



WorldView-1

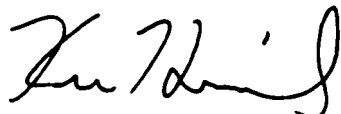
Delta Launch Vehicle Programs



WorldView-1

Boeing Launch Services and United Launch Alliance are honored to launch WorldView-1, the first of the DigitalGlobe Next-Generation imaging satellites. WorldView-1 will be launched aboard a Delta II launch vehicle from Vandenberg Air Force Base (VAFB). The launch vehicle will deliver the satellite into a sun-synchronous orbit where the satellite will begin its mission of recording and collecting high resolution, commercial, digital Earth imagery from space.

United Launch Alliance provides the Delta II launch vehicle and mission services under a commercial launch service contract administered by Boeing Launch Services for DigitalGlobe located in Longmont, Colorado. The first of the DigitalGlobe constellation of satellites, Quickbird, was launched by a Delta II in October 2001. We are pleased that DigitalGlobe once again has selected the Delta II for this first Next-Generation WorldView satellite. Our congratulations to the entire Delta team for their continued efforts in achieving this milestone.



Kenneth A. Heintz
Vice-President, Boeing Launch Services
The Boeing Company



Kristen T. Walsh
Director, NASA/Commercial Programs
United Launch Alliance

WorldView-1 System Overview

The high-capacity (331 Gb per orbit collection), panchromatic imaging system will produce 0.5-m resolution imagery with a swath width of 17.7 km at nadir. Operating at an altitude of 496 km, WorldView-1 will have an average revisit time of 1.74 days (for 1-m or less ground sample distance) and a global collection capacity of up to 628,000 km² (242,500 mi²) per day of 0.5-m imagery.

The system utilizes control moment gyros (CMGs) and will be the most agile satellite ever flown commercially; exhibiting stunning agility with rapid acceleration between targets of 2.5 deg/s² and efficient in-track stereo collection. The satellite will also be equipped with state-of-the-art geolocation accuracy capabilities. The predicted performance is in the range of 3.0 to 7.6 m CE90.

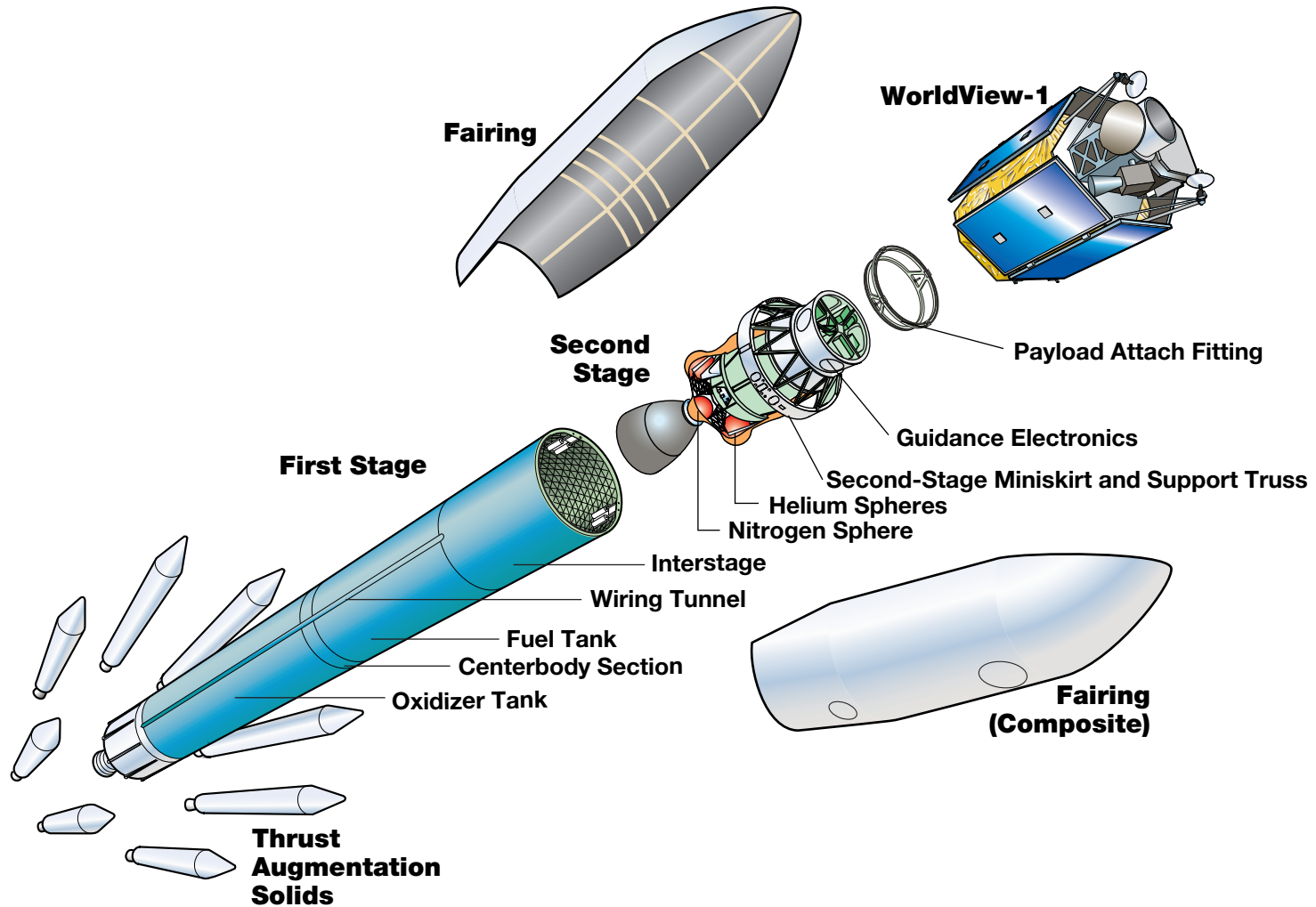
Mission Objectives

The WorldView-1 remote sensing satellite will return high resolution, commercial, digital Earth imagery from space.

