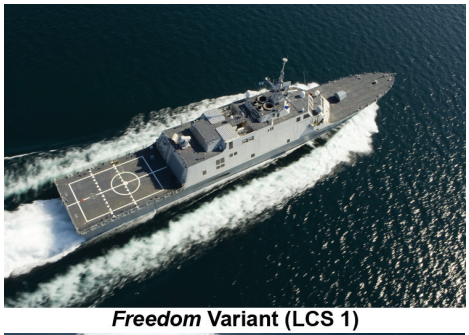
Littoral Combat Ship (LCS)

Executive Summary

- During FY14, the Navy conducted both developmental testing and operational testing of the *Freedom* class Littoral Combat Ship (LCS) seaframe and Increment 2 Surface Warfare (SUW) Mission Package aboard USS *Fort Worth* (LCS 3). The 2014 operational testing identified shortcomings in air defense, reliability, and endurance, and significant vulnerabilities in cybersecurity. When equipped with the Increment 2 SUW Mission Package, LCS 3 was able to defeat a small number of Fast Inshore Attack Craft under the particular conditions specified by the Navy's reduced incremental requirement and after extensive crew training and tailoring of the tactics described in Navy doctrine; however, testing conducted to date has not been sufficient to demonstrate LCS capabilities in more stressing scenarios consistent with existing threats.
- The core combat capabilities of the *Independence* class variant seaframe remain largely untested. Developmental testing has focused on evaluating the performance of the seaframe and the Increment 1 Mine Countermeasures (MCM) Mission Package, with multiple deficiencies identified.
  - The MCM Mission Package has not yet demonstrated sufficient performance to achieve the Navy's minimal Increment 1 requirements. Although the ship's and its crew's ability to launch and recover Remote Multi-Mission Vehicles (RMMVs) has improved, LCS has had difficulty establishing and maintaining reliable communications with the RMMV, and the RMMV continues to exhibit reliability problems. The current communications systems also do not support bottom mine identification beyond the horizon.
  - Attempts to demonstrate the sequence of events necessary for an LCS to complete end-to-end mine clearance operations have been limited by low operator proficiency, software immaturity, system integration problems, and poor Remote Minehunting System (RMS)/RMMV reliability.
  - During a shore-based assessment, the Airborne Mine Neutralization System (AMNS) did not meet the Navy's requirement for mine neutralization success. Failures of the host MH-60 aircraft's systems and its associated Airborne MCM kit severely limited AMNS availability. Frequent loss of fiber-optic communications between the aircraft and the neutralizer was the primary cause of unsuccessful attack runs. Both problems increase the time needed to conduct LCS-based AMNS operations and reduce the ship's sustained area coverage rate.
- LCS is not expected to be survivable in high-intensity combat because its design requirements accept the risk that the ship must be abandoned under circumstances that would not require such an action on other surface combatants. Although the ship incorporates capabilities to reduce susceptibility to attack, previous testing of analogous capabilities demonstrates it cannot be assumed LCS will not be hit in high-intensity combat.
  - While both seaframe variants are fast and highly maneuverable, they are lightly armed and possess no significant offensive capability without the planned SUW Increment 4 Mission Package or Increment 2 Anti-Submarine Warfare (ASW) Mission Package.
- Equipment reliability problems have degraded the operational availability of both LCS classes. The Navy reports that recent reliability improvements made to the affected seaframe components have led to improved operational availability; however, that improvement has not been verified in operational testing.
- At the request of the Secretary of Defense, DOT&E prepared in October 2014 an independent assessment of the combat capabilities and survivability of the alternative concepts for a new small surface combatant (SSC) developed by the Navy's SSC Task Force. Using the Task Force's results, that assessment found that only major modifications to the existing LCS design, or a new ship design, could provide the multi-mission combat capabilities and survivability features found in a modern frigate.



***Freedom* Variant (LCS 1)**

***Independence* Variant (LCS 2)**

System

Seaframes

- The LCS is designed to operate in the shallow waters of the littorals that can constrain the ability of larger ships to maneuver.
- The Navy planned to acquire a total of 52 LCSs; however, in a February 24, 2014, memorandum, the Secretary of Defense announced that no new contract negotiations beyond 32 ships will go forward and directed the Navy to submit alternative proposals to procure a capable and lethal SSC, generally consistent with the capabilities of a frigate. In December, he approved the Navy's recommendation to modify the existing LCS designs for the remaining 20 ships.
- The Navy is currently procuring two variants of LCS seaframes:
  - The *Freedom* class (LCS 1, 3, 5, and follow-on odd-numbered ships) is a semi-planing monohull design constructed of steel (hull) and aluminum (deckhouse) with two steerable and two fixed-boost water jets driven by a combined diesel and gas turbine main propulsion system.
  - The *Independence* class (LCS 2, 4, 6, and follow-on even-numbered ships) is an aluminum trimaran design with two steerable water jets driven by diesel engines and two steerable water jets driven by gas turbine engines.
- Common design specifications include:
  - Sprint speed in excess of 40 knots, draft of less than 20 feet, and an unrefueled range in excess of 3,500 nautical miles at 14 knots
  - Accommodations for up to 98 personnel
  - A Common Mission Package Computing Environment for mission package control
  - Hangars sized to embark MH-60R/S and Vertical Take-Off Unmanned Aerial Vehicles (VTUAVs)
  - Mk 110 57 mm gun
- The designs have different core combat systems to provide command and control, situational awareness, and self-defense against anti-ship cruise missiles and surface craft.
  - *Freedom* Class Variant:
    - COMBATSS-21, an Aegis-based integrated combat weapons system with a TRS-3D (SPS-75) air/surface search radar
    - Ship Self-Defense System Rolling Airframe Missile (RAM) system (one 21-cell launcher)
    - Soft Kill Weapon System
    - DORNA gunfire control system with an electro-optical/infrared sensor to control the Mk 110 57 mm gun.
  - *Independence* Class Variant:
    - Integrated Combat Management System (derived from Dutch TACTICOS system) with a Sea Giraffe (SPS-77) air/surface search radar
    - One Mk 15 Mod 31 SeaRAM launcher (integrates the search, track, and engagement scheduler of the Close-in Weapon System with an 11-round RAM launcher assembly)
    - ALEX (Automatic Launch of Expendables) System (off-board decoy countermeasures)
    - Sea Star SAFIRE electro-optical/infrared systems for 57 mm gun fire control.

