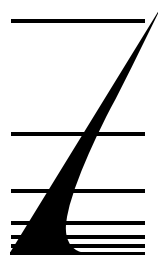


# The Market for Aviation Turboprop Engines

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Product Code #F641

A Special Focused Market Segment Analysis by:



**FORECAST** INTERNATIONAL



# Analysis 3

## The Market for Aviation Turboprop Engines: 2009-2018

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## PROGRAMS

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The following reports are included in this section: (**Note:** a single report may cover several programs.)

Europrop International TP400-D6

General Electric CT7 (Turboprop)

Honeywell TPE331

OMSK Aircraft Engine Bureau Aviation Turboprops

Pratt & Whitney Canada PT6A

Pratt & Whitney Canada PW100 Series

Rolls-Royce AE 2100

Rolls-Royce Model 250 (Turboprop)

Rolls-Royce T56/501



## Introduction

This analysis of the turboprop engine market covers the factors that will affect engine production worldwide over the next 10 years. Included in this discussion are industry trends that affect the competitive environment, varied market statistics, and individual manufacturers' engine programs.

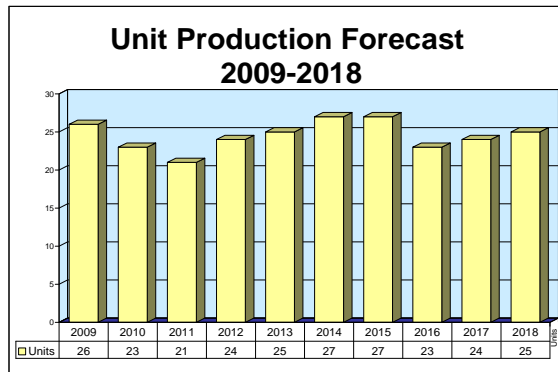
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# Rolls-Royce Model 250 (Turboprop)

## Outlook

- Rolls-Royce's small turboprop line augmented by new RR500
- GE's Walter 601 enters retrofit market



## Orientation

**Description.** Axial-centrifugal and centrifugal-flow free-turbine turboprop engine in the 300-500-shp class.

**Note:** This report covers the Model 250 turboprop version only. The Model 250 turboshaft is covered in a separate report.

**Sponsor.** The Model 250 turboprop effort was privately sponsored by the prime contractor.

**Power Class.** 420-715 shp (313-533 kW) for engines in production.

**Status.** In production for the Pilatus Britten-Norman BN-2T Turbine Islander, Maule MX-7-420, and Macchi SF-260, and for the Fuji T-3 and T-5 trainers.

**Total Produced.** At the start of 2009, an estimated 2,350 Model 250 turboprop engines had been built.

Engine Variant	Power Rating	Application	Engines per Airframe
250-B17B(a)	400 shp (298 kW)	ASTA (GAF) N-22C/N-24 Nomad (prod. completed)	2
	317 shp (236 kW)	SIAI-Marchetti SM-1019A/E (production completed)	1
250-B17C(b)	400 shp (298 kW)	ASTA (GAF) N-22C/N-24 Nomad (prod. completed)	2
	420 shp (313 kW)	Goodyear GZ-22 Airship (production completed)	2
	350 shp (260 kW)	Taneja Aerospace AP-68TP (production completed)	2
	420 shp (313 kW)	Maule M-7, MX-7-420	1
	350 shp (260 kW)	Pilatus Britten-Norman Turbine Islander BN-2T(c)	2
250-B17D(b)	350 shp (260 kW)	Agusta (SIAI-Marchetti) SF-260TP	1
	420 shp (313 kW)	Enaer T-35TX Turbo Pillan (production completed)	1
	420 shp (260 kW)	Fuji KM-2 (T-3/T-5)	1
250-B-17F/F1/F2	360 shp (268 kW)	Jaffe SA-32T (production completed)	1
	450 shp (335 kW)(d)	Agusta (SIAI-Marchetti) SF-600TP	2
	450 shp (335 kW)	Fuji KM-2 (T-7)	1
	450 shp (335 kW)	Grob G140TP (planned)	1
		O&N Silver Eagle Cessna P210 Conversion	1
		Ruschmeyer R95 (production completed)	1
	500 shp (372 kW)	B-N Group: BN-2T Defender 4000/MSSA	2
500 shp (372 kW)(e)	Aermacchi/Valmet L-290TP Redigo (proposed)	1	

(a) Maximum T-O rating is 400 shp (298 kW).