Highly detailed satellite imagery is currently used for a plethora of applications:

- Precise map creation
- In-depth image analysis
- Urban planning
- Environmental impact assessment
- Oil and gas exploration
- Agriculture and disaster assessment and response

Delta II 7920-10 Launch Vehicle



Mission Requirements

- Spacecraft Mass (lb/kg) 5,049.4 / 2290.4
- Launch Window 11:35 – 11:49 PDT
(18:35 – 18:49 UTC)
- Orbit Requirements*
 - Local Mean Time at Descending Node 10:15 AM
 - Semi-Major Axis (km/nmi) 6877.950 / 3713.796
 - Eccentricity 0.001188
 - Inclination (deg) 97.489
 - Argument of Perigee (deg) 114.95758
- Free Molecular Heating Rate (FMHR) ≤ 0.1 BTU/ft²-sec
at fairing jettison
- Spacecraft Contamination Level
from Evasive Burn <5 Angstroms
- Spacecraft Separation Orientations
 - Z_{SC} axis and sun vector angle between 30 and 40 deg
 - 9.0 ± 0.5 dps spin rate about $+Z_{SC}$ axis

*(Defined at First Descending Node after Spacecraft Separation)

Flight Mode Description – Boost-to-Orbit

- 7920-10 launch from Vandenberg Air Force Base (VAFB) SLC-2W
- Flight azimuth of 196 deg
- 6/3 GEM solid motors firing sequence
- Separation of ground-ignited GEMs at 1 min, 26 sec and 1 min, 27 sec to assure clearance of coastal oil platforms
- Air-ignited GEMs jettisoned at 2 min, 11.5 sec
- Dog-leg maneuver (1 min, 30 sec to 2 min, 22 sec) performed to attain required orbital inclination
- Main Engine Cutoff (MECO) occurs approximately 4 min, 23.4 sec after liftoff
- Stage I-II separated 8 sec after MECO; Stage II ignited 5.5 sec later
- Payload fairing jettisoned when free molecular heating rate ≤ 0.1 BTU/ft²-sec (1135 W/m²)
- Command Receiver Decoders (CRDs) turned off at 6 min, 27 sec
- Stage II first burn cutoff (SECO-1) occurs at 10 min, 28 sec
 - Vehicle inserted in a 99 x 278 nmi (183 x 515 km) orbit with an inclination of 97.415 deg
- Mobile Telemetry (MT) required for coverage of last portion of second-stage burn

Sequence of Events – Boost-to-Orbit

Event	Time (hr:min:sec)
Liftoff	0:00:00.0
Mach 1	0:00:32.9
Maximum Dynamic Pressure	0:00:47.8
Solid Motor Burnout (6 ground-ignited)	0:01:04.0
Solid Motor Ignition (3 air-ignited)	0:01:05.5
Solid Motor Separation (3 ground-ignited)	0:01:26.0
Solid Motor Separation (3 ground-ignited)	0:01:27.0
Begin Dog-leg Maneuver	0:01:30.0
Solid Motor Burnout (3 air-ignited)	0:02:09.7
Solid Motor Separation (3 air-ignited)	0:02:11.5
End Dog-leg Maneuver	0:02:22.0
Main Engine Cutoff (MECO)	0:04:23.4
Stage I-II Separation	0:04:31.4
Stage II Ignition	0:04:36.9
Jettison Fairing	0:04:43.0
Turn Off CRDs	0:06:27.0
First Cutoff – Stage II (SECO-1)	0:10:28.0

Flight Mode Description – Coast to Spacecraft Injection Orbit

- Following SECO-1, vehicle reoriented to desired coast attitude
- At end of reorientation maneuver, thermal conditioning roll at 2 dps initiated
- Following termination of roll maneuver, vehicle reoriented to second-stage restart burn attitude
- Second-stage restart occurs at 54 min, 10 sec over Hartebeesthoek tracking station
 - Restart burn duration of 12.3 sec
 - At end of restart burn, vehicle in an orbit of 266.2 x 272.4 nmi (493.0 x 504.5 km) with an inclination of 97.49 deg
- Following second-stage restart, vehicle reoriented to desired attitude for spacecraft separation
- 9 dps roll initiated 75 sec prior to separation
- Spacecraft separation will occur at 1 hr, 13 min, 20 sec over Oakhanger tracking station
 - Spacecraft reaches first descending node approximately 1 hr, 45 min after liftoff, at which point orbit requirements are met

Sequence of Events – Coast to Spacecraft Orbit Injection

Event	Time (hr:min:sec)
Maneuver to Thermal Conditioning Attitude	0:11:40.0 – 0:17:30.0
Thermal Conditioning Roll	0:18:10.0 – 0:42:50.0
Maneuver to Restart Attitude	0:43:00.0 – 0:51:40.0
Stage II Restart Ignition	0:54:10.0
Second Cutoff – Stage II (SECO-2)	0:54:22.3
Maneuver to Separation Attitude	1:01:40.0 – 1:10:0.0
Initiate Spin	1:12:05.0
Spacecraft Separation	1:13:20.0
Spacecraft at Descending Node (Orbit Injection)	1:45:26.6

