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TPQ-37(V) - Archived 9/2008

Outlook

- With delivery of final TPQ-37 for India, production of system has been completed
- The United States has begun development of replacement for FIREFINDER system, called the Enhanced TPQ-36, or EQ-36
- Funding for spare parts, maintenance, and upgrades should continue, as there are many systems in service around the world; however, the United States will begin phasing out their systems when new radar becomes operational
- If there are no new developments, this report will be archived in 2008

Orientation

Description. The TPQ-37(V) is an artillery-locating radar, which operates as part of the FIREFINDER system.

Sponsor

U.S. Army
Communications-Electronics Command (CECOM)
PEO - IEW-FIREFINDER
Ft. Monmouth, NJ 07703-5000
USA
Tel: + 1 (201) 532-2534
Web site: <http://www.monmouth.army.mil>

(Project Manager)

Status. In service/FMS procurement/modification.

Application. Locate enemy artillery and rocket units to allow counterfire; register friendly fire. FIREFINDER is organic to separate infantry and armor brigades, the target acquisition battery at division artillery, and/or corps target acquisition detachments.

Price Range. Approximately \$4 million to \$6 million each, depending on requirements.

Contractors

Prime

ThalesRaytheonSystems	http://www.thalesraytheon.com , 1801 Hughes Dr, PO Box 34055, Fullerton, CA 92834-9455 United States, Tel: + 1 (714) 446-3118, Fax: + 1 (714) 446-3260, Prime
Northrop Grumman Defense Systems Division	http://www.dsd.es.northropgrumman.com , 600 Hicks Rd, Rolling Meadows, IL 60008-1098 United States, Tel: + 1 (847) 259-9600, Fax: + 1 (847) 870-5705, Email: contact_dsd@ngc.com , Consortium Member

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TPQ-37(V)

Technical Data

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Weight		
Antenna trailer (excluding generator)	1,362 kg	3,000 lb
Operating shelter	1,135 kg	2,500 lb
Size		
Antenna	3.3 x 2.1 m	11 x 7 ft
Antenna height	3.6 m	12 ft
Characteristics		
Frequency	2 to 8 GHz	
Power	45 kW avg	
Range		
Artillery/mortars	30 km	18.6 mi
Rockets	50 km	31 mi
Accuracy		
Mortars	35 m or 0.4% range	
Artillery/rockets	35 m or 0.65% range	
Antenna		
	Phase scanning	
	2 deg x 1.7 deg pencil beam	
Beamwidth		
Elevation	0.6 deg	
Azimuth	0.9 deg	
Coverage angle		
Elevation	90 deg	
Azimuth	360 deg	
Sector scan	60 deg	
Target capacity		
	Locate 10 simultaneously	
	Store 100 targets	
Emplace time	30 min	
Displace time	15 min	
Distance from FLOT	8 to 12 km	5 to 7.4 mi
Operators	12	
Operational readiness		
Active Army	91%	
Army Reserve	86%	
Generator	60 kW	

Design Features. The TPQ-37(V) is a coherent, electronically scanned, range-rated pulse Doppler radar that generates accurate location information on artillery and/or rockets at extended ranges. The radar has a flat vertical antenna that sweeps pencil-shaped radar beams along the horizon. The limited-scan phased-array antenna is made up of 360 diode phase shifters, each controlling six radiating elements arrayed in a vertical line. Each phase shifter can handle 4 kW peak and 165 W average power.

The system combines a phased-array radar and sophisticated signal processing for the detection, verification, and tracking of projectiles and the extrapolation of track data to determine the point from where a projectile was fired. The computed map coordinates are sent to the tactical fire-control system as the computer memory stores target locations for

display/counterbattery purposes. Once the target's location has been determined, the position of the hostile fire is automatically transferred to the field artillery's Tactical Fire Control (TACFIRE) system. The radar can also register friendly counterfire and generate targeting adjustments.

The radar emits a "fence" of pencil-shaped beams that sweep over a 90-degree sector of the horizon several times a second. A verification beam is transmitted when an object passes through the beams. When the radar notices a target, it generates tracking beams and performs trajectory computations. The TPQ-37(V) uses the path of the projectile to correlate the position of the launcher. At the same time, the radar continues to scan for other targets. The TPQ-37(V) was the first tactical radar with an antenna to incorporate phased-array scanning in both elevation and azimuth.

TPQ-37(V)

The TPQ-36(V) and TPQ-37(V) use different hardware and software, although the original operations shelter is identical to that in the TPQ-36(V)⁵. The TPQ-37(V) radiates more power with a larger antenna because of the longer range at which it operates. The incoming round must be picked up farther away. The antenna's multiple track channels track each shell for a few seconds to determine firing position. Since artillery shells have a low trajectory, the TPQ-37(V) has a high-performance clutter rejection capability to distinguish the target echoes from ground and sky clutter.

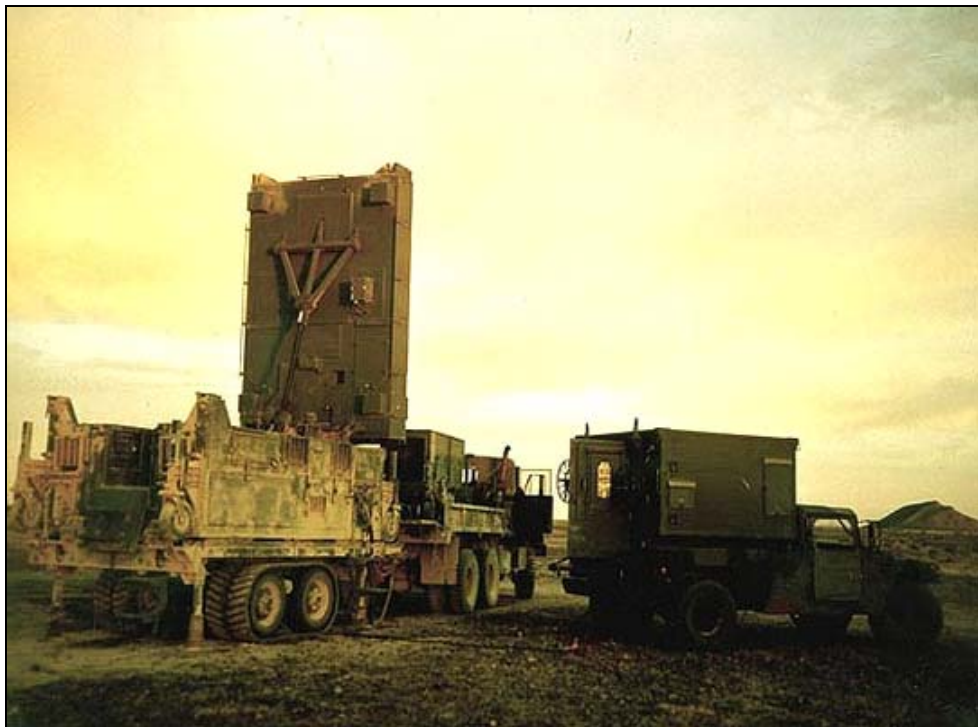
Extensively refined discriminants are applied throughout the tracking process to give a high probability of location with a low false location rate. The TPQ-37(V) can handle dense barrages without operator assistance.

The TPQ-37(V) consists of two vehicles and an antenna trailer. A 5-ton vehicle carries the 60-kW generator and

pulls the antenna trailer. The operations shelter is mounted on another 5-ton vehicle. The system has a crew of 8 to 12 men, but one operator can handle normal operations. It is transportable by land or by air, in fixed-wing aircraft or by helicopter.

Operational Characteristics. The TPQ-37(V) radar gave the U.S. Army its first capability to locate hostile artillery and rocket launchers at their normal firing ranges. It is able to locate weapons firing simultaneously from multiple positions and can also register and adjust friendly fire.

Three TPQ-36(V) and two TPQ-37(V) radars form a typical Division Artillery's Target Acquisition Battery FIREFINDER system. The TPQ-37(V) is positioned farther back to locate opposing longer-range artillery. It is typically fielded 4.3 to 5.4 nautical miles (8 to 10 km) behind the forward edge of the battle area. There are usually two TPQ-37(V)s to each division sector.



TPQ-37(V)

Source: Raytheon

Variants/Upgrades

Ongoing upgrade efforts have focused on general operational improvements to overcome identified deficiencies. Operational software changes have improved the use of meteorological data.

TPQ-37(V)3. The Operations Control Group is mounted on an M-35 truck. This is the standard FMS version.

TPQ-37(V)

ATG Mobility Improvement Program. This upgrade was initiated in response to mobility problems encountered during Operation Desert Shield/Storm. Problems included difficulties moving the trailer through sand and improper tracking of the trailer behind the prime mover – an especially troublesome trait in the high-speed travel that characterized force maneuvers in the Persian Gulf War.

A variant of the M-200 trailer tracked-suspension system was adapted to the M1048 ATG trailer. The primary elements of the modification were a walking beam suspension and reinforced rubber belts that wrap around dual idler tires on the trailer. These improve on-road travel and mobility through soft dirt, mud, and sand. The wider trailer footprint improves off-road use and does not degrade performance on paved surfaces. It has better side-slope capability and requires less horsepower from the prime mover, which tows the trailer.

TPQ-37(V)8 Enhanced FIREFINDER, Block I. This incorporates mechanical upgrades that improve reliability, availability, and maintainability. Software improvements include reduced false location reports and a long-range mode. Special features include an improved cooler, a C-130 transportability kit, a MAPS-Self survey, a separate tape for long-range software, and a survivability kit. The system is strategically deployable.

TPQ-37(V)9 Enhanced FIREFINDER, Block II. This features electronics upgrades that nearly double the range. It also upgrades the antenna/transceiver group and incorporates the TPQ-36(V)8 operation central.

FIREFINDER P³I. The Army is developing an upgrade that would double the range performance and improve target throughput to 50 targets per minute. The design would ensure that the system is mobile, transportable, and survivable. The upgraded system would be capable of detecting missiles at a range of 150 to 300 kilometers (81 to 162 nm), depending on radar cross-section. The P³I system will have to be capable of simultaneous transmission of target launch-point location and trajectory vector-cue information to theater missile-defense assets, such as JSTARS.

In its request for concept papers, the Army emphasized non-developmental approaches, including the replacement of the current antenna/receiver group and incorporating the TPQ-36(V)8 operational central shelter. For transportability, the new system would have to be drive-on/drive-off using a C-130 transport. The crew is reduced from 12 to nine.

This system was at first designated the TPQ-47(V), but that project has since been canceled in favor of the Lightweight Counter Mortar Radar.

Program Review

The TPQ-37(V) program began in FY73. In December 1976, an Army Systems Acquisition Review Council (ASARC) approved low-rate production. The Army conducted production acceptance testing on the first 10 limited procurement systems in 1980 and 1981. A full-scale production contract was awarded in May 1981 and completed in 1986. Fielding of the system was completed for the Regular Army in October 1990. Fielding to the Reserve components was completed in March 1991.

With tensions escalating on the Korean Peninsula over North Korea's nuclear program, Secretary of Defense William Perry initiated a South Korean military equipment upgrade, in 1994, including nine FIREFINDER systems to supplement the two South Korea already had. The units came from existing U.S. stocks.

In November 1995, Israel signed a contract to procure two TPQ-37(V) counterbattery FIREFINDERS. A similar notice of an intended Greek purchase was released in May 1996.

Success in the Balkans

The TPQ-37(V) supported operations in Yugoslavia in early 1999. Data collected by radar proved invaluable in identifying targets for attack. Officials said the TPQ-37(V) was finding between 5 and 15 targets a day and forwarding the coordinates to the Battlefield Control Element, the Army's liaison unit in the NATO Combined Air Operations Center. Operations combined Q-37 and Hunter UAV data to develop targeting plans and monitor the success of operations. An estimated 20 percent of the total targets selected by Task Force Hawk were the result of FIREFINDER and Hunter data. Analysts were credited with making extraordinary target determination because of these high-quality inputs and their ability to track enemy units in detail.

The March 2001 RITEC, Simi Valley, California, upgraded 100 currently fielded printers with new commercial off-the-shelf (COTS) printer hardware. The military printer being used was based on an electrosensitive technology that required a specialized print head and specialized paper.

FIREFINDER in an Integrated System to Destroy Mobile Missile Launchers

As the Pentagon developed its Battlefield Operational Concept for FIREFINDER, the focus was on an end-to-end system for destroying mobile missile transporter-erector-launchers. This system would use all possible surveillance and reconnaissance assets. The TPQ-37(V) FIREFINDER was used successfully in the Precision/Rapid Counter-Multiple Rocket launcher advanced technology demonstration (ATD), as discussed in the 1997 *Emerging Operational Concept Report*. As such, FIREFINDER is considered part of the battlefield-wide Rapid Targeting System being developed and implemented. It joined sensors like JSTARS, the U-2, and UAVs as inputs to the command and control system.

In late February 2002, the Defense Security Cooperation Agency (DSCA) and the Army Security Assistance Command (USASAC) sent a team to New Delhi to open government-to-government discussions on this system.

India signed an agreement with the U.S. to buy eight TPQ-37(V) FIREFINDER counterbattery artillery radars with related support, including generators, trailers, communications equipment, training, and logistics services.

Problems Arise but TPQ-37 Continues to Soldier on

In early 2005, the Army decided to terminate the TPQ-47(V) follow-on FIREFINDER radar because of line-of-sight problems in the urban environment. Developers will concentrate instead on the Lightweight Counter Mortar Radar.

Despite these problems, the TPQ-37 is still the main indirect fire-locating radar in U.S. military inventory. Therefore, the Army has contracted ThalesRaytheon Systems to supply \$220 million worth of spare parts. The total amount of parts adds up to 18,500, with 150 part types. This includes parts for the TPQ-36 as well.

Current projects also include a fire-support digitization project. The project will improve connectivity by replacing the versatile computer unit (VCU) with a MILTOPE TSC 750-M laptop computer. Money is also procured to field and integrate the radar into Stryker Brigade Combat Teams. Each brigade will receive one radar. In addition, TPQ-37(V)6s will be upgraded to the (V)8 standard. This includes mechanical upgrades to the cooler and dehydrator to improve reliability, availability, and maintainability (RAM). The new version will also allow the removal of the antenna to make transportation easier. A modular azimuth positioning system (MAPS) will also be included for self-survey capability.

EQ-36 to Replace FIREFINDER

The TPQ-37 has had some difficulties in the asymmetric warfare environments found in Iraq and Afghanistan. The system is not designed for urban warfare against insurgents. It was designed during the Cold War to counter massed Soviet armored divisions on the battlefields of Europe. For this reason, the U.S. Army is developing the Enhanced TPQ-36, or EQ-36, which will replace both the TPQ-36 and TPQ-37 that make up the FIREFINDER system. The EQ-36 will be more ideally suited to modern warfare.

Significant News

India Receives Final TPQ-37 – In March 2007, India took delivery of the final TPQ-37 radar, which was part of an order for 12 systems signed in 2002. The contract was worth about \$200 million and in addition to the systems, included generators, trailers, communications equipment, logistics services, quality assurance, spare parts, and other support. (Bharat Rakshak, 4/07)

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TPQ-37(V)

Funding

	U.S. FUNDING							
	FY06 <u>QTY</u>	FY06 <u>AMT</u>	FY07 <u>QTY</u>	FY07 <u>AMT</u>	FY08 <u>QTY</u>	FY08 <u>AMT</u>	FY09 <u>QTY</u>	FY09 <u>AMT</u>
Procurement (U.S. Army)								
PE#0204154N								
TPQ-37 Upgrades (BZ7325)	-	7.2	-	23.1	-	6.5	-	-

All \$ are in millions.

Source: FY2008 U.S. Budget Documents

Contracts/Orders & Options

(Contracts over \$5 million.)

