EVOLVED SEA SPARROW MISSILE (ESSM)

Navy ACAT II Program

Total Number of Systems:	2,076 (U.S. only)	
Total Program Cost ((TY$):	$1,615.2M	
Average Unit Cost (TY$):	$0.656M	
Full-rate production:	FY03	

Prime Contractor

Raytheon Systems Company,
Tucson, AZ

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The Evolved Sea Sparrow Missile (ESSM) is a short-range missile intended to provide self-protection for surface ships. On Aegis ships, ESSM will be launched from the MK 41 Vertical Launch System, requiring a thrust vector control system on the ESSM rocket motor; guidance will be by up-linked commands until the ESSM is near the target, at which time guidance will transition to semi-active homing on reflected radar signals from the target. It may also be launched in a home-all-the-way mode (no up-linked commands). On non-Aegis ships (aircraft carriers, amphibious assault ships, other surface combatants), it will be fired from other launch systems; guidance will be in homing all the way to intercept. ESSM uses an 8-inch diameter forebody that includes a modified guidance section from the in-service RIM-7P Sea Sparrow. The guidance section, which includes a radome-protected antenna for semiactive homing, attaches to a new warhead section. A new transition section connects the warhead to the rocket motor and contains a computer, an inertial measurement unit, a warhead-compatible telemeter, and an Aegis-only S-Band transceiver. The forebody is attached to a new 10-inch diameter rocket motor, which provides higher thrust for longer duration than predecessor Sea Sparrow missiles. ESSM uses skid-to-turn steering (tail control), whereas earlier Sea Sparrows were wing-controlled. ESSM will retain capability of the RIM-7P missile, but will also have capability against maneuvering anti-ship missiles. ESSM is a cooperative development effort by ten participating governments.

ESSM contributes to the ***Joint Vision 2020*** concept of ***full-dimensional protection*** by enhancing ship self-protection against air threats that have "leaked" past outer air defenses. Given that some of the ships that will use ESSM are also platforms from which strike operations are executed, ESSM indirectly contributes to the concept of ***precision engagement***.

BACKGROUND INFORMATION

Milestone II was conducted in November 1994. The TEMP was approved by OSD in January 1995, through the first at-sea phase of developmental testing. The results of this testing were supposed to provide the data for an operational assessment supporting the LRIP decision. This provisional approval was assigned because the aerial targets proposed in the TEMP for the DT and OT (in support of the full production decision) were unacceptable in adequately representing Anti-Ship Cruise Missile (ASCM) threats. (Since that time, the PEO (TSC) has taken initiatives to obtain targets that are more threat-representative.) During 1998, the program was restructured with an OA based on missile flights at White Sands Missile Range, NM, to support the initial LRIP decision. A second LRIP decision was added and will be supported by testing with the Self Defense Test Ship (SDTS). The full production decision will be supported by an OPEVAL planned for late FY02 or early FY03 conducted with an Aegis destroyer. Subsequent to program restructuring, the TEMP was revised and approved by OSD T&E Principals on March 30, 2000.

TEST & EVALUATION ACTIVITY

Fiscal Year 2000 activity included initial test flights for the DT at the White Sands Missile Range. The DT consists of firing both control test vehicles (CTVs) and guidance test vehicles (GTVs). CTVs are ESSMs with inert guidance sections programmed to execute maneuver patterns. GTVs are ESSMs with guidance sections for homing on targets. The fourth CTV flight test was conducted in November 1999. The first GTV flight test was conducted as a combined CTV/GTV flight in March 2000. GTV-2 was fired at a sub-sonic target drone in July 2000. GTV-3 was fired at a supersonic target in August 2000. GTV-4 was fired at a maneuvering target drone in November 2000. GTV-5 was fired at a low altitude, close-range, sub-sonic target in December 2000. The GTV results will serve as the basis for an OA to support an LRIP decision. Tests were conducted in accordance with a DOT&E-approved TEMP and OA plan.

Activity also included preparation for the two phases of DT/OT planned for FY01: Aegis S-Band testing at the White Sands Missile Range (February-May) and at-sea testing on the Self Defense Test Ship (planned to start in June). Results of this testing will serve as the basis for a second LRIP decision.

