

## Littoral Combat Ship (LCS)

### Executive Summary

- The Littoral Combat Ship (LCS) program conducted no operational testing of seaframes and mission package (MP) capabilities in FY17.
- The Coastal Battlefield Reconnaissance and Analysis (COBRA) Block I in the mine countermeasures (MCM) MP completed one of five phases of IOT&E in FY17.
- DOT&E published an assessment of the results of operational testing of the *Independence*-variant seaframe equipped with the Increment 2 surface warfare (SUW) MP in November 2016. The Navy did not conduct any additional testing or perform any modifications to the seaframe and SUW MP in 2017 that would affect the 2016 assessment.
- In March 2016, the Navy completed a partial update of the LCS Test and Evaluation Master Plan (TEMP) to support future operational testing of the seaframes and MPs. Since then, DOT&E and the Navy worked to extensively revise the TEMP by incorporating developmental and integrated testing as well as examining reductions in operational testing to accommodate the Navy's restricted program budget for LCS testing. DOT&E expects to approve the LCS Program TEMP Test and Evaluation Identification Number (TEIN) 1695 Revision B in 2QFY18.
- DOT&E published the LCS 4 Total Ship Survivability Trial (TSST) Report in September 2017. The report included recommendations the Navy should consider implementing on the *Independence* variant. DOT&E is awaiting the Navy delivery of the LCS 5 and LCS 6 Shock Trial reports. Shock trials on both variants occurred between June and September 2016 off the northeastern coast of Florida. Based on the analysis and testing performed by the Navy to date, DOT&E's assessment of the survivability of both LCS variants is unchanged from previous annual reports.

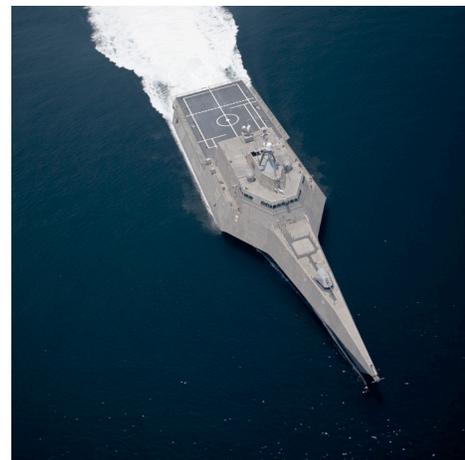
### System

#### 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.
- 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.



**Freedom Variant (LCS 1)**



**Independence Variant (LCS 2)**

- Accommodations for up to 98 personnel.
- A common Mission Package Computing Environment for use when an MP is embarked.
- A Multi-Vehicle Communications System for simultaneous communications with multiple unmanned off-board vehicles.
- Hangars sized to embark MH-60R/S helicopters and the MQ-8 Fire Scout.
- MK 110 57 mm gun.
- Both variants include ballistic protection for magazines and other vital spaces, such as, installed and portable damage control, firefighting, and dewatering systems intended to support recoverability
- The designs have different core combat systems to provide command and control, situational awareness, and self-defense against anti-ship cruise missiles (ASCMs) and surface craft.
  - *Freedom* variant: COMBATSS-21, an Aegis-based integrated combat weapons system with a TRS-3D (AN/SPS-75) air and surface search radar (ASR); a Rolling Airframe Missile (RAM) system; a Terma Soft Kill Weapon System; and a DORNA Electro-Optical Device (EOD) gunfire control system with an

electro-optical/infrared sensor to target the MK 110 57 mm gun. Starting with LCS 17, *Freedom*-variant ships will be fitted with a TRS-4D ASR and the MK 15 Mod 31 SeaRAM system as the air defense hard-kill weapon system. The Navy is also developing plans to retrofit earlier *Freedom* seaframes with SeaRAM in the 2020 to 2025 timeframe.

- *Independence* variant: Integrated Combat Management System derived from the TACTICOS system with a Sea Giraffe (AN/SPS-77) ASR; one MK 15 Mod 31 SeaRAM system; the Automatic Launch of Expendables (ALEX) system for decoy countermeasures; and the SAFIRE electro-optical/infrared sensor to target the 57 mm gun.