Mission Packages

- LCS is designed to host a variety of individual warfare systems (mission modules) assembled and integrated into interchangeable mission packages. The Navy currently plans to field MCM, SUW, and ASW Mission Packages. A mission package provides the seaframes with capability for a single or "focused" mission. Multiple individual programs of record involving sensor and weapon systems and off-board vehicles make up the individual mission modules.

SUW Mission Package

- Increment 1 includes:
  - Gun Mission Module (two Mk 46 30 mm guns)
  - Aviation Module (embarked MH-60R)
- Increment 2 adds:
  - Maritime Security Module (small boats)
- Increment 3 adds:
  - Surface-to-Surface Missile Module Increment I, employing the AGM 114L Longbow HELLFIRE missile
  - One MQ-8B Fire Scout VTUAV to the Aviation Module
- Increment 4 adds:
  - Surface-to-Surface Missile Module Increment II to replace Increment I

MCM Mission Package

- Increment 1 includes:
  - Remote Minehunting Module, consisting of two RMMVs and three AN/AQS-20A/B sensors. The Navy is considering plans to incorporate an improved sensor (AN/AQS-20B) in the current increment; otherwise, the AN/AQS-20B will most likely be delivered in a future increment.
  - Near Surface Detection Module consisting of two Airborne Laser Mine Detection Systems (ALMDS). The Navy is also developing pre-planned product improvements that it expects to incorporate in a future increment.
  - Airborne Mine Neutralization Module consisting of two AMNS. In Increment 1, the AMNS does not include a near-surface mine neutralization capability; the Navy plans to develop this capability in a future increment.
  - Aviation Module consisting of an MH-60S Block 2B or subsequent Airborne Mine Countermeasures (AMCM) Helicopter outfitted with an AMCM system operator workstation and a tether system.

- Increment 2 adds:
  - Coastal Battlefield Reconnaissance and Analysis (COBRA) Block I system and one MQ-8B VTUAV for daytime unmanned aerial tactical reconnaissance to detect and localize mine lines and obstacles in the beach zone.
- Increment 3 adds:
  - Unmanned Influence Sweep System to activate acoustic-, magnetic-, and combined acoustic/magnetic-initiated volume and bottom mines in shallow water so they self-destruct.
- Increment 4 adds:
  - COBRA Block II system, which retains Block I capability and adds night-time minefield and obstacle detection capability and day/night detection capability in the surf zone.
  - Knifefish Unmanned Undersea Vehicle, an untethered, autonomous underwater vehicle, employing a low-frequency broadband sonar sensor to detect, classify, and identify volume and bottom mines in shallow water.

ASW Mission Package (only Increment 2)

- Torpedo Defense and Countermeasures Module (Lightweight Tow torpedo countermeasure)
- ASW Escort Module (Multi-Function Towed Array and Variable Depth Sonar)
- Aviation Module (embarked MH-60R and MQ-8B Fire Scout VTUAV) (Inclusion of Fire Scout has reportedly been deferred because of fiscal constraints.)

Mission

- The Maritime Component Commander will employ LCS to conduct MCM, ASW, or SUW tasks depending on the mission package fitted into the seaframe. Commanders can employ LCS in a maritime presence role in any configuration because of capabilities inherent to the seaframe. With the Maritime Security Module, installed as part of the SUW Mission Package, the ship can conduct Visit, Board, Search, and Seizure maritime interception operations.
- The Navy can employ LCS alone or in company with other ships. The Navy's Concept of Operations for LCS anticipates that the ship's primary operational role will involve preparing the operational environment for joint force assured access to critical littoral regions by conducting MCM, ASW, and SUW operations, possibly under an air defense umbrella as determined necessary by the operational commander.

