MH-60S Multi-Mission Combat Support Helicopter

Executive Summary

- In FY16, in conjunction with delays in the Littoral Combat Ship (LCS) mine countermeasures (MCM) mission (MCM) package, the Navy delayed IOT&E of the MH-60S equipped with the Airborne Laser Mine Detection System (ALMDS) and the Airborne Mine Neutralization Systems (AMNS) until at least FY21. Since the Navy plans to declare Initial Operational Capability (IOC) of these systems in early FY17 and deploy them by FY18, prior to the completion of operational testing, DOT&E issued an early fielding report in June 2016. The report concluded that the MH-60S Airborne Mine Countermeasures (AMCM) helicopter equipped with ALMDS or AMNS would not be operationally effective or operationally suitable if called upon to conduct MCM missions in combat. The primary reasons for these conclusions are:
  - The combined AMCM systems are not reliable.
  - The ALMDS minehunting capabilities are limited in other-than-benign environmental conditions.
  - The AMNS cannot neutralize most of the mines in the Navy's threat scenarios.
  - The fleet is not equipped to maintain the ALMDS or the AMNS.
- DOT&E issued a classified FOT&E report in April 2014 that assessed the MH-60S Multi-spectral Targeting System (MTS) Automatic Video Tracker (AVT) does not adequately meet surface warfare (SUW) requirements. Currently, there are no prospective remediation modifications planned to address the system deficiencies that would likely enable it to meet SUW requirements. The Navy has shifted its focus to the long-term replacement for the HELLFIRE missile, the Joint Air-to-Ground Missile (JAGM), which employs a different guidance system that would obviate the need to correct the MTS AVT deficiencies.
- The Digital Rocket Launcher (DRL) with Advanced Precision Kill Weapon System (APKWS) II rockets, installed in response to an urgent operational need request, provides additional SUW capability to the MH-60S, but presents technical and operational risks that should be addressed for improved performance. Fielding the JAGM would also address the major shortcomings of the DRL with APKWS II.
- The Navy is currently procuring the Helmet Display and Tracking System (HDTS) on the MH-60S based solely on developmental testing. Current plans are to field the system without conducting operational testing.

System

- The MH-60S is a medium lift ship-based helicopter manufactured in three variants (blocks) that are derived from the Army UH-60L Blackhawk.
- All three blocks share a common cockpit, avionics, flight instrumentation, and power train with the MH-60R.
- Installed systems differ by block based on mission:
  - Block 1, Fleet Logistics – precision navigation and communications, maximum cargo or passenger capacity.
  - Block 2A/B, AMCM System – AMCM system operator workstation; a tether/towing system, two AMCM systems that the Navy plans to IOC in FY17 – ALMDS for detection and classification of near-surface mines and AMNS for neutralization of in volume and bottom mines – and a third system in early development, the Barracuda Mine Neutralization System, which the Navy expects to provide a near surface mine neutralization capability. The draft Capability Development Document hints that the Navy will integrate Barracuda with the MH-60S prior to the planned IOC in FY22. Any Block 2B or subsequent aircraft (e.g., Block 3 A/B aircraft) can be an AMCM aircraft.
  - Block 3A, Armed Helicopter – 20 mm Gun System, forward-looking infrared with laser designator, crew served side machine guns, dual-sided HELLFIRE air-to-ground missiles, the 2.75-inch family of rockets, and defensive electronic countermeasures.
  - Block 3B, Armed Helicopter – adds a tactical datalink (Link 16) to Block 3A capabilities.

Mission

The Maritime Component Commander can employ variants of MH-60S to accomplish the following missions:

- Block 1 – Vertical replenishment, internal cargo and personnel transport, medical evacuation, Search and Rescue, and Aircraft Carrier Plane Guard.
- Block 2 – Detection, classification, identification, and/or neutralization of sea mines, depending on the specific AMCM systems employed on the aircraft.
- Block 3 – Combat Search and Rescue, Surface Warfare, Aircraft Carrier Plane Guard, Maritime Interdiction Operations, Special Warfare Support, and detection, classification, identification, and/or neutralization of sea mines, depending on the specific AMCM systems employed on the aircraft.