<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
Northrop Grumman	7.5	Apr 2004 – Mod to FFP contract for various spare parts for FIREFINDER TPQ-36(V) and TPQ-37(V). Completed September 2005. (DAAB07-02-C-H302)
Thales Raytheon Systems	30.6	Apr 2004 – FFP contract for various spare parts for FIREFINDER TPQ-36(V), TPQ-37(V), and TPQ-47(V). Completed April 2005. (W15P7T-04-L002)
Northrop Grumman	5.0	Apr 2004 – Mod to FFP contract for various spare parts for TPQ-36(V) and TPQ-37(V). Completed September 2005. (DAAB07-02-H302)
Thales Raytheon Systems	13.2	Oct 2004 – Mod to an FFP contract for 106 various spare parts for the FIREFINDER TPQ-36(V), TPQ-37(V), and TPQ-46(V). To be completed November 2008. (W15P7T-04-C-L002)
Raytheon Technical Services	26.0	Dec 2004 – Delivery order as part of a time and material contract for inspection, evaluation, and overhauling of redeployed FIREFINDER radar systems. (DAAB07-00-D-H004)
Thales Raytheon Systems	12.1	Dec 2004 – Mod to an FFP contract for 106 various spare parts for the FIREFINDER TPQ-36(V), TPQ-37(V), and TPQ-46(V). To be completed April 2008. (W15P7T-04-C-L002)
Thales Raytheon Systems	6.8	Feb 2005 – Mod to an FFP contract for 28 spare parts in support of the FIREFINDER TPQ-36(V), TPQ-37(V), and TPQ-46(V). Completed June 2005. (W15P7T-04-C-L002)
Thales Raytheon Systems	62.0	Mar 2005 – Mod to an FFP contract for 3,500 deliverable spare parts of more than 100 part types for the FIREFINDER TPQ-36(V), TPQ-37(V), and TPQ-46(V). To be completed April 2008. (W15P7T-04-C-L002)
Raytheon Technical Services	13.8	Aug 2005 – Delivery order as part of a time and material contract to rebuild three TPQ-37 and two TPQ-36 radars. To be completed September 2007. (DAAB07-00-D-H004)

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Jun	1972	Mission Needs Statement approved, two-contractor (Sperry, Hughes) competitive validation phase program initiated
	1974	Advance Development Model live-fire test
Nov	1975	DT/OT
Dec	1976	Authorization of low-rate initial production, 10 radars
Nov	1979	First three units delivered to the U.S. Army
Feb	1981	Full-scale production contract awarded
Feb	1983	IOC Europe
Jul	1983	IOC Korea
Feb	1984	IOC FORSCOM
Feb	1986	U.S. Army production completed
	1988	FAA borrows TPQ-37(V) from California National Guard for installation in Los Angeles Traffic Control Area to test the radar's capability to detect non-transponder-equipped aircraft in the Terminal Control Area
Apr	1992	Last U.S. units fielded
Oct	1992	Block I approval, award of delivery order, basic kit start
3Q	FY93	Survivability suite start
Apr	1994	Mobility Improvement Program Milestone III
Jul	1994	Mobility Improvement Program production contract award, Block I production decision
4Q	FY94	Survivability Suite design review and contract award
2Q	FY95	P ³ I ORD approved
3Q	FY95	Delivery of two A and B kits for survivability suites
4Q	FY95	Block I production complete, fielding begins; Survivability Suite user evaluation
Sep	1996	P ³ I Mission Needs Statement approved
4Q	FY96	Block I fielding completed
2Q	FY98	P ³ I solicitation release
May	1998	Contract for next-generation FIREFINDER (TPQ-47) awarded
Feb	2002	India signs contract to procure eight TPS-37(V)s
Feb	2005	FY06 budget reveals termination of follow-on radar (TPQ-47(V)) development
	2009	End of funding for TPQ-37

Worldwide Distribution/Inventories

Systems are known to be operational in the following nations: **Australia, Canada, China, Egypt, India, Israel, Greece, Jordan, the Netherlands, Pakistan, Saudi Arabia, South Korea, Singapore, Spain, Thailand, Turkey,** and the **U.S.**

Forecast Rationale

The TPQ-37 has served successfully in the U.S. Army for many years. However, its lifespan is coming to an end. Battles in Iraq and Afghanistan have revealed the system's shortcomings, and so the U.S. Army has begun to develop a replacement.

The development of a replacement system, along with the final deliveries of the TPQ-37 to India, indicates that new production is unlikely. However, countries that already operate the TPQ-37 will continue to do so for many years to come. This will fuel production of spare parts, maintenance contracts, and logistics services.

TPQ-37 Expected to Begin Phase Out of Service in 2010

The United States will begin to phase the TPQ-37 out of service once the EQ-36 becomes operational and begins entering service. Most likely, that process will begin around 2010. It is also likely that the system will remain in the arsenals of other countries much longer than the United States. Although money is going into maintenance and upgrades, it is not expected to be significant. Because no new production is expected, this report will be archived in 2008.

TPQ-37(V)

Ten-Year Outlook

No production expected at this time. This report will be archived in 2008.

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