Major Contractors

- *Freedom* Class Variant (LCS 1, 3, 5, and follow-on odd-numbered ships)
  - Prime: Lockheed Martin Maritime Systems and Sensors – Washington, District of Columbia
  - Shipbuilder: Marinette Marine – Marinette, Wisconsin
- *Independence* Class Variant (LCS 2, 4, 6, 8, and follow-on even-numbered ships)
  - Prime for LCS 2 and LCS 4: General Dynamics Corporation Marine Systems, Bath Iron Works – Bath, Maine
  - Prime for LCS 6, LCS 8, and follow-on even numbered ships: Austal USA – Mobile, Alabama
  - Shipbuilder: Austal USA – Mobile, Alabama
- Mission Packages
  - Future Mission Package Integration contract awarded to Northrop Grumman – Los Angeles, California

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Activity

LCS Program

- DOT&E published an Early Fielding Report providing an assessment of the LCS seaframes and mission packages in December 2013.
- DOT&E forwarded a response to the reporting requirement in the FY14 Conference Report (113-66) accompanying H.R. 3304, the National Defense Authorization Act for FY14, to the Navy for inclusion with the Navy's response on April 4, 2014.
- DOT&E will publish an assessment of the results of operational testing of the *Freedom* class seaframe and SUW Mission Package (Increments 1 and 2) in 2QFY15.

Seaframes

- *Freedom* Class Variant:
  - USS *Freedom* (LCS 1) returned to San Diego, California, from operations in the Western Pacific in December 2013.
  - After receiving modifications needed to host the ASW Mission Package, USS *Freedom* (LCS 1) participated in engineering tests designed to test the integration of the ASW mission modules into the *Freedom* class seaframe.
  - The Navy conducted developmental testing of the *Freedom* class variant seaframe aboard USS *Fort Worth* (LCS 3) in 1Q-2QFY14.
  - The Navy conducted operational testing of the *Freedom* class variant seaframe aboard USS *Fort Worth* (LCS 3) in March and April 2014. The testing was conducted in accordance with a DOT&E-approved test plan.
- *Independence* Class Variant:
  - USS *Independence* (LCS 2) hosted a scheduled phase of developmental testing focused on the integrated seaframe and Increment 1 MCM Mission Package operations in October 2014.

- USS *Independence* (LCS 2) participated in a phase of developmental testing designed to evaluate RMMV launch and recovery operations using modified hardware and revised procedures and communications between the LCS and RMMVs using the Multi-Vehicle Communications System.
- The Navy conducted Heavy Weather developmental testing in early FY14. Subsequently, the Navy discovered cracks in the welds at the base of support stanchions located in the mission bay and imposed a weight limit on the launch and recovery system for USS *Independence* (LCS 2) and USS *Coronado* (LCS 4).
- The Navy placed USS *Coronado* (LCS 4) in commission in April 2014.
- The Board of Inspection and Survey (INSURV) conducted Final Contract Trials aboard USS *Coronado* (LCS 4) in June 2014.
- USS *Coronado* (LCS 4) completed a series of basic seaframe developmental tests, including 57 mm gunnery events, before starting her post-shake-down availability in 1QFY15.

SUW Mission Package

- The Navy conducted developmental testing of the Increment 2 SUW Mission Package aboard USS *Fort Worth* (LCS 3) in 1Q-2QFY14.
- The Navy conducted an initial phase of operational testing of the Increment 2 SUW Mission Package aboard USS *Fort Worth* (LCS 3) in March and April 2014. This test examined the *Freedom* class variant's self-defense capability against small swarms of high-speed boats and its effectiveness in conducting simulated maritime interdiction operations that required the crew to intercept and board a vessel suspected of transporting contraband.
- The testing was conducted in accordance with a DOT&E-approved test plan.

MCM Mission Package

- In 1QFY14, the Navy completed two phases of developmental testing (DT-IIG) of the RMS consisting of a version 4.2 (v4.2) RMMV and an AN/AQS-20A sensor from a shore base at the contractor's facility in West Palm Beach, Florida. A third phase of testing described by the RMS Test and Evaluation Master Plan as an opportunity to assess risk of the interfaces with the LCS, including cybersecurity, was not conducted. The Navy cited lack of LCS availability as the rationale for cancellation of this phase, but incompatibility of the v4.2 RMMV with LCS was also a factor. In 3QFY14, the Navy conducted dockside and at-sea developmental testing to verify correction of the RMMV launch, handling, and recovery system and communications deficiencies observed in FY13 developmental testing. Finally, in 1QFY15, the Navy conducted the last scheduled phase of the Increment 1 MCM Mission Package developmental test DT-B2 aboard USS *Independence* (LCS 2). This phase was the first time that RMS and the airborne MCM Mission Package components had operated together off an LCS.
- The Navy conducted Phase A of an operational assessment of the AMNS in 3QFY14 with the MH-60S helicopter operating from Naval Air Station Oceana, Virginia. The test included the use of explosive neutralizers and inert training neutralizers against inert moored and bottom mine targets.
- The Navy conducted Phase B of the AMNS operational assessment to focus on shipboard integration and the system's suitability, but was also able to collect some limited effectiveness data. This phase of test was conducted aboard USS *Independence* (LCS 2) in 1QFY15 during Increment 1 MCM Mission Package developmental testing. Because some deficiencies in mission package performance discovered earlier had not been corrected, some deviations from the approved test plan occurred; those deficiencies are discussed in the assessment section below.
- The Navy completed Phase B (LCS-based phase) of the test in 1QFY15 aboard USS *Independence* (LCS 2) during Increment 1 MCM Mission Package developmental testing. The test examined system effectiveness and the shipboard suitability of the MH-60S helicopter equipped with ALMDS.
- The Navy postponed a scheduled operational assessment of COBRA Block I after an Antares rocket exploded just after lift-off from the Wallops Island launch pad on October 28, 2014. Although all test preparations had been completed, both MQ-8B Fire Scout VTUAVs that were to host the COBRA system during the test suffered shrapnel damage from the rocket explosion. The Navy has not yet established a new date for the operational assessment.