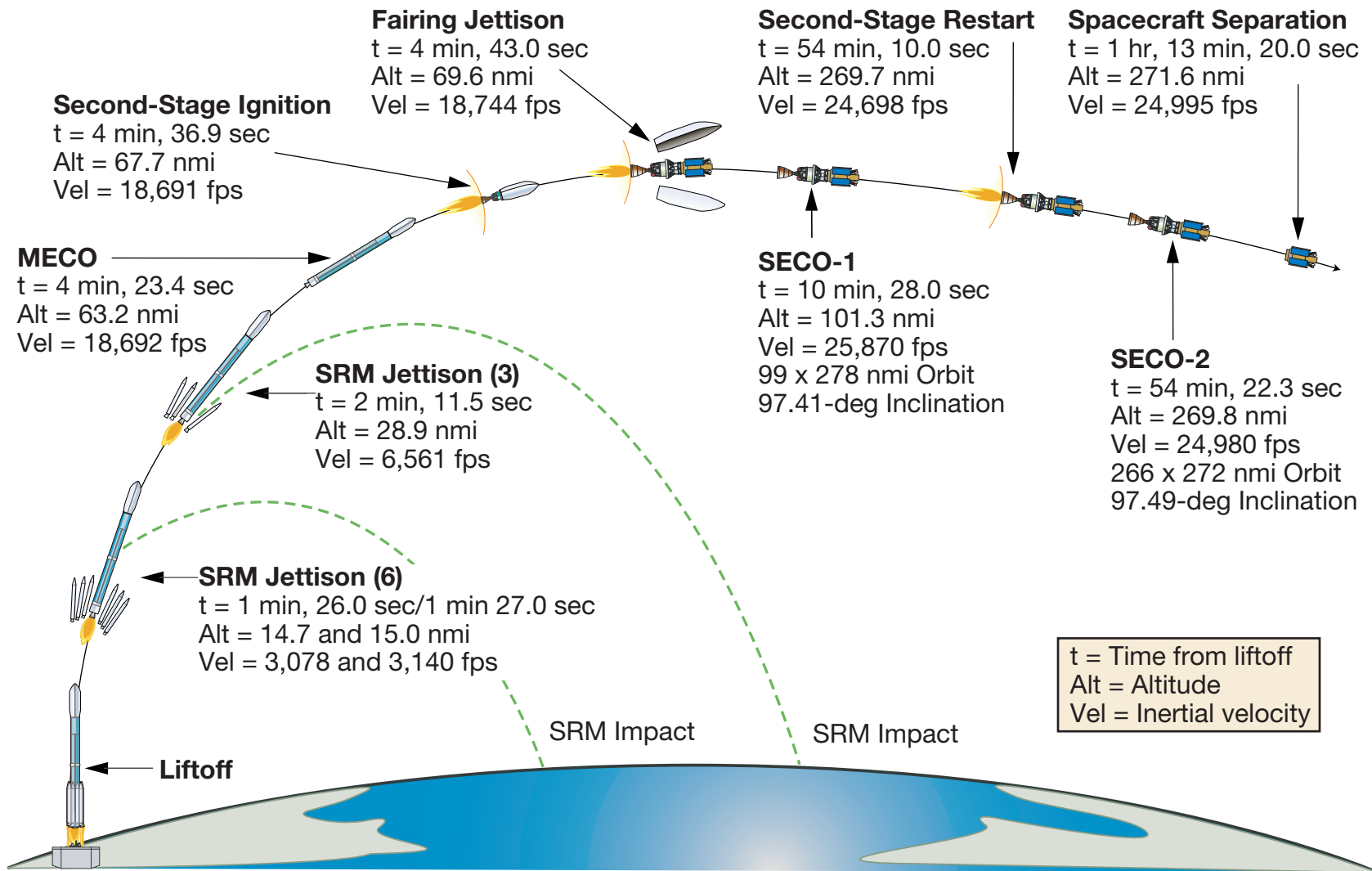
Flight Mode Description – Post-Separation

- Following spacecraft separation, vehicle reoriented to cold-gas evasive maneuver (CGEM) attitude
- CGEM provides additional separation velocity
 - Duration of 25 sec, beginning at 1 hr, 19 min, 10 sec after liftoff
 - 1.0 fps DV imparted to second stage
- Following the CGEM, second stage reoriented for evasive burn in view of Pillar Point tracking station
 - Burn duration of 5 sec, beginning at 1 hr, 32 min, 30 sec after liftoff
 - 101 x 264-nmi (187 x 489-km) orbit at 97.76-deg inclination
 - Burn attitude designed to minimize contamination potential and meet contamination requirement of <5 Angstroms
- Following evasive burn maneuver, vehicle reoriented for second-stage depletion burn in view of Hawaii tracking station
 - Nominal burn duration of 1 min, 23.5 sec, beginning at 1 hr, 41 min, 40 sec after liftoff
 - At end of nominal depletion burn, second stage in a 110 x 267 nmi (204 x 494 km) orbit with an inclination of 111.33 deg

Sequence of Events – Post-Separation

Event	Time (hr:min:sec)
Maneuver to Cold-Gas Evasive Attitude	1:15:00.0 – 1:19:00.0
Begin Cold-Gas Evasive Maneuver	1:19:10.0
End Cold-Gas Evasive Maneuver	1:19:35.0
Maneuver to Evasive Burn Attitude	1:21:40.0 – 1:30:30.0
Stage II Evasive Burn Ignition	1:32:30.0
Second Cutoff – Stage II (SECO-3)	1:32:35.0
Maneuver to Depletion Burn Attitude	1:35:00.00 – 1:39:40.0
Stage II Restart Ignition (Depletion Burn)	1:41:40.0
Depletion Cutoff – Stage II (SECO-4)	1:43:03.5

