

Joint Standoff Weapon (JSOW)

Executive Summary

- The Navy completed Joint Standoff Weapon (JSOW) C-1 operational testing and declared Initial Operational Capability (IOC) in FY16.
- DOT&E published a classified FOT&E report in early FY17. This report indicates:
 - Weapon accuracy against stationary land targets has been maintained and moving maritime target accuracy was demonstrated in seven developmental, integrated, and operational free flight test events.
 - JSOW C-1 Mean Flight Hours Between Operational Mission Failure exceeded the requirement value of 95 hours.
 - The Navy has reduced the complexity of the Pilot Vehicle Interface (PVI) in the F/A-18E/F H10 software. There remain minor PVI challenges that could prevent successful mission execution. These challenges can be effectively overcome with proper training prior to employment. The Navy is addressing these challenges in F/A-18E/F H12 Operational Flight Program, scheduled for release in FY17.
 - In operational testing, aircrew workload to employ the weapon increased due to display errors in target location on multiple displays and intermittent errors in the status of the weapon entering the datalink and during post-launch weapon control. The Navy implemented a fix and tested it post-IOC, eliminating these errors.
- Cybersecurity testing of the JSOW C-1 was insufficient to test the cybersecurity vulnerabilities of the weapon and support equipment.

System

- The AGM-154 JSOW family uses a common and modular weapon body capable of carrying various payloads. The JSOW is a 1,000-pound class, air-to-surface glide bomb intended to provide low observable, standoff precision engagement with launch and leave capability. All variants employ a tightly coupled GPS/Inertial Navigation System.
- AGM-154A (JSOW A) payload consists of 145 BLU-97/B combined effects submunitions.
- AGM-154C (JSOW C) utilizes an imaging infrared seeker and its payload consists of an augmenting charge and follow through bomb that can be set to detonate both warheads simultaneously or sequentially.

Activity

- The Navy concluded operational testing and declared IOC of the JSOW C-1 in June 2016.
- The Navy completed 166 captive flight test (CFT) runs versus stationary land targets and 160 CFT runs versus mobile maritime targets. However, due to range, target,



- AGM-154A and AGM-154C are fielded weapons and no longer under DOT&E oversight. AGM-154C-1 (JSOW C-1) adds moving maritime target capability and the two-way strike common weapon datalink to the baseline AGM-154C weapon.

Mission

- Combatant Commanders use aircraft equipped with JSOW A to conduct pre-planned attacks on soft point and area targets such as air defense sites, parked aircraft, airfield and port facilities, command and control antennas, stationary light vehicles, trucks, artillery, and refinery components.
- Combatant Commanders use aircraft equipped with JSOW C to conduct pre-planned attacks on point targets vulnerable to blast and fragmentation effects and point targets vulnerable to penetration such as industrial facilities, logistical systems, and hardened facilities.
- Combatant Commanders will use F/A-18 E/F aircraft equipped with JSOW C-1 to conduct attacks against moving maritime targets and aircrew will have the ability to retarget weapons post launch. JSOW C-1 will retain the JSOW C legacy capability against stationary land targets.

Major Contractor

Raytheon Company, Missile Systems – Tucson, Arizona

and environmental limitations as well as a problem with the computer system used to collect the data, many of the planned target runs in the approved operational test plan design of experiments were not accomplished adequately to fully assess

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weapon accuracy. The computer system that was used to collect and store the data was unable to produce complete data files for a substantial number of runs against both land and maritime targets. The end-game portions of many runs were missing, resulting in incomplete data files that allowed for the collection of reliability data but not weapon accuracy. The Navy, through follow-on analysis of captive carry test seeker video, was able to assess weapon seeker tracking, but not miss-distance data, for many of the CFT runs.

