Commercial Space Transportation

QUARTERLY LAUNCH REPORT

Featuring the launch results from the 3rd quarter 2000 and forecasts for the 4th quarter 2000 and the 1st quarter 2001

Special Report:

Recent Developments in U.S. Expendable Launch Vehicle Technology

4th Quarter 2000

United States Department of Transportation • Federal Aviation Administration
Associate Administrator for Commercial Space Transportation
800 Independence Ave. SW Room 331
Washington, D.C. 20591

Introduction

The Fourth Quarter 2000 Quarterly Launch Report features launch results from the third quarter of 2000 (July-September 2000) and launch forecasts for the fourth quarter of 2000 (October-December 2000) and the first quarter of 2001 (January-March 2001). This report contains information on worldwide commercial, civil, and military orbital space launch events. Projected launches have been identified from open sources, including industry references, company manifests, periodicals, and government sources. Note that projected launches are subject to change.

This report highlights commercial launch activities, classifying commercial launches as one or more of the following:

- *Internationally competed launch events (i.e., launch opportunities considered available in principle to competitors in the international launch services market),*
- *Any launches licensed by the Office of the Associate Administrator for Commercial Space Transportation of the Federal Aviation Administration under U.S. Code Title 49, Section 701, Subsection 9 (previously known as the Commercial Space Launch Act).*

Contents

Photo credit: Cape Canaveral Air Station, FL, July 14, 2000 - A Lockheed Martin Atlas IIAS from Complex 36 Pad B, successfully placing the Space Systems/Loral-built EchoStar VI satellite into geosynchronous transfer orbit. Liftoff occurred at 1:21 a.m. EDT followed by successful spacecraft separation approximately 30 minutes later.

Highlights From Third Quarter 2000

Delta 3 Launch

A notable launch event in the third quarter of 2000 was Boeing's successful launch of the Delta 3 launch vehicle. The Delta 3 is the largest privately developed launch vehicle to date and serves as a bridge between Boeing's ongoing Delta 2 program and its forthcoming Delta 4 family. In particular the upper stage developed for the Delta 3 will be utilized by the Delta 4 in addition to a smaller Delta 2 derived upper stage (for smaller payloads).

On August 23, 2000 the Delta 3 successfully carried the DM-F3 satellite simulator into its planned orbit. While there is some issue as to the accuracy of the final orbit achieved by the DM-F3 payload, Boeing reports that this internally funded flight achieved all of its intended goals and paves the way for further launches with operational payloads

Two previous attempts to launch the Delta 3 were unsuccessful. On August 28, 1998 in its initial launch attempt (carrying PanAmSat's Hughes-built Galaxy 10 satellite), greater than anticipated use of hydraulic fluid exhausted the fluid supply resulting in loss of vehicle control and causing a launch failure. On its second launch attempt, manufacturing defects in the RL-10 upper stage engine caused an engine failure that kept the Orion F3 from reaching its intended GEO orbit.

Sea Launch Returns to Service

Another major launch event in the third quarter of 2000 was the return to flight of the multinational Sea Launch's Zenit 3SL. On July 28, 2000, Sea Launch returned to operation with the successful launch of PanAmSat's PAS-9 communication satellite from its Odyssey launch platform. This launch followed the March 12, 2000 loss of ICO Global communications satellite ICO Z1 (a Hughes 601 satellite) due to a logic error made while modifying ground software to suit the narrow launch window required to achieve the satellite's intended orbit.

The Boeing-led Sea Launch joint venture plans to make two more launches of the Zenit booster before the end of this year. The two payloads planned for launch this year are the Hughes-built Thuraya communications satellite for the United Arab Emirates and the Hughes-built XM radio 1 satellite designed to provide direct broadcast radio service.

Third Quarter 2000 Launch Events Summary
(July 2000 – September 2000)

Figure 1: Launch Vehicle Use

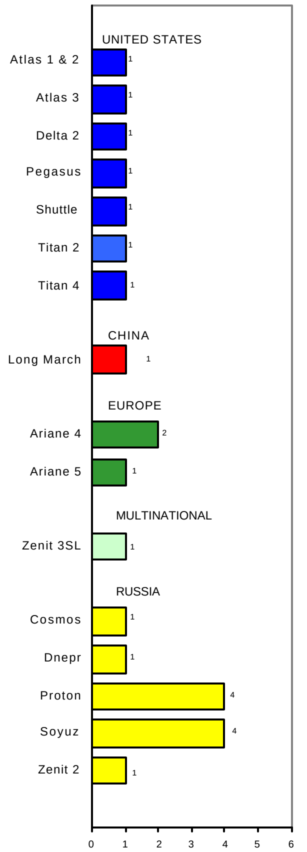

Figure 2: Launch Events by Country

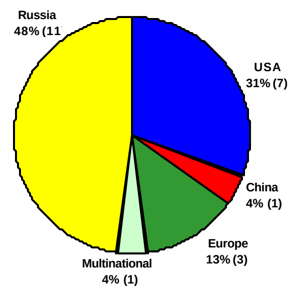

Figure 3: Commercial Launch Events by Country

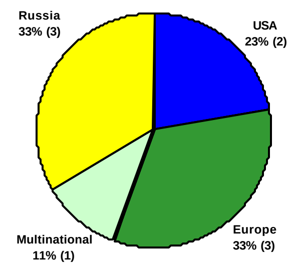

Figure 4: Payload Use Summary

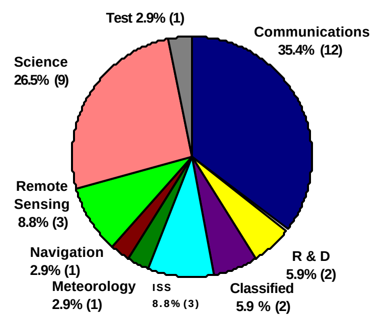

Figure 5: Launch Successes vs. Failures

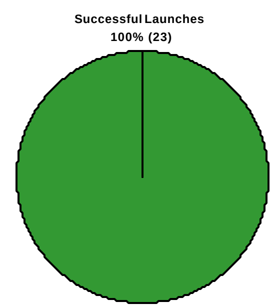

Figure 1 shows the number of launches of each launch vehicle that occurred in the third quarter of 2000. The launches are grouped by the country in which the primary vehicle manufacturer is based. Exceptions to this grouping are launches preformed by Sea Launch, which are designated as "Multinational."