(b) Maximum T-O rating is 420 shp (313 kW).

(c) Normal-duty aircraft models.

(d) Flat rated to 450 shp (335 kW).

(e) Flat rated to 420 shp (313 kW).

## Rolls-Royce Model 250 (Turboprop)

**Price Range.** Estimated at \$140,000-\$160,000 (in 2009 U.S. dollars).

**Competition.** The Model 250 faces competition chiefly from piston engines in its power range, though

the Pratt & Whitney PT6A at its lowest ratings of 500-550 shp (372.8-410.1 kW) offers competition to the Model 250 at its highest rating. GE's Walter 601 has recently entered the small turboprop retrofit market, and competes with the Model 250.

## Contractors

### Prime

<b>Rolls-Royce Corp</b>	<a href="http://www.rolls-royce.com/northamerica">http://www.rolls-royce.com/northamerica</a> , PO Box 420, 2001 S Tibbs Ave, Indianapolis, IN 46206-0420 United States, Tel: + 1 (317) 230-2000, Fax: + 1 (317) 230-4020, Prime
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### Subcontractor

<b>Honeywell Aerospace</b>	<a href="http://www.honeywell.com/sites/aero/">http://www.honeywell.com/sites/aero/</a> , 717 N Bendix Dr, South Bend, IN 46620 United States, Tel: + 1 (574) 231-2000, Fax: + 1 (574) 231-3335 (Power Turbine Governor)
<b>PTI Technologies Inc</b>	950 Rancho Conejo Blvd, PO Box 2000, Newbury Park, CA 91320 United States, Tel: + 1 (805) 499-2601, Fax: + 1 (805) 375-2299 (Engine Fuel & Lube Filtration Assembly)
<b>Timken Super Precision (MPB)</b>	<a href="http://www.timken.com">http://www.timken.com</a> , 7 Optical Ave, PO Box 547, Keene, NH 03431-0547 United States, Tel: + 1 (602) 352-0310, Fax: + 1 (602) 355-4554 (Main Shaft & Accessory Ball & Roller Bearings)
<b>Woodward Governor Co</b>	<a href="http://www.woodward.com">http://www.woodward.com</a> , 5001 N Second St, PO Box 7001, Rockford, IL 61125-7001 United States, Tel: + 1 (815) 877-7441, Fax: + 1 (815) 639-6033 (P.T. & Propeller Governor Control)

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to [www.forecastinternational.com](http://www.forecastinternational.com) (see Products & Samples/Governments & Industries) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; [rich.pettibone@forecast1.com](mailto:rich.pettibone@forecast1.com)

## Technical Data

**Design Features.** The Rolls-Royce Model 250 turboprops have the following design features:

**Intake.** Annular with fixed inlet guide vanes; hot bleed air anti-icing.

**Compressor.** All Model 250s through 250-B17E have a six-stage, axial-stage compressor followed by a single, one-piece forged titanium centrifugal-flow compressor impeller, and provide 3.45 lb/sec (1.56 kg/sec) of airflow at a pressure ratio of 7.2:1. The 250-B17F/F1/F2 series incorporates the compressor from the Model 250-C20R turboshaft, which uses a new four-stage axial section followed by a redesigned centrifugal stage providing a 3.82-lb/sec (1.732-kg/sec) airflow at a pressure ratio of 7.91:1. The compressor section of the 250-B17F incorporates a new cast compressor case with aluminum graphite coating for erosion protection. A new No. 2 ball bearing is incorporated, as are new abrasion tip and seal coatings, thicker airfoils with longer chord in the axial compressor stages, and

improved sealing and lubrication systems. Compressor stator vane rings are made up of two 180-degree castings.

**Combustor.** Single can-type chamber at the aft end of the engine. It has a single duplex fuel nozzle, and capacitive discharge ignition.

**Gas Generator Turbine.** A two-stage, axial-flow, high-pressure turbine composed of integrally cast nickel-based alloy blades and discs drives the compressor at a maximum rated speed of 50,970 rpm.

