ABF Pilot Training Manual

Part 5

Aerostatics and Airmanship (A&A)

VERSION 1 – JUNE 2006

CONTENTS

Aerostatics and Airmanship

Reading

ABF Operations Manual.
ABF Student Training Record or a balloon manufacturer's flight manual (load chart)
Watch Out for Power Lines (NSW Office of Energy booklet, available from the ABF office)
Ballooning Handbook by Don Cameron, Pelham Books UK, 1986 (thanks to Don for permission to reprint some illustrations here)
The Ballooning Manual by Bob and Carol Howes, Airlife UK 1991.

The A&A exam

- Twenty question multiple choice exam.
- Time allowed 70 minutes.
- Minimum pass mark is 70%.
- You should bring a ruler and calculator to the exam.

Airmanship

Airmanship is all about attitude, and is demonstrated in many ways. It includes:

- Acting responsibly to give you and the sport of ballooning a good name
- Following best safety practice at all times
- Flying within your abilities
- Not being afraid or embarrassed to stay on the ground even if others are flying
- Carrying out even small repairs promptly
- Filling in logbooks accurately and promptly
- Reporting incidents promptly for the improvement of our sport, and
- Never thinking that you know it all, but continuing to learn.

Have fun but be sensible too. Remember you can fail the airmanship test at any time.

Balloon components

Become familiar with the name and function of the various parts of a balloon through handling them, and practise using the correct terms from the start. The following are common to most balloons:

Parts of the envelope
Fabric panels, vertical and horizontal load tapes, crown (top centre of the envelope), crown ring, crown rope, equator (widest part of the envelope), mouth, scoop (or skirt if it extends right around the mouth), nomex fabric, rotation vents, control lines and flying wires. The envelope may also be called the 'canopy'.

Rotation vents simply rotate the balloon left or right around its vertical axis. Their most important use is to orient the basket in a suitable direction for safer flight and landing. They also allow the pilot to give passengers a better view, or to show a sponsor banner in a particular direction. They do not provide steering.

The vent and deflation system (for releasing air from the envelope) is now usually a simple parachute vent or a combination (Smart Vent or similar), with a circular 'parachute' which covers the vent opening. Older style deflation systems include the velcro rip which usually has a dump (separate side vent). Any line used for deflation may be called a 'ripline', or referred to by colour (eg red, white, candy stripe).

The basket and equipment in it
Karabiners, basket wires (or cables), burner support poles, pole sleeves or covers, cylinder straps, rope handles (internal for passengers, external for carrying), basket floor, basket runners or skids, rawhide, handling line, fire extinguisher, first aid kit, flight manual.

Burner and fuel system
Burner/s, burner frame, gimbals, preheating coils, jets, fuel pressure gauges, main and quiet burner valves, crossflow valve, piezo igniters, pilot lights and pilot light valves, liquid and vapour fuel lines, fuel cylinder (master or slave), guard ring, liquid and vapour offtake valves, pressure relief valve, bleed valve, automatic fill limiter. Inside a cylinder – dip tubes (below liquid offtake valve and bleed valve), fuel contents float gauge, vapour space.

Instruments and radios
Altimeter, variometer, ambient (outside air) and envelope temperature gauges, GPS. Fuel quantity gauge (on each cylinder), fuel pressure gauge (on each burner).
UHF and VHF radios.

Extra equipment
Inflation fan, launch rope and quick release, tether ropes.

ARE YOU UP TO DATE?
New regulations and procedures may apply from time to time.
Check on the ABF website that you have the latest version of these study notes.

Buoyancy

The **all up weight (AUW)** of a balloon is the sum of all the **visible** items, ie:

AUW	=	**BALLOON** (envelope, basket, burner and fixed equipment)	+	**PAYLOAD** (people, fuel and loose equipment)

The **total mass** of a balloon is much greater. It includes **the contained air**, which weighs more than we would expect – several tonnes in an average sport balloon.

TOTAL MASS = BALLOON + PAYLOAD + AIR

There is an upwards force (**lift**) acting on the balloon which is equal to the weight of the atmospheric air displaced by the balloon (this is an example of 'Archimedes Principle').

When the air inside the balloon is gradually heated, it becomes less dense and therefore lighter in weight. The total mass is gradually reduced, while the lift due to displacement remains. Eventually a point is reached where the total mass is exactly equal to the lift. At this point the balloon has **neutral buoyancy** and is **in equilibrium** (perfectly balanced, not wanting to move up or down). Further heating will give **positive buoyancy**, causing the balloon to rise. Cooling will cause it to descend. (See also **www.howstuffworks.com** and search 'hot air balloon'.)

The difference in temperature between the air inside the balloon and the outside air is called the **differential temperature**. Greater differential temperature causes greater lift.

Balloon controls

In flight, buoyancy is increased by **burning** (using the gas burner), which makes the balloon climb, or reduces the rate of descent. Releasing air by **venting** (pulling the vent line to release hot air for a few seconds) will make the balloon descend, or reduce the rate of climb. A balloon is constantly losing heat to the surrounding atmosphere, so regular burns are necessary just to maintain buoyancy.

Surprisingly, the air in an average size sport balloon (say 84,000 cu ft) weighs around 4 tonnes at normal ambient temperatures and sea level. When heated to around 100°C this air weighs about half a tonne less, which effectively provides half a tonne of lift. As a result of its substantial mass a balloon has considerable **inertia** (tendency to stay still, or to keep moving with the same speed and direction), and considerable **kinetic energy** (energy of motion) due to its **momentum** (its mass multiplied by its speed). The larger the envelope volume, the greater the inertia and momentum.

This helps explain the long **control reaction time** (the delayed response of a balloon to the controls). It is important for the pilot to constantly monitor the balloon's movement, anticipate the need for a burn or vent, and apply these controls sufficiently in advance of the required result. The control reaction time will increase if:

- the total inertia or momentum of the balloon increases (larger balloon size or faster speed), or
- the burner power is reduced (see Fuel and Burner Systems below).

A balloon flies at exactly the speed and direction of the wind. **Steerage** may be available by climbing or descending to fly in different directions of wind at different altitudes. So any directional control relies on effective vertical control.

Optional **rotation vents** may be fitted, which release air to rotate the balloon around its vertical axis. They do not assist steering but are used to counteract the slight natural rotations that may occur when changing altitude. Like shopping trolleys, balloons don't always face the direction they are going. Rotation vents can be used to keep a particular side of the basket facing the direction of flight. The controls and instruments thus remain in the same general relationship to the pilot's position, which reduces confusion and increases safety, especially when landing. As hot air is lost from the balloon when using rotation vents, a **check burn** may be required after rotating to maintain buoyancy.

Atmospheric variables and stability

Balloon **buoyancy is reduced by**:

- **increased altitude** – as the air pressure reduces, the ambient air becomes less dense. This effect is partly counteracted by the reduction in temperature which usually occurs at higher altitude.

- **increased ambient (outside air) temperature** – reduces the density of the ambient air and the differential temperature. For example, in an inversion buoyancy is reduced as the ambient temperature increases with altitude instead of decreasing.

- **increased humidity** – because water molecules are lighter than air molecules, so humid air is less dense than dry air (the opposite to what you might expect!).

In a **stable** atmosphere any variations in temperature, pressure and humidity are fairly predictable. Wind flow is generally **laminar** (smooth flow parallel to the earth's surface), allowing a balloon to be controlled with some confidence and precision.

In an **unstable** atmosphere conditions may change suddenly and unexpectedly. Even a slight vertical movement of air due to local turbulence effects will tend to carry a balloon with it, dramatically reducing vertical (and therefore directional) control. So it is essential to have a sound knowledge of weather systems and their likely effects on a balloon, and to constantly monitor weather developments while flying. This enables the pilot to maintain flight safety – by timely use of the controls in order to avoid or counteract minor local instability, or by landing before being affected by a more serious weather development.

See the MET section of this manual for inversions and other local weather effects and how they affect balloon flight.

Flight limitations

These are listed in the manufacturer's flight manual and are specific to the make and model of balloon. The pilot is required to know and follow them, and the manual is carried in the balloon for easy reference. Typical limitations include:

- maximum rates of climb and descent, maximum envelope temperature, and maximum all up weight (MAUW)
- minimum fuel pressure and minimum number of fuel cylinders
- permissible damage which the balloon can sustain and still be safe and legal to fly.

