PHOENIX

Delta Launch Vehicle Programs

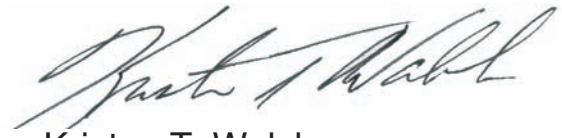
United Launch Alliance

Phoenix

United Launch Alliance takes great pride in launching the Phoenix mission. It will launch from Cape Canaveral Air Force Station, Florida, aboard a ULA Delta II 7925-9.5 launch vehicle. Phoenix will land in the north of Mars. During its 90-Martian-day surface mission, Phoenix will examine material from the layers of water ice found there. These layers could contain organic compounds that are necessary for life.

Overall mission responsibility resides with the Principal Investigator from the University of Arizona (UA). The Jet Propulsion Laboratory (JPL) manages the Phoenix mission for NASA's Office of Space Science and the University of Arizona. Phoenix payloads are provided by a combination of JPL and UA as well as foreign contributions. Mission operations will be conducted from JPL while science operations will be conducted at the Science Operations Center constructed at the University of Arizona. The NASA Deep Space Network will be used to communicate with the spacecraft in cruise and through relay orbiters (Mars Odyssey and Mars Reconnaissance Orbiter). The Phoenix spacecraft was built by Lockheed Martin Space Systems.

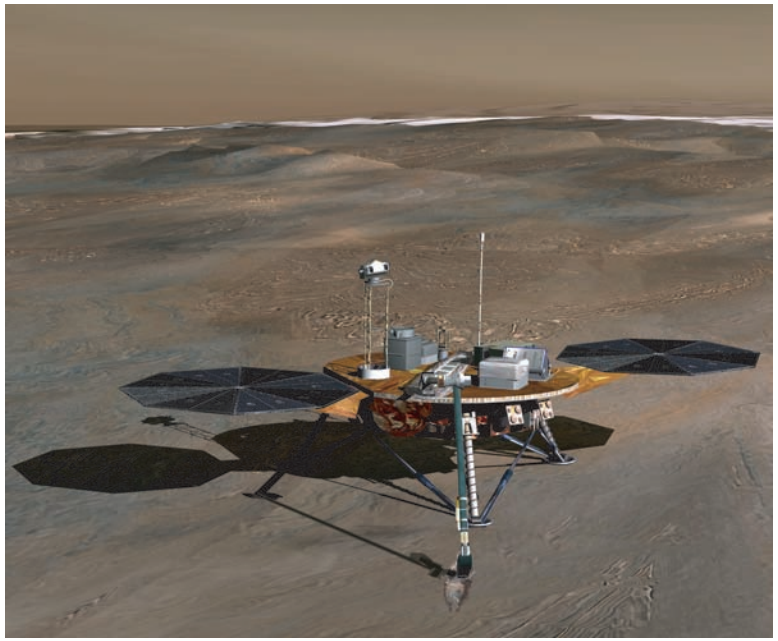
United Launch Alliance provides the Delta II launch under the NASA Launch Services (NLS) contract with NASA KSC ELV Launch Services Project. We are pleased NASA once again selected the Delta II for this mission. My congratulations to the entire Delta team for your continued efforts in achieving this milestone. We look forward to adding to our knowledge of Mars by spacecraft launched by Delta.



Kristen T. Walsh
Director, NASA Programs
Delta Launch Vehicles

Phoenix Science Objective

In the continuing pursuit of water on Mars, the poles are a good place to probe, as water ice is found there. Phoenix will land in the icy north of Mars between 65 deg and 72 deg latitude, an area known to the mission designers as “Green Valley.” During the course of its 90-Martian-day surface mission, Phoenix will deploy its robotic arm and dig trenches up to 0.5 m (1.6 ft) into the layers of water ice. These layers, thought to be affected by seasonal climate changes, could contain organic compounds necessary for life.



Phoenix Science Objective
Continued

To analyze soil samples collected by the robotic arm, Phoenix carries an "oven" and a "portable laboratory." Selected samples will be heated to release volatiles that can be examined for their chemical composition and other characteristics.

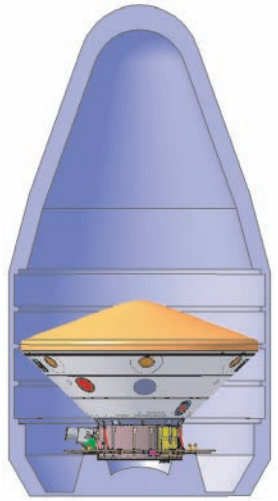
Imaging technology inherited from both the Pathfinder and Mars Exploration Rover missions is used in Phoenix's camera, located on its 2-ft mast. The camera's two "eyes" will reveal a high-resolution perspective of the landing site's geology and also will provide range maps that will enable the team to choose ideal digging locations. Multi-spectral capability will enable the identification of local minerals.

