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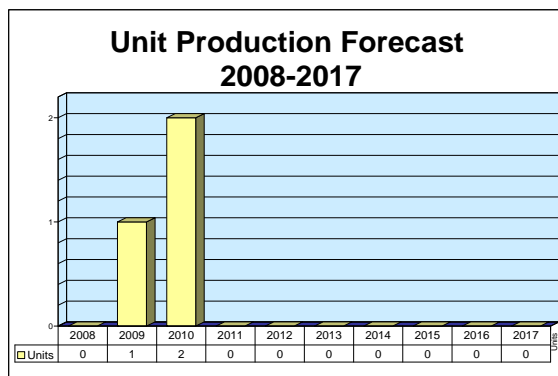
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FPS-117(V)/TPS-77(V)

Outlook

- The Danish Ministry of Defense has formally accepted two TPS-77 radars into service that were delivered under a contract signed in June 2006
- In December 2007, Lockheed Martin received a contract valued at \$44 million from Latvia for two TPS-77s, as well as options for long-term technical support
- Latvia contract includes options for up to four additional TPS-77 radars for Estonia and Lithuania



Orientation

Description. The FPS-117 is a long-range, 3-D search radar. The TPS-77 is a mobile version of the FPS-117.

Sponsor

U.S. Air Force
Electronic Systems Center
ESC/PAM
Joint Program Office
Hanscom AFB, MA 01731-5000
USA
Tel: + 1 (617) 377-5191
Web site: <http://www.hanscom.af.mil>
(Management)

Status. In service, ongoing logistics support.

Application. Air surveillance/defense with air traffic control applications.

Price Range. Based on recent contracts, the cost of a single TPS-77 ranges between \$14.6 and \$15 million.

Contractors

Prime

Lockheed Martin Ocean Radar & Sensor Systems

<http://www.lockheedmartin.com>, 6417 Deere Rd, Syracuse, NY 13206-1304 United States, Tel: + 1 (315) 431-4546, Prime

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Technical Data

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Antenna array	7.3 x 7.3 m	24 x 24 ft
Characteristics		
Performance		
Range	9.25 to 462.5 km \pm 46m	5 to 250 nm \pm 0.25 nm
Azimuth	360° \pm 0.18°	
Altitude	328,000 m	100,000 ft
Elevation angle	-6° to 20°	
RF (transmitter) characteristics		
Frequency	1,215 to 1,400 MHz	
Bandwidth	185 MHz	
Agility	20 frequencies (quasi-random selection, beam-to-beam)	
Type waveform		
Pulse width	51.2 μ sec (short range) 409.6 μ sec (long range)	
Power		
Total system	70 kW maximum	
Transmit power		
Peak	24.75 kW	
Effective radiated	125 MW	
Duty factor	16 percent maximum	
Power supply	28 volts	
FPS-117(V)		
MTBF	1,076 hr (required)	
MTTR	30 min	
Availability	99.6%	
TPS-117(V)		
MTBF	> 2,000 hr	
MTTR	30 min	
Availability	99.7%	
Periodic maintenance	35 hr/yr	
Process and control	Pre-processor MTI/Pulse compressor Doppler/Target processor Data processor Beacon/Target processor Data entry terminal Power supply equipment Operations control console P/M status display Target data display	
Operation control		

Design Features. The FPS-117(V) air defense radar is a solid-state, L-band, three-dimensional system that was designed to provide long-range aircraft detection and position data for air defense, navigational assistance, and tactical control for both counter-air operations and close air support. It is a fixed-site derivative of the TPS-59(V) tactical radar.

The planar antenna is made up of 44-row transceivers, 44-row feed assemblies, four-column feed assemblies, and 12-row power supplies. The exciter and final receiver are located in the platform electronics unit

mounted at the base of the antenna itself. The TPS-77(V) uses 34 solid-state transmitters and receivers located on the antenna array and directly coupled to their antenna elements. Both carry a separate monopulse beacon system with Mode 4 and Mode S Identification Friend or Foe (IFF) systems. The antenna is mounted on top of the radar sail.

The planar array produces a series of pencil beams phase-positioned to scan up to 20° in elevation while the complete antenna rotates. The elevation scan consists of 5- to 100-nautical-mile short-range beams, and 100-

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to 250-nautical-mile long-range beams. Through use of pencil beams, the radar provides elevation coverage while eliminating some of the clutter problems typically associated with CSC² beams.

