Littoral Combat Ship (LCS)

Executive Summary

- The Navy conducted operational testing of the Littoral Combat Ship (LCS) *Freedom* variant with surface warfare (SUW) mission package (MP) Increment 3, November 2018 through September 2019.
- The Navy conducted an operational assessment on Knifefish, a component of the mine countermeasures (MCM) MP, in May 2019.
- The Navy has scheduled operational testing of the LCS *Independence* variant with SUW MP Increment 3 for 1QFY20. That testing is not adequately resourced; the current Navy target inventory does not fully support testing requirements.
- The Navy conducted no anti-submarine warfare (ASW) MP operational testing in FY19.

System

Seaframes

- The LCS is designed to operate in shallow waters that limit the access of larger ships.
- The Navy is procuring two LCS seaframe variants:
  - The *Freedom* variant (odd-numbered ships) is a semi-planing monohull design constructed of steel (hull) and aluminum (deckhouse) with two steerable and two fixed-boost waterjets driven by a combined diesel and gas turbine main propulsion system.
  - The *Independence* variant (even-numbered ships) is an aluminum trimaran with two steerable waterjets driven by diesel engines and two steerable waterjets driven by gas turbine engines.
- Both LCS variants are approximately the same size and displacement, though the composition, configuration, and arrangement of mission and auxiliary systems are different for each design.
- The LCS *Freedom* and *Independence* variant baselines include a newly developed Light Weight Tow (LWT) to provide torpedo defense capability. The Navy has not funded the LWT.

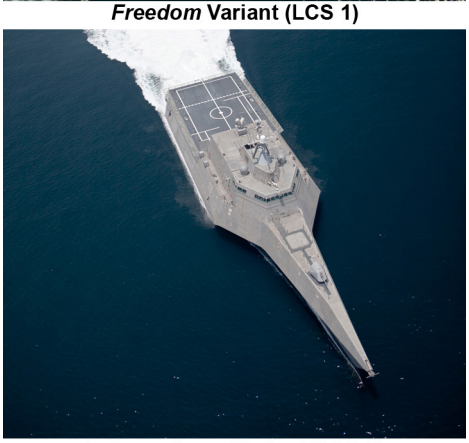
Mission Packages

- LCS seaframes are designed to host specific warfare MPs. The Navy plans to install individual MCM, SUW, and ASW MPs semi-permanently on the seaframes, dedicating specific ships to specific missions. The three MPs consist of the following components:

SUW MP Increment 3 (the final increment of SUW MP)

- Gun Module: two MK 46 30-mm guns.
- Aviation Module: one MH-60S Armed Helicopter Weapon System and one MQ-8 Fire Scout.
- Maritime Security Module: two 11-meter rigid-hull inflatable boats with launch and recovery equipment.

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



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

- Surface-to-Surface Missile Module (SSMM): 24 Longbow HELLFIRE missiles modified for the maritime environment.

MCM MP

- Near Surface Detection Mission Module (MM): one Airborne Laser Mine Detection System unit for employment on the MH-60S multi-mission helicopter.
- Remote Minehunting (RMH) MM: two minehunting sonar units and one MCM Unmanned Surface Vehicle (USV) for minehunting capabilities. The Navy is considering integrating the AN/AQS-20C and AN/AQS-24C minehunting sonar systems for use from the MCM USV. The AN/AQS-24C is an upgrade to the airborne MCM minehunting sonar that is in fleet use now. The Navy has implemented several Engineering Change Proposals to the Unmanned Influence Sweep System (UISS) surface craft as the production baseline for the MCM USV.
- Buried Minehunting MM: two battery-powered, autonomous, Knifefish Unmanned Undersea Vehicles, employing a low frequency, broadband, synthetic aperture sonar to detect, classify, and identify mines

moored in the ocean volume, laying on the ocean bottom, or buried in bottom sediment.
- Coastal Mine Reconnaissance MM: one Coastal Battlefield Reconnaissance and Analysis System Block I, Block II, or Block III system for integration with the MQ-8 Fire Scout. Fire Scout is a Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle for daytime unmanned aerial tactical reconnaissance to detect and localize mine lines and obstacles in the beach zone (Blocks I and II) and the surf zone (Block II). The Navy conducted IOT&E on Block I in FY18. Blocks II and III are currently unfunded.
- Airborne Mine Neutralization MM: two Airborne Mine Neutralization System (AMNS) units for employment on the MH-60S multi-mission helicopter.
- Near Surface Neutralization MM (projected for FY24): the Barracuda Mine Neutralization System completed preliminary design review in June 2019. The system may begin developmental testing in FY21, and if successful, augment AMNS in other portions of the water column. The Navy plans to deploy Barracuda from LCS using the MCM USV.
- Unmanned Minesweeping MM: one UISS composed of one MCM USV and the sweep payload deployment system to detonate acoustic-, magnetic-, and combined acoustic/magnetic-initiated mines moored in the ocean volume, laying on the ocean bottom, or buried in bottom sediment.
- Aviation MM: consists of one MH-60S multi-mission helicopter with the AMCM mission kit and one MQ-8B or MQ-8C Fire Scout.

