

## APPENDIX C

### ATLAS

Structural Loads

Limit load factors for various mission events are given in Table C-1 for the commercial Atlas I, II, IIA, and IIAS launch vehicles. The load factors given are intended to provide a conservative design envelope for a typical spacecraft in the 1800 kg (4000 lb) to 3600 kg (8000 lb) weight class with first lateral modes above 10 Hz and first axial mode above 15 Hz. In addition, the center of gravity offset from the payload adapter interface is in the range of 89-152 cm (35-60 inches).

Gust/flight wind is a low frequency event (<12 Hz) that produces maximum loss of clearance between the spacecraft and payload fairing, and high loads near the base of the spacecraft primary structure. BECO/BPJ excites all frequencies (3 to 40 Hz) and produces the majority of the maximum loads throughout the spacecraft. MECO excites all frequencies and produces the highest tension (negative axial) loads and sometimes the maximum loads on secondary structure.

Table C-1  
ATLAS I, II, IIA & IIAS  
Limit Load Factor (G)  
at spacecraft C.G.

| Event            | Axial             | Lateral       |
|------------------|-------------------|---------------|
| Launch           |                   |               |
| ATLAS I, II, IIA | $1.2 \pm 1.2$     | $\pm 1.0$     |
| ATLAS IIAS       | $1.3 \pm 1.8$     | $\pm 1.3$     |
| Flight Winds     | $2.2 \pm 0.3$     | $0.4 \pm 1.2$ |
| BECO/BPJ         |                   |               |
| (max axial)      | $5.2 \pm 0.5$     | $\pm 0.5$     |
| (max lateral)    | $2.5-1.0 \pm 1.0$ | $\pm 2.0$     |
| SECO*            | $2.0-0.0 \pm 0.4$ | $\pm 0.3$     |
| MECO*            | $4.0-0.0 \pm 0.5$ | $\pm 0.2$     |
|                  | $0.0 \pm 2.0$     | $\pm 0.6$     |

Note: Dynamic Uncertainty Factors (DUF's) are not accounted for in the above load factors.

\* Decaying to zero.

+ Is compression.

BECO = Booster Engine Cut-off  
BPJ = Booster Package Jettison  
SECO = Sustainer Engine Cut-off  
MECO = Main Engine Cut-off

### Acoustics

Qualification and acceptance acoustic test levels are given in Tables C-2 and C-3 for the ATLAS I, II, or IIA with 3.4 m (11-ft) and 4.3 m (14-ft) payload fairings respectively. The acoustic levels for the ATLAS IIAS are given in Table C-4.

For the 4.3 m (14-ft) payload fairing with acoustic blanket, special consideration should be given to components located within 76 cm (30-in.) of the payload fairing vents; the expected sound pressure level can be greater than the levels given in Tables C-3 and C-4 at higher frequencies. Table C-5 gives expected Sound pressure levels for components located 0.3 m (1 ft) from the vents. The 3.4 m (11-ft) payload fairing vents are fewer in number and located farther from the spacecraft envelope.

### Spacecraft Random Vibration

The maximum expected random vibration flight levels (limit levels) at the spacecraft interface are given in Table C-6.

### Sine Vibration

The maximum expected sine vibration levels given in the ATLAS user's guide are given in Table C-7.

### Mechanical Shock

Test levels representing typical spacecraft separation and payload nose fairing and insulation panel jettison are given in Tables C-8.

The maximum acceptable shock level at the equipment module interface for a customer-provided separation system is given in Figure C-1.

