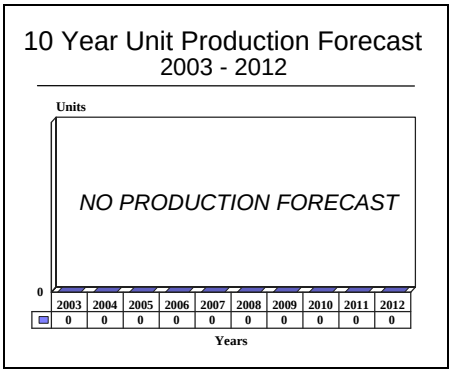
BSY-1(V) - Archived 10/2004

Outlook

- No additional full system production expected
- Enhancements and upgrades in development
- CCS Mk 2 development to continue
- This report will be archived in the near future



Orientation

Description. The BSY-1(V) is the advanced combat system for the U.S. Navy's SSN-688 and SSN-688I Los Angeles class submarines.

Sponsor

U.S. Navy
Sea Systems Command
Washington, DC
USA

Prime Contractors

Lockheed Martin Corp
Naval Electronics & Surveillance Systems - Undersea Systems
9500 Godwin Drive
Manassas, Virginia (VA) 22110-4157
USA
Tel: +1 703 367 2121
Fax: +1 703 367 6091
Web site: http://www.lockheedmartin.com/manassas
(Prime contractors production and HF sonar program)

Secondary Contractors

EG&G
900 Clopper Road, Suite 200
Gaithersburg, Maryland (MD) 20878
USA
Tel: +1 301 840 3000
Fax: +1 301 840 3123
Web site: http://www.egginc.com
(Systems engineering and integration)

McLaughlin Research Corp
Aquidneck Corporate Park
PO Box 4132
Middletown, Rhode Island (RI) 02842
USA
Tel: +1 401 849 4010
Web site: http://www.mrcds.com
(Engineering, technical and logistics support)

Raytheon Co
Naval and Maritime Integrated Systems
1847 W Main Road
Portsmouth, Rhode Island (RI) 02871-1037
USA
Tel: +1 401 842 2050
Fax: +1 401 842 5214
Web site:
http://www.raytheon.com/systems_integration
(CCS Mk 2, spares, transmit group systems)

Rockwell Autonetics & Missile Systems Division
Boeing North American Inc
D/2114. M/C GE96
3370 Miralom Avenue
Anaheim, California (CA) 92806
USA
Tel: +1 714 762 0225
Fax: +1 714 762 6222
Web site: http://www.boeing.com
(NSN 7H 1287-LL-HGO-0335 display assemblies)

Vitro Corp
520 Thames Street
Groton, Connecticut (CT) 06340-3967
USA
Tel: +1 860 441 2200
Fax: +1 860 441 2213
(Engineering and technical support)

Status. In operational service and upgrade.

Total Produced. All 25 systems have been delivered to the U.S. Navy (23 for submarine installation, two for shore based training).

Application. The BSY-1(V) has been fitted to Improved Los Angeles class submarines (SSN-751 onward).

Price Range. Last known estimate was US$43 million per system (in FY92 dollars based on contract cost averaging).

Technical Data

Design Features. As a result of numerous problems encountered in selecting a successor to the problem-plagued Submarine Advanced Combat System (SUBACS) program, the U.S. Navy chose a go-slow approach. The new path restructured the original SUBACS program into two parts, the BSY-1(V) and the BSY-2.

The BSY-1(V) contains improvements developed under other current programs. These improvements include the Submarine Active Detection Systems (SADS), the Long Thin Line Towed Array (TBX), and the Mine and Ice Detection and Avoidance System (MIDAS). The size of the BSY-1(V) system software at deployment is estimated to be 4.3 million lines of code. Total weight of the 117 separate modules in the BSY-1(V) is 32 tons.

The main components of the system include array processors, a post processor (LBF, DIMUS and UYK-43), a combat control processor, a weapons processor (UYK-44), a weapon launch system, acoustic displays (ICDC), and combat control displays (Mk 81). There are a total of 100 general-purpose and 50 special-purpose processors.

While the original BSY-1(V) includes the Combat Control System (CCS) Mk 1, this was replaced by the CCS Mk 2 upgrade, which was backfit to all SSN-688s.

BSY-1(V) TT/WLSOT. Lockheed Martin (first IBM then Loral Federal Systems) is the prime contractor for the BSY-1(V) and the BSY-1(V) Team Trainer (TT) and Weapons Launch System Operator Trainer (WLSOT). The TT provides realistic combat training for both the sonar and the attack center, separately or together. It includes the tactical computers and software and also provides training in the areas of fire control console operation, plotting, sonar detection, localization, tracking, and classification. The WLSOT is an interactive mockup of the weapon launch system. The trainer provides for weapon launch sequence training, including casualty control for torpedo room crews. The TT/WLSOT is used by Improved Los Angeles class (from SSN-751 onward) based-in-port submarine crews to provide refresher training on tactical operations.

