Q-53 Counterfire Target Acquisition Radar System

Executive Summary

- In October and November 2012, the Army conducted the Q-53 radar Limited User Test (LUT) at Yuma Proving Ground, Arizona. Soldier crews operated two Q-53 radars during a 48-hour pilot test and three 72-hour record test scenarios observing mortar, artillery, and rocket fires.
  - During the LUT, the Q-53 acquired and provided targeting information consistent with user requirements in both the 90- and 360-degree modes against threat munitions fired simultaneously from multiple locations.
  - The Q-53 radar did not meet reliability growth estimates during the LUT. To meet reliability growth estimates, the Army expected the radars to operate 294 hours before a system abort during the LUT. The radars averaged a system abort every 51 hours.
  - Against threat munitions fired in volleys during the LUT, the Q-53 radar did not acquire or provide targeting information consistent with requirements in either the 90- or 360-degree modes. The Army has not established a radar performance requirement for threat munitions fired in volleys.
- The Army Program Executive Officer for Missile and Space (PEO M&S) conducted a Q-53 radar program review on April 16, 2013, and approved the procurement of Lot 3 (21 systems). Lot 3 was the last of three planned low-rate production lots.
- Testing previously planned to occur in October 2013 was delayed due to shutdown of the Federal Government and the lack of a Defense Appropriation.

System

- The Q-53 Counterfire Target Acquisition Radar System is a mobile radar system designed to detect, classify, and track projectiles fired from mortar, artillery, and rocket systems using a 90-degree or continuous 360-degree sector search.
- The radar provides target location of threat indirect fire systems with sufficient accuracy for effective counterfire.
- The Q-53 is designed to operate with the Counter – Rocket, Artillery, Mortar system and the future Indirect Fire Protection Capability system.

- The Army intends to field the Q-53 radar to the target acquisition platoons in Brigade Combat Teams (BCTs) and target acquisition batteries in Fire Brigades to replace the legacy AN/TPQ-36 and AN/TPQ-37 Firefinder radars.
- The Q-53 is operated by a crew of four Soldiers and transportable by C-17 aircraft. Battlefield mobility is provided by two Family of Medium Tactical Vehicle trucks.
- The Army contracted with Lockheed Martin Missile Systems and Sensors to develop and field 38 Quick Reaction Capability radars to support an Urgent Material Release. The Army intends to produce 136 program of record Q-53 radars.

Mission

Field Artillery units employ the Q-53 radar to protect friendly forces by determining timely and accurate location of threat rocket, artillery, and mortar systems for defeat with counterfire engagements. Air Defense Artillery integrate the Q-53 radar into the Counter – Rocket, Artillery, Mortar and Indirect Fire Protection Capability System to warn friendly forces and to engage incoming threat indirect fires.

Major Contractor

Lockheed Martin Missile Systems and Sensors – Syracuse, New York

Activity

- In October and November 2012, the Army conducted the Q-53 radar LUT at Yuma Proving Ground, Arizona, in accordance with a DOT&E-approved test plan. Soldier crews operated two Q-53 radars during a 48-hour pilot test and three 72-hour record test scenarios observing mortar, artillery, and rocket fires. DOT&E published an Operational Assessment report based on the LUT on April 5, 2013, providing input to the Army PEO M&S planned program review in mid-April 2013.
- In January and February 2013, the Army conducted cold-weather testing on an initial production Q-53 radar at the Cold Regions Test Center, Fort Greely, Alaska. A

Soldier crew operated the radar in 90-degree and 360-degree modes while observing artillery and mortar live firings.
- The Army completed Q-53 radar Developmental Test Phase 2 (DT2) testing at Yuma Proving Ground, Arizona, and White Sands Missile Range, New Mexico, February through August 2013. The Army collected radar data for performance, reliability, operations in an electronic warfare environment, and environmental durability.
  - The government-operated radars completed 13 test cycles accumulating 2,118 test hours.
  - Radar crews conducted continuous operations during the 72-hour test cycles, employing the radar in 90-degree and 360-degree modes with tactical and survivability moves.
- The Army PEO M&S conducted a Q-53 radar program review on April 16, 2013, and approved the procurement of Lot 3 (21 systems). Lot 3 was the last of three planned low-rate production lots.
- The Army executed Phase 1 of the Q-53 radar Logistics Demonstration at the contractor's Syracuse, New York, facility in June through August 2013. Q-53 radar Soldier maintainers and operators performed 288 radar logistical tasks during the demonstration. Phase 2 of the Logistics Demonstration scheduled for October 7-8, 2013, at Aberdeen Proving Ground, Maryland, was delayed due to shutdown of the Federal Government and the lack of a Defense Appropriation. The Army planned for Soldiers to perform 33 radar logistical tasks during the demonstration.

Assessment
- During the Q-53 radar LUT, the radars observed mortar, artillery, and rockets fired at various firing rates, trajectories, and radar-to-weapon ranges.
  - A workaround was required to overcome a Global Positioning System/Inertial Navigation Unit (GPS/ INU) problem that caused targeting errors as great as 1 kilometer. The program made changes to the radar software and the problem did not occur during post-LUT reliability developmental testing.
  - Against threat munitions fired one at a time during the LUT, the Q-53 acquired and provided targeting information (using the GPS/INU workaround) consistent with requirements in the 360-degree mode, but not in the 90-degree mode.
  - The Q-53 acquired and provided targeting information (using the GPS/INU workaround) consistent with requirements in both the 90- and 360-degree modes against threat munitions fired simultaneously from multiple locations.
  - Against threat munitions fired in volleys from the same general location during the LUT, the Q-53 did not acquire or provide targeting information (using the GPS/INU workaround) consistent with requirements in either the 90- or 360-degree modes. The Army has not established a radar performance requirement for threat munitions fired in volleys. Volley fire is a known threat artillery technique in which two or more howitzers located in the same unit engage the same target at the same time.
  - The Q-53 radar contractor has informed the Army that radars operating in the 360-degree mode within a BCT zone must be positioned 20 kilometers apart for optimal performance. Due to terrain restrictions in the LUT, radars operating in the 360-degree mode were positioned less than 20 kilometers apart. The Army cited radar-to- radar interference for the degraded radar performance during LUT.
  - The counterfire cell supporting the Q-53 LUT could not effectively employ the Q-53 radar. During combat operations, the counterfire cell is located in the tactical operations center of BCTs and Fires Brigades and controls the placement of the radars, establishes search sectors, coordinates frequency allocations to prevent interference, and directs the radars' survivability and tactical moves. The expertise of counterfire cells to manage high volumes of incoming threat projectiles seen in major combat operations has atrophied in the last eight years due to a hybrid threat that engaged deployed BCTs and Fires Brigades with low volumes of incoming threat projectiles.
- The Q-53 radar contractor has developed optimization modes to increase radar short- and long-range performance and performance in adverse weather conditions. The Army has conducted limited developmental testing and no operational testing of these new modes.
- The Q-53 radar is not meeting planned reliability growth targets to achieve Army requirements. The user requires the Q-53 radar to operate 185 hours between system aborts. To achieve this requirement in the IOT&E, the Army established a reliability growth target of 361 hours between system aborts.
  - The LUT reliability growth target was 294 hours between system aborts. The radars demonstrated an average system abort every 51 hours at the conclusion of the LUT.
  - The IOT&E reliability entrance criterion was 352 hours between system aborts. The radars demonstrated an average system abort every 289 hours at the conclusion of DT2 and did not achieve the IOT&E reliability entrance criteria.
  - Demonstrating the reliability growth target of 361 hours between system aborts as a point estimate is consistent with having a high statistical probability of demonstrating 185 hours between system aborts in the IOT&E with 80 percent confidence.
- Throughout Q-53 radar DT2 testing, the contractor installed three new versions of radar software. Radar performance and reliability decreased using the first two software upgrades. Operating performance improved and reliability increased using the final software version at the end of DT2 testing. The Army has not completed reliability testing of the software version planned for the IOT&E.

Recommendations

- Status of Previous Recommendations. The Army satisfactorily addressed all of the FY12 recommendations.
- FY13 Recommendations. The Army should:
  1. Confirm and characterize suspected radar-to-radar degradation caused by violating radar contractor positioning guidance. Develop and test techniques to overcome radar degradation if contractor positioning guidance is confirmed.
  2. Characterize radar performance in all planned operational modes.
  3. Determine if there is a valid requirement for Q-53 radar performance against threat munitions fired in volleys.