THUNDER & COLT AS - GD
FLIGHT MANUAL
ISSUE 5

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THUNDER & COLT AS-GD

FLIGHT MANUAL

DATE: 16.01.02

This Flight Manual is issued for the following airship:

Type: .....

Registration: .....

Construction No: .....

Section 1 : Technical Description

Section 2: Operational Limitations

Section 3: Emergency Instructions

Section 4: Flight Instructions

All Sections are approved by the Civil Aviation Authority

The Airship shall be operated in accordance with the limitations in Section 2.

Amendment	Effective Pages	CAA. Approval

Section 1 - Technical Description

Section 2 - Operational Limitations & Charts

Section 3 - Emergency Instructions

Section 4 - Flight Instructions

1.1 ENVELOPE

The airship envelope is manufactured using established hot air balloon practice, albeit with a higher strength fabric. The gores run from front to rear with a network of load tape to act as rip stoppers. The empennage is of cruciform configuration. The horizontal fins and the vertical fins (the latter of which incorporate the rudder) are inflated through a scoop positioned immediately aft of the propeller. The rudder is operated by two cords that run through eyelets in the envelope skin to the gondola. Two catenary curtains transmit most of the flight loads into the envelope skin. These are connected to the gondola by four karabiners, one in each corner of the gondola. Deflation is achieved by means of a deflation panel system near the tail.

1.2 GONDOLA

1.2.1 Gondola Frame

The frame is a tubular space frame manufactured from stainless steel tubing. It has two seats equipped with full safety harnesses set in a tandem configuration. The undercarriage is of tricycle type with a double nose wheel assembly.
The front end of the frame is covered with a Polycarbonate windshield. The lower sides of the front and rear part of the passenger compartment are sheeted in non-structural aluminium panels. The weight, torque and thrust loads from the gondola are transmitted into the envelope via the four hookup points. Two propane tanks are suspended, one on each side, underneath the rear seat. There is an option to remove the rear seat to make it possible to carry one extra 30 kg tank.

1.2.2 Propulsion and Pressurisation

Forward propulsion is provided by a ROTAX 462 or ROTAX 582 twin cylinder, two stroke, water cooled engine which maybe fitted with the following propeller/gearbox combinations.

Engine Type	Gearbox	Propeller	Pitch	Measured At
Rotax 462	'A'-Type 1:2.58	Farr 62" x 40"	N/A	N/A
Rotax 462	'A'-Type 1:2.58	Junkers 160/R/3*	11°	60 mm from blade tip
Rotax 462	'A'-Type 1:2.58	Helix 1,60m/RS*	11°	50 mm from blade tip
Rotax 582	'E'-Type 1:2.62	Junkers 160/R/4*	12°	60 mm from blade tip
Rotax 582	'E'-Type 1:2.62	Helix 1,60m/RS*	12°	50 mm from blade tip
Rotax 582	'E'-Type 1:3.47	Helix 1,60m/RS*	16°	50 mm from blade tip

* Fixed Pitch Ground Adjustable

1.2.2 Propulsion and Pressurisation (cont'd).

A tubular propeller guard tube protects the right and left sides of the propeller arc from accidental contact with foreign objects.
The engine is fitted with a 12V alternator system either driven by a V-belt from the propeller pulley (Rotax 462) or dual integral alternators (Rotax 582). This produces the electricity needed to run the electric fan situated underneath the burner. This fan, together with a fabric scoop behind the propeller supplies the necessary airflow needed to pressurise the envelope.

The fabric scoop has two functions :-

i) It deflects air into the main envelope for pressurisation.
ii) It deflects air into the tail planes to ensure good pressurisation and stability of the fins.

The envelope is fitted with two pressure relief valves set to release excess pressure from the envelope and prevent over-pressurisation of the envelope.

1.2.3 Burner

The propane burner is a double Shadow unit. The burners are fitted with one electric blast valve each, making it possible for the pilot to use the two burners separately or together. The burner will fold down into the gondola to reduce the overall height when in transit.
Two types of pilot light system are available. The standard system is a liquid pilot light which is identical to that used in the Magnum burner. These are fed via a non-return valve from the main burner liquid feed. This system is shown in Figure 1.
An alternative system is the vapour pilot light system. This uses vapour pilot lights as used on the C3 burner. These pilot lights are supplied by a separate vapour feed either from the main propane cylinders, or from a separate mini-cylinder located behind the rear seat. This system is shown in Figure 2.

1.2.4 Propane Cylinders

The propane gas for the main burners is contained in purpose made stainless steel horizontal pressure vessels of 30 or 40 kg capacity.
The normal configuration is to have one tank suspended on each side of the gondola underneath the rear seat. If operated solo, there is an option to carry two 40 kg tanks on the sides and one 30 kg instead of the rear seat. Each tank is equipped with carrying handles, float level gauges, liquid take off valves, vapour take off / bleed valves and a pressure relief valve set to discharge at 26 BAR (375 psi).

Note : If the extra tank is fitted for solo operation it should be used first.