Major Contractors

- Sikorsky Aircraft Corporation – Stratford, Connecticut
- Lockheed Martin Mission System and Sensors – Owego, New York

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Activity

- In October 2015, the Navy delayed IOT&E of the *Independence*-variant LCS equipped with the first increment of the MCM mission package and its MH-60S AMCM systems pending the outcome of an independent review.
- In early 2016, following the completion of the independent review, the Navy announced plans to delay IOT&E of the LCS-based AMCM systems and declare an IOC for these systems in early FY17.
- In May 2016, DOT&E provided comments on the Navy's draft Capability Development Document for the Barracuda Mine Neutralization System. The Navy approved the Barracuda Mine Neutralization Capability Development Document in September 2016.
- In June 2016, DOT&E submitted an early fielding report to the Congress in response to the Navy's plan to deploy the *Independence*-variant LCS equipped with the MCM mission package, including the MH-60S with ALMDS and with AMNS, prior to the conduct of operational testing. The classified report, which does not support the Full-Rate Production decision, provided DOT&E's interim assessments of operational effectiveness and operational suitability of the *Independence*-variant LCS employing the MCM mission package and the AMCM systems.
- In 2016, the Navy reallocated funding intended to support near-term development of ALMDS pre-planned product improvements. The Navy also reported that the modified system would not be available to the LCS MCM mission package until at least FY21, thus indicating it will not be available in time to support the planned LCS MCM mission package IOT&E.
- In September 2016, the Navy announced that it plans to use fleet exercises to gather additional data to characterize previously unknown attributes of the AMCM systems it plans to IOC in FY17. For ALMDS, the Navy expects to characterize the system's probability of detection and classification as a function of mine spacing and water depth. For AMNS, the Navy expects to characterize performance of the system against buried mines.

Assessment

- The MH-60S AMCM helicopter, equipped with ALMDS or with AMNS, would not be operationally effective or operationally suitable if called upon to conduct MCM missions in combat. The primary reasons for these conclusions are:
  - The combined AMCM systems are not reliable.
  - The ALMDS minehunting capabilities are limited in other-than-benign environmental conditions.
  - The AMNS cannot neutralize most of the mines in the Navy's threat scenarios.
  - The fleet is not equipped to maintain the ALMDS or the AMNS.
- Since each LCS relies on a single helicopter to support all airborne MCM operations, MH-60S and AMCM mission kit reliability are critical factors affecting the timeliness of LCS-based MCM operations. Nonetheless, the Navy established a reliability requirement for the MH-60S (20.3 hours MTBOMF) but neglected to establish any requirements for the AMCM mission kit or for the combined AMCM system.
  - Based on data from combined developmental and integrated testing and operational assessments since 2011, MH-60S reliability is 26.3 hours MTBOMF, which exceeds the Navy's threshold requirement with high confidence. During the same period of testing, the average AMCM mission kit reliability is 24.5 hours MTBOMF; thus, its OMFs occur at approximately the same rate as MH-60S OMFs. The average reliability of the combined MH-60S AMCM helicopter is 12.7 hours MTBOMF, significantly less than the requirement for MH-60S reliability.
  - Mission kit reliability varies based on the AMCM mission configuration. On average, mission kit reliability is 59.1 hours MTBOMF during ALMDS missions and 19.0 hours MTBOMF during AMNS missions. The differing results are not surprising, since the MH-60S uses the AMCM tow cable and winch during AMNS missions but does not need these components during ALMDS missions. When the results are further merged with MH-60S reliability results, which vary little by mission

type, the combined MH-60S AMCM helicopter reliabilities are 16.9 hours MTBOMF during ALMDS missions and 10.7 hours MTBOMF during AMNS missions. Thus, the probability that the MH-60S and its mission kit can complete three 2.5-hour flights on any given day without experiencing a failure, which might be required during MCM operations, is 64 percent for ALMDS missions and 50 percent for AMNS missions. Those probabilities fall to 41 percent and 25 percent, respectively, for six 2.5-hour sorties on 2 consecutive days. Consequently, the probability of a single LCS sustaining high operating tempo AMCM missions is low.