Figure 2 shows all orbital launch events that occurred in the third quarter of 2000 by country.

Figure 3 shows all *commercial* orbital launch events that occurred in the third quarter of 2000 by country. The definition of "commercial" can be found on Page 1.

Figure 4 shows the payloads launched into orbit in the third quarter of 2000 by the mission of the payload. Note: the total number of payloads launched may not equal the total number of launches. This is due to multi-manifesting, i.e., the launching of more than one payload by a single launch vehicle.

Figure 5 shows launch outcome for all orbital launch events that occurred in the third quarter of 2000.

Fourth Quarter 2000 Launch Events Summary

(October – December 2000)

Figure 6: Projected Launch Vehicle Use

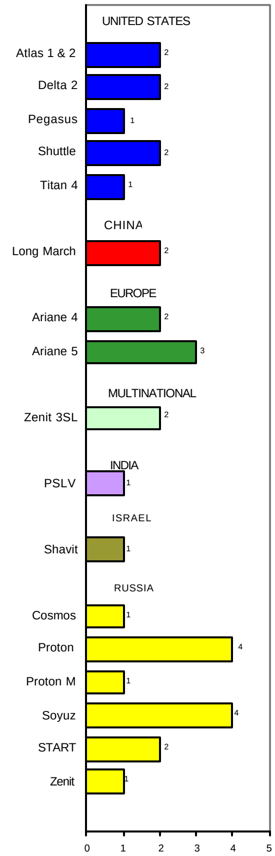

Figure 7: Projected Launch Events by Country

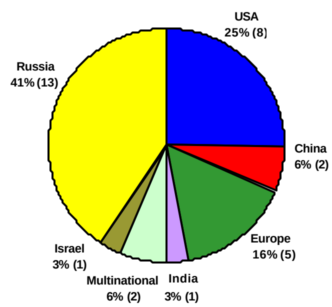

Figure 8: Projected Commercial Launch Events by Country

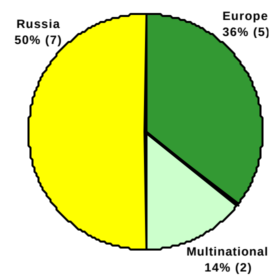

Figure 9: Projected Payload Use Summary

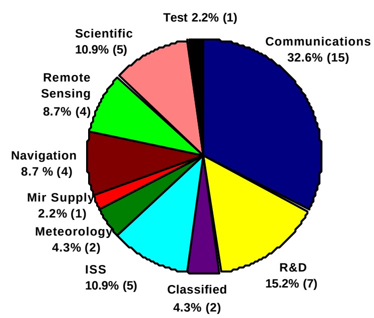

Figure 10: Projected Payload Mass Class Summary

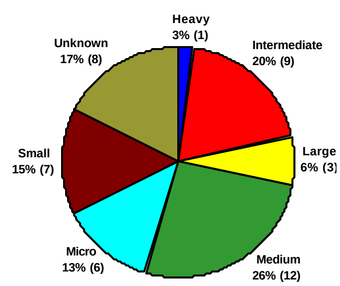

Figure 6 shows the number of launches projected to occur in the fourth quarter of 2000 by launch vehicle, by country.

Figure 7 shows all orbital launch events projected to occur in the fourth quarter of 2000 by country.

Figure 8 shows all *commercial* orbital launch events projected to occur in the fourth quarter of 2000 by country.

Figure 9 shows the payloads projected to launch into orbit in the fourth quarter of 2000 by the mission of the payload. Note: the total number of payloads launched may not equal the total number of launches. This is due to multi-manifesting, i.e., the launching of more than one payload by a single launch vehicle.

Figure 10 shows payloads projected to launch in the fourth quarter of 2000 by mass class. Micro (0 to 200 lbs.), Small (201 to 2,000 lbs.), Medium (2,001 to 5,000 lbs.), Intermediate (5,001 lbs. to 10,000 lbs.), Large (10,001 lbs. to 20,000 lbs.), and Heavy (Over 20,000 lbs.)

First Quarter 2001 Launch Events Summary

(January – March 2000)

