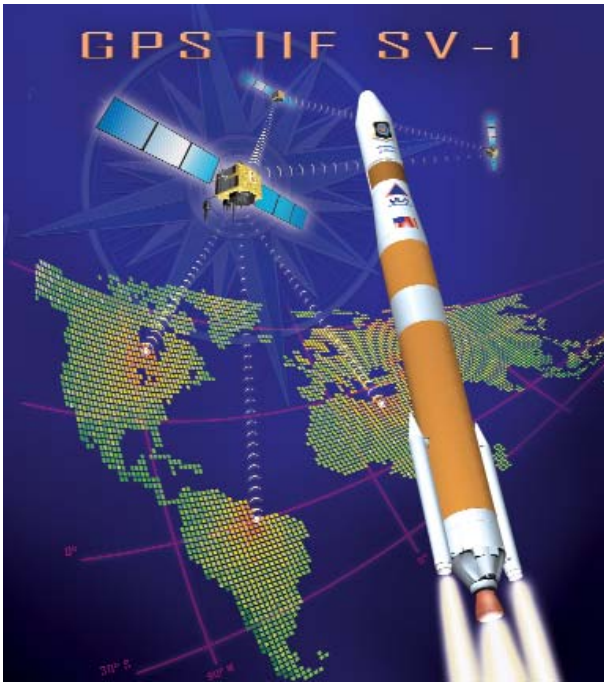
United Launch Alliance

Delta IV Launches GPS IIF SV-1

Mission Overview



Delta IV Medium+ (4,2)
Cape Canaveral Air Force Station, FL
Space Launch Complex 37

DELTA

BOEING

Delta IV/GPS IIF SV-1

The ULA team is proud to be the launch provider for the U.S. Air Force (USAF) Global Positioning System (GPS) Wing by delivering replenishment satellites aboard the Atlas V and Delta IV rockets. GPS satellites serve and protect our war fighters 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 SV-1 is the first of the next generation GPS satellites, incorporating various improvements to provide greater accuracy, increased signals, and enhanced performance for users. GPS IIF SV-1 will be launched on a Delta IV Medium+ (4,2) launch vehicle from Space Launch Complex (SLC) 37 at Cape Canaveral Air Force Station (CCAFS), FL.

We wish to thank our team, which consists of the USAF, The Aerospace Corporation, ULA, and major suppliers of ULA, for their continued hard work and commitment to mission success. We look forward to continuing our support of the USAF.