ASW Mission Package

- The Navy conducted Advanced Development Model (ADM) testing of the ASW Escort Module aboard LCS 1 in September 2014. Testing was focused on the integration of the Variable Depth Sonar and Multi-Function Towed Array with the LCS platform, to include pull stresses and stern door effectiveness with penetrating systems. Testing also included some long-range passive and active ASW search in deep water against a U.S. nuclear submarine. Testing was highly scripted, which is appropriate for early system integration efforts, but the results cannot be used to make any assessment of operational performance under realistic combat conditions. The test was conducted with full knowledge of the target submarine's position throughout the test, and the operators focused their search only in the region where the submarine was known to be.

LFT&E

- The Navy conducted a Total Ship Survivability Trial (TSST) on USS *Fort Worth* (LCS 3) in accordance with the DOT&E-approved trial plan.
- DOT&E provided an interim survivability assessment of both LCS designs in the Early Fielding Report issued on December 9, 2013.

- As part of the response to the reporting requirement in the FY14 Conference Report (113-66) accompanying H.R. 3304, the National Defense Authorization Act for FY14, DOT&E provided the Navy a review of the survivability testing, modeling, and simulation conducted to date on the two seaframes and an assessment of the expected survivability of LCS in the context of the planned employment of LCS as described in the concept of operations.

SSC Study

- At the request of the Secretary of Defense, DOT&E prepared in October 2014 an independent assessment of the combat capabilities and survivability of the alternative concepts for a new SSC developed by the Navy's SSC Task Force. The DOT&E assessment is a classified document.

Assessment

This assessment is based on information from DOT&E's observations of post-delivery testing and trial events, fleet operations, developmental test data, results provided by the Navy program offices, operational assessments of some mission systems, and operational testing of the *Freedom* class seaframe with the Increment 1 and 2 SUW Mission Packages.

LCS Program

- The Navy intends to field LCS capabilities incrementally as mission package systems mature and become ready for fleet use. Additionally, the Navy directed changes to the seaframe designs based on the results of early developmental testing and operations.
  - The Navy has indicated that the seaframe designs will be stabilized in the third ship of each variant (LCS 5 and LCS 6).
  - Since the Navy expects each increment to deliver significant increases in mission capability, the approved Test and Evaluation Master Plan anticipates an appropriately-designed phase of OT&E on all delivered mission package increments on each seaframe variant. The details of the testing to be accomplished for later Increments of mission package capability will be decided when the content of those later increments are defined by the Navy.
  - An initial phase of operational testing was completed in FY14 for the *Freedom* class variant seaframe and SUW Mission Package only, but the final phases will not be completed until the FY19 timeframe.

Seaframes

- While both seaframe variants are fast and highly maneuverable, they are lightly armed and possess no significant offensive capability without the planned Increment 4 SUW Mission Package or the Increment 2 ASW Mission Package.
  - In comparison to other Navy ships, the LCS seaframes have relatively modest air defense capabilities; however, their air defense capabilities cannot be characterized fully until tests on LCS 5 and LCS 6 (the production-representative seaframes) and the Navy's unmanned Self-Defense Test Ship provide data for the Navy Probability of Raid Annihilation high-fidelity modeling and simulation analyses in FY18. The Navy plans to test the *Independence* class variant's capability to defeat unmanned aerial vehicles and slow-flying aircraft in FY15.
  - The *Freedom* class seaframe's surface self-defense capability was operationally tested in FY14 (see below) and the *Independence* class seaframe's capability is scheduled to be tested in FY15 aboard USS *Coronado* (LCS 4).
  - The seaframes include no systems designed to detect torpedo attacks or mines without the appropriately configured mission packages installed.
- Crew size can limit the mission capabilities, combat endurance, and recoverability of the ships. The Navy continues to review manning to determine appropriate levels, and is adding 20 berths to all seaframes. The increased berthing supports small increases in the size of the core crew, mission package detachments, and the aviation detachment.
- *Freedom* Class Variant (LCS 1 and 3):
  - Although not all aspects of operational effectiveness and operational suitability could be examined during the 2014 operational testing, that testing identified shortcomings in air defense, reliability, and endurance, and significant vulnerabilities in cybersecurity.
  - Cybersecurity testing conducted during operational testing aboard LCS 3 uncovered significant vulnerabilities in the ship's capability to protect the security of information and prevent malicious intrusion. Limited cybersecurity testing conducted during a 2012 Quick Reaction Assessment aboard LCS 1 also found vulnerabilities.
  - Tracking events conducted during operational testing aboard LCS 3 demonstrated that in some scenarios the SPS-75 (TRS-3D) air search radar is unable to detect and track some types of air threats in operationally realistic environments. Tracking performance improved significantly when the LCS received tracking information via datalink from a nearby Aegis destroyer. The lack of an integrated electronic support measures system limits the ship's capability to make best use of its inventory of RAM surface-to-air missiles.
  - Critical equipment required to support ship operations, core mission functions, and mission package operations is unreliable. The ship's crew does not have adequate training and technical documentation to troubleshoot equipment failures; the Navy lacks repair parts for some critical systems; and the Navy's plan for distribution of the maintenance workload among the ship's crew,

