

APPENDIX L

LOCKHEED MARTIN LAUNCH VEHICLE (LMLV)

Structural Loads

Table L-1 provides limit load factors for the LMLV1, LMLV2, and LMLV3 configurations. These values are usable for preliminary design.

Table L-1
LMLV
Quasi-Static Limit Load Factors¹

Flight Event	LMLV1		LMLV2		LMLV3	
	Axial ²	Lateral	Axial ²	Lateral	Axial ²	Lateral
Launch/First Stage Ignition	- 4.0/+6.0	± 2.0	- 1.0/+3.0	± 1.5	- 1.0/+3.0	± 1.5
First Stage Motor Resonance	3.5 ± 2.0	±2.0	2.0 ± 1.0	± 1.5	2.0 ± 1.0	± 1.5
Wind Gust	3.5	±2.5	2.0	±2.5	2.0	±2.5
First Stage Maximum Acceleration	8.0	±2.0	2.0	±2.0	4.5	±2.0
Second Stage Ignition	~	~	- 1.0/+6.0	± 1.5	- 1.0/+6.0	± 1.5
Second Stage Motor Resonance	~	~	4.0 ± 3.0	± 2.5	4.0 ± 3.0	± 2.5
Second Stage Maximum Acceleration	~	~	8.0	± 2.0	6.0	± 2.0
ORBUS	- 2.0/+5.0	±2.0	- 2.0/+5.0	± 2.0	- 2.0/+5.0	± 2.0
ORBUS	7.0	±1.0	7.0	± 1.0	7.0	± 2.0
Envelope	- 4.0/+8.0	±2.5	- 2.0/+8.0	± 2.5	- 2.0/+7.0	± 2.5

1 - 99th percentile.

2 - Positive axial load factor acts aft at spacecraft c.g.

Acoustics

The qualification and acceptance acoustic test levels are given in Tables L-2 through L-4 for the LMLV1, LMLV2, and LMLV3 vehicles. These levels are for empty payload fairings without acoustic blankets. The payload fairings are as noted in the Tables.

Spacecraft Random Vibration

The maximum expected random vibration input at the spacecraft interface for the LMLV1, LMLV2, and LMLV3 are given in Tables L-5, L-6, and L-7 respectively.

Mechanical Shock

Test levels representing launch vehicle induced shock levels at the payload separation plane are given in Table L-8.

Table L-2
LMLV1
Acoustic Test Levels
Inside Empty Model 92 Aluminum Payload Fairing

One-Third Octave Center Frequency (Hz)	Noise Level (dB) re: .00002 Pa	
	Qualification	Acceptance
25	120	117
32	121	118
40	122	119
50	122	119
63	122	119
80	122	119
100	122	119
125	122	119
160	122	119
200	123	120
250	123	120
315	123	120
400	124	121
500	128	125
630	126	123
800	120	117
1000	119	116
1250	120	117
1600	121	118
2000	126	123
2500	120	117
3150	117	114
4000	115	112
5000	112	109
6300	109	106
8000	105	102
10000	103	100
Overall	136	133

* The minimum test level should be 138 dB to comply with NASA vibroacoustic test recommendations.

Table L-3
LMLV2 Acoustic Test Levels
Inside Empty Model 120 Aluminum Payload Fairing

One-Third Octave Center Frequency (Hz)	Noise Level (dB) re: .00002 Pa	
	Qualification	Acceptance
25	119	116
32	119	116
40	120	117
50	120	117
63	120	117
80	120	117
100	121	118
125	120	117
160	119	116
200	119	116
250	119	116
315	120	117
400	122	119
500	127	124
630	119	116
800	118	115
1000	115	112
1250	114	111
1600	114	111
2000	119	116
2500	115	112
3150	116	113
4000	111	108
5000	107	104
6300	105	102
8000	102	99
10000	98	95
Overall	133	130

* The minimum test level should be 138 dB to comply with NASA vibroacoustic test recommendations.

Table L-4
LMLV3 Acoustic Test Levels
Inside Empty Model 141 Aluminum Payload Fairing

One-Third Octave Center Frequency (Hz)	Noise Level (dB) re: .00002 Pa	
	Qualification	Acceptance
25	121	118
32	121	118
40	121	118
50	122	119
63	123	120
80	124	121
100	125	122
125	126	123
160	127	124
200	128	125
250	128	125
315	129	126
400	129	126
500	129	126
630	130	127
800	130	127
1000	129	126
1250	127	124
1600	124	121
2000	135	132
2500	128	125
3150	124	121
4000	121	118
5000	118	115
6300	115	112
8000	114	111
10000	112	109
Overall	141	138

Table L-5
LMLV1
Spacecraft Random Vibration

Frequency (Hz)	ASD Level (G^2/Hz)	
	Qualification	Acceptance
20	.0038	.0001
20-500	+2.5 dB/oct	+2.5 dB/oct
500	.015	.015
500-2000	0 dB/oct	0 dB/oct
2000	.0015	.0015
Overall Level	7.2 G_{rms}	5.1 G_{rms}

Table L-6
LMLV2
Spacecraft Random Vibration

Frequency (Hz)	ASD Level (G^2/Hz)	
	Qualification	Acceptance
20	.0028	.002
20-600	+0.8 dB/oct	+0.8 dB/oct
600	.07	.05
600-1000	0 dB/oct	0 dB/oct
1000	..002	.0015
1000-2000	-10 dB/oct	-10 dB/oct
2000	.007	.005
Overall Level	10.9 G_{rms}	7.8 G_{rms}

Table L-7
LMLV3
Spacecraft Random Vibration

Frequency (Hz)	ASD Level (G^2/Hz)	
	Qualification	Acceptance
20	.07	.05
20-600	+0.9 dB/oct	+0.9 dB/oct
600	.2	.14
600-1000	0 dB/oct	0 dB/oct
1000	.2	.14
1000-2000	-11.5 dB/oct	-11.5 dB/oct
2000	.014	.01
Overall Level	17.8 G_{rms}	12.7 G_{rms}

Table L-8
LMLV
Launch Vehicle Induced
Shock Response Spectrum
at Spacecraft Interface
 $Q=10$

Frequency (Hz)	Shock Response Spectrum (G)	
	Qualification	Acceptance
100	35	25
100-600	10.7 dB/oct	10.7 dB/oct
600	840	600
600-1000	4.8 dB/oct	4.8 dB/oct
1000	1260	900
1000-1500	8.5 dB/oct	8.5 dB/oct
1500	2240	1600
1500-2000	0 dB/oct	0 dB/oct
2000	2260	1600