Operational Characteristics. The BSY-1(V) provides and supports the following capabilities: detection of multiple contacts, including early warning threat determination through processing and analysis of sensor data; classification of sensor data for the purpose of identifying contacts; localization (tracking) of contacts to determine position and motion through analysis of sensor data; launch and control of weapons and countermeasures; command and control of the combat system management using controls, displays, and audio circuits, and by correlating sensor data; communications with submerged, surface, airborne, and land forces via voice and datalinks; and navigation in open ocean and restricted water.

Variants/Upgrades

The BSY-1(V) initially included the CCS Mk 1. This has been replaced by the CCS Mk 2 upgrade, which was backfit to all SSN-688s. Raytheon was awarded the prime contract for CCS Mk 2 in September 1988. The contract called for 37 systems to be engineered and integrated by the company. The Raytheon contract was for US$405.5 million. The CCS Mk 2 may also be fitted to Ohio class ballistic missile submarines in the future.

U.S. Navy BSY-1 Combat System training for Los Angeles class submarines

Source: U.S. Navy

Program Review

Background. Due to the complexity of the issues surrounding the Submarine Advanced Combat System (SUBACS) and its restructuring, it is appropriate to detail the history of the program itself as a way to explain the controversy surrounding the program.

SUBACS Mission. The SUBACS program provided for the development of an evolutionary combat system using a top-down approach to deliver effective submarine combat systems to the Fleet. It was intended to provide ships with clear tactical superiority in engagements against improved threat platforms. The U.S. Navy created the SUBACS program in 1981 to develop a preplanned block upgrade to the Improved Los Angeles class submarine combat system. Integral to this new capability was the use of a fiber-optic databus for distributing acoustic and combat control data. Although originally planned as a single-phase program for ships authorized in FY89, the Secretary of Defense in 1983 approved the Navy's plan to introduce SUBACS six years earlier, for FY83 authorized ships, with further upgrades in FY86 and FY89. In addition, the final SUBACS block upgrade would serve as the baseline combat system for the new-design attack submarine, the SSN-21. RDT&E costs for the entire SUBACS program were estimated in 1983 at US$1.3 billion.

The SUBACS program was structured into a Preplanned Product Improvement Program having three phases: SUBACS BASIC, SUBACS A, and SUBACS B. SUBACS BASIC was to provide significant space and weight savings that, when combined with other improvements, would allow for the addition of several new required missions for the Improved Los Angeles class SSNs. Additionally, SUBACS BASIC would have provided increased passive and active sonar performance. The acoustic enhancements were to be provided by the SUBACS Acoustic Detection Sub-system, Mine and Ice Detection and Avoidance System, and Long Thin Line Towed Array, and by the addition of an improved weapon launch control group.

SUBACS A was to provide significant combat control improvements with the addition of common displays and improved solution time (new signal processor). Upgraded sensors in combination with the decreased time to solution would result in improved operability.

SUBACS B was to add the Wide Aperture Array detection and localization system to decrease localization times to two minutes. Additionally, a Sea Nymph variant would have been added to provide full electronic support measures capability. An improved mission-oriented communications system was to be incorporated at that time. SUBACS B was to be the ultimate objective of the phased improvement program for the SSN-688 class submarines.

SUBACS Problems. It became increasingly evident that the whole SUBACS program was in deep trouble by early 1985. After the Navy had spent several hundred million dollars and four years of development on a distributed SUBACS concept, it suddenly scrapped the design and went back to the drawing board.

After the Navy killed the original IBM SUBACS fiber-optic distributive processing system of dozens of small tactical computers (prematurely according to some sources, as evidence later showed the BSY-2 to use fiber-optic databuses), it ordered a competitive bid for an advanced SUBACS version that would use a central computer complex working with the new standard Navy UYK-43 large-scale tactical computer. However, the Navy encountered serious difficulties in coming up with a revised advanced SUBACS design, as the widely varying factions within the Navy, lobbyists from industry groups, and Congress were all doing their part to confuse the issue.

The Navy awarded a US$33 million sole-source contract to IBM Federal Systems in September 1985 to develop a new interim SUBACS. Immediately an outcry arose from other competitors, who argued that giving IBM a sole-source award to develop a new interim SUBACS design gave the company an advantage in capturing the follow-on SUBACS design for the Seawolf class. The interim design provided essentially the existing Mk 1 combat control system (CCS Mk 1) with Sperry UYK-43 computers and the IBM BQQ-5 sonar.