The radar was designed for high reliability and can tolerate component failures, continuing to operate effectively. Downtime is put at less than 35 hours per year for corrective and preventive maintenance. The system has a 30-minute mean time to repair (MTTR). MTBF (mean time between failures) for each power module is over 300,000 hours, with the automated maintenance computer controlled using built-in fault isolation. An FPS-117(V) at King Salmon Airport in Alaska demonstrated an MTBF of 1,432 hours, exceeding the 1,076 hours specified in the contract.

The antenna array electronics of older systems have been upgraded. The changes capitalize on available commercial components and technologies.

Operational Characteristics. The FPS-117(V)/TPS-77(V) provides long-range, accurate aircraft detection and position data for early warning surveillance, and supplements air traffic control systems. Clutter rejection processing automatically adapts to or rejects land, sea, and weather clutter. MTI (moving target

indication) processing is used to enhance low-beam coverage and increase siting flexibility. Sidelobe nulling is used to eliminate ground clutter for the higher elevation beams.

The radars use a variety of interference rejection techniques. These include greater than 10 percent agile bandwidth, pulse-to-pulse frequency agility, low side-lobes, sidelobe blanking, MTI and constant false alarm rate processing, pseudo-random pulse repetition frequency, pseudo-random beam positioning, and a linear frequency-modulated waveform.

The system automatically adapts to changing ground and sea clutter environments, maintaining accuracy and target resolution capabilities under a variety of surveillance conditions. The data processor controls radar performance and monitors system status. Sweep-to-sweep and scan-to-scan correlation reduces false alarms and multiple reports.

The TPS-77(V) was tailored to be adaptable to a variety of siting situations. It can “look down” into valleys to detect low-flying aircraft in spite of severe clutter. Performance in rain and mountainous/forested locations is good.



TPS-117/77(V)

Source: Lockheed Martin

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FPS-117(V)

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Variants/Upgrades

FPS-117(E)1. The basic solid-state NATO Class 1 fixed-site radar.

FPS-117(E)1T. A transportable version, used in Croatia, that features most of the characteristics of the basic radar. Five Croatian systems interface with air traffic control centers. This version is modified to conduct coastal surveillance and search-and-rescue missions. It also is used to monitor commercial shipping and border areas.

FPS-117(V)3. This version is used by Saudi Arabia as part of the Peace Shield air defense system.

FPS-117(V)4. This version is installed at North Warning System (NWS) sites. The NWS radars were upgraded with the ability to detect low radar cross-section cruise missiles. The most important element of the upgrade was the provision of a correlator to separate small-target tracks from surrounding clutter.

FPS-117(V)5. This system was installed in Iceland. The (V)5 version saw some significant changes and formed part of the Iceland Air Defense System (IADS).

FPS-117(V) Tactical Ballistic Missile Defense Upgrade. This upgrade improved detection and missile cueing capabilities to provide for long-range detection of ballistic missiles, launch and impact point prediction, and better air surveillance capability. The radar can be tailored to meet specific theater ballistic missile (TBM) requirements as needed.

A high-power aperture provides sufficient energy for small target detection. Full monopulse processing ensures “one hit” position determination and provides programmable beam coverage to adapt to the environment. Electronic counter-countermeasures (ECCM) are designed to counter most jamming, while programmable data interfaces provide data handoff flexibility.

Type 92 (T92). This is the Royal Air Force nomenclature for two systems installed at remote sites in Scotland. They are early-production versions of the radar. Under an RAF contract, the transmit/receive electronics in the array were upgraded in August 2001.

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TPS-117/77(V). This version features enhanced siting adaptability. Pencil beam terrain-following, MTI processing, and Doppler filtering, in combination with sidelobe nulling to eliminate ground clutter in high-angle beams, all allow the radar to be sited for optimal mission performance. The radar can “look down” from elevated sites to detect aircraft in valleys without the need for gap-filler radars, and it can “step over” mountains to avoid transmitting into mountains or population centers.

It features 80 percent commonality with the FPS-117(V). A six-person team can have the radar set up and operational in 30 minutes. The antenna and

electronics shelter can be transported by two trucks or in two C-130s. It can be operated remotely.