Figure 11: Projected Launch Vehicle Use

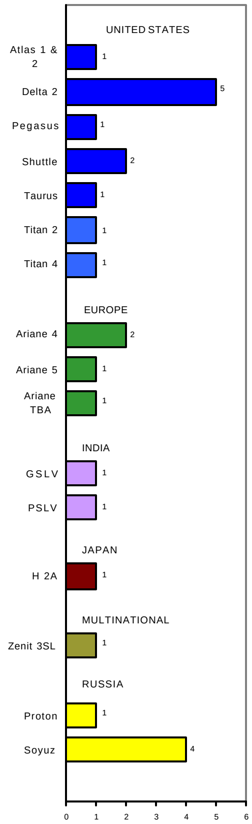

Figure 12: Projected Launch Events by Country

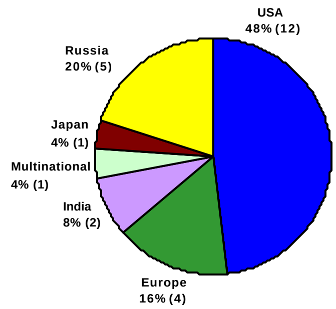

Figure 13: Projected Commercial Launch Events by Country

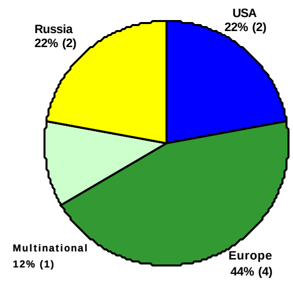

Figure 14: Projected Payload Use Summary

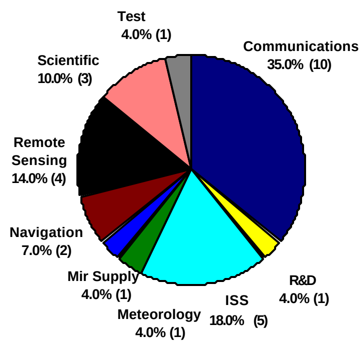

Figure 15: Projected Payload Mass Class Summary

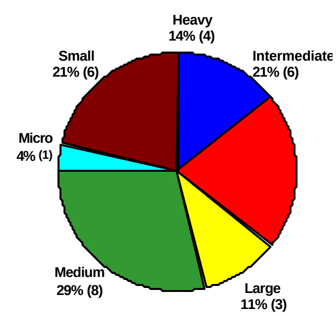

Figure 11 shows the number of launches projected to occur in the first quarter of 2001 by launch vehicle, by country.

Figure 12 shows all orbital launch events projected to occur in the first quarter of 2001 by country.

Figure 13 shows all *commercial* orbital launch events projected to occur in the first quarter of 2001 by country.

Figure 14 shows the payloads projected to launch into orbit in the first quarter of 2001 by the mission of the payload. Note: the total number of payloads launched may not equal the total number of launches. This is due to multi-manifesting, i.e., the launching of more than one payload by a single launch vehicle.

Figure 15 shows payloads projected to launch in the first quarter of 2001 by mass class. Micro (0 to 200 lbs.), Small (201 to 2,000 lbs.), Medium (2,001 to 5,000 lbs.), Intermediate (5,001 lbs. to 10,000 lbs.), Large (10,001 lbs. to 20,000 lbs.), and Heavy (Over 20,000 lbs.)

Historical Commercial Launch Trends

Figure 16: Commercial Launch Events, Last 12 Months

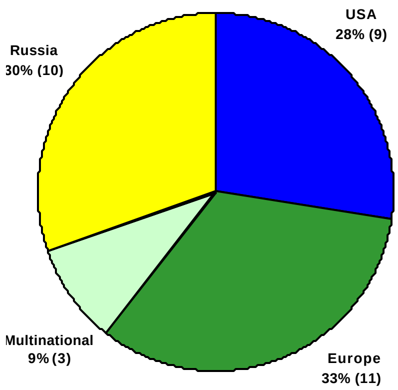

Figure 17: Commercial Launch Revenue, Last 12 Months

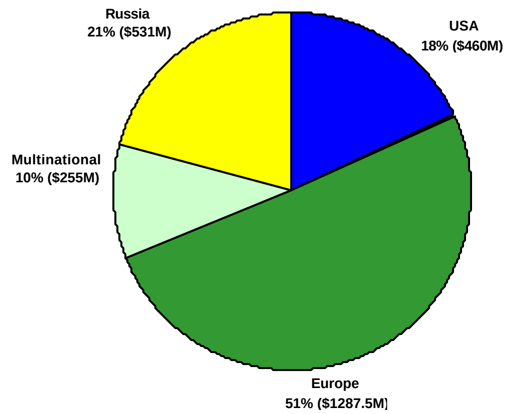

Figure 18: Commercial Launches by Country, Last Five Years

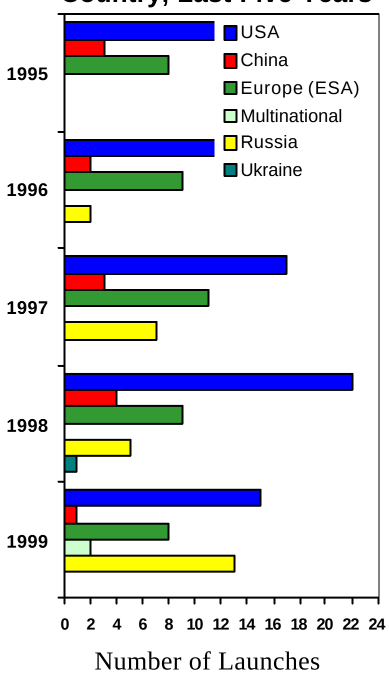

Figure 19: Commercial Launch Revenue by Country, Last Five Years

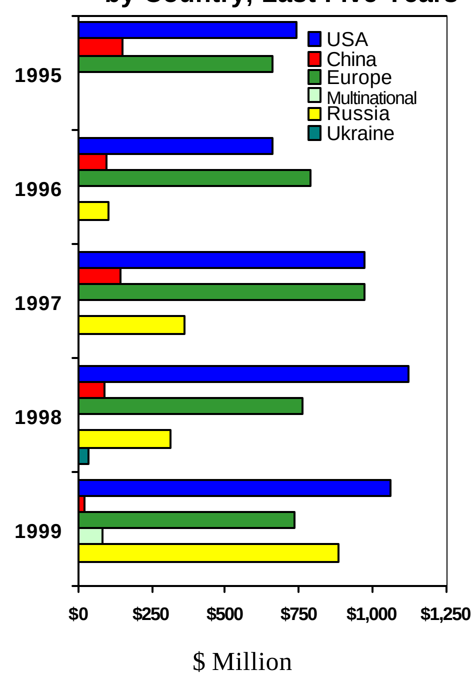

Figure 16 shows commercial launch events for the period July 1999 to June 2000 by country.

Figure 17 shows commercial launch revenue for the period July 1999 to June 2000 by country.

Figure 18 shows the trend in commercial launch events for the last five full years by country, by year.

Figure 19 shows the trend in commercial launch revenue for the last five full years by country, by year.

