Small Diameter Bomb (SDB) II

Executive Summary

- The Small Diameter Bomb (SDB) II developmental and live fire testing is ongoing. The Air Force began Government Confidence Testing (GCT) in October 2016. The Air Force awarded the Low-Rate Initial Production Lot 3 contract for 250 weapons in January 2017.
- The SDB II is progressing in the Normal Attack (NA) mode, the primary employment method for the SDB II. The Air Force successfully demonstrated Coordinate Attack (CA) in 2017 and is progressing toward demonstrating Laser Illuminated Attack (LIA) in 2017 prior to entering IOT&E.
- The program implemented corrective actions and fixes for all failure modes discovered in developmental test. The program discovered five anomalies in GCT, identified and implemented a fix for one, and continues working solutions to address the remaining four.
- The Air Force is scheduled to begin IOT&E in 3QFY18 with an adequately resourced test program.

System

- The SDB II is a 250-pound, air-launched, precision-glide weapon that uses deployable wings to achieve standoff range. F-15E aircraft employ SDB IIs from the BRU-61/A four-weapon carriage assembly.
- The Air Force directed design of the SDB II to provide the capabilities deferred from SDB I. It includes a weapon datalink allowing for post-launch tracking and control of the weapon, as well as a multi-mode seeker to provide the ability to strike mobile targets in adverse weather.
- The SDB II combines Millimeter-Wave radar, imaging infrared, and laser-guidance sensors in a terminal seeker, in addition to a GPS and an Inertial Navigation System to achieve precise guidance accuracy in adverse weather.
- It incorporates a multi-function warhead (blast, fragmentation, and shaped charge jet) designed to defeat armored and non-armored targets. The weapon can be set to initiate on impact, at a preset height above the intended target, or in a delayed mode.

- The Air Force intends the SDB II to provide reduced collateral damage while achieving kills across a broad range of target sets by precise accuracy, small warhead design, and focused warhead effects.
- There are three principal attack modes: NA, LIA, and CA. The SDB II can be used against moving or stationary targets using its NA (radar/infrared sensors) or LIA modes, and fixed targets with its CA mode.
- The SDB II provides increased weapons load per aircraft compared to legacy air-to-ground munitions used against offensive counter-air, strategic attack, interdiction, and close air support targets in adverse weather.

Mission

- Combatant Commanders will use units equipped with the SDB II to attack stationary and moving ground targets in degraded weather conditions at standoff ranges.
- An SDB II-equipped unit or Joint Terminal Attack Controller (JTAC) will engage targets in dynamic situations and use a weapon datalink network to provide in-flight target updates, in-flight retargeting, weapon in-flight tracking, and, if required, weapon abort.

Major Contractor

Raytheon Missile Systems – Tucson, Arizona

Activity

- As of 2017, the Air Force has completed 19 NA, 3 CA, 4 LIA Guided Test Vehicle (GTV) and 13 Live Fire (LF) tests against moving and stationary targets as part of contractor-led developmental testing. The Air Force conducted 7 GTV and 6 LF tests with ultrahigh frequency updates; 12 GTV and 7 LF test shots were conducted with Link 16 updates. NA is the primary employment method for the SDB II.
- The Program Office completed 17 rounds of seeker Captive Flight Tests, resulting in over 2,260 target runs in a wide variety of terrain and environmental conditions. These tests provided terabytes of seeker performance data and logged over 483 hours of seeker operation without a single failure.
- The program has augmented and refined the Integrated Flight System (IFS) model by incorporating the results of over 2,260 Captive Flight Test runs as well as weapon flight tests. Raytheon released its IFS model verification and validation report in July 2017, and the Air Force Operational Test and

