Delta II Aquarius/SAC-D

Mission Overview
Vandenberg Air Force Base, CA

United Launch Alliance

DELTA

United Launch Alliance (ULA) is proud to launch the Aquarius/SAC-D mission. Aquarius/SAC-D will be launched aboard a Delta II 7320-10C launch vehicle from Vandenberg Air Force Base (VAFB), California. The Delta II will deliver the Aquarius/SAC-D spacecraft into Sun-synchronous orbit, where it will begin its mission to improve our understanding of Earth's climate system by mapping the concentration of dissolved salt at the ocean's surface.

ULA provides Delta II launch services under the NASA Launch Services (NLS) contract with the NASA Kennedy Space Center Launch Services Program. We are delighted that NASA has chosen the Delta II for this mission developed by the Comision Nacional de Actividades Espaciales (CONAE), Argentina and the Jet Propulsion Laboratory (JPL) and built by Investigciones Aplicades (INVAP), Argentina.

I congratulate the entire team for their significant efforts. ULA looks forward to continued launches of scientific space missions.

Vernon L. Thorp
NASA Program Manager
United Launch Alliance

AQUARIUS/SAC-D OBSERVATORY | Overview

The Aquarius/SAC-D Observatory is a joint U.S./Argentinian mission to map the salinity—the concentration of dissolved salt—at the ocean surface. This information is critical to improving our understanding of two major components of Earth's climate system: the water cycle and ocean circulation. By measuring ocean salinity from space, the Aquarius/SAC-D mission will provide new insights into how the massive natural exchange of freshwater between the ocean, atmosphere and sea ice influences ocean circulation, weather and climate.

NASA's Aquarius is the primary instrument on the SAC-D spacecraft. It consists of three passive microwave radiometers to detect the surface emission that is used to obtain salinity and an active scatterometer to measure the ocean waves that affect the precision of the salinity measurement.

The Aquarius instrument was jointly built by NASA's Jet Propulsion Laboratory and NASA's Goddard Space Flight Center.

Complementing data from Aquarius, the SAC-D platform has several CONAE-sponsored instruments and sensors from the French Space Agency (Centre National D-Etudes Spatiales) and the Italian Space Agency (Agenzia Spaziale Italiana) as noted below:

MWR—Microwave Radiometer (CONAE): Measures precipitation, wind speed, sea ice concentration and water vapor.

NIRST—New Infrared Sensor (CONAE): Senses hot spots on the Earth's surface (fires) and sea surface temperature.

HSC—High Sensitivity Camera (CONAE): Captures urban lights, fires and the auroras.

DCS—Data Collection System (CONAE): Performs environmental data collection.

ROSA—Radio Occultation Sounder for Atmosphere (ASI): Gathers atmospheric temperature and humidity profiles.

ICARE (CNES): Measures the effects of cosmic radiation on electronics.

SODAD (CNES): Measures the distribution of micro-particles and space debris.

Image Courtesy of NASA

DELTA II 7320-10C LAUNCH VEHICLE | Overview

The Delta II 7320-10C consists of the Delta II booster stage, the Delta II hypergolic second stage, three solid rocket motors (SRMs), and a 10-foot diameter payload fairing (PLF).