Jim Sponnick
Vice President, Delta Product Line

Delta IV Medium+ (4,2) Vehicle
Configuration Overview

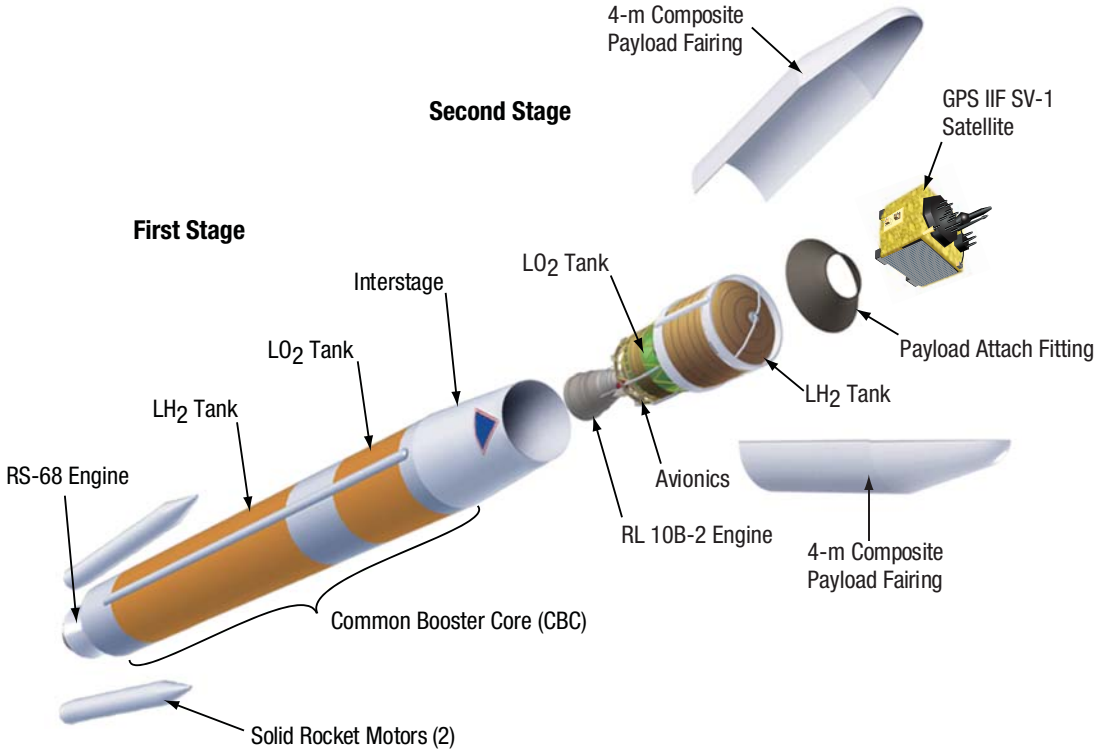
The Delta IV M+ (4,2) consists of a single Delta IV common booster core (CBC), the Delta cryogenic second stage (DCSS), and two solid rocket motors (SRMs). The CBC and the DCSS are connected by a composite cylindrical interstage adapter (ISA). The SRMs are connected to the booster by two ball-and-socket joints and structural thrusters.

The SRMs are approximately 60 in. in diameter and 53 ft. long, and are constructed of a graphite-epoxy composite. The SRMs burn for approximately 94 seconds and are jettisoned approximately 100 seconds into the flight.

The Delta IV booster tanks are structurally rigid and constructed of isogrid aluminum barrels, spun-formed aluminum domes, machined aluminum tank skirts, and a composite centerbody. Delta IV booster propulsion is provided by the RS-68 engine system. The RS-68 burns cryogenic liquid hydrogen and liquid oxygen and delivers 663,000 lb of thrust at sea level. The booster's cryogenic tanks are insulated with a combination of spray-on and bond-on insulation and helium-purged insulation blankets. The Delta IV booster is controlled by the DCSS avionics system, which provides guidance, flight control, and vehicle sequencing functions during CBC and DCSS phases of flight. The boost phase of flight ends 6 seconds after main engine cutoff (MECO), when the separation charge in the interstage adapter is fired and 16 pneumatic actuators push the spent Delta IV CBC stage and the DCSS apart.

The DCSS stage propellant tanks are structurally rigid and constructed of isogrid aluminum ring forgings, spun-formed aluminum domes, machined aluminum tank skirts and a composite intertank truss. The DCSS is also a cryogenic liquid hydrogen/liquid oxygen-fueled vehicle. It uses a single RL10B-2 engine that produces 24,750 lb of thrust. Like the CBC, the DCSS cryogenic tanks are insulated with a combination of spray-on and bond-on insulation, and helium-purged insulation blankets. An equipment shelf attached to the aft dome of the DCSS liquid oxygen tank provides the structural mountings for vehicle electronics. The structural and electronic interfaces with the spacecraft (SC) are provided via the payload attach fitting (PAF). The GPS missions use a 4-m diameter payload fairing (PLF). The PLF is a composite bisector (two-piece shell) fairing. The vehicle's height, with the 38.5-ft tall PLF, is approximately 206 ft.

