2 variant to the Seawolf class.

## Recent Contracts

No recent contracts valued over US$5 million have been identified at this time.

## Timetable

| Month | Year | Major Development |
|---|---|---|
| | 1985 | SUBACS program overhaul due to design problems and contractor incompetence |
| Jan | 1986 | Navy awards RCA team US$20 million for FY89 SCS design definition |
| Mar | 1986 | IBM contract for FY89 SCS design definition phase |
| Jun | 1986 | FY89 SCS Milestone I Joint Management Review Board review |
| | FY87 | RFP for full-scale development/limited production contract for FY89 SCS, Acquisition Streamlined Certification received, Combat System Design Architecture contract awarded for system design definition, competitive contractor FSD proposals |
| Jun | 1987 | Defense Systems Acquisition Review Council set up for FY89 SCS |
| Nov | 1987 | Milestone II for BSY-2 |
| Dec | 1988 | Award of full-scale development contracts for BSY-2 |
| Apr | 1989 | Martin Marietta contract for development of Wide Aperture Array |
| | FY90 | Critical Design Review complete; BSY-2 Maintenance Trainer limited production option; limited production option for BSY-2 long-lead material |
| | FY91 | Critical Item tests complete of wide aperture array, offboard expendables, and system response time; Team Trainer Unique Equipment contract award |
| Oct | 1991 | System integration testing of BSY-2 acoustics and combat control hardware and software |
| | FY93 | Costs to complete lead ship only determined; remainder of program terminated |
| Feb | 1995 | Delivery of BSY-2 to SSN-21 |
| Jan | 1996 | Delivery of BSY-2 to SSN-22 |
| | 1997 | Post-Shakedown Availability; acoustic trials and WSAT extended due to rescheduling of the Seawolf (SSN-21) delivery |
| | 2000 | Commencement of TECHEVAL and OPEVAL slipped from FY98 and FY99 to FY00 |
| Late | 2000 | EMSP replacement |
| | 2004 | Last Seawolf class submarine to be commissioned |

## Worldwide Distribution

This is a **US Navy** program only.

## Forecast Rationale

Production of Lockheed Martin's BSY-2 Advanced Combat System appears to be complete with a total of four systems built for the US Navy's SSN-21 Seawolf class of attack submarines. No further systems are expected to be produced. Indeed, the BSY-2 is now being integrated into the Acoustics Rapid COTS Insertion (ARCI) effort on the ARCI-(V)5 variant designed for the Seawolf class platform with development primarily on Seawolf's unique interfaces which includes the BSY-2 system. Certification of ARCI-(V)5 is expected by the end of 2003.

## Ten-Year Outlook

Production complete. The forecast chart has been omitted. Barring a sudden surge of activity, this report will be archived next year in October 2004.

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