

TOMAHAWK



Navy ACAT IC Program

Baseline III and Prior

Total Number of Systems:	2,805 missiles
Total Program Cost (TY\$):	\$12,481M
Average Unit Cost, Missile (TY\$):	\$1.4M
Full-rate production:	3QFY84

Prime Contractor

Raytheon

Baseline IV Tactical Tomahawk

Total Number of Systems:	1,365 missiles
Total Program Cost (TY\$):	\$1,863.4M
Average Unit Cost (TY\$):	\$1.4M
Full-rate production:	3QFY03

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

Tomahawk is a long-range cruise missile designed to be launched from submarines and surface ships against land targets. Three primary variants are currently operational: (1) Tomahawk Land Attack Missile-Nuclear (TLAM-N) (not deployed); (2) Tomahawk Land Attack Missile-conventional (TLAM-C); and (3) Tomahawk Land Attack Missile-conventional submunition (TLAM-D). Each missile is contained within a pressurized canister to form an all-up-round (AUR). The submarine AUR is launched from torpedo or vertical tubes. Surface ships employ a vertical launching system to launch various missile types, including the Tomahawk AUR. Engagement planning, missile initialization, and launch control functions are performed aboard the launch platform by a Combat Control System (submarines) or

Tomahawk Weapon Control System (surface ships). Targeting, mission planning, and distribution of Tomahawk tactical data are supported by the Tomahawk Command and Control System (TC2S).

Tomahawk provides a recognizable example of a *precision engagement* system in the U.S. inventory, and has done so since its IOC in 1984. Upgrades leading to the Block III TLAM-C and TLAM-D configurations have improved the system's flexibility. Additional technological innovations are currently in development and are envisioned to further increase Tomahawk's responsiveness and exploit *information superiority* to a very high degree.

BACKGROUND INFORMATION

Development of the Tomahawk began in 1972. The program originally included a Tomahawk Anti-Ship Missile (TASM) in addition to the three land-attack variants. IOT&E began in 1981. DOT&E submitted B-LRIP reports for TASM and TLAM-N in 1984; TLAM-C in 1985; and TLAM-D in 1991.

The Block III upgrades to TLAM-C and TLAM-D include: (1) Global Positioning System navigation; (2) improvements to the terminal update system (DSMAC IIA); (3) time-of-arrival control; and (4) a new warhead for TLAM-C. The Tomahawk Weapon Control System software was also upgraded to a Block III configuration. A major upgrade (hardware and software) to the TC2S was undertaken at approximately the same time. Operational Test and Evaluation of the Block III AUR was completed in FY92 and Tomahawk Weapon Control System testing was completed in FY93. Operational Test and Evaluation of the upgraded TC2S was completed in FY94. End-to-end FOT&E of the Block III Tomahawk Weapon System was also completed in FY94.

Improvements to the Block III Tomahawk Weapon System are ongoing. The most recent upgrades are software version Tomahawk Mission Planning Center 3.1 for the TC2S and further development of the Advanced Tomahawk Weapon Control System (ATWCS). ATWCS is planned as a comprehensive upgrade to the current Tomahawk Weapon Control System, replacing the 1970s vintage hardware and re-hosting/upgrading the software. ATWCS implementation is proceeding in two stages: first replacing the current Tomahawk Weapon Control System, the Track Control Group, then the current Launch Control Group.

The next major upgrade, the Baseline IV Phase I Tactical Tomahawk, is in development. The Tactical Tomahawk will be more responsive and more flexible than current variants. The AUR will be equipped with a significantly more capable mission computer, a two-way satellite data link, and an anti-jam Global Positioning System receiver. The Tactical Tomahawk will be capable of being redirected to secondary pre-planned targets after launch ("en route flex"). The missile will also be able to receive a new or modified mission plan after launch ("in-flight retargeting"). Meanwhile, the missile will be able to provide information on its in-flight status and confirm arrival in the target area ("battle damage indication"). Improvements to the mission planning and launch platform weapon control systems will reduce the overall Tomahawk planning cycle. Crews aboard launch platforms will be able to plan some types of missions from launch to impact. The EMD contract for the Tactical Tomahawk AUR was awarded in June 1998. The Tactical Tomahawk is currently scheduled to enter Government Developmental Testing in FY01 and Operational Testing in FY02.

