

SLS Block IB with four RS–25E core and small upper stage with one AJ10–190 engine. Payload to 51.6° 400 km orbit LEO = 75.4 t. 18 May 2016. Author: Steven S. Pietrobon, PhD.

RSRMV thrust curve obtained from page 56 of [1]. A number of corrections have been made so as to match the parameters in [2] and other sources.

Boosters	SLS1B4O1
Name	RSRMV
Segments	2x5
Aft Skirt Diameter (m)	5.288
Additional Area (m ²)	–0.038
Nozzle Diameter (m)	3.875
Sea Level Thrust at 0.2 s (N)	15,471,544
Maximum Vacuum Thrust (N)	17,355,582
Vacuum Isp (m/s)	2,605.4
Total Mass (kg)	729,240
Usable Propellant (kg)	631,185
Residual Propellant (kg)	1304
Burnout Mass (kg)	96,751
Action Time (s)	128.4

The core values have been updated according to [2] and other sources with RS–25E engines.

Core Stage	SLS1B4O1
Stage Diameter (m)	8.407
Additional Area (m ²)	2.073
Engines	RS–25E
Number of Engines	4
Nozzle Diameter (m)	2.304
Vacuum Isp (m/s)	4,420.8
Engine Thrust (N)	2,320,637
Engine Thrust Rating (%)	111
Total Mass at Liftoff (kg)	1,074,908
Dry Mass (kg)	100,682
Total Propellant (kg)	982,663
Usable Propellant (kg)	964,564
Reserve Propellant (kg)	7,984
Fuel Bias Propellant (kg)	1,678
Startup Propellant (kg)	8,437

At the end of the core burn, the core is separated, ascends to apogee and then reenters at perigee. The upper stage and payload ascends to apogee where the upper stage engine fires, circularising the orbit.

Parameters	SLS1B4O1
Engine	AJ10–190
Number of engines	1
Nozzle Diameter (m)	1.168
Vacuum Isp (m/s)	3071.4
Engine Thrust (N)	26,689
Total Mass (kg)	3,865
Total Propellant (kg)	2,783
Usable Propellant (kg)	2,701
Reserve Propellant (kg)	27
RCS Propellant (kg)	32
Unusable Propellant (kg)	23
Dry Mass (kg)	1,082
Adaptor Mass (kg)	971

Simulation results for SLS1B4O1 are shown in Figures 1–4. Figure 5 shows the ascent to apogee. Payload into a 400 km 51.6° orbit is 75.4 t.

	SLS1B4O1
Orbit (km)	400.0 ± 0.0
Transfer Orbit (km)	37.0×399.0
Liftoff Thrust at 0.2 s (N)	38,536,173
Liftoff Mass (kg)	2,623,307
Liftoff Acceleration (m/s ²)	14.70
MaxQ (Pa)	28,488
Maximum Acceleration (m/s ²)	39.24
Fairing Mass (kg)	9,707
Fairing Jettison Time (s)	330
Spacecraft (kg)	75,376
Total Delta–V (m/s)	9,404

[1] Alliant Techsystems Inc., “ATK space propulsion products catalog,” Aug. 2012.

[2] B. Donahue and S. Sigmon, “The Space Launch System capabilities with a new large upper stage,” *AIAA Space Conf. and Exhib.*, San Diego, CA, USA, Sep. 2013.