To update our understanding of Martian atmospheric processes, Phoenix will scan the Martian atmosphere up to 20 km (12.4 miles) in altitude, obtaining data about the formation, duration, and movement of clouds, fog, and dust plumes. Phoenix will also carry temperature and pressure sensors.

Phoenix Mission Description

- Launch period: 3 to 24 August 2007
- Launch times for 3 August
  - First opportunity: 5:35:18 EDT
  - Second opportunity: 6:11:24 EDT
- Launch time generally moves about 10 minutes earlier each day.
- Flight azimuth
  - First opportunity: 93 deg
  - Second opportunity: 99 deg
- Payload mass: 680 kg (1,499 lb)
- Injection conditions for 3 August launch (93-deg flight azimuth)
  - Altitude: 1,217.6 nmi
  - Velocity: 36,159.8 fps

Launch Vehicle Configuration



Delta II Fairing Protects Phoenix for Launch

Phoenix Flight Mode Description

Boost Phase

- Launch from Cape Canaveral Air Force Station Complex 17A
- 93- and 99-deg flight azimuths
- Direct flight azimuth mode employed (combined pitch/yaw rates)
  – Eliminates early large roll maneuver to orient vehicle Quad II downrange
  – Quad II oriented downrange after solid motor jettison
- 6 solid motors ignite at liftoff and 3 ignite in the air, after first 6 have burned out
- Boost trajectory designed to meet controllability, structural, and environmental constraints while maximizing performance
- Main engine cutoff (MECO) occurs at first-stage propellant depletion
- Stage I-II separation 8 sec after main engine cutoff
- Fairing jettison occurs when free molecular heating rate is < 0.1 BTU/ft^2-sec
- At first second-stage cutoff, vehicle is in 90 nmi (167 km) circular parking orbit
  – Inclination = 28.5 deg for 93-deg flight azimuth
  – Inclination = 29.3 deg for 99-deg flight azimuth

Phoenix Sequence of Events

Boost Phase

Event	Time (min:sec)	
	93-deg Flt Az	99-deg Flt Az
Liftoff	00:00.0	00:00.0
Mach 1	00:32.3	00:32.3
Maximum Dynamic Pressure	00:49.6	00:49.6
Six Ground-Lit Solid Motors Burnout	01:03.1	01:03.1
Three Air-Lit Solid Motors Ignition	01:05.5	01:05.5
Jettison Three Ground-Lit Solid Motors	01:06.0	01:06.0
Jettison Three Ground-Lit Solid Motors	01:07.0	01:07.0
Three Air-Lit Solid Motors Burnout	02:08.8	02:08.8
Jettison Three Air-Lit Solid Motors	02:11.5	02:11.5
Main Engine Cutoff (MECO)	04:23.3	04:23.3
Stage I-II Separation	04:31.3	04:31.3
Stage II Ignition	04:36.8	04:36.8
Jettison Fairing	05:03.0	05:03.0
First Cutoff – Stage II (SECO-1)	09:20.5	09:21.0

Phoenix Flight Mode Description

Second and Third Stages

- Following SECO-1, vehicle is reoriented to BBQ roll attitude (Sun normal)
  +1 deg/sec BBQ roll during first half of coast

