GPS IIF-4

Atlas V

MISSION OVERVIEW

SLC-41
CCAFS, FL

ULA®
United Launch Alliance

ATLAS®

The ULA team is proud to be the launch provider for the U.S. Air Force (USAF) Global Positioning System (GPS) Directorate by delivering replenishment satellites aboard Atlas V and Delta IV launch vehicles. GPS satellites serve and protect our warfighters by providing navigational assistance for U.S. military operations on land, at sea, and in the air. Civilian users around the world also use and depend on GPS for highly accurate time, location, and velocity information.

GPS IIF-4 is one of the next generation GPS satellites, incorporating various improvements to provide greater accuracy, increased signals, and enhanced performance for users.

The ULA team is focused on attaining Perfect Product Delivery for the GPS IIF-4 mission, which includes a relentless focus on mission success (the perfect product) and also excellence and continuous improvement in meeting all of the needs of our customers (the perfect delivery).

We sincerely thank the entire team, which includes the USAF, The Aerospace Corporation, ULA, and our suppliers and other mission partners, for their continued hard work, and commitment to mission success and perfect product delivery.

Go Atlas, Go GPS!

Jim Sponnick
Vice President, Mission Operations

Atlas V GPS IIF-4

GPS IIF-4 SATELLITE | Overview

The Navstar GPS is a constellation of satellites that provides navigation data to military and civilian users worldwide. The system is operated and controlled by the 50th Space Wing, located at Schriever Air Force Base, CO.

GPS utilizes 24 satellites, in six different planes, with a minimum of four satellites per plane, positioned in orbit approximately 11,000 miles above the Earth's surface. The satellites continuously transmit digital radio signals pertaining to the exact time (using atomic clocks) and exact location of the satellites. The GPS IIF series has a design life of 12 years. With the proper equipment, users can receive these signals to calculate time, location, and velocity. The signals are so accurate that time can be measured to within a millionth of a second, velocity within a fraction of a mile per hour, and location to within feet. Receivers have been developed for use in aircraft, ships, land vehicles, and to hand carry.

As a result of increased civil and commercial use as well as experience in military operations, the USAF has added the following capabilities and technologies to the GPS IIF series to sustain the space and control segments while improving mission performance:

- Two times greater predicted signal accuracy than heritage satellites.
- New L5 signals for more robust civil and commercial aviation.
- An on-orbit, reprogrammable processor, receiving software uploads for improved system operation.
- Military signal "M-code" and variable power for better resistance to jamming hostile environments, meeting the needs of emerging doctrines of navigation warfare.