An example of permissible damage from one manufacturer's manual is: minor panel damage up to 6 metres above the mouth; a hole or tear less than 25mm diameter above that; structural damage of less than 10% of the cross section of any wires or load tapes; no other fabric or structural damage.

Loading

A balloon must be loaded so that it does not **overheat** at any time during hot inflation or flight, ie does not exceed the maximum envelope temperature which is typically around 120°C. Significant overheating will cause the fabric to deteriorate more quickly than normal. Before take-off, a **load chart** should be used to confirm that the intended all up weight does not exceed the maximum safe lift for that balloon, given the expected altitude and ambient temperature for the flight. A typical load chart is based on an envelope temperature of 100°C, which is well within the maximum envelope temperature so as to allow for the extra heat that takes a few seconds to disperse after a long burn.

How to use a load chart

A sample load chart showing the usual method of calculation is found in the ABF Student Training Record and in balloon flight manuals. **A pilot must be able to do these calculations.**

In the example below, a 77,000cu ft balloon plans to launch in 15°C at 2,000ft AMSL, and fly to a ceiling of 5,000ft AMSL. You can follow the steps on the chart on the next page:

1. Select the ambient temperature at the launch field (15°C) on the horizontal temperature scale.
2. Move vertically upwards from that point until you intersect the diagonal line that represents the elevation of your launch field (2,000ft) – shown as point A. On this chart, it is necessary to estimate the position of the 2,000ft elevation line between the sea level and 3,000ft lines.

3. From point A, move parallel to the direction of the ISA lines (the other set of diagonal lines) until you intersect the line that represents the altitude you wish to reach during the flight (5,000ft) – shown as point B. (You can see that the temperature below point B is about 9°C, so the chart has assumed the typical drop in temperature of 2°C per 1000ft gain in altitude. If you knew the actual temperature at this altitude from a weather balloon trace, you could plot point B directly from that.)
4. From point B, read across to the right hand scale to find the lift at point C – in this case 7.2kg per 1,000cu ft of balloon size. Multiply this figure by the balloon size (77,000cu ft) to get the lift for this balloon –

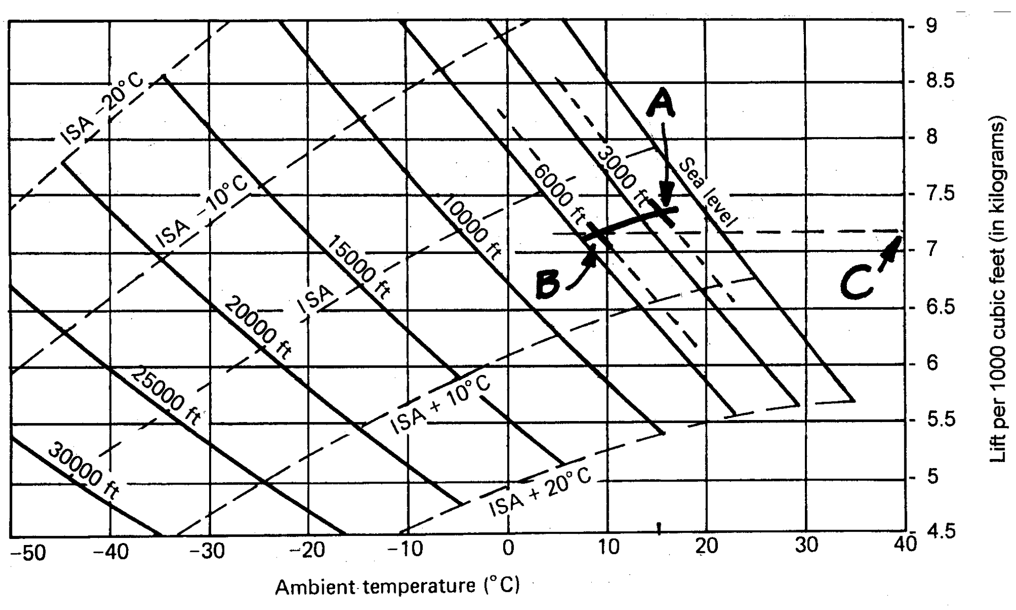
   7.2 x 77 = 554kg
5. Subtract from this the known weight of the balloon (envelope, basket and burner). The difference is the maximum additional payload (fuel tanks and people) that the balloon could lift in these conditions, ie

		554
minus	balloon weight	210
=	additional payload	344kg

   So, on this flight the balloon could lift (for example) a 90kg pilot, a passenger weighing 85kg, and three fuel tanks weighing 54kg each – a total of 337kg.

The **maximum all up weight** (MAUW) given in the flight manual is the combined weight of the balloon plus fuel, equipment and passengers on board that **must never be exceeded**. The safe all up weight (or safe lift) for a specific flight may be considerably less than the MAUW.

LOAD CHART



A - plot launch elevation and temperature (2000ft, 15°C)
B - follow ISA lines to intended flight ceiling (5000ft)
C - read across to maximum safe lift (7.2 kg per 1000 cu ft)

Load chart variations
Another way to use the load chart is to start with the all up weight which includes a particular combination of fuel and passengers, and calculate the maximum safe altitude for that combination.

The load chart can be a bit slow and confusing to use, especially in the half dark when the brain is still a bit sleepy! Many pilots prefer to make an easy reference table to keep with balloon logbook, using the load chart in advance to figure out various acceptable passenger and fuel combinations for a specific balloon, pilot and launch field elevation in different temperature conditions.

The load chart temperature trap
If a temperature inversion exists at flight time, the actual temperature at altitude may be greater than, not less than, the surface temperature at the launch field. This will substantially reduce the lift (or all up weight).

In an actual example from Canberra, the surface temperature was 0°C. The assumed temperature at 2,000ft above that point (using the chart) was therefore – 4°C, giving a lift of 9kg per 1000cu ft. However, due to a strong inversion the actual temperature at that height was 8°C, which instead gives a lift of 7.5kg per 1000cu ft. In a 77,000cu ft balloon this amounts to a total difference of 1.5 x 77 = 115kg (up to one and a half passengers). And in a 300,000cu ft balloon the total difference is 450kg, about 5 to 6 passengers!

To avoid possible overheating while in flight, it is therefore wise to allow for a possible inversion by assuming the temperature at altitude is warmer than the load chart assumes it to be.

Checking temperature during flight
The envelope temperature can be monitored during flight using an **envelope temperature gauge**. If a gauge is not fitted, the ambient temperature in flight can be compared with the temperature estimate on the load chart.

If an envelope temperature gauge is not fitted the balloon must have a **temperature flag**. This is a fusible link designed to melt at a specific temperature, usually just below the maximum permitted envelope temperature. This releases a streamer of balloon fabric that drops down into the basket as a warning that the maximum temperature has been reached. If this happens, the altitude should be reduced promptly, and the flag must be replaced with a new fusible link before the balloon is next flown.

Other load considerations
Porous balloon fabric – carry more fuel, and load lightly
Fuel tanks cold – burner output likely to be reduced, so load lightly
Inexperienced pilot – may have slower reactions, so load lightly.

Flight duration and fuel management

Flights are typically limited by running short of fuel, deteriorating weather conditions or running out of landing options. **Fuel consumption** varies with balloon size and condition, the load carried, atmospheric conditions and how the balloon is flown. Fuel use should be monitored regularly during flight. The remaining flight duration may be calculated from time to time using the fuel contents gauges and the elapsed time (see example in the NAV section of this manual).

An average sport balloon uses about one litre of fuel per minute. Actual fuel use will be increased by a **heavier load, flying at higher altitude, warmer weather, more climbing or venting during flight, rain cooling the envelope,** or **increased fabric porosity** due to age or wear.

Sunlight falling on a dark balloon may heat the contained air slightly and improve performance, but heat losses are usually much more significant than any gains. Heat is constantly being lost due to the combined effects of:

- heat **radiation**
- heat **conduction** directly through the fabric, and
- heat **convection** as heated air just outside the envelope is replaced by cooler air when climbing or descending.

You should plan to land with a **fixed fuel reserve** (say 20 litres, enough for about 20 minutes) still untouched. This is standard practice in all private as well as commercial aviation. If your original landing area is unsuitable and you have to fly on to another one, this should be done on your main fuel. The fixed reserve is not intended for this purpose, but is for emergencies only: if you think you will need to use it, you should alert your crew (and possibly others) and land promptly while you still have fuel.

When planning to fly for a particular distance or duration, allow an additional **variable fuel reserve** (say 10%) that may be needed in case of slower winds or higher than expected fuel consumption. Both fixed and variable fuel reserves are mandatory for commercial passenger balloon flights.

In-flight fuel management:
The system of fuel management you use will depend on the number of burners and tanks and the way these are connected, but some general rules apply to all systems.

- Maintain adequate fuel supply to each burner, or to both fuel feed lines of a single burner (in case of a problem with any part of the fuel system)
- Ensure successive cylinders to be used are connected and functional in advance of being required. Consider using master cylinder/s first, and maintain a reserve in them (say 20-25%).
- At all times be aware which cylinders are in use, the fuel remaining in each, and the total fuel and flight duration remaining
- Plan ahead to change fuel cylinders at a convenient and safe time. Ensure hoses are evacuated and valves at each end of the hose are OFF before disconnection. When a new cylinder is connected, check cautiously for leaks, then do a burner test to ensure the cylinder is working.
- Always plan ahead in order to land with adequate fuel and a safe reserve in the fuel tank/s in use.

Liquefied Petroleum Gas (LPG)

What is LPG?

Balloons are heated by burning LPG, which may be either pure **propane** or a mixture of propane and up to 50% butane known as **autogas**. We tend to use these terms interchangeably, but in fact pure propane is preferable for use in balloons due to its higher pressure and less impurities. It is readily available at gas depots either from bulk tanks or in take-away domestic cylinders (45kg and larger). Autogas from bulk tanks at petrol stations has slightly higher calorific value but lower pressure, and may contain 'heavy end' impurities from the production process. When it burns it may leave more soot than propane. Some 'autogas' tanks in country areas are in fact filled with propane – the retailer or supplier should know.

LPG General Properties

In order to emphasise the need for safety in handling LPG the following brief notes on some properties of the product may assist. Figures used are fairly broad because of the considerable variation in properties of a mixture containing varying amounts of propane and butane, eg propane boils at -45° while butane boils at 0°, so vapour pressure characteristics of various mixtures will vary considerably.

LPG is naturally tasteless, odourless, colourless, non-corrosive and non-poisonous. However, during production an odorant is added to positively indicate the presence of free gas before the concentration exceeds one-fifth of the lower limit of flammability. The stronger the smell, the more the danger!

LPG is liquefied by pressure at normal temperatures. In liquid form LPG is approximately half as heavy as water. As a vapour LPG is between 1.5 and 2 times as heavy as air, so a higher concentration of gas will occur at any low points such as hollows or drains.

When LPG liquid is released it boils immediately, drawing heat from its surroundings so that anything in contact with the liquid is cooled very quickly. The briefest contact with exposed skin can cause cold burns just as severe as any heat burn and requiring similar first aid and medical treatment.

A small amount of liquid released will result in a very large volume of combustible mixture. One part liquid gives 272 parts vapour which combines with 24 x 272 parts of air for a combustible mixture of ideal proportions. Ie, one part of liquid produces 6800 parts of combustible air+gas mixture! Any uncontrolled burning therefore borders on an explosion. The percentage amount of vapour which when mixed with air will make a flammable mixture is very broad, ranging from 1.5 to 9.6 per cent. Unburned LPG should be regarded as dangerous until the smell has dispersed in the open air.

Liquid LPG under pressure in a cylinder expands significantly with any rise in temperature. A completely filled cylinder if it was heated even slightly could therefore explode – or its pressure relief valve could release dangerous amounts of LPG without warning. For this reason a cylinder must never be filled with liquid LPG to more than 80% of its capacity. The remaining 20% naturally fills with a 'cushion' of LPG vapour, that allows the liquid level to rise and fall safely with normal temperature changes.

To avoid overfilling cylinders
Balloon cylinders are normally fitted with a **bleed valve**, fitted on top of a **fixed liquid level dip tube** that extends down into the cylinder to the 80% capacity level. During refuelling the bleed valve is opened slightly to release vapour – when white liquid LPG begins to show, refuelling must stop immediately and any excess liquid must be allowed to escape before the bleed valve is closed.

Filling with autogas at petrol stations may not be permitted using the bleeding off process above. It may be acceptable if the balloon cylinder has an **automatic fill limiter (AFL)** fitted, similar to those used in car LPG cylinders. Fitting AFLs to your balloon cylinders is highly recommended - filling is safer as the bleed valve on the cylinder stays closed and no vapour is released. An AFL may not shut off exactly at the 80% level, so it is wise to check the level by opening the bleed valve briefly once filling is complete, and then bleeding off any excess.

The cylinder must be properly oriented (usually upright on a level surface) for the dip tube or AFL to operate correctly.

Refuelling methods
Two normal methods of filling cylinders are used:

- by **pumping** from a bulk tank at a gas depot or service station. Pumping is quick so the pump must be shut off IMMEDIATELY liquid shows at the bleed valve. (A cylinder with AFL fitted will shut off automatically)
- by **decanting** using a combination of gravity and the pressure difference between the supply cylinder and the cylinder being filled. The supply cylinder needs to be fitted for liquid withdrawal (eg a bulk tank, or a smaller 'blue top' cylinder in Australia). Decanting is slow and only used where a pump is not available. LPG refuelling rules vary from state to state in Australia. Decanting may require a permit to fill cylinders over 25 litres capacity.

General LPG safety
LPG equipment should be handled, and cylinders refuelled, in a safe environment by people who are suitably trained or supervised. Care and concentration should be used at all times, and the potential risks of cold or heat burns, explosion and fire should never be underestimated. The fire brigade considers a safe distance in the event of a balloon cylinder exploding to be not less than one kilometre!

Cylinders should be stored upright, and should never be stored in a basement, cellar or any situation where leaking gas can collect.

Handlers should wear suitable gloves and clothing with long sleeves and long trousers to leave minimum exposed skin. Natural fibres are safer in the event of a fire.

Refuelling safety

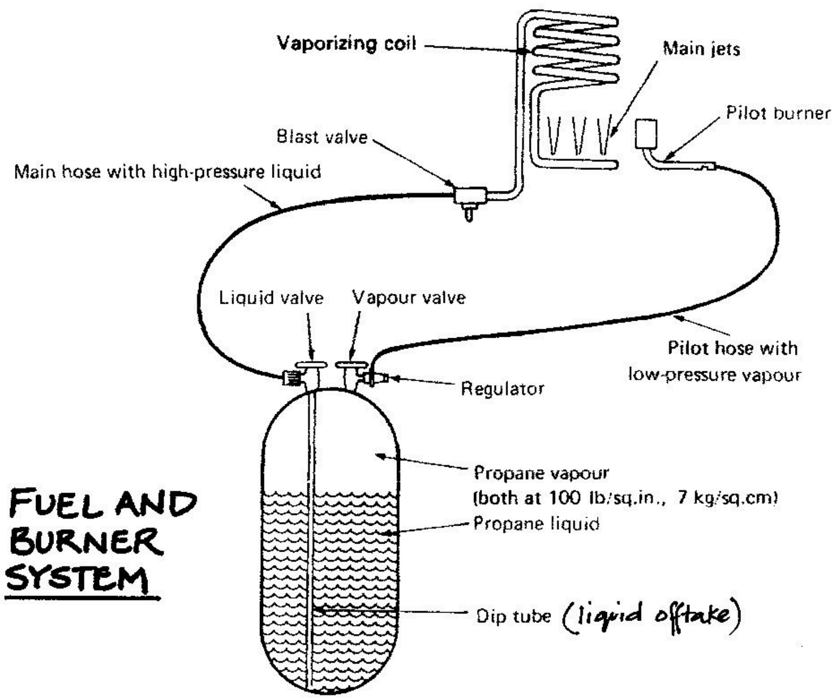
- Maximum of two experienced persons to refuel (others well clear)
- Wear gloves and suitable clothing
- Note the location of any shutoff switches or valves

- Have a fire extinguisher at hand ready to use
- Remove all possible ignition sources (engine, radios and mobile phones switched off, no naked lights, gas lighters put away)
- Refuel away from low lying areas and drains
- Enclosed trailer doors must be opened to let vapour escape
- Do not stand in the balloon basket (to avoid ignition and be able to escape quickly)
- After filling, empty LPG from any refuelling connector hoses

Fuel and burner systems

Fuel and burner systems may vary slightly, but the principle is the same and essentially simple. Cylinder pressure forces liquid LPG up a **dip tube** and out of the cylinder, through a flexible hose to the burner. When the **burner valve** (or **blast valve**) is opened the liquid fuel passes through the **vaporising coil**, is converted to vapour and released through narrow **jets** where it is ignited by a constantly burning **pilot light**.