shore-based Navy support organizations, and technical experts from other organizations is immature. The operational availability of shipboard systems in 10 of 12 categories examined met or exceeded Navy requirements, however, failures of critical propulsion and maneuvering and Total Ship Computing Environment systems forced the ship to return to port for repairs that, respectively, caused 42 and 36 days of downtime during the period of data collection during operational testing. Excluding scheduled maintenance periods, LCS 3 was fully mission capable less than 25 percent of the time during that period.

- During operational testing, LCS 3 did not demonstrate that it could achieve the Navy requirement for fuel endurance (operating range) at the prescribed transit speed or at sprint speed. Information provided by the Navy indicated that between 91 and 92 percent of the ship's total diesel fuel (F-76) tank capacity would actually be available for use since some room must be left for expansion when the tanks are filled, a portion of the tanks' volume is filled with piping and structural members, and a small amount of fuel remains inaccessible when the tanks are emptied. Based on fuel consumption data collected during the test, the ship's operating range at 14.4 knots is estimated to be approximately 1,961 nautical miles (Navy requirement: 3,500 nautical miles at 14 knots) and the operating range at 43.6 knots is approximately 855 nautical miles (Navy requirement: 1,000 nautical miles at 40 knots). In an emergency, the ship could use its aviation fuel (F-44) to extend the transit and sprint ranges by 360 and 157 nautical miles, respectively. The shortfall in endurance may limit the flexibility of the ship's operations in the Pacific and place a heavier than anticipated demand on fleet logistics.
- Operational testing confirmed earlier observations that, except for the ships' lack of endurance, the *Freedom* class variant is well-suited for Maritime Security Operations. LCS 3 readily demonstrated the capability to position, launch, and recover the 11-meter boats included in the SUW Mission Package when the launch, recovery, and handling system is operational.
- The ship's Mk 110 57 mm gun system performed reliably during operational testing, and the ship was able to demonstrate the core capability for self-defense against a small boat in two valid trials. The Navy attempted to collect additional data from swarm presentations, but the data were invalid. The 57 mm gun failed to achieve a mission kill during one swarm presentation, and the target killed by the 57 mm gun during a second swarm presentation had previously been engaged by 30 mm guns.
- The *Freedom* class LCS has sufficient aviation facilities and meets Navy requirements to safely launch, recover, and handle all appropriate aircraft while operating in Sea State 4 conditions. However, the ship frequently experienced difficulty with establishing and maintaining a Tactical Common Data Link with the aircraft during the FY14 operational test. The crew's efforts were hampered by an antenna failure and the total lack of technical documentation on the operation and maintenance of the datalink.
- The LCS 3 anchoring system could not securely anchor the ship in an area with a bottom composed of sand and shells. Despite repeated efforts, the ship was unable to set the anchor. It appears that the anchor and chain are too light and there are too many friction points along the anchor chain's internal path from the chain locker to the hawse pipe to allow the anchor and chain to pay out smoothly.
- The fenders designed to guide the 11-meter Rigid Hull Inflatable Boats included in the SUW Mission Package during launch and recovery are fragile and occasionally sheared off when impacted by the boats during operational testing. Although the fenders have undergone several redesigns, they are not yet strong enough to sustain such impacts.

• *Independence* Class Variant (LCS 2):

- DOT&E still has no data to assess the core mission capabilities of the *Independence* class variant seaframe.
- The USS *Independence* (LCS 2) crew encountered multiple problems with the twin-boom extensible crane (TBEC) and other mission package support systems during initial developmental testing of the MCM Mission Package. Since then, the vendor has improved the TBEC, and the Navy has made changes to the RMMV launch and recovery hardware. Developmental testing in August 2013, May 2014, and October 2014 demonstrated that the ship's capability to launch and recover the RMMV has improved because of crew training, but it is not yet clear that launch and recovery can be completed routinely without problems.
- In the past, availability of the USS *Independence* (LCS 2) to support testing has been degraded by equipment failures, including problems with operator consoles, power generation equipment, components of the ship's computing and networking equipment, propulsion drive train components, and communications systems. DOT&E is unable to evaluate the success of Navy efforts to improve the reliability of these systems. In September and October 2014, the start of developmental testing of the MCM Mission Package was delayed by LCS air conditioning and propulsion system failures. During at-sea testing, observers noted that LCS sometimes experienced difficulties when communicating with a simulated Mine Warfare Commander operating from a shore-based command center.