ATLAS V 401 LAUNCH VEHICLE | Overview

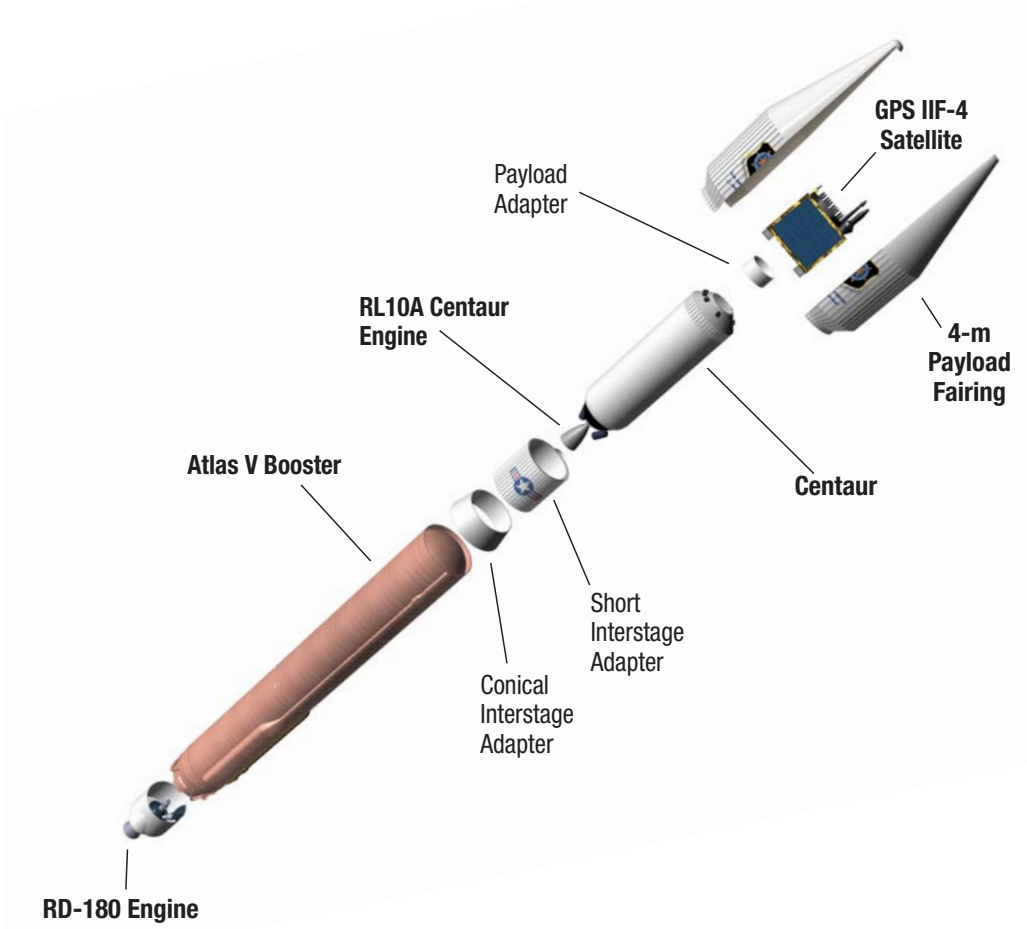
The Atlas V 401 consists of a single Atlas V booster stage, the Centaur upper stage, and a 4-m diameter payload fairing (PLF).

The Atlas V booster is 12.5 ft in diameter and 106.5 ft in length. The booster's tanks are structurally rigid and constructed of isogrid aluminum barrels, spun-formed aluminum domes, and intertank skirts. Atlas booster propulsion is provided by the RD-180 engine system (a single engine with two thrust chambers). The RD-180 burns RP-1 (Rocket Propellant-1 or highly purified kerosene) and liquid oxygen, and delivers 860,200 lb of thrust at sea level. The Atlas V booster is controlled by the Centaur avionics system, which provides guidance, flight control, and vehicle sequencing functions during the booster and Centaur phases of flight.

The Centaur upper stage is 10 ft in diameter and 41.5 ft in length. Its propellant tanks are constructed of pressure-stabilized, corrosion resistant stainless steel. Centaur is a liquid hydrogen/liquid oxygen- (cryogenic-) fueled vehicle. It uses a single RL10A-4-2 engine producing 22,300 lb of thrust. The cryogenic tanks are insulated with a combination of helium-purged insulation blankets, radiation shields, and spray-on foam insulation (SOFI). The Centaur forward adapter (CFA) provides the structural mountings for the fault-tolerant avionics system and the structural and electrical interfaces with the spacecraft.

The GPS IIF-4 satellite is encapsulated in the 4-m (14-ft) diameter large payload fairing (LPF). The 39.3-ft long LPF is a bisector (two-piece shell) fairing consisting of aluminum skin/stringer construction with vertical split-line longerons. The vehicle's height with the PLF is approximately 188 ft.