- Since no operational testing of an AMCM-equipped MH-60S has occurred onboard an LCS, the LCS MCM TECHEVAL is the best source of data to assess the ability of ship and crew to sustain MH-60S AMCM operations. During the FY15 TECHEVAL, the MH-60S and its associated AMCM mission kit experienced nine problems that interrupted or delayed LCS MCM activities, nearly the same as the now canceled Remote Minehunting System (RMS). Operationally, the flight crew would have incurred at least one additional MH-60S AMCM delay because of an AMNS destructor launch failure that would have required aircrew to jettison the launch and handling system if live (explosive) neutralizers (operational assets) had been employed. Because of these problems, LCS 2 demonstrated sustained MH-60S AMCM operations lasting more than 1 week just once during TECHEVAL. Although the LCS Design Reference Mission suggests the MH-60S will operate daily in intervals of 10 to 12 days over several months, LCS 2 conducted MH-60S operations for 2 days or less on nine occasions during TECHEVAL before needing essential maintenance that in many cases required the ship or helicopter to return to port for spare parts or repairs.

• Although the Navy has taken action to mitigate ALMDS reliability problems observed in early testing, the system continues to experience occasional failures and, more often, nuisance faults that affect LCS AMCM operations. Over multiple periods of testing completed since 2012, system reliability has averaged 30.9 hours MTBOMF, exceeding the Navy's requirement of 25 hours MTBOMF. DOT&E did not include less-critical faults that interrupted missions only briefly or reduced the ALMDS search rate by 50 percent (because one or two of the four receivers were not functioning properly) in this calculation. However, a strict interpretation of the requirements document would count each of these faults as an additional OMF that would further reduce the reported reliability. Considering only the phases of testing completed after the Navy implemented an engineering change to mitigate the most common failure modes, ALMDS pods have experienced only one OMF in 74.4 hours of operations. However, each of the pods employed during this time completed less than 20 hours of lasing operations after the prime contractor groomed the system for testing. DOT&E cannot assess that the system is meeting its reliability requirement with confidence until it can verify that performance observed in these short periods is representative of sustained operations.

- The further combined results of MH-60S, AMCM mission kit, and ALMDS reliability suggest the integrated AMCM system experiences 1 OMF every 11.9 flight hours. Although the high failure rate of the combined system would make it difficult to sustain LCS-based operations, ALMDS pods have generally not been the primary source of mission downtime during stateside testing. Testers have also minimized ALMDS downtime during stateside testing by pre-positioning replacement systems to make them readily available in the event of a failure. This arrangement has produced high ALMDS availability results because testers assumed the system was available when at least one pod was operational, as opposed to recording uptime and downtime for each unit involved in the test. In the near-term, this approach is viable because the Navy has procured more ALMDS pods than deployable MCM mission packages; however, unless the Navy updates its ALMDS acquisition strategy to acquire additional units, it might not realize the same level of availability while operating more than a handful of MCM mission packages.
- Commander Task Force (CTF) 52 monitored the availability of individual ALMDS pods deployed to the Navy's Fifth Fleet area of responsibility in 2014 and reported that pods demonstrated an average operational availability of 62 percent compared to the Navy's requirement of 80 percent. Although the pods did not include the Navy's reliability improvements, root cause analysis determined that even if the Navy had implemented the engineering changes prior to deployment, they would not have prevented several failures responsible for significant downtime. CTF 52 also concluded that the lack of in-theater repair capability negatively affected ALMDS operational availability because of the need to transport pods to the contractor's facility in Melbourne, Florida, for intermediate- and depot-level repair. By eliminating transit time from the calculation, CTF 52 showed that ALMDS operational availability would improve to approximately 75 percent if a repair capability equal to that of the contractor's facility were available in theater.

• The Navy established two reliability requirements for the AMNS that address the system's LHS and neutralizer separately. The Navy's threshold requirements are 24 hours MTBOMF for the LHS and 0.85 for neutralizer reliability. Assessing compliance with the former requirement is challenging because the AMNS Capability Production Document does not define LHS operating time. Although the Navy often equates LHS operating time with MH-60S flight time, DOT&E limits its assessment of LHS operating time to the period during which the aircrew employs the system (e.g., from initial deployment to final retrieval).