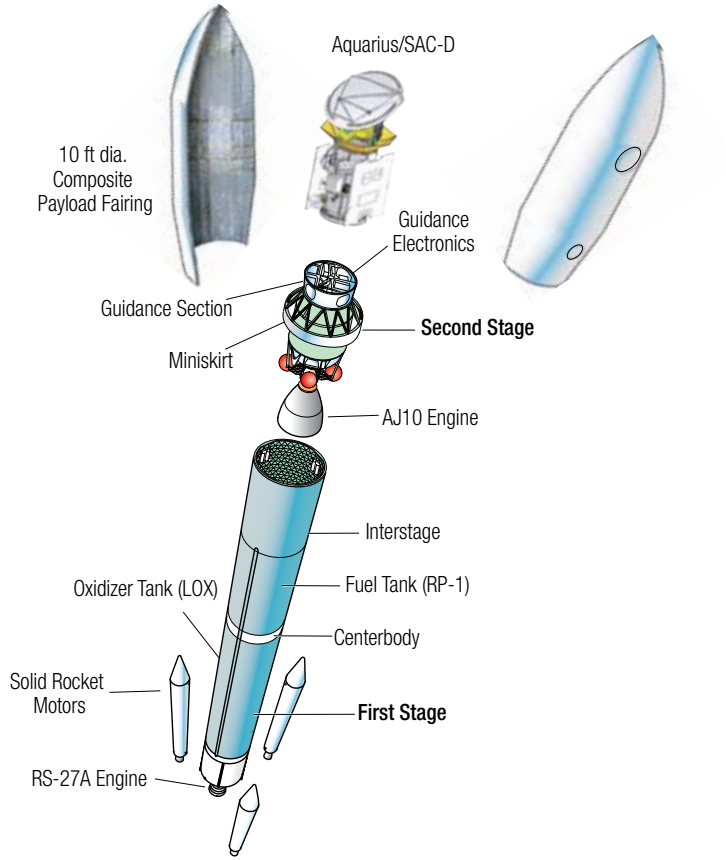
The Delta II booster is 8 ft in diameter and approximately 87 ft in length. The booster's fuel and oxidizer tanks are structurally rigid and constructed of stiffened isogrid aluminum barrels and spun-formed aluminum domes. The booster structure is completed by the centerbody; which joins the fuel and oxidizer tanks and the LO_2 Skirt; which joins the tank structure to the engine section. Delta booster propulsion is provided by the RS-27A engine. The RS-27A burns RP-1 (Rocket Propellant-1 or highly purified kerosene) and liquid oxygen, and delivers 200,000 lb of thrust at sea level. The Delta II booster is controlled by the second-stage avionics system, which provides guidance, flight control, and vehicle-sequencing functions during the booster and second-stage phases of flight.

The SRMs, approximately 40 in. in diameter and 42 ft 6.7 in. in length, are constructed of a graphite epoxy composite with the throttle profile designed into the propellant grain. The SRMs are jettisoned by structural thrusters following a 64-second burn.

The second stage is 8 ft in diameter and approximately 20 ft in length. Its propellant tanks are constructed of corrosion resistant stainless steel. The Delta II second stage is a hypergolic-(Aerozine 50 and Nitrogen Tetroxide) fueled vehicle. It uses a single AJ10-118K engine producing 9,850 lb of thrust. The propellant tanks are insulated with Dacron/Mylar blankets. The second stage's miniskirt/guidance section provides payload's load path to the booster, the structural support for the second-stage propellant tanks and the PLF, mountings for vehicle electronics, and the structural and electronic interfaces with the spacecraft. The second-stage, other than the miniskirt, is nested inside the interstage adapter.

The Aquarius/SAC-D observatory is encapsulated in the 10-ft diameter PLF. The 10-ft PLF is a sandwich composite structure made with a structural foam core and graphite-epoxy face sheets. The bisector (two-piece shell) PLF encapsulates the second stage's miniskirt/guidance section and the spacecraft; and separates using a debris-free pyrotechnic actuating system. The vehicle's height with the 10-ft PLF is approximately 128 ft.

DELTA II 7320-10C LAUNCH VEHICLE | Expanded View



SLC-2 | Overview

1 Mobile Service Tower (MST)
2 Launch Vehicle
3 Fixed Umbilical Tower (FUT)

Delta II Aquarius/SAC-D

DELTA II AQUARIUS/SAC-D | Mission Overview

The Delta II vehicle will launch the Aquarius/SAC-D Observatory from Space Launch Complex 2 West (SLC-2W) at Vandenberg Air Force Base down an initial flight azimuth of 196 degrees from true north.

The three solid rocket motors burn for approximately 64.0 seconds before they are jettisoned at 99.0 seconds in order to satisfy range safety trajectory shaping constraints.