Figure 1

Propane System - Liquid Pilot Lights

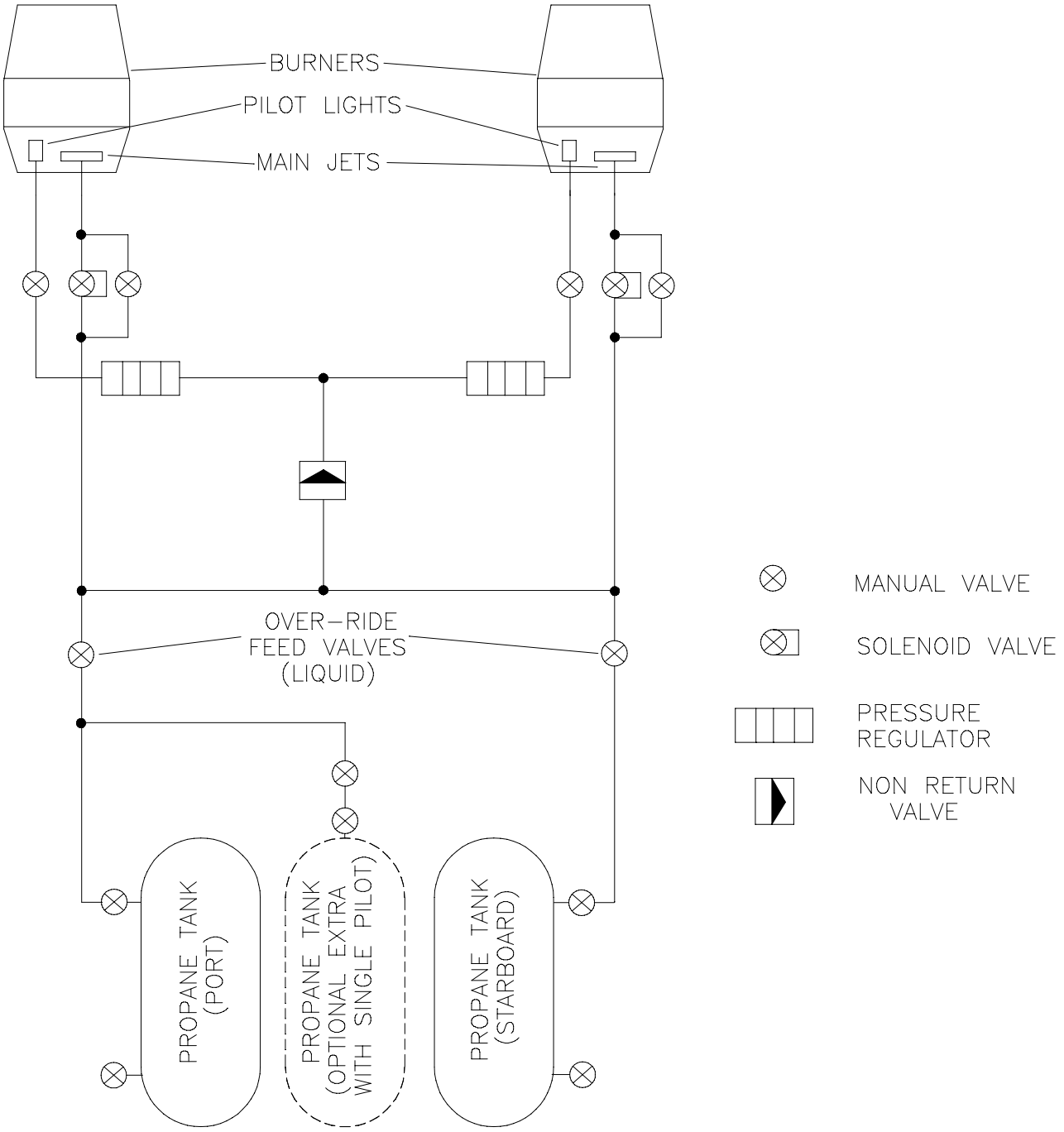
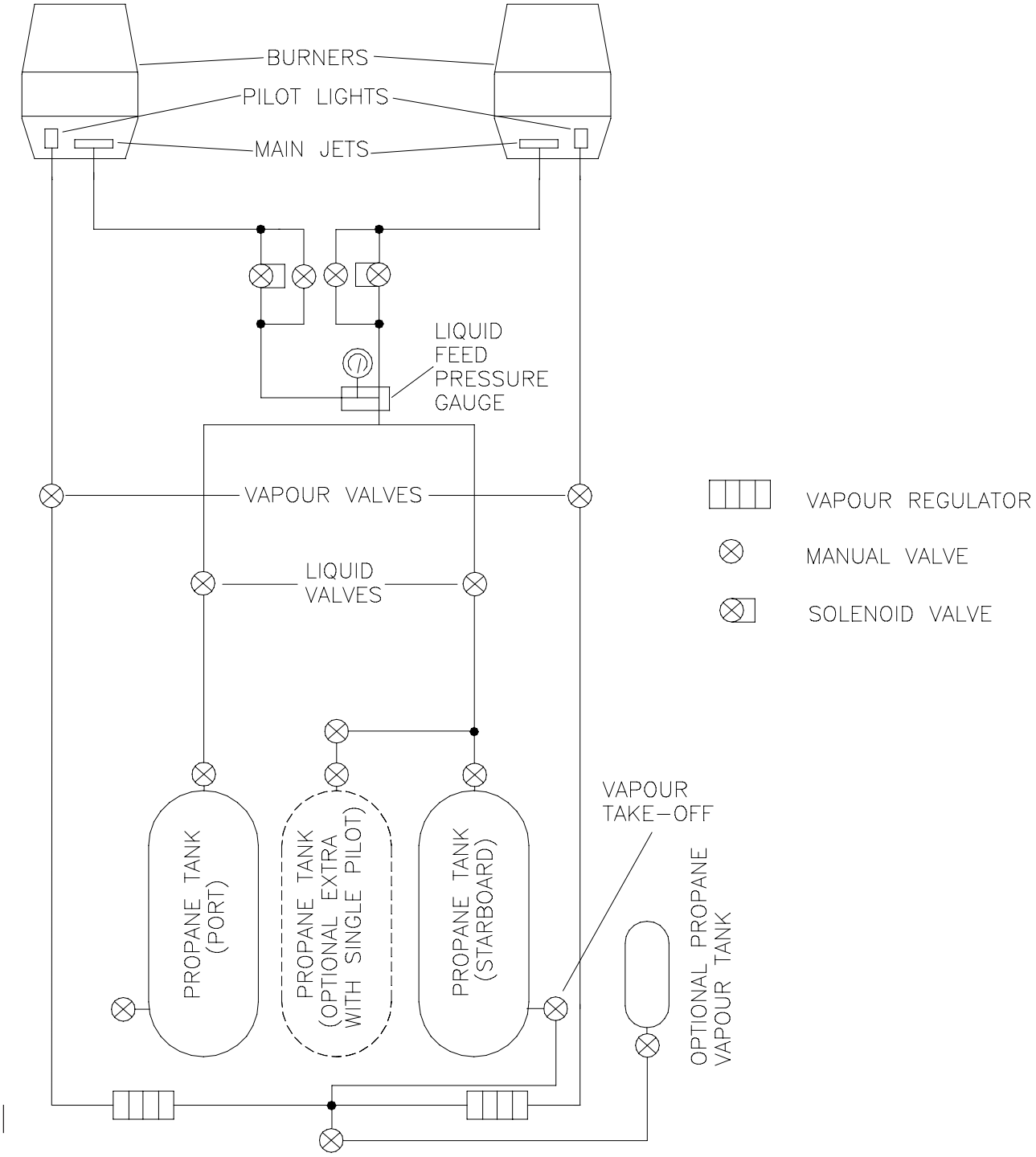