Flight Profile



Orbit Trace – Boost-to-Orbit

Legend (time, sec)

1 – Main Engine Cutoff (263.4)

2 – SECO-1 (628.0)

WR Tracking Sites

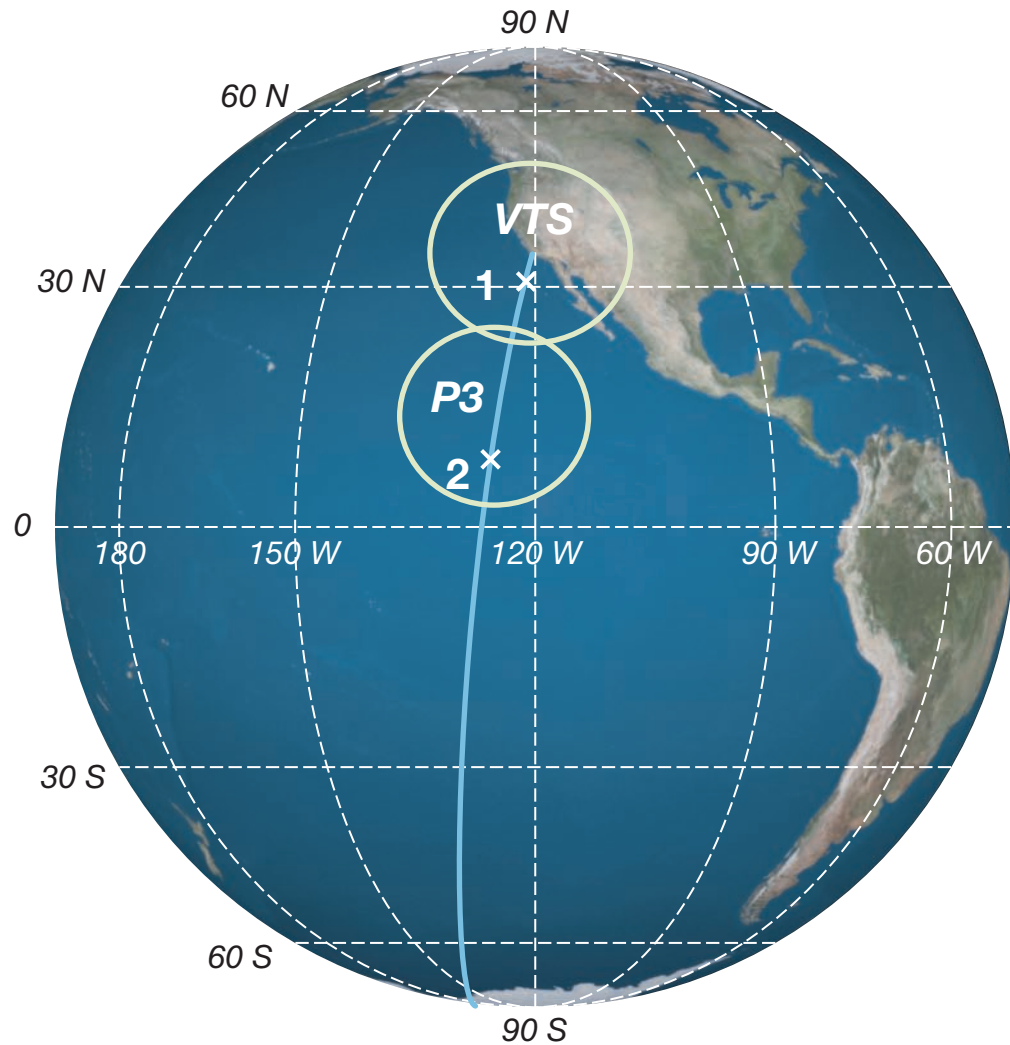
VTS – AFSCN Vandenberg

TRS – VAFB WR Telemetry Receiving Station

SNI – NAWC San Nicolas Island

NP-3D

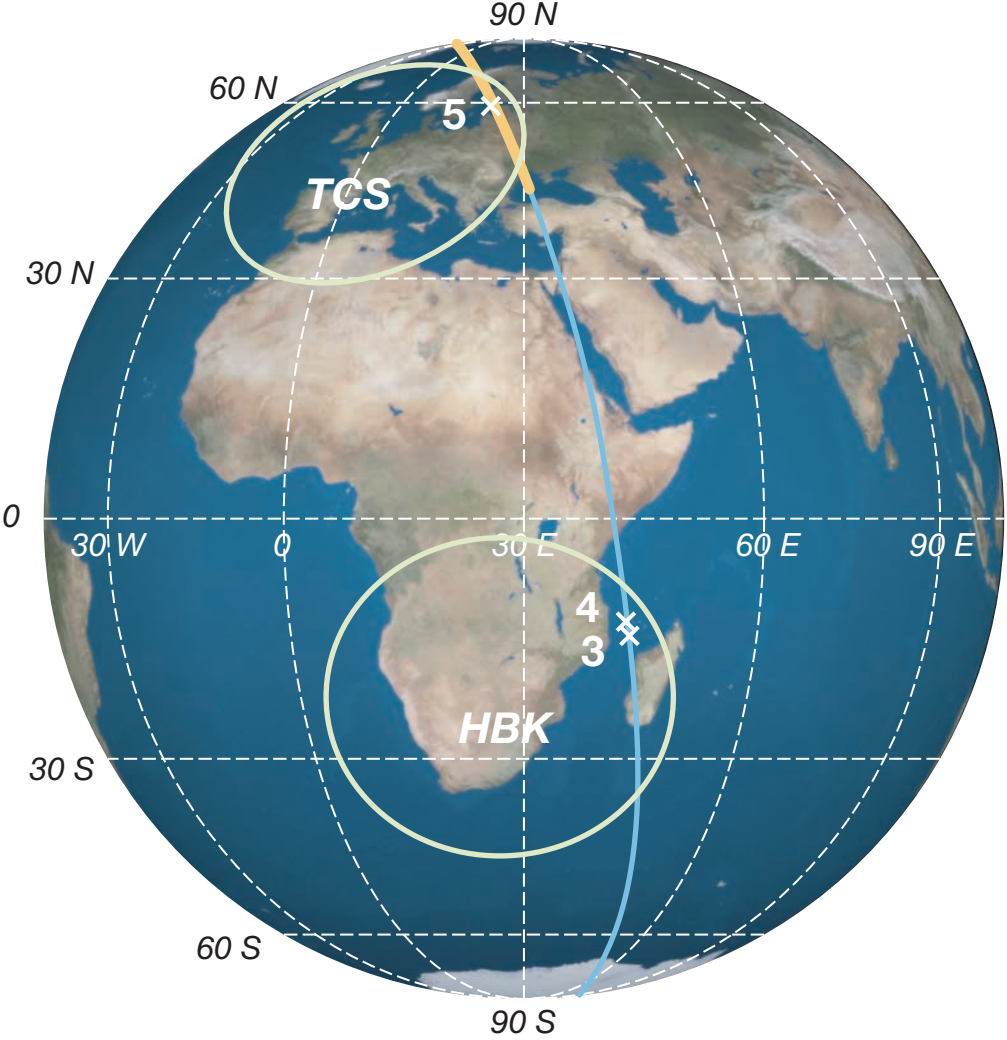
P-3 – NAWC Instrumented Aircraft



Orbit Trace – Coast to Spacecraft Separation