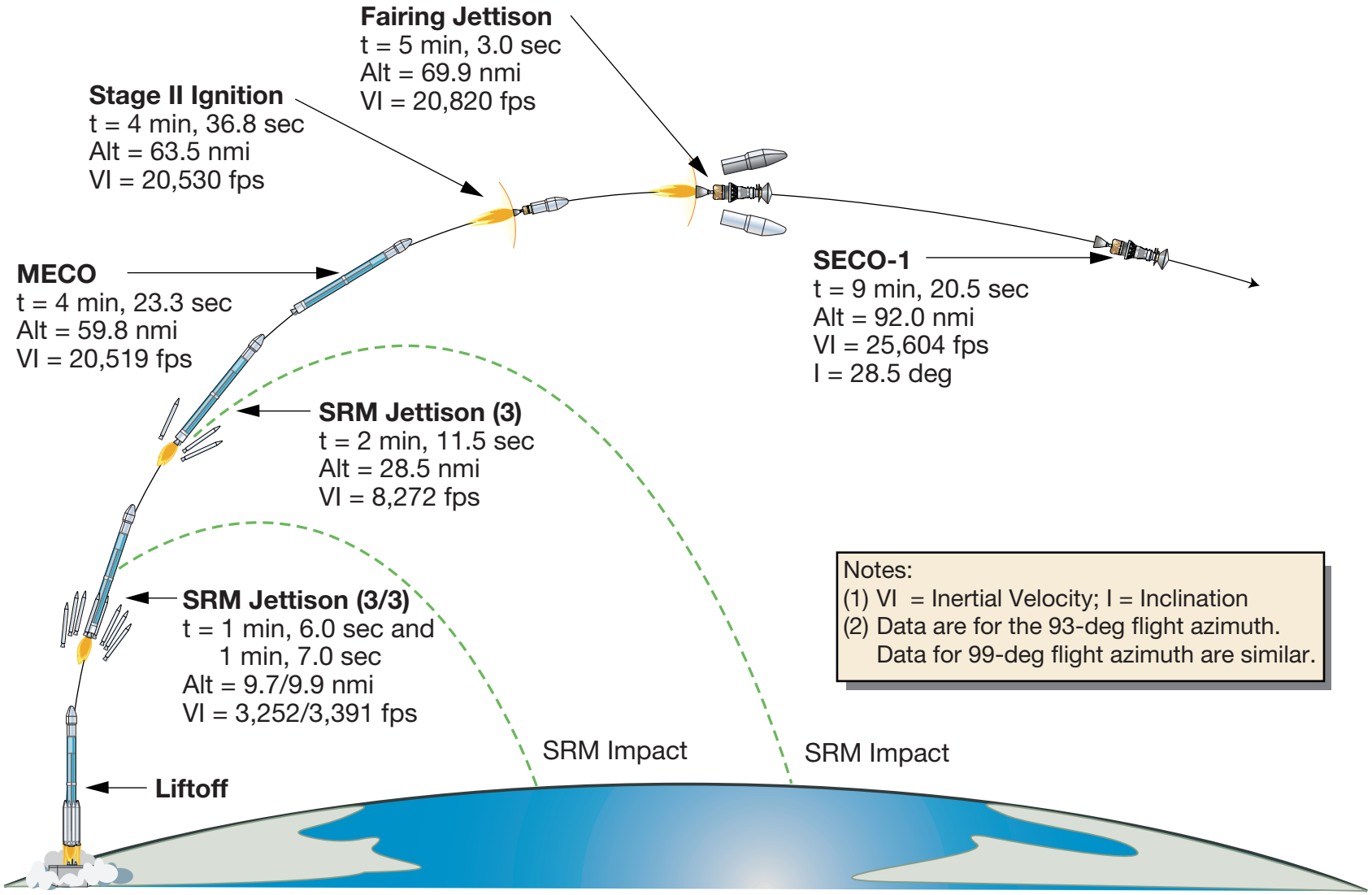
  -1 deg/sec BBQ roll during second half of coast
- Second-stage reoriented to restart burn attitude following BBQ maneuver
- Second stage restart and third-stage burns occur at optimum location to maximize performance and satisfy targeting requirements
  - Optimum attitude maintained during second stage-restart burn
  - Small reorientation maneuver after SECO-2 to achieve optimum third-stage burn attitude
- Third-stage spinup occurs 60 sec after SECO-2
- 87.5-sec third-stage motor burn injects spacecraft into the desired orbit
- Yo-Yo despin weights deploy 5.2 sec prior to spacecraft separation
- Spacecraft separation occurs 387.5 sec after third-stage ignition
- Primary mission duration ranges from 82 min to 96 min

Phoenix Sequence of Events

Second and Third Stages for 3 August

Event	Time (min:sec)	
	93-deg Flt Az	99-deg Flt Az
First Restart – Stage II	73:47.2	71:51.3
Second Cutoff – Stage II (SECO-2)	76:02.3	74:06.3
Fire Spin Rockets	77:02.3	75:06.3
Jettison Stage II	77:05.5	75:09.5
Stage III Ignition	77:42.8	75:46.9
Stage III Burnout (TECO)	79:10.3	77:14.3
Disable NCS/Initiate Yo-Yo Despin	84:05.2	82:09.2
Jettison Stage III	84:10.3	82:14.4
Target Interface Point (TIP)	87:42.8	85:46.9