**Power Turbine.** A two-stage, axial-flow, low-pressure free power turbine, also with integrally cast blades and discs of nickel-based alloy, drives the output gearbox at 33,290 rpm. Reduction gear provides 2,030-rpm propeller speed.

**Control System.** A hydromechanical/pneumatic gas producer fuel control is used, having a single-element fuel pump and filter.

## Rolls-Royce Model 250 (Turboprop)

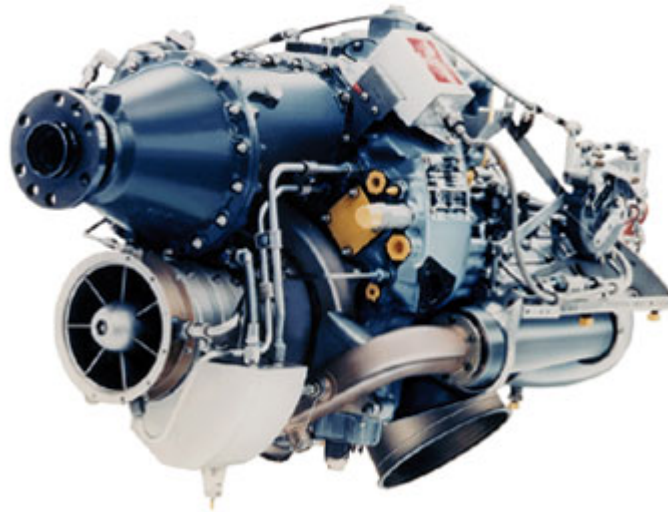
**Accessories.** The magnesium gearbox is mounted on the forward portion of the engine, and is driven by the inner concentric power shaft. The gearbox reduces the

power shaft speed of 33,290 rpm to a propeller speed of 2,030 rpm. The engine is started using an electric starter generator.

**Dimensions.** The approximate dimensions of the 250-B17C/D/E and 250-B17F/F1/F2 are as follows (first data, 250-B17C/D/E; second data, 250-B17F/F1/F2):

	<b>Metric Units</b>	<b>English Units</b>
Length	1,141/1,141 mm	44.92/44.92 in
Width	477/477 mm	18.78/18.78 in
Height	574/574 mm	22.60/22.60 in
Weight, dry(a)	88.4/96.2 kg	195/212 lb

(a) Includes basic engine, fuel pump and filter, ignition, and fuel control system. The 250-B17F1 weighs 215 pounds (97.52 kg).



Rolls-Royce Model 250

Source: Rolls-Royce

## Variants/Upgrades

**250-B15.** The original turboprop engine, the 250-B15, was a direct conversion from the 250-C18 turboshaft, with a propeller reduction gearbox and other adaptations. This early variant is rated at 317 shp (236 kW) at T-O.

**250-B15A/E/G.** The 250-B15G was the last production version of this improved subfamily, used in the prototype SIAI-Marchetti SM-1019. The 250-B15A and 250-B15E are basically the same with minor differences: the 250-B15A has no provision for a coordinator, while the 250-B15E has no provision for a coordinator and propeller brake. Models A, E, and G were certificated in March 1969, at 317 shp at T-O and 270 shp (201.3 kW) max continuous (at S/L).

**250-B17/B17B/C/D/E.** These variants are based on the 250-C20B turboshaft, having a larger diameter first-stage compressor, larger power turbine, increased

air mass flow, and higher turbine temperatures. The 250-B17 was certificated at 400-shp T-O in April 1971, while the 250-B17B was certificated in July 1974 with an improved hot-day performance of 400 shp. The 250-B17C variant incorporates a slight increase in power to 420 shp, and is essentially similar to the 250-B17B except for the deletion of the propeller brake. It was certificated in May 1979. The 250-B17D is similar to the 250-B17C but the propeller reduction gearbox was changed to accommodate aerobatic maneuvers. It was certificated in November 1983. The Model 250-B17E is similar to the 250-B17C but the guaranteed performance ratings are accomplished at reduced rated-measure gas temperatures. It was certificated in May 1985.