Legend (time, sec)
3 – First Restart (3250.0)
4 – SECO-2 (3262.3)
5 – Spacecraft Separation (4400.0)

Downrange Tracking Site(s)
HBK – Satellite Applications Center
Hartebeesthoek, South Africa
TCS – Telemetry and Commanding
Station



Orbit Trace – Post-Separation

Legend (time, sec)

6 – Second Restart (5550.0)

7 – SECO-3 (5555.0)

8 – Third Restart (6100.0)

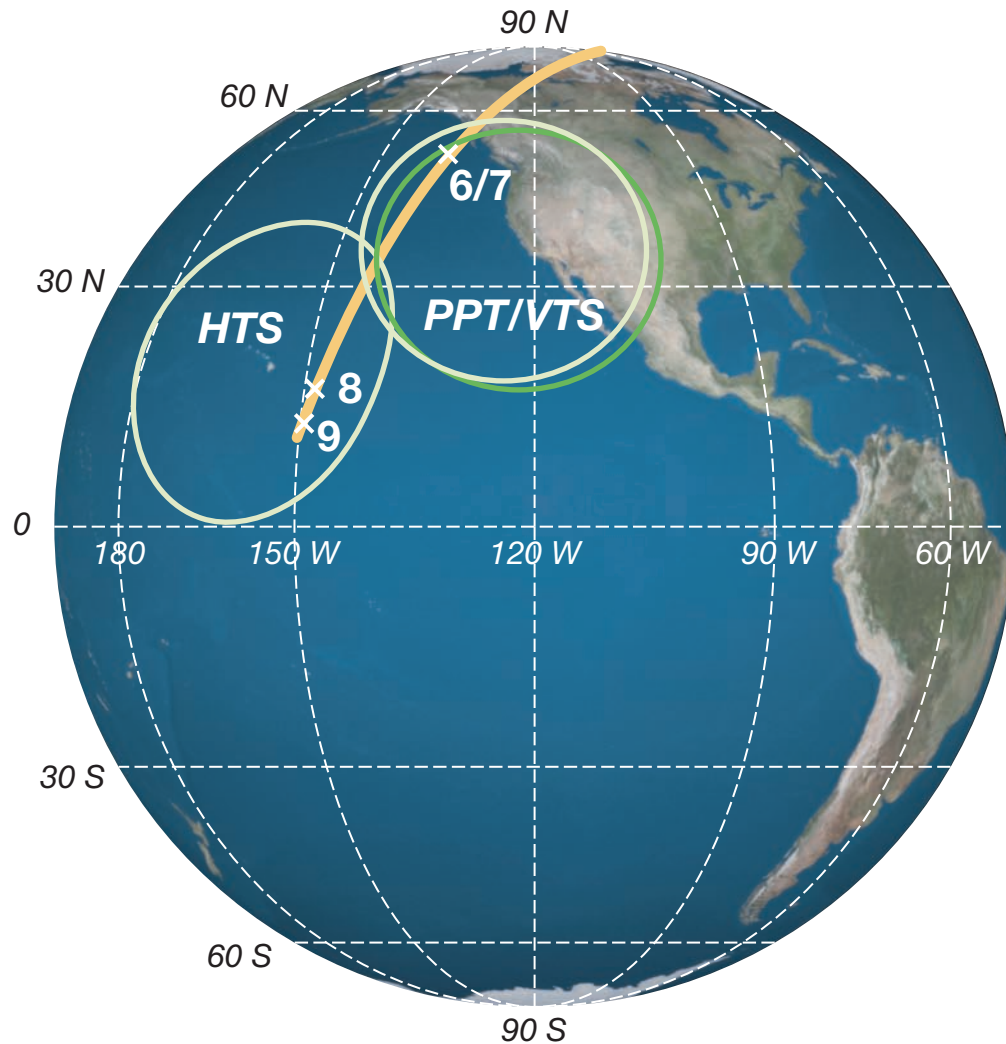
9 – SECO-4 (6183.5)