Figure 2

Propane System - Vapour Pilot Lights



1.2.5 Propane System

Liquid Phase

The propane system includes the propane tanks, manual valves, electric blast valves, pilot light regulators / vaporisers, burner and connecting hoses.
The port and starboard tanks feed the burner assembly through dual feed hoses, each with its own tank over-ride feed valve. The optional third tank, for single pilot operation, feeds into the starboard tank feed hose.
At the burner assembly the feed hoses are joined. From here one feed goes through an electric blast valve to each of the fore or aft burner.

Vapour phase

If vapour pilot lights are fitted the pilot lights are fed by a vapour take off from the propane tanks or a separate mini-tank situated behind the rear seat. The pilot controls the flow of propane via two ball valves situated along the upper edges of the gondola frame.

1.2.6 Petrol System

The petrol tank is equipped with a non-venting filler cap, a remote reading electrical level gauge, a shut off valve, a drain tap and an air vent. From the tank the fuel runs through the valve and a hose to the fuel pump. The pump is a membrane type pump driven by the pressure pulses generated in the crankcase. The fuel is pre-heated prior to entering the carburettor. The shut-off valve can be closed from the pilot seat by pulling a lever behind the front seat on the right hand side.

1.2.7 Electrical System and Instrumentation

The airship is equipped with a 12 Volt electrical system which powers the electric burner / pressurisation fan, engine monitoring/flight instruments and avionics. Power in flight is provided by an alternator. A battery provides power for starting and emergency power in the event of an alternator failure. The instruments are housed in a box mounted on A-V. mountings in the roof of the gondola in front of the pilot.

The instruments are:

Engine monitoring:	Rev Counter Petrol gauge Alternator warning light	Water temperature gauge Voltmeter
Envelope monitoring:	Envelope pressure	Envelope temperature
Flight instruments:	Altimeter	Rate of climb
Avionics:	720 Channel transceiver Transponder	 (both optional)

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2.1 OPERATIONAL LIMITATIONS

Type	AS80MKII / AS80GD	AS105MKII / AS105GD / AS120MKII
Max all up weight	640 / 680 kg	850 / 850 / 850 kg
Maximum envelope temp.	120°C	120°C
Maximum climb rate	2.5 m/s (500 ft/min)	2.5 m/s (500 ft/min)
Maximum descent rate	2.5 m/s (500 ft/min)	2.5 m/s (500ft/min.)
Maximum wind speed at surface	10 knots	10 knots.
Maximum envelope pressure	15 mm WG	15 mm WG
Minimum envelope pressure	5 mm WG	5 mm WG
Minimum crew	One (pilot)	One (pilot)
Propane pressure limits	5-12 bar (70-170 psi)	5-12 bar (70-170 psi)
Maximum engine RPM	6500 r.p.m.	6500 r.p.m.
Maximum engine coolant temp.	80°C	80°C

FLIGHT IN GUSTY CONDITIONS NOT PERMITTED

2.2 EQUIPMENT WEIGHTS

Type / Construction number	.....
Registration	.....
Gondola (dry)	.....kg
Propane tank (H40) (empty)	19 kg
Propane tank (H30) (empty)	16 kg
Propane tank (vapour) (empty) (contents 3.4 kg)	3.6 kg
Petrol (28 litres)	20 kg
Envelope weight	.....kg

2.3 LIFT CHARTS

How to use the charts

The lift charts are drawn assuming ISA conditions:

Atmospheric pressure: 1013.2 mb (at sea level)
Atmospheric temperature: 15°C

To find total available lift you do the following:

a) Turn to appropriate chart.
b) Find the ambient temperature on the horizontal axis.
c) Plot a line vertically upwards to intersect with the line representing the take off altitude.
d) Read horizontally across to the vertical scale to find the available lift.

NOTE: The following charts will give the available lift at 100°C envelope temperature.