Table C-2  
 ATLAS I, II, & IIA  
 Acoustic Test Levels  
 Inside 3.4 m (11 ft) Payload Fairing  
 Assumes 50-60% Fill by Cross Section Area)

| One-Third Octave<br>Center Frequency<br>(Hz) | Noise Level (dB) re: .00002 Pa |            |                        |            |
|--|--------------------------------|------------|------------------------|------------|
|  | Without Acoustic Blankets      |            | With Acoustic Blankets |            |
|  | Qualification                  | Acceptance | Qualification          | Acceptance |
| 25   | 121                            | 118        | 121                    | 118        |
| 32   | 123                            | 120        | 123                    | 120        |
| 40   | 124.5                          | 121.5      | 124.5                  | 121.5      |
| 50   | 126                            | 123        | 126                    | 123        |
| 63   | 128                            | 125        | 128                    | 125        |
| 80   | 129                            | 126        | 129                    | 126        |
| 100  | 130.5                          | 127.5      | 130                    | 127        |
| 125  | 132                            | 129        | 131                    | 128        |
| 160  | 132.5                          | 129.5      | 131                    | 128        |
| 200  | 133.5                          | 130.5      | 131.5                  | 128.5      |
| 250  | 134                            | 131        | 131                    | 128        |
| 315  | 133                            | 130        | 129                    | 126        |
| 400  | 132                            | 129        | 127                    | 124        |
| 500  | 131                            | 128        | 125                    | 122        |
| 630  | 129.5                          | 126.5      | 123.5                  | 120.5      |
| 800  | 127                            | 124        | 121                    | 118        |
| 1000   | 125                            | 122        | 119                    | 116        |
| 1250   | 122                            | 119        | 116                    | 113        |
| 1600   | 120                            | 117        | 114                    | 111        |
| 2000   | 119                            | 116        | 113                    | 110        |
| 2500   | 118.5                          | 115.5      | 112.5                  | 109.5      |
| 3150   | 118                            | 115        | 112                    | 109        |
| 4000   | 117.5                          | 114.5      | 111.5                  | 108.5      |
| 5000   | 117                            | 114        | 111                    | 108        |
| 6300   | 116.5                          | 113.5      | 110.5                  | 107.5      |
| 8000   | 116                            | 113        | 110                    | 107        |
| 10000  | 115.5                          | 112.5      | 109.5                  | 106.5      |
| Overall                                      | 143                            | 140        | 140                    | 137        |

Table C-3  
 ATLAS I, II, & IIA  
 Acoustic Test Levels  
 Inside 4.3 m (14 ft) Payload Fairing  
 Assumes 50-60% Fill by Cross Section Area)

| One-Third Octave<br>Center Frequency<br>(Hz) | Noise Level (dB) re: .00002 Pa |            |                        |            |
|--|--------------------------------|------------|------------------------|------------|
|  | Without Acoustic Blankets      |            | With Acoustic Blankets |            |
|  | Qualification                  | Acceptance | Qualification          | Acceptance |
| 25   | 116                            | 113        | 116                    | 113        |
| 32   | 120                            | 117        | 120                    | 117        |
| 40   | 123.5                          | 120.5      | 124.5                  | 121.5      |
| 50   | 124.5                          | 121.5      | 125.5                  | 122.5      |
| 63   | 125.5                          | 122.5      | 127                    | 124        |
| 80   | 126.5                          | 123.5      | 128                    | 125        |
| 100  | 127                            | 124        | 129.5                  | 126.5      |
| 125  | 128                            | 125        | 131                    | 128        |
| 160  | 128                            | 125        | 132                    | 129        |
| 200  | 128                            | 125        | 133                    | 130        |
| 250  | 127.5                          | 124.5      | 132.5                  | 129.5      |
| 315  | 127                            | 124        | 131.5                  | 128.5      |
| 400  | 126                            | 123        | 131                    | 128        |
| 500  | 123.5                          | 120.5      | 130.5                  | 127.5      |
| 630  | 121.5                          | 118.5      | 129                    | 126        |
| 800  | 119.5                          | 116.5      | 126.5                  | 123.5      |
| 1000   | 116.5                          | 113.5      | 123.5                  | 120.5      |
| 1250   | 114.5                          | 111.5      | 121                    | 118        |
| 1600   | 113                            | 110        | 121                    | 118        |
| 2000   | 113                            | 110        | 122                    | 119        |
| 2500   | 111                            | 108        | 119.5                  | 116.5      |
| 3150   | 111                            | 108        | 118                    | 115        |
| 4000   | 110.5                          | 107.5      | 117                    | 114        |
| 5000   | 110                            | 107        | 116.5                  | 113.5      |
| 6300   | 110.5                          | 107.5      | 116                    | 113        |
| 8000   | 112.5                          | 109.5      | 116.5                  | 113.5      |
| 10000  | 113.5                          | 110.5      | 117.5                  | 114.5      |
| Overall                                      | 138                            | 135        | 142                    | 139        |