Downrange Tracking Site(s)

VTS – Vandenberg Tracking Station

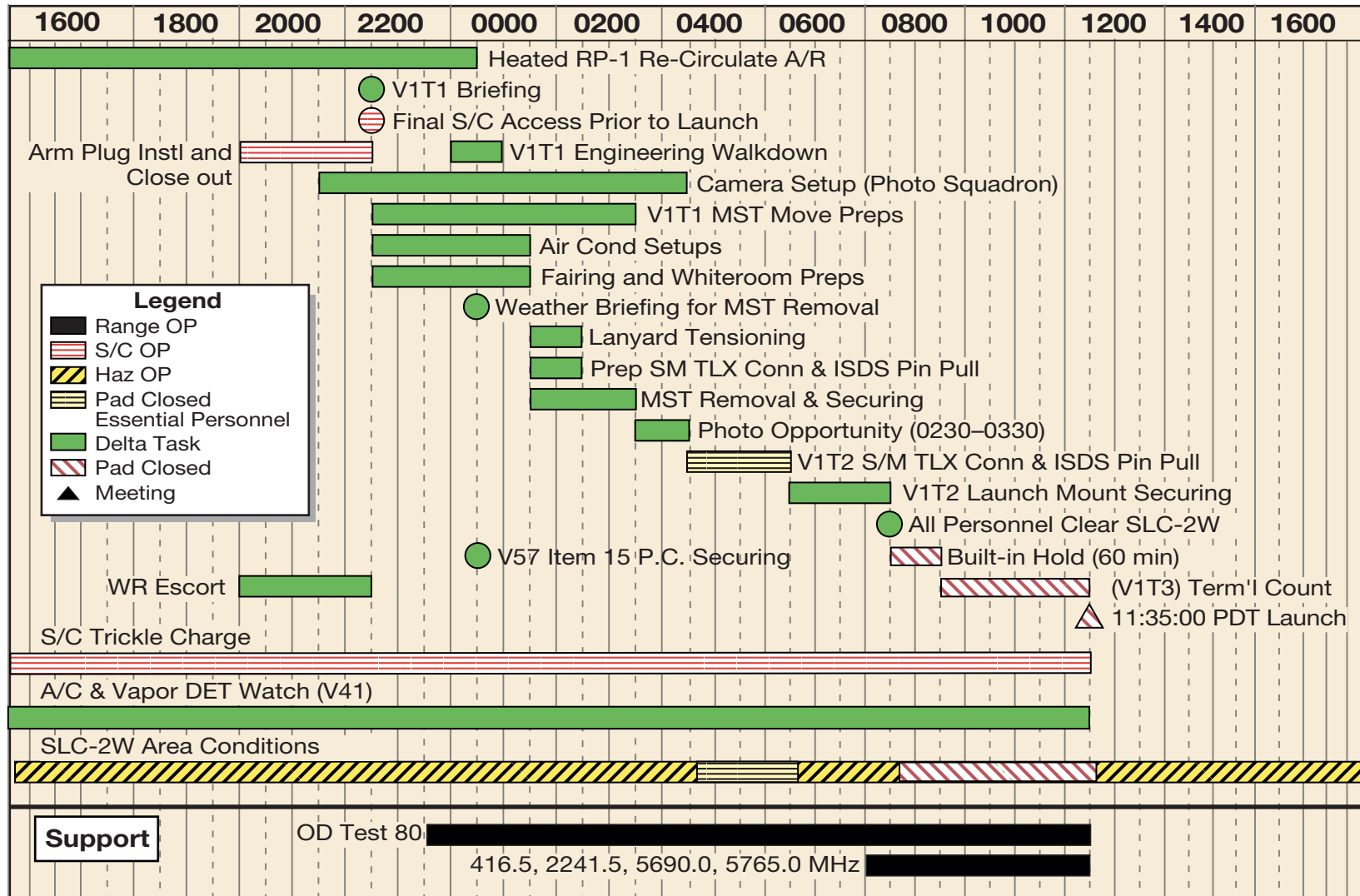
PPT – Pillar Point Tracking Station

HTS – Hawaii Tracking Station



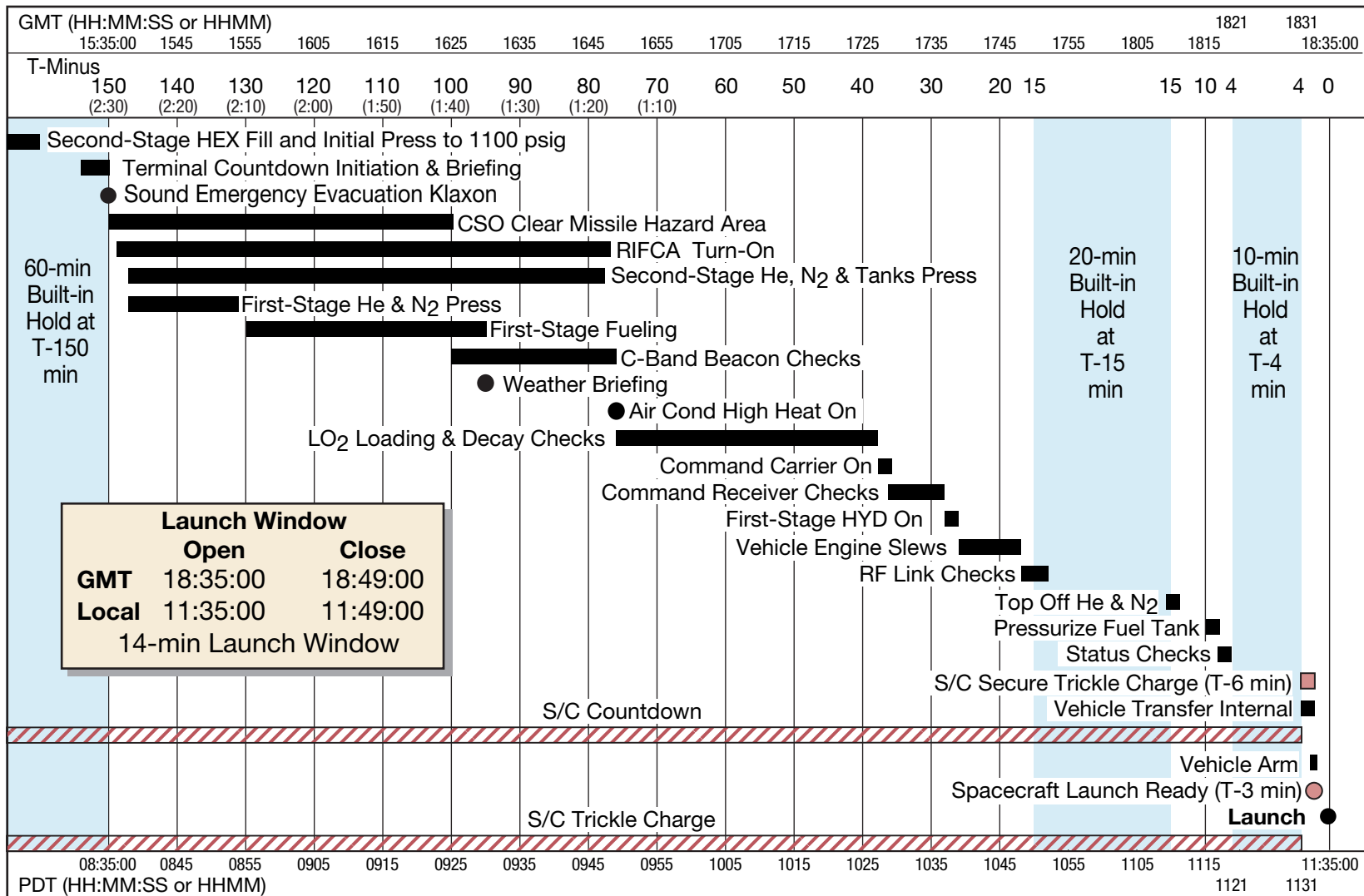
Delta Countdown