Recent Developments in U.S. Expendable Launch Vehicle Technology

INTRODUCTION

In recent years, a number of new developments have been initiated by the expendable launch vehicle (ELV) industry. These developments are aimed at simplifying traditionally complex launch vehicle components and processes, lowering production and operational costs, and streamlining the vehicle manufacturing and integration process.

These efforts can be grouped into three general areas: Launch Vehicle Technology, Propulsion Systems, and Operations. Each area will be discussed within the context of newly introduced or emerging launch vehicle families, including the Beal BA-2, Boeing Delta 4 series, Lockheed Martin Atlas 3 and 5 series, and the Orbital Sciences Minotaur.

BEAL BA-2

Launch Vehicle Technology

Beal Aerospace was founded by entrepreneur Andrew Beal in 1997 to provide international customers with reliable and economically attractive launch vehicles. Beal is currently developing a heavy lift launch vehicle called the BA-2. Components for the BA-2 are being designed, manufactured and integrated at factories near Beal Aerospace headquarters in Frisco, Texas.

The vehicle's three stages carry hydrogen peroxide and kerosene fuels that are pressure fed to the engines by gaseous helium. This pressure-fed system is much simpler than corresponding turbo pump systems that have intricate components with large numbers of moving parts. Environmental concerns as well as a desire for cost savings motivated the choice of hydrogen peroxide and kerosene fuel. Hydrogen peroxide produces a cleaner exhaust than most commonly used rocket fuels (an exception being hydrogen and oxygen), these fuels are safer to handle, and they require a less complex infrastructure for production and transport.

The propellant tanks of the BA-2 are manufactured using a filament-winding technique, which produces extremely durable and lightweight structures at a reasonable cost. To accommodate the large size of these tanks, Beal Aerospace designed the world's largest filament-winding machine. See Table 1 for further information about the BA-2.

Propulsion Systems

The BA-3200 engine, which has not yet been test fired, will power the BA-2 first stage. The BA-3200 produces 4,100,000 pounds of thrust. It will be the largest and most powerful liquid-fueled engine used in history, far outperforming the F-1 engine used on the Saturn 5 first stage. By comparison, the F-1 produced about 1,520,000 pounds of thrust. The engine is also the largest engine ever built by a private program with no ties to or funding from the government

The BA-810, which will power the BA-2 second stage, was successfully test fired for the third time on March 4 of this year for approximately 21 seconds, producing a thrust of 810,000 pounds.

The third stage BA-44 engine will provide 44,000 pounds of thrust, and is a gimbaled unit with restart capability. This engine was first tested in 1998.

Table 1. Specifications for Beal Aerospace BA-2

Vehicle Type	Heavy
Vehicle Capacities	LEO 37,400 lbs GTO 13,200 lbs
Thrust	First stage BA-3200: 4,100,000 lbs Second stage BA-810: 810,000 lbs Third stage BA-44: 44,000 lbs
Fuel	Hydrogen peroxide and kerosene
Number of Stages	3
Launch Site(s)	To be determined

BOEING DELTA 4

Launch Vehicle Technology

The Delta 4 Evolved Expendable Launch Vehicle (EELV) program is intended to streamline production and operations time, thereby reducing costs. The Delta 4 series consists of a common booster core (CBC) supplemented by a selection of Graphite Epoxy Solid Rocket Motors (GEM-60), two types of upper stages, and three payload fairings depending on customer needs. The Delta 4 Medium, for example, will consist of one CBC, while three versions of the Delta 4 Medium Plus will use various combinations of the GEM-60 boosters, upper stages and fairings. A heavy lift version will also be available, and will involve a combination of three core boosters with an upper stage and larger fairing. Table 2 on page SR-3 provides specifications on the Delta 4 series.

Propulsion Systems

The Delta 4 CBC will be powered by the Rocketdyne RS-68. This engine is the first engine developed in the United States since the Space Shuttle Main Engine (SSME) was developed in the 1970s. The RS-68 produces 50,000 pounds of thrust with a specific impulse of 410 seconds and is fueled by liquid oxygen and liquid hydrogen. It contributes to Delta 4 cost savings for several reasons. It has 95% fewer parts than the SSME (which is a comparable engine in terms of thrust) and requires only 8,000 hours of touch labor, compared with 171,000 hours for the SSME. In addition, the RS-68 has no welded components, instead employing parts that are cast. A computer-integrated manufacturing system is used to produce the RS-68. Five of these engines have been tested successfully as of September 2000.

The Pratt & Whitney RL10B-2 engine provides thrust for the Delta and Delta 4 upper stages. The RL-10B-2 is essentially unchanged from the proven RL10 engine, which has flown for more than 30 years. Eighty-five percent of the engine was transferred from the RL10 base design, but includes several modifications that will increase efficiency and performance. The RL10B-2 has an extended nozzle to boost specific impulse and improved gimbal actuators. It can provide 25,000 pounds of thrust.

Operations

Delta 4 CBC's are built in "focused factory" built by Boeing in Decatur, Alabama for the Delta 4 program. Integration of the CBC with the RS-68 engine also takes place at this facility. This centralization reduces production time, and therefore cost, because supplies and resources are located on site. In addition, vehicle components need not be moved to separate facilities for any reason. The site also employs an automated system designed to keep assembly on schedule and reduce labor time. The completed boosters are then shipped to Cape Canaveral Air Station (CCAS) or Vandenberg Air Force Base (VAFB) by sea. The transport time to CCAS is 14 days, with 28 days required to reach VAFB through the Panama Canal.

The CBC is an important aspect of Boeing's standardized modular approach to the Delta 4, making manufacture and operations simpler and more cost effective. In addition to production efficiencies, however, it will also use improved processing procedures. The Delta 4 will be integrated and transported in a horizontal configuration before being erected vertically at the launch pad. This horizontal integration will allow processing to occur close to the ground and away from the launch pad making processing easier and reducing the time spent on the pad before launch. This is the first time this type of vehicle processing has been used in the United States although it has long been standard for Russian vehicles.