ATLAS V 401 LAUNCH VEHICLE | Expanded View



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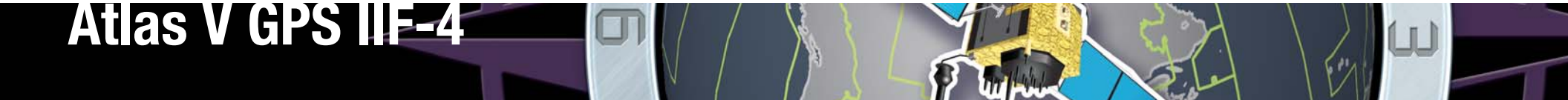
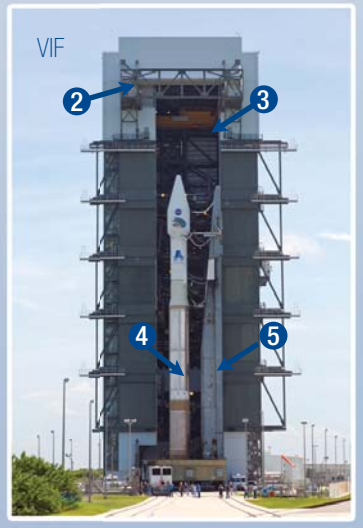


SPACE LAUNCH COMPLEX 41 (SLC-41) | Overview

1 Vertical Integration Facility (VIF) (See inset)
2 Bridge Crane Hammerhead
3 Bridge Crane
4 Launch Vehicle
5 Mobile Launch Platform (MLP)
6 Launch Vehicle
7 Centaur LO_2 Storage
8 High Pressure Gas Storage
9 Booster LO_2 Storage
10 Pad Equipment Building (PEB)
11 Pad ECS Shelter



ATLAS V GPS IIF-4 | Mission Overview

The GPS IIF-4 mission will launch from the Space Launch Complex 41 (SLC41) at Cape Canaveral Air Force Station (CCAFS), FL on an Atlas V 401 vehicle.

Mission Telemetry data will be gathered by the Eastern Range (ER), Air Force Space Control Network (AFSCN) in New Hampshire (BOSS), RAF Oakhanger (LION), Diego Garcia (REEF) and Guam (GUAM) tracking stations. The orbiting Tracking and Data Relay Satellite (TDRS) constellation will also participate in the gathering of telemetry during the GPS IIF mission.

The two-burn mission will fly a northeasterly trajectory from SLC-41 with a 45.8-degree flight azimuth. The Atlas V will release the GPS IIF-4 satellite into a semi-synchronous circular orbit at an altitude of 11,047-nautical miles (nmi) perigee and apogee with a 55-degrees inclination.

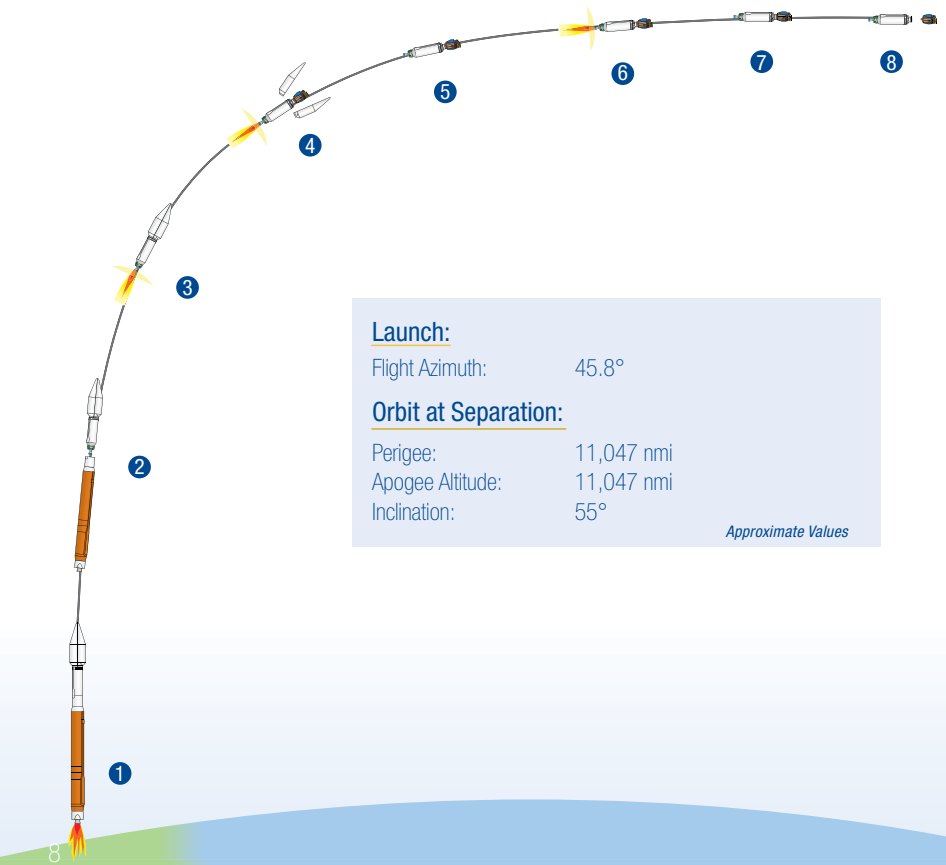
Launch begins with the RD-180 engine ignition at 2.72 seconds prior to liftoff. Liftoff occurs at T+1.1 seconds. Shortly after the vehicle clears the pad, it performs its pitch/yaw/roll program. Maximum dynamic pressure occurs approximately 90 seconds into flight.