Phoenix Boost Profile



Phoenix Second and Third Stage Profile

SECO-2
t = 76 min, 2.3 sec
87.7 X 3,128.1 nmi orbit
at 28.5 deg Inclination

Stage III Ignition
t = 77 min, 42.8 sec

Payload Separation
t = 84 min, 10.3 sec

Stage II–III Separation
t = 77 min, 5.5 sec

Stage III Burnout (TECO)
t = 79 min, 10.3 sec

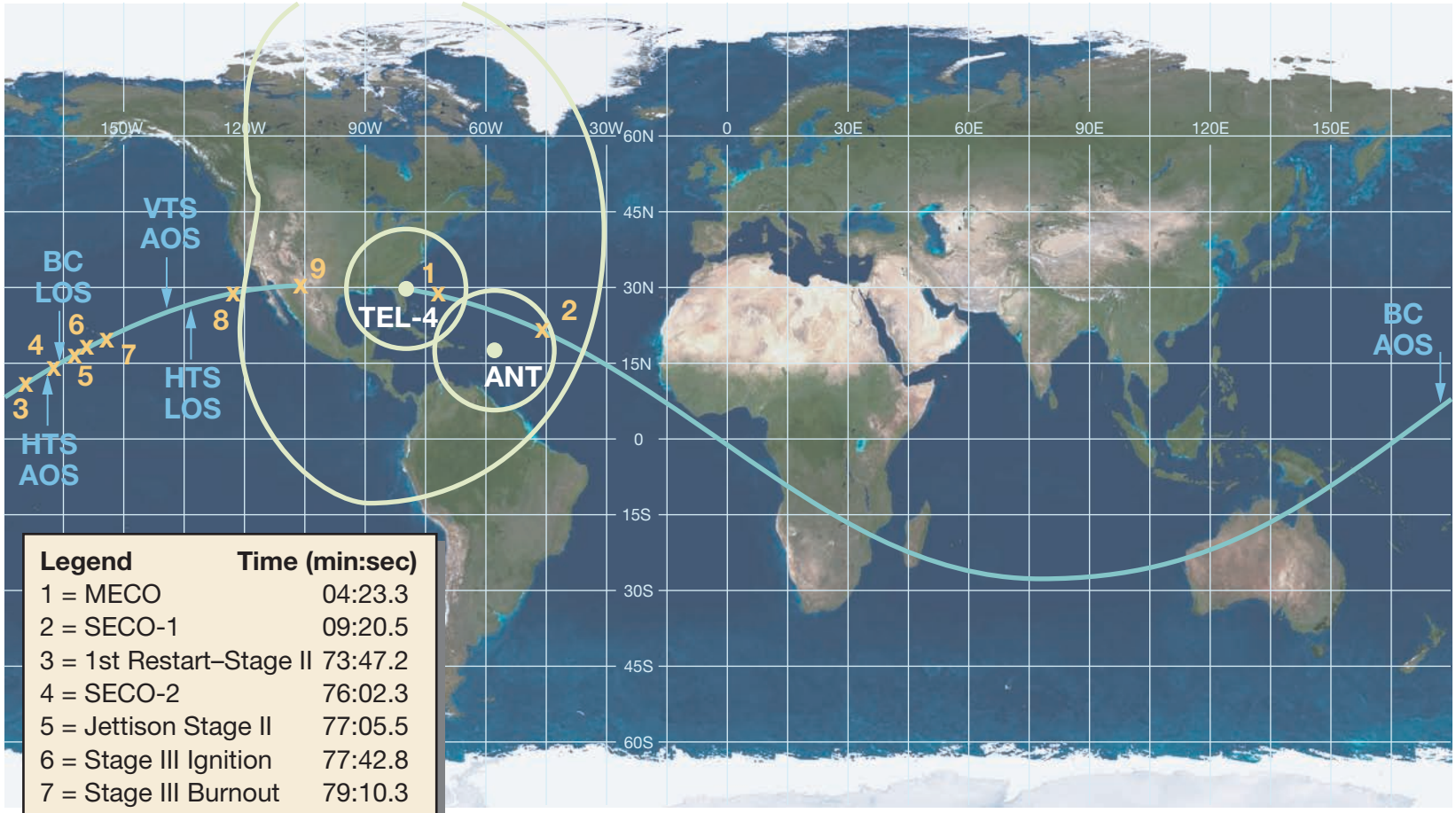
Stage II Restart
t = 73 min, 47.2 sec
86.4 X 96.5 nmi orbit at
28.5-deg Inclination

Targeting Interface Point
t = 87 min, 42.8 sec
HP = 105.4 nmi
C3 = 29.080 km^2/sec^2
DLA = 3.196 deg
RLA = 91.978 deg

Notes:
Values shown are for the 93-deg flight azimuth 3 August launch date.