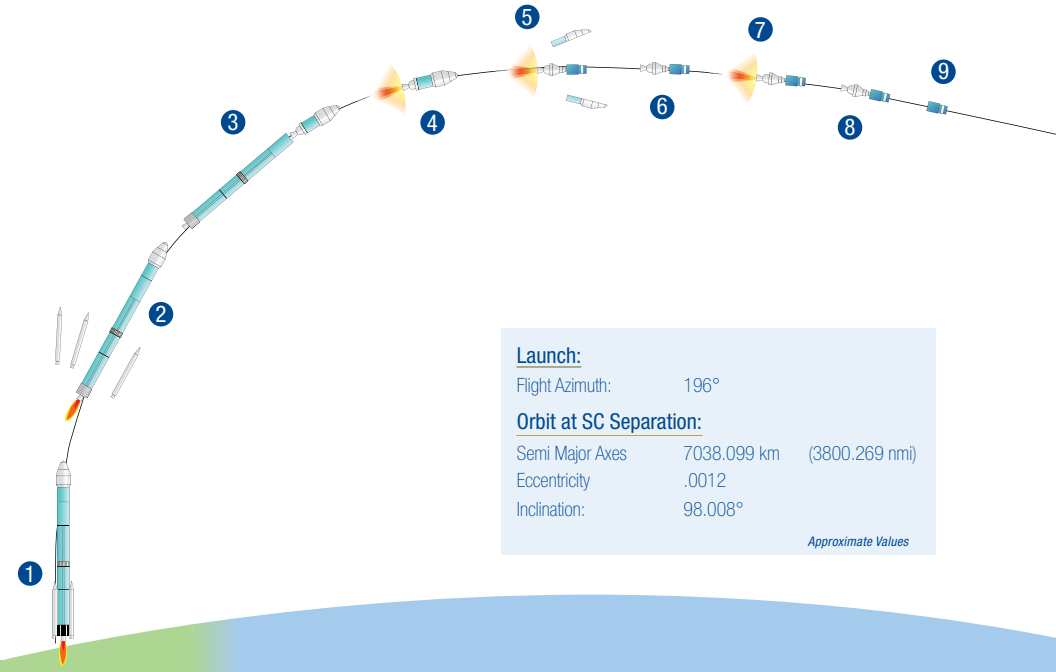
Main engine cutoff (MECO) occurs at 264.2 seconds after liftoff when booster propellants are depleted. First stage separation follows 8 seconds later with second stage ignition occurring at 277.7 seconds. Payload fairing jettison occurs at 290 seconds when the free molecular heating rate has dropped below 0.1 BTU/ft^2-sec (1135 W/m^2).

After the first cutoff of the second-stage engine (SECO-1) at 676.1 seconds after liftoff, the second stage then performs two sets of attitude reorientation maneuvers and one thermal conditioning maneuver during the coast phase between SECO-1 and the first restart.

Following SECO-2, the second stage is re-oriented to the desired attitude for separation of the Aquarius/SAC-D spacecraft, which occurs at 3,402 seconds in view of the TDRS satellites for telemetry coverage and Hartebeesthoek (HBK) for video coverage of separation and post-separation events.

Spacecraft separation ends the primary portion of this Delta II mission at just over 56 minutes after liftoff.

FLIGHT PROFILE | Liftoff to Spacecraft Separation



Launch:

Flight Azimuth:	196°

Orbit at SC Separation:

Semi Major Axes	7038.099 km	(3800.269 nmi)
Eccentricity	.0012	
Inclination:	98.008°	