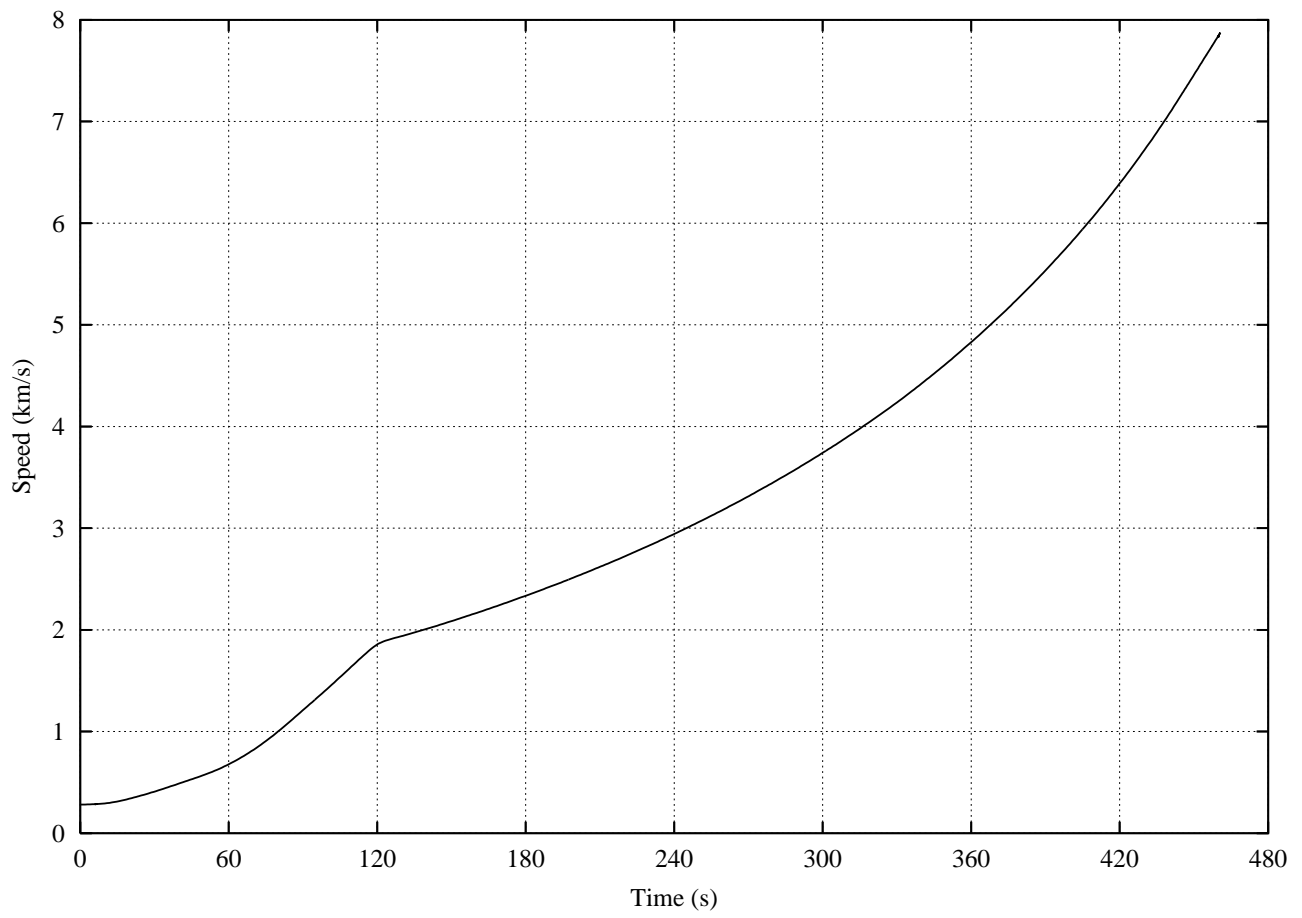


Figure 1: Speed versus time.