A more general formula for the lift of the airship is:

$$L = \text{VOLUME} \times \text{AIR DENSITY} \times \frac{(T1 - T0)}{(T1 + 273)}$$

T1 = Envelope Air Temperature (°C)
T0 = Ambient Air Temperature (°C)

VOLUMES

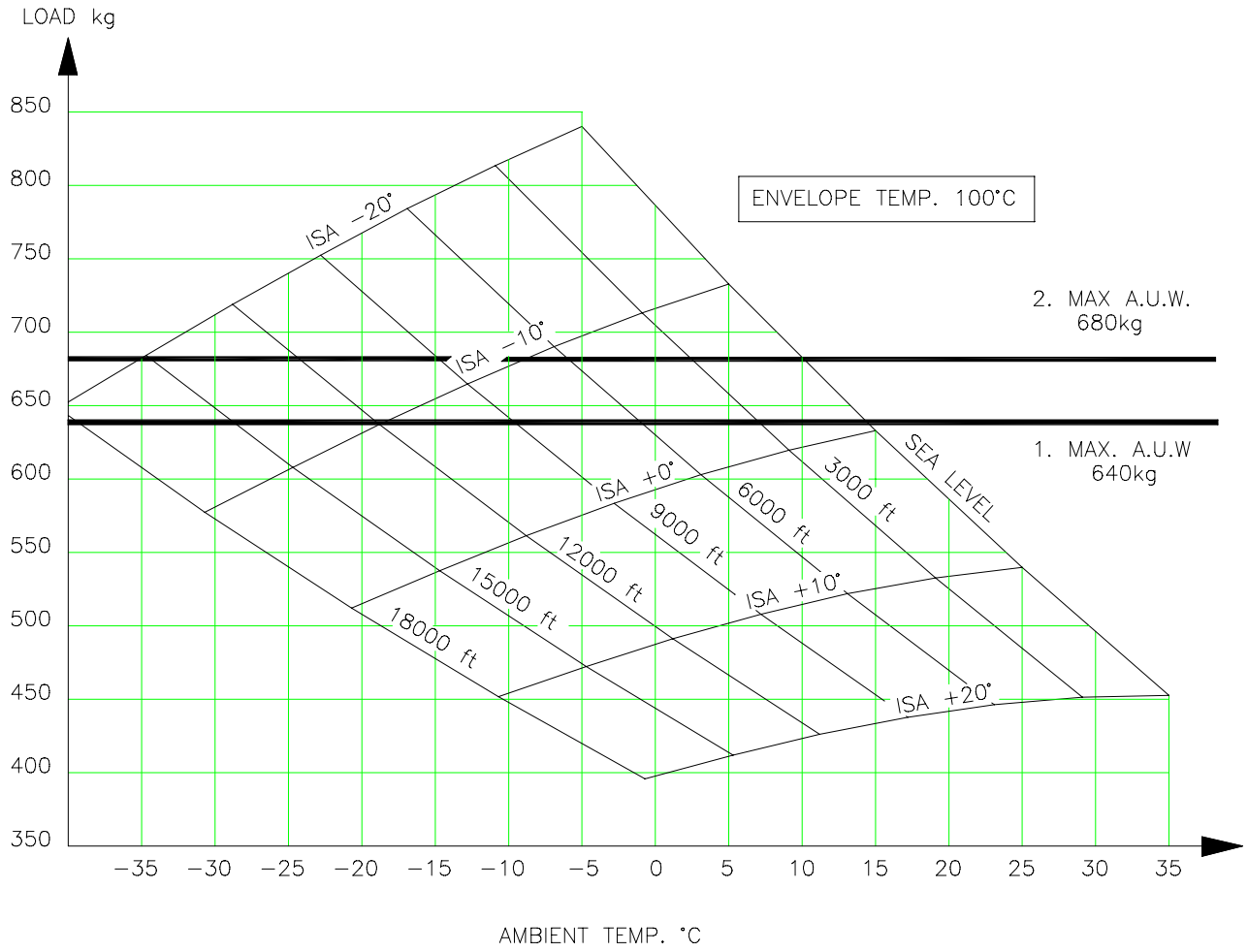
AS80MKII	AS80GD	AS105MKII	AS105GD	AS120MKII
2,123 m^3	2,265 m^3	2,927 m^3	3,000 m^3	3,395 m^3

Air density at sea level is approx. 1.225 kg/m^3

2.4 MINIMUM EQUIPMENT LIST

- Two H30 type propane tanks.
- Fire extinguisher.
- Leather gloves or equivalent fire protection garment for hands.
- Serviceable envelope temperature gauge.
- Serviceable envelope pressure gauge.
- Two independent means of relighting pilot lights.

