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ZPQ-1(V) (TESAR) – Archived 6/2010

Outlook

- ZPQ-1 is being replaced on newer UAVs with more modern radars such as the APY-8 Lynx SAR and STARLite radar
- In order to save weight onboard Predators, the U.S. Air Force has removed ZPQ-1 TESARs from the aircraft
- The system is no longer produced. This report will be archived in June 2010

Orientation

Description. The Tactical Endurance Synthetic Aperture Radar (TESAR) is a small, light, low-cost sensor for use on unmanned aerial vehicles (UAVs).

Sponsor

U.S. Air Force
AF Systems Command
Aeronautical Systems Center
ASC/PAM
Wright-Patterson AFB, OH 45433-6503
USA
Tel: + 1 (513) 255-3767
Web site: <http://www.wpafb.af.mil>

Status. The ZPQ-1 is no longer in production.

Application. The ZPQ-1 TESAR equips the MQ-1 Predator UAV, and the TUAVR equips the MQ-5 Hunter UAV.

Price Range. The ZPQ-1(V) unit cost is estimated to be roughly \$550,000 to 750,000.

Contractors

Prime

Northrop Grumman Electronic Systems	http://www.es.northropgrumman.com , 1580-A W Nursery Rd, Linthicum, MD 21090 United States, Tel: + 1 (800) 443-9219, Email: ES_Communications@ngc.com , Prime
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ZPQ-1(V) (TESAR)

Technical Data

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
<u>ZPQ-1(V)</u>		
Antenna		
Box	45.7 x 18.8 x 19.0 cm	18.0 x 7.4 x 7.5 in
Diameter	47.0 cm	18.5 in
Total height	45.3 cm	19.9 in
Receiver/Exciter/Transmitter	48.2 x 32.6 x 26.1 cm	19.0 x 12.8 x 10.3 in
COTS Processor	52.8 x 23.3 x 37.8 cm	20.8 x 9.2 x 14.9 in
Weight	74.9 kg	165 lb
Volume	0.12 m ³	4.15 ft ³
<u>TUAVR variant</u>		
Weight (current/production goal)	28.8 kg/25.9 kg	63.5 lb/57 lb
Volume (current/production goal)	36.4 cm ³ /28 cm ³	1.3 ft ³ /1 ft ³
Characteristics		
RF frequency	Ku-band	
Bandwidth	1,200 MHz	
Power	1,050W	
Cooling	Ambient air	
MTBF	>700 h	
Ground speed	50-90 kt	
Mission duration	40 h	
Altitude	7,620 m/25,000 ft	
SAR Strip Mode		
Range	10 km @ 0.3 m 18 km @ 0.6 m 25 km @ 1.0 m	
Swath Width/Resolution	800 m/0.3 m 1.6 km/0.6 m 2.6 km/1.0 m	
Rate	100.8 km ² /h @ 0.3 m 210.6 km ² /h @ 0.6 m 336.0 km ² /h @ 1.0 m	
SAR Spot Mode		
Range	18 km @ 0.3 m 25 km @ 0.6 m 28 km @ 1.0 m	
Size/Resolution	800 x 800 m/0.3m 1.6 x 1.6 km/0.6 m 2.6 x 2.6 km/1.0 m CEP 25 m (P-coded GPS)	
MTI Mode		
MVD	1.5 m/s on nose 3.5 m/s ± 135 deg az	
Frame time	< 1 min	
Sector scan selection	± 22.5 deg, 45 deg, 60 deg, 90 deg, 135 deg @ 5 and 25 km	
Elevation scans	1, 2, or 3 bars	

Design Features. The Predator system is made up of both air and ground segments. The air segment consists of four full composite air vehicles powered by turbocharged Rotax 914 engines. They can simultaneously carry electro-optic/infrared (EO/IR) and synthetic aperture radar (SAR) sensor payloads. Four EO/IR payloads and three SAR payloads are provided for each of four air vehicle systems. The air vehicle can also carry one HELLFIRE missile under each wing; however, the SAR payload cannot be operated when the air vehicle is configured to carry and fire HELLFIRE missiles.

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The system can operate in somewhat less than ideal weather conditions, and a glycol-weeping wing deicing system was developed to provide the capability to transit through moderate icing conditions. Two sets of weeping wings will be provided for each system, with four air vehicles. The weeping wings are not internally configured for weapons carriage.