The first-stage booster engine cuts off at approximately four minutes into flight. Approximately six seconds later the Atlas booster and Centaur stages separate, ignition of the second stage or Centaur occurs ten seconds later. The payload fairing jettison takes place eight seconds later or four minutes and 28 seconds into flight.

Approximately 17 minutes into the mission the Centaur main engine cuts off and the mission enters a nearly three-hour coast phase. The Centaur main engine re-starts and burns for approximately one and one-half minutes. Approximately 5 minutes later the Centaur spins up to 5 RPM. The GPS IIF-4 satellite is released from the Centaur second stage at approximately 3 hours and 23 minutes after liftoff.

Atlas V GPS IIF-4

FLIGHT PROFILE | Liftoff to Separation



Launch:

Flight Azimuth: 45.8°

Orbit at Separation:

Perigee: 11,047 nmi
Apogee Altitude: 11,047 nmi
Inclination: 55°

Approximate Values

SEQUENCE OF EVENTS | Liftoff to Separation

	Event	Time (seconds)	Time (hr:min:sec)
1	RD-180 Engine Ignition	-2.7	-0:00:02.7
	T=0 (Engine Ready)	0.0	0:00:00.0
	Liftoff (Thrust to Weight > 1)	1.1	0:00:01.1
	Full Thrust	1.5	0:00:01.5
	Begin Pitch/Yaw/Roll Maneuver	17.2	0:00:17.2
	Mach 1	78.4	0:01:18.4
	Throttle Down	90.0	0:01:30.0
	Maximum dynamic pressure	90.5	0:01:30.5
2	Atlas Booster Engine Cutoff (BECO)	244.4	0:04:04.4
	Atlas Booster/Centaur Separation	250.4	0:04:10.4
3	Centaur First Main Engine Start (MES1)	260.4	0:04:20.4
4	Payload Fairing Jettison	268.4	0:04:28.4
5	Centaur First Main Engine Cutoff (MECO1)	1,027.1	0:17:07.1
6	Centaur Second Main Engine Start (MES2)	11,857.8	3:17:37.8
7	Centaur Second Main Engine Cutoff (MECO2)	11,947.1	3:19:07.1
8	Spacecraft Separation	12,232.8	3:23:52.8