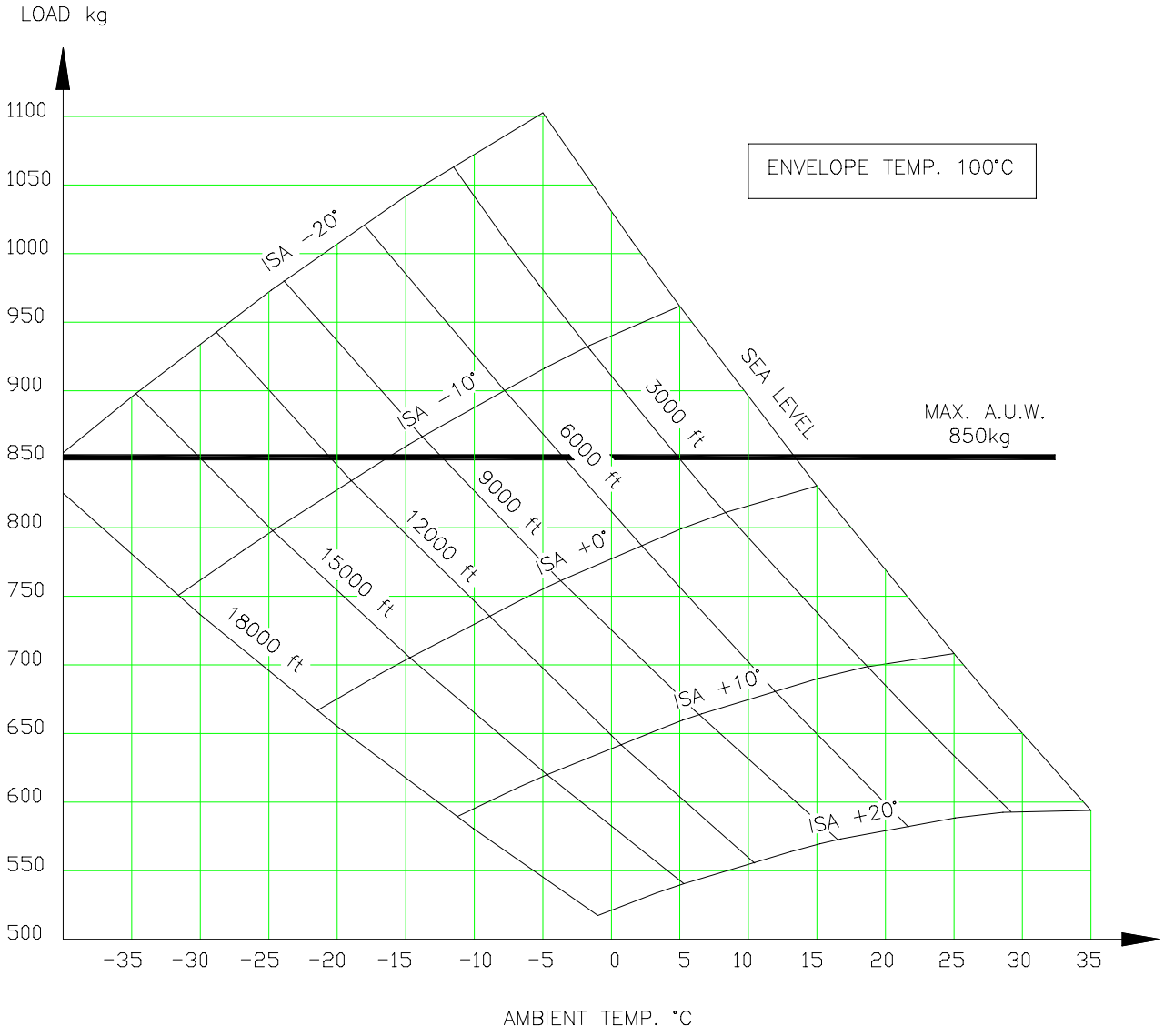
LIFT CHART FOR AS80GD/ AS80MKII HOT AIR AIRSHIP



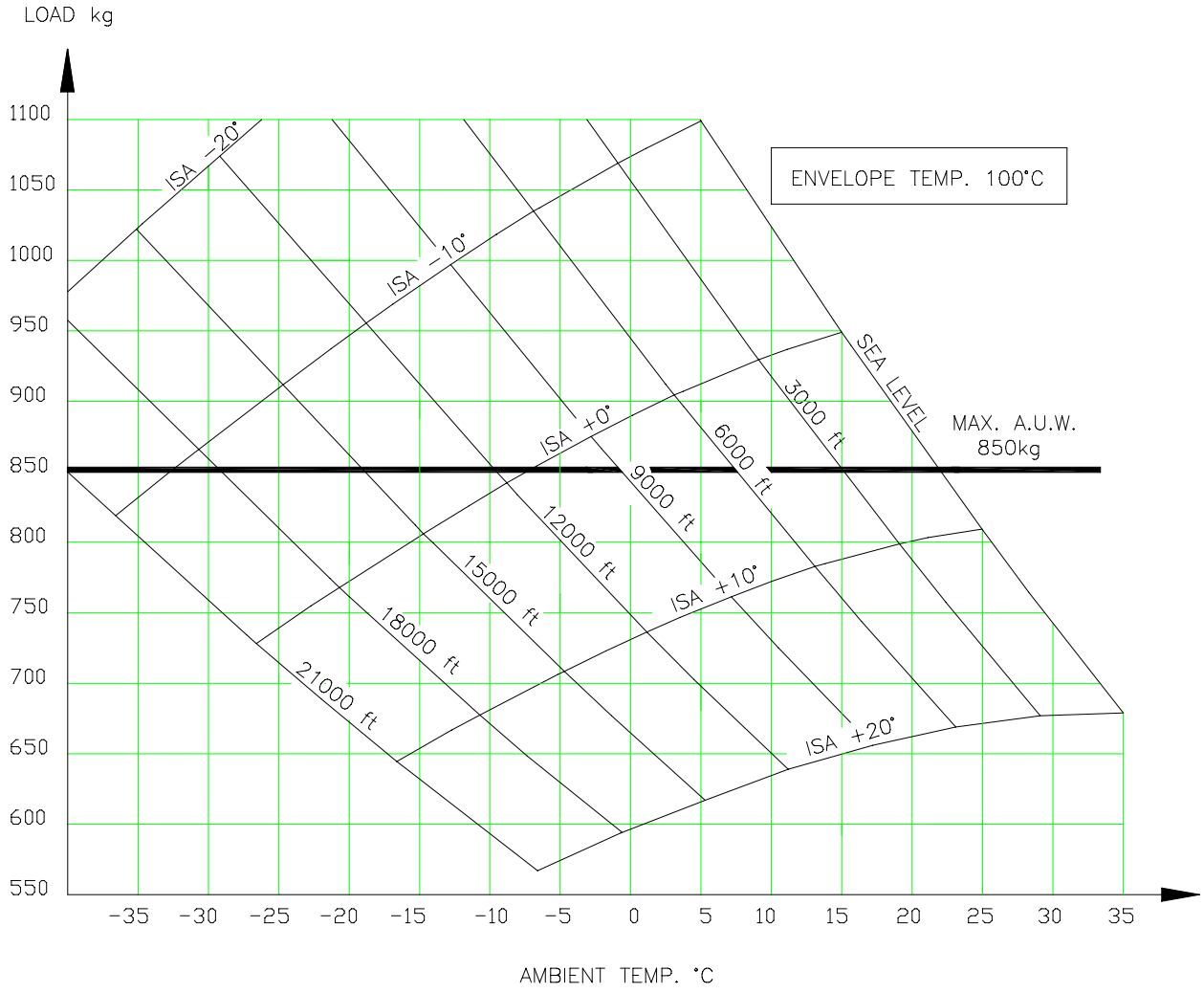
1. AS80MKII - Max^{m} All Up Weight - 640 kg.