In October 2001, the radar was given the official designation TPS-77(V).

L-88. This is the aerostat version of the FPS-117(V). The L-88 system is tethered up to a height of 15,000 feet. From this altitude, the radar is capable of spotting small aircraft as far as 200 nautical miles away.

The U.S. Customs Service ordered four of these radar-equipped aerostats in 1988 for deployment to the Caribbean and along the southwest border of the U.S. for drug traffic interdiction.

Program Review

Following studies that led to the selection of a minimally attended radar, three six-month design competition contracts were awarded in August 1978. This activity became known as the SEEK IGLOO project. (Then) General Electric was selected as the prime contractor in July 1979, and the company fabricated/tested a pre-production prototype system. Production of subassemblies and radar groups began in early FY80, with development, test and evaluation (DT&E) starting later that year.

During FY81, CONUS (Continental U.S.) DT&E was completed, as was the planning phase for Alaskan DT&E and initial operational test and evaluation (IOT&E). In FY83, the production of 12 FPS-117(V)s began and the original King Salmon Air Force Station prototype was refurbished.

FMS Begins

In October 1991, Turkey contracted for four FPS-117(V) radars for delivery in 1993. The contract carried an option for two additional systems. Also in 1991, Saudi Arabia selected the FPS-117(V) for its Peace Shield radar network, with 15 operational sites around the kingdom. The first radar was delivered late in the year. Problems plagued the integrated command and control system developed for Peace Shield, but the Persian Gulf War provided impetus for completing the early warning defense system, with the radar installation completed in 1992.

In late 1991, Canada announced plans to install three additional radars in Newfoundland and Nova Scotia. A fourth unit would be installed in western British Columbia. These radars were in addition to those in the North Warning System, and were designed to provide seaward radar coverage. Installation was completed in 1993.

Alaskan Radars Upgraded

In February 1992, the Air Force issued a solicitation for contractors to improve the data-handling capabilities of the FPS-117(V) radars in Alaska. The resulting program integrated the FPS-117(V) and TPS-63(V) radars with the Aircraft Combat Maneuvering Instrumentation System, the Command Tactical Information System, the Advanced Interface Control Unit, and the Regional Operational Control Center. The system was intended to correlate target, IFF, and jamming strobes, in addition to offering data recording and playback, ground control intercept, and radar performance monitoring.

In January 1993, work began on a Kuwaiti air defense system based on a combination of the FPS-117(V) and French short-range equipment for a combined military/civilian air traffic control system.

Reliability Upgrades

In FY96 and FY97, the FPS-117(V)'s digital data processor and multi-modular processor were replaced with a new commercial off-the-shelf (COTS) radar data processor under a Radar Reliability, Maintainability and Supportability (RMS) upgrade. This upgrade improved the reliability of the process and control (P&C) group, eliminated manual adjustments within that group, and replaced the maintenance control system. The effort also replaced the multi-scan detection processing algorithm with an improved correlation algorithm, and replaced the maintenance control facilities processor with commercial equipment. These changes eliminated low MTBF and unsupportable equipment.

In May 2000, Lockheed Martin Naval Electronics & Surveillance Systems-Syracuse announced that it had been awarded a contract from the U.K.'s Royal Air Force (RAF) for continued upgrades to its FPS-117(V)

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radars. The transportable radars were situated at two remote sites in Scotland and referred to by the RAF as Type 92 (T92). These were early versions of the radar.

Each system received a new radar control and display system in the mid-1990s, followed by an upgrade of the electronics equipment. The new RAF contract upgraded the transmit/receive electronics. The installation was completed at the first site in August 2001, and at the second site a month later.

Systems to Croatia/BALTNET

On December 9, 1999, Lockheed Martin Naval Electronics & Surveillance Systems-Syracuse announced that the U.S. government had approved a license allowing it to provide an integrated radar surveillance system to meet Croatia's civil and military needs. The contract included construction of five long-range, dual-use FPS-117E(1)T radars with associated display consoles, and five monopulse secondary surveillance radars. The license included the establishment of three operations centers equipped with large-screen displays and airspace management consoles. The communications system linking all the sites would use the expanding Croatian telecommunications network.