## Mission Packages

- LCS is designed to host specific warfare area mission modules (MMs) assembled and integrated into interchangeable MPs. The Navy plans to install individual MCM, SUW, and anti-submarine warfare (ASW) MPs semi-permanently on the seaframes, dedicating specific ships to specific missions. Twenty-four of the planned 28 ships will be formed into 6 divisions with 3 divisions on each coast; *Independence* variants on the west coast and *Freedom* variants on the east coast. The Navy plans to use the first four ships as test platforms.
- The component MMs making up the MPs are:

### MCM MP

- Near Surface Detection MM: one Airborne Laser Mine Detection System (ALMDS) 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 the AN/AQS-20C and AN/AQS-24C minehunting sonar systems for use in the RMH MM. The AN/AQS-24C is an upgrade to the airborne MCM minehunting sonar that is in fleet use now. The Navy expects to use a variant of the Unmanned Influence Sweep System (UISS) surface craft in development as the MCM USV.
- Buried Minehunting MM: two battery-powered, autonomous, Knifefish Unmanned Undersea Vehicles, employing a low frequency, broadband, synthetic aperture sonar to detect and classify volume and bottom mines in shallow water.
- Coastal Mine Reconnaissance MM: one COBRA Block I, Block II, or Block III system for integration with the MQ-8 Fire Scout. This capability is intended 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 expects the Block II system to add improved beach zone detection capability against small mines and add nighttime capability. Block III is intended to detect buried mines in the beach zone and surf zone.

- Airborne Mine Neutralization MM: two Airborne Mine Neutralization Systems (AMNS) units for employment on the MH-60S multi-mission helicopter.
- Near Surface Neutralization MM (projected for FY23): the Barracuda Mine Neutralization System (MNS) should begin developmental testing in FY22, 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 sweep gear to detonate acoustic-, magnetic-, and combined acoustic/magnetic-initiated volume and bottom mines.
- Aviation MM: consists of one MH-60S multi-mission helicopter with the AMCM mission kit and one MQ-8B or MQ-8C Fire Scout.

### SUW MP

- Increments 1 and 2 included:
  - Gun MM: two MK 46 30 mm guns
  - Aviation Module: embarked MH-60S Armed Helicopter Weapon System
  - Maritime Security Module: two 11-meter rigid-hull inflatable boats (RHIBs) with launch and recovery equipment
- Increment 3 will add:
  - Surface-to-Surface Missile Module, employing the AGM-114L-8A Longbow HELLFIRE missile modified for the maritime environment
  - One MQ-8 Fire Scout to augment the Aviation Module

### ASW MP

- Torpedo Defense and Countermeasures Module: lightweight towed torpedo countermeasure
- ASW Escort Module: Multi-Function Towed Array (MFTA) and variable depth sonar (VDS) with AN/SQQ-89A(V)15 Surface Ship Undersea Warfare Combat System. MFTA and VDS are intended to provide submarine search, detection, localization, and track capability. MFTA is also intended to detect incoming torpedoes and be a catalyst for LCS torpedo evasion.
- Aviation Module: embarked MH-60R and an MQ-8 Fire Scout. MH-60R provides organic submarine prosecution capability using MK 54 torpedoes.

## 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 in any configuration. 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 can employ LCS alone or in company with other ships. The Navy Concept of Operations (CONOPS)

# FY17 NAVY PROGRAMS

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. However, the latest CONOPS observes, “The most effective near-term operational roles for LCS to support the maritime strategy are theater security cooperation and maritime security operations supporting deterrence and maritime security.”

