4.13 G Tolerance

4.13.1 The average pilot can probably tolerate about +5G for extended periods without losing consciousness, but this figure can vary significantly for different individuals, and an individual's tolerance can also vary from day to day.

4.13.2 The following table gives some idea of normal levels of G tolerance.

Table 1. Thresholds In Relation To +G Tolerance

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Average Threshold</th>
<th>Deviation</th>
<th>Standard Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Grey-out'</td>
<td>4.1 G</td>
<td>± 0.7 G</td>
<td>2.2 to 7.1 G</td>
</tr>
<tr>
<td>'Black-out'</td>
<td>4.7 G</td>
<td>± 0.8 G</td>
<td>2.7 to 7.8 G</td>
</tr>
<tr>
<td>Unconsciousness</td>
<td>5.4 G</td>
<td>± 0.9 G</td>
<td>3.0 to 8.4 G</td>
</tr>
</tbody>
</table>

4.14 Establishing Individual G Tolerance.

4.14.1 Some pilots can tolerate more G than others, but all have a limit which can vary considerably from day to day for the same individual. Not all pilots may be capable of competing in advanced aerobatic competitions because of the extreme G forces associated with the required manoeuvres.

4.14.2 Aerobatic pilots need to realise the potential hazards of high G and establish personal limits based on their own experience and taking into account their current state of health, fitness, and recent aerobatic experience.

4.14.3 A warm up manoeuvre of three to five G for ten seconds will confirm adequate G tolerance on the day and raise the G tolerance level slightly by increasing blood pressure.

4.15 G Resistance Straining

4.15.1 G resistance straining can significantly increase +G tolerance, but needs to be initiated prior to the application of G forces to be fully effective. Effective straining is intended to prevent pooling of blood in the extremities, particularly the legs and lower body, thus maintaining sufficient blood pressure to the brain. Properly done, the straining manoeuvre can increase normal +G tolerance by three G or more.

4.15.2 Straining consists of tensing the lower body muscle groups, abdominals, buttocks and upper leg muscles. Straining should be commenced as +G is applied and maintained until +G is released. Relaxing the straining while still pulling +G could result in immediate GLOC.
4.15.3 Frequent aerobatic practice and physical conditioning can increase the effectiveness of the straining manoeuvre. Conditioning exercises should aim at increasing the strength of the abdominal and upper leg muscles. Aerobic exercise and fitness is beneficial in increasing endurance and assisting recovery from high G but will not of itself raise the G tolerance level.

4.16 ‘Hook’ manoeuvre

4.16.1 The ‘hook’ or modified valsalva manoeuvre is used by military pilots in addition to the muscle straining technique to further increase +G tolerance, but if not done correctly it could be hazardous by actually bringing on GLOC. It should only be done in conjunction with the G straining manoeuvre. The term ‘valsalva’, is more commonly understood by pilots as the process of clearing ears by pinching the nose, closing the mouth and exhaling.

4.16.2 The technique is not easy to do correctly and requires considerable practice to be safe, effective and automatic:
- Take a deep breath and exhale against a closed glotis (airway) to increase and maintain pressure in the chest;
- About every three to five seconds make a short forced exhalation and take a quick breath.

4.16.3 This is also known as the 'hook' manoeuvre because sounding and holding the initial 'hoo' sound for three to five seconds closes the glotis, and the final 'k' sound achieves the short exhalation and intake of breath. The 'hook' sequence is repeated continuously while straining under +G.

4.16.4 The technique is intended to increase blood pressure and assist the heart to maintain circulation to the brain by increasing and maintaining a higher pressure in the chest cavity.

4.16.5 However, the correct timing is vital. If the time interval between exhalations is too short the manoeuvre is ineffective, but if it is too long the increased pressure in the chest impedes blood return to the heart, resulting in a loss of circulation and probable GLOC.

4.16.6 The hook or modified valsalva is used by military pilots to allow extended periods at very high +G, but is not necessarily essential for sport aerobatics, given the shorter duration of G forces involved. Before using the hook or valsalva under high +G, pilots should be well practised and should carefully consider the hazards.

4.17 Head Elevation

4.17.1 Reducing the distance of the head above the heart, or elevating the legs, will reduce the pressure required to maintain blood circulation to the brain during +G. Some aircraft may incorporate a semi-reclining position for this purpose.
4.18 Resistance Strategies For -G
4.18.1 There is no known method to counter the effects of -G, other than to continue to breathe normally and relax the abdominal and leg muscles, although it has been suggested that practising hanging or standing inverted may possibly assist adaptation.

4.19 Physiological Factors Adversely Affecting G Tolerance
4.19.1 Pilots can build up their tolerance to G with practice, but need to be aware that tolerance levels that have been established can be significantly reduced by various factors affecting their physical condition. For example, studies have shown that dehydration can reduce G tolerance by up to 50%. Factors that can reduce G tolerance include:

- Dehydration;
- Low blood sugar level;
- Eating a large meal before flying;
- Fatigue;
- Prolonged standing or sitting;
- Hypoxia;
- Illness;
- Smoking;
- Alcohol;
- Drugs;
- Medications;
- Low blood pressure;
- Cardiovascular fitness level;
- Recent weight gain or loss.

4.19.2 Pilots with any medical condition listed would be advised to consult a DAME before undertaking aerobatics.

4.19.3 Lack of recent aerobatic practice will also reduce a pilot's G tolerance and pilots returning to aerobatics after some time away will need to check and then gradually re-establish their tolerance level.

4.20 Disorientation
4.20.1 The human balance mechanism was not designed for the forces experienced during normal flight, let alone aerobatics. Balance therefore cannot be relied on for orientation, and maintaining visual reference to the horizon and prominent ground features is the best method of minimising feelings of disorientation.