Q-53 Counterfire Target Acquisition Radar System

Executive Summary

- In April and May 2014, the Army conducted the Q-53 radar IOT&E at Yuma Proving Ground, Arizona. Soldier crews operated four Q-53 radars during four, continuous 72-hour record test scenarios observing mortar, artillery, and rocket fires. Soldiers conducted counterfire operations, based on the tactical scenario presented.
- Based on IOT&E results, DOT&E emerging results found the Q-53 to be operationally suitable, not operationally effective, and not survivable. The Army plans to conduct additional operational testing and DOT&E is working with them to develop the scope and details of that testing. DOT&E will then re-evaluate the Q-53 based on the changes made to the radar software in a future operational test.
- The Army will conduct a series of developmental cyber tests, to include threat realistic cyber attacks, and the tests will culminate in an operational cyber event.
- The Army Program Executive Officer for Missile and Space conducted a Q-53 radar program review on March 17, 2014, and approved the procurement of Lot 4 (13 systems).

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 Army intends the radar to provide target location of threat indirect fire systems with sufficient timeliness and 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 and target acquisition batteries in Fire Brigades to replace the legacy AN/ PQ-36 and AN/TPQ-37 Firefinder radars.

- The Q-53 is operated by a crew of five Soldiers and transportable by C-17 aircraft. Two Family of Medium Tactical Vehicle trucks provide battlefield mobility.
- 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 accurate location of threat rocket, artillery, and mortar systems for defeat with counterfire engagements. Air Defense Artillery units 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

- The Army began training in October 2013 for a planned IOT&E the same month. Due to the FY14 Federal Government shutdown and lack of a Defense Appropriation, travel restrictions forced the Army to postpone the IOT&E until April 2014.
- The Army completed Developmental Test Phase 3 from December 2013 through February 2014 at Yuma Proving Ground, Arizona. Developmental testing focused on reliability of the IOT&E software.
  - Civilian crews conducted continuous, 72-hour operations employing the radar in 90- and 360-degree modes with tactical maneuver.
  - After each 72-hour period, and as the schedule permitted, crews operated the radars additional hours without movements. The radars accumulated 1,033 hours in six test cycles.
  - The Army conducted tests characterizing the radar's performance in the 90-degree normal, long-range

optimized mode, short-range optimized mode, and 360-degree modes.
- The Army Program Executive Officer for Missile and Space conducted a Q-53 radar program review on March 17, 2014, and approved the procurement of Lot 4 (13 systems).
- In April and May 2014, the Army conducted the Q-53 radar IOT&E at Yuma Proving Ground, Arizona, in accordance with a DOT&E-approved Test and Evaluation Master Plan and test plan.
  - Soldier crews operated four Q-53 radars during a 72-hour pilot test and four 72-hour record test scenarios observing mortar, artillery, and rocket fires.
  - The radars operated in 90- and 360-degree modes throughout the IOT&E.
  - Based on the tactical scenario presented, Soldiers in the counterfire cell managed the radars and conducted counterfire operations.
- The contractor is implementing software fixes for problems discovered in operational testing. The Army will conduct a series of developmental cyber tests, to include threat realistic cyber attacks, which will culminate in an operational cyber event. DOT&E is working with the Army to develop the details of the operational cyber test.
- The Army plans to conduct IOT&E2 in FY15.
- DOT&E intends to publish an IOT&E report in FY15 and is currently working with the Army to develop the scope and details of follow-on testing.

Assessment
- Based on IOT&E results, DOT&E emerging resilts found the Q-53 to be operationally suitable, not operationally effective, and not survivable. DOT&E will re-evaluate the Q-53 changes made to the radar in a future operational test.
  - The Q-53 radar is operationally suitable because the radar was available to complete its mission 99 percent of the time. The Army requires the radar to be operationally available 95 percent of the time.
  - The Q-53 radar did not meet the Army's reliability requirement. During the IOT&E, there were 10 system aborts during 1,152 operating hours. Based on these test results, there is an 80 percent chance the radar will average greater than 84 hours between system aborts. The Army requires the system to have an 80 percent chance of averaging greater than 185 hours between system aborts. Soldiers fixed the majority of the failures, which were software problems, in less than 30 minutes, resulting in a small amount of downtime and high availability.
  - In the 90-degree mode and 360-degree mode, the radar met accuracy requirements for single-fired artillery, mortar, and rocket projectiles.
  - The counterfire cell was able to manage the radars and conduct counterfire missions in a timely fashion. The Army discovered in a past operational test, Soldiers did not receive sufficient training in the counterfire cell to employ the radar effectively. Prior to the IOT&E, the Army adjusted the counterfire cell training and replaced some personnel with experienced Advanced Field Artillery Tactical Data System operators in the counterfire cell.
  - The radar is not operationally effective because of the large number of false targets reported by the radar in the IOT&E. While in the 90-degree normal, short-range optimized mode and 360-degree modes, the radar averaged 20, 32, and 7 false targets per 12 radiating hours. The Army's requirement is 1 false target per 12 radiating hours. The Army is continuing to investigate the cause of the high-false location rates. The contractor developed software fixes for false target problems and continues to assess the software changes.
  - The radar is not operationally effective because it had difficulty locating volley-fired projectiles in both 90- and 360-degree modes. Currently, there is no written requirement for the radar to perform against volley-fired weapons. Volley-fire is a well-established indirect fire technique. When volley-fired projectiles were located, the radar was accurate in both 90- and 360-degree modes. DOT&E added the volley-fire mission in addition to the single-fire mission to increase the test's operational realism; however, because the user determined there is no Q-53 requirement for volley-fired projectiles, the Program Office has no current plans to address the issue.
  - The radar is not survivable against a persistent cyber threat. The contractor has implemented software fixes for problems discovered during testing and the Army will conduct an operational test to verify those fixes.

Recommendations
- Status of Previous Recommendations. The Army addressed one of the three previous recommendations; however, the following remain outstanding:
  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. Determine if there is a valid requirement for Q-53 radar performance against threat munitions fired in volleys.
- FY14 Recommendations. The Army should:
  1. Continue to investigate the cause of the high-false target rates observed in the IOT&E.
  2. Continue to test and improve the radar's cyber defenses.
  3. Continue to improve the radar's capability of detecting volley-fired projectiles in both 90- and 360-degree modes.