In SAR mode, the ZPQ-1(V) radar provides continuous, fully focused, high-resolution, near-real-time stripmap imagery from either side of the aircraft. Coordinates of each map center can be provided to within ± 25 meters CEP (assuming P-coded GPS). The radar provides two SAR stripmap modes and a spot map mode. In stripmap mode, the radar can map parallel to the aircraft flight path or along a specified ground path.

The SAR is capable of operations with resolutions of 0.3 to 1.0 meter, with commensurate changes in range and swath width. Airborne image formation eases both datalink bandwidth and ground processing requirements. In moving target indicator (MTI) mode, the radar provides targets overlaid on a digital map.

The antenna assembly features a one-axis electronic scan, two-axis mechanical gimbal, and ± 135 -degree-wide field of regard. The Receiver/Exciter/Transmitter features a single-channel digital waveform generator and MPM transmitter. The commercial off-the-shelf (COTS) processor features 540 MOPS (million operations per second) signal processing and a 1553 interface.

The SAR ground control station (GCS) provides the ability to record digital imagery along with GPS timer and geographical reference data. Imagery is displayed at full resolution and can also be replayed simultaneously while real-time imagery is being recorded. The GCS interfaces with the UAV mission computer for mission profile and

SAR payload control. The configuration and operation of the SAR GCS for display, analysis, and reporting functions have been designed to ease the operator's workload.

Operational Characteristics. The Predator medium-altitude-endurance UAV is a theater asset that provides a cued and non-cued reconnaissance, surveillance, targeting acquisition, and limited strike capability. Its long-dwell capability is intended to provide the theater commander with continuous imagery coverage of any area of interest.

Since 2002, all MQ-1 Predator air vehicles are capable of being equipped with two HELLFIRE missiles and a Multispectral Targeting System (MTS), which is a sensor turret that incorporates EO/IR, laser designator/rangefinder, and IR illuminator. Originally designated RQ-1, multirole systems capable of reconnaissance, surveillance, and limited strike are designated MQ-1.

The ground segment consists of a shelter containing the GCS and a Predator primary satellite link for satellite communications between the air vehicle and the ground station. Datalink systems between the air vehicle and the ground system offer C-band line-of-sight (LOS) capability, and Ku-band satellite capability for operations beyond LOS. Dissemination of imagery, both video and still image files, beyond the GCS is the responsibility of the commander.

A typical deployment detachment consists of one Predator system and 55 personnel. United States Air Force 11th, 15th, and 17th Reconnaissance Squadrons at Creech Air Force Base (formerly Indian Springs Air Force Auxiliary Field, Nevada, just north of Nellis AFB), currently operate 12 combat-coded Predator systems (68 aircraft and 16 GCS). There are plans to add three more squadrons.

Variants/Upgrades

TUAVR. This is a lighter, smaller version of the ZPQ-1(V) developed for the Army Tactical UAV program. The first radars were delivered to the Army in mid-2001 for evaluation by the Communications and Electronics Command Intelligence and Information Warfare Directorate. Demonstrations were planned at Ft. Huachuca, Arizona. Plans are to eventually develop the capability to install the TUAVR on the Shadow 200

UAV. The TUAVR will provide commanders with all-weather, day-night information.

The system was designed to weigh 63.5 pounds and fit in a 1.3-cubic-foot unit. The production system is planned to weigh 57 pounds and occupy 1 cubic foot of payload space.

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The ZPQ-1(V) TESAR Radar

Source: Northrop Grumman

Program Review

Through the 1990s, interest in UAVs increased as technology improved. Parallel to the development of the UAV itself came industry efforts to design and produce SAR/MTI sensors small and light enough to be carried by the pilotless drones and, at the same time, provide useful imagery to ground commanders. In addition to the radar, datalinks had to be perfected, along with ground video terminals appropriate to the battlefield.

Northrop Grumman had been working on a variety of UAV-appropriate systems through the 1990s, demonstrating the TESAR in 1996. As officials turned to the Predator for battlefield operations, designers turned to the ZPQ-1(V) as part of the sensor package.

The Air Force procured its original planned force of 12 Predator systems when Initial Operational Test and Evaluation (IOT&E) took place in October 2000. Predator system No. 6 was the first system to be retrofitted with all baseline capabilities, and was used for initial operational testing.

War on Terrorism Expands UAV Needs

In response to the war on terrorism, funding for additional Predator assets and improvements was provided. The Predator fleet expanded by three squadrons beginning in FY04. Additional MQ-1 systems were procured in concert with the development

of a follow-on system, the MQ-9, also known as Predator B. Plans are for this larger, turboprop version to carry the APY-8(V) SAR/GMTI radar and to function in a hunter-killer role.