2. AS80GD - Max^{m} All Up Weight - 680 kg.

LIFT CHART FOR AS105GD /AS105MKII HOT AIR AIRSHIP.



LIFT CHART FOR AS120MKII HOT AIR AIRSHIP.



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INTRODUCTION: Flying the airship as a hot air balloon

The airship is designed in such a manner that is possible to fly it as a balloon, i.e. without pressurisation. The envelope will sag and lose its shape and some of its stiffness. To ensure better air supply to the burner, the roof hatch should be left open. The deflation panel should not be used for manoeuvring, only for final landing and deflation. This technique is referred to in the following set of emergency instructions. Flight without pressure fan running should not exceed 20 minutes.

3.1 PROPULSION ENGINE FAILURE

If engine stops:

1. Check PETROL LEVEL.
2. Check IGNITION - ON.
3. Check THROTTLE lever and cable.
4. Check FUEL SHUT-OFF - OPEN.
5. Check CHOKE - for correct setting.

RESTART ENGINE

If engine does not restart:

- LAND AS SOON AS PRACTICAL. Fly the airship as a hot air balloon.
  Leave the PRESSURISING FAN - ON.

3.2 PRESSURISATION FAILURE

Loss of pressurisation is caused by two factors:-

1. Excessive loss of air from envelope, i.e. pressure relief valve stuck open, or deflation vent is accidentally opened.
2. Insufficient pressurising air is entering the envelope via fan and scoop.

Actions if air is escaping

1. Check that rip panel is closed.
2. Check relief valves for correct function.
3. Visually inspect envelope internally by opening the roof hatch and standing up in the gondola. Look for holes, particularly in the upper half of the envelope.
4. Maintain pressure fan running. Use propulsion engine at maximum practicable level.

LAND AS SOON AS PRACTICAL

Action if pressure air feed is low

1. Check that electric fan is running.
2. Check that inlet scoop is not restricted in any way.
3. If checks and remedial action are unsuccessful:-

LAND AS SOON AS PRACTICABLE.

3.3 PILOT LIGHT FAILURE

- Check pilot light valve(s) - ON.

RE-IGNITE THE PILOT LIGHTS using the electric ignition system or matches.

If not successful :

Open the MANUAL OVERRIDE VALVE a fraction and ignite the propane at the main jets. Leave it open making the main burner act as a constant pilot light.

LAND AS SOON AS PRACTICAL.

3.4 BURNER FAILURE

1. Check PILOT LIGHTS - ON AND WORKING.
2. Check PROPANE LEVEL.
3. Check PROPANE PRESSURE.
4. Check PROPANE SHUT OFF VALVES - OPEN.
5. Check ELECTRIC VALVES - SERVICEABLE.

If one or both of the electric valve(s) has failed (closed or open).

1. Open MANUAL BYPASS VALVES
2. Fly using feed line override valve as blast valve.

LAND AS SOON AS PRACTICAL.

If burner cannot be re-lit :-

EXERCISE A HARD LANDING (See 3.6)

3.5 FIRE ON BOARD

Locate source and type of fire.

- Petrol fire?
- Propane fire?
- Electric fire?

CLOSE FUEL COCKS AND PROPANE VALVES
Aim fire extinguisher at base of fire.

When fire is out:

- Assess the damage and isolate faulty parts.

If burner cannot be re-lit :

PREPARE FOR HARD LANDING (See 3.6)

3.6 HARD LANDING

A hard landing made with a high rate of descent due to a major failure such as burner malfunction.

1. Check SAFETY HARNESS - Occupants to be strapped in until airship has come to a stop after landing.

2. Close GAS VALVES and VENT FUEL LINES.

3. Leave PRESSURISATION FAN RUNNING.

4. Keep PROPULSION ENGINE RUNNING. This can be used together with the rudder to change direction of the ship away from obstacles on the ground.

5. STOP ENGINE AND ISOLATE THE ELECTRICAL SYSTEM WITH THE MASTER SWITCH PRIOR TO TOUCH DOWN.

6. Pull rip system and keep open until airship has come to a full stop.

ALWAYS TRY TO LAND INTO WIND.

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4.1 PRE-INFLATION CHECKS

- Brief your ground crew well to save time and effort during the inflation. Point out the dangers of the propeller and fan once they are running. Specifically warn about items like scarves and ropes being sucked into the propeller. Make sure only authorised people approach the gondola once the propulsion engine is running.
- Put gondola facing into the wind with the burner raised and secure.

Check Propulsion Engine.

- Check nuts and bolts, engine mounts for security.
- Check propeller serviceable.
- Drain some petrol from tank and examine for water contamination.
- Check radiator water.
- Check oil level in rotary valve tank.
- Check battery level and mounting clip.
- Check exhaust for security and damage.
- Check fuel lines for leaks and security.
- Check generator belt and mounting.
- Start engine and check for clean running.

Note: Avoid running the propeller when the gondola is standing on ground with loose stones, sand or long grass. It can suffer substantial damage if fed with things other than air.

