Q-53 Counterfire Target Acquisition Radar System

Executive Summary

- In June 2015, the Army conducted the Q-53 radar IOT&E 2 at Yuma Proving Ground, Arizona. Soldier crews operated two Q-53 radars during five, continuous 72-hour record test scenarios observing mortar, artillery, and rocket fires. Soldiers conducted counterfire operations based on the tactical scenario.
- The Q-53 is operationally effective for single-fired rocket, artillery, and mortar munitions. The Q-53 is not operationally effective for volley-fired mortar munitions.
- The radar will report false targets when no projectiles are in the search area. A false target occurs when the radar determines that a threat weapon is firing, when none is present.
- The radar is required to characterize projectiles as a mortar, artillery, or rocket fire. The radar correctly characterized every single-fired mortar shot as a mortar. The radar often mischaracterizes single-fired rockets and artillery as mortars.
- The Q-53 demonstrated an operational availability of 0.99 during IOT&E 2 (0.95 required) indicating the radar is operationally suitable. The demonstrated performance of the Q-53 during IOT&E 2 indicates it is not meeting reliability or maintainability requirements.
- The Q-53 has improved cybersecurity from IOT&E 1 and is survivable.
- In October 2015, DOT&E submitted an IOT&E report detailing the results of testing.
- The Army Program Executive Officer for Missile and Space will make a Full-Rate Production decision in November 2015. The Army intends to procure 136 Q-53 Program of Record radars.

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 search sector.
- The Army intends the radar to provide target location for 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, target acquisition batteries in Field Artillery Brigades and Division Artillery headquarters to replace the legacy AN/TPQ-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 procure 136 Program of Record Q-53 radars.

Mission

Field Artillery units employ the Q-53 radar to protect friendly forces by determining the 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 Training – Syracuse, New York

Activity

- Based on IOT&E 1 conducted at Yuma Proving Ground, Arizona, in May 2014, the Program Executive Officer for Missiles and Space decided to postpone the Full-Rate Production decision to November 2015 and conduct a second IOT&E in June 2015. The radar did not meet false target rate requirements, reliability requirements, cyber vulnerabilities, and had low probability of detection against volley-fired munitions during IOT&E 1.

- The Army completed Developmental Test Phase 5 from January through February 2015. Testing focused on software changes that addressed deficiencies discovered in IOT&E 1.
- The Army completed a developmental capstone event in March 2015. The Program Office designed the capstone event to be similar to IOT&E 2. The test used Soldier crews operating for four, 72-hour vignettes. Units deployed the radars in the 90-degree and the 360-degree modes.
- In May and June 2015, the Army conducted the Q-53 IOT&E 2 at Yuma Proving Ground, Arizona, in accordance with the DOT&E-approved Test and Evaluation Master Plan and test plan.
  - Soldier crews operated two Q-53 radars during a 48-hour pilot test and five, 72-hour record test scenarios observing mortar, artillery, and rocket fires.
  - The radars operated in 90- and 360-degree modes throughout IOT&E 2.
  - Army electronic warfare and cyber teams conducted attacks against the test unit during one 72-hour period.
- DOT&E submitted the Q-53 IOT&E 2 report in October 2015 and is working with the Army to develop the scope and details of all follow-on testing.

Assessment

- Based on IOT&E 2 results, DOT&E assessed the following:
  - The Q-53 is operationally effective for single-fired munitions and volley-fired artillery. The radar is not effective acquiring volley-fired mortars. Volley-fire is a common technique used by a variety of threat nations and an important component of an operational evaluation for the counterfire radar.
    - The Q-53 consistently and accurately detects single-fired munitions and volley-fired artillery.
    - For volley-fired weapons, the Q-53 provided consistent counterfire acquisitions for artillery projectiles while operating in the 90-degree modes.
    - The radar had problems acquiring volley-fired mortars in 360-degree and 90-degree modes and volley-fired artillery in the 360-degree mode. Volley-fired rockets were not tested. The radar does not characterize artillery and rockets properly. After acquiring a projectile, the radar is required to characterize the projectile as mortar, artillery, or rocket. The radar characterizes mortars correctly, but often mischaracterizes rockets and artillery as mortars. Incorrect characterizations could result in ineffective counterfire missions. The Program Office is investigating ways to improve Q-53's ability to characterize projectiles.
    - The Q-53 met false target rate requirements for the 360- and 90-degree normal operating modes, but not for the 90-degree short range optimized mode. While in the 360-degree, 90-degree normal, and 90-degree short range optimized modes, the radar averaged, 0.5, 0.7, and 6.6 false targets per 12 radiating hours, respectively. The Army requires the Q-53 radar to have no more than one false target location per 12 radiating hours. Operators are not able to distinguish between real and false targets, which can result in wasted counterfire missions and loss of confidence in the radar. When operating near an air station in IOT&E 2, the Q-53 had high false target rates while in the 90-degree normal operating mode. These rates are likely due to activity at the air station. The Program Office is investigating ways to reduce Q-53's false target rate.
    - The test did not include 240 mm rockets or 122 mm cannon artillery. These munitions will be addressed in FOT&E.
    - In the 90-degree modes, the radar incorrectly uses Digital Terrain Elevation Data to calculate the terrain mask, causing some projectile trajectories to travel below the radar beams. During IOT&E 2, 18 of 188 threat missions experienced this deficiency. The conditions under which this deficiency occurred are terrain dependent and may occur in mountainous terrain. The Program Office discovered this problem in developmental testing prior to IOT&E 2. The Program Office has developed a fix and are testing it.
  - The Q-53 is operationally suitable primarily due to its high operational availability. During IOT&E 2, the Q-53 radar was available for 496 of 500 hours (99 percent). This exceeded the 95 percent availability requirement.
    - The demonstrated performance of the Q-53 radar during the IOT&E 2 indicates that the program is not meeting reliability and maintainability requirements. The radar did not meet the reliability requirement because of the total number of failures.
    - The four hours of down time were the result of eight system aborts. Although the radar experienced more system aborts than allowed by the requirements threshold, the downtime for most aborts was small. The majority (5 of 8) of the system abort failures were software-related and five of the aborts required less than 30 minutes to resolve. The Q-53 is survivable and demonstrated significant improvement over cyber vulnerability from the IOT&E 1 in May 2014.

Recommendations

- Status of Previous Recommendations. The Army addressed two of the three previous recommendations. However, the Army still should improve the radar's capability of detecting volley-fired projectiles in both 90- and 360-degree modes.
- FY15 Recommendation. The Army should:
  1. Conduct an FOT&E to address 122 mm cannon and 240 mm rocket performance, as well as changes to improve false target rates, false target rates near air stations, volley-fire detection, characterization, cybersecurity, and generator replacement.