APPENDIX D

# U.S. Space Launch Vehicles

| Vehicle | Stages: Engine/Motor | Propellant[a] | Thrust (kilonewtons)[b, c] | Max. Dia x Height (m) | Max. Payload (kg)[d] 185-km Orbit | Geosynch. Transfer Orbit | Sun-Synch. Orbit[e] | First Launch[f] |
|---|---|---|---|---|---|---|---|---|
| Pegasus | | | | 6.71x15.5[h] | 380<br>280[e] | — | 210 | 1990 |
| 1. | Orion 50S | Solid | 484.9 | 1.28x8.88 | | | | |
| 2. | Orion 50 | Solid | 118.2 | 1.28x2.66 | | | | |
| 3. | Orion 38 | Solid | 31.9 | 0.97x1.34 | | | | |
| Pegasus XL | | | | 6.71x16.93 | 460 | — | 335 | 1994[g] |
| 1. | Orion 50S-XL | Solid | 743.3 | 1.28x10.29 | 350[e] | | | |
| 2. | Orion 50-XL | Solid | 201.5 | 1.28x3.58 | | | | |
| 3. | Orion 38 | Solid | 31.9 | 0.97x1.34 | | | | |
| Taurus | | | | 2.34x28.3 | 1,400 | 255 | 1,020 | Not |
| 0. | Castor 120 | Solid | 1,687.7 | 2.34x11.86 | 1,080[e] | | | scheduled |
| 1. | Orion 50S | Solid | 580.5 | 1.28x8.88 | | | | |
| 2. | Orion 50 | Solid | 138.6 | 1.28x2.66 | | | | |
| 3. | Orion 38 | Solid | 31.9 | 0.97x1.34 | | | | |
| Delta II | | | | 2.44x29.70 | 5,089 | 1,842[i] | 3,175 | 1990, |
| (7920, 7925) | | | | | 3,890[e] | | | Delta-7925 |
| 1. | RS-270/A | LOX/RP-1 | 1,043.0 (SL) | 3.05x38.1 | | | | [1960, Delta] |
| | Hercules GEM (9) | Solid | 487.6 (SL) | 1.01x12.95 | | | | |
| 2. | AJ10-118K | N204/A-50 | 42.4 | 2.44x5.97 | | | | |
| 3. | Star 48B[j] | Solid | 66.4 | 1.25x2.04 | | | | |
| Atlas E | | | | 3.05x28.1 | 820[e]<br>1,860[e, k] | — | 910[k] | 1968, Atlas F [1958, |
| 1. | Atlas: MA-3 | LOX/RP-1 | 1,739.5 (SL) | 3.05x21.3 | | | | Atlas LV-3A] |
| Atlas I | | | | 4.2x43.9 | — | 2,255 | — | 1990, I [1966, Atlas Centaur] |
| 1. | Atlas: MA-5 | LOX/RP-1 | 1,952.0 (SL) | 3.05x22.16 | | | | |
| 2. | Centaur I: RL10A-3-3A (2) | LOX/$LH_2$ | 73.4/ engine | 3.05x9.14 | | | | |
| Atlas II | | | | 4.2x47.5 | 6,580<br>5,510[e] | 2,810 | 4,300 | 1991, II [1966, Atlas Centaur] |
| 1. | Atlas: MA-5A | LOX/RP-1 | 2,110.0 (SL) | 3.05x24.9 | | | | |
| 2. | Centaur II: RL10A-3-3A (2) | LOX/$LH_2$ | 73.4/engine | 3.05x10.05 | | | | |
| Atlas IIA | | | | 4.2x47.5 | 6,828<br>6,170[e] | 3,062 | 4,750 | 1992, Atlas IIA [1966, |
| 1. | Atlas: MA-5A | LOX/RP-1 | 2,110.0 (SL) | 3.05x24.9 | | | | Atlas Centaur] |
| 2. | Centaur II: RL10A-4 (2) | LOX/$LH_2$ | 92.53/engine | 3.05x10.05 | | | | |
| Atlas IIAS | | | | 4.2x47.5 | 8,640<br>7,300[e] | 3,606 | 5,800 | 1993, IIAS [1966, |
| 1. | Atlas: MA-5A | LOX/RP-1 | 2,110.0 (SL) | 3.05x24.9 | | | | Atlas Centaur] |
| | Castor IVA (4)[j] | Solid | 433.6 (SL) | 1.01X11.16 | | | | |
| 2. | Centaur II: RL10A-4 (2) | LOX/$LH_2$ | 92.53/engine | 3.05x10.05 | | | | |