## Major Contractors

- *Freedom* variant
  - Prime: Lockheed Martin Maritime Systems and Sensors – Washington, District of Columbia
  - Shipbuilder: Marinette Marine – Marinette, Wisconsin

- *Independence* variant
  - Prime for LCS 2 and LCS 4: General Dynamics Marine Systems Bath Iron Works – Bath, Maine
  - Prime for LCS 6 and subsequent even-numbered ships: Austal USA – Mobile, Alabama
  - Shipbuilder: Austal USA – Mobile, Alabama
- MPs
  - MP Integration contract awarded to Northrop Grumman – Los Angeles, California
  - VDS: Raytheon Company – Waltham, Massachusetts

## Activity

### LCS Program

- The Navy plans to field warfighting capability in multiple increments of each MP have changed. The Navy now intends to field a single increment of the ASW MP and complete the SUW MP with the introduction of the Surface-to-Surface Missile Module in Increment 3. Plans for the MCM MP are uncertain following the Navy’s cancellation of the Remote Minehunting System and the development of several other minehunting and mine neutralization systems.
- The Navy expects to complete operational testing of both LCS seaframe variants with the SUW Increment 3 MP in FY18 and with the ASW MPs in FY20.
- DOT&E approved an update to the LCS TEMP in March 2016. Since that time, the Navy and DOT&E worked on updates to the TEMP, including operational and integrated testing plans, changes to reflect the Navy’s evolving plans to acquire and field the MCM MP, air defense testing of seaframes, and plans to test a seaframe over-the-horizon SUW missile capability. DOT&E expects to approve LCS Program TEMP Revision B in 2QFY18.
- In November 2016, DOT&E published a classified Early Fielding Report on the *Independence*-variant seaframe equipped with the Increment 2 SUW MP.
- In September 2017, DOT&E published the LCS 4 TSST Report. Shock trials on LCS 5 and LCS 6 occurred between June and September 2016 off the northeastern coast of Florida. DOT&E is awaiting Navy delivery of the LCS 5 and LCS 6 shock trial reports.

### Seaframe

- The Navy has not conducted any air warfare test events against ASCM surrogates planned as part of the Enterprise Air Warfare Ship Self-Defense TEMP or the LCS TEMP. The Navy’s Program Executive Office for Integrated Warfare Systems has halted all work to develop a Probability of Raid Annihilation (PRA) Modeling and Simulation (M&S) suite of the ships’ combat systems for FY18. Delaying these efforts postpones evaluation of LCS air warfare capabilities.

- The Navy revised the LCS Capability Development Document in April 2017, moving the requirement for an Over-the-Horizon Weapon System (OTH-WS) from the SUW MP to the seaframe. The Navy is selecting a vendor for the OTH-WS, an ASCM for all LCS seaframes regardless of the installed MP. Source selection is expected in mid-FY18, with Initial Operational Capability scheduled for FY20.
- In August 2017, the USS *Coronado* (*Independence* variant) fired a Harpoon missile that hit a surface target beyond visual range. An MQ-8B Fire Scout and an MH-60S helicopter provided targeting for this live fire event.
- DOT&E reviewed the Navy draft Detail Design Survivability Assessment Report (DDSAR) for the *Freedom* variant. The Navy plans to release the final document in late CY17.

### MCM MP

- The Navy continues to plan for the LCS MCM MP IOT&E scheduled in FY20. The Navy’s CONOPS and tactics, techniques, and procedures for employment of the LCS MCM MP capability in the intended operational environments are unknown.
- In May 2017, the Navy completed the first of five planned phases of IOT&E for COBRA Block I. The testing focused on the operational effectiveness of the system to detect and classify mine lines, minefields, and obstacles on the beach. Fleet sailors operated the system from a shore base during this phase of IOT&E. The remaining LCS-based phases of IOT&E could not be completed in FY17 because of higher priority operational commitments for in-service LCS seaframes. The Navy conducted the testing in accordance with a DOT&E-approved test plan.
- In November 2017, the Navy completed AMNS medium current developmental testing.
- The Navy continued development of the UISS TEMP in FY17 and intends to submit it for DOT&E approval in FY18. The Navy continued development of the UISS, expects to complete contractor testing in 1QFY18. The

# FY17 NAVY PROGRAMS

Navy intends to conduct UISS developmental testing during the rest of FY18, concluding with an operational assessment (OA) on LCS 2 in 1QFY19.