Phoenix Ground Trace

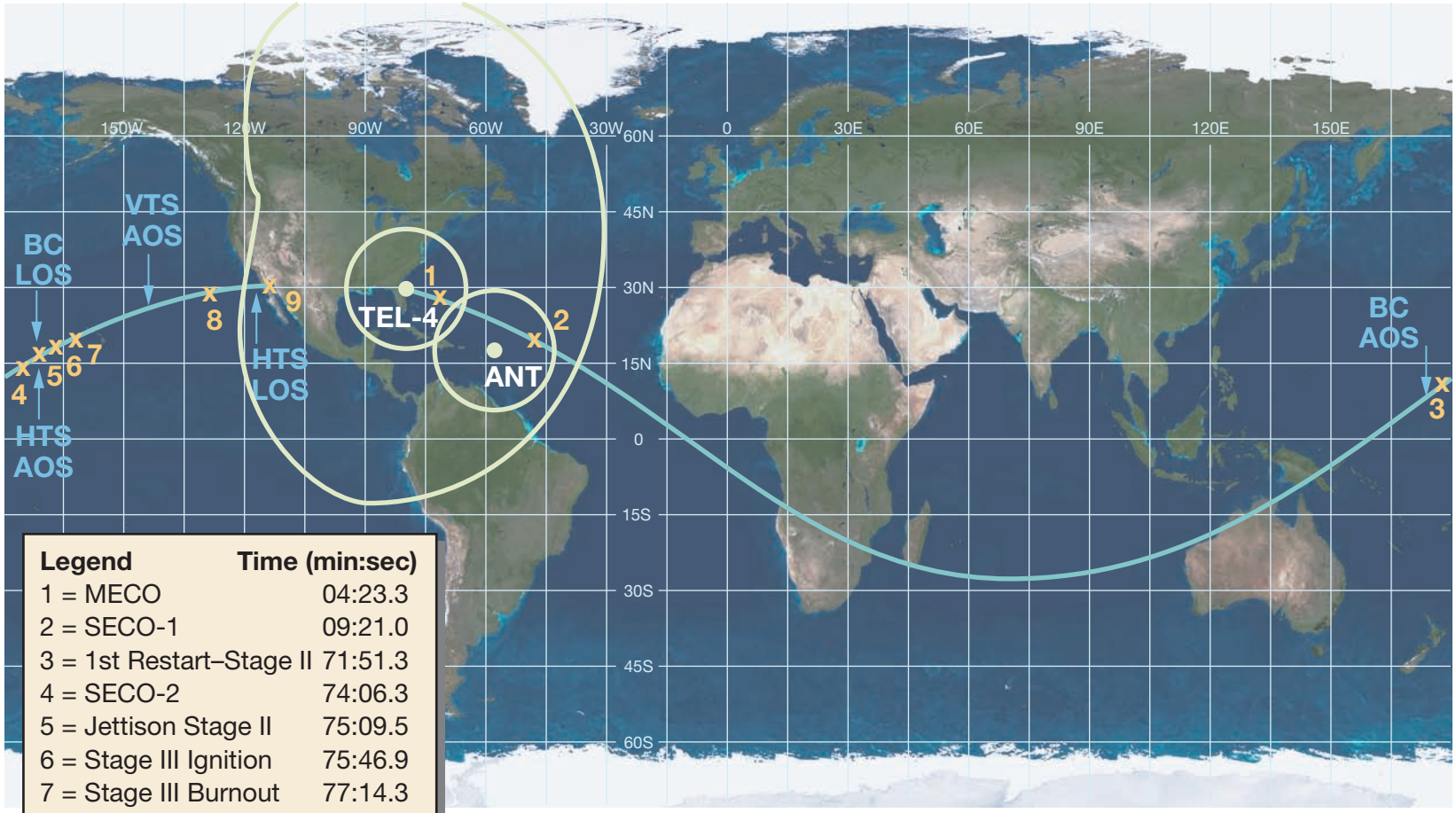
3 August – First Opportunity (93-deg Azimuth)



Legend	Time (min:sec)
1 = MECO	04:23.3
2 = SECO-1	09:20.5
3 = 1st Restart–Stage II	73:47.2
4 = SECO-2	76:02.3
5 = Jettison Stage II	77:05.5
6 = Stage III Ignition	77:42.8
7 = Stage III Burnout	79:10.3
8 = Jettison Stage III	84:10.3
9 = TIP	87:42.8