In December 2000, the Republic of Korea purchased four FPS-117(V) systems to supplement eight already in service. At the same time, Estonia selected the TPS-77(V) for its share of the expansion of the BALTNET (a cooperative air surveillance network covering the airspace around Estonia, Lithuania, and Latvia). The last Estonian radar was delivered in May 2003.

In November 2001, the South Korean Air Force (ROKAF) contracted for three TPS-77(V) radars, along with integrated air operations, communications and logistics support. Deliveries began in 2004.

In December 2001, the Latvian Ministry of Defense contracted for one TPS-77(V) to expand the range of BALTNET. Delivery took place in 2003. The system was to be used by the Latvian Air Force for surveillance and air traffic control.

In July 2002, the Defense Security Cooperation Agency notified Congress of a possible Foreign Military Sale (FMS) to Pakistan of six Aerostat radar systems equipped with the L-66 and associated equipment and services. Pakistan procured these systems in response to Operation Enduring Freedom and used them to monitor ground traffic and low-flying aircraft along its western borders. The systems also enhanced the control of narcotics trade activities along the border.

Romania Upgrades FPS-117s

In February 2007, Romania contracted Lockheed Martin to upgrade its FPS-117s. The upgrades will consolidate the radar's electronics from the current four cabinets into a single cabinet, in addition to increasing the capability and reliability of the system. The upgrades are intended to allow the radars to remain in service for another 15-20 years.

The Danish Ministry of Defense has formally accepted two TPS-77 radars into service. The radars were delivered under a contract signed in June 2006; the contract also includes four years of logistics support.

Related News

Latvia Orders TPS-77 – On December 18, 2007, Lockheed Martin received a contract valued at \$44 million from the Latvian National Armed Forces for two long-range TPS-77 transportable air surveillance radar systems, as well as options for long-term technical support. Included in the contract were priced options for up to four additional TPS-77 radars for Estonia and Lithuania. (Lockheed Martin, 12/07)

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Contracts/Orders & Options

(Recent contracts over \$5 million)

<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
Lockheed Martin	14.7	May 2004 – Letter contract modification to add a second long-range radar at the Pacific Alaska Range Complex. The system was to include a TPS-77(V), microwave equipment, support equipment, critical spares, and training. Completed Sep 2006. (F19628-03-C-0048, P00008)

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<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
Lockheed Martin	44	Dec 2007 – Contract from the Latvian National Armed Forces for two TPQ-77 radar systems as well as long-term technical support. The contract includes options for Estonia and Lithuania to purchase radars as well.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Feb	1985	Contract for first 10 FPS-117(V) radars for the North Warning System
Apr	1985	First contract for the FPS-117(V) segment of the Saudi Arabian Peace Shield program
Jul	1987	Completion of contract for first radars for NWS; contract for four FPS-117(V)5s for the NATO Iceland Air Defense System
May	1988	Germany selects FPS-117(V)s
Mid	1988	Four L-88-equipped aerostats ordered by U.S. Customs Service
Aug	1988	NWS Initial Operational Capability
Jan	1989	Last FPS-117 installed at NWS
Oct	1991	First Peace Shield radar delivered
	1992	Peace Shield installations completed; North Warning System fully operational
	1993	Installation of additional radars in Canada and Turkey
1Q	FY95	NWS IOC; radars installed in Alaska
Mar	1995	RFP for RMS upgrade
Dec	1999	Croatia approved for five FPS-117E(1)T air defense/ATC radar and control systems
May	2000	RAF contract for T92 upgrades
Oct	2000	MSSR solicitation announced
Dec	2000	ROKAF requests four FPS-117(V) radars
Aug	2001	First RAF upgrade completed
Sep	2001	Second RAF upgrade completed
Nov	2001	ROKAF issues contract for three TPS-117/77(V) radars
Dec	2001	Latvia purchases FPS-117(V)
	2002	Estimated end of Croatian production
Apr	2002	Jordan requests an FPS-117(V)
Jul	2002	Pakistan requests six Aerostat radars with the L-88
May	2003	Last Estonian radar delivered
Nov	2003	Latvia takes possession of first BALTNET radar
1Q	2004	Delivery of TPS-77(V) radars for ROKAF
Jun	2004	RAF accepts T92 upgrades
Sep	2006	Delivery of second, and last, long-range radar for Pacific Alaska Range Complex
Feb	2007	Romania awards Lockheed Martin contract to upgrade FPS-117