Boeing plans to launch a medium version of the Delta 4 from CCAS in 2001 and is planning to use both the Cape and VAFB as launch sites in the long term. At CCAS Launch Complex 37 (LC-37) is the Delta 4's designated launch site. As of September 2000 LC-37 is about 75% complete. This complex includes a Mobile Service Tower (MST) which is about 60% complete, a Horizontal Integration Facility (HIF) which is almost entirely complete, and a liquid oxygen and liquid hydrogen tank farm about 80% complete.

At VAFB, Space Launch Complex 6 (SLC-6) is undergoing significant modifications to accommodate the Delta 4. Amongst other additions and modifications a Delta 4 HIF will also be constructed at SLC-6.

Table 2. Specifications for Boeing Delta 4 Series

	Delta 4 Medium	Delta 4 Medium Plus (3 variants)	Delta 4 Heavy
Vehicle Type	Intermediate	Intermediate to Heavy	Heavy
Vehicle Capacities	LEO 17,900 lbs GTO 9,285 lbs	LEO 17,600 lbs - 25,300 lbs GTO 10,230 lbs - 14,475 lbs	LEO 50,800 lbs GTO 28,950 lbs
Lift-off thrust	650,000 lbs	964,600 lbs	1,950,000 lbs
Fuel	Liquid hydrogen and liquid oxygen	Liquid hydrogen and liquid oxygen, plus 2-4 solid boosters	Liquid hydrogen and liquid oxygen
Number of Stages	2	2, plus 2-4 GEMs	4 (3 CBCs)
Launch Site(s)	CCAS and VAFB	CCAS and VAFB	CCAS and VAFB

LOCKHEED MARTIN ATLAS 5

Launch Vehicle Technology

Lockheed Martin's EELV is the Atlas 5. Like Boeing's Delta 4, the Atlas 5 series will be composed of at least one Common Core Booster (CCB, not to be confused with the Boeing CBC) powered by a single RD-180 engine. The Atlas 5 400 will simply be the CCB itself, topped by one of two available payload fairings. The Atlas 5 500 series will use a single CCB supplemented, if necessary, by up to five strap-on boosters, with one available large payload fairing. The Atlas 5 Heavy will be a combination of three CCBs topped with a 5 meter-long payload fairing. Table 3 on page SR-5 provides more detail on the Atlas 5 series.

The Atlas 5 CCB will use an RD-180 engine delivered complete to the integration facility, and an avionics module common to all variants. On previous Atlas launch vehicles, the engine was reassembled after testing and avionics packages were specifically designed for each type of launch vehicle, making interchangeability impossible.

Launch vehicle reliability is also a major goal in the Atlas 5 program, with a first stage design reliability expected to be .9954. The Atlas 5 401 has approximately 125 single point failures as opposed to over 250 for the Atlas 2AS. It will also have 100% availability during high-wind conditions in the upper atmosphere (up from 90% availability for the Atlas 2).

Four different flight-proven payload adapters will also be available, and can be interchanged among the several Atlas 5 variants. The Atlas 5 will be available beginning in 2002, with the proposed Atlas 5 Heavy to be produced and delivered upon order.

The Lockheed Martin Atlas 3A had a successfully initial launch from Cape Canaveral Air Station (CCAS) on May 24, 2000. Marketed by International Launch Services (ILS) the Atlas 3A is a transitional launch vehicle to be used until the Atlas 5 becomes fully operational. The Atlas 3 represents an initial effort to reduce with improved first stage fuel tank construction, reduced component complexity and an increase in overall launch vehicle performance. The Atlas 3 first stage thrust section only undergoes one staging event, and the engine is supplied by only seven fluid interfaces. The Atlas 2 thrust section, by comparison, undergoes six staging events and its engines are supplied by seventeen fluid interfaces. New versions of the Centaur Upper Stage also are used on the Atlas 3 series, paving the way for their use on the Atlas 5. The Atlas 3 program will provide valuable experience needed for Atlas 5 production and operation and once the Atlas 5 is operational, the Atlas 3 will be phased out.

Propulsion Systems

The Glushko RD-180 is used to power the Atlas 3 first stage, and will also be used on the Atlas 5 CCB. The engine is a derivative of the RD-171 engine used to power the Zenit Launch vehicle's first stage. This engine represents a cooperative venture between Russian industry and Pratt & Whitney. Seventy percent of the RD-171's parts were transferred directly into the design of the RD-180. The dual thrust chamber, burning liquid oxygen and kerosene, has two gimbaled nozzles and provides 933,000 pounds of thrust. The 338-second specific impulse engine uses a health monitoring system, a single-stage oxygen pump, a self-contained hydraulic system and has a 47-100% throttling range.

The RD-180 has significantly fewer vehicle and pad interfaces than the MA-5A and RS-56 series engines used on the Atlas 2, reducing the chance of leaks and simplifying operations. It requires only twelve days to assemble and inspect before it is ready to be mated to the first stage where the main engines on the Atlas 2AS require 80 days for the same process. The RD-180-powered first stage undergoes only one staging event, while previous Atlas variants required several staging events during the first phase of flight increasing the chances of system failure.

The Centaur Upper Stage used by the Atlas 3A uses a single engine. The removal of one RL10A-4-1 engine and the centering of the remaining engine along the Centaur's axis differentiate it from earlier Centaur versions. The upper stage for the Atlas 3B is a stretched version of the Centaur and is outfitted with two RL10A-4-2 engines, each producing a thrust of 22,300 pounds. The RL10A-4-2 engines are virtually identical to their predecessors, but include upgrades (such as chiller modifications and a health monitoring system) designed to increase reliability and operational standards. Each of these engines burn liquid oxygen and liquid hydrogen. Both the single-engine Centaur and the stretched Centaur with dual RL10A-4-2 engines will be used on the Atlas 5 series as well as on the Atlas 3.