- The MCM USV, the intended UISS tow vehicle, began builder's trials in 1QFY18. The Navy plans to conduct LCS launch and recovery testing and sweep testing from LCS 2 in southern California in late 3QFY18.
- The Navy continued development of the mine-like Navy Instrumented Threat Target (NAVITTAR), a key test resource for future developmental and operational testing of UISS and a potential training asset for the fleet.
- Until the MCM USV becomes available for testing, the Navy intends to conduct AN/AQS-20C developmental testing using manned surface platforms in FY18. The Navy is still developing a test strategy and TEMP to document required RMH MM testing.
- The Knifefish completed contractor testing and began Factory Acceptance Testing in September 2017. Sea acceptance testing is expected to begin in 1QFY18. The Navy intends to conduct developmental testing in early 2QFY18, followed by an OA in mid-2QFY18. However, the DOT&E OA report will likely not be available to inform the Navy Milestone C decision, scheduled for late 2QFY18.

## SUW MP

- The Navy conducted preliminary developmental tests of the Longbow HELLFIRE missile to include missile firings from a barge at moving targets and a structural test firing aboard a *Freedom*-variant LCS.

## ASW MP

- The Navy conducted no at-sea testing of the ASW MP in FY17.
- In March 2017, the Navy awarded a contract to develop the VDS. The vendor's proposal uses a single towline to deploy both VDS and MFTA. The vendor intends to deliver a test article in late 2018.
- In September 2015, the Navy completed a formal study that identified capability gaps in currently available torpedo surrogates and presented an analysis of alternatives for specific investments to improve threat emulation capability. The Navy has since taken the following actions to address the identified capability gaps:
  - The Navy received approximately \$1.4 Million through an FY16 Resource Enhancement Project (REP) proposal to develop a threat-representative, high-speed quiet propulsion system.
  - The Navy received approximately \$6.2 Million through an FY17 REP proposal to develop a General Threat Torpedo (GTT). The GTT expands upon the high-speed quiet propulsion system by developing threat representative tactics and countermeasure logic.

## Assessment

### Seaframes

- DOT&E provided early fielding reports of the *Freedom* variant in December 2015 and the *Independence* variant in November 2016. The Navy did not conduct any additional

testing or perform any modifications to either LCS seaframe variant in 2017 that would affect these assessments.

- 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 operation with a combat system that is 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 to develop a PRA M&S suite of LCS combat systems in FY15 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 in FY18.
- The Navy delivered draft versions of the *Freedom*- and *Independence*-variant Detail Design Integrated Survivability Assessment Reports, which include a summary of TSST data, assessment of ship vulnerabilities to air and underwater threats, and assessment of their compliance with survivability requirements.
- Survivability testing and preliminary analyses on both LCS variants continue to demonstrate that neither LCS variant is survivable in high intensity combat. Although the ships incorporate capabilities to reduce their susceptibility to attack, testing of analogous capabilities in other ship classes demonstrated that such capabilities have limited effectiveness in high intensity combat. As designed, the LCS lacks redundancy and the vertical and longitudinal separation of vital equipment found in other combatants. These features are required to reduce the likelihood that a single hit will result in loss of propulsion, combat capability, and the ability to control damage and restore system operation.
- The final survivability assessment of the LCS variants is ongoing and is largely dependent on Navy delivery and quality of shock trial reports, completion of FY16 surrogate test reports, and the final survivability analysis runs.
- Based on the testing and analysis performed by the Navy to date, the DOT&E assessment of the survivability of both LCS variants is unchanged.

## MCM MP

- The first phase of COBRA Block I IOT&E provided data to evaluate the effectiveness of the system to detect, classify, and localize mine lines, minefields, and obstacles on pure sand and on sand with beach vegetation. The COBRA Block I system performed reliably with few operational mission failures. However, both MQ-8B Fire Scout test platforms were not operationally available for several days during this IOT&E period. MQ-8B troubleshooting and repairs required significant maintenance support.