Phoenix Ground Trace

3 August – Second Opportunity (99-deg Azimuth)

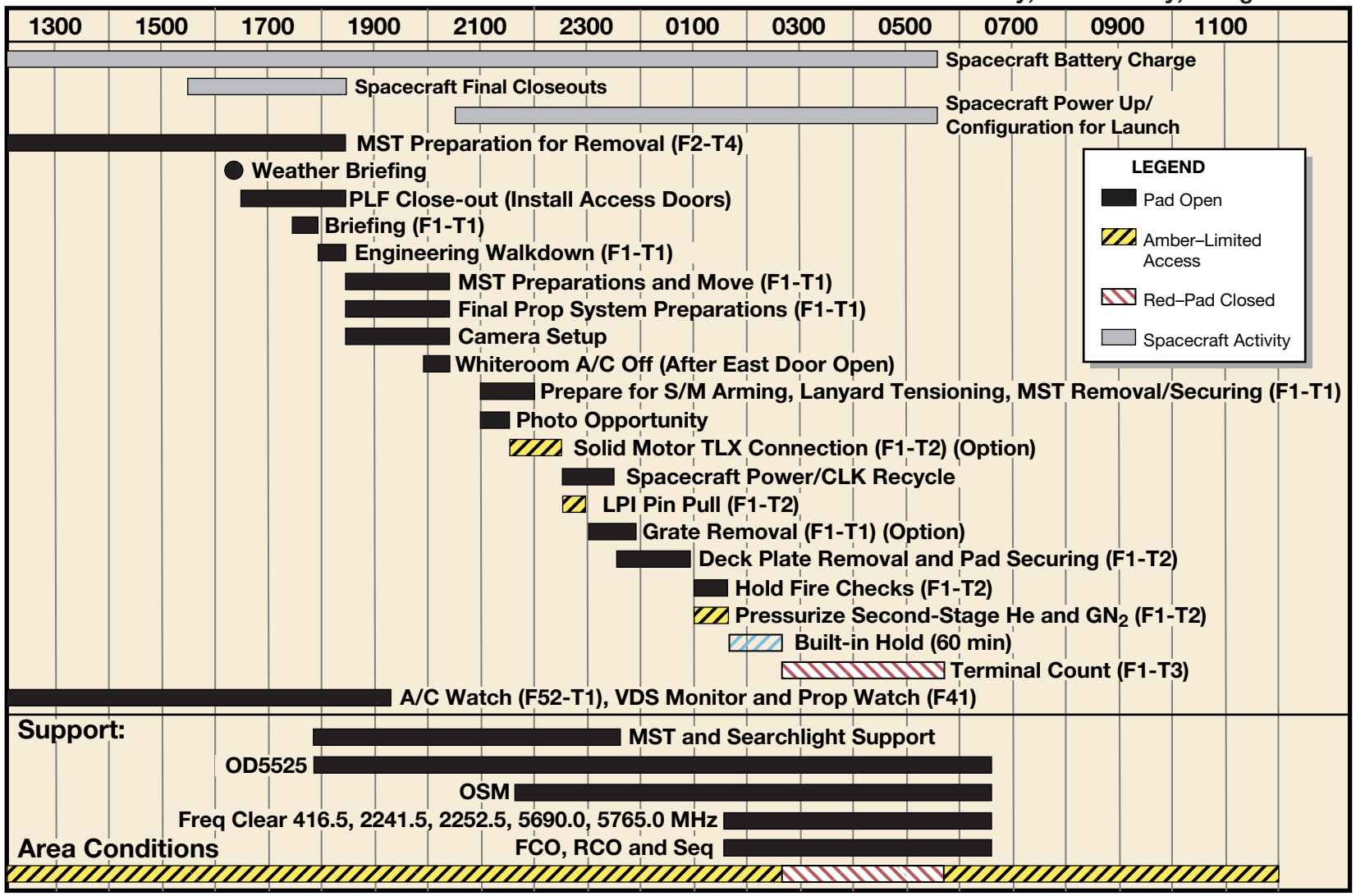


Legend	Time (min:sec)
1 = MECO	04:23.3
2 = SECO-1	09:21.0
3 = 1st Restart–Stage II	71:51.3
4 = SECO-2	74:06.3
5 = Jettison Stage II	75:09.5
6 = Stage III Ignition	75:46.9
7 = Stage III Burnout	77:14.3
8 = Jettison Stage III	82:14.4
9 = TIP	85:46.9