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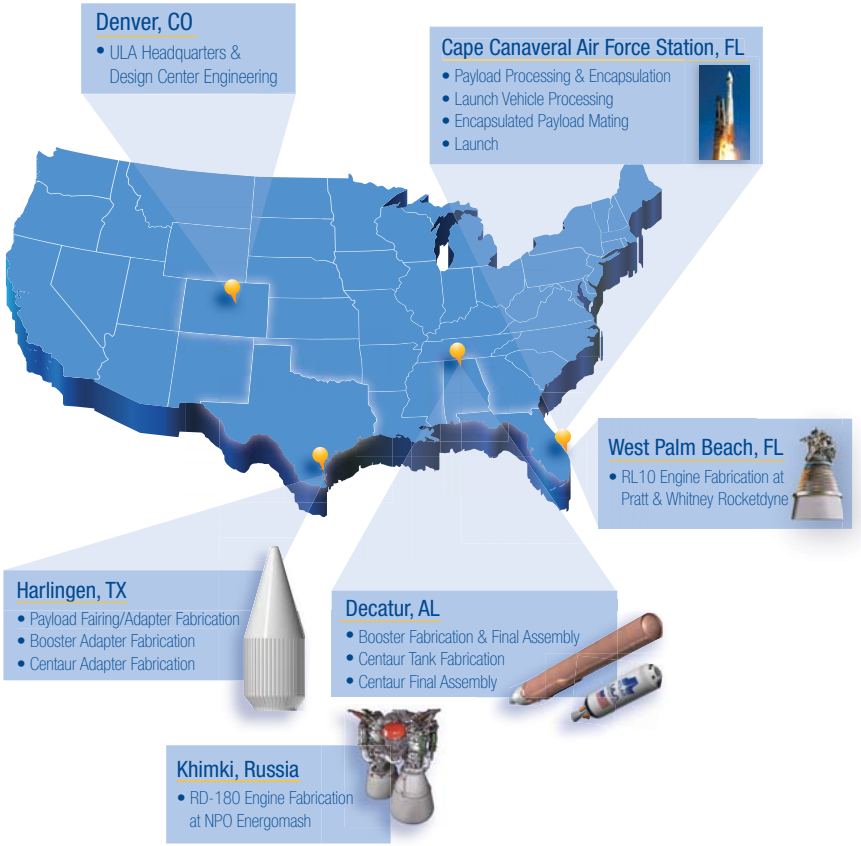
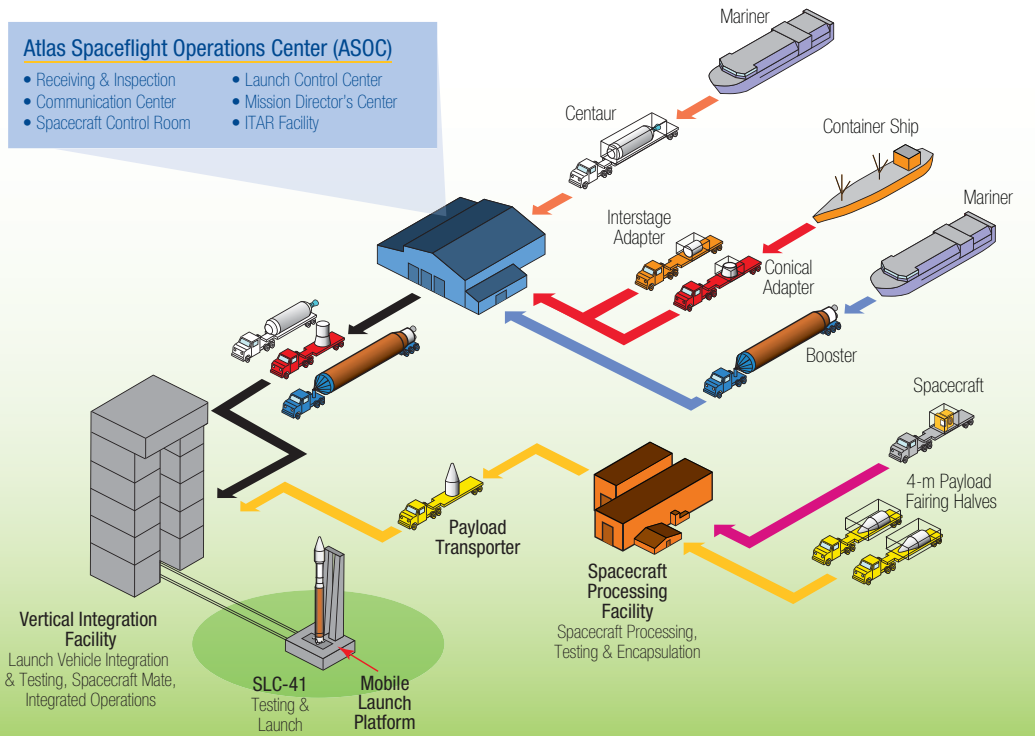
ATLAS V PRODUCTION & LAUNCH | Overview