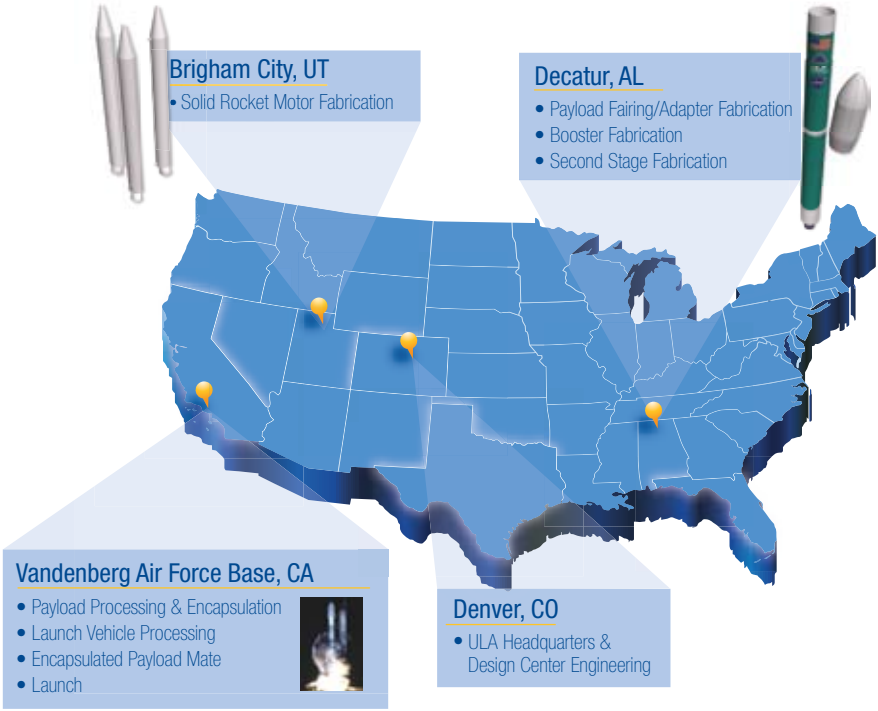
Approximate Values

Delta II Aquarius/SAC-D

SEQUENCE OF EVENTS | Liftoff to Spacecraft Separation

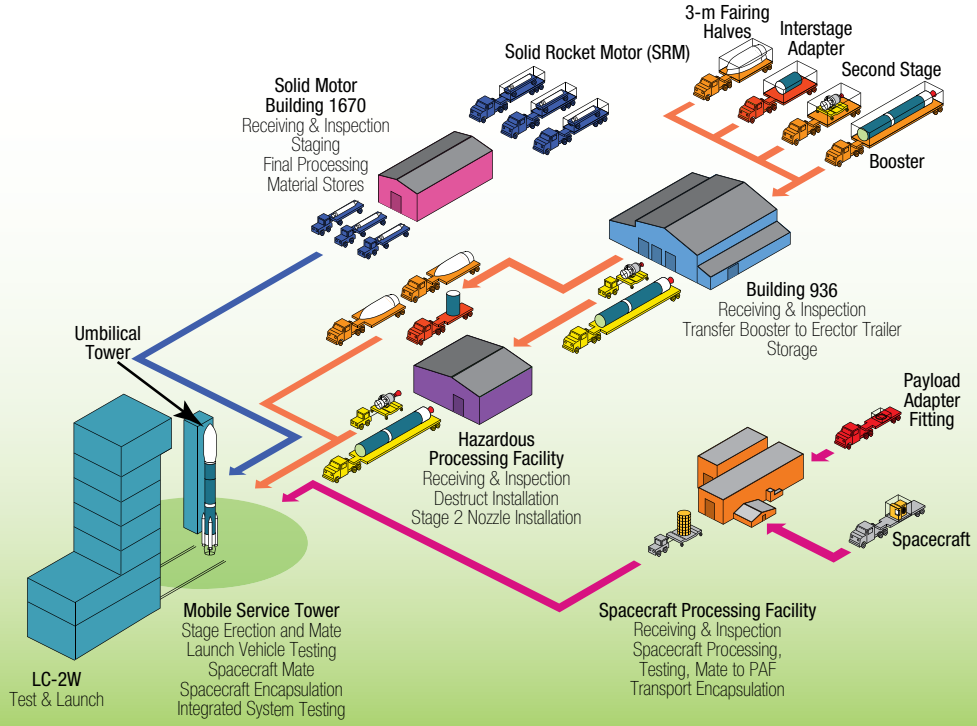
	Event	Time (seconds)	Time (hr:min:sec)
1	Liftoff	0.0	00.00.0
	Mach 1	36.1	00.36.1
2	SRM Burnout	64.0	01.04.0
	SRM Jettison	99.0	01.39.0
3	Main Engine Cutoff (MECO)	264.2	04.24.2
	First-Stage Separation	272.2	04.32.2
4	Second-Stage Ignition	277.7	04.37.7
5	Payload Fairing Jettison	290.0	04.50.0
6	First Cutoff—Second Stage (SECO-1)	676.1	11.16.1
7	First Restart—Second Stage	3139.7	52.19.7
8	Second Cutoff—Second Stage (SECO-2)	3251.0	52.32.0
9	Spacecraft Separation	3402.0	56.42.0