ASW MP
- Escort Mission Module: multi-function towed array (MFTA) and variable depth sonar (VDS) with the AN/SQQ-89A(V)15 Surface Ship Undersea Warfare Combat System. MFTA and VDS provide submarine search, detection, localization, and track capability. MFTA also supports incoming torpedo detection and is the catalyst for LCS torpedo evasion.
- Aviation Mission Module: A MH-60R helicopter provides submarine prosecution capability with MK 54 torpedoes.
- DOT&E previously reported LWT as an ASW MP component for torpedo defense. LWT is now in the LCS *Freedom* and *Independence* variant baselines although, as previously stated, LWT remains unfunded.

Mission
- The Maritime Component Commander will employ LCS to conduct MCM, ASW, or SUW tasks depending on the MP installed in the seaframe. Because of capabilities inherent to the seaframe, commanders can employ LCS in a maritime presence role with any MP supporting deterrence and maritime security operations. With the Maritime Security Module, installed as part of the SUW MP, the ship can conduct Maritime Security Operations including Visit, Board, Search, and Seizure of ships suspected of transporting contraband.
- The Navy intends to employ LCS alone or in company with other ships. The Navy Concept of Operations (CONOPS) anticipates LCS will prepare the environment for joint force assured access to critical littoral regions by conducting MCM, ASW, and SUW operations, possibly under an air defense umbrella.

Major Contractors
- *Freedom* variant
  - Prime: Lockheed Martin Maritime Systems and Sensors – Washington, D.C.
  - Shipbuilder: Marinette Marine – Marinette, Wisconsin
- *Independence* variant
  - Prime for LCS 6 and subsequent even-numbered ships: Austal USA – Mobile, Alabama
  - Shipbuilder: Austal USA – Mobile, Alabama

Activity

LCS Program
- The Navy scheduled the following operational testing for FY20: *Independence* variant with SUW MP Increment 3 and both the *Freedom* and *Independence* variants with the ASW MP. However, operational testing for the *Independence* variant with SUW MP is encountering scheduling and resource allocation problems.
- In April 2019, the Navy conducted mine susceptibility trials using the USS *Sioux City* (LCS 11). These trials included underwater electromagnetic and acoustic signature trials to determine the *Freedom* variant's as-built signatures. The trials also included testing using the Advanced Mine Simulator System (AMISS) mine emulator to validate worldwide mine susceptibility predictions for both variants. While the mine susceptibility trials intended to be completed in accordance with the DOT&E-approved test plan, difficulty in test execution resulted in completion of approximately only one third of the planned trials. DOT&E participation in the AMISS trial event helped prioritize the runs to maximize the utility of the data collected.
- In June 2019, the Navy issued the LCS Final Survivability Assessment Report (FSAR). The FSAR included updates to previous survivability assessments of both seaframes using findings from recent surrogate test events and new vulnerability assessments of both seaframes to fires and underwater threats. In October 2019, the Navy delivered an FSAR addendum that addressed both LCS variants' susceptibility to naval mines. In support of the FSAR and addendum, the Navy completed verification, validation,

and accreditation (VV&A) of the vulnerability and recoverability modeling and simulation (M&S). The Navy issued separate LCS-specific Verification and Validation (V&V) reports for the Advanced Survivability Assessment Program, the Dynamic System Mechanics Advanced Simulation, and Integrated Recoverability Model.
- The Navy selected the Norwegian Naval Strike Missile as the Over-the-Horizon Weapon System (OTH-WS) to be incorporated as an LCS seaframe component. The Initial Operational Capability of the OTH-WS is scheduled for FY20. The Navy conducted a Quick Reaction Assessment (QRA) of the missile in July 2019 to support early deployment of the capability. The QRA assessed the system training but did not include any missile firings. See the OTH-WS Annual Report article on page 157 for details.