The Plot Thickens. The U.S. General Accounting Office (GAO) recommended to the Navy in November 1995 that it terminate IBM's US$772 million SUBACS contract and contemplate remaining with the BQQ-5 system developed in the mid-1970s (also by IBM). The report came after the House deleted the entire US$205 million requested for SUBACS in the FY86 budget. However, the Senate Defense Authorization Bill still contained the project funds. The GAO noted that an audit of IBM in June estimated a contract cost overrun of US$146.2 million because of "increased software and system development, additional test and integration requirements, and subcontract and vendor production problems."

The Navy then adopted a third modification of its original SUBACS plan, dubbed Replan III. In May 1985, a Navy review panel suggested a "BQQ-5-like" system as an alternative to SUBACS. According to the GAO report, the panel found that "Replan III was overly optimistic, had a low chance of meeting delivery schedules, and had unpredictable cost and schedule risks." A further review panel reported that it found neither system acceptable, and further concluded that to implement the BQQ-5-like alternative would cost six times more than the cost increase for SUBACS under Replan III. Congressional hearings reported that total RDT&E cost was estimated at US$2.4 billion and that shipbuilding costs for ships already authorized were estimated to be 40 percent more than were appropriated.

The GAO report implied that it did not believe that the Navy was in a position to make a decision on SUBACS or the BQQ-5-like system, and it urged the Navy to consider the current BQQ-5 as an alternative to either system. The GAO further stated that the Navy should consider "terminating the SUBACS program and returning to the current BQQ-5 system or developing a new distributed system databus."

PE#0604562N Submarine Tactical Warfare Systems

Project F0236 SSN Combat System Improvement. Beginning in FY93, BSY-1 maintenance and support funding was transferred to PE#0604562N Submarine Tactical Warfare Systems. Since FY94, the thrust of the Combat Control System Improvement program has been the fleet introduction of CCS Mk 2 program D0, BSY-1 Engineering Change Proposal (ECP) 134 and Navy Tactical Command System-Afloat (NTCS-A), and the development of CCS Mk 2 Program D0 Blocks 1 and 2.

In FY93, the System Design Certification Testing (SDCT) was completed for BSY-1 ECP 134, and the integration of NTCS-A into CCS Mk 1 and BSY-1 was begun. The BSY-1 ECP 134 completed TECHEVAL/ OPEVAL during FY94 and was released to the Fleet. Also, the NTCS-A for the CCS Mk 1 and BSY-1 was certified during this time.

From FY95 to FY97, efforts focused on integrating the CCS Mk 2 Program D0 Block upgrades into BSY-1 systems and replacing additional obsolete equipment, as well as incorporating a direct interface to the global positioning systems (GPS) and incorporating the Joint Maritime Command Information System (JMCIS) into CCS Mk 2. System Design Certification Testing (SDCT) for CCS Mk 2 Program D0 Block 1C commenced in FY98 and was completed by the end of FY99.

In FY00 and FY01, operational tests were conducted for CCS Mk 2 Program D0 Block 1C to obtain Milestone III. Once testing was completed, efforts were made to incorporate ADCAP torpedo Common Broadband Advanced Sonar System (CBASS) capability.

Efforts during FY03 focused on developing engineering changes to CCS Mk 2 Program D0 Block 1C to incorporate Tactical Tomahawk capabilities and upgrade for commonality with the Virginia class submarines. Other work focused on mitigating combat systems obsolescence, improving life-cycle costs, increasing commonality, and providing advanced warfighting capability to the submarine fleet based on the CCS Mk 2 combat system. Further efforts were made to develop the BSG-1 and mission distribution system upgrades. Also on the agenda was the integration of Advanced Tactical Software, commercial off-the-shelf (COTS) technology, and government off-the-shelf (GOTS) technology into the Backfit Submarine Combat Control Program.

PE#0604503N Submarine System Equipment Development

Project F0219 Submarine Sonar Improvement. Under this project, the sonar systems installed on Los Angeles, Improved Los Angeles, and Trident class submarines are updated. The goal is to maintain clear acoustical, tactical, and operational superiority over submarine and surface combatants in all scenarios through detection, classification, localization, and contact following. The development of BSY-1 ECP 1000 is expected to continue for several years under this project.

During FY97, a Milestone II approval was obtained. The First Article Test of high-frequency sensor and transmit equipment was conducted in FY98. System integration and testing of the BSY-1 HF Upgrade was scheduled for FY99. (The BSY-1 HF Upgrade is a stand-alone program that will be introduced as ARCI (Acoustic Rapid COTS Insertion) Phase IV for the SSN-688I class only.)