Operations

LC-41 at CCAS is being constructed for the Atlas 5 launch vehicle's payload integration and launch. The Atlas 5 Vertical Integration Facility will provide a completely enclosed and clean environment for processing, as well as full weather protection for the launch vehicle and payload. LC-41 is designed to limit the time an Atlas 5 launch vehicle spends on the pad, provide common processing for all Atlas 5 vehicle configurations, and sustain a high launch rate. In addition, facilities have been designed with reduced maintenance and refurbishment requirements in mind.

LC-41 is designed to provide complete mission flexibility, since fuel and transportation of equipment and supplies are provided on site. In addition, the vehicle will be protected during inclement weather, and moved to its pad in a very short time. The simplification of launch vehicle and payload integration is designed to permit a higher launch capacity. These improvements in flexibility and efficiency should translate to cost savings and more frequent launch activity from the site.

Table 3. Specifications for Lockheed Martin Atlas 5 Series

	Atlas 5 400	**Atlas 5 500 (6 variants)**	**Atlas 5 Heavy**
Vehicle Type	Intermediate	2 intermediate and 4 heavy	Heavy
Vehicle Capabilities	LEO 20,000 lbs GTO 10,900 lbs	LEO 19,900 lbs - 38,200 lbs GTO 8,700 lbs - 19,100 lbs	GTO 28,660 lbs GEO 14,310 lbs
Lift-off Thrust	860,200 lbs	1,000,120 lbs - 1,787,720 lbs	2,580,600 lbs
Fuel	Liquid hydrogen and liquid oxygen	Liquid hydrogen and liquid oxygen, solid boosters	Liquid hydrogen and liquid oxygen
Number of Stages	2	2, plus 0 to 5 solid boosters	4 (3 CCBs)
Launch Site(s)	CCAS	CCAS	CCAS

ORBITAL SCIENCES MINOTAUR

Launch Vehicle Technology

Orbital Sciences Corporation, in conjunction with the Air Force, introduced the Minotaur launch vehicle by launching it for the first time on January 26, 2000 from Vandenberg Air Force Base. The Minotaur is a significantly modified version of the Minuteman 2 ballistic missile, a deactivated weapon system used by the Air Force during the Cold War. The first and second stage components, some of which are thirty years old, are used with little modification and mated to an Orion 38 and Orion 50XL upper stage (essentially Pegasus XL upper stages). Orbital's modular avionics are installed, and a either of two fairings can be used. Table 4 below provides statistics on the Minotaur.

Operations

The Air Force-initiated Minotaur program is an effort to reduce waste by using retired but well maintained and flight-ready Minuteman 2 missiles. The Minotaur provides a cost-effective and simplified mission profile for Air Force-approved customers specializing in small payloads. Minotaur launch vehicles can be launched from the CCAS, VAFB, Virginia's Wallops Island and Alaska's Kodiak Island with minimal infrastructure modifications.

The launch facilities consist of a 20-foot tall launch stool, an umbilical tower, a movable gantry system (composed of commercially procured scaffolding), a Launch Support Van that contains the launch vehicle support equipment and houses the launch team during operations, and a Launch Equipment Vault that houses batteries and other support equipment on the launch pad. The launch vehicle's solid propellant is vulnerable to cold temperatures, so the launch facilities include a thermal blanket. The blanket is normally removed by ground personnel, but it is possible for the vehicle to simply fly out of the sheath during extreme weather conditions.

The Minotaur's first stage (designated M-55A1) is required to be compliant with international arms control treaties. The treaty compliance requirements include the disclosure of all vehicle telemetry and certain limitations on launch locations for the vehicle.

Table 4. Specifications for Orbital Sciences Minotaur

Vehicle Type	Small
Vehicle Capabilities	LEO 700 lbs - 1100 lbs
Lift-off Thrust	200,435 lbs
Fuel	Solid
Number of Stages	4
Launch Site(s)	CCAS, VAFB, Wallops Island, and Kodiak Island

Third Quarter 2000 Orbital Launch Events

Date		Vehicle	Site		Payload	Operator	Manufacturer	Use	Vehicle Price	L	M
7/5/00		Proton (SL-12)	Baikonur		Kosmos 2371	Russian MoD	Russia	Communications	$75-85M	S	S
7/12/00		Proton (SL-13)	Baikonur		Zvezda	Russia	RKK Energia	ISS	$75-85M	S	S
7/14/00	√ +	Atlas 2AS	CCAS	*	Echostar 6	EchoStar Satellite Corp.	SS/Loral	Communications	$90-105M	S	S
7/15/00	√	Cosmos	Plesetsk		Champ	DARA	Jena-Optronik GmbH	Scientific	$12-14M	S	S
					Mita	Italian Space Agency (ASI)	Carlo Gavazzi Space	Communications			
					RUBIN	Germany	OHB System	Scientific			
7/16/00		Delta 2 7925	CCAS		Navstar GPS 2R- 5	DoD	Lockheed Martin	Navigation	$50-60M	S	S
7/16/00		Soyuz	Baikonur		Salsa	ESA	Dornier	Scientific	$35-40M	S	S
					Samba	ESA	Dornier	Scientific			
7/19/00		Minotaur	VAFB		MightySat 2-1	DoD	Spectrum Astro, Inc.	Development	$12-14M	S	S
					DARPA Picosat 2	DARPA	DARPA	Scientific			
7/28/00	√ +	Zenit 3SL	Sea Launch Platform	*	PAS 9		Hughes	Communications	$75-85M	S	S
8/6/00		Soyuz	Baikonur		Progress M-ISS-01	RKK Energia	RKK Energia	ISS	$35-40M	S	S
8/9/00		Soyuz	Baikonur		Rumba	ESA	Dornier	Scientific	$35-40M	S	S
					Tango	ESA	Dornier	Scientific			
8/17/00		Titan 4B	VAFB		NRO 2000-2	NRO	TBA	Classified	$350-450M	S	S
8/17/00	√	Ariane 44LP	Kourou	*	Nilesat 102	ERTU	Matra Marconi Space	Communications	$90-110M	S	S
				*	Brazilsat B4	Embratel	Hughes	Communications			
8/23/00	√ +	Delta 3	CCAS		DM-F3	Boeing	Boeing	Test	$75-90M	S	S
8/28/00		Proton (SL-12)	Baikonur		Globus 2	Russia/CIS MoD	Russia	Communications	$75-85M	S	S
8/31/00		Long March 4B	Taiyuan		Ziyuan 2	China	China	Remote Sensing	$25-35M	S	S
9/5/00	√	Proton (SL-12)	Baikonur	*	Sirius Radio 2	Sirius Satellite Radio Inc.	SS/Loral	Communications	$75-85M	S	S
9/6/00	√	Ariane 44LP	Kourou	*	Eutelsat W1R	Eutelsat	Alcatel Espace	Communications	$90-110M	S	S
9/8/00		Shuttle Atlantis	KSC		ISS 2A.2b	NASA	NASA	ISS	$300M	S	S
					STS 106	NASA	Rockwell	Crewed			
9/14/00	√	Ariane 5	Kourou	*	Astra 2B	SES	Matra Marconi Space	Communications	$150-180M	S	S
				*	GE 7	GE Americom	Lockheed Martin	Communications			
9/21/00		Titan 2	VAFB		NOAA L	NOAA	Lockheed Martin	Meteorological	$30-40M	S	S

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Third Quarter 2000 Orbital Launch Events

Date		Vehicle	Site		Payload	Operator	Manufacturer	Use	Vehicle Price	L	M
9/25/00		Zenit 2	Baikonur		Kosmos 2372	Russia	Russia	Classified	$35-50M	S	S
9/26/00	√	Dnepr 1	Baikonur	*	MegSat 1	MegSat S.P.A	MegSat S.P.A	Communications	$10-20M	S	S
					Saudisat 1-1	Space Research Inst.	Space Research Inst.	Scientific			
					Saudisat 1-2	Space Research Inst.	Space Research Inst.	Scientific			
					Tiungsat 1	TBA	TBA	Remote Sensing			
					Unisat	University of Rome	University of Rome	Development			
9/29/00		Soyuz	Baikonur		Kosmos 2373	Russia	Russia	Remote Sensing	$35-40M	S	S

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Fourth Quarter 2000 Projected Orbital Launch Events

Date		Vehicle	Site		Payload	Operator	Manufacturer	Use	Vehicle Price
10/1/00	√	Proton (SL-12)	Baikonur	*	GE 1A	Americom Asia-Pacific	Lockheed Martin	Communications	$75-85M
10/5/00		Shuttle Discovery	KSC		ISS 3A	NASA	NASA	ISS	$300M
					STS 92	NASA	Rockwell	Crewed	
10/6/00	√	Ariane 42L	Kourou	*	NSat 110	JSAT/SCC	Lockheed Martin	Communications	$80-100M
10/7/00		+Pegasus XL	Kwajalein		HETE-2	MIT	MIT	Scientific	$12-15M
10/12/00		Atlas 2A	CCAS		DSCS III 3-12	DoD	Lockheed Martin	Communications	$90-105M
10/15/00	√	Soyuz	Baikonur		Progress M1-3	MirCorp	RKK Energia	Mir Supply	$35-40M
10/20/00	√	Proton (SL-12)	Baikonur	*	GE 6	GE Americom	Lockheed Martin	Communications	$75-85M
10/30/00		Soyuz	Baikonur		ISS 2R	NASA	NASA	ISS	$35-40M
10/31/00	√	Ariane 5	Kourou	*	PAS 1R	PanAmSat	Hughes	Communications	$150-180M
					AMSAT Phase 3-D	AMSAT	AMSAT - Deutschland	Communications	
					STRV 1C	British MoD	DRA	Development	
					STRV 1D	British MoD	DRA	Development	
10/XX/00	√	+Zenit 3SL	Sea Launch Platform	*	Thuraya 1	Thuraya Sat. Comm. Co.	Hughes	Communications	$75-90M
10/XX/00		Long March 2F	Jiuquan		Shenzhou 2	China NSA	China RICRT	Development	N/A
10/XX/00	√	START 1	Plesetsk	*	EROS A1	West Indian Space	IAI	Remote Sensing	$5-10M
11/7/00	√	Ariane 44L	Kourou	*	Anik F1	Telesat Canada	Hughes	Communications	$100-125M
11/9/00		Delta 2 7925	CCAS		Navstar GPS 2R- 6	DoD	Lockheed Martin	Navigation	$50-60M
					ProSEDS	NASA	University of Michigan	Development	
11/14/00		Soyuz	Baikonur		Progress M-ISS-02	RKK Energia	RKK Energia	ISS	$35-40M
11/16/00		Delta 2 7320	VAFB		Earth Observing 1	NASA	Swales & Ass./Lincoln Labs	Development	$45-55M
					Citizen Explorer	Colorado SGC	Colorado SGC	Scientific	
					Munin	TBA	IRF	Scientific	
					SAC C	Argentina	Bariloche Company Invap.	Scientific	
11/28/00	√	Ariane 5	Kourou	*	Eurasiasat 1	Eurasiasat SM	Alcatel Espace	Communications	$150-180M
11/30/00		Shuttle Endeavour	KSC		ISS 4A	NASA	NASA	ISS	$300M
					STS 97	NASA	Rockwell	Crewed	

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Fourth Quarter 2000 Projected Orbital Launch Events