Delta IV Medium+ (4,2) Vehicle



GPS Mission

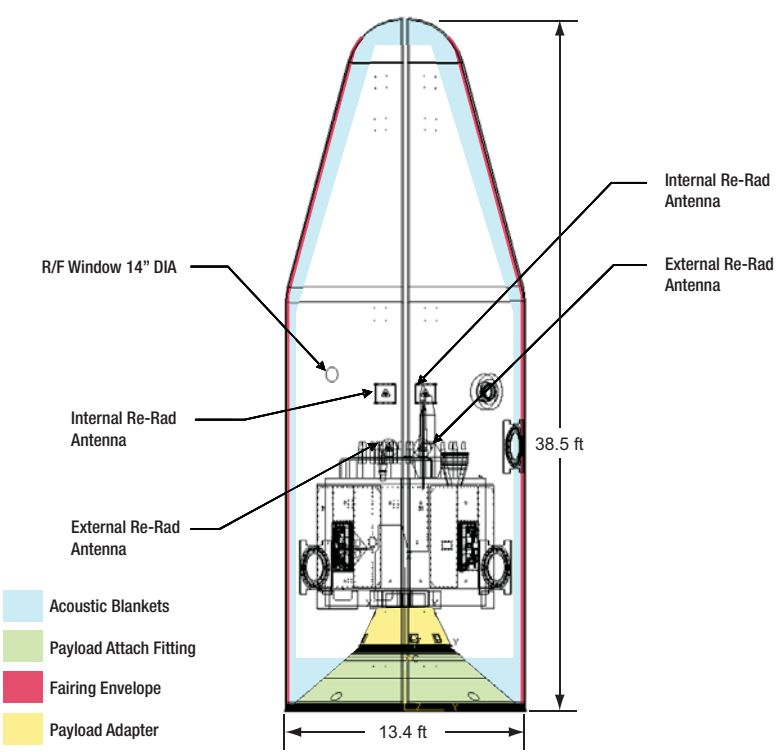
The Navstar GPS is a constellation of orbiting satellites that provides navigation data to military and civilian users worldwide. The system is operated and controlled by the 50th Space Wing, located at Schriever Air Force Base, CO.

GPS is a worldwide timing and navigation system utilizing 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 is the next generation of GPS satellites and have 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 meters. 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 is adding the following new 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

GPS IIF SV-1 Satellite



GPS IIF SV-1 Mission Overview

- Delta IV Med+ (4,2) launch vehicle configuration
- Launch from CCAFS SLC-37 down-flight azimuth of 105.28 deg
- Two GEM-60 motors ignite at liftoff and burn for approximately 94 sec
- Common boost trajectory utilized for both descending and ascending node injections
- Boost trajectory designed to meet controllability, structural, and environmental constraints while maximizing vehicle performance
- A pitch-yaw-roll maneuver initiated to maximize performance and bring the vehicle to a 147-degree CBC roll angle for second-stage flight
- Main engine cutoff (MECO) occurs at first-stage propellant depletion; approximately 246 sec after liftoff
- Second stage separates 6 sec after MECO; second-stage engine ignited 7 sec later
- Payload fairing jettisoned when free molecular heating rate is 391 Btu/ft^2-sec
- Payload fairing jettison occurs approximately 10.4 sec after second-stage ignition

GPS IIF SV-1 Mission Overview (concl'd)

- Ascending or descending node injection is possible after 3-burn second-stage set maneuvers
- Spacecraft separation occurs approximately 3 hours and 33 min after liftoff
- Ascension Tracking Station provides telemetry coverage of second-stage restart through spacecraft separation for descending node injection
- 2 sec after spacecraft separation the second stage de-spins, performs a short coast to increase distance, and performs a contamination and collision avoidance maneuver (CCAM)
- 15 min after separation another maneuver begins to point the second stage 30 degrees out of the orbit plane and perform propellant blowdown to place the second stage into disposed orbit of approximately 11,000 x 11,600 nautical miles (nmi) and off operational plane inclination