ATLAS V PROCESSING | Cape Canaveral



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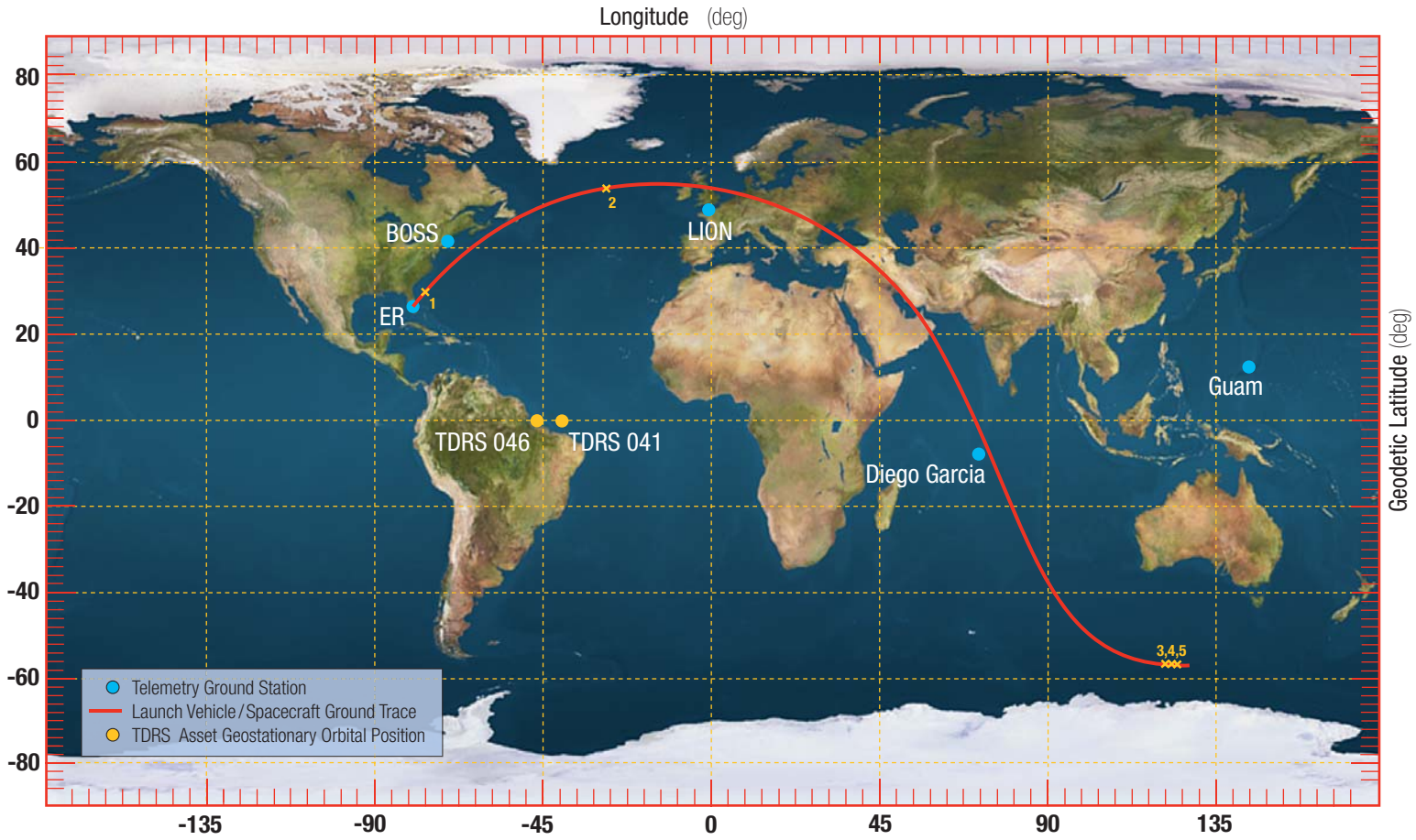
GROUND TRACE | Liftoff to Separation