Seaframe
- The Navy has neither resourced nor conducted any air warfare test events against anti-ship cruise missile surrogates planned as part of the DOT&E-approved Enterprise Air Warfare Ship Self-Defense Test and Evaluation Master Plan (TEMP) or the LCS TEMP. The Navy's Program Executive Office for Integrated Warfare Systems halted all work to develop a Probability of Raid Annihilation (PRA) M&S suite of the combat systems in FY15 and has not yet restarted the effort.

SUW MP
- The Navy conducted operational testing of the LCS *Freedom* variant with SUW MP Increment 3 during FY19. The Commander, Operational Test and Evaluation Force submitted a Test Plan Change Plan Request in 2QFY19 to reduce the operational testing identified in the TEMP by one operational test run when a similar developmental live-fire test run was successfully completed. DOT&E approved the change request and that operational test run was not executed.

MCM MP
- The Navy conducted an operational assessment on Knifefish unmanned under sea vehicles in May 2019. See the Knifefish Annual Report article on page 165 for details.

ASW MP
- In September 2019, the Navy completed initial integration testing of the ASW MP on an LCS *Freedom* variant.

Assessment

Seaframes
- The Navy commissioned LCS *Freedom* in 2008 and LCS *Independence* in 2010. Both LCS seaframes have limited anti-ship missile self-defense capability. The Navy has not fully tested these combat systems and the Navy does not plan to conduct further air warfare operational testing of *Freedom* seaframes 1 through 15 in their current combat system configuration. The Navy has accepted the risk of continued operations with a combat system that they have not operationally tested. DOT&E cannot fully assess the operational effectiveness and suitability of the combat system aboard each variant without further testing.
- The Navy halted all work developing a PRA M&S suite of LCS combat systems because some combat system element models (e.g., radars) were not available. The lack of combat system element models persists. The Navy has not funded the development of the LCS PRA combat system M&S suite. The subsequent delay of these efforts also delays the evaluation of LCS self-defense capabilities.
- The LCS Mine Susceptibility trials provided the largest set of test data to date to validate the predictions of the Navy's Total Mine Simulation System (TMSS). As part of the Navy Standard Method, TMSS uses measured ship signatures to predict worldwide susceptibility to naval mines. Preliminary analysis of the AMISS trial data demonstrated poor statistical correlation between the AMISS data and the TMSS predictions. The Navy validated, verified, and accredited TMSS without considering the AMISS data.
- The FSAR summarizes classified findings regarding LCS vulnerabilities and recommendations for design improvements. The FSAR also reports on compliance with requirements in the LCS Capability Development Document. The FSAR is based on new modeling techniques, developed as part of the LCS LFT&E effort to allow survivability assessments to include damage control and recoverability using M&S rather than subject matter expert judgment alone.
- The Navy completed VV&A of the M&S tools used in the FSAR, but not in accordance with DOT&E guidance on the validation of M&S used in operational test and live fire assessments, issued in 2016. The deficiencies in the V&V of survivability tools limit the credibility of the results presented in FSAR, though most of the conclusions drawn regarding vulnerabilities in the design and potential corrective actions remain valid.

SUW MP
- The Navy completed operational testing of the LCS *Freedom* variant with the Increment 3 SUW MP in 3QFY19. The addition of the SSMM, provides the ship with an effective defense against small-boat swarms at long ranges. The test was unable to assess the ship's ability to defend itself under conditions requiring the simultaneous use of guns and missiles and/or maritime operational environments of mixed shipping (i.e., hostile, friendly, neutral).

MCM MP
- See the Knifefish Unmanned Undersea Vehicles Annual Report article on page 165 for complete details.

ASW MP
- DOT&E has no data to make a preliminary assessment of the operational effectiveness and suitability of the LCS *Freedom* variant with ASW MP.

Recommendations

The Navy should:
1. Conduct operational testing of the LCS *Independence* variant with SUW MP Increment 3.

2. Resource and conduct the air warfare test events against anti-ship cruise missile surrogates planned as part of the DOT&E-approved Enterprise Air Warfare Ship Self-Defense TEMP and the LCS TEMP.
3. Resource the development of the LCS PRA combat system M&S suite.
4. Use the LCS AMISS trial data to determine the root cause of discrepancies between the trial results and the TMSS predictions (e.g., sensitivity to threat, environmental, and ship variables).
5. Work with DOT&E to develop a plan to adequately V&V the vulnerability and recoverability M&S tools for future naval LFT&E programs in accordance with DOT&E policy.