- The Navy, through follow-on analysis of captive carry test seeker video, was able to assess attack success, but not miss-distance data, on an additional 37 maritime target runs.
- In operational testing, the Navy successfully completed one free flight test event versus a stationary land target on October 21, 2015, and one free flight test versus a mobile maritime target on January 26, 2016.
- The Navy unsuccessfully attempted a free flight test versus a mobile maritime target on February 9, 2016.
 - This shot was designed to be a long-range Advanced Targeting Forward Looking Infrared (AT-FLIR) targeting pod cued shot with handover to a second aircraft for weapon control. Due to range weather limitations, the aircraft providing initial target location and in-flight target updates to the missile was artificially close to the target and passed a very small target location error to the missile to define its search area for the target. However, this aircraft also had an unknown AT-FLIR boresight error, which resulted in a large error in target location. This combination resulted in the target being outside of the missile's search area and a weapon miss. Due to this combination of errors, this event was considered a no-test.
 - A previous captive carry rehearsal of this event on the same sortie, with the aircraft at range providing the initial target location as designed, and without these errors, was assessed as successful.
- The Navy completed carrier suitability testing in February 2016, with 10 catapults and 10 arrestments with aircraft carrying two weapons. The weapons were tested for functionality with no discoveries after this testing.
- Post-IOC, the Navy operational units conducted a live fire Fleet Exercise, Valiant Shield 16, where seven JSOWC-1 weapons were successfully employed against a former Oliver Hazard Perry class frigate. All weapons dropped impacted the ship and achieved high order detonation.
- The Navy conducted cybersecurity testing in April 2016, in accordance with the DOT&E-approved Test and Evaluation Master Plan and operational test plan – except it did not conduct a complete threat representative Adversarial Assessment versus JSOW employment.

Assessment

- DOT&E published a classified FOT&E report in early FY17. This report indicates:
 - Significant amounts of unrecoverable data from captive carry runs, a no-test live fire event, and limited cybersecurity testing resulted in limited information

to assess all aspects of JSOW C-1 effectiveness and survivability.

- Weapon accuracy against stationary land targets has been maintained and moving maritime target accuracy was demonstrated in seven developmental, integrated, and operational free flight test events. Although the data collected was adequate to demonstrate overall weapon accuracy, it was not adequate to test all the factor effects specified in the approved operational test plan. The additional analysis conducted by the Navy on captive carry test, while unable to gather miss-distance data, was useful in assessing weapon performance and likelihood of attack success.
- JSOW C-1 Mean Flight Hours Between Operational Mission Failure exceeded the requirement value of 95 hours.
- The Navy has reduced the complexity of the PVI in the F/A-18E/F H10 software. There remain minor PVI challenges that could prevent successful mission execution. These challenges can be effectively overcome with proper training prior to employment. The Navy has further reduced these challenges in F/A-18E/F H12 software, scheduled for release in FY17.
- In operational testing, aircrew workload to employ the weapon increased due to display errors in target location on multiple displays, a persistent incorrect advisory of missing cryptographic key data, and intermittent errors in the status of the weapon entering the datalink and during post launch weapon control. The Navy implemented a fix to the Joint Tactical Information Distribution Network Library after the completion of operational testing. This fix was tested during Harpoon II+ testing and in Exercise Valiant Shield with the JSOW; these errors are no longer present.
- Cybersecurity testing of the JSOW C-1 was insufficient to fully test the cyber vulnerabilities of the weapon and support equipment.

Recommendations

- Status of Previous Recommendations. The Navy has partially addressed the previous recommendations. The Navy has demonstrated a reduction in software-driven failures during the extended integrated testing phase. While it has significantly reduced the complex PVI, its plan will not fully address this issue until the F/A-18E/F H12 software release, scheduled for FY17.
- FY16 Recommendations. The Navy should:
 1. Continue to reduce the PVI complexity between the JSOW C-1 and the F/A-18E/F to permit successful mission execution.
 2. Conduct a more complete Cooperative Vulnerability and Penetration Assessment to identify all JSOW and supporting equipment vulnerabilities and a threat-representative Adversarial Assessment, as required by the approved operational test plan.