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Delta IV Launch History

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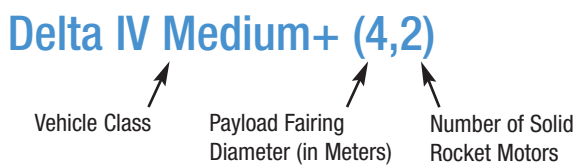
Flight	Configuration	Mission	Launch Date
Delta 293	Medium+ (4,2)	Eutelsat W5	20 Nov 2002
Delta 296	Medium	DSCS III A3	10 March 2003
Delta 301	Medium	DSCS III B6	29 Aug 2003
Delta 310	Heavy	Heavy Demo	21 Dec 2004
Delta 315	Medium+ (4,2)	GOES-N	24 May 2006
Delta 317	Medium+ (4,2)	NROL-22	27 Jun 2006
Delta 320	Medium	DMSP F17	4 Nov 2006
Delta 329	Heavy	DSP-23	10 Nov 2007
Delta 337	Heavy	NROL-26	17 Jan 2009
Delta 342	Medium+ (4,2)	GOES-O	27 Jun 2009
Delta 346	Medium+ (5,4)	WGS-3	5 Dec 2009
Delta 348	Medium+ (4,2)	GOES-P	4 Mar 2010

Delta IV Naming Convention



Delta IV Processing Overview

Brigham City, UT
- Solid Rocket Motor Fabrication

Decatur, AL
- Payload Fairing/Adapter Fabrication
- Booster Fabrication
- Second Stage Fabrication

Cape Canaveral Air Force Station, FL
- Payload Processing & Encapsulation
- Launch Vehicle Processing
- Encapsulated Payload Mating
- Launch

Delta IV Hardware Flow at Eastern Range

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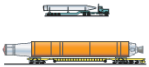
Delta IV Launch Vehicle Processing

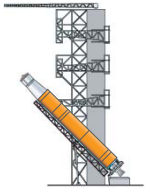
Delta Mariner Delivers CBCs, 5-m Upper Stages, and 5-m Fairings to Launch Site

Horizontal Integration and Testing of CBC and Second Stages

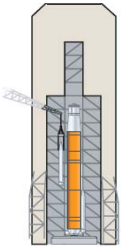
Optional GEM-60 Solid Rocket Motors Transportation to Launch Pad



Transport to Launch Pad



Erect Vehicle on Launch Pad



GEM-60s Attach to Launch Vehicle

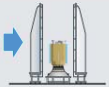
Payload Encapsulation in Parallel to Delta IV Vehicle Processing