- AMNS LHS reliability and neutralizer launch data show that on average, the LHS experiences one OMF for every 6.4 hours of operation and 17 neutralizer launches. Even if DOT&E used flight hours as the basis for its reliability

calculation, LHS reliability would still be well short of the Navy's threshold. Moreover, the combined results of MH-60S, AMCM mission kit, and AMNS reliability suggest that the integrated AMCM system experiences one OMF every seven neutralizer launches and 5.9 flight hours, on average, during AMNS operations. By either measure, system reliability precludes timely and sustained operations.

- Neutralizer reliability is measured by the percentage of neutralizers launched that function as designed (i.e., give the operator an opportunity to identify and neutralize a mine) and is a component of the AMNS metric for probability of successful attack run. AMNS neutralizer reliability varies with environmental conditions, but is 65 percent, on average. Although the FY15 TECHEVAL produced the highest numerical result for neutralizer reliability, one should not attribute the change in the point estimate of neutralizer reliability to improvements in the underlying system. Instead, the combination of more favorable environmental conditions and the Navy's decision to avoid neutralizing most bottom targets, which had the highest incidence of failures in earlier testing, most likely led to the change in estimated performance between the operational assessment and the TECHEVAL. In addition to failures of the aircraft, mission kit, and LHS that delay completion of AMNS operations, multiple attempts to identify and neutralize the same contact (because of low neutralizer reliability) further extend AMNS and LCS MCM mission timelines.

- The ALMDS does not meet Navy detection/classification requirements. In particular, the system does not meet the Navy's requirements for minimum probability of detection and classification in all depth bins or the average probability of detection and classification in all conditions over a region of the water column that extends from the surface to a reduced maximum depth requirement. When the system and operator detect and classify a smaller percentage of mines than predicted by fleet planning tools, the MCM commander will likely underestimate the residual risk to transiting ships following clearance operations. To mitigate this uncertainty, the Navy might find it necessary to conduct follow-on minesweeping operations. However, the Navy does not plan to include the mechanical minesweeping capability that would be required in the MCM mission package. In some conditions, the system also generates a large number of false classifications (erroneous indications of mine-like objects) that can delay near-surface minehunting operations until conditions improve or slow mine clearance efforts because of the need for additional search passes to reduce the number of false classifications. In very favorable conditions, such as those observed during LCS MCM mission package TECHEVAL in FY15, detection performance meets the Navy's requirements and tactics, techniques, and procedures have been successful in reducing false classifications to the Navy's acceptable limits.
- The current increment of the AMNS has a system design limitation that prevents damage to the helicopter and is essential for the safety of aircrew. The current increment of the AMNS cannot neutralize mines that are moored above the system's prescribed operating ceiling, which will preclude neutralizing most of the mines expected in some likely threat scenarios; thus, alternative means, such as an Explosive Ordnance Disposal Team provided by another unit must be used to complete mine clearing. Within its operating range, AMNS performance is frequently degraded by the loss of fiber-optic communications between the aircraft and the neutralizer. The system has experienced loss of fiber-optic communications in a wide range of operationally relevant conditions, including those that are relatively benign. Although the Program Office has stated that it intends to develop an improved AMNS to extend its depth range and potentially improve performance in coarse bottom conditions and higher currents, none of these efforts are funded, and the Navy is considering needed Barracuda Mine Neutralization System capabilities that will compensate for shortfalls in AMNS operational performance.
- Consistent with the concept of operations, the LCS is reliant on shore-based support for assistance with diagnosis and repair of MCM mission systems including ALMDS and AMNS. The mission package detachment lacks the wherewithal to handle anything beyond relatively uncomplicated preventive maintenance and minor repairs. Thus, when ALMDS and AMNS failures occur, the Navy assumes that in most cases these systems will be replaced by embarked or shore-based spares.
- The MH-60S, as well as ALMDS and AMNS integrated on an LCS-based MH-60S have not completed cybersecurity testing.
- DOT&E's June 2016 early fielding report provides additional classified detail on MH-60S AMCM performance.
- DOT&E's classified April 2014 FOT&E report noted that the upgraded MH-60S MTS software showed some improved tracking performance compared to prior operational testing, but the MTS still did not meet its requirement for tracking. Additionally, the SUW mission capability of the MH-60S helicopter equipped with MTS and the HELLFIRE missile was not tested throughout the operational mission environment. Although the Navy is pursuing replacement of the AGM-114 HELLFIRE missile with the JAGM, which would obviate the need to correct the MTS deficiencies, the Milestone C decision for procuring JAGM is scheduled for late FY17 at the earliest. MTS tracking risks should be addressed as soon as possible. Failing to do so has left the Navy with a significant current capabilities gap in SUW that remains unaddressed. Should the JAGM fail to perform to requirements, this capabilities gap would continue to the foreseeable future with no alternative solution forthcoming.
- During FY14, a Quick Reaction Assessment of the MH-60S equipped with the DRL and APKWS II rockets demonstrated additional SUW capability for the MH-60S but identified technical and operational risks that should be addressed for improved mission performance. The preceding discussion on JAGM is also germane for the DRL with APKWS II.

