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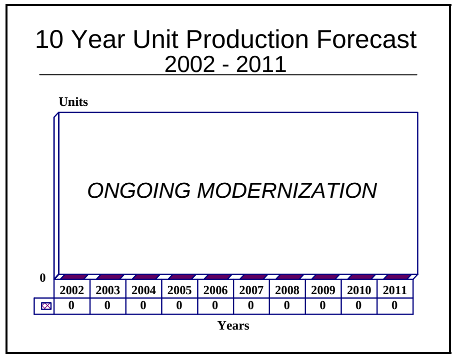
TPS-75(V) – Archived 03/2003

Outlook

- Key US battlefield sensor
- In service, with ongoing logistics support and upgrades
- System shelter replacement and missile tracking upgrade programs under way
- Taiwan to upgrade four TPS-43Fs



Orientation

Description. A land-based, long-range, transportable 3D tactical radar.

Sponsor
US Air Force
Electronic Systems Center
ESC/PAM
Joint Program Office
Hanscom AFB, Massachusetts (MA) 01731-5000
USA
Tel: +1 617 377 5191
Web site: http://www.hanscom.af.mil
(Program Manager, TACS Improvements)

Contractors
Northrop Grumman Corp
Electronic Sensors & Systems Division
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Baltimore, Maryland (MD) 21203-7319
USA
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Status. In service, ongoing logistics support, upgrade efforts continue.

Total Produced. An estimated 67 TPS-43(V) radars were upgraded to the USAF TPS-75(V) standard. A total of 213 TPS-43/70/75(V) radars were produced.

Application. Lightweight, air-transportable 3D radars designed for deployment as part of the 407/485L Tactical Air Control System (TACS) or similar air control systems.

Price Range. The estimated cost of the TPS-75(V) is US$8.3 million.

Price is estimated based on an analysis of contracting data and other available cost information, and a comparison with equivalent items. It represents the best-guess price of a typical system. Individual acquisitions may vary depending on program factors.

Technical Data

	Metric	US
Dimensions		
Weight		
Shelter module	3,814 kg	8,400 lb
Antenna module	3,360 kg	7,400 lb
Antenna	3.4 x 5.5 m	11 x 18 ft
Characteristics		
Frequency	2,900-3,100 MHz in 16 discrete steps (with pulse-to-pulse agility)	
Power output	2.8 MW peak 4.7 kW average	
Transmitter tube	Linear beam twystron (wideband amplifier)	
Pulse duration	6.8 µsec +/- 0.25µsec	
PRF	235, 250, 275 pps +/- 0.5 Hz, and two selectable average PRFs; 250 and 275 staggered. For each staggered selection, the transmitter operates sequentially on one of seven PRFs	
Instrumented range	444 km	240 nm
Data rate	9.4 s ± 10%	
Track capacity	500 simultaneous auto initiate, auto update	
Noise figure	4.5 dB	
IF frequency	32 MHz	
IF band width	1.6 MHz	
Dynamic range	90 dB (receivers & STC)	
STC	0 to 46.5 dB	
A/D converter	12 bit, 4 MHz sample rate	
Receiver channels	7 with automatic switching and redundancy	
MTI improvement factor	50 dB (all beams, full range)	
Small target probability of detection (1.7 $m^{2)}$	75%	
P_{FA}	75%	
Range accuracy	107 m	350 ft
Azimuth coverage	360° (operator-controlled blanking optional)	
Scan rate	6.5 rpm	
Elevation coverage	0.5° -20° above radar horizon	
Altitude coverage	0-95,500 ft (29.1 km)	
Antenna gain	Transmit, 36 dB; receive, 40 dB	
Azimuth beam width	1.1°	
IFF azimuth beam width	4.0° (or sum/difference ISLS antenna)	
Accuracy		
Range	107 m	350 ft
Bearing	0.22°	
Height (@100 nm)	± 457 m	± 1,500 ft
Resolution (2m^2 target)		
Range (50% probability)	490 m	1,600 ft
Bearing (50% probability)	2.4°	
MTBF	600 to 1,000 hr	

Characteristics (continued)