Table C-4  
ATLAS IIAS  
Acoustic Test Levels  
Inside 4.3 m (14-ft) Payload Fairing  
Assumes 50-60% Fill by Cross Section Area)

| One-Third Octave<br>Center Frequency<br>(Hz) | Noise Level (dB) re: .00002 Pa |            |                        |            |
|--|--------------------------------|------------|------------------------|------------|
|  | Without Acoustic Blankets      |            | With Acoustic Blankets |            |
|  | Qualification                  | Acceptance | Qualification          | Acceptance |
| 25   | 117                            | 114        | 117                    | 114        |
| 32   | 121                            | 118        | 121                    | 118        |
| 40   | 124.5                          | 121.5      | 125                    | 122        |
| 50   | 125.5                          | 122.5      | 126                    | 123        |
| 63   | 127                            | 124        | 127.5                  | 124.5      |
| 80   | 127.5                          | 124.5      | 129                    | 126        |
| 100  | 128.5                          | 125.5      | 130.5                  | 127.5      |
| 125  | 129                            | 126        | 132                    | 129        |
| 160  | 129.5                          | 126.5      | 133                    | 130        |
| 200  | 130                            | 127        | 134                    | 131        |
| 250  | 129.5                          | 126.5      | 133.5                  | 130.5      |
| 315  | 129.5                          | 126        | 133                    | 130        |
| 400  | 128                            | 125        | 133                    | 130        |
| 500  | 126.5                          | 123.5      | 133                    | 130        |
| 630  | 125                            | 122        | 131.5                  | 128.5      |
| 800  | 122.5                          | 119.5      | 130                    | 127        |
| 1000   | 119.5                          | 116.5      | 127                    | 124        |
| 1250   | 117                            | 114        | 125                    | 122        |
| 1600   | 115                            | 112        | 123.5                  | 120.5      |
| 2000   | 115                            | 112        | 122                    | 119        |
| 2500   | 114                            | 111        | 121                    | 118        |
| 3150   | 113                            | 110        | 120                    | 117        |
| 4000   | 112                            | 109        | 118.5                  | 115.5      |
| 5000   | 111.5                          | 108.5      | 117.5                  | 114.5      |
| 6300   | 111                            | 108        | 116.5                  | 113.5      |
| 8000   | 112.5                          | 109.5      | 117                    | 114        |
| 10000  | 113.5                          | 110.5      | 118                    | 115        |
| Overall                                      | 139                            | 136        | 143                    | 140        |

Table C-5  
Acoustic Levels 0.3 m (1 ft) from the Vents  
for the 4.3 m (14 ft) Payload Fairing

| One-Third Octave<br>Center Frequency<br>(Hz) | Noise Level (dB)<br>re: .00002 Pa |            |
|--|-----------------------------------|------------|
|  | Qualification                     | Acceptance |
| 1600   | 113.5                             | 110.5      |
| 2000   | 115.5                             | 112.5      |
| 2500   | 115.5                             | 112.5      |
| 3150   | 114                               | 111        |
| 4000   | 115                               | 112        |
| 5000   | 116.5                             | 113.5      |
| 6300   | 116.5                             | 113.5      |
| 8000   | 117                               | 114        |
| 10000  | 117.5                             | 114.5      |

Table C-6  
ATLAS I, II, IIA, IIAS  
Spacecraft Random Vibration  
Limit Levels

| Frequency (Hz) | ASD Level ( $G^2/Hz$ ) |
|----------------|------------------------|
| 20             | .00048                 |
| 20-80          | +9 dB/oct              |
| 80-200         | .03                    |
| 200-2000       | -9 dB/oct              |
| 2000           | .00003                 |
| Overall        | 2.7 $G_{rms}$          |

