

APPENDIX H

ARIANE

Structural Loads

For structural loads testing, limit loads shall be determined by combining the acceleration with low-frequency dynamic levels. Preliminary design limit loads are given in Table H-1.

To avoid dynamic coupling between the low-frequency vehicle and spacecraft modes, the spacecraft should be designed such that the fundamental lateral and axial frequencies are above 10 and 31 Hz respectively assuming that the spacecraft is hardmounted at the separation plane.

Table H-1
ARIANE 4
Limit Load Factor (G)
at Spacecraft C.G.

Flight Event	Quasi-Static Load (G)	
	Axial	Lateral
Maximum Dynamic Pressure	3.0	± 1.5
Before Thrust Termination	5.5	± 1.0
During Thrust Tail-off	-2.5 -4.5 ⁽¹⁾	± 1.0

(1) For spacecraft having a mass < 1200 kg (2640-lb) and a longitudinal frequency > 40 Hz.

Note: Plus represents a compression load.

Acoustics

The acoustic specification levels are given in Table H-2.

Spacecraft Random Vibration

The maximum expected random vibration (limit levels) at the spacecraft interface is given in Table H-3.

Sine Vibration

A spacecraft sine vibration test is generally required by ARIANE. The test levels are given in Table H-4.

Mechanical Shock

The primary sources of shock are payload fairing separation and spacecraft separation. Table H-5 provides specification levels for the maximum expected levels due to launch vehicle induced separation events.

If the spacecraft is providing the separation system, the maximum allowable shock levels at the spacecraft interface plane are given in Table H-6.

Table H-2
ARIANE-4
Acoustic Test Levels*
Inside Payload Fairing

One-Third Octave Center Frequency (Hz)	Noise Level (dB) re: .00002 Pa	
	Qualification	Acceptance
25	115	112
32	118	115
40	120	117
50	122	119
63	125	122
80	128	125
100	130	127
125	133	130
160	135	132
200	136	133
250	138	135
315	138	135
400	135	132
500	132	129
630	130	127
800	129	126
1000	126	123
1250	122	119
1600	122	119
2000	122	119
2500	122	119
3150	120	117
4000	118	115
5000	117	114
6300	116	113
8000	114	111
10000	113	110
Overall	145	142

* Test levels represent 1/3 octave band levels derived from Ariane 1/1 octave band levels

Table H-3
ARIANE-4
Spacecraft Random Vibration

Frequency (Hz)	ASD Level (G^2/Hz)
20	.0007
20-150	+6 dB/oct
150-700	.04
700-2000	-3 dB/oct
2000	.014
Overall Level	7.3 G_{rms}

Table H-4
ARIANE-4
Sine Vibration Requirements

Axis	Frequency (Hz)	Sine Vibration (G_{0-p})	
		Qualification	Acceptance
Axial	5-6	1	1.0
	6-100	1.25	1.0
Lateral	5-18	1.0	0.8
	18-100	0.8	0.6

Table H-5
ARIANE 4
Maximum Launch Vehicle Generated Shock Levels
at Spacecraft Separation Plane
Shock Response Spectrum
Q=10

Payload Adapter	Frequency (Hz)	Shock Response Spectrum (G)	
		Qualification	Acceptance
1194A, and 1194B	100	28	20
	100-600	15 dB/oct	15 dB/oct
	600	2520	1800
	600-2150	+4.8 dB/oct	+4.8 dB/oct
937, 937A, 937C, and additional Cylindrical Adapter	2150-10000	7000	5000
	100	28	20
	100-1600	10 dB/oct	10 dB/oct
	1600-10000	2800	2000
937B	100	25	18
	100-2000	10.5 dB/oct	10.5 dB/oct
	2000	4620	3300
	2000-10000	1.6 dB/oct	1.6 dB/oct
1666A, and 1666B	10000	7000	5000
	100	28	20
	100-800	13.7 dB/oct	13.7 dB/oct
	800	3220	2300
	800-10000	1.3 dB/oct	1.3 dB/oct
	10000	5600	4000

Table H-6
ARIANE 4
Maximum Allowable Spacecraft Generated Shock Levels
at Designated Launch Vehicle Bolted Interface Plane
Shock Response Spectrum
Q=10

Interface Plane	Frequency (Hz)	Shock Response Spectrum (G)	
		Qualification	Acceptance
2624	100	28	20
	100-1600	10 dB/oct	10 dB/oct
	1600-10000	2800	2000
1920	100	28	20
	100-3700	10 dB/oct	10 dB/oct
	3700-10000	14000	10000

Structural Loads

For structural loads testing, limit loads shall be determined by combining the acceleration with low-frequency dynamic levels. Preliminary design limit loads are given in Table H-7.