TEST & EVALUATION ASSESSMENT

CTV Results. Primary objectives of the four CTV flights were to demonstrate kinematic capability and aerodynamic control during high G maneuvers, evaluate autopilot stability, and collect data to validate simulations. Autopilot performance was closely monitored during these flights, with design changes implemented as the flight series progressed. A "tactical" autopilot was used in the third flight, but performance was marred by loss of roll stability during an early maneuver, resulting in high roll rates that exceeded the capability of the inertial measurement unit. As a result, the autopilot gains were adversely affected for the remainder of the flight. The initial loss of stability was caused by incorrect entries in the autopilot software. A problem that persisted at least through the first three flights was that the rear reference antenna, located near the rocket motor exhaust, suffered thermal damage to its radome, which could have affected RF properties. The seeker antenna radome came apart during the first CTV flight test and, although a failure cause was believed determined at the time, subsequent radome failures during two GTV flights helped isolate the problem to radomes of a particular make (discussed under GTV phase below). A battery failure occurred during the second flight test. The failure cause was determined and the problem was fixed. The fourth CTV flight, conducted from a vertical launch cell, resulted in the thrust vector controller failing to detach from the rocket motor. Failure cause was determined to be a missing g-switch in the control actuation assembly; processes have been implemented to preclude recurrence. The CTVs were launched from both a MK 29 rail launcher and a MK 41 vertical launcher.

GTV phase: Three GTVs were flight-tested during FY00, and two more have been fired in early FY01. GTV-1 was modified to incorporate test objectives from CTV-4. The missile executed the programmed CTV-4 maneuvers, then locked on and guided to successful intercept with a sub-sonic, "middle of the envelope" target drone augmented to increase its radar cross-section. GTV-2 was launched at a sub-sonic drone, at higher altitude than GTV-1, but without the increased radar cross-section. The ESSM seeker antenna radome came apart during flight, precluding terminal guidance on the target. GTV-3 was launched at a supersonic target. The seeker antenna radome on this ESSM also came apart during flight, just as the ESSM began terminal homing on the target. As of this writing, the cause of the radome failures appears to be thermally-induced stress experienced in the high acceleration environment of ESSM. All three radomes that failed were from the same source (which no longer produces them). Of the radomes that performed successfully, three were from a second source, and one was from the first source. The fact that it did not fail is attributed to the less demanding maneuver profile. GTV-4 was launched from a vertical launcher at a sub-sonic, maneuvering target, with successful intercept at medium range and low altitude. GTV-5 was launched from a vertical launcher at a sub-sonic target, with successful intercept at close-in range and low altitude.

Among the significant limitations accompanying the testing of ship-launched missiles at the White Sands Missile Range, that will qualify conclusions drawn from the results of the testing, is the decidedly non-maritime nature of the high desert environment. The harsh environment encountered when engaging sea-skimming ASCMs cannot be adequately represented because targets cannot be flown low enough and the radar reflectivity characteristics of the sea surface cannot be represented. Safety zones surrounding the launcher preclude flying targets directly toward the launcher, creating a crossing aspect that is not present in a self-defense scenario at sea. Further, the fire control system at White Sands Missile Range differs in many respects from those used on ships firing ESSMs.

Self Defense Test Ship Phase. The DT/OT scheduled for FY01 on the Self Defense Test Ship promises to be very realistic, with the opportunity to learn more about ESSM capability in the actual operational environment. The SDTS combat system represents that on non-Aegis ships using the MK 29 rail launch system.

OPEVAL and FOT&E. Although OPEVAL is considered adequate, with the possible interoperability exception noted below, a new ASCM threat has appeared for which there is no credible surrogate to use as a target. Given the time required to obtain such a surrogate, this is expected to be an issue for examination during FOT&E. Limitations in the Aegis Weapon System Baseline 6.3 computer program and shipboard illuminator radars will preclude testing ESSM's capability against surface targets.

Interoperability with Aegis Weapon System. ESSMs are intended to provide close-in defense of Aegis ships against anti-ship cruise missiles, with Standard Missile providing interceptor capability at longer ranges (both self-defense and defense for other ships). There are circumstances where the Aegis Weapon System could be controlling both ESSMs and SM-2s simultaneously. This is primarily an Aegis Weapon System (Baseline 6.3) issue that requires operational testing, either during the ESSM OPEVAL or during DDG 51 FOT&E.