T-1/T-0 Day

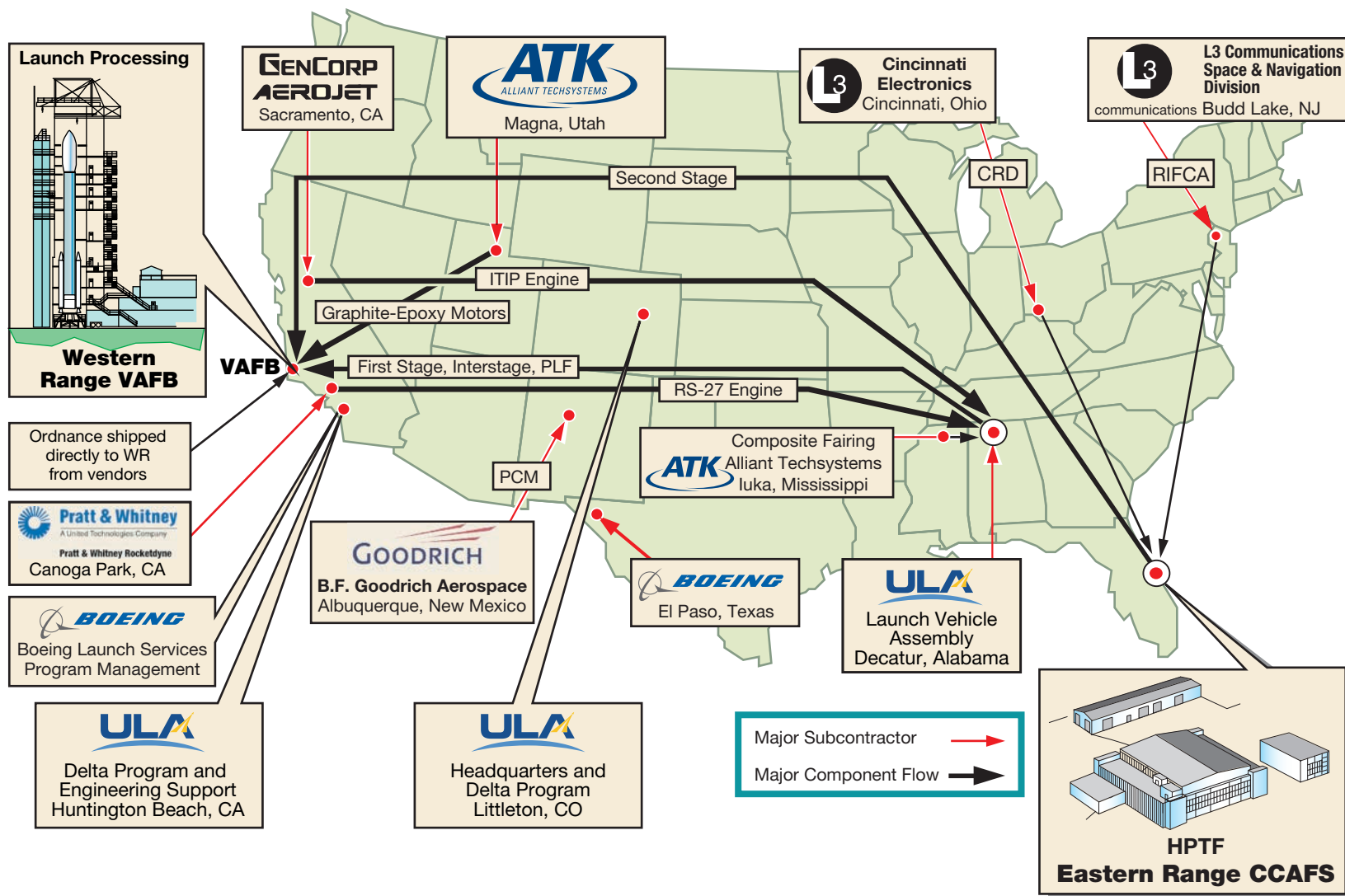


WorldView-1 Terminal Count

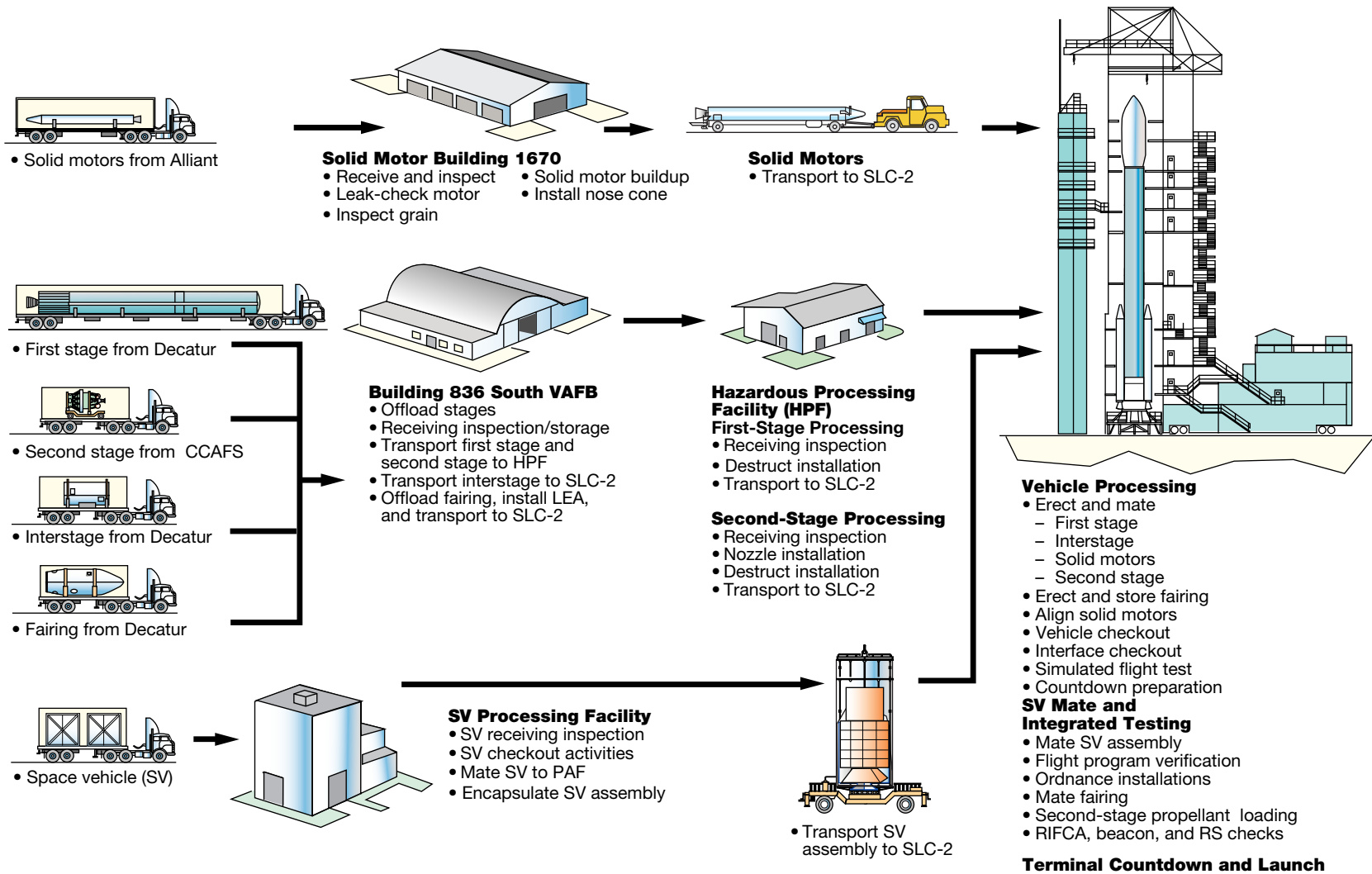
T-0 Day



Delta II Operational Flow at Western Range

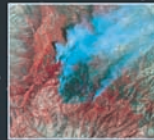


Delta II Hardware Flow at VAFB



WorldView

A Next-Generation Commercial
Remote Sensing Satellite



WorldView-1

DELTA II



DIGITALGLOBE



Delta Launch Vehicle Programs

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