Delta Countdown

T-0 Day

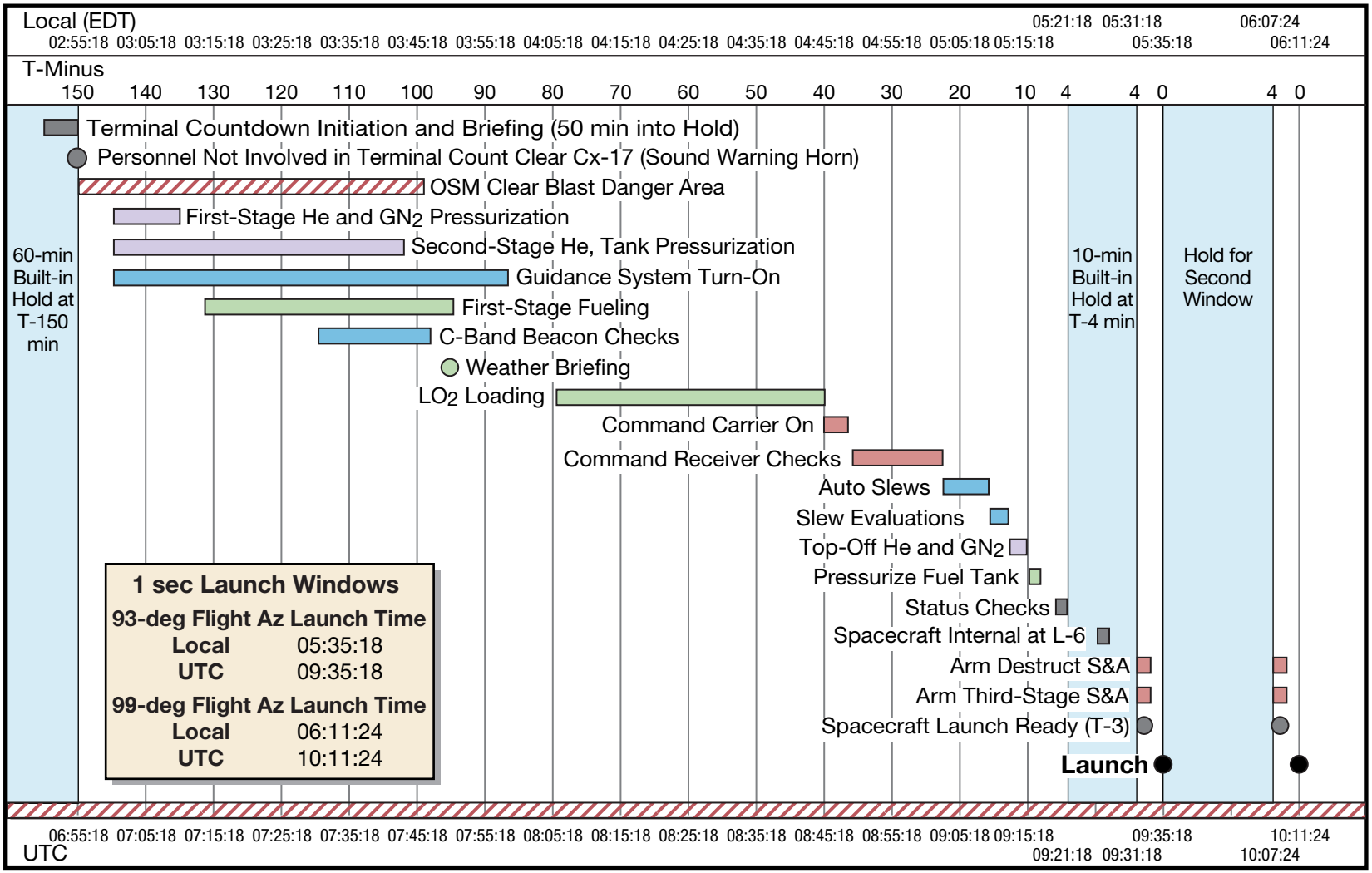
Thursday, 2 and Friday, 3 August 2007



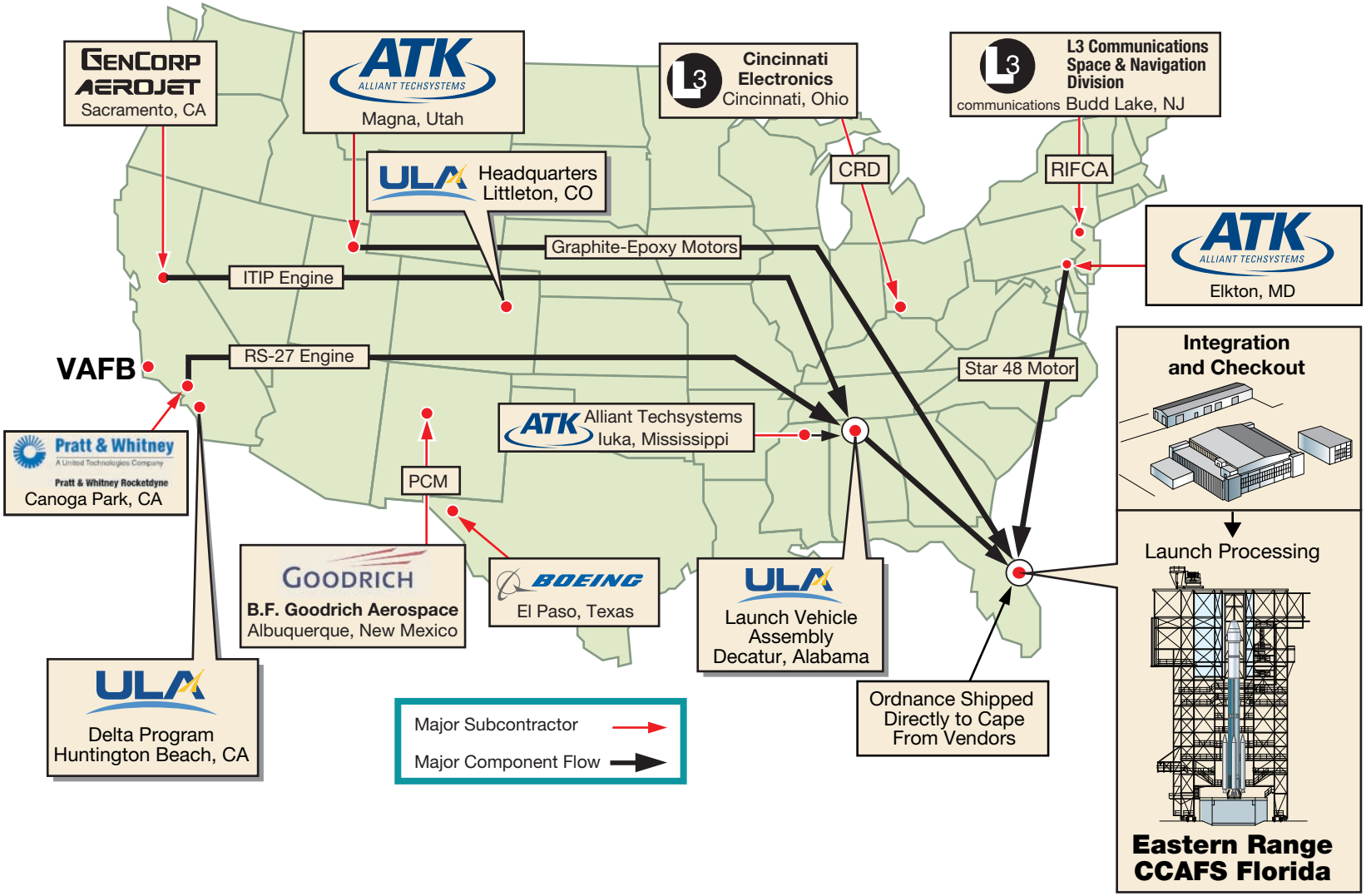
Terminal Count

T-0 Day

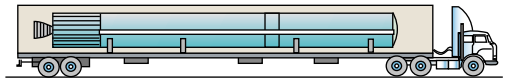
Friday, 3 August 2007



Delta II Operational Flow at Eastern Range



Total Vehicle Integration and Checkout at the Launch Site



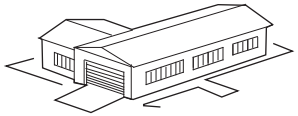
• First-stage from assembly plant

• Second-stage fairing interstage from assembly plant

Delta Mission Checkout (Hangar AO)

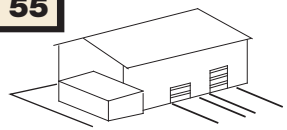
Delta II integration and checkout area
- Receive and inspect
- Mission integration and checkout
- Dual composite tests
- Storage
- Load on pad erection trailers

Horizontal Processing Facility



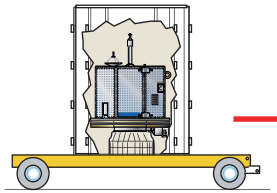
• Destruct installation

Area 55