During FY00 and FY01, development continued of ARCI Phase III and Phase IV. At-sea testing of ARCI Phases I to IV was conducted, and the Advanced Processing Build Sea Testing continued. Other activity in FY01 included OPEVAL and TECHEVAL for ARCI Phase III and Phase IV. Also, development of the TB-29(A) towed array was completed. One other item on the agenda was the development of the TB-16 replacement.

The project schedule for FY03 showed work continuing on many of the efforts in progress from FY02, along with completion of the Precision Bottom Mapping transition, integration and testing. Additionally, acoustic intercept development for SSGN submarines was started by the end of the year.

Funding

The following U.S. Navy programs partially fund BSY-1(V) development, upgrade enhancements, and operational maintenance. Specific funding for the BSY-1(V) portion of the projects is not broken out.

U.S. FUNDING

	FY02		FY03		FY04		FY05	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (U.S. Navy)								
PE#0604562N Submarine Tactical Warfare Sys: Project F0236 SSN CCS	-	37.2	-	25.0	-	32.2	-	35.6
PE#0604503N SSN-688 and Trident Modernization	-	66.7	-	123.7	-	80.8	-	66.7

	FY06		FY07		FY08		FY09	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (U.S. Navy)								
PE#0604562N Submarine Tactical Warfare Sys: Project F0236 SSN CCS	-	40.6	-	54.6	-	56.4	-	57.4
PE#0604503N SSN-688 and Trident Modernization	-	72.7	-	76.2	-	74.4	-	76.1

All US$ are in millions.

Source: U.S. Department the Navy FY2004 RDT&E Budget Item Justification (R-2)

Note: In FY93, the BSY-1 was put into operational service, and support funding was transferred to PE#0604562N Submarine Tactical Warfare Systems, which develops software upgrades to integrate improved weapons capabilities within the submarine Combat Control System (CCS), Mk 1, Mk 2, and BSY-1 (Combat

Control), and to the Obsolete Equipment Replacement program, which develops improvements to hardware which has become difficult and uneconomical to maintain.

Recent Contracts

No recent contracts valued over US$5 million have been identified through open sources.

Timetable

Month	Year	Major Development
	1978-80	Navy conducts future attack submarine studies
Oct	1982	Sonar full-scale development contract
	FY83	Engineering studies complete
Sep	1983	SUBACS Pre-Planned Improvement Program approval
Oct	1983	SUBACS full-scale development contract to IBM
	1985	SUBACS program overhaul
	FY85	Detailed design and fabrication of engineering development prototypes complete
	FY86	Navy and IBM sign for contract for development and production of seven BSY-1 systems
May	1986	Limited production decision for 15 systems
	FY87	Initial BSY-1 system integration test and certification complete
Oct	1987	Program review of BSY-1 prior to limited production in FY88
Sep	1988	Raytheon contract for CCS Mk 2
Feb	1989	IBM delivers first full-up version of BSY-1
Mar	1989	Limited production decision for two systems
Aug	1989	Limited production decision for next two systems
Oct	1989	Milestone III BSY-1 approval for full production
Nov	1989	First upgrade to full performance system complete (SSN-751)
Mar	1990	Technical evaluation starts on board SSN-751
Dec	1990	TECHEVAL complete; OPEVAL commences
Fall	1991	OPEVAL completed
Fall	1992	BSY-1 approved for fleet use
Fall	1993	Completion of SDCT for BSY-1 ECP 1134
Fall	1994	Certification of NTCS-A for BSY-1
	1998	HF development contract
Fall	1999	Development of ARCI Phase IV
Fall	2000	ARCI Phases I - IV at-sea testing
Fall	2001	ARCI Phases III and IV OPEVAL and TECHEVAL
	2002	Engineering change to CCS Mk 2 Program D0 Block 1C to incorporate Tactical Tomahawk capabilities and upgrade for commonality with the Virginia class submarines
	2003	Acoustic intercept development for SSGN submarines to begin

Worldwide Distribution

The BSY-1(V) is a **U.S. Navy** program only.

Forecast Rationale

The BSY-1(V) Advanced Submarine Combat System is deployed on U.S. Navy Los Angeles class submarines where it is used to track and target platforms and weapons for combat systems management. No further units are expected to be produced or sold; however, extensive upgrade and enhancement work is likely to

continue as long as the Los Angeles class is active. Upgrades in progress include the CCS Mk 2 combat control system and the Acoustic Rapid COTS Insertion (ARCI) kits, which are expected to provide significant improvements in towed-array data processing and display. Extensive use of COTS equipment for upgrades and modifications should keep the BSY-1(V) up and running for several more years.

Ten-Year Outlook

Full system production complete. Major upgrades and enhancements in progress. The production chart has therefore been omitted. This report will be archived in the near future.

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