MTTR	0.5 hr
Operational availability	>99%
Digital signal processor	
Type	Microprocessor controlled Parallel signal processing Separate in each channel
MTI processing	4-pulse, I&O in each channel, full range burst mode for anomalous propagation
Automatic radar height	Target height simultaneous with detection Unlimited capacity Height in clutter Environmentally adapted height corrections
ECCM	Ultra-low sidelobe antenna (ULSA) Coded pulse anti-clutter system (CPAS) Frequency agility (programmed/random) Jamming analysis transmission selection (JATS) PRF stagger Precision jam sidelobes for triangulation Cool antenna to reduce IR signature Enhanced ARM resistance Instantaneous radar silence – remote control available
IFF system	Interrogator sidelobe suppression (ISLS)
Modes	1, 2, 3, C Active/passive decode (UPA-59)
Antenna	Sum-difference
Beam width	4°
Prime power	400 Hz 3-phase 120/208 V
Transport	Single C-130 Hercules transport aircraft, two M 35 trucks, two sets of transporters or two helicopter loads
Siting requirements	6 by 10.5 m clear area on slope of 10% or less
Reaction time	50 min with a six-man team
Wind resistance	Operate to 52 kt, survive 92 kt (tied down)
Operating temperature	-40 to 125° F
Outputs	3,120 m cables with storage reels
Operations centers PPI	Two operational positions featuring UYQ-509 color raster displays, digital height readouts and active/passive IFF decoders. Each position also has an access to built-in UHF ground/air communications and HF point-to-point communications facilities

Design Features. The TPS-75(V) houses the receiver, a transmitter, and monitoring equipment in a shelter, with the fold-away antenna and mounting pedestal on a pallet. The TPS-75(V) is the latest variant of the original TPS-43(V), and consists of the ultra-low sidebar antenna (ULSA), updated electronics, and digital displays retrofitted to existing TPS-43(V) systems. The radar interfaces with the GSQ-120(V) radar remoting system, which transmits the radar inputs/ outputs to both the TSQ-91(V) and TSQ-61(V) operation central. It is in use with the US Air Force.

This variant uses a stripline matrix to produce a fan of multiple receive beams rather than a single "pencil beam." The multiple beams provide elevation data while physical rotation is used for azimuth scanning. This allows for increased target illumination per antenna scan. The low sidelobe antenna has a receive beam width of 1.1 degrees and varies in elevation to provide a total 20° of elevation coverage.

The digital signal processor is microprocessor controlled with parallel signal processing in each channel. The simultaneous-beam design provides the time needed per target to perform effective signal processing in a heavy clutter environment. The data output can be sent directly to automated air defense systems.

A low sidelobe antenna is used to discriminate against stand-off jamming and reduce the threat of anti-radiation missiles. The transmitted signal is frequency agile (random or programmed) and has jamming analysis transmission selection (JATS). The pulse repetition frequency (PRF) is staggered, and the receiver features a coded pulse anti-clutter system (CPAS). The system uses precision jamming strobe triangulation and a cool antenna to reduce the set's IR signature. Transmission can be silenced instantaneously by local or remote control. The design was tailored to be especially effective against stand-off jamming aircraft.

The IFF antenna provides sidelobe suppression for the interrogator. A small printed circuit reference antenna is mounted on the back of the radar feed to act as the radar sidelobe reference antenna; the JATS function uses it during the dead time between transmitter pulses. Later versions of the TPS-43(V) included a built-in programmable post-processor for target extraction and target tracking, and to forward data to automated command centers.

In 1980, the Air Force initiated the ninth upgrade to the TPS-43. This involved an ULSA which was designed to reduce the radar's susceptibility to jamming. Designated TPS-43E (ULSA), this version of the radar employed a 42-inch-wide, 4-foot-high dipole array with eight rows, each having 64 dipoles.

By 1981, the ULSA upgrade entered full-scale engineering development. Improvements included the addition of a new 11-foot x 18-foot antenna to reduce unwanted signals from other than the radar's main beam and make it more difficult for hostile aircraft to detect and jam the radar. The ULSA, combined with advanced signal analysis and processing electronics, increased radar range and sensitivity.

The new, flat-faced, rectangular antenna minimizes susceptibility to jamming and lowers the probability of detection by radar warning receivers. The antenna has greater instantaneous bandwidth, which facilitates the use of complex waveforms that are more resistant to countermeasures.

Operational Characteristics. The TPS-75(V) is used as an airspace control sensor. It interfaces with a tactical air control center and can detect inbound strike aircraft. It is a 3D radar producing azimuth, range and height information on all targets. It is ECCM-capable, and operators can control both air-to-air and air-to-ground operations, allowing commanders to exercise effective control over assigned air forces.

The transportable system moves with the combat force. The radar can be erected in one hour and disassembled in 30 minutes. To facilitate air shipment, the system divides into two pallet loads, each of which can be accommodated by a C-130 transport. For road travel, each pallet can be loaded onto an M 35-size military truck.

Radar data are sent to data processors which drive operator displays that can be tailored based on the mission at hand. The radar range and video processing were tailored to maximize target pickup and tracking under a variety of weather and electronic jamming situations. Until the development of the E-3A Airborne Warning and Control System, this was the prime frontline air control sensor for the Air Force.

TPS-75(V) Battlefield Radar

Source: Northrop Grumman

Variants/Upgrades

TPS-43E. The basic radar with the ULSA.

TPS-43E2. This was an enhanced version planned for the advanced tracker system. The program was canceled.

TPS-70. A slightly modified export version of the basic radar.

TBM Capabilities Development. To accommodate an expanding role in theater missile defense, UYQ-509(V) displays and Expert Missile Trackers (EMTs) were incorporated in FY95. In mid-1995, the Air Force awarded a contract to develop a prototype theater missile tracker and correlator prototypes. EMT modification kits will consist of a radar missile tracker and a correlator kit. These systems will establish and display the trajectory, launch point, impact point, heading, missile type, and time-to-impact of tactical ballistic missiles based on data from the radar. Both three-dimensional and tabular displays are used. Plans to move into full engineering and manufacturing development (EMD) were announced in July 1999.

P^3I. Preplanned Product Improvement refers to the development of a solid-state transmitter for the radar to reduce costs. P^3I efforts also include the provision of system engineering support to the System Program Office.

Program Review

Background. The TPS-43(V) went into production in 1966, with initial deliveries in 1970. By 1980, large numbers of the radar were in use with both American and foreign services. A continuous product improvement program developed no fewer than eight generations of the radar by 1980, making the unit one of the most widely used transportable tactical surveillance radars in the West.

In October 1983, the Royal Australian Air Force (RAAF) contracted for a rewiring of the RAAF TPS-43(V) radar sites with fiber-optic cables. This increased the allowable distance between the radars and operating shelters from about 15 feet to up to 2 kilometers, greatly enhancing operator safety (a prime RAAF concern).

On March 5, 1984, Westinghouse received a contract to upgrade the communications shelters and remote display equipment for Saudi Arabia’s Radar Defense Complex.

In FY88, Westinghouse produced and stored 19 ULSAs and began retrofitting the first of the US units. The ULSA and updated electronics package were installed only on US radars.

In November 1989, the Air Force solicited the development of an anti-radiation missile decoy system to protect battlefield radar assets. The specific system to receive the decoy units was the TPS-75(V). LTV Missiles and Electronics Group, Aydin Corporation Radar & EW Division, and ITT Gilfillan responded to the solicitation under the Seek Screen program.

In April 1990, ITT Gilfillan was selected for pre-production development; a delivery contract was awarded in July of that year. Developmental testing and evaluation was conducted at Eglin AFB, Florida, and an initial production contract was awarded in March 1993. Fourteen TLQ-32(V) ARM Decoy production systems were contracted and two preproduction systems were to be refurbished.

On April 22, 1994, the Air Force announced that it would award a contract to design, develop, integrate, test, install, and deliver theater missile defense kits to upgrade four TPS-75(V) radars and four TYQ-23(V) modular control equipment operations modules. These kits would be installed in the field since the radars and operations modules (OMs) are deployed worldwide.

The TYQ-23(V) kits are Unix-based workstations housed in ruggedized transit cases and located external to the Mission Control Equipment (MCE) OMs. They provide the ability to detect, track and identify theater ballistic missiles in real time using radar plot data; determine launch/impact points; display missile information to a radar operator; and transmit plot and track data via an encrypted tactical communications link to the TYQ-23(V) OM kit. Each radar kit is a form/fit/function replacement of an existing UYQ-27(V) console in the TPS-75(V). All current UYQ-27(V) functions are performed by the added console, and baseline TPS-75(V) functions and performance are not affected. Hardware and firmware changes to the baseline radar will be required.

In June 1995, the Air Force awarded the theater missile tracker prototype and correlator prototype awards to (then) Westinghouse. The development was planned to be completed by April 1997.

In an August 1995 *Commerce Business Daily*, the Air Force announced plans to award a contract modification for the purchase 20 additional Automatic Radar Evaluation System (ARADES) IV test sets, reserving the right to acquire more ARADES test sets in the future. The solicitation was made sole source to Northrop Grumman, Electronic Sensors & Systems Division.

During FY95, the Air Force completed a near-term availability assessment of solid-state, high-power devices for the TPS-75(V) solid-state transmitter. At the same time, Multiple Sidelobe Canceler (MSLC)/ Mainlobe Noise Canceler (MNC) development was completed.

The development of a tube-based transmitter was begun in FY96 and completed in FY97.

Radar System Shelter Replacement (RSSR) Acquisition. In August 1997, the USAF Electronic Systems Center awarded a contract to acquire new shelters for the TPS-75(V) radar system. Plans carried options for a production run of a minimum of two and potential total of 20 to 60 shelters. Three to 15 shelters would be produced per year over a five-year period.

The shelters are similar in design to the current S-280C/G shelter used by the US Army, but accommodate the RSSR dimensions and weight requirements. The shelters directly replace the shelters previously housing the TPS-75(V) radar, but the layout of the system equipment, the internal and external shelter dimensions, and the maintenance concept remain the same.

The exterior is 84 inches high x 87 inches wide x 177 inches long. The interior is 74.5 inches high x 81.5 inches wide x 168 inches long. The tare weight does not exceed 2,000 pounds and the payload is not less than 8,500 pounds. The unmodified shelter requires 60 dB of electro-magnetic interference shielding effectiveness.

In a March 2001 *Commerce Business Daily*, the Air Force announced that the Tactical Shelter Program Office at Ogden Air Logistics Center was seeking alternatives for the acquisition of a family of composite shelters. This will be the major part of the Tactical Shelter Modernization Program (TSMP). The government is refining an acquisition strategy for the TSMP, seeking a new family of tactical shelters that will meet the performance requirements outlined in the specifications for the TPS-75(V) system.

Under the specifications, non-corrosive composite materials would replace metal structural components. The TSMP envisions the purchase of approximately 600 tactical shelters between FY2003 and FY2007. The estimated procurement quantities by fiscal year are: FY03 - 50; FY04 - 75; FY05 - 125; FY06 - 150; and FY07 - 200.

Missile Tracking Upgrades. In March 1998, tests of two prototype Expert Missile Tracker systems were completed, and the systems were delivered to the Republic of Korea. The missile correlator is installed at the Hardened Tactical Air Control Center, Osan Air base, Korea.

In the July 15, 1999 *Commerce Business Daily*, the Air Force Electronics System Center announced plans for development of a Ground Theater Air Control System (GTACS) Theater Missile Defense system. Evolution of a Theater Missile Defense (TMD) capability for the GTACS was centered on using the TPS-75(V) radar set as the primary surveillance platform. Leveraging off experience gained from the HIGH GEAR and EMT prototype efforts, the US Air Force desires to move into EMD and production.

During the EMD phase, the contractor will:

- Modify the radar set to detect and track TBMs and perform Ground Control Intercept (GCI) within its surveillance volume, simultaneously, with no degradation of either mission.
- Re-host previously developed EMT correlator software to a DII COE platform. The correlator will be configured to integrate a minimum of five EMT radar inputs. Additionally, the correlator must accommodate expansion (i.e., incorporating TMD data from dissimilar [non-GTACS] sensors).
- Ensure the correlator provides TADIL B and TADIL J datalink output(s), with the capability to interface with the latest version of TYQ-23 Mission Control Equipment (MCE) as well as the TSQ-214(V) Air Defense System Integrator.
- Provide and integrate the capability to send plot data from the TPS-75 to the Battle Management Control and Command Centers, the FAA, and the Drug Enforcement Agency.
- Provide the first two production-model EMT radar mod kits and correlators.
- Support government-directed Initial Operational Test and Evaluation and field testing for the developed system.
- Develop the manufacturing capability to produce enough EMT radar modification kits and correlators to upgrade the entire GTACS radar fleet.
- Support a 24-month delivery schedule.

Upon successful completion of the EMD phase and system acceptance, the government intends to procure and field the system.