SUW Mission Package

- LCS 3 equipped with the Increment 2 SUW Mission Package demonstrated the capability to defeat a small swarm of Fast Inshore Attack Craft under the conditions specified in the Navy requirement; however, the crew received extensive hands-on training that might not be available to crews on other ships. Testing conducted to date has not been sufficient to demonstrate LCS capabilities in more stressing scenarios consistent with existing threats.
- The SUW Mission Package has not yet been tested aboard an *Independence* class LCS.
- The 30 mm Gun Mission Modules (GMM) remain prone to jams caused by separation of ammunition links and accumulation of spent cartridges in the ejection path; however, LCS 3 experienced fewer jams during operational testing than had been observed in past developmental testing. While the Navy has made a concerted effort to improve ammunition belts, the problem was not entirely eliminated. Ammunition jams interrupt firing but can typically be cleared in a few minutes; however, they are still sufficiently disruptive to cause the ship to maneuver to bring the other 30 mm GMM to bear on the target.

MCM Mission Package

- During developmental testing, attempts to demonstrate the sequence of events necessary for an LCS to complete end-to-end mine clearance operations have been limited by low operator proficiency, software immaturity, system integration problems, and poor reliability of MCM components including RMS/RMMV. In the most recent period of developmental testing in 1QFY15, fleet operators using mission package tools such as the Organic Post Mission Analysis (OPMA) and the new Contact Management Tool (CMT) failed to convey some mine targets, correctly detected by the RMS in an initial search pass, to the AMNS for neutralization. As a result, fleet operators were unable to execute operationally-realistic, end-to-end mine reconnaissance and clearance without intervention by testers with knowledge of ground truth target positions. The Navy continues to investigate the root cause of target position errors and incorrectly dropped contacts; unless corrected, these problems will limit LCS MCM mission effectiveness.
- During developmental testing, the operational availability of MCM Mission Package systems has been degraded by low reliability, the LCS crew's limited capacity for corrective maintenance, and the ship's constrained inventory of repair parts. Testing has often been delayed to obtain the assistance of shore-based technicians and repair parts not available onboard LCS. Left uncorrected, these problems will severely limit LCS's operational capability for mine reconnaissance and clearance.
- Mission package minehunting systems (AN/AQS-20A and ALMDS) have not demonstrated the detection and localization capabilities needed for an LCS equipped with an Increment 1 MCM Mission Package to meet its required sustained area coverage rate. During developmental testing and a shore-based operational assessment, AN/AQS-20A contact depth (vertical localization) errors have exceeded Navy limits in all operating modes. A shore-based operational assessment of ALMDS showed that the system does not meet Navy detection requirements. Both systems generate a large number of false classifications (objects erroneously classified as mine-like). Unless eliminated from the contact list, these false classifications require identification and neutralization effort, result in the expenditure of limited neutralizer assets, and substantially reduce the LCS sustained area coverage rate. As an alternative, the Navy has implemented tactics that require multiple search passes over the same area to minimize the number of false classifications conveyed for identification/neutralization. Although multiple search passes also reduce the LCS sustained area coverage rate relative to single pass systems, Navy modeling suggests this approach is less detrimental to MCM timelines. Whether LCS can meet the already-reduced low area clearance requirement for the Increment 1 Mission Package remains in question. Furthermore, testing has not yet shown whether the goal of minimizing AN/AQS-20A false classifications can be accomplished without also eliminating correct classifications from the contact list and degrading minehunting performance.
  - The Navy expected to correct AN/AQS-20A deficiencies prior to the first phase of operational testing in FY15 by implementing pre-planned product improvements (the AN/AQS-20B version of the sonar) and integrating the improved sensor into the MCM Mission Package. Delays in the delivery of AN/AQS-20B prototypes and problems discovered in early characterization testing in FY14 leave little time to complete necessary developmental and operational testing of the AN/AQS-20B prior to the planned operational test of LCS equipped with the first increment of the MCM Mission Package in FY15.
  - The Navy is working on pre-planned product improvements to improve ALMDS detection performance and reduce the frequency of receiver failures, but does not expect to integrate these changes into the first increment of the MCM Mission Package. Frequent receiver failures continued to affect ALMDS performance during an experimental deployment to the Navy's 5th fleet and recent developmental testing aboard LCS 2. During LCS developmental testing, the MH-60S aircrew was also unable to assess ALMDS achieved search/clearance level during post-mission analysis. Observations from 5th fleet operators also indicate mission planning and evaluation tools do not adequately support ALMDS mission planning and post-mission clearance estimates.