Check Pressurisation Fan

- Check nuts and bolts for security.
- Check fan and surrounding cage for damage.

Petrol Tank

- Check fuel level.
- Open fuel cock, check for leaks.
- Ensure fuel cap is closed and vent open.

Propane Tanks

- Check propane level.
- Check straps for security and condition.
- Pressurise propane hoses and check for leaks and signs of wear.

Burner

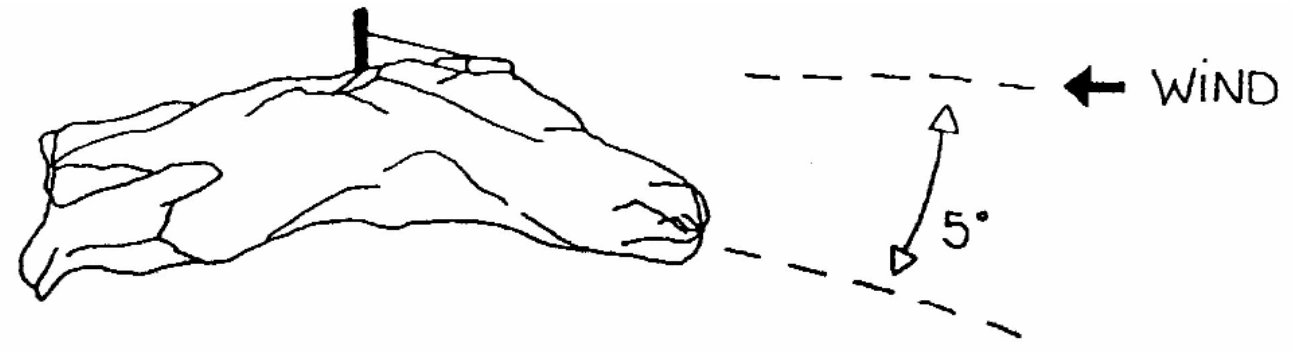
- Check shut off valves and electric valves.
- Check both pilot valves for function and re-ignition.
- Check swivel mechanism and locking toggle.
- Do burner check using both electric valves and by-pass valves.

4.2 ASSEMBLY

- Spread out the envelope on the starboard side of the gondola and attach the four corner karabiners.

Note: The gondola and nose of the envelope should be aimed approximately 5° to the right of the wind direction (see figure below).

VIEW FROM ABOVE



This is to make the envelope stay on the right side during inflation. The burner can tilt to the right inside the envelope but not to the left.

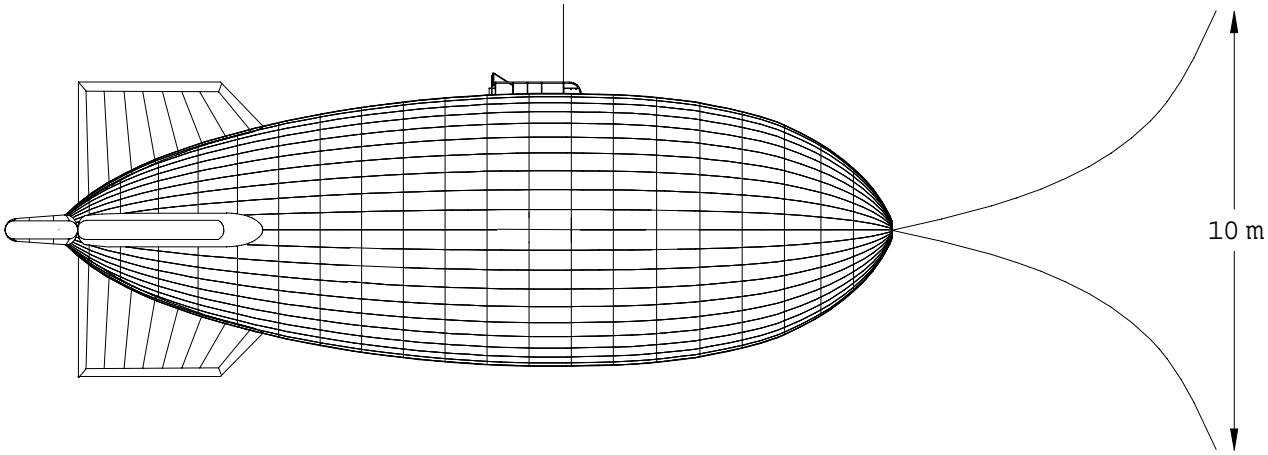
4.3 INFLATION

Depending upon weather conditions, crew skills, inflation site and other factors, the inflation procedure may vary. Described here is a standard inflation.

- The airship should be attached to tether points in the following manner:

- One line from the front corner karabiner to a tether point at 90° to the gondola and attach the two nose lines to a tether point in line with the gondola (see figure below). (Normally two people).

VIEW FROM ABOVE

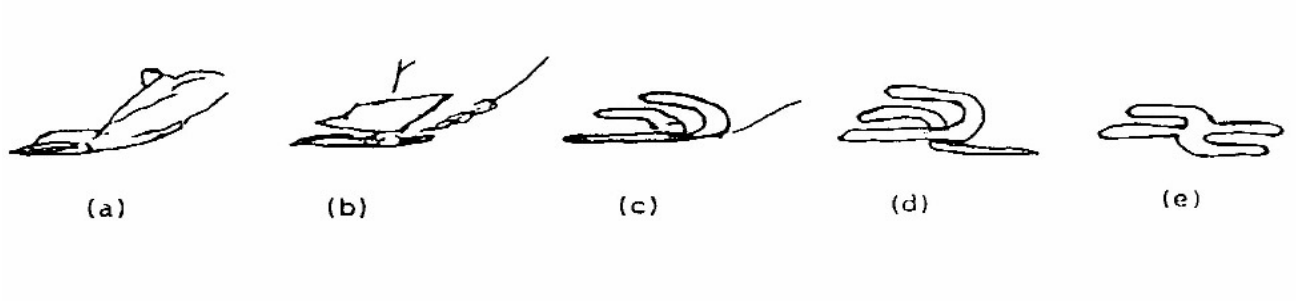


- Locate and attach the rip lines, rudder lines and temperature cable to the gondola.