# FY17 NAVY PROGRAMS

- The UISS must be survivable in the intended operating environment to repeatedly sweep and detonate mines. The Navy plans to test UISS mission survivability, prior to full-rate production, using underwater explosive testing of the operational system are uncertain. Without this testing, the Navy risks acquiring a minesweeping system with limited survivability against the threats it is intended to counter.
- The Navy is deciding whether the RMH MM, a core capability for the LCS MCM MP, will integrate the AN/AQS-20C or AN/AQS-24C minehunting sonar system with the MCM USV tow craft. The MCM USV is still under development, and must be further modified to serve as the tow craft in the RMH MM.
- Navy plans to develop, integrate, and test the RMH MM in the LCS MCM MP are not mature. A production-representative RMH MM is not expected to be available for test until the MP IOT&E and the Navy intends to operationally test RMH MM capability for the first time during the LCS MCM MP IOT&E scheduled in FY20. This testing strategy adds risk to successful completion of the LCS MCM MP IOT&E and delivery of its intended capability to the fleet.
- Despite having plans and funding to develop, integrate, and test multiple MM programs of record in the MCM MP, the Navy does not have approved CONOPS or tactics, techniques, and procedures to employ the family of MCM MP systems and capabilities to complete a combat mission. This information is essential for successful MP development, testing, and fleet employment.
- The slow pace of development, production, and validation of NAVITTAR, a mine like test resource, raises doubts as to whether accredited moored and bottom mine targets will be available in sufficient quantities to support planned operational testing of UISS in FY18.

## SUW MP

- In December 2015, DOT&E issued a classified assessment of the *Freedom* variant with the Increment 2 SUW MP. The ship's mixed performance in live fire testing resulted in DOT&E deferring a determination of its effectiveness until the completion of Increment 3 SUW testing, scheduled for FY18. The Navy did not conduct any additional testing or perform any modifications to the seaframe and SUW MP in 2017 that would affect the 2015 assessment.
- In November 2016, DOT&E issued a classified assessment of the *Independence* variant with the Increment 2 SUW MP. The Navy did not conduct any additional testing or perform any modifications to the seaframe and SUW MP in 2017 that would affect the 2016 assessment.

## ASW MP

- The observed operational availability of MFTAs in the fleet will reduce the percentage of time that LCS with the ASW MP is able to support the ASW mission. The MFTA is required for the LCS to conduct the ASW mission. Repair of a MFTA requires LCS to return to port to replace the MFTA with a spare. An effective ASW mission capability will depend on a logistics plan that includes pre-placement

of MFTA spares in strategic locations and a tow design that supports replacement of the MFTA on the single VDS and MFTA towline.

- Current test surrogates have significant limitations representing threat torpedoes. Operational assessments of each LCS variant with the ASW MP using these test assets will not fully characterize the capability provided by an LCS to defeat incoming threat torpedoes. The Navy proposed development of a GTT addresses many shortfalls, but the capability to support realistic operational testing depends on future Navy decisions to procure a sufficient quantity of GTTs.

## Recommendations

- Status of Previous Recommendations. The Navy has partially addressed one recommendation from the DOT&E FY16 Annual Report relating to MCM MP. DOT&E is not aware of any other actions taken by the Navy to address the recommendations relating to LCS seaframes, cybersecurity, and the MCM, SUW, and ASW MPs.
- FY17 Recommendations. The Navy should address the remaining FY16 recommendations and the following FY17 recommendations:

### MCM MP

1. Complete the remaining COBRA Block I IOT&E phases that include LCS-based testing at sea and cybersecurity testing on LCS.
2. Fund and integrate the COBRA Block I system on a more robust and reliable platform to mitigate risks caused by poor MQ-8B Fire Scout operational reliability and availability observed during testing.
3. Complete the MCM MP CONOPS and the tactics, techniques, and procedures for employing the MCM MMs in expected combat environments.
4. Characterize RMH MM capabilities using the MCM USV and minehunting sonar in operational testing prior to conduct of the LCS MCM MP IOT&E.
5. Accelerate completion of development, production, and validation to support accreditation of NAVITTAR for use in planned UISS testing in FY18.
6. Fund and execute full system shock testing for the UISS prior to full-rate production to ensure the production-representative system is survivable in a combat environment.

### ASW MP

7. Develop a logistics plan that includes pre-placement of MFTA spares in strategic location and ensure that the combined tow for the vertical depth sonar and MFTA supports replacement of the MFTA.

### LFT&E

8. Address recommendations listed in the Navy and DOT&E LCS 4 TSST reports.

### Future Operational Testing

9. Complete the air warfare testing of both seaframes, including development and execution of the LCS PRA testbed.

# FY17 NAVY PROGRAMS