TEST & EVALUATION ACTIVITY

Test event OT-IIIIE was conducted in 4QFY99 to evaluate the latest software release for the TC2S. Software version TMPC 3.1 introduced the Post-Digital Scene Matching Area Correlator-Global Positioning System (PDGPS) capability. This feature permits the use of Global Positioning System aiding after the inertial navigation system has received a Digital Scene Matching Area Correlator (DSMAC) update. As a result, inertial navigation system drift is sharply reduced and the accuracy of the DSMAC update can be preserved over greater distances. With PDGPS, the separation between the final DSMAC scene and the target can be increased five-fold (compared with the current allowable maximum) with no loss in terminal accuracy. This capability allows greater flexibility in pairing DSMAC scenes with targets. OT-IIIIE testing was conducted at U.S. Pacific Command Headquarters, employing the operators and maintenance personnel of the Cruise Missile Support Activity. Twenty operational missions and one Operational Test Launch mission were prepared for FOT&E. All missions were validated by means of accredited simulations. To conclude OT-IIIIE, an Operational Test Launch mission is scheduled for early FY00. The evaluation will be completed in 1QFY00.

Developmental Tests and advanced OPEVAL planning for the ATWCS Launch Control Group Replacement (LCGR) were conducted in FY99. COMOPTEVFOR observed the developmental tests and provided informal feedback to DOT&E and the PEO. Test event OT-IIIIL, the operational evaluation for the LCGR, will be conducted in 1QFY00.

All Tomahawk TEMP and Test Plans are approved and testing is proceeding in accordance with these documents.

TEST & EVALUATION ASSESSMENT

DOT&E has been monitoring ATWCS development and testing since 1994. It became apparent early in the program that re-hosting the system in commercial off-the-shelf hardware, together with significant expansions of software functions, would present serious technical challenges. This early concern was confirmed in the operational evaluation of the ATWCS Track Control Group Replacement (TCGR). Software problems necessitated additional testing to verify correction of deficiencies before deployment. Accordingly, DOT&E encouraged earlier involvement by COMOPTEVFOR in the remaining test program. In FY99, an ATWCS LCGR early operational test was conducted approximately one year ahead of the operational evaluation. The users' perspective provided by COMOPTEVFOR helped the developers save time by correcting the deficiencies early and showed how software features could be improved to reduce the user's workload and make shipboard targeting and launch planning more efficient.

A draft TEMP for Tactical Tomahawk was provided for DOT&E review in early 1998. The LFT&E strategy in the draft TEMP included three warhead sled tests. The purpose of these tests was to evaluate the integration and function of a new fuze in conjunction with the Tactical Tomahawk warhead. The PEO later proposed deleting these tests, based on the use of the Block III TLAM-C warhead as the warhead for the Tactical Tomahawk AUR. DOT&E does not concur in deleting the sled tests due to the differences in airframe structure, terminal environment, and fuze functioning in the Tactical Tomahawk as compared to the Block III TLAM-C. An update to the Tactical Tomahawk TEMP, reflecting recent changes in the acquisition program, is currently in progress.

RECOMMENDATIONS

The Tactical Tomahawk Weapon Control System (TTWCS) will be required to perform limited end-to-end mission planning capability aboard the launch platform. This capability is needed for "emerging, relocatable targets." This rapid response mode of operations is very different from the layered and lengthy preparations required for current Tomahawk launches and needs to be well tested. The concept of operations for this new capability should be developed with care. Above all, the viability of this process must be demonstrated through stringent and realistic testing. For missile systems, the Navy and DOT&E validate new modes of operation via flight testing. An earlier version of this capability, planned for the Block III but subsequently deferred to the Tactical Tomahawk, could not be validated by means of flight testing. The PEO should ensure that the effectiveness and suitability of this capability will be validated through flight testing.

LESSONS LEARNED

Tomahawk Block II and Block III inventories have been depleted in recent operations in Southwest Asia and the Balkans but not replenished with newer versions. The Tactical Tomahawk program has been restructured several times since its inception in 1994. The overall Tomahawk program has had difficulty in building consensus for TEMP updates through the IPT process. The proposed updates are late in arriving at DOT&E relative to the commencement of testing. Completion of the Tactical Tomahawk TEMP and ORD should be expedited. The PEO needs to be proactive in using the IPT process to ensure the TEMP approval process will be timely to support evaluation of the test strategy.