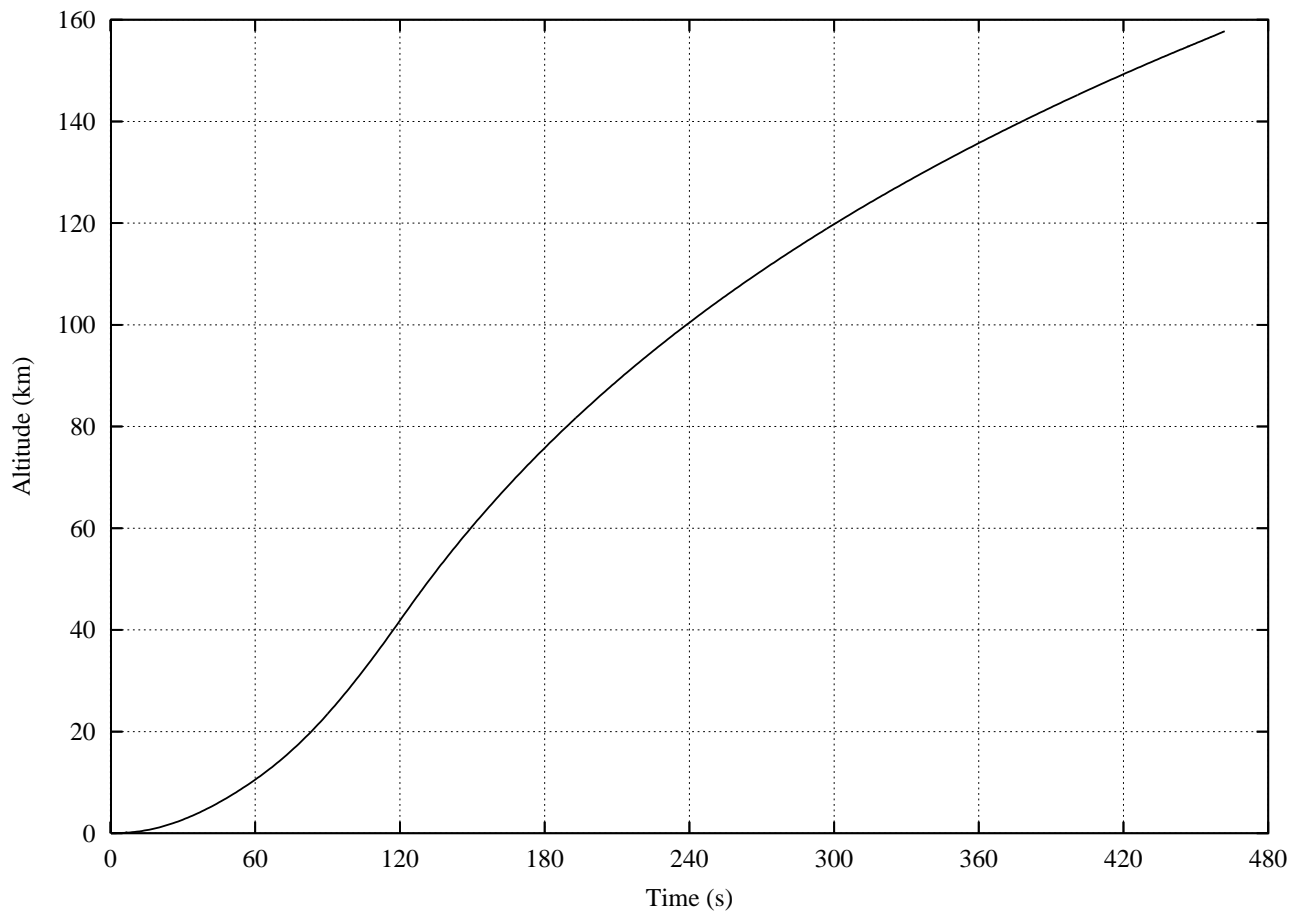


Figure 2: Altitude versus time.