**250-B17F/F1/F2.** The latest model series, the 250-B17F/F1/F2, incorporates the compressor from the Model 250-C20R, giving a higher pressure ratio and

## Rolls-Royce Model 250 (Turboprop)

better fuel efficiency, as well as greater power output (450 shp/335 kW): SFC at T-O is approximately 0.610 lb/shp/hr (102 mg/J). The 250-B17F1 is similar to the 250-B17 but incorporates an electronic power

turbine (N2) overspeed detection system. Both the 250-B17F1 and F2 retain the original propeller reduction gearbox. The 250-B17F was certificated in May 1988.

## Program Review

**Background.** The Rolls-Royce (formerly Allison Gas Turbine Division) Model 250 turboprop is one of the smallest and lightest in operation today. With variants less than 45 inches (114 cm) in length and up to 215 pounds (97.5 kg) in weight, the Model 250 is well suited for general aviation (GA) and military training applications where space and structural limitations necessitate the selection of a small, lightweight propulsion package.

While the Model 250 is indeed small and light, it was reputed to be overly complex. Variants up to the 250-B17E incorporate six axial compressor stages and a single centrifugal stage, and the reverse-flow configuration of the engine has made for some support problems. Rolls long ago recognized the limitations of its engine and sought to reduce the complexity. The Model 250-C20R, whose core is now employed in the Model 250-B17F, uses one centrifugal and four axial stages. The newest variant, the Model 250-B21B, uses the C30 core, employing only a single, high-through-flow and high-pressure-ratio centrifugal compressor impeller, greatly reducing the engine's length and maintenance requirements.

The Model 250 turboshaft was first developed in the late 1950s with funding from the Army, which was seeking a light helicopter engine. The Model 250 turboshaft was used as the basis for development of the Model 250 turboprop. The first turboshaft version was certificated in 1962, and was first used in flight on a Hughes 369 helicopter. This development led, in turn, to the use of Model 250 (T-63) turboshaft engines on the Hughes OH-6A, which won the U.S. Army's Light Observation Helicopter competition in 1964-1965. Several thousand engines have since been delivered to two airframe builders for light military helicopter production. A large number of civil helicopters are also powered by Model 250 engines, which accounts for the overwhelming number of Model 250 engines produced – more than 30,000.

**Model 250 Turboprop Applications.** Note that the following discussion is not intended to include all 250 turboprop applications, since many have been one-of-a-kind models. Described below are the most notable applications, or applications likely to enter production.

**B-N Group BN-2T.** The BN-2T Turbine Islander is a twin 250-B17C/F-powered variant of the older piston-powered BN-2A/B Islander series; the BN-2T has a maximum gross weight of 7,000 pounds (3,175 kg). The BN-2T allows a 700-pound (320-kg) payload increase over the piston-powered BN-2A. The turbine also operates over a wider range of altitudes and temperatures than the piston. The turboprop-powered model first flew in August 1980.

Since the BN-2T's first flight, several models of the aircraft line have evolved. The Defender is the militarized variation of the BN-2T. The aircraft is on offer in several specialized versions, including an ASW/AEW variant, as well as maritime patrol, counterinsurgency, and command and control variants. The latest Defenders offered are the Defender Multi-Sensor Surveillance Aircraft, certificated in 1995.

Britten-Norman will also upgrade (or provide technical support for upgrading) piston-powered BN-2A aircraft to BN-2T standard with the Model 250-B17C engine, plus new propellers, engine controls, and instrumentation.

**SIAI-Marchetti SF-260TP.** The SF-260 has been one of the world's most popular single-piston-powered basic trainers. The SF-260TP is a 250-powered variant; deliveries of 70 SF-260TP aircraft began in 1983. SIAI-Marchetti offers a conversion kit for existing piston-powered aircraft.

**Fuji KM-2 (T-3/T-5/T-7).** The Fuji KM-2D (Japanese military designation: T-3) is a single-engine, high-performance, basic/primary military trainer currently in service with the Japan Air Self-Defense Force (JASDF). It has a maximum T-O weight of 3,979 pounds (1,805 kg).

The KM-2D is a turboprop derivative of the piston-powered KM-2 basic trainer. The KM-2 was itself a derivative of the Beech Mentor.

The KM-2B, or T-3, aircraft came equipped with a single Lycoming IGSO-480-A1A6 engine. Approximately 60 of the Lycoming-powered KM-2B trainers were produced.