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# U.S. Space Launch Vehicles

| Vehicle | Stages: Engine/Motor | Propellant[a] | Thrust (kilonewtons)[b, c] | Max. Dia x Height (m) | Max. Payload (kg)[d] 185-km Orbit | Geosynch. Transfer Orbit | Sun-Synch. Orbit[e] | First Launch[f] |
|---|---|---|---|---|---|---|---|---|
| Titan II | | | | 3.05x42.9 | 1,905[e] | — | — | 1988, |
| 1. | LR-87-AJ-5 (2) | N204/A-50 | 1,045.0 | 3.05x21.5 | | | | Titan II SLV |
| 2. | LR-91-AJ-5 | N204/A-50 | 440.0 | 3.05x12.2 | | | | [1964, Titan II Gemini] |
| Titan III | | | | 3.05x47.3 | 14,515 | 5,000[l] | — | 1989, |
| 0. | Titan III SRM (2) (5-1/2 segments) | Solid | 6,210.0 | 3.11x27.6 | | | | Titan III [1964, |
| 1. | LR87-AJ-11 (2) | N204/A-50 | 1,214.5 | 3.05x24.0 | | | | Titan IIIA] |
| 2. | LR91-AJ-11 | N204/A-50 | 462.8 | 3.05x10.0 | | | | |
| Titan IV | | | | 3.05x62.2 | 17,700 | 6,350[m] | — | 1989, |
| 0. | Titan IV SRM (2) (7 segments) | Solid | 7,000.0 | 3.11x34.1 | 14,110[e] | | | Titan IV |
| 1. | LR87-AJ-11 (2) | N204/A-50 | 1,214.5 | 3.05x26.4 | | | | |
| 2. | LR91-AJ-11 | N204/A-50 | 462.8 | 3.05x10.0 | | | | |
| Titan IV/ | | | | 4.3x62.2 | — | 5,760[a] | — | 1994, |
| 0. | Titan IV SRM (2) (7 segments) | Solid | 7,000.0 | 3.11x34.1 | | | | Titan IV Centaur |
| 1. | LR87-AJ-11 (2) | N204/A-50 | 1,214.5/engine | 3.05x26.4 | | | | |
| 2. | LR91-AJ-11(1) | N204/A-50 | 462.5 | 3.05x10.0 | | | | |
| 3. | Centaur: RL-10A-3-3A | LOX/LH2 | 73.4 | 4.3x9.0 | | | | |
| 4. | SRMU (3 segments) | | 7690 | 3.3x34.3 | | | | |
| Space Shuttle[n] | | | | 23.79x56.14[h] | 24,900[o] | 5,900[p] | — | 1981, |
| 1. | SRB: Shuttle SRB (2) | Solid | 11,790.0 (SL) | 3.70x45.46 | | | | *Columbia* |
| 2. | Orbiter/ET: SSME (3) | $LOX/LH_2$ | 1,668.7 (SL) | 8.41x47.00 (ET) 23.79x37.24[h] (orbiter) | | | | |
| 3. | Orbiter/OMS: OMS engines (2) | $N_2O_4$/MMH | 26.7 | 23.79x37.24[h] | | | | |

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*(Continued)*

# U.S. Space Launch Vehicles

NOTES:

a. Propellant abbreviations used are as follows:
   A-50 = Aerozine 50 (50% Monomethyl Hydrazine, 50% Unsymmetrical Dimethyl Hydrazine)
   RP-1 = Rocket Propellant 1 (kerosene)
   Solid = Solid Propellant (any type)
   $LH_2$ = Liquid Hydrogen
   LOX = Liquid Oxygen
   MMH = Monomethyl Hydrazine
   $N_2O_4$ = Nitrogen Tetroxide

b. Thrust at vacuum except where indicated at sea level (SL).

c. Thrust per engine. Multiply by number of engines for thrust per stage.

d. Inclination of 28.5° except where indicated.

e. Polar launch from Vandenberg AFB, CA.

f. First successful orbital launch [ditto of initial version].

g. First launch was a failure

h. Diameter dimension represents vehicle wing span.

i. Applies to Delta II-7925 version only.

j. Two Castor IVA motors ignited at lift-off. Two Castor IVA motors ignited at approximately 57 seconds into flight.

k. With TE-M-364-4 upper stage.

l. With Transfer Orbit Stage (TOS).

m. With appropriate upper stage.

n. Space Shuttle Solid Rocket Boosters fire in parallel with the Space Shuttle Main Engines (SSME), which are mounted on the aft end of the Shuttle Orbiter Vehicle and burn fuel, and oxidizer from the External Tank. The boosters stage first, with SSME's continuing to fire. The External Tank stages next, just before the orbiter attains orbit.The Orbiter Maneuvering Subsystem is then used to maneuver or change the orbit of the Orbiter Vehicle.

o. 204-km circular orbit.

p. With Inertial Upper Stage or Transfer Orbit Stage.

***NOTE*: Data should not be used for detailed NASA mission planning without concurrence of the Director of Space Transportation System Support Programs.**