1 = MES1 (0:04:20.4) | **2 =** MECO1 (0:17:07.1) | **3 =** MES2 (3:17:37.8) | **4 =** MECO2 (3:19:07.1) | **5 =** GPS IIF-4 Separation (3:23:52.8)

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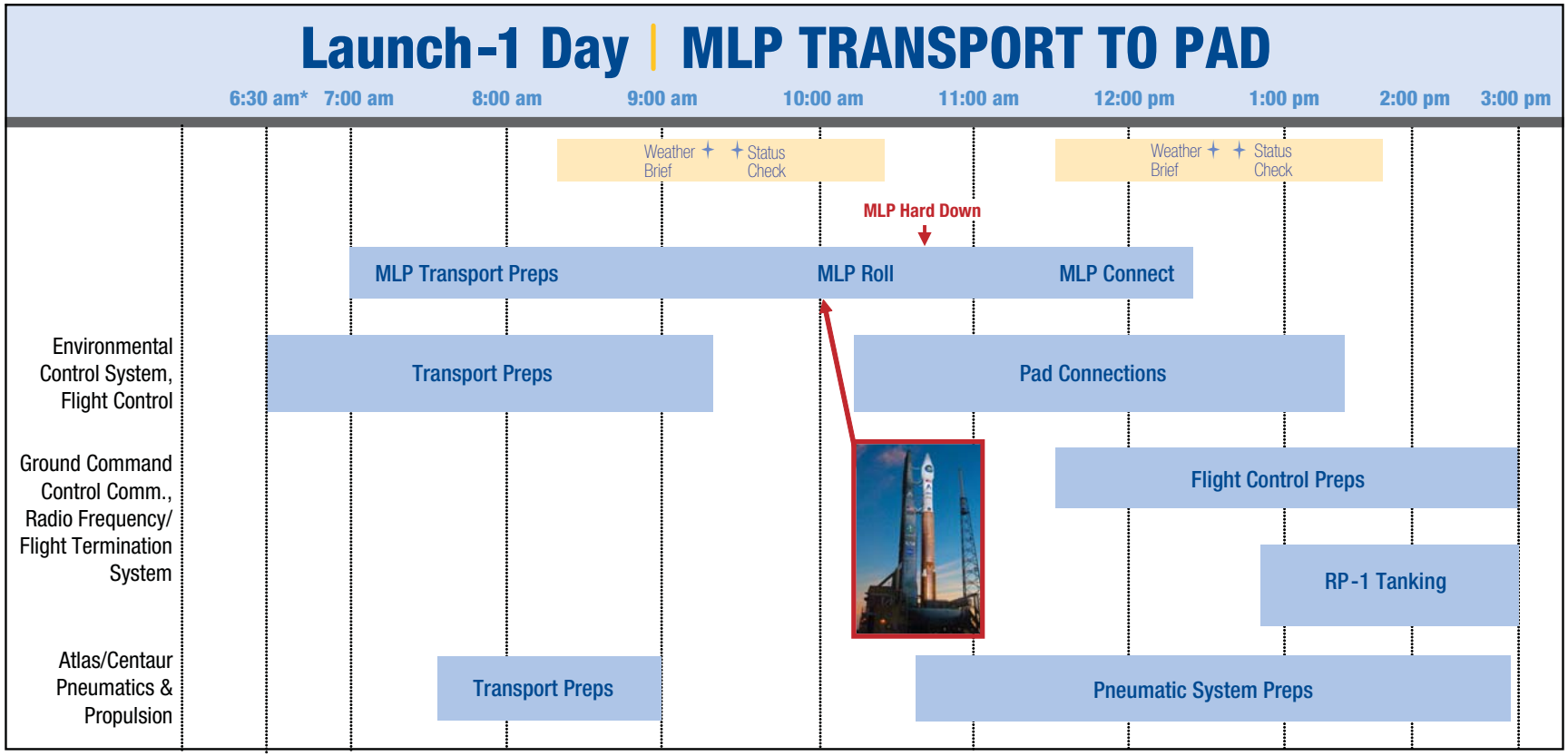