- During a shore-based operational assessment of the AMNS in FY14, AMNS was unable to achieve the Navy's requirement for mine neutralization success except under limited conditions not generally expected during combat. Failures of the host MH-60S aircraft's systems and its associated AMCM Mission Kit limited AMNS mission availability. Frequent loss of fiber-optic communications between the aircraft and the neutralizer was the primary cause of unsuccessful attack runs. Although the Navy attributed the failures to the bottom composition (sand and shells), the root cause of these failures has not yet been determined, and the bottom compositions used in testing are representative of realistic operating areas. Both problems negatively affect the timeliness of LCS-based AMNS operations and will likely reduce the ship's sustained area coverage rate.
- As noted earlier, the *Independence* class LCS has had difficulty launching and recovering the RMMV because of the vehicle's erratic motion in the ship's wake. In past developmental testing, violent RMMV yaw and roll motions have overstressed and damaged the launch and recovery hardware and resulted in damage to the RMMV, causing the Navy to limit handling operations to when sea state is less than 3. Following changes to launch and recovery hardware, procedures, training, and RMMV hardware, the Navy demonstrated 16 RMMV launches and 14 RMMV recoveries during 23 days at sea in developmental testing during favorable sea state conditions in 1QFY15. Nonetheless, the most recent period of developmental testing witnessed several instances of equipment damage that delayed or prevented recovery of an off-board RMMV. Because of the cracks in the welds at the base of support stanchions located in the mission bay, during this phase of testing, launch and recovery operations could be conducted only when wave-induced loading on the recovery system (a function of wave height and period) did not exceed 32,000 pounds-force. For example, a wave height of 2 feet coupled with a wave period of 2 seconds, which could occur in a Sea State 2, would have precluded RMMV recovery until calmer sea conditions developed. The Navy revealed they are making design changes to LCS 6 and later seaframes to correct the problem and remove the weight limit. LCS 2 and LCS 4 will be corrected during the next shipyard availability. This problem must be corrected to ensure safe and sustained RMS operations.
  - No RMMV launch and recovery operations have been conducted aboard a *Freedom* class LCS at sea.
  - Although the RMMV can search autonomously while operating over the horizon from the LCS, it can currently only conduct operations to reacquire and identify bottom mines within the range of Ultra High Frequency communications. This limitation will complicate MCM operations in long shipping channels, and may make it necessary to clear a series of LCS operating areas to allow MCM operations to progress along the channel. The cleared operating areas will be needed to keep the LCS and its crew out of mined waters. The additional effort required to clear these LCS operating areas would increase the demand for mine clearance and delay attainment of strategic objectives. This issue is not new to RMS; however, it did not become operationally significant until the Navy decertified the MH-60S helicopter for towing MCM devices, including the AN/AQS-20A/B sensor. The RMS communication range limitation was not an operational concern when the option existed for the helicopter with towed sensor to conduct identification operations beyond the horizon. The Navy has not yet identified a solution.
  - RMS reliability problems persisted in the recent phase of developmental testing (1QFY15) evidenced in part by fewer vehicle recoveries than vehicle launches. Problems observed include the inability to align the system's inertial navigational unit, intermittent communications, a lube oil pump failure that caused a mission abort, capture latch impairment that precluded shipboard recovery of the RMMV, degraded electro-optic identification resulting in a mission abort to replace the AN/AQS-20A towed body, tow cable damage following an apparent snag that rendered the system inoperable in the assigned mission until a replacement tow cable could be installed with the assistance of shore-based support, and multiple incidents of AN/AQS-20A stuck fins or fin actuation faults. Although the Navy demonstrated more frequent RMMV launches during this period of testing, continued RMS reliability problems limited system minehunting to less than 50 hours during the 3 weeks of most intensive testing (approximately 16 hours per week).
    - LCS reliability problems also forced the ship to remain in port for repairs instead of conducting at-sea RMS testing as planned. Including an additional week spent in port for LCS repairs, RMS averaged approximately 12 hours of minehunting per week. This result is consistent with the assessment of RMS capability DOT&E provided to members of the Defense Acquisition Board following RMMV v4.2 and AN/AQS-20A testing to indicate that the Navy had not yet demonstrated that it could sustain operations of more than one 14-hour RMMV sortie per week (i.e., 10 to 12 hours of RMS minehunting per week). Unless greater minehunting operating tempo is achieved, the Navy will not meet its interim area clearance rate requirements.
    - The Navy reports that the RMS operated for approximately 140 hours during LCS developmental testing in 1QFY15. DOT&E's preliminary assessment of test data identified at least seven RMS failures that precluded vehicle recovery, required sensor replacement, or required assistance from shore-based support contractors to restore system availability. In

operational testing, these failures would be assessed as operational mission failures. Thus, by operational criteria, RMS demonstrated reliability was no more than 20 hours Mean Time Between Operational Mission Failure during this phase of testing. Because much of the operating time cited by the Navy was not devoted to minehunting activities, this estimate should be considered an upper bound for current RMS operational reliability Moreover, statistical analysis of all existing data does not yet support the Navy's assertions of improving RMS reliability.

- Since RMS is critical to achieving the Navy's sustained area coverage rate requirement, this Annual Report includes a separate article on the RMS that provides additional detail.

LFT&E

- LCS is not expected to be survivable in high-intensity combat because the design requirements accept the risk the ship must be abandoned under circumstances that would not require such an action on other surface combatants. Although the ship incorporates capabilities to reduce susceptibility to attack, previous testing of analogous capabilities demonstrates it cannot be assumed LCS will not be hit in high-intensity combat.
- During the TSST on LCS 3, the Machinery Plant Control and Monitoring System (MPCMS) appeared to be improperly controlling the ventilation system for the highest of three material conditions of damage control readiness known as "Condition ZEBRA." This could allow smoke to spread through fire boundaries. Pressure differentials were observed in several spaces that made hatches and doors difficult to operate.
- There is a problem with the MPCMS that caused every fire alarm on the ship to activate during shot 1 of the TSST on LCS 3, even though the fire was limited to the 01 Level. Based on discussions with system experts, this is a known problem with the MPCMS.