Worldwide Distribution/Inventories

Australia	The RAAF uses several TPS-117/77(V) systems.
Belgium	Has one FPS-117 in operation, the first production radar.
Brazil	The Brazilian government has purchased the TPS-117/77(V) for its SIVAM (System for the Vigilance of the Amazon) environmental monitoring network.
Canada/U.S.	The North Warning System program included the installation of 13 FPS-117(V)s – 10 to replace 10 Distant Early Warning/Long-Range Radar sites in Alaska and Canada, and three (one each) at three new sites on Canada's northeast coast. FPS-124 gap-filler radars augment coverage between the FPS-117(V) sites. Canada added four new radars to coastal sites in Newfoundland and Nova Scotia in 1993 and held an option for one additional radar.

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Croatia	Approved for five joint air defense/air traffic control systems for use in air space management, maritime search and rescue, and the monitoring of commercial shipping.
Denmark	Denmark purchased two TPS-77s in 2005. They were formally accepted into service in 2007.
Estonia	Selected the TPS-117/77(V) to expand its share of BALTNET. The systems are supplemented by two smaller radars. BALTNET integrates the radars of Estonia, Latvia, and Lithuania.
Germany	Germany replaced an aging radar in Berlin with the FPS-117(V). The Berlin Radar Program upgraded the radar coverage and air traffic control capabilities of Tempelhof Central Airport. Three more radars were later acquired.
Iceland	Iceland installed four of the long-range radars in the four corners of the country.
Italy	Italy procured four FPS-117(V) radars.
Korea	Eight systems were procured.
Kuwait	One system was combined with existing French equipment to provide data for both military and civilian air traffic control.
Latvia	Procured one TPS-117/77(V) radar for BALTNET. Additional two radars ordered in 2007.
Pakistan	Pakistan is receiving six TPS-77s.
Romania	Acquired five FPS-117(V)s for its air traffic control system. These may be supplemented by possible co-production of 21 gap-filler radars.
Saudi Arabia	Saudi Arabia's air defense system was upgraded under the Peace Shield program, which ties five regional control centers to a master command center. All the centers are linked with 17 FPS-117(V)3 radars and five Boeing E-3A AWACS early warning aircraft. Saudi Arabia specified use of the FPS-117(V). The deployment of the FPS-117(V)3 provides a nationwide air defense radar system that can, if needed, be expanded to the six nations of the Gulf Cooperation Council.
Taiwan	The Republic of China purchased two radars.
Turkey	Purchased one radar, with options for two more.
United Kingdom	Three T92 radars installed in Scotland.

Forecast Rationale

Lockheed Martin continues to produce its TPS-77, finding buyers worldwide for its long-range radar. The TPS-77, based on the FPS-117, has been produced steadily over the past few years. A steady stream of contracts has kept the production line open. The most recent contract is for provision to Latvia of two TPS-77s. Also included in the contract is an option for four additional radars for Estonian and Lithuanian forces.

Lockheed Martin is marketing its radar throughout the world, and expects to sell between 15 and 20 radars over the next five to ten years. Under current contracts, production is under way for Latvia and Thailand. Romania is the latest country to award Lockheed a

contract for upgrade work. Upgrades increase the radar's capability and reliability while consolidating electronic components. They will allow the radar to operate for another two decades. Because these radars have a long lifespan, there will be upgrade opportunities for decades to come.

Three TPS-77 units will be produced over the next ten years. The number could, of course, change should new contracts be signed. The market that these radars occupy is characterized by stability and longevity, as ground-based radars are typically operated for many years once they are installed. Production levels will remain low but steady. Additionally, following the current trend, future orders will be from countries outside the United States.

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Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			
	Thru 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Lockheed Martin Ocean Radar & Sensor Systems												
TPS-77 <> Latvia <> Armed Services												
	1	0	0	2	0	0	0	0	0	0	0	2
TPS-77 <> Thailand <> Air Force												
	0	0	1	0	0	0	0	0	0	0	0	1
Subtotal	1	0	1	2	0	0	0	0	0	0	0	3
Total	1	0	1	2	0	0	0	0	0	0	0	3