DELTA II PRODUCTION & LAUNCH | Overview

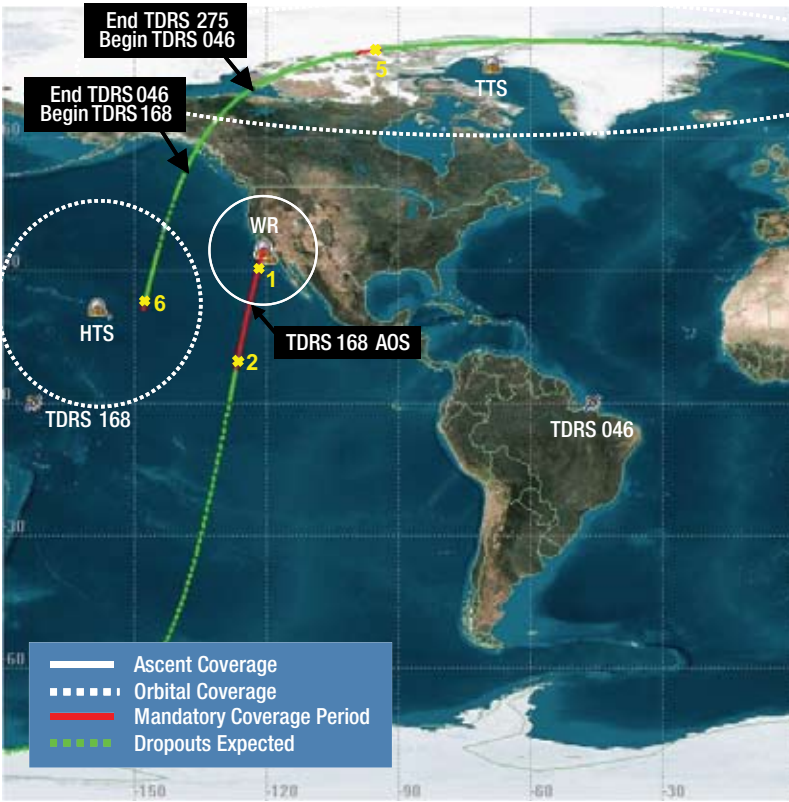


Delta II Aquarius/SAC-D

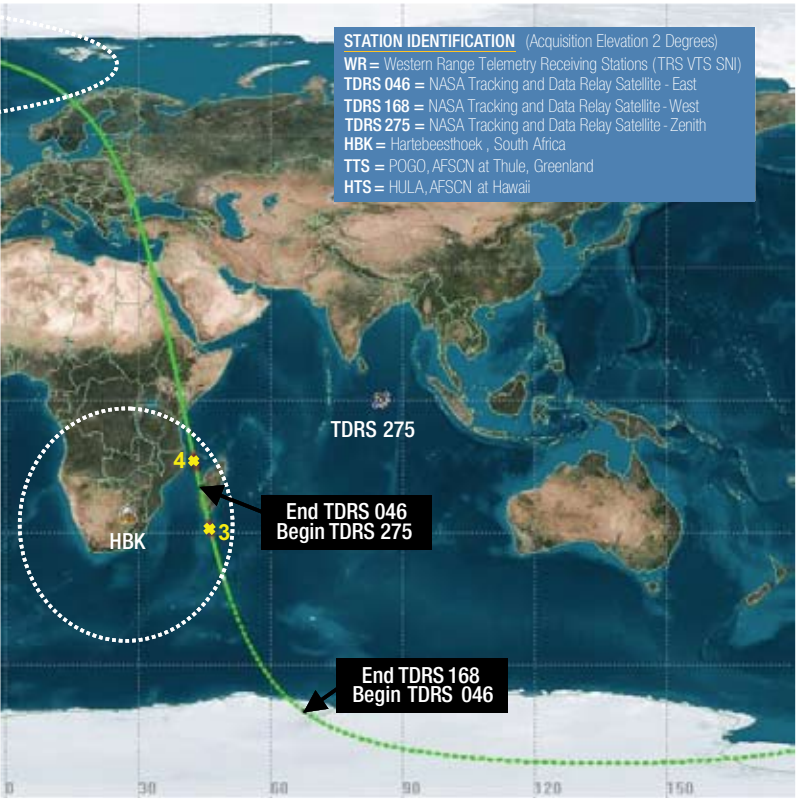
DELTA II PROCESSING | Vandenberg



GROUND TRACE | Liftoff to Spacecraft Separation

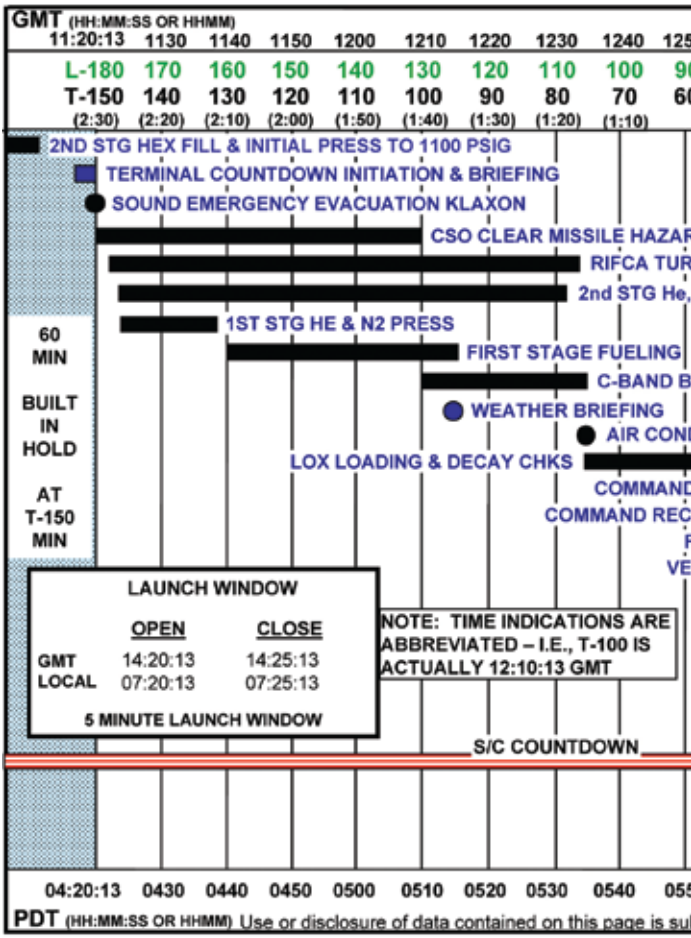


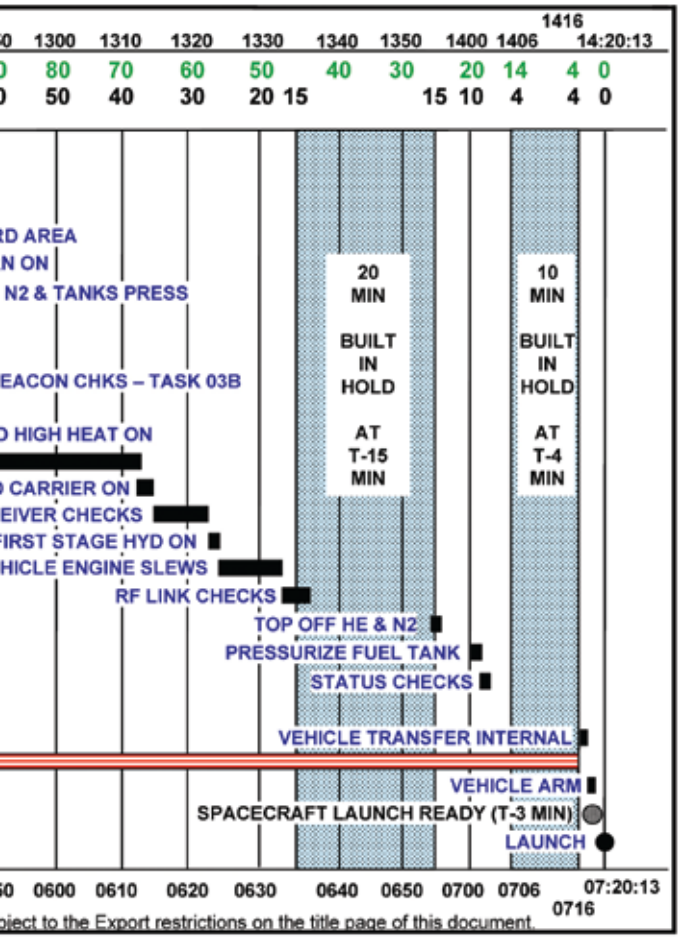
1 = MECO (00:04:24.2) | **2** = SECO-1 (00:11:16.1) | **3** = SII Burn
5 = SII Evasive Burn (01:26:40.0 – 1:26:45.0) |



2 (00:52:19.7 – 00:52:32.0) | **4 =** Spacecraft Separation (00:56:42.0)
6 = SII Depletion Burn (01:43:20.0 – 01:43:42.2)

COUNTDOWN TIMELINE | Launch Day





NOTES

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