Date		Vehicle	Site		Payload	Operator	Manufacturer	Use	Vehicle Price
11/XX/00	√	Proton (SL-12)	Baikonur	*	Sirius Radio 3	Sirius Satellite Radio Inc.	SS/Loral	Communications	$75-85M
11/XX/00	√	START 1	Svobodny		Odin	Swedish National	Swedish Space	Scientific	$5-10M
12/5/00		Atlas 2AS	CCAS		NRO 2000-1	NRO	TBA	Classified	$90-105M
12/12/00		Soyuz	Baikonur		Progress M-	RKK Energia	RKK Energia	ISS	$35-40M
12/19/00	√	Ariane 5	Kourou	*	GE 8	GE Americom	Lockheed Martin	Communications	$150-180M
				*	Astra 2D	SES	Hughes	Communications	
					Ldrex	NASDA	N/A	Development	
12/XX/00		Zenit 2	Baikonur		Meteor 3M-1	Russia	VNII Elektromekhaniki	Meteorological	$35-50M
					Badr 2	SUPARCO	SUPARCO	Remote Sensing	
					Maroc-Tubsat	TBA	TBA	Development	
					Reflector	TBA	TBA	TBA	
4th Quarter		Proton M	Baikonur	*	Ekran M	Russia/CIS PTT	NPO PM	Communications	$85-100M
4th Quarter	√	Cosmos	Plesetsk	*	QuickBird 1	Earthwatch, Inc.	Ball Aerospace	Remote Sensing	$12-14M
4th Quarter	√	+Zenit 3SL	Sea Launch Platform	*	XM Radio 1	XM Satellite Radio, Inc.	Hughes	Communications	$75-85M
4th Quarter		PSLV	Sriharikota		TES	India	India	Remote Sensing	$15-25M
4th Quarter		Long March 4B	Taiyuan		New Gen. FSW	China (Unknown)	China	Meterological	$25-35M
2000		Shavit 1	Palmachim AFB		Offeq 5	Israel Space Agency	IAI	Intelligence	$10-15M
2000		Titan 4B/Centaur	CCAS		Milstar II-F2	DoD/USAF	Lockheed Martin	Communications	$350-450M
2000		Proton (SL-12)	Baikonur		Kosmos 2376	Russian MoD	NPO PM	Navigation	$75-85M
					Kosmos 2374	Russian MoD	NPO PM	Navigation	
					Kosmos 2375	Russian MoD	NPO PM	Navigation	

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First Quarter 2001 Projected Orbital Launch Events

Date			Vehicle	Site		Payload	Operator	Manufacturer	Use	Vehicle Price
1/15/01			Titan 2	VAFB		DMSP 5D-3-F16	DoD	Lockheed Martin	Meteorological	$30-40M
1/18/01			Shuttle Atlantis	KSC		ISS 5A	NASA	NASA	ISS	$300M
						STS 98	NASA	Rockwell	Crewed	
1/30/01			Delta 2 7925	CCAS		Navstar GPS 2R- 7	DoD	Lockheed Martin	Navigation	$50-60M
1/XX/01	√		Ariane TBA	Kourou	*	Intelsat 9 F1	Intelsat	SS/Loral	Communications	N/A
1/XX/01			Soyuz	Baikonur		ISS 3S	TBA	N/A	ISS	$35-40M
2/1/01			Soyuz	Baikonur		Progress M-ISS-04	RKK Energia	RKK Energia	ISS	$35-40M
2/10/00			Delta 2 7326	CCAS		Genesis	NASA/ JPL	Lockheed Martin	Scientific	$45-55M
2/15/01			Shuttle Discovery	KSC		ISS 5A.1	NASA	Rockwell	Crewed	$300M
						MPLM 1	NASA	N/A	ISS	
36943	√	+	Atlas 2AS	CCAS	*	Tempo 1	DirecTV, Inc.	SS/Loral	Communications	$90-105M
2/XX/00			Delta 2 7925	CCAS		Navstar GPS 2R- 8	DoD	Lockheed Martin	Navigation	$50-60M
2/XX/00			H 2A 202	Tanegashima		MDS 1	NASDA	N/A	Development	$75-95M
3/1/01			Delta 2 7925	CCAS		GeoLite	NRO	TRW	Communications	$50-60M
3/7/01			Delta 2 7920	VAFB		TIMED	NASA	APL	Scientific	$45-55M
						Jason 1	NASA/CNES	Aerospatiale	Remote Sensing	
3/28/01			Soyuz	Baikonur		Docking Compartment 1	RKA	N/A	ISS	$35-40M
3/28/01			Pegasus XL	CCAS		HESSI	NASA	Spectrum Astro, Inc.	Scientific	$12-15M
3/31/01	√	+	Taurus 1	VAFB	*	OrbView 4	Orbimage	OSC	Remote Sensing	$18-20M
						QuikTOMS	Orbital Sciences Corp.	OSC	Remote Sensing	
3/XX/01			Titan 4	CCAS		Milstar II-F3	DoD/USAF	Lockheed Martin	Communications	$350-450M
1st Quarter			GSLV	Sriharikota Range (SHAR)		Gramsat 1	ISRO	ISRO	Communications	$25-45M
1st Quarter	√		Proton (SL-12)	TBA	*	PAS 10	PanAmSat	Hughes	Communications	$75-85M

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First Quarter 2001 Projected Orbital Launch Events

Date		Vehicle	Site		Payload	Operator	Manufacturer	Use	Vehicle Price
1st Quarter	√	Ariane 5	Kourou	*	AmeriStar 1	WorldSpace, Inc.	Alcatel Espace	Communications	$150-180M
1st Quarter	√	Ariane 4 TBA	Kourou	*	Measat 3	Bina Riang Pte. Ltd.	TBA	Communications	N/A
1st Quarter		PSLV	Sriharikota Range (SHAR)		IRS P5	ISRO	ISRO	Remote Sensing	$15-25M
					BIRD	DLR	DLR	Test	
1st Quarter	√	Soyuz	Baikonur	*	Soyuz TM-31	MirCorp	RKK Energia	Mir Suply	$35-40M
1st Quarter	√	+ Zenit 3SL	Sea Launch Platform	*	XM Radio 2	XM Radio	Hughes	Communications	$75-90M
1st Quarter	√	Ariane 44LP	Kourou	*	Europe Star 1	Europe Star	Alcatel Espace	Communications	$90-110M

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