- Seal the rip panel in the rear of the envelope.

- Lay out the tail fins. Begin with the bottom fin and seal the 4 velcro deflation ports. Next lay the left horizontal fin over the top of the bottom fin and seal the 4 deflation ports. Lay the top fin over the top of the left horizontal fin and seal the 4 deflation ports. Lay the right horizontal fin out on the right of the envelope and seal the 4 deflation ports. Next pull the top fin back over the right horizontal fin. Seal the 6 deflation ports in the rudder. In total there are 22 deflation ports.

VIEW FROM REAR OF AIRSHIP SHOWING FIN POSITIONS AT STAGES OF LAYING OUT.



- Check the envelope has no tears or other damage. NO DAMAGE ALLOWED FOR FLIGHT.
- Start filling the envelope using the external fan. Check the catenary curtain and remove any knots or tangles.
- Start using the burner when envelope is well filled with cold air.

CAUTION: ONCE HOT AIR INFLATION STARTS, THE ENVELOPE PRESSURE MUST BE MONITORED AND KEPT BELOW 15 MM WATER GAUGE.

- When using the burner, the pilot aims the flame so as to avoid touching the envelope skin or the internal rigging with the flame.

- The crew should attempt to keep the envelope to the right of the gondola and not allow nose or tail to rise individually but try to keep the envelope level with the horizon. One crew member must assist the pilot at the gondola to prevent it from toppling over on its side.

  Once inflated and buoyant the airship will weathercock on its nose lines.

4.4 PRE-FLIGHT CHECKS

- The airship is up and buoyant.
- Start propulsion engine and pressurise the fins.
- Check rudder action.
- Check that rip line safety locks are connected and velcro seal on rip panel connected.
- Ensure that envelope pressure relief valves release air at correct pressure.

Final Checks.

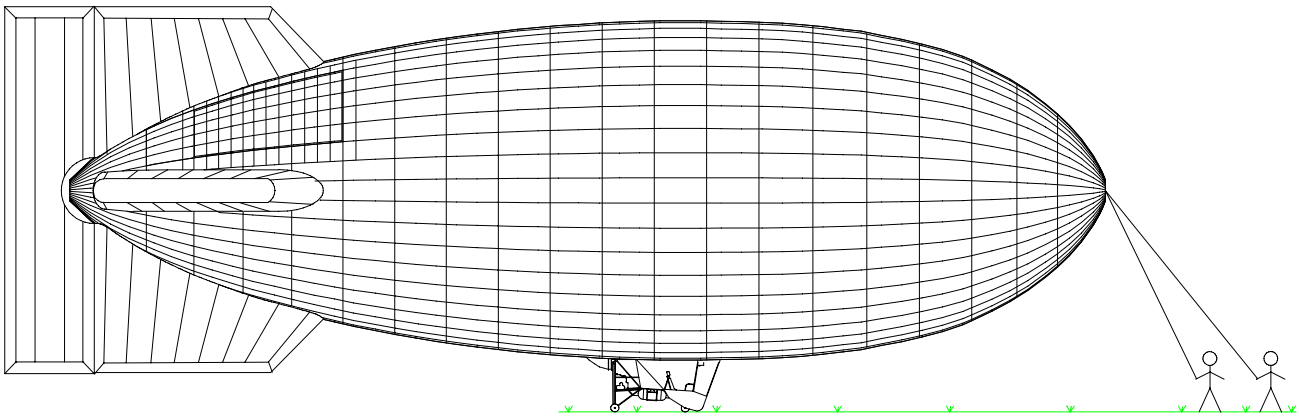
- Seat belts fastened.
- Pilot lights working.
- Throttle response good on propulsion engine.
- Propane level.
- Petrol level.
- Switch on variometer and temperature gauge.
- Set altimeter to desired reference height.

4.5 TAKE OFF

Bring the ship into equilibrium with nose into wind.

ALWAYS MONITOR ENVELOPE PRESSURE CLOSELY, MAX. 15 MM WG.

Signal to the crew that you are ready for take off. Both crew members should always hold on to their nose lines as far forward towards the nose as possible to assist in keeping the nose into the wind during the last moments before initial climb begins. (See figure below).



4.6 FLYING

The airship is controlled in its movements through the air by three different inputs:

BURNER- Controls the ascent and descent rate of the airship by changing the density of the captive air in the envelope. The burners can be used individually to provide pitch trim by distributing heat to front and rear of the envelope.

ENGINE- The propeller delivers a thrust force that will push the airship through the air.

RUDDER- This controls the yaw of the airship and enables it to make turns in the horizontal plane.

To complete the picture we have the pressurisation fan and scoop which supply air into the envelope to sustain the combustion and the internal pressure. To understand how the flying characteristics are affected by changes in the internal pressure of the envelope is important.

Superpressure

The superpressure inside the envelope makes it stiffer, it will therefore maintain its shape when flying at higher speeds than those possible without superpressure. The pressure will increase if more air is pumped into the envelope, or if the air inside is expanded (by using the burner).

The balance between pressure and temperature must be properly understood for the pilot to use the airship to its full potential.

Aerodynamic Lift

A force that a free balloon never experiences in free flight is that of aerodynