

Appendix A
ELV Specifications and Descriptions

SPECIFICATIONS AND DESCRIPTION OF EXPENDABLE LAUNCH VEHICLES (ELVs)

TAURUS II LAUNCH VEHICLE

Orbital Sciences Corporation is currently developing the Taurus II, which is designed to carry medium-class payloads into a variety of orbits (See Figure A-1). More information on Taurus II is provided below.

Taurus II is a two-stage launch vehicle designed to transport medium-class payloads weighing up to 5,750 kg (12,676 lbs) (Orbital, 2008). An optional third stage can be added. Taurus II incorporates both liquid and solid stages; the first stage uses liquid oxygen (LOX) and rocket propellant-1 (RP-1) as the propellant, the second stage is a solid motor propelled by hydroxyl-terminated polybutadiene (HTPB), and the optional third stage called Orbit Raising Kit (ORK) uses bipropellant hypergolics (nitrogen tetroxide [NTO] and monomethyl hydrazine [MMH]). For high-energy orbits, a Star 48V solid propellant kick motor could be used as a third stage.

Taurus II will stand roughly 40 meters (131 feet) tall, assuming a 9- to 10-meter- (30- to 33-foot-) long payload fairing. The 2.36-meter- (7.74-foot-) diameter Castor 30 second stage would fit within a 3.9-meter- (12.8-foot-) diameter, 4 to 5-meter- (13 to 16 foot-) tall “interstage” section.

Stage 1 will carry approximately 177,436 kg (391,179 lbs) of LOX and 65,000 kg (142,339 lbs) of RP-1 propellant, weigh 18,751 kg (41,253 lbs) empty, and stand 27 meters (88 feet) tall. The first stage structure features two AJ26-62 (Americanized Ukrainian NK33) engines.

The first option for Stage 2 would use a new Castor 30 motor fueled by a solid composite propellant with AP, aluminum, and HTPB. Propellant weight for the Castor 30 is 12,815 kg (28,252 lbs). A second option for Stage 2 would utilize a liquid-propelled motor that will carry approximately 13,250 liters (3,500 gallons) of LOX and 10,600 liters (2,800 gallons) of liquid methane (CH₄).

The optional third stage consists of a 3-engine bipropellant hypergolic pressure-fed propulsion system called an ORK. After completion of the second stage burn, the Castor 30 motor would be jettisoned from the ORK, allowing the third stage to provide the final precision orbit insertion burn and/or orbit raising maneuvers. The ORK will contain up to 322 kg (710 lbs) of NTO as oxidizer and 358 kg (789 lbs) of MMH as fuel. For higher energy missions, the Taurus II third stage could be a Star 48V solid propellant kick motor that would utilize 2,010 kg (4,431 lbs) of composite (AP, ammonium, and HTPB) propellant.