In March 2005, the Air Force established the USAF Unmanned Aerial Vehicle Center of Excellence at Creech AFB. The organization will coordinate various activities at the tactical, operational, and strategic levels. The goal of the center will be to improve interoperability among the various systems and develop common operating systems, standards, and requirements, and to provide joint warfighters with the required training.

USAF Increases Predator Fleet

At the same time, in response to increasing demand for Predators, the Air Force announced plans to expand its Predator fleet to as many as 15 squadrons; a typical squadron has 12 Predators. Furthermore, in a Future Total Force initiative, the USAF is establishing two Air National Guard units, one in Texas (2006) and one in Arizona (2007). A squadron within an Air National Guard unit in New York (2009) is also planned.

These would add to the three Predator squadrons already in existence at Nellis and Creech. Air Force Special Operations Command and Air Force Reserve personnel will also operate Predators out of Creech.

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Another Future Total Force initiative is to establish a Distributive Ground Station in western New York to process global intelligence information.

In March 2006, the U.S. Army announced it would replace the Hunter UAV with an Extended Range/Multipurpose (ERMP) UAV. The Sky Warrior UAV has been selected as the ERMP. The APY-8 Lynx radar

was originally chosen as the radar for the ERMP. However, technical and cost issues associated with the APY-8 forced the Army to select the Northrop Grumman STARLite radar instead.

In order to save weight onboard Predators, the U.S. Air Force has removed ZPQ-1 TESARs from the aircraft.

Funding

U.S. FUNDING								
	FY07 <u>QTY</u>	FY07 <u>AMT</u>	FY08 <u>QTY</u>	FY08 <u>AMT</u>	FY09 <u>QTY</u>	FY09 <u>AMT</u>	FY10 <u>QTY</u>	FY10 <u>AMT</u>
Procurement (U.S. Air Force)								
Predator UAV	60	676.15	24	276.12	38	378.70	42	247.74
	FY11 <u>QTY</u>	FY11 <u>AMT</u>	FY12 <u>QTY</u>	FY12 <u>AMT</u>	FY13 <u>QTY</u>	FY13 <u>AMT</u>	FY14 <u>QTY</u>	FY14 <u>AMT</u>
Procurement (U.S. Air Force)								
Predator UAV	26	149.13	24	131.82	18	109.90	-	-

All \$ are in millions.

Source: FY09 U.S. Budget Documents

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1994	ACTD development, RQ-1A Predator first flight
	1995	Begins surveillance missions (Bosnia, Kosovo, and Afghanistan)
Mar	1996	SAR module development
May/Jun	1996	SAR/MTI integration captive flight tests
Oct	1996	UAV demonstration, Hunter UAV targeted
	1996	Predator used in Bosnia combat operations
	1997	Program transitioned to Air Force
	2001	Predator used in Afghanistan; carries weapons (HELLFIRE missiles) for the first time, designation changed to MQ-1 because of new, multimission capability
	FY02	MQ-9 Predator B procurement added
	FY03	Predator appropriations plus-up by Congress
Oct	2004	MQ-1 fleet reaches 100,000 flight hours
Mar	2005	Declared IOC

Worldwide Distribution/Inventories

This is a U.S. program. **Italy** is procuring the Predator, but with the APY-8(V).

ZPQ-1(V) (TESAR)

Forecast Rationale

The U.S. Air Force has removed ZPQ-1 TESARs from its Predator UAVs. Current Air Force plans call for the UAVs to be equipped with electro-optical equipment and missiles to attack targets in Iraq and Afghanistan. The radars were considered too heavy and were removed in favor of carrying offensive payloads.

Even though the Air Force is removing ZPQ-1s from its Predator UAVs, many military planners believe that radars can form an important part of intelligence gathering suites onboard UAVs. The U.S. Army plans to equip both the Sky Warrior and Fire Scout UAVs it plans to buy with synthetic aperture radars. However, these new UAVs will be equipped with newer radars.

Both of those aircraft will be equipped with Northrop Grumman's new STARLite radar. No new contracts have been announced for the ZPQ-1 in the past five years.

With no new production forecasted, Forecast International will archive the ZPQ-1 report in 2010. New-build UAVs are being equipped with newer radars. Old ZPQ-1s that have already been produced are receiving very little support, as they have been removed from their original platforms to make way for additional weapons. This leaves little opportunity to spare and repair work to maintain the systems.

Ten-Year Outlook

The U.S. Air Force has removed the ZPQ-1 TESAR from its Predator UAVs. The system is no longer produced. This report will be archived in June 2010.

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