During the production phase, the contractor will:

- Support the installation of EMT radar kits and correlators in the field, both overseas and stateside.
- Develop and provide a technical data package and level-three technical drawings to allow for sustainment and re-procurement by the depot. This package must include text fixtures and test procedures.
- Develop Time Compliance Technical Orders (TCTOs) to support EMT modification kit installation, as well as changes to the baseline Technical Orders for the EMT radar.
- Provide initial operating spares, as well as readiness spares packages, for the developed system.
- Provide interim contractor support for the system prior to the establishment of a depot capability.
- Provide a Type 1 training program, both operator and maintainer, for the developed system.
- Update the Theater Command and Control Simulator facility to be able to participate in Operation Roving Sands and Operation ULCHI Focus Lens with a Theater Missile Defense System Exerciser.
- Support the prototype EMT systems located in Korea and CENTCOM until they can be updated with the EMT production system baseline configuration.

The anticipated EMT production quantity was 25 to 27 radar mod kits and 10 correlators.

According to a March 2000 *Commerce Business Daily*, the Combat Air Force Command and Control System Program Office, Electronic Systems Center, Hanscom Air Force Base, Massachusetts, anticipated release of Request for Proposal F19628-00-R-0020 for the TMD Missile Tracker System. A follow-on contract was to be awarded for EMD of the HIGH GEAR and EMT effort using the TPS-75(V) radar set and would be a sole-source contract with Northrop Grumman Corporation.

Funding

Funding is from O&M accounts.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Northrop Grumman	12.1	Oct 2000 – FFP contract to provide two missile tracking modification kits for the TPS-75(V) tactical radar. This effort includes EMD and preproduction testing of the modification kits. To be completed September 2002. (F19628-00-C-0013)
Raytheon Tech Services	2.5	Jun 2001 – Upgrade kits for FPS-75(V). (F42600-01-C-0019, F42600-01-R-0004 0001)
Northrop Grumman	87	Nov 2001 – Not-to-exceed FFP FMS contract for the upgrade of four TPS-43F Taiwanese Air Force radars to the TPS-75(V) configuration. To be completed November 2004. (F42600-02-C-0001)

Timetable

Month	**Year**	**Major Development**
	FY65	Initial study contracts awarded
	FY66	Contract definition phase contracts awarded
	FY66	Prototype production begins
	1970	Initial production deliveries
	1977	Foreign sales initiated
	1982	Advanced Tactical Radar (ATR) contract awarded
Apr	1984	USAF terminates efforts on ATR
Nov	1984	ULSA antennas enter production
Dec	1987	Delivery of first two TPS-75(V) radars
Sep	1990	ARM decoy contract awarded
	1994	Delivery of first production TLQ-32 ARM decoys
Jun	1995	Prototype theater missile tracker and correlator awards
Mar	1997	RSSR acquisition announcement
Apr	1997	Missile tracker and correlator prototype development complete, RSSR RFP
Aug	1997	Planned RSSR contract award
Mar	1998	Installation of two Expert Missile Tracker systems in Korea
Jul	1999	Notice of planned EMD and production of EMT-based GTACS
Oct	2000	EMD of missile tracking upgrade
Nov	2001	Taiwanese upgrade contract (four radars)
Sep	2002	EMD of missile tracking upgrade completed
Nov	2004	Taiwanese upgrades to be completed

Worldwide Distribution

According to the U.S. Department of Defense, the TPS-75 is deployed worldwide.

Forecast Rationale

The Air Force updated the radars to keep pace with emerging technology and ensure that the sensor was as capable as possible, with processing improvements picking up where the radar improvements left off. As a consequence, the TPS-43/75(V) has continued to set the standard for tactical radars. The ULSA modification and TLQ-32(V) ARM decoy overcome much of the anti-radiation missile threat, and enhancements to the Command Center processing will further enhance the capability of the TPS-75(V), ensuring many more years of active service.

When AWACS is available, radars such as the TPS-75(V) will fill secondary, backup or mission-limited roles in future combat. The tactical radars will no longer be deployed and operated as the primary battlefield sensor, but used as gap-fillers or for air traffic/flow control and coordination.

US production is complete, and no further TPS-75(V) radars are expected to be procured. However, upgrades will continue, many involving processing and software enhancements.

Efforts to create a netted battlefield TBM capability are receiving significant attention. These efforts will peripherally impact the TPS-75(V), as the radar is to be upgraded to accommodate new data processors and network requirements. With the first systems deployed to a hot-button area (South Korea), and the intense interest in protection of the battlefield from tactical ballistic missiles, the Air Force is making a statement that this will be an important upgrade for all radars. EMD plans indicate that testing was successful and that the TBM mission is being taken seriously.

The number of radars in operation will ensure an active spare and repair parts market. Upgrades and refurbishment activities will continue well into the 21st century.

Ten-Year Outlook

No further production expected.

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