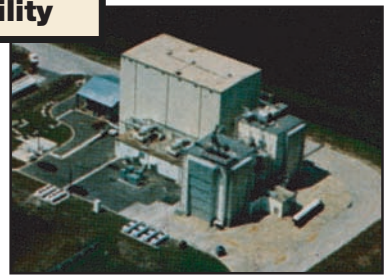


- Destruct installation
- Erection preparation
- Leak checks

Processing Facility

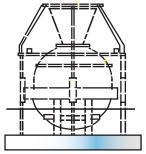


• Space vehicle

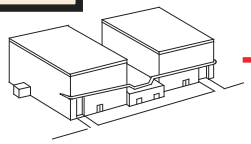


• Mate to upper stage

Area 59

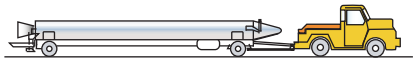


• Upper-stage motor

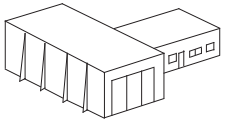


• Balance motor

Area 57

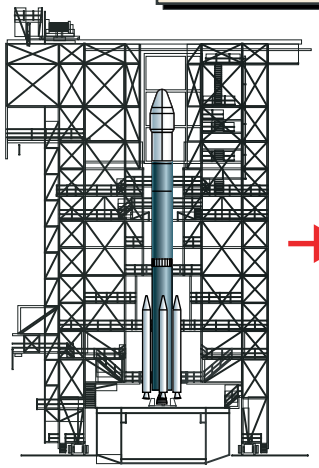


• GEM graphite-epoxy motors



- Motor buildup
- Destruct installation

Launch Complex-17



- Erect and mate stages
- Install solid motors
- Check out subsystems
- Simulated flight test
- Preflight finalization

Notes:


Phoenix
NASA
Jet Propulsion Laboratory
DELTA II
University of Arizona
Lockheed Martin Corporation
ULA
United Launch Alliance

Delta Launch Vehicle Programs

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