To avoid dynamic coupling between the low-frequency vehicle and spacecraft modes, the spacecraft must be designed such that its lateral and axial fundamental frequencies are above minimum levels. These are dependent on the spacecraft, the adapter system used, and the spacecraft interface plane. These minimum frequencies, along with allowable C.G. offsets and balance requirements must be negotiated on a case-by-case basis.

Table H-7
ARIANE 5
Limit Load Factor (G)
at Spacecraft C.G.

Flight Event	Quasi-Static Load (G)			
	Axial		Lateral	
	Static	Dynamic	Static	Dynamic
Lift-off	1.7	± 1.5	0	± 1.5
Maximum Dynamic Pressure	2.7	± 0.5	0	± 2
P 230 Burn-out	4.25	± 0.25	± 0.25	± 0.25
H 155 Burn-out	3.6	± 1.0	± 0.1	0
H 155 Thrust Tail-off	0.7	± 1.4	0	0

For a payload with a mass > 5,000 kg (11,000 lb.), the user should contact ARIANSPACE to obtain the appropriate load factors.

Acoustics

The acoustic specification levels are given in Table H-8.

Spacecraft Random Vibration

The maximum expected random vibration (limit levels) at the spacecraft interface is given in Table H-2..

Sine Vibration

A spacecraft sine vibration test is generally required by ARIANE. The test levels are given in Table H-9.

Mechanical Shock

The primary sources of shock are payload fairing separation and spacecraft separation. Table H-10 provides specification levels for the maximum expected levels due to launch vehicle induced separation events.

If the spacecraft is providing the separation system, the maximum allowable shock levels at the spacecraft interface plane are given in Table H-11.

Table H-8
ARIANE-5
Acoustic Test Levels
Inside Payload Fairing

One-Third Octave Center Frequency (Hz)	Noise Level (dB) re: .00002 Pa	
	Qualification	Acceptance
25	119	116
32	122	119
40	124	121
50	125	122
63	128	125
80	131	128
100	132	129
125	133	130
160	135	132
200	136	133
250	138	135
315	138	135
400	134	131
500	132	129
630	130	127
800	129	126
1000	126	123
1250	122	119
1600	122	119
2000	122	119
2500	122	119
3150	120	117
4000	118	115
5000	117	114
6300	116	113
8000	114	111
10000	113	110
Overall	145	142

* Test levels represent 1/3 octave band levels derived from Ariane 1/1 octave band levels

Table H-9
ARIANE-5
Sine Vibration Requirements

Axis	Frequency (Hz)	Sine Vibration (G_{0-p})	
		Qualification	Acceptance
Axial	4-100	1.25	1.0
Lateral	2-18	1.0	0.8
	18-100	0.8	0.6

Table H-10
ARIANE 5
Maximum Launch Vehicle Generated Shock Levels
at Spacecraft Separation Plane
Shock Response Spectrum
Q=10

Payload Adapter	Frequency (Hz)	Shock Response Spectrum (G)	
		Qualification	Acceptance
1194A	100	28	20
	100-600	15 dB/oct	15 dB/oct
	600	2520	1800
	600-2150	4.8 dB/oct	4.8 dB/oct
	2150-10000	7000	5000
937	100	28	20
	100-1600	10 dB/oct	10 dB/oct
	1600-10000	2800	2000
937B	100	25	18
	100-2000	10.5 dB/oct	10.5 dB/oct
	2000	4620	3300
	2000-10000	1.6 dB/oct	1.6 dB/oct
	10000	7000	5000
1666A	100	28	20
	100-800	13.7 dB/oct	13.7 dB/oct
	800	3220	2300
	800-10000	1.3 dB/oct	1.3 dB/oct
	10000	5600	4000
Separable 1920	100	28	20
	100-700	+13.7 dB/oct	+13.7 dB/oct
	700	2380	1700
	700-3350	+6.8 dB/oct	+6.8 dB/oct
	3350-10000	14000	10000

Table H-11
ARIANE 5
Maximum Allowable Spacecraft Generated Shock Levels
at Designated Launch Vehicle Bolted Interface Plane
Shock Response Spectrum
Q=10

Launch Vehicle Bolted Interface	Frequency (Hz)	Shock Response Spectrum (G)	
		Qualification	Acceptance
1920, 2624, and 3936	100	28	20
	100-700	13.7 dB/oct	13.7 dB/oct
	700	2380	1800
	700-3350	6.8 dB/oct	6.8 dB/oct
	3350-10000	14000	10000