A turboprop-powered KM-2D prototype was built by Fuji in 1984, refitting a piston-powered KM-2 with the Model 250-B17D engine.

## Rolls-Royce Model 250 (Turboprop)

In 1987, Fuji was issued a contract to replace the Japan Maritime Self-Defense Force (JMSDF) fleet of 32 piston-powered KM-2s with a version of the turboprop-powered KM-2D called the KM-2 Kai. The Japanese military designation of the KM-2 Kai is the T-5. This version incorporates additional changes in the aircraft's cabin structure and equipment.

The JASDF selected the KM-2F (Japanese military: T-7) in 1998 to replace additional T-3 primary aircraft from 2000. The Model 250-17F was selected for these aircraft (about 30 hp more powerful than the -17D), with anywhere from 50 to 100 units to be provided from 2000 on, depending upon how many aircraft are approved by the government.

Enaer T-35TX Turbo Pillan. The single-engine T-35TX trainer was developed by Enaer in Santiago, Chile, with private funding. The prototype aircraft

made its initial flight in 1986. While Chile is reported to have a requirement for 40 aircraft, the program has now been suspended. In 1991, Enaer flew a T-35 Pillan whose engine had been converted from a piston to a Model 250-B17D. The aircraft was designated the T-35DT. To date, no international orders for the aircraft have been placed.

Aermacchi M-290TP RediGo. Aermacchi continues to market the Model 250-B17F-powered RediGo trainer. No orders for the aircraft have been announced.

Aermacchi has been studying a number of improvements for the RediGo. These include the 500-shp version of the Model 250-17F engine.

## Funding

No funding pertaining to the Model 250 turboprop has been identified.

## Contracts/Orders & Options

No major contracts pertaining to the Model 250 turboprop have been identified in the past year.

## Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1958	U.S. Army development
	1959	First run of the engine
Dec	1962	FAA certification of the Model 250-C10 turboshaft
Mar	1969	Model 250-B15A/E/G certificated by U.S. FAA
Apr	1970	Model 250-B17 turboprop certificated
Mar	1978	GAF Nomad engined with 250-B17C introduced in U.S.
Jun	1984	Rollout of first production Rheinflugzeugbau (RFB) Fantrainer
Jun	1986	L-90TP first flight
Jul	1986	M-7 first flight
May	1988	Model 250-B17F certificated
Jun	1989	MX-7-420 land version certificated
Thru	2018	Continued production/support of Model 250 turboprop

## Worldwide Distribution/Inventories

Model 250 turboprop engines are used for private general aviation aircraft and very small commercial fleets. At the start of 2009, an estimated 2,350 Model 250 turboprops had been built.

## Rolls-Royce Model 250 (Turboprop)

## Forecast Rationale

Rolls-Royce continues in the light turboprop engine market with its Model 250 powering a handful of general aviation aircraft and military derivatives. The 250 competes with Pratt & Whitney Canada's PT6A, and now General Electric's Walter 601.

**General Aviation Derivatives**

With the end of Japan's Fuji T-7 trainer program, the T-5 will continue in production at very low rates until its expected phasing out in 2012. Both aircraft were based on the Beechcraft T-34C trainer operated by the U.S. Air Force, which is in the process of retiring the type in favor of the Beechcraft T-6A/B.

The Britten-Norman BN-2 Turbine Islander is derived from the Islander, a general aviation light piston twin. By upgrading the aircraft to turbine power, it became attractive to the military and law enforcement as a surveillance aircraft. The recent trend toward unmanned aircraft in that role, however, is having an effect on BN-2 production, and modest demand for the aircraft will result in low production.

**New A-Viator Twin**

The Rolls 250 did pick up a new application with Italy's Vulcanair A-Viator twin. As a nine-passenger aircraft, the A-Viator is being offered for reconnaissance and patrol use, as well as passenger duty. The addition of this aircraft has significantly increased the Model 250 production forecast, and the first aircraft was delivered in January 2008.

**RR500 Joins the Lineup**

Rolls' new RR500 turboprop is a derivative of the RR300 turboshaft engine, designed for fixed-wing aircraft. It will augment the Model 250 turboprop series, but as of this writing, does not have any applications. The RR500 may find most of its applications on existing aircraft through the STC process. In terms of power, the RR500 slots in below the 250.