Pilot lights typically use LPG vapour drawn from the top of a fuel cylinder through a regulator and a separate supply hose. An alternative is the **liquid pilot light** that uses the liquid LPG supply from the main burner hose.



Many balloons are also equipped with a **quiet burner** which has a separate valve and jet and no vaporising coil. Quiet burners help to minimise disturbance to people and livestock and are standard on most modern burners. They have a softer, more yellow flame which is more easily distorted by windshear.

The **burner power** (ie the heat output and its effect on the balloon) is directly proportional to the **fuel cylinder pressure**, so the most reliable indicator of burner output is the **pressure gauge**. Half the pressure will produce half the heat output from a given length of burn. Fuel pressure can be improved by keeping the cylinders in a shed away from cold overnight temperatures before flight, or by using approved **cylinder heater** pads (a kind of electric blanket). Another method is to pressurise the cylinder by adding nitrogen, but this should only be done with professional advice.

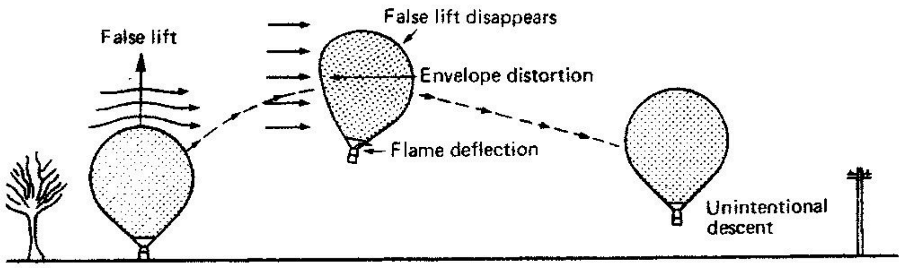
Cylinder pressure naturally decreases slightly during flight as the contents are used. The pressure drops much more quickly as the level falls below 5%, so that progressively longer burns and earlier application are required to get the same response.

When **multiple burners** are used together, the total output is equivalent to the sum of the number of burners. When two burners are supplied from one cylinder by using a **crossflow valve** (which allows multiple burners to be operated with one hand using a single valve) the output is less than double. Opening two separate valves to a single burner makes very little difference.

The **fuel contents gauge** on a balloon cylinder typically indicates only the lower 30% of contents, and gives no indication at all between full and 30%. It is therefore essential to check *before flight* that each cylinder is full by opening the bleed valve to see that white liquid LPG escapes (it may be necessary to shake the cylinder slightly). When checking a contents gauge it is good practice to bump the cylinder firmly to check that the gauge is moving freely.

False lift

False lift occurs whenever wind blows over the top of a balloon, whether on the ground or in a windshear at any altitude while in flight (see Inversions and Windshear in the MET section of this manual). False lift is proportional to the difference between the wind speed and the balloon's speed. It is the same principle as the lift caused by airflow over the curved upper surface of an aeroplane wing.



FALSE LIFT

When launching a balloon in any noticeable wind, false lift will be a proportion of the total lift at take-off. After take-off, the balloon usually takes several seconds to reach wind speed. As it does, the false lift component gradually reduces to zero, and the total lift therefore decreases. The balloon is likely to drop below its intended flight path, and unexpected ground contact may occur. To avoid this:

- allow extra clear space downwind
- take off more buoyant than usual
- be very attentive to the flight path and buoyancy of the balloon after take-off, avoiding any distractions
- continue heating as necessary until well clear of obstacles and the balloon has adjusted to the wind speed.

Clearing obstacles

The balloon is likely to accelerate towards downwind obstacles as it picks up the wind speed, so they should be given a wide berth. Experience and judgement are the best guide to clearing small downwind obstacles. A useful test is to release a pibal (small helium balloon – see Weather Sources in the MET section of this manual), which climbs at about 200 to 300ft per minute. If the pibal clears the obstacle, you should be able to, provided that you take off with plenty of buoyancy and then burn again as necessary. A significant downwind obstacle such as a powerline, tower or silo may require a precautionary calculation (see the NAV section of this manual).

Launch rope and quick release

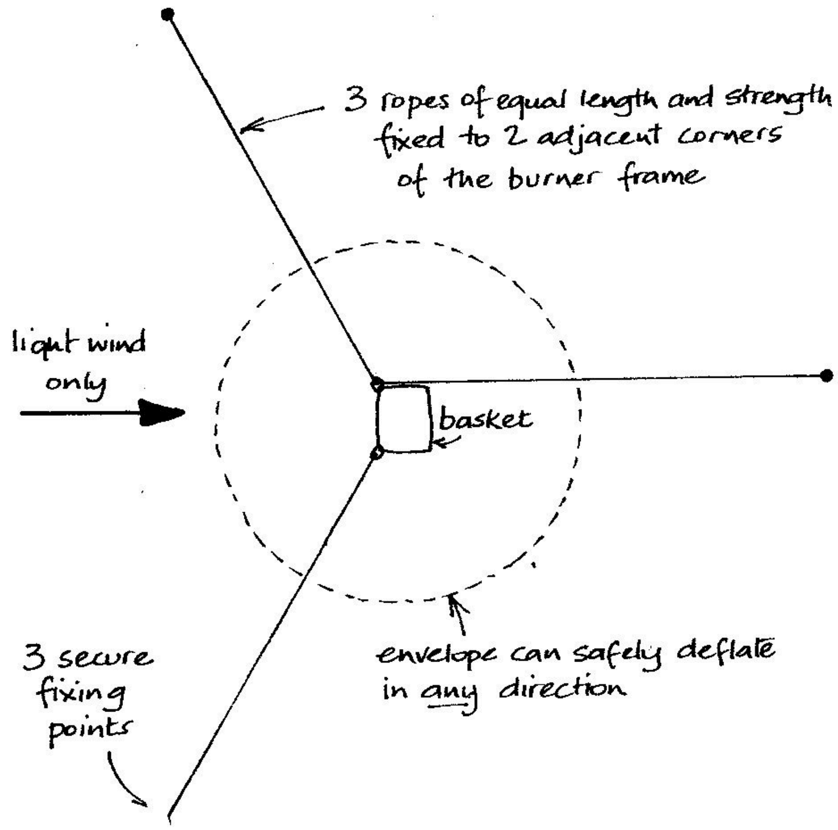
From the start of cold inflation until just before take-off the balloon must be secured by a launch rope to a vehicle or other solid object, preferably with a **quick release** mechanism easily operated by the pilot from the basket. The breaking strain of the rope should be similar to the total weight of the balloon including contained air, ie several tonnes. It should be kept short (5 metres is adequate), and be fixed to appropriate structural points at either end. A towing point or bull bar on the vehicle is suitable. At the balloon end the best control is provided by a V-bridle attached to two adjacent corners of the burner frame or around the steel basket wires at basket top height. Any slack should be taken up before starting cold inflation, and again as soon as the balloon is upright following hot inflation, to minimise sudden movements of the basket due to false lift or wind changes. In addition, one or two crew members should be ready to put **hands on** (apply some weight to the edge of the basket) until the balloon is buoyant. The pilot must warn the crew to **stand clear** before pulling the quick release as recoil of the launch rope has the potential to cause injury.

Tethering a balloon

Sometimes a pilot may wish to tether a balloon (restrain it with ropes) in order to demonstrate it without flying away. Tethering should never be carried out in windy conditions as the balloon and equipment (and whatever the balloon is tethered to) may be damaged, and it may create a very poor impression of ballooning as a sport.

Take care to avoid excessive strain on any part of the balloon or tether system. If the flight manual does not give instructions, the following points are recommended.

Use a minimum of three ropes, laid out at equal angles when looked at from above, and tied off securely to heavy vehicles or other solid objects. If the wind direction is steady, two ropes can remain taut upwind and any slack in the downwind rope can be taken up by experienced crew members.



TETHER LAYOUT

Ropes should be synthetic fibre, in good condition, of a kind which does not degrade quickly in sunlight, and each with a breaking strain about equal to the total mass of the balloon including the enclosed air (eg, 3 x 3 tonne ropes for an 84,000cu ft balloon are recommended). Nylon is excellent but more stretchy. Polypropylene is satisfactory, less stretchy and less expensive. Climbing rope is better avoided as it is braided rather than laid (twisted) which makes it difficult to tell when the central fibres break down and the rope weakens. Braided kevlar rope is stronger and has been used successfully.

Ropes with knots or damage in them should not be used – the simplest overhand knot reduces rope strength by up to 50%. The ends are best fitted with eyelets or secured with a bowline knot, avoiding sharp metal edges. Each rope should be at least as long as the balloon is high, so the balloon can be deflated safely in any direction if necessary.

Ropes should be fitted to the balloon as directed in the manufacturer's manual. If the manual does not specify a method, it may be safe to fit them to two adjacent corners of the burner frame, using suitable strength karabiners. A V-bridle helps to keep the basket stable. Ropes should not be fitted to diagonally opposite corners of the burner frame, as any strain between them may distort the frame.

Solid vehicles like 4WDs or station wagons make suitable anchor points. Ropes should be tied off to a bull bar or suitable towing point, preferably at the front of the vehicle to make use of the weight of the engine. The vehicle should be left in gear with handbrake firmly on, facing towards the basket, with keys available in case it needs to be moved. The amount of slack in the ropes should be adjusted to suit the space available and the weather conditions. Remember that a rope is much more easily broken when it is slack and then jerked tight rather than under a steady firm strain.

Crew members should wear gloves and be experienced at tethering. Other people should be kept well clear of the ropes and away from where the basket may land. If there is any wind over the balloon the pilot should make allowance for false lift, in order to avoid any unexpected lift-off or hard landing. If rides are given, there should be plenty of crew to hold the basket steady as well as to assist people getting in and out. Giving tethered balloon rides is potentially hazardous and may not be covered by the balloon insurance policy.

Inflation fans

Due to the high speed of blade rotation, inflation fans can cause serious accidents. They should be carefully maintained to avoid fuel leaks or loose or broken parts, especially damaged blades that could cause catastrophic failure with broken pieces flying off. The blades should move freely and be protected with strong mesh so that fingers or loose objects cannot contact them. The cut-off switch should be easily accessible to the pilot, and crew members should know how to use it. A simple one-touch stop button fitted on top is an added safety feature.

A cowling (solid panel surrounding the airflow) is recommended as it improves the airflow and also reduces any tendency to suck objects up off the ground and propel them forward.

During hot inflation, as the lower fabric starts to leave the ground, the fan should be switched off and moved out of the way. Wait until it stops before moving it.

Fan safety

- Before each use, check there is no structural damage
- Keep loose clothing, ropes etc well clear so they do not get caught
- Put a competent crew member in charge of the fan – especially during a windy inflation (the basket might move sideways, causing the fan to tip over), or on a smooth surface where it may slip, or if necessary to keep bystanders clear
- Never lift a fan off the ground or move it suddenly while it is running. It may be acceptable to move it carefully on its wheels

- Keep bystanders well clear – if necessary by placing safety cones around the fan. Do not allow people to stand close in front of a fan while it is turned on, as even flying sand or grass can cause injury

Checklists and briefings

Pilots should memorise their checklists and briefings or refer to a written list.

<u>THE FOLLOWING MUST BE PERFORMED AS A MINIMUM.</u>

(A more comprehensive list of items to consider for checklists is given in Appendix A at the end of these notes. Your instructor may suggest a specific system or mnemonic to assist in remembering a list – eg, 'I COME PC', 'top down', or 'PPPSSSTTT') – and these are acceptable provided they include the items below.)

Before cold inflation
Fuel contents – checked (open bleed screws to be sure)
Launch rope – fully attached
Deflation line – attached to the basket
Balloon components – correctly connected (karabiners closed, cylinder straps tight)

Brief all crew – suitable clothing and gloves, do not be lifted off the ground unless inside the basket, once the balloon is upright hold basket edge and follow 'hands on' and 'hands off' instructions with both feet firmly on the ground
Brief crown line crew – how to restrain the balloon, not to wrap rope around hands or body, not to accept any help unless the pilot knows, allow the balloon up gradually as it heats, watch for pilot's signal to bring crown rope to basket
Brief mouth crew – how to hold where wires connect to envelope, may put foot on bottom wire but do not hook heel behind it, keep body behind flameproof nomex during hot inflation, be alert for pilot instructions, let go as balloon rises out of reach.
Brief fan crew – how to operate stop switch, turn off fan when instructed, do not lift fan while moving, wait till fan stops before moving it

Before take-off
Control lines – operating freely and correctly (pulleys and fixings OK), vent operation checked, any velcro tabs have released and vent has reseated correctly
Envelope – no visible envelope damage sufficient to preclude flight, temperature flag fitted
Flying wires – not twisted
Karabiners – closed
Equipment present and serviceable – fire extinguisher, handling line, spare gas lighter (minimum of 2 ignition sources on board), maps and airspace information, radio/s on and checked, instruments on and set, any other necessary items checked
Fuel system – at least two cylinders connected and operating, all burner operations checked, no gas leaks (look, listen and smell)
External – obstacles (especially downwind), weather developments (especially upwind)

Brief passengers – personal equipment to be secured before landing; landing position and handholds demonstrated and explained; basket may tip on its side and drag along; stay inside basket and hold on firmly until balloon has completely stopped; do not exit the basket until pilot says so; what to hold while flying; do not operate any controls during flight unless pilot says so; importance of not operating any deflation line during flight. Confirm passengers have understood briefing.

Brief retrieve crew – car keys and maps available; instructions about following the balloon, using radios, flight intentions, and relevant sections of the ABF Code of Conduct.

In flight
(about every 10 minutes or as required)
Fuel management – 2 fuel sources at all times, plan to land with fixed reserve
Navigation – current position, upcoming airspace and terrain considerations
Code of Conduct – livestock, houses, SZ's
Weather developments – especially upwind
Power lines (whenever flying at low level, or planning to)

Before landing
Fuel – adequate supply available
Site – clear of obstacles, especially powerlines and livestock
Passengers – say what kind of landing expected, repeat key points of the pre-flight briefing, check passengers are in appropriate landing position
Loose equipment – secured
Deflation line – appropriate line chosen and ready to hand
Pilot lights – turn off just before landing (includes intermediate landings!)
Pilot – in secure position before ground contact

After landing
Fuel – turn off and clear hoses
Passengers – allow to leave basket only when balloon no longer buoyant
Envelope – deflate promptly to avoid damage or power line contact
Landowner relations – follow Code of Conduct.

Cold descent

If a balloon is allowed to cool naturally and descend for a thousand feet or more without the addition of any heat from the burner (**cold descent**), it will soon reach a stable maximum descent rate referred to as **terminal descent** or **terminal velocity**. The descent rate reached will vary depending on a combination of atmospheric factors and the size and load of the balloon. If the flight manual specifies a maximum rate of descent, this should not be exceeded.

The balloon may rotate as it descends, and the lower panels of the envelope may become slack. The burner should not need to be used as the mouth normally remains wide open unless passing through a momentary windshear. A slight increase in envelope temperature occurs naturally during descent, as the atmospheric pressure increases and this in turn pressurises and heats the contained air. During a cold descent, air is also forced into the mouth of the balloon. (The internal pressure needed to keep the balloon inflated is only about 6psi.)

Landing

Landings can vary widely according to the weather conditions and space available. It is good practice to 'set up' your landing well ahead, by planning your approach and checking for safety (powerlines, other obstacles, ground surface) and suitability (livestock, access). On board preparations should be completed in advance so the pilot can concentrate fully on the landing knowing passengers and gear are secure, and adequate fuel is available.

When there is plenty of clear space ahead, the balloon can be brought down gradually over any final obstacles such as trees or a fence. A comfortable landing approach is to level out until a metre or so above the ground, then use the deflation line to bring the balloon to a stop in a suitable landing area with minimum downward speed (similar to landing an aeroplane). By reducing the descent rate gradually as you approach, it is usually possible to land very gently with virtually zero descent rate. As a rough guide, if the depth of air beneath the balloon is at least half the descent rate, you should be able to level out comfortably before reaching the ground (eg if at 250ft AGL your descent rate is 500fpm).

It is possible to land with a descent rate of up to 400fpm if necessary, for example in a tight space, but even this will be a hard jolt and anything more than this should be avoided in case of injury (see Hard Landings below). After landing with downward speed, the balloon is likely to bounce back up into the air unless deflated enough to keep it grounded (a smart vent certainly helps here). Timing the deflation is important and comes with practice. **The aim is to land with a comfortable downward speed that will allow a safe landing in the space available, and for the basket to stay grounded with minimum bounce or drag.**

A slight breeze in your face as you descend to land is a reliable indicator of slower wind conditions near the ground. To check this in advance you can spit over the basket edge and watch the spit as it descends (this may sound unattractive but it works well). If wind at ground level is calm or light, it may be possible to keep the balloon and basket upright for an **intermediate landing**, perhaps change passengers or fuel cylinders, and then take off again. Keeping the balloon inflated after landing may also help your retrieve crew to locate you, and give you the option to fly on in case there is a locked gate. A parachute vent is typically used for this type of landing. A smart vent may be used instead, provided it is not opened too much or for too long, and is reseated promptly as soon as the basket is well grounded.

If it is necessary to bring the balloon to a stop in a short distance, the most effective vent line available should be used, and held open until the envelope has fully deflated. If fabric is likely to come into contact with the burner, delay full inflation until a crew person (or a passenger if safe) can pull the crown line away from the basket to avoid this.

If the wind speed is moderate at landing, the deflating envelope may pull the basket onto its side and drag it along until friction with the ground stops further movement (see Fast Landings below).

Passengers can assist the pilot before landing by looking for power poles, to ensure that all powerlines have been sighted. Once passengers are down in their landing positions, a 'running commentary' by the pilot can reassure them and help to ensure a safe landing, eg 'We're just coming over the fence. I'll tell you before we touch. OK hold on tight now. (Bump) We're going to bump again – hold on now. (Another bump) We'll just drag to a stop now. Keep holding on, and remember don't get out until I say it's OK.'

Fast landing (high horizontal speed)

It is possible with practice to land quite safely in faster wind than you can launch in. A quick and reliable deflation system makes the landing safer and more comfortable.

In fast surface wind:

- do all checks and controls well ahead
- brief passengers to hold tightly, expect the basket to lie down and drag, and stay fully within the basket
- keep a very sharp eye out for powerlines
- watch out for accelerating upslope winds on rising ground
- look for a landing area with less wind such as a hollow or the lee side of trees
- remember a light breeze in your face at low level indicates slower wind near the ground – stay airborne at low level until the balloon loses speed
- if wind is unavoidable, pick the longest smoothest landing field you can see and make a shallow approach to the near end of the landing area
- pull the deflation line fully, secure yourself in the basket and brace for contact
- to land promptly beyond trees, you can brush the basket firmly through the top of the last tree to slow it down, then open the vent positively as the basket swings clear. It is good to practise this in comfortable conditions.

In a fast landing any balloon, including one with a smart vent that is fully deployed, can **'spinnaker'**. This is a condition where the upward half of the envelope subsides into the lower half as the envelope deflates, leaving a 'spinnaker' or 'spoon shape' which continues to catch the wind and drag the balloon considerably further than normal.

A downhill slope or a slippery ground surface can also cause a longer drag. During any drag landing it is important for the pilot to remain secure, and to check that passengers also keep holding on until there is no chance of further movement.

Hard landing (high descent rate)

Hard landings should be avoided whenever possible, especially in combination with fast surface wind. A descent rate of 400fpm on landing can be very uncomfortable, and anything more than this could cause personal injury and damage the equipment. If a hard landing is unavoidable (eg in an emergency, in mild turbulence, or when aiming for a tight landing spot):

- brief passengers to bend knees and hold on tightly until landing is complete
- expect the balloon to bounce back into the air if you have been heating it just before landing
- to minimise any bounce, open the deflation vent positively *just before impact*, and hold it open after landing to allow the hot air to escape
- once the basket is grounded, close the vent promptly again if you want the balloon to remain inflated
- in an emergency descent, if you cannot use the burner, as a last resort throw **ballast** (eg spare equipment or fuel cylinders) overboard to reduce the descent rate
- put on crash helmets if available, to avoid head injuries especially if burner support poles are not fitted.

Quick deflation systems

The Smart Vent and similar recent improvements allow very quick and reliable deflation. Any unfamiliar system should be operated with great care until the pilot is used to it. The pilot should familiarise with the vent and deflation procedures before take-off, to be sure of the different controls and when and how to use them.
The parachute line (white or candy striped) of a Smart Vent system may be used anytime just like a normal parachute vent. The red (smart vent) line should only be used for landing, and not more than a few metres above the ground, as advised by the manufacturer. The red line generally requires a lighter pull than expected, and air is lost very quickly through the large opening as the fabric gathers to the centre. With practice a Smart Vent can produce a very positive landing with less bounce and less drag than a parachute vent.

Emergencies

It is not easy or natural to think clearly in a crisis. Your ability to respond quickly and appropriately – and therefore have the best chance of a safe outcome – will be dramatically improved if you think through the most likely emergencies and practise responses to them.

You should follow any emergency procedures listed in your balloon flight manual. The following notes are useful additional information.

Protect people before balloons
In any emergency, minimise injury to people first, then minimise any damage to equipment. Injury to livestock should also be strenuously avoided.

Protective clothing
Protective clothing can dramatically reduce potential injuries. Even a thin cotton shirt can provide surprisingly effective protection from the flash burns caused by propane igniting. On the other hand, synthetic fibre clothing can melt or burn and cause far worse damage.

The minimum recommended protection is:
- natural fibre clothing with long sleeves and minimum exposed skin, and sturdy enclosed shoes – pilot, passengers and crew
- sturdy gloves – pilot and crew
- crash helmets available to pilot and passengers if the basket does not have upright poles to support the burner.

Unsuitable landing areas
If it is not possible to find a suitable landing area, a balloon can often be landed with minimal damage provided the pilot keeps a clear head. Remember that it is the people (and therefore the basket) that need to land safely. If you are **becalmed or low on fuel**, it may be possible to land the basket in a tight space and **walk the balloon out** to a more suitable deflation area by having people push the slightly airborne basket. If the basket needs to stay higher off the ground, the **handling line** may be dropped so that ground crew can pull the balloon to a more suitable area. Avoid using a handling line if becalmed over power lines – it is preferable to be patient or climb to find a slight wind to clear the lines.
Flying over water it is not easy to judge how close you are to the surface. An intended 'splash and dash' (basket just touching the water) can turn into an unplanned final landing. If the basket takes on water, it can become too heavy to lift off without overheating the envelope. If deflation in water cannot be avoided, fuel cylinders will float even when full, and can be used to keep people afloat. The envelope however may be a total loss. A prompt radio call is advisable before the radio gets wet!
Landing in trees may be done fairly safely by gently wedging the basket among firm supporting branches, then deflating the envelope and climbing down the tree or down the handling line.

Fast landing or hard landing emergency
See Fast Landing and Hard Landing sections above.

Power line emergency
Contact with power lines should be very carefully avoided. Any voltage can cause fatal or very serious injuries. To avoid power lines you first need to see them. The wires can be invisible from the air, in particular **SWER lines** – the single wires found in some rural areas with long spans that do not follow roads or fence lines. Whenever descending to power line height or below it is essential to locate and avoid any lines using the following procedures:

- **ASSUME THERE ARE POWERLINES**, and that your job is to find *all* of them.
- **LOOK WIDE – FROM SIDE TO SIDE**. Turn your head so that you really check effectively. Your central vision is sharper than your peripheral vision. Ask others on board to help look. Ask your ground crew to warn you if they see power lines.

- **LOOK FOR POLES, THEN WIRES**. Check especially around any building, pump or other structure which may use power. Then look carefully at the top of the poles to see where the wires go. The arrangement of insulators at the top of a pole may help indicate this. Once you see a wire at the pole, your eyes should be able to follow it across open country where it is otherwise very hard to spot.
- **ALLOW SAFE CLEARANCE**. Check you have adequate fuel and cross the line at a safe height. As a guide, **wires should be cleared by at least the height of the poles** they are carried on. Safe clearance will depend on factors such as wind speed, the stability of the air and how the balloon is responding to the controls. The balloon should be **level or climbing slightly** as you approach.
- **IF IN DOUBT, RIP OUT.** If there is any doubt about your ability to clear the wires, make an emergency landing without hesitation. Pull the ripline as you warn passengers to hold on for landing, and turn off pilot lights and vent fuel hoses if there is time. There is considerably less risk of injury, fire and electrocution if the envelope contacts the wires than if the basket does.

For information on the dangers of power line contact, and what to do if it happens, read the booklet *Watch Out for Power Lines* which is available from the ABF.

If a balloon remains in contact with powerlines, the local electricity authority must be contacted to confirm that power is switched off before any attempt is made to rescue people or touch the balloon. Any other action could result in death.

Low level obstacles
As for power lines, make a decision to climb over the obstacle or descend and land before it, and stick to that decision. If climbing, consider using all burners for maximum power. If descending, vent air positively, and follow the emergency procedure for a hard landing.

Pilot light out
Though it is a rare occurrence these days, especially with more efficient and multiple pilot lights, and piezo lighters on most burners, it is important to practise these procedures. Pilot light problems can still happen due to dirty fuel or sudden windshear.

If one of a pair of pilot lights goes out, both burners can be operated from the remaining pilot light either by turning on a crossflow valve (if fitted), or by turning on one burner and then immediately turning on the other which will light from it. If there is gas flow at the pilot light, it will be relit by this procedure.

If there is only one pilot light and it goes out:
- quickly look for a cause (eg, tap turned off or hose disconnected) and rectify this if possible
- relight the pilot light using your spare lighter if necessary
- if the pilot light cannot be re-lit, continue as below.

Emergency pilot light
Open a main burner valve VERY slightly and light the gas as it escapes. The balloon can then be flown by opening the quiet burner or other main burner valve and igniting it from this emergency pilot light. Alternatively open the same valve fully when burning and then close it again just enough to leave a small pilot flame at the end of each burn.

If the burner has spring-closing blast valves, use a different procedure in order to avoid the blast valve freezing and leaking gas. Close the supply valve on the cylinder, burn out the line and leave the blast valve open. Then open the cylinder valve slightly, light the escaping gas at the burner, and control the burner from the cylinder valve. This is equally effective but the control is slightly delayed due to the time taken for propane to travel up the hose.

In either case, make a safe landing as soon as possible. These techniques are short term only as continuous partial opening of a liquid fuel valve will cause the valve to freeze up quite quickly.

Propane leak
- immediately shut off sources of ignition (burners and pilot lights)
- turn off fuel sources (cylinder valves)
- have a fire extinguisher ready to use in case of fire
- identify the cause, and stop the leak if possible
- relight pilot lights and regain control of the balloon
- if repairs are required, land as soon as possible.

Propane fire on the ground
- cut off fuel source if possible by closing the cylinder valve. Switch off fan if running
- use extinguishers to fight fire
- if unable to control fire, clear all personnel from a wide area, call the fire service and take shelter behind solid objects (building, retrieve vehicle) in case cylinders explode
- a burning leak from a cylinder may be allowed to burn safely if there is no risk of other things catching fire
- if a cylinder is in danger of overheating and exploding, evacuate the area and leave it to the fire brigade.

Propane fire in the air
A serious fire in the air could be life-threatening. Follow procedures for a fire on the ground, and land as soon as possible. A 1kg dry powder fire extinguisher (the minimum required in a balloon) will last several seconds at best, so it is unlikely to put out any propane fire unless the propane leak has been stopped first. An asbestos fire blanket or even some spare clothing may give brief protection from flames while stopping the leak. If a fire in the air can not be put out, other options include:
- throw burning objects overboard
- if this is not possible, keep people and equipment away from flames
- bring the balloon as close to the ground as possible
- as a last resort, jump overboard (preferably all occupants at once) if serious injury is unavoidable by any other means.

Minor fire in the air

The most likely place for a fire in the air is at a leaking burner valve stem. For a minor fire anywhere in the gas system:

- close the cylinder valve and open the burner valve to release the gas in the line.
- use a fire extinguisher, fire blanket or even a gloved hand to extinguish any residual flame
- continue flying on another cylinder and make a safe landing as soon as possible.

YOUR FEEDBACK PLEASE!

If you have any corrections or suggested improvements to these study notes please advise the ABF Operations Manager.

APPENDIX A - CHECKLIST ITEMS TO CONSIDER

A previous section 'Checklists and Briefings' in these notes lists the essential items which must not be omitted at critical stages of preparation and flight. This Appendix contains many additional items you may want to consider including on a checklist to suit a particular balloon and/or operation.

NOTE: Where the flight manual for a particular balloon contains a checklist, that checklist shall have precedence over the general considerations contained in this section.

1 BEFORE INFLATION

1.1 Weather

WEATHER FORECAST If mandatory or at pilot's discretion obtain a meteorology briefing for intended flight area before travelling to launch area.
CHANGES ON SITE Once on site assess local conditions in relation to forecast conditions and from local knowledge.
WIND DIRECTION/STABILITY/STRENGTH Send up a helium balloon watching for indications of wind speed and direction, changes in speed and direction with increase in height. Watch for sudden changes of trajectory to indicate instability or wind shear.

1.2 Site orientation

SITE From previous observations orient basket and envelope bag on site.
DOWNWIND AND SHELTER Consider downwind obstacles, use of available shelter, sources of upwind turbulence. Balance all factors against wind strength and direction.

1.3 Fuel

BURNER VALVES OFF AND LEAK CHECK Ensure burner valves are OFF before turning main cylinder valves on. Look, listen and smell for leaks.
QUANTITY Make a positive check of quantity, using the bleed valve if cylinders are expected to be full, feeling the weight if partly filled.
SECURITY OF CYLINDERS AND HOSES Retaining straps correctly positioned and tight around fuel cylinders, hose connections tight.

1.4 Burners

PILOT LIGHTS Warning - ensure area in front of the burner is clear of people before the pilot light is ignited and that the area remains clear at all times while the pilot light is alight. Ignite pilot light/s
BURN CHECK AND PRESSURE CHECK On all burners and at least 2 cylinders, check each in turn for normal/correct flame, amount of pressure. Turn off all valves, - leaving burner valves off. This burner check may be done after inflation in very light conditions, but in windy conditions the more that can be checked before unpacking the envelope the better.

1.5 Instruments

CHECK TEMPERATURE GAUGE AND VARIOMETER Check vario and temperature gauge for indication of operation with power turned on; zero the instruments if required.
SET QNH AND CHECK ALTIMETER Particularly important if operating in or beneath controlled airspace. Set QNH on altimeter sub-scale; altimeter should then show launch field elevation. Or, if field elevation is known, setting that elevation on the altimeter should give the correct QNH setting in the sub-scale window.

1.6 Equipment

SPARE LIGHTERS	MAPS	HELMETS
FIRE	COMPASS	GLOVES
EXTINGUISHER	TOOLS	FIRST AID KIT
HANDLING LINE	RADIO/S	LAUNCH ROPE

Ensure all equipment required is correctly stowed or ready to place in basket before flight.

1.7 Plan

AIRSPACE Check ERC and VTC for airspace limits in direction of flight - especially important if flying in a new area.
DOWNWIND COUNTRY AND OBSTACLES Check topographical maps for indications of the nature of downwind country for type of flight, i.e. intermediate landings, ease of retrieve vehicle while following, powerlines shown on map.
LOAD AND TEMPERATURE Check proposed load against the appropriate load chart or envelope temperature when buoyant.

1.8 Crew

ADVISE INTENTIONS AND PROBABLE TRACK Advise crew of type of flight planned, discuss expected track
ORGANISE RETRIEVE PHONE NUMBER AND LOST CONTACT PROCEDURE and any special procedures, eg if few roads or river ferry crossing, radio schedule details.
ENSURE RETRIEVE CREW ARE FAMILIAR WITH VEHICLE – jack, spare wheel, phone and petrol money location.
CODE OF CONDUCT Emphasise to retrieve crew requirements of Code of Conduct, especially landowner contact, minimum people and only retrieve vehicle in landing site.
EMERGENCY ACTION Ensure crew are familiar with power line "strike" procedure. Advise location of any additional written information in vehicle.
CLOTHING All crew should have gloves, wear clothing covering arms and legs and wear full shoes or boots. Care should be taken with the selection of material for ballooning clothing. The use of wool or cotton is recommended: use of synthetic material is not desirable.
AVOID BURNER If crew are moving about the balloon ensure they stay clear of the area in front of the burner and between the flying wires, passing behind the basket when moving from one side to the other during inflation.

ALLOCATE SPECIFIC DUTIES AND BRIEF AS FOLLOWS:
CROWN CREW
Wear gloves
Do not wrap rope around hands or body

Refuse extra help unless you need it
Hold near end of crown line
Resist lift of balloon once hot inflation starts
Do not allow yourself to be lifted from ground - let go first
Keep downwind of basket by moving if wind changes
Bring line to basket when inflation complete
MOUTH CREW
Wear gloves
Keep wires tight and as high as possible while holding mouth of envelope open
Place foot on lower wires, ensure body is outside all wires and feet not on vent line.
Keep scoop tucked under envelope or connect as required by pilot
Watch pilot for indication that hot inflation is to commence
Feed wires up as balloon inflates
FAN CREW
If available, have separate person responsible to control at pilot's directions
Shift clear when turned off
ALL CREW
When allocated job is completed, move to basket and hold in accordance with pilot's directions.

2. INFLATION

2.1 Laying out

BASKET Fit burner, tanks and other equipment in basket, connect fuel system. Lay out basket in previously decided direction
ENVELOPE Open envelope bag and attach envelope to basket
BAG IN BASKET Place envelope bag in basket
VENT/DEFLATION LINE Locate and attach vent line before starting cold inflation.
FAN Position fan, ensure area is clear of material which may be drawn into blades, ensure a crew member is responsible for operation; pilot can reach controls if required.
ATTACH LAUNCH ROPE Position vehicle and trailer to provide suitable attachment for launch rope having regard to the conditions.
KEYS IN CAR If pilot was driving, check keys are in car.
CREW READY Final check that crew are in position, and crowd control is adequate if required.

2.2 Cold Inflation

FAN Start fan, fit vent system as some air is introduced into envelope.
FIT DEFLATION SYSTEM
FABRIC, VENT OR DEFLATION LINES, RIGGING, KARABINERS As inflation proceeds check exposed fabric, check vent line and associated rigging for condition and freedom, suspension rigging and attachments for twists, tangles and security.
INFLATION CYLINDER Select suitable inflation cylinder
BURNER VALVES OFF, VAPOUR FEED ON, LIGHT PILOTS

2.3 Hot Inflation

VENT LINE READY Ensure that vent line is clear and ready for use.
WARN CREW "BURNING" When pilot is satisfied envelope is developed fully by fan, shout "BURNING" particularly to warn mouth crew and public.

FAN Fan fuel and ignition turned off at pilot's direction and fan moved clear.
SCOOP/SKIRT Stand basket up, fit scoop or skirt as required.

3 BEFORE TAKE-OFF

VALVE Operate valve line to release any Velcro tabs and stabilise the balloon.
CONTROL LINES Check all lines are free and ready to use, loose lines stowed.
ENVELOPE Check envelope for condition.
KARABINERS Check karabiners and rigging for security, twists or tangles.
PILOT LIGHT Check pilot light for strength, sound, locknut on, regulators secure, no icing.
BURNER Confirm burner pressure checked on two cylinders. Inspect for evidence of leakage, icing or twisted hoses.
FUEL Ensure fuel cylinders checked for security, contents, confirm cylinders in use.
EQUIPMENT Check equipment required is in basket and stowed; maps, compass, spare lighters, fire extinguisher, handling line, envelope bag, instruments set and functional, water bottle.
PASSENGERS Get passengers on board, settled and briefed (see 6.1 below).
LOADING Recheck ambient temperature and effect of any rise on previously calculated load, or monitor temperature of envelope as buoyancy is obtained
LAUNCH ROPE & RELEASE SYSTEM Check ready to release
OBSTACLES Check any downwind obstacles. Crew check for any balloons overhead or about to launch upwind.
WEATHER Final check for any changes in wind and weather indicators.
CLEARANCE Get clearance to take off in controlled airspace.
THANK CREW Thank crew on lift-off.

4. IN FLIGHT

FUEL MANAGEMENT See Flight Duration and Fuel Management earlier in these notes.
NAVIGATION As flight progresses stay aware of airspace boundaries (vertical and horizontal), access roads for retrieve, type of country ahead (scrub, crops, steep hills, built-up areas), river crossings, freeway crossings and access to opposite side, licensed aerodromes and private landing strips. Plot position and track on map to assist in unfamiliar area.
CODE OF CONDUCT Avoid disturbing livestock and homes. Stay clear of known Sensitive Zones.
WEATHER DEVELOPMENTS Watch for indications of change (including upwind) – eg cloud build-up indicating convection, cloud shadow movement showing increase in speed or change in direction of wind, fog developing below, surface indicators, (wind lanes on water, mist on dams, smoke, movement of trees, dust movement) perhaps showing mixing of upper and lower level winds on dissipation of inversion layer.
POWER LINES Before descending and while flying at low level, check for poles ahead and to left and right of balloon path. Watch for insulators, the shape often indicates direction of wire and so may indicate a branch line, i.e. line to a bore. Single strand lines can have enormous spans. If poles are on high ground line could be 200 ft. above ground in valley. If contour flying be alert when approaching a crest,

there may be a line just beyond it. When landing in light conditions give lines reasonable clearance in case ground wind has a significant directional change.

5 LANDING

5.1 Before landing

GEAR Ensure loose gear is stowed, including cameras and other personal items.
PASSENGERS Brief passengers again as appropriate to the expected landing (see 6.2 and 6.3 below).
ORIENTATION Check which cylinder should be used for landing and maintain orientation to cylinders in use for pilot light/s and burner.
POWER LINES/POLES Carry out final check for power lines.
CHECK FIELD Final check for obstacles, crops, stock, slope.
PILOT LIGHTS Close down pilot light/s
FUEL OFF AND CLEAR HOSES IF APPROPRIATE

5.2 After landing

FUEL OFF AND CLEAR HOSES
INSTRUMENTS TURNED OFF
COLLECT ALL GEAR
RETRIEVE Contact the landowner. Crew to retrieve the balloon according to the ABF Code of Conduct.

6. PASSENGER BRIEFINGS

6.1 Prior to take-off

Consider potential landing conditions and choose passengers accordingly, eg with regard to age, agility, medical problems.

- NO SMOKING IN OR NEAR BALLOON
- EMPHASISE WEIGHT IS IMPORTANT IN A BALLOON. PASSENGERS MUST NOT LEAVE OR ENTER BASKET WITHOUT CLEAR DIRECTION FROM PILOT.
- SHOW WHAT MAY BE HELD DURING FLIGHT – ROPE HANDLES OR POLES, EDGE OF BASKET. AND WHAT MAY NOT BE TOUCHED UNLESS DIRECTED BY THE PILOT – GAS CONTROLS AND FUEL HOSES, CONTROL LINES (ESPECIALLY FINAL DEFLATION LINE, EXPLAIN FUNCTION), INSTRUMENTS
- DEMONSTRATE APPROPRIATE POSITIONING REQUIRED (see 6.3 below) DURING LANDING OR WHEN REQUESTED BY PILOT, INCLUDING WHAT TO HOLD AND NOT HOLD WHEN IN THAT POSITION
- ADVISE ON STOWAGE OF GLASSES AND CAMERAS, AND TO AVOID EARRINGS OR LONG HAIR BEING CAUGHT

6.2 Prior to Landing

- RE-EMPHASISE NEED FOR PASSENGERS TO STAY IN BASKET
- ENSURE PASSENGERS HAVE LOCATED HAND GRIPS AND HAVE A FIRM GRIP.

6.3 Landing Positioning

ALL LANDINGS Passengers, particularly first time ones, tend to relax their grip after the first touch down. If the landing is such that some bouncing occurs, talk the passengers through the landing emphasising the need to "*keep holding on*" until all movement has stopped.
NORMAL LANDINGS Hold on. Stand with knees together and slightly flexed, brace to anticipate sudden body movement forward as basket touches the ground in all landings.
DRAG LANDING Hold on, resist temptation to put hands out as basket lays over. Stand with knees together and slightly flexed, brace to anticipate sudden body movement forward as basket touches the ground in all landings. Adopt a slightly lower position in basket.
HARD LANDING As for normal landing but warn of hard contact and vital importance to "*keep holding on*". Stand with knees together and slightly flexed, brace to anticipate sudden body movement forward as basket touches the ground in all landings.

ARE YOU UP TO DATE?
New regulations and procedures may apply from time to time.
Check on the ABF website that you have the latest version of these study notes.

YOUR FEEDBACK PLEASE!
If you have any corrections or suggested improvements to these study notes please advise the ABF Operations Manager.