SLS Block IB with RSRMV boosters, four RS–25E core and four RL–10C–2 upper stage. Payload to 200 km LEO = 97.1 t. 3 Mar. 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: RSRMV 2x5–Segment	IB
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
Vacuum Isp (m/s)	2,605.4
Total Mass (kg)	729,240
Usable Propellant (kg)	631,185
Residual Propellant (kg)	1,304
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	IB
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 Liffoff (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

The size of the upper stage mass parameters were obtained from [3]. The interstage mass was adjusted according to total maximum weight carried by the core. Ullage engine data is from [4]. Choice and number of ullage engines is from [5].

Upper Stage:	IB
Stage Diameter (m)	8.407
Engines	RL–10C–2
Number of Engines	4
Nozzle Diameter (m)	2.146
Vacuum Isp (m/s)	4,530.7
Single Engine Thrust (N)	110,093
Ullage Engines	R–40B
Number of Ullage Engines	4
Ullage Nozzle Diameter (m)	0.040
Ullage Vacuum Isp (m/s)	2,873.3
Ullage Single Engine Thrust (N)	4,003
Total Mass (kg)	63,450
Total Propellant (kg)	48,864
Usable Propellant (kg)	45,764
Deorbit Propellant (kg)	189
Reserve Propellant (kg)	387
Unusable Propellant (kg)	2524
RCS Propellant (kg)	71
Dry Mass (kg)	14,515
Interstage Mass (kg)	3,752

The PLF jettison time was obtained from [5]. Simulation results are shown in Figures 1–4.

	IB
Orbit (km)	200 ± 0.0
Liftoff Thrust at 0.2 s (N)	38,536,173
Liftoff Mass (kg)	2,707,388
Liftoff Acceleration (m/s^2)	14.24
MaxQ (Pa)	25,445
Maximum Acceleration (m/s^2)	33.65
PLF Jettison Time (s)	330
Payload Fairing (kg)	9,707
Total Payload (kg)	97,091
Total Delta–V (m/s)	9,516

[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.
[3] B. Donahue and D. Sauvageau, “The Space Launch System capabilities for beyond Earth missions,” *Space Access Int. Conf.*, Paris, France, Apr. 2014.
[4] Aerojet, “R–40B 4,000 N (900–lbf) bipropellant rocket engine,” IAF–1987–0283, June 2006.
[5] S. Creech, J. Holladay and D. Jones, “SLS dual use upper stage (DUUS) opportunities,” NASA, Apr. 2013.

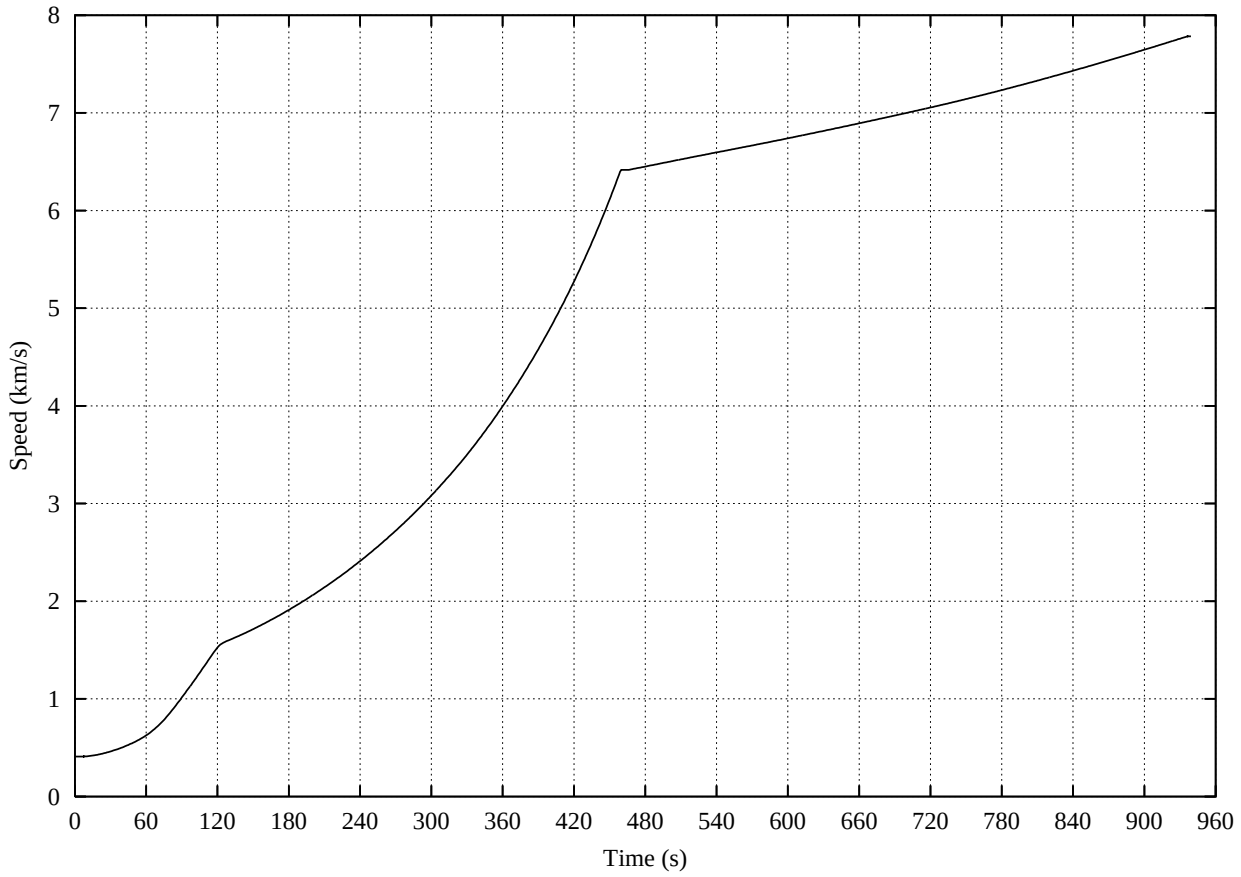

Figure 1: Speed versus time.

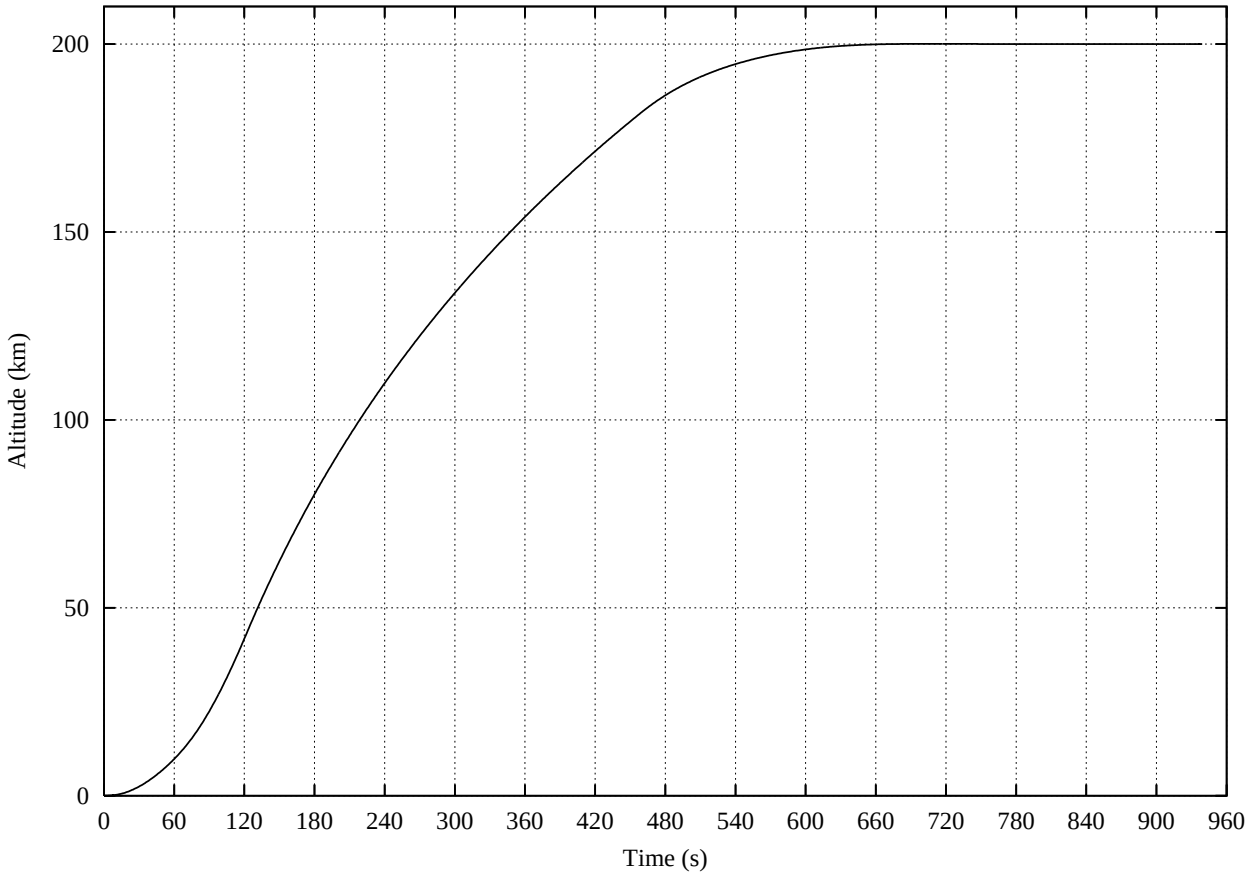

Figure 2: Altitude versus time.

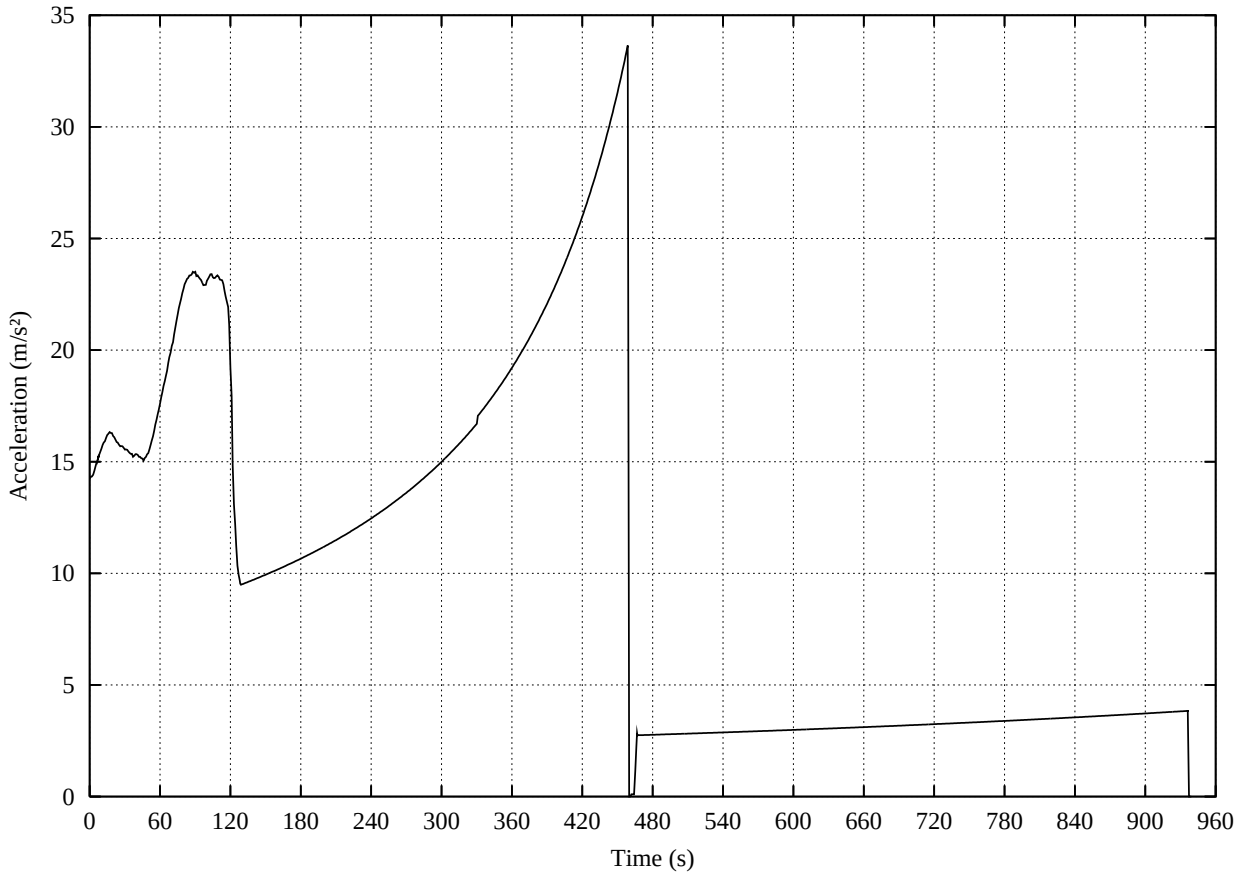

Figure 3: Acceleration versus time.

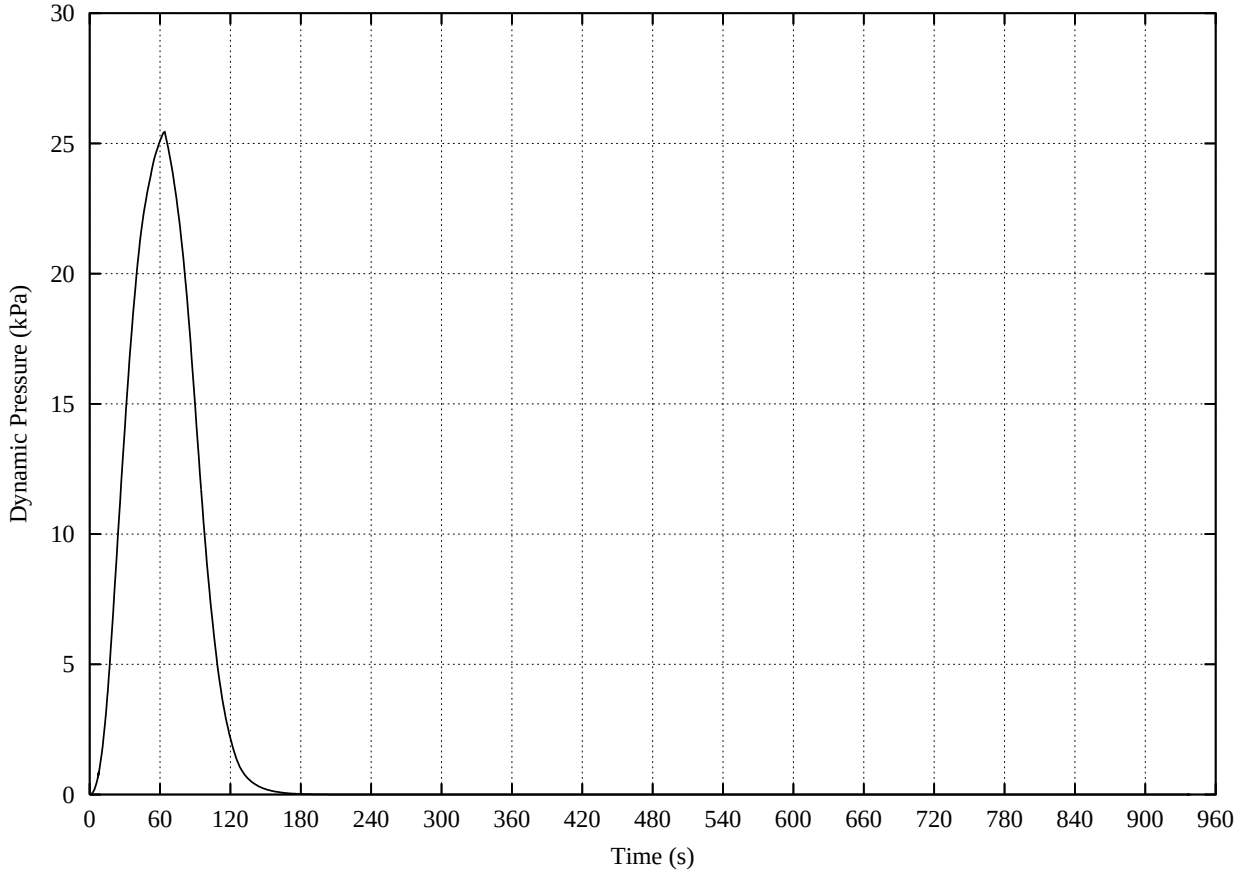

Figure 4: Dynamic pressure versus time.