CHAPTER 3

PARACHUTES AND PARACHUTE DESCENT

CONTENTS

	Paras
Introduction	1–2
PARACHUTE CONSTRUCTION AND CARE	
The Canopy	3–7
Parachute Packs	8–12
Parachute Harness	13–14
Parachute Care	15
PARACHUTE OPERATION	
Manual Operation	16
Automatic Operation	17–19
PARACHUTE DESCENT AND LANDING	
Action to Control Descent	20–26
Parachute Landing	27–36
Summary	37

Introduction

1. The parachute was originally designed to enable the occupants of a disabled aircraft to descend to earth in safety. Although parachutes have since been used for many other purposes (*eg* supply dropping and aircraft braking) it is the original function—emergency escape—with which this chapter is concerned. All aircrew must know how to operate and handle the type of parachute that they may have to use, if they are to reach the earth's surface safely after an emergency abandonment.

2. The final design of a parachute results from certain basic requirements and a close study of the conditions under which it will be used. These requirements include the load (approx 118 kg (260 lb) for aircrew with full AEA), heights and speeds of operation, opening shock (usually about 9*g*) and rate of descent. The maximum rate of descent at impact to avoid significant injury is 8 m/s (26 ft/s); that of the current parachute (Irvin 24) is between 5.5 and 7.5 m/s (18–25 ft/s) and the new GQ aeroconical parachute is about 6 m/s (20 ft/s).

PARACHUTE CONSTRUCTION AND CARE

The Canopy

3. The Canopy is the drag-producing part of a parachute. It is made of nylon and is designed to form an umbrella-like shape during descent. Rigging lines provide the connection between the canopy and the

wearer and they maintain the shape of the canopy during descent. Each rigging line is continuous from one lift web to the apex of the canopy and thence to the opposite lift web, by way of diametrically opposite points on the periphery of the canopy *ie* 12 rigging lines on a 24 gore canopy.

4. Parachute canopies are constructed of gores extending from the apex to the periphery. Each gore is made up of a number of panels; in each panel the material is cut on the bias *ie* the warp and weft of the material lie at an angle (45°) to the centre-line of the gores; usually there are 4 panels per gore designated A to D from periphery to apex (5 in the aeroconical parachute, designated A to E). The peripheral hem and the vent at the apex are reinforced.

5. There are two basic types of canopy—flat and shaped. A flat canopy can be laid out to form a circle; each gore being a straight-sided segment of that circle. The measurement of such a canopy is its flat diameter. A shaped canopy cannot be so laid out and the measurement is its flying diameter. The flying diameters of 7 m (24 ft) flat and 5.5 m (18 ft) shaped canopies would both be about 5.5 m.

6. Shaped canopies assume a deeper form when deployed than flat canopies because the gores have curved sides. The aeroconical parachute has been developed from both basic types to have the following advantages:

a. A lower terminal vertical rate of descent than a flat canopy of the same flying diameter.

b. A lower opening shock than a similar flat canopy at the same IAS and altitude.

c. It is more stable and less inclined to oscillate.

7. An auxiliary parachute—a small canopy or vane parachute used to deploy the main canopy—is normally attached to the apex of the main canopy. This small canopy is stowed on, or contains, a spring so that when the closure pins of a pack are removed the spring provides the force necessary to throw the auxiliary parachute clear of the pack and into the slipstream. An auxiliary parachute is fitted to all ejection seat packs although the drogue system normally deploys the main parachute canopy. The auxiliary only functions when the main canopy is deployed manually following a manual separation.

Parachute Packs

8. The emergency escape parachute, complete with rigging lines (and normally an auxiliary parachute) is stowed into various types of fabric or solid pack. The type of pack depends on the type of seat used (static or ejection) and whether the pack is always worn in the air.

9. All parachute packs fitted to ejection seats are operated automatically. The pack is opened by tension either from a drogue or, in the Folland system, a vane parachute. Some parachute packs associated with static seats are opened by a static line from the aircraft structure and connected to the pack opening mechanism. This opens the pack after a time delay which is also controlled by a barometric capsule to ensure that the pack cannot open automatically at high altitude. In addition, all parachute packs can be operated manually. In these cases, the parachute is extracted by a pilot parachute. Those packs normally operated by a static line usually have a manual handle to activate the automatic system should the static line fail to work.

10. The parachute packs in Service use fall broadly into one of four types:

a. *Chest Type Packs.* Chest type packs are for use in aircraft where the use of permanently fitted assemblies is impracticable. They connect by snap hooks to the front of the parachute harness, and are connected only when an emergency appears imminent. Until this time, the pack is kept in a stowage provided in the aircraft.

b. *Seat Type Packs.* Seat type packs are designed to fit into a shaped pan in the aircraft seat and the wearer sits on the pack. Such packs are normally used by crew members who remain in their seats during flight; this type of pack is used in many static and some early ejection seats.

c. *Back Type Packs.* Back type packs can be classified into three distinct classes. One is similar in shape to the seat type pack, but is positioned on the back near the shoulders, the aircraft seat back being suitably shaped to accommodate the pack in this position. The second class of back pack is commonly called the 'horse shoe pack', because of the shape. This also fits into the aircraft seat back near the wearer's shoulders. These two classes are fitted to ejection seats. The third class is worn by aircrew in static and swivel seats in high flying aircraft and fits on the back between the shoulders and the hips. A similar pack is worn by air loadmasters and dispatchers whilst carrying out air dropping duties.

d. *Head Box Packs.* A recent innovation is to remove the parachute pack from the seat back and to fit the parachute into the head box of an ejection seat, together with the drogues. Such a pack has the advantage that the parachute cannot be damaged in storage and is less susceptible to damage from contact with the seat structure during extraction. As the pack is fitted to the seat and not the man, manual bale-out is impossible.

11. All parachute packs, irrespective of type, contain a 7 m (24 ft) flat canopy (Irvin 24) except for the following:

a. The back type pack fitted to the Folland 4GT ejection seat used in the Gnat contains a 5.7 m (18.5 ft) GQ lightweight shaped canopy. The system is slug deployed, the slug extracting a vane parachute which in sequence extracts a stabilizer and then the main parachute canopy.

b. The head box pack fitted to the Martin Baker Type 10 ejection seat (Hawk, MRCA) contains a 5.2 m (17 ft) GQ aeroconical parachute.

It is probable that the aeroconical parachute will be retrofitted to other Service aircraft.

12. Anti-squid lines are now fitted to many parachute canopies. These lines consist of a pair of cords or tapes from the parachute risers to the central vent of the parachute canopy. During the deployment of the parachute, the anti-squid lines transfer the tension from the drogues directly to the crewman. This relieves the tension on the shroud lines and the periphery of parachute allowing the canopy to open more quickly. As rapid parachute inflation is undesirable at higher speeds, the anti-squid lines are designed to break under these conditions so that the parachute canopy inflates more slowly.

Parachute Harness

13. Several types of parachute harness are in use, differing from one another in design details, to provide for the particular requirements of the seat, aircraft or wearer. In general they consist of a sling in which the wearer sits and auxiliary straps to secure this sling to the wearer. The latter usually provide for adjustment in size. The straps meet at a quick release fitting normally fitted to a waist-belt situated in front of the body. Extensions of the sling above the shoulders, called the lift webs, connect to the parachute rigging lines. There are usually four of these lift webs, two on each side, described as left or right, front or rear, as appropriate. On harnesses designed for use with chest type parachute packs there are only two lift webs, known as the left or right lift webs.

14. Most types of ejection seat use a combined harness, which combines the role of both safety harness and parachute harness. Later types of combined harness have only one set of adjusting buckles. Ejection seats may have one of three types of harness:

a. Separate parachute and restraint harnesses.

b. Combined parachute and restraint harness (seat mounted).

c. Combined torso harness (man mounted).

Parachute Care

15. Survival Equipment Sections on all units take great care to ensure that parachutes are issued in perfect condition. However, aircrew must follow the advice given below to prevent damage during handling:

a. Never pick up or carry a parachute by:

(1) Any ring-shaped handle.

(2) Any knob.

(3) A flexible housing.

(4) Elastics or springs.

b. Never drop or throw a parachute.

c. Never place a parachute on an oil drum, battery, dirty bench, ground or damp area. Keep it away from stoves and radiators.

d. Do not hang a parachute by the harness or allow the harness to drag along the ground.

e. Carry the parachute in your arms, with the harness wrapped neatly round the pack. If it has to be taken on a rail, road or sea journey, use a parachute transit bag. *Note:* Many "portable" parachute packs have carrying handles.

PARACHUTE OPERATION

Manual Operation

16. After an unassisted escape from the aircraft, the parachute is deployed by removing the closure pins from the parachute pack. This is done either by a static line or by pulling either a knob or a D-shaped ripcord handle, which is situated either on the left hand side of the parachute harness or on the pack itself. This release is normally pulled from left to right across the body. The ripcord handle of manually operated parachutes should be operated as soon as the parachutist is clear of all parts of the aircraft. When the closure pins are removed, the auxiliary parachute springs out of the pack, and as this fills, it extracts and streams the main parachute, which has also been freed by the unfastening of the pack. The rigging lines are hanked inside the pack and are extended as the canopy streams.

Automatic Operation

17. The parachute packs associated with ejection seats and some packs used in static and swivel seats are operated automatically. The automatically operated packs used in static and swivel seats are fitted with a device known as the Barometric Power Unit (BPU) which is described below.

18. A BPU is needed to operate parachutes which may have to be used in high speed, high altitude escapes from aircraft. Its purpose is to operate the opening mechanism of the assemblies after the wearer has fallen to a pre-set height, or after a pre-determined delay. A powerful spring provides the motive force necessary to drive the time delay mechanism and withdraw the ripcord pins; an aneroid capsule prevents the release from operating above a pre-set height; a simple escapement and pallet delays operation for a pre-determined time after falling to the barometric operating height. This height is normally 10000 ft and the time delay is 2 ± 0.5 s.

19. The release is normally housed within the parachute pack and is activated by the removal of a pin; the means by which this is done varies with the type of installation, but is either by a static line to a point in the aircraft near the escape exit, or by the manual operation of a D-ring or knob on the parachute harness. The time delay mechanism runs for its set time, but if the height of operation is more than the barometric height, an interference pin controlled by an aneroid device will prevent it from running

until the pre-set altitude is reached. At the end of the time delay, the spring is released and it withdraws the ripcord pins. If for any reason the wearer should suspect that the power unit has failed, or if he has failed to fasten his static line to the aircraft, he can pull the manual parachute which will exert a direct pull on the pack rip pins and the auxiliary parachute will be ejected and extract the main parachute canopy.

PARACHUTE DESCENT AND LANDING

Action to Control Descent

20. Following a manual escape it is possible that the body may somersault before the parachute is deployed, whether this is achieved manually or automatically. If height permits, body stability can be achieved by adopting the "free fall" position, *ie* body arched back, legs straight and slightly parted (about 450 mm), arms held straight out at right angles to the body.

21. It is not possible in this Manual to quote one drill that can apply to all aircraft and all circumstances. However, the Vital Actions listed below must be carried out in the descent as soon as the main canopy is fully deployed:

a. Inflate the life preserver.

b. Remove the safety pins from both Koch fasteners (if applicable).

c. Drop the oxygen mask.

d. Check the security of the PSP lowering line.

e. Lower the PSP unless the descent is likely to be into trees or overhead cables.

22. If time permits, the following subsequent actions may be taken to minimize problems in the descent and landing:

a. Disconnect and discard the oxygen mask.

b. Pull up the PSP if oscillations become excessive.

c. Adopt the appropriate landing position.

d. Release the parachute when the feet touch the water or when the landing is complete.

23. Descent by parachute can be influenced by the manipulation of the lift webs. Correct application of this parachute flying technique will:

a. Reduce oscillation.

b. Reduce drift and thereby the horizontal component landing impact.

c. Enable the parachutist to attempt to avoid obstacles and, to a limited degree, select his landing area.

24. **Oscillation.** One of the characteristics of the current flat canopy emergency parachute is its tendency to oscillate, often violently. During a long descent this can be most unpleasant, resulting sometimes in sickness or panic. Oscillation may be reduced to some extent by pulling down on any lift web or pair of front or rear lift webs. The oscillation of the man may be aggravated by lowering the PSP, as it can swing one way whilst the parachutist is swinging the other; thus subjecting him to a series of violent jerking movements. *Note:* This oscillation is significant with the flat canopy (Irvin 24) only. It does not occur to a noticeable extent with the GQ aeroconical parachute.

25. **Control of Drift.** Pulling on the lift web tends to make the parachutist drift in the direction of the pull, but as air is being spilled out of the canopy, it also causes an increase in the rate of descent. From this it will be seen that pulling on the downwind side will increase the drift across the ground and the force of landing. Pulling on the upwind side will reduce drift and landing speed. When below 1000 ft it is therefore advantageous to check drift as follows:

a. Look at any suitable fixed point on the ground and assess the direction of drift. As wind velocity (wind shear) is most likely to change considerably below 1000 ft the drift should be continually monitored. At heights in excess of 1000 ft there is little awareness of descent but below this descent and drift become progressively more noticeable becoming significant in the last few hundred feet.

b. If drifting forwards, check drift by reaching as high as possible and grasp the back lift webs, with the thumb inwards and the palm to the front. Pull down until the hands are level with the face.

c. If drifting backwards, pull down on the front lift webs as described above.

d. If drifting sideways, pull down on the front lift webs and just before reaching the ground let up on the lift web on the side to which you are drifting.

e. As long as the drift continues in the original direction it is not advisable to let up before landing, except in the case of sideways drift when the lift web on the downwind side is let up. Should the pull on the lift webs overcome the drift then the lift webs must be let up gently just before reaching the ground.

Notes: 1. Maintain the correct parachute position throughout the descent.

2. All manipulation of the lift webs should be positive and steady. They must not be jerked down or let up too quickly due to the risk of re-introducing oscillation.

3. In the event of the parachute turning, or an alteration of drift, change to the correct lift webs; if close to the ground, let up gently.

4. Aeroconical parachutes have a significant glide ratio. This feature, known as drive, may be up to 6 m/s (20 f/s) and hence it will have a marked effect on the apparent drift.

5. Chest packs (and some others) have harnesses with only 2 lift webs; one lift web only should be pulled down to reduce oscillation and drift.

6. During the descent the escapee should note the main features of the surrounding countryside.

26. **Avoidance of Obstacles.** If there is a danger of landing on buildings, trees or other obstructions, it is possible to change the descent path by side-slipping. This is accomplished by pulling down on the lift webs or rigging lines on the side towards which it is desired to move. This causes air to spill from the opposite side of the canopy producing a movement in the desired direction. The canopy may appear to collapse in a violent side slip, but this need not cause alarm as it will recover as soon as the lift webs are released. Side slipping causes a marked increase in the rate of descent and should not be done close to the ground except in extreme emergency. When side slipping is used to avoid landing on rough ground the object should be to land short or steer round to one side of the obstacle. Attempts to glide over an obstacle will invariably fail because of the increased rate of descent.

Parachute Landing

27. When making a forward landing, the lower limbs and feet should be turned across the line of drift to allow the roll after touchdown to be made on the side of the leg and thigh, feet and legs should be together, knees slightly bent, head tucked well in and the arms, with hands grasping the lift webs, should be bent, with the elbows held forward. The initial landing shock is taken by the flat of the feet, through comparaively well-braced legs, although the shock is made transitory by the relaxed attitude of the body. There should be no attempt to strike or beat the ground with the feet; the body should touch with the feet, leg, thigh and buttock. On touchdown, the near shoulder should be be twisted round and the fall completed diagonally across the back.

28. When making a sideways landing, the sequence of movements is almost identical with that of a forward landing, except that since the body is already across the line of drift, further turning is unnecessary; the final twisting of the shoulders at touchdown need not be so pronounced.

29. When making a backward landing, the aim should be to turn the lower limbs so that the landing is half backward, half sideways. When approaching the ground the legs, with slightly bent knees, should reach backwards to take the initial shock of the fall. The weight of the body should be left well forward with the shoulders rounded and the head tucked well in and it should be anticipated that there will be a tendency for the body to be pulled backwards. As the feet touch the ground, pull down strongly on the front lift webs and urge the body to one side; in this way a direct blow on the base of the spine is avoided.

30. After landing the parachute canopy should be deflated immediately by pulling in on a handful of rigging lines at ground level. This will avoid being dragged. If, in strong wind, dragging takes place before the canopy is deflated, proceed as follows:

a. If using a conventional harness, roll onto the back and undo the quick release fitting (QRF).

b. If wearing a torso harness, roll onto the back and release the Koch fasteners in the normal fashion.

31. If the descent is made into trees it will not be as dangerous as may be imagined. The drill is:

a. Retain the helmet and do not lower the PSP.

b. Adopt the normal parachute landing position but with the arms across the front of the face until the descent ceases. (The parachutist may crash through light branches and land on the ground.)

c. If the parachute catches in a tree, try to get a safe anchorage on a branch or the trunk, but with the minimum of movement. Do not release the QRF until a safe anchorage has been obtained. The PSP may be dropped and the PSP lanyard used to secure equipment to the tree and assist in the descent.

32. If the descent is made into water, remember to ensure that:

a. The life preserver is inflated.

b. The oxygen mask is discarded.

c. The PSP is lowered as late as possible.

d. At about 100 ft, turn the QRF to its fullest extent if appropriate; the hands should locate and be in position to operate the harness release. (Hands just below the Koch fasteners or thumbs behind the QRF).

e. Release the parachute when the feet strike the water.

33. If there is any wind the canopy should drift clear. Should the canopy collapse on top of the survivor this would mean a light wind and a low sea state. Hence there would be little danger and no reason to panic. Float with the head back and, using alternate arms, grasp a handful of material and draw it down to the chest, grasping another handful before releasing. Where possible, work along an embedded rigging line between two gores; if the apex is reached first continue across it to the periphery. Breathing is no more difficult than normal while under the canopy if the parachute material is held clear of the face.

34. In high winds the survivor may be dragged in the harness. Should this happen, he must roll onto his back in the dragging position, which is:

a. Chin on chest, shoulders and back rounded.

b. Buttocks dropped.

c. Legs maintained wide apart.

d. Hands on release mechanism.

This position affords a comfortable and stable ride with the face well clear of the water. The protective helmet reduces water splashing on the face.

35. Release the parachute; the method depends on the fastening as below:

a. With a QRF squeeze it; if the dragging force is high the straps may bind in the groin. Maintain the legs wide apart and work on the leg straps with the hands.

b. With Koch fasteners try to release both fasteners simultaneously. If only one releases maintain the leg position for stability until the other is released. If due to injury only one hand is available reach over the life preserver and effect release on the injured side first, otherwise it may be difficult to reach the fastener on the injured side.

36. With systems deployed by a drogue bullet and duplex drogues the duration of drag is very short as the bullet falls into the water and sinks. This submerges the drogues which then acts as a sea anchor and the line rapidly collapses the main chute. A degree of entanglement with the rigging lines may ensue. Use the knife methodically and with care.

Summary

37. The construction, care and operation of parachutes has been dealt with in general terms in this chapter. Further details of individual parachute assemblies may be found in AP 1182A. Information on the uses of parachutes in survival situations is contained in AP 3456J. The parachuting technique is the result of the lessons learned from numerous descents by aircrew and experienced parachutists; the advice given should enable aircrew to avoid serious injury after abandoning an aircraft in flight.