SSC Study

- In February 2014, the Secretary of Defense directed the Secretary of the Navy and the Chief of Naval Operations to "Submit to me, in time to inform the PB 2016 budget deliberations, alternative proposals to procure a capable and lethal small surface combatant, generally consistent with the capabilities of a frigate." In October 2014, the Secretary of Defense requested DOT&E provide an independent assessment of the work done by the SSC Task Force established by the Navy pursuant to the Secretary's direction. In response, DOT&E provided a written classified assessment report to the Secretary.
- In its report, DOT&E concluded that the Navy's SSC Task Force's results indicate, of the alternatives it considered, the multi-mission combat capabilities and survivability design features of a modern frigate could be provided only by a new ship design or a major modification to the LCS design – the so-called large plug insertion developed by the Task Force. While offering some improvements in combat capability and survivability (primarily via reduced susceptibility) relative to LCS, the minor modifications to LCS considered by the Task Force and recommended by the Navy Leadership do not satisfy significant elements of a capability concept developed by the Task Force for a modern frigate. (The Task Force developed a number of capability concepts incorporating various mixes of capabilities consistent with a frigate. After consulting with the Task Force's lead, DOT&E's assessment used one particular concept as representative of a modern frigate's capabilities. Also, "major modification to LCS" and "minor modification to LCS" are the characterizations used by the Task Force of its alternatives.) Notwithstanding potential reductions to its susceptibility relative to LCS, DOT&E's assessment is that minor modifications to LCS will not yield a ship that is significantly more survivable than LCS.
- DOT&E also noted in its report provided to the Secretary that DOT&E's assessment was based on results that might subsequently change, because the Task Force's report remained unfinished at the time of DOT&E's report.

Recommendations

- Status of Previous Recommendations.
  - The Navy partially addressed one FY09 recommendation to develop an LFT&E program with the approval of the LFT&E Management Plan; however, the details of the surrogate testing and the lethality testing still need to be developed.
  - The Navy partially addressed the FY10 recommendations to implement recommendations from DOT&E's Combined Operational and Live Fire Early Fielding Report. Significant remaining recommendations include enhancing seaframe sensors and improving capability of seaframe and SUW Mission Package gun systems.
  - With respect to FY11 recommendations regarding AN/AQS-20A and ALMDS, the Navy is adjusting tactics and, for the AN/AQS-20A, funding improvements to address deficiencies. The FY11 recommendation for the Navy to continue to report vulnerabilities during live fire tests remains valid.
  - For FY12 recommendations:
    - The Navy partially addressed the recommendations to complete the revised capabilities document defining the incremental approach to fielding mission packages.
    - The Navy has released requirements letters for Increments 1 and 2 SUW and Increment 1 MCM Mission Packages only; however, the requirements have not been codified in an approved Capabilities Production Document. The Navy published the LCS Platform Wholeness Concept of Operations Revision D in January 2013.
    - The Navy has not published the concept of employment for all the mission packages, but advises that initial manning level studies have been completed. The Navy has adjusted ship and mission package manning levels

and is continuing studies to determine the final manning levels.
  - The Navy has stated that gun reliability problems identified during the Quick Reaction Assessment have been resolved based on limited testing conducted in October 2012. Additional testing conducted aboard LCS 3 in 2013 and 2014, which was observed by DOT&E, indicates that the gun reliability has improved.
  - The Navy conducted LCS ship-based phases of the planned operational assessments of the MH-60S Block 2/3 and ALMDS and the MH-60S Block 2/3 and AMNS MCM systems in 1QFY15.
  - Throughout FY13/14, the Navy focused on correction of material deficiencies with seaframe launch and recovery systems, and manpower and training deficiencies that prevent safe shipboard launch and recovery of the RMS, and can now launch and recover the RMMV with less frequent damage to equipment in low to moderate sea states.
- The Navy should still address the FY13 recommendation to provide a Surface-to-Surface Missile LFT&E Management Plan for DOT&E approval.

- FY14 Recommendations. The Navy should:
  1. Continue to address material reliability issues for both ship classes.
  2. Address the cybersecurity vulnerabilities identified during operational testing of the *Freedom* class. Conduct in-depth cybersecurity testing of the *Independence* class as soon as practicable and address deficiencies.
  3. Emphasize live-fire swarm engagements for future testing of the SUW Mission Package to enhance confidence in the probability of successful engagement. As the SUW Mission Package matures to Increments 3 and 4, focus testing on more challenging threats.
  4. Investigate the use of communications relays and other solutions that might improve the standoff distance between an RMMV and its host ship to improve the efficiency of LCS MCM operations.
  5. Improve mission system (RMMV, ALMDS, AMNS, AMCM mission kit, AN/AQS-20A/B) reliability to facilitate timely and sustained MCM operations without excessive reliance on shore-based support.
  6. Continue to investigate the root cause of contact management and communications problems observed during recent MCM developmental testing; develop corrective actions.
  7. Develop corrective actions to eliminate early termination fiber optic communications losses observed in the AMNS operational assessment; fund and develop LCS near-surface mine neutralization capability.
  8. Review the ventilation lineup during condition ZEBRA to determine if the system is operating as intended.
  9. Correct problems with the MPCMS fire alarm system.