Payload Processing Facility

Erect and Store Fairing

Install Payload Attach Fitting on Buildup Stand

Integrate Payload to PAF and Perform Integrated Checkout

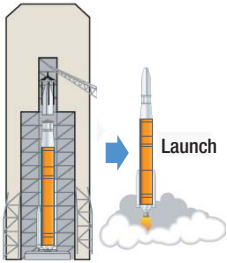


Prepare Fairing Bisectors for Payload Encapsulation

Encapsulate Payload

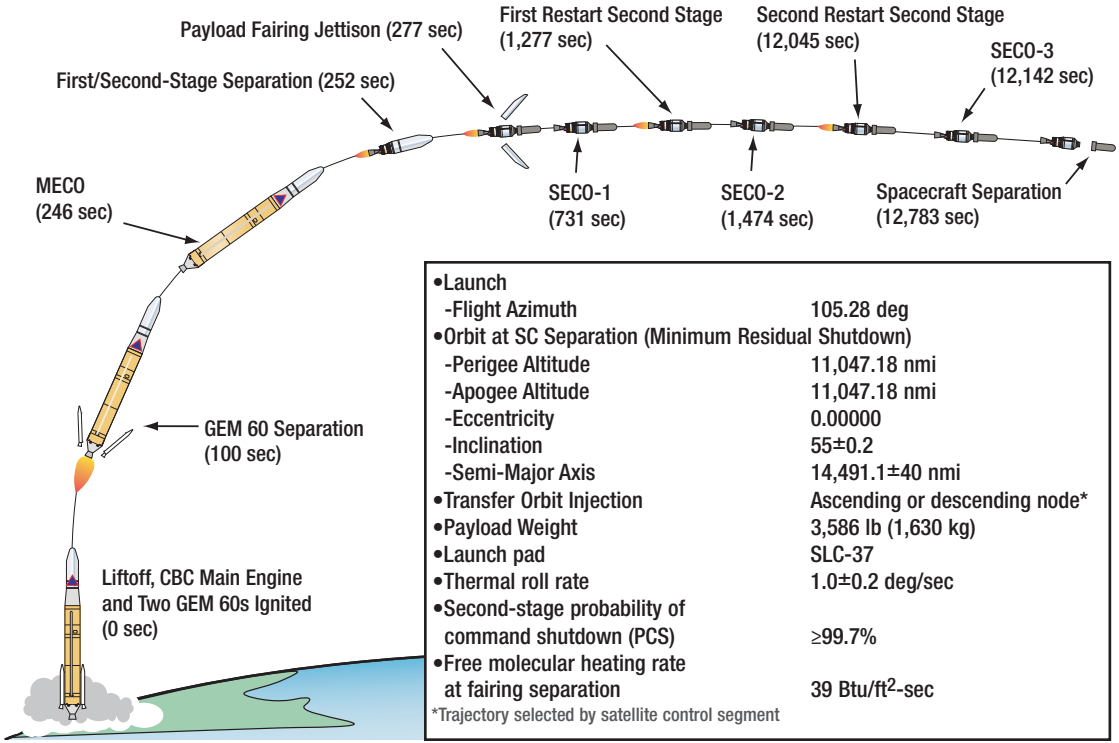
Transport Payload to Launch Pad

Payload Lifted by Crane and Attached to Launch Vehicle



Launch Site Overview

GPS IIF SV-1 Flight Profile



•Launch	
-Flight Azimuth	105.28 deg
•Orbit at SC Separation (Minimum Residual Shutdown)	
-Perigee Altitude	11,047.18 nmi
-Apogee Altitude	11,047.18 nmi
-Eccentricity	0.00000
-Inclination	55±0.2
-Semi-Major Axis	14,491.1±40 nmi
•Transfer Orbit Injection	Ascending or descending node*
•Payload Weight	3,586 lb (1,630 kg)
•Launch pad	SLC-37
•Thermal roll rate	1.0±0.2 deg/sec
•Second-stage probability of command shutdown (PCS)	≥99.7%
•Free molecular heating rate at fairing separation	39 Btu/ft^2-sec