Overall, we estimate Model 250 turboprop production at 245 engines from 2009-2018.

## Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			Total
	Thru 2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
<b>Rolls-Royce Corp</b>												
<b>250 -B -17C &lt;&gt; BN-2 T</b>												
	165	4	4	4	4	3	5	6	4	4	3	41
<b>250 -B 17C &lt;&gt; A-Viator</b>												
	14	15	14	12	13	17	19	18	16	19	20	163
<b>250 -B 17C &lt;&gt; M-7 Series MXT-7-420</b>												
	21	1	1	0	2	2	1	2	1	0	0	10
<b>250 -B 17C Military &lt;&gt; BN-2 T -4S Defender 4000</b>												
	27	2	0	1	3	3	2	1	2	1	2	17
<b>250 -B 17D Military &lt;&gt; T-5</b>												
	46	4	4	4	2	0	0	0	0	0	0	14
<b>Subtotal</b>	273	26	23	21	24	25	27	27	23	24	25	245
<b>Total</b>	273	26	23	21	24	25	27	27	23	24	25	245

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	U.S.	World		U.S.	World		U.S.	World
<b>Market Intelligence Services (Pages 6-25)</b>			<b>Intermediate Military Library</b>			<b>Governments &amp; Industries</b>		
Binder	\$45	\$85	Binder	\$540	\$1,020	Binder	\$540	\$1,020
DVD	\$50	\$95	DVD	\$50	\$95	DVD	\$50	\$95
Binder & DVD	\$95	\$180	Binder & DVD	\$590	\$1,115	Binder & DVD	\$590	\$1,115
Binder & RT	\$45	\$85	Binder & RT	\$540	\$1,020	Binder & RT	\$540	\$1,020
<b>Worldwide Inventories</b>			<b>Basic Military Library</b>			<b>International Military Markets (A Subset of G&amp;I above)</b>		
<b>Aerospace Systems (Pages 12-13)</b>			Binder	\$315	\$595	Binder	\$270	\$510
CD	\$50	\$95	DVD	\$50	\$95	DVD	\$50	\$95
<b>Weapons Systems (Page 22)</b>			Binder & DVD	\$365	\$690	Binder & DVD	\$320	\$605
Hard Copy	\$45	\$85	Binder & RT	\$315	\$595	Binder & RT	\$270	\$510
CD	\$50	\$95	<b>Civil/Commercial Library</b>			<b>Naval</b>		
<b>Power Systems (Page 25)</b>			Binder	\$360	\$680	Binder	\$90	\$170
Hard Copy	\$45	\$85	DVD	\$50	\$95	DVD	\$50	\$95
<b>Focused Market Segment Analyses (Pages 30-34)</b>			Binder & DVD	\$410	\$775	Binder & DVD	\$140	\$265
Hard Copy	\$25	\$45	Binder & RT	\$360	\$680	Binder & RT	\$90	\$170
<b>Market Intelligence Libraries (Pages 26-27)</b>			<b>Market Intelligence Group Libraries (Pages 28-29)</b>			<b>Power</b>		
<b>Complete Library (Civil/Commercial &amp; Military)</b>			<b>Aerospace</b>			Binder		
Binder	\$1,575	\$2,975	Binder	\$360	\$680	DVD	\$50	\$95
DVD	\$50	\$95	Binder & DVD	\$410	\$775	Binder & DVD	\$140	\$265
Binder & DVD	\$1,625	\$3,070	Binder & RT	\$360	\$680	Binder & RT	\$90	\$170
Binder & RT	\$1,575	\$2,975	<b>Electronics</b>			<b>Weapons</b>		
<b>Complete Military Library</b>			Binder	\$360	\$680	Binder	\$180	\$340
Binder	\$1,440	\$2,720	DVD	\$50	\$95	DVD	\$50	\$95
DVD	\$50	\$95	Binder & DVD	\$410	\$775	Binder & DVD	\$230	\$435
Binder & DVD	\$1,490	\$2,815	Binder & RT	\$360	\$680	Binder & RT	\$180	\$340
Binder & RT	\$1,440	\$2,720	<b>NOTE: No charge for Real-Time format.</b>					

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