Table C-7  
ATLAS I, II, IIA, & IIAS  
Maximum Expected Spacecraft Interface  
Sinusoidal Vibration Environment

| Frequency (Hz) |         | Sine Vibration Level ( $G_{0-p}$ ) |
|----------------|---------|------------------------------------|
| Thrust Axis    | 5-6.2   | 12.5-mm (0.5-in) DA<br>1.0         |
|                | 6.2-100 |                                    |
| Lateral Axes   | 5-100   | 0.7                                |

Table C-8  
ATLAS I, II, IIA, & IIAS  
Spacecraft Separation  
Shock Response Spectrum  
Q=10

| Event  | Frequency (Hz)               | Shock Response Spectrum (G) |                            |
|--|------------------------------|-----------------------------|----------------------------|
|  |                              | Qualification               | Acceptance                 |
| Spacecraft Separation                            |                              |                             |                            |
| Type D Payload Adapter<br>[1.65 m (66 in)]       | 100<br>100-800<br>800-3000   | 210<br>+7.1 dB/oct<br>4200  | 150<br>+7.1 dB/oct<br>3000 |
| Type B & B1 Payload Adapter<br>[1.18 m (47 in)]  | 100<br>100-1500<br>1500-3000 | 140<br>8.5 dB/oct<br>6300   | 100<br>8.5 dB/oct<br>4500  |
| Type A & A1 Payload Adapter<br>[0.92 m (37 in)]  | 100<br>100-1500<br>1500-3000 | 70<br>10 dB/oct<br>6300     | 50<br>10 dB/oct<br>4500    |
| Payload Fairing and<br>Insulation Panel Jettison | 100<br>100-500<br>1500-2000  | 20<br>5.4 dB/oct<br>84      | 14<br>5.4 dB/oct<br>60     |



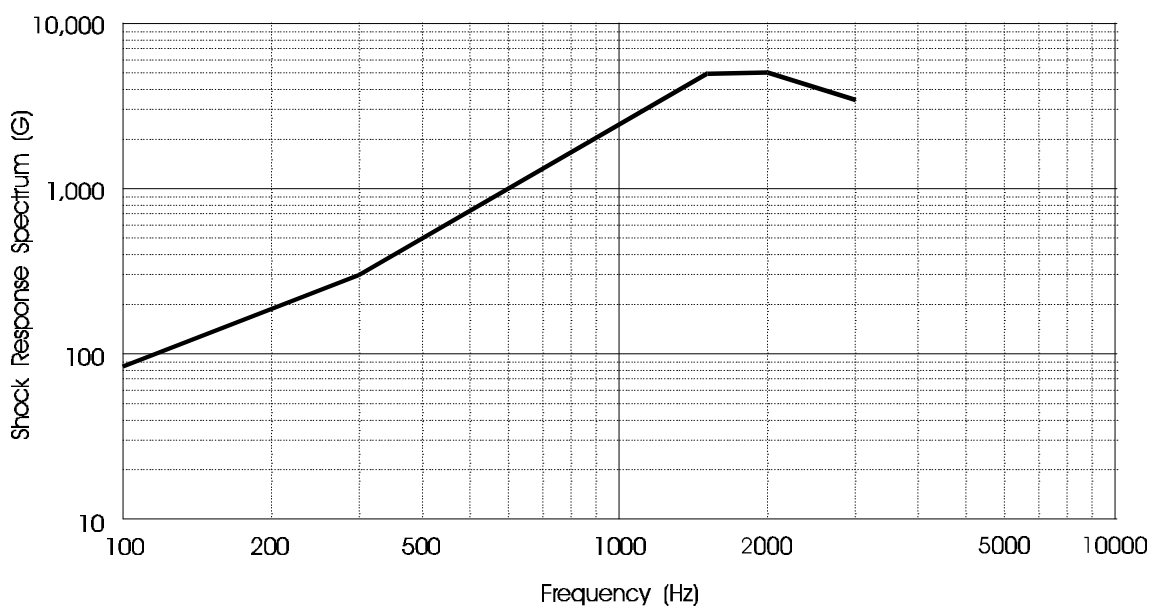


Figure C-1 Maximum Allowable Spacecraft-Produced Shock at Equipment Module Interface