*Trajectory selected by satellite control segment

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Sequence of Events

Liftoff to Spacecraft Separation

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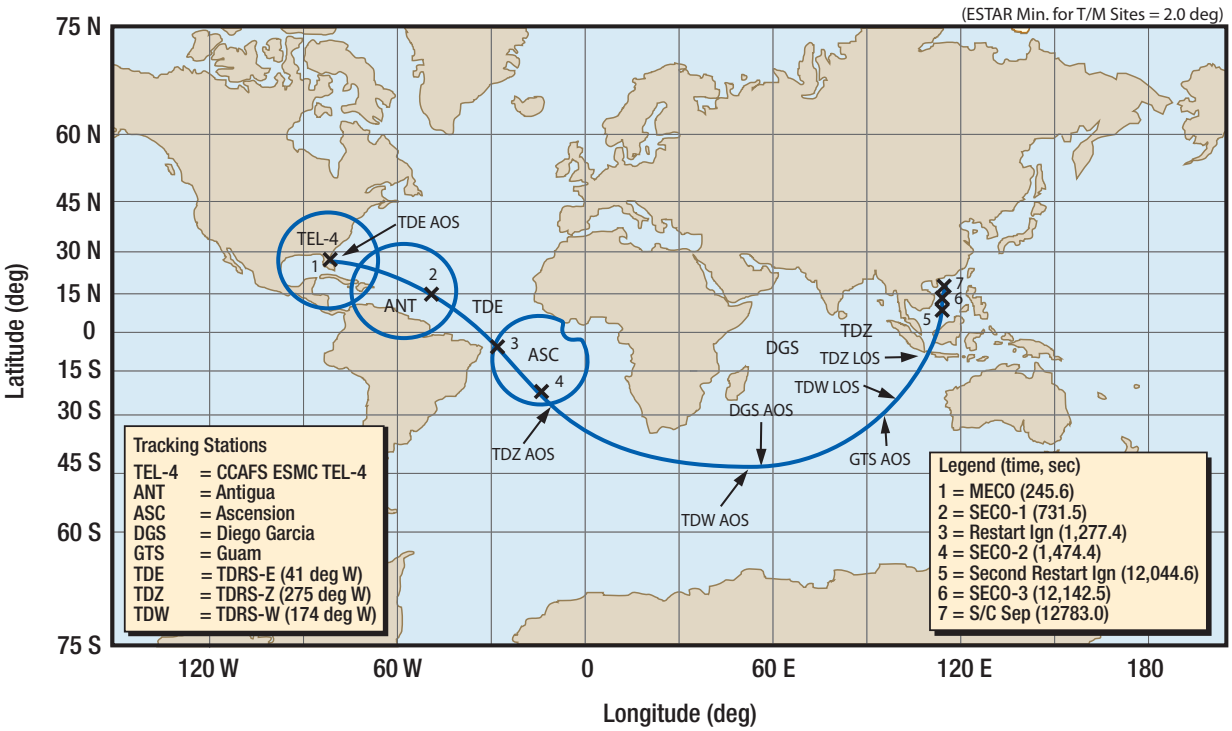
Event	Time (seconds)	Time (hr:min:sec)
Liftoff	0.00	00:00:00.00
Mach 1	46.87	00:00:46.87
Maximum dynamic pressure	60.18	00:00:60.18
Two GEM 60 burnout	94.11	00:01:34.11
Jettison two GEM 60	100.00	00:01:40.00
MECO	245.58	00:04:05.58
First-stage separation	251.58	00:04:11.58
Second-stage ignition	266.09	00:04:26.09
Jettison fairing	276.50	00:04:36.50
First cutoff—second stage (SECO-1)	731.46	00:12:11.46
First restart—second stage	1,277.40	00:21:17.40
Second cutoff—second stage (SECO-2)	1,474.42	00:24:34.42
Second restart—second stage	12,044.62	03:20:44.62
Third cutoff—second stage (SECO-3)	12,142.49	03:22:22.49
Begin separation attitude maneuver	12,173.00	03:22:53.00
End separation attitude maneuver	12,247.00	03:24:07.00
Begin spacecraft spinup	12,533.00	03:28:53.00
Spacecraft separation	12,783.00	03:33:03.00