*Approximate times based on process time

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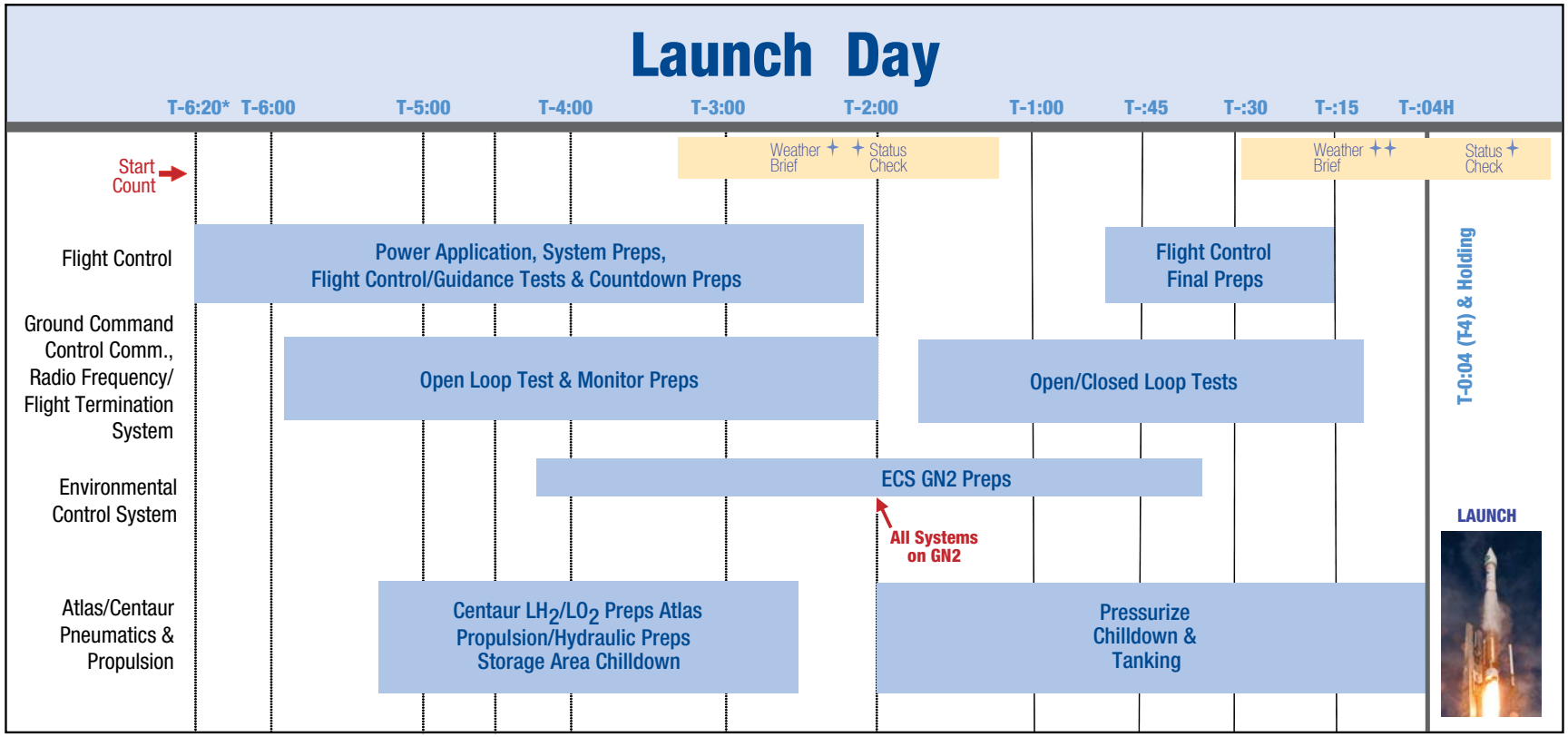

*Times based on countdown to launch

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United Launch Alliance | P.O. Box 3788 Centennial, CO 80155 | www.ulalaunch.com