Recommendations

- Status of Previous Recommendations. The Navy has partially addressed the FY11 recommendation to investigate solutions and correct the ALMDS False Classification Density and reliability deficiencies prior to IOT&E. The Navy has partially addressed the FY12 recommendation to assess corrections made to resolve previously identified MTS deficiencies by conducting FOT&E. The Navy has not acted or has yet to complete action on FY13, FY14, and FY15 recommendations:
  1. Complete comprehensive survivability studies for MH-60S employing the 20 mm Gun System and 2.75-inch Unguided Rockets.
  2. Conduct comprehensive live fire lethality testing of the HELLFIRE missile against a complete set of threat-representative small boat targets.
  3. Correct the tracking deficiencies in the MTS and conduct appropriate FOT&E in order to satisfactorily resolve the SUW Critical Operational Issue.
  4. Complete comprehensive IOT&E on the 2.75-inch Unguided Rocket and APKWS II to resolve the SUW Critical Operational Issue not resolved in limited assessments of system performance provided in Quick Reaction Assessments against small boat threats.
  5. Test the SUW mission capability of the MH-60S helicopter equipped with MTS and the HELLFIRE missile throughout the operational mission environment in FOT&E and LFT&E.
  6. Complete vulnerability studies for MH-60S employing the LAU-61G/A DRL armed with APKWS II rockets.
  7. Conduct comprehensive lethality testing of the LAU-61G/A DRL armed with APKWS II rockets against a complete set of threat-representative small boat targets.
  8. Correct AMCM mission kit reliability issues that limit AMNS mission availability identified during the operational assessment.
  9. Develop corrective actions to eliminate early termination fiber-optic communications losses observed in the AMNS operational assessment.
  10. Conduct AMNS medium current testing from MH-60S.
  11. Provide LCS with a mine neutralization capability in water depths above the current AMNS operating ceiling.
- FY16 Recommendations. The Navy should address the prior recommendations and consider the following actions:
  1. Conduct a comprehensive LCS-based cybersecurity assessment of the MH-60S helicopter with ALMDS and with AMNS.
  2. Limit procurement of ALMDS and AMNS, which are not meeting the Navy's original requirements and negatively affect LCS MCM capability, until much needed performance improvements are developed, tested, and proven effective in testing representative of realistic LCS mine-clearance operations.
  3. Fully resource the development of improvements to the ALMDS and AMNS (or alternative systems such as Barracuda). For ALMDS, efforts should focus on improving probability of detection over all required depths and relevant operating conditions, reducing the incidence of false contacts, and eliminating the need for multi-pass search tactics. For mine neutralization systems, efforts should focus on reducing the incidents of fiber-optic communications losses, developing the ability to neutralize near-surface mines, and operating in high-current environments.
  4. Avoid overreliance on shore-based testing, which often results in unwarranted confidence in system performance that may not be achieved during shipboard operations.
  5. Demonstrate through end-to-end testing that the systems included in future mission packages can achieve the area search rate and detection/classification performance needed to support LCS effectiveness in timely and sustained minehunting and clearance operations. Testing should avoid segmented evaluations of individual components of the mission package.