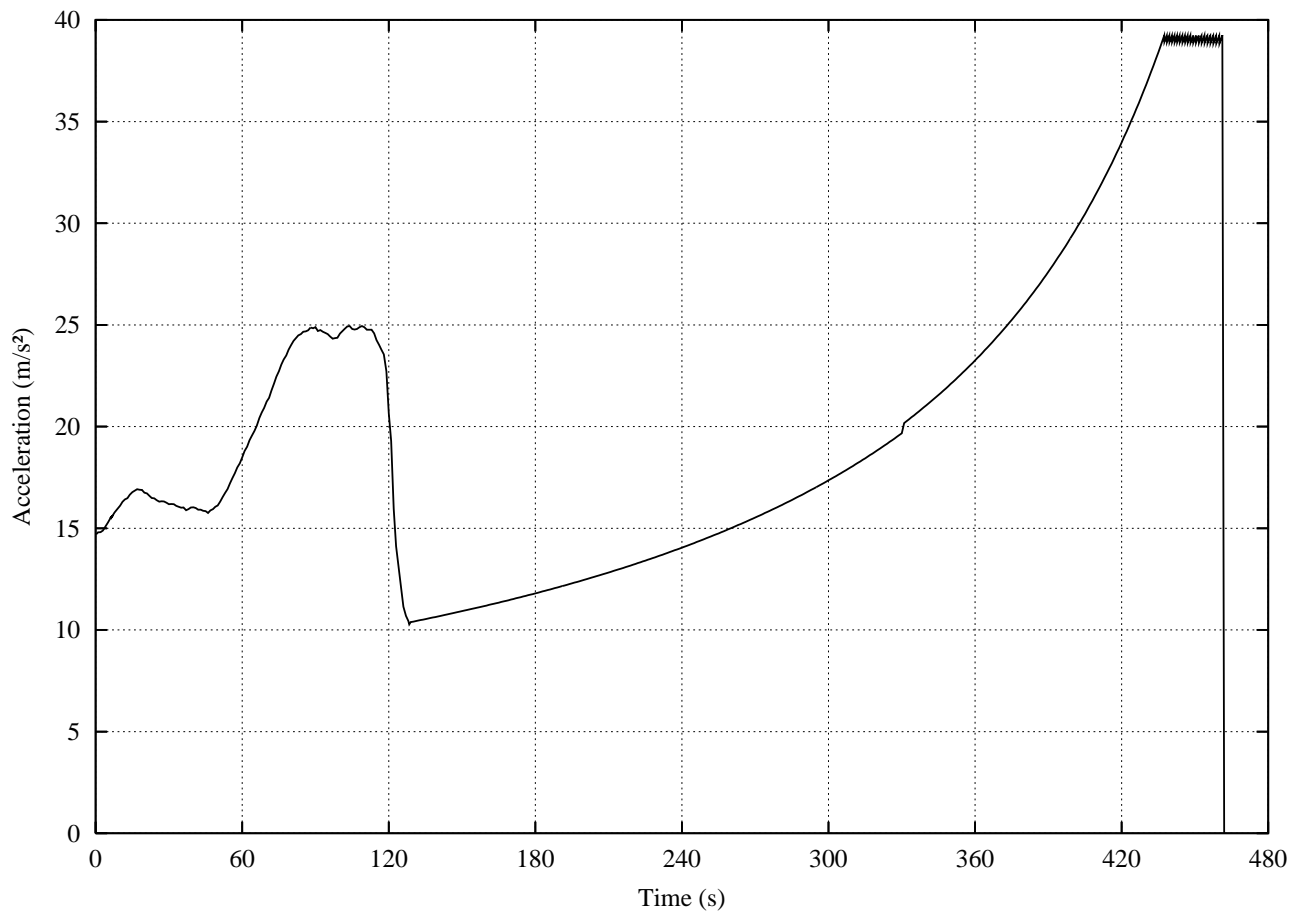


Figure 3: Acceleration versus time.

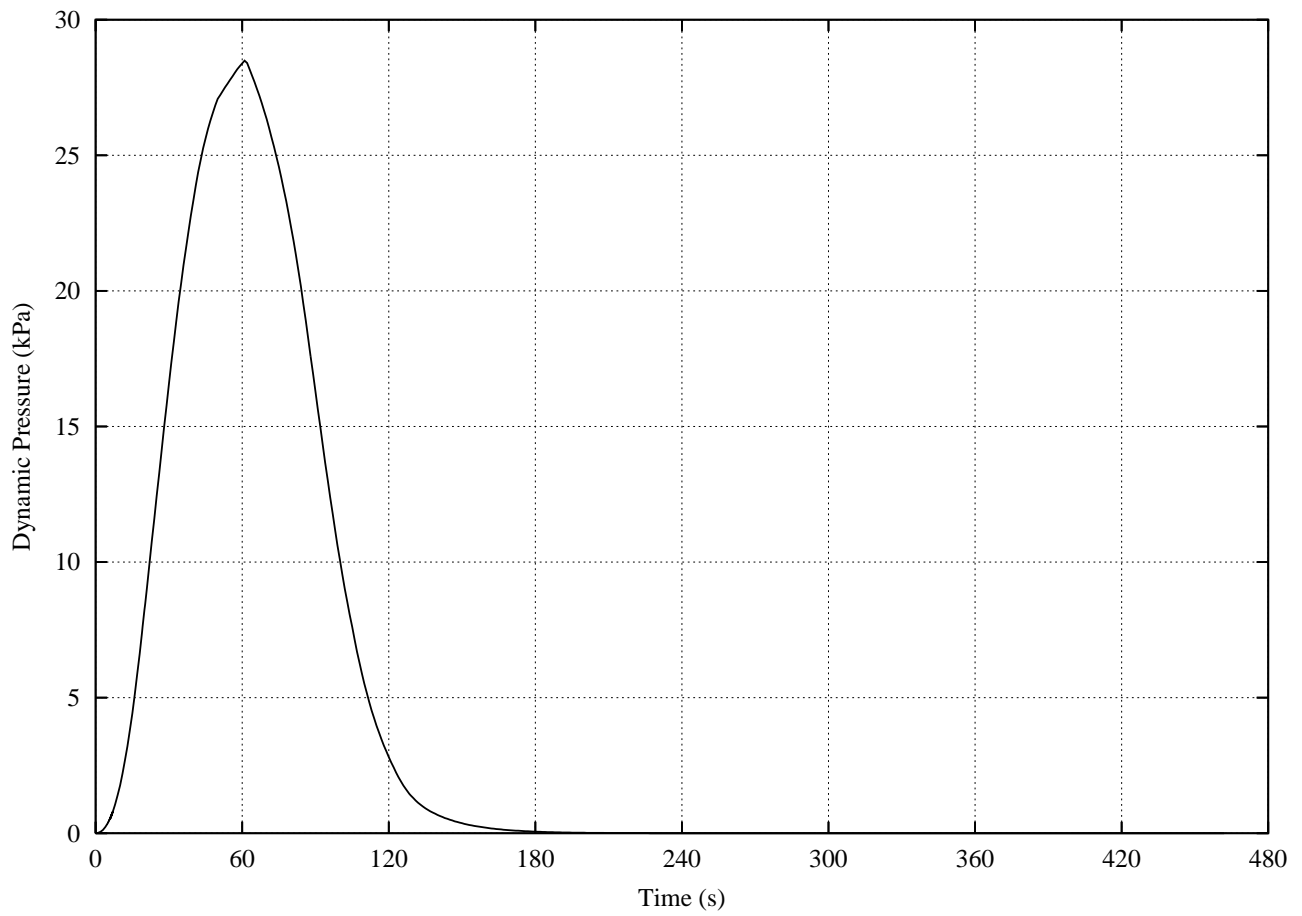


Figure 4: Dynamic pressure versus time.