Evaluation Center expects to give initial accreditation prior to the start of operational testing.
- The Program Office completed over 2,000 hours of ground reliability testing and over 1,000 hours of in-flight reliability testing. The in-flight portion of captive carry reliability testing is ongoing.
- The program redesigned the Air Turbine Alternator (ATA), which provides power to the SDB II fuze, to address a deficiency identified during a captive flight test failure. Regression testing is nearing completion. At least 10 weapons incorporating the new ATA will be available and employed during IOT&E.
- The program began a 28-shot NA mode GCT program in October 2016, which is testing the weapon in more operationally realistic environments with more operationally representative hardware and software. GCT has completed 18 shots resulting in 14 successes, 3 failures, and 1 shot with anomalies still officially under review.
- The Air Force awarded the Low-Rate Initial Production Lot 3 contract on January 31, 2017, for 250 weapons.
- The Air Force conducted all testing in accordance with the DOT&E-approved Test and Evaluation Master Plan.

Assessment
- In the NA mode, the primary employment method for the weapon, the SDB II successfully engaged both moving and stationary targets, including proper classification of target type (wheeled versus tracked) on 19 of 22 GTV flight tests (including GCT); 3 events had failures. The program has implemented corrective actions and fixes for all failure modes discovered in test.
- The Air Force has completed 18 flight tests during GCT, which included instances of GPS degradation/denial, several JTAC-controlled weapons, simple denial and deception measures, in-flight retargeting, maneuvering and stop/start motion by targets, and higher clutter environments, including more decoy or confuser targets to stress the classification feature of the weapon. The Air Force has not yet accomplished successful employment against maritime targets, nor a ripple release (dropping multiple bombs in rapid succession) in GCT, both of which are planned to be completed prior to IOT&E.
- In the CA and LIA modes, the program adequately addressed the two failure types found in the CA mode, as demonstrated in test. The program conducted a successful test of a new software version in the LIA mode with another test scheduled before IOT&E to validate the fix.
- A total of 57 SDB IIs have been employed during testing to date. Forty weapons have been successful in terms of Free Flight Reliability, with 13 failures and 1 more under review because of anomalous performance. The resulting reliability level is between 0.75-0.76, depending on the resolution of the outstanding anomalies. This is below the 0.80 level to be achieved by the end of IOT&E; the rate of discovering new failure modes has been steady, implying the weapon is not yet fully mature. In addition, the program has thoroughly implemented corrective actions and fixes for all failure modes discovered in test and there have been no failures of components or software for which a fix has been implemented. Further testing in GCT and the Captive Carry Reliability Test program will be performed in an attempt to increase confidence in weapon reliability.
- The Program Office is preparing for IOT&E with an adequately resourced test program and no major unresolved programmatic testing problems. IOT&E is scheduled to begin in 3QFY18.
- One of the live fire test events (LF-10) detonated but failed to guide to the target. LF-10 was the first LF mission using LIA. The previous test using LIA (LIA-2) also missed its moving target. The failure investigation revealed the laser guidance algorithm to be inadequate against moving targets. The modification of the algorithm is ongoing. LIA-2 has been repeated and LF-10 will be repeated prior to IOT&E.
- The Air Force discovered five anomalies during GCT to date. These include: a software coding error that has been fixed and tested; a maritime target problem; and three anomalies related to employment against static targets, which are being addressed in a final weapon software version that will be tested prior to IOT&E.
- The SDB II continues to perform well against moving targets in the NA mode, but has difficulty in some conditions against static targets. A combination of software improvements and modified employment procedures to be implemented prior to IOT&E are expected to improve performance against static targets.
- Continued comparisons of the IFS model pre- and post-flight predictions indicate the model is adequate for the kinematics flown in flight test to date. Raytheon Missile Systems continues to develop and update the IFS model, which will be essential to the assessment of the results of live fire and operational testing. IFS, in combination with lethality and free flight reliability data, will produce single shot kill probability values needed to assess end-to-end weapon effectiveness against a range of operationally relevant targets.

Recommendations
- Status of Previous Recommendations. The Air Force completed all previous recommendations.
- FY17 Recommendations. The Air Force should:
  1. Continue to refine and coordinate the GCT test matrix to maximize confidence in readiness for IOT&E.
  2. Ensure that weapon software is finalized and adequately tested prior to the commencement of IOT&E.