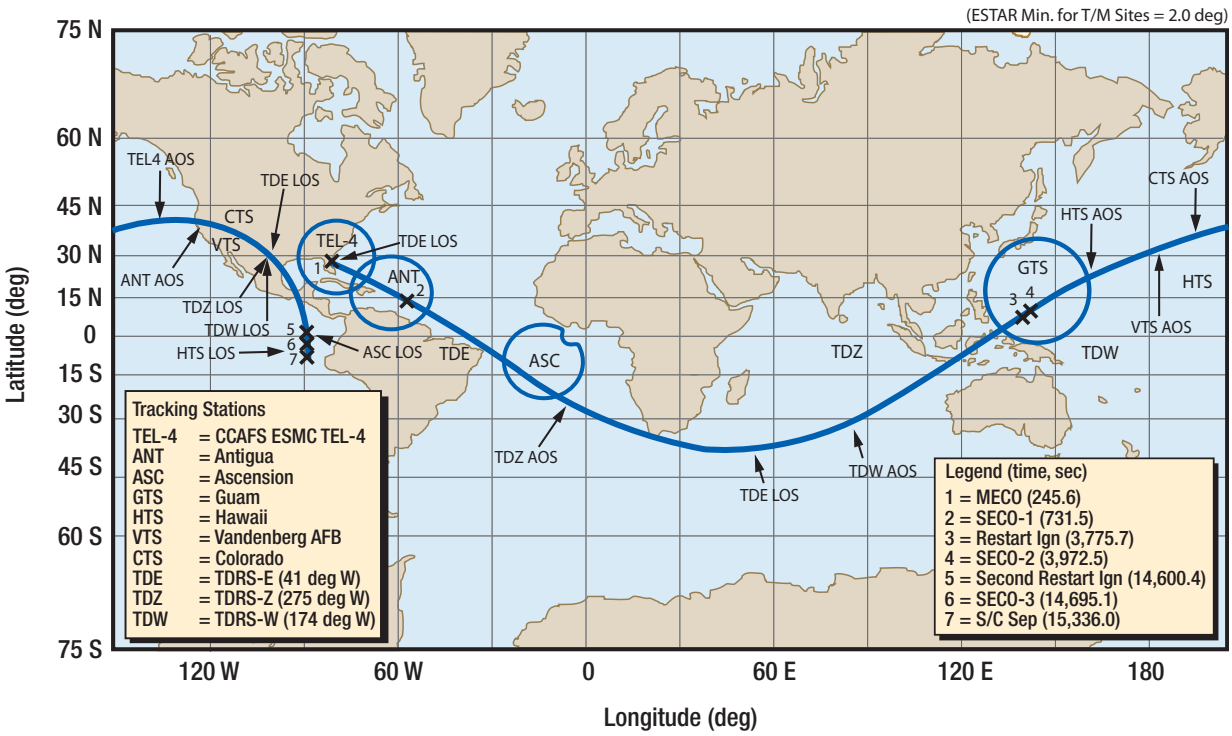
Descending Node Ground Trace

(GPS IIF SV-1 Trajectory)

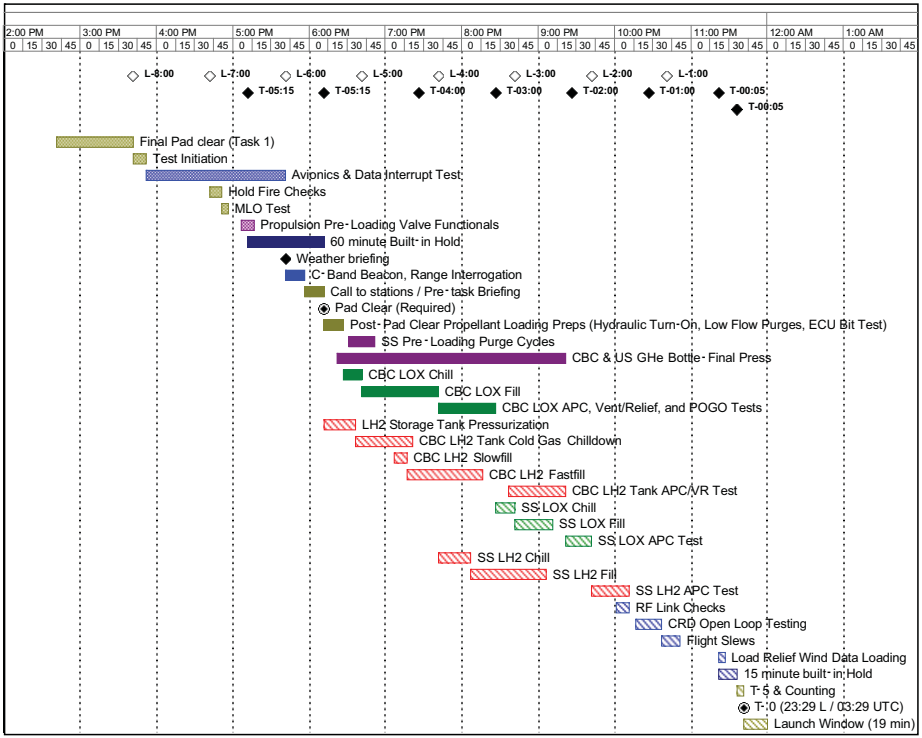


Ascending Node Ground Trace

(Reference Trajectory for Future Missions)



Delta IV Countdown (T-0 Day)



Notes