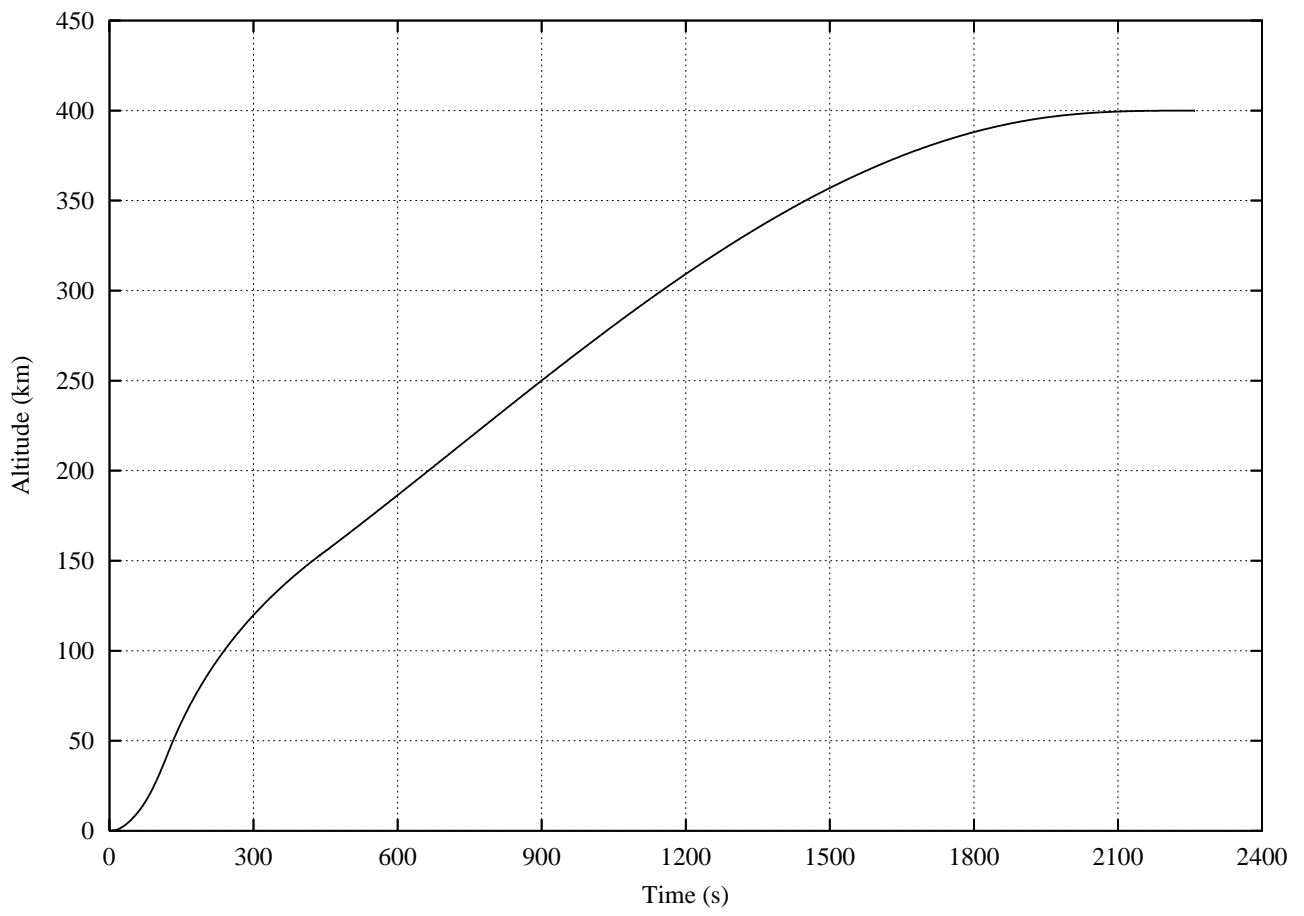


Figure 5: Height versus time to apogee.