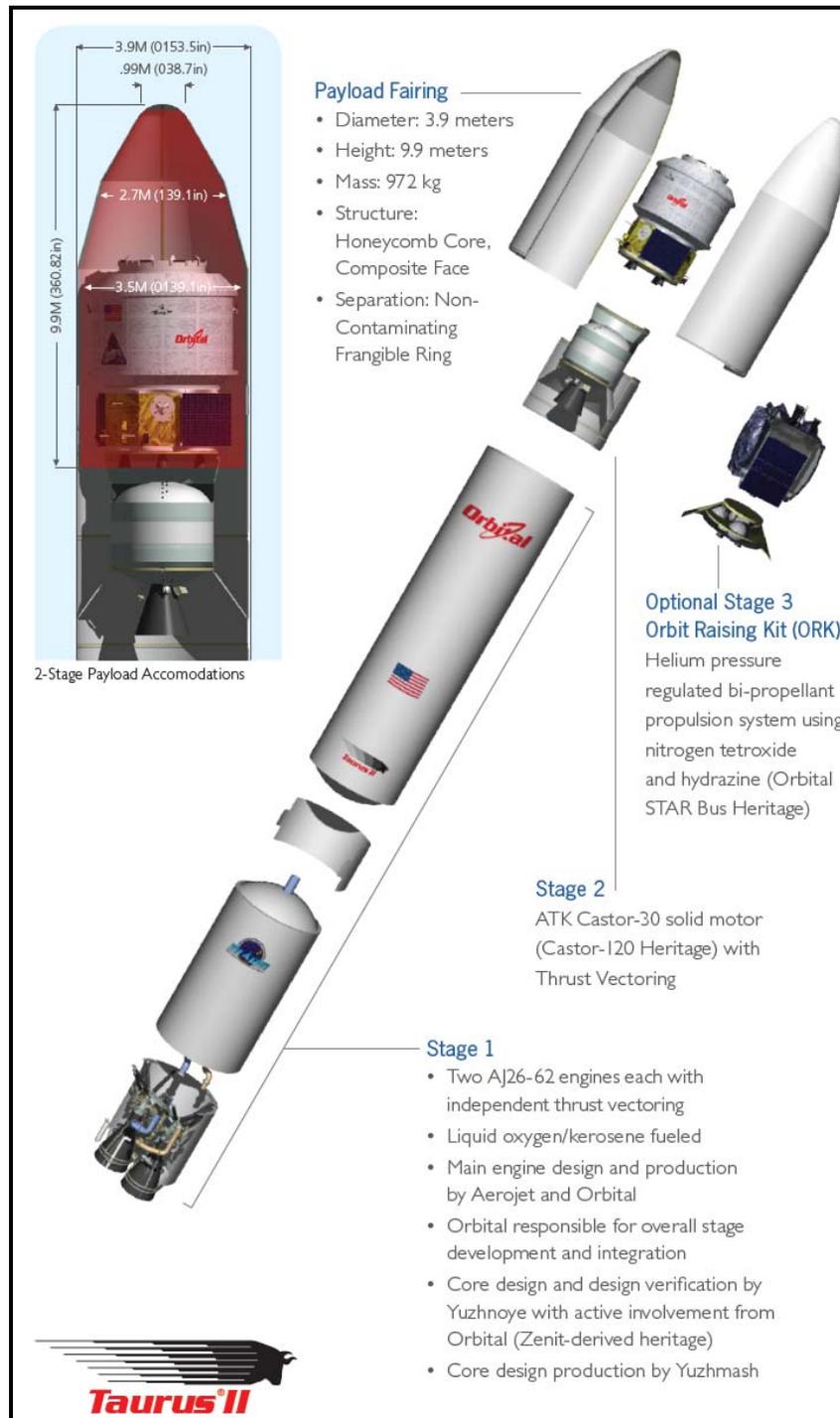


Figure A-1. Taurus II Rocket Configuration (Source: Orbital Taurus II Fact Sheet, 2008)

FALCON FAMILY OF LAUNCH VEHICLES

The Falcon family of launch vehicles utilizes a partially reusable launch system designed and manufactured by SpaceX. The two-stage-to-orbit rockets use LOX/RP-1 for both stages.

Falcon 1 and 1e

The Falcon 1 is a small, unmanned, light-lift, two-stage, liquid-fueled vehicle with a gross lift-off weight of approximately 27,273 kg (60,000 lbs) that can carry payloads between 125 kg (275 lbs) and 454 kg (1000 lbs) depending on the orbit. The Falcon 1 measures 21 meters (70 feet) in length with a diameter of 167 centimeters (66 inches), tapering to 152 centimeters (60 inches) on the second stage.

The Falcon 1e is based on the Falcon 1; however, it has an extended first stage tank. The Falcon 1e is also rated as a light-class launch vehicle with a gross lift-off weight of approximately 35,000 kg (77,000 lbs) and an overall length of approximately 27.4 meters (90 feet).

Both the first and second stages of the Falcon 1 and Falcon 1e use only liquid propellants (LOX and RP-1). The first stage uses a turbo pump to feed the propellant, while the second stage is pressure-fed using gaseous helium stored in high pressure, composite over-wrapped cylinders to pressurize the propellant tanks. Quantities of helium required for Falcon 1 processing are 16.5 kg (36.9 lbs) for first stage pressurization, engine spin start, and purging, and 9.8 kg (21.7 lbs) for second stage pressurization. The helium flow is controlled through solenoid valves. Propellant use and specifications for each stage are as follows.

First and Second Stages

The first stage uses a turbo pump to feed the propellant, while the second stage is pressure-fed using gaseous helium stored in high-pressure, composite over-wrapped cylinders to pressurize the propellant tanks.

The first stage consists of aluminum LOX and RP-1 tanks with a common bulkhead powered by a 40,823 kg (90,000 lbs) thrust Merlin LOX/RP-1 engine with Pintle Injector, a pump-fed gas generator cycle, turbine exhaust roll control, and hydraulic thrust vector control. The propellant tanks hold 15,586 kg (34,362 lbs) of LOX and 7,159 kg (15,782 lbs) of RP-1. The second stage consists of aluminum-lithium LOX and RP-1 tanks with a common bulkhead, and uses helium as a pressurant. The engine is a 3,402 kg (7,500 lbs) thrust Kestrel engine with Pintle injector, hot helium attitude control, and an electromagnetic actuator for thrust vector control. The propellant tanks hold 5,941 kg (5,941 lbs) of LOX and 1,142 kg (2,517 lbs) of RP-1. Please refer to Table 4 of this EA for amounts of LOX and RP-1 and engine specifications for Falcon 1e.

Falcon 9

The Falcon 9 is a medium class launch vehicle with a gross lift-off weight of approximately 315,000 kg (693,000 lbs) and an overall length of 54 meters (178 feet). The Falcon 9 uses LOX and RP-1 to carry payloads into orbit and is basically a scaled-up version of the Falcon 1 vehicle.

First and Second Stages

The first stage of the Falcon 9 is approximately 3.6 meters (12 feet) by 30.5 meters (100 feet), and includes 9 Merlin engines, the same engine used on the first stage of the Falcon 1. The second stage is approximately 3.6 meters (12 feet) by 12.5 meters (41 feet), not including the fairing and payload, and uses one or two Merlin engines. The fairing is 5.2 meters (17 feet) by 15.2 meters (50 feet), and a smaller version may also be used. The first stage consists of LOX and kerosene tanks that hold 146,000 liters (38,672 gallons) of LOX and 94,000 liters (24,840 gallons) of kerosene. The second stage consists of 27,600 liters (7300 gallons) of LOX and 17,400 liters (4600 gallons) of kerosene in tanks with a common bulkhead.



Figure A-2. Falcon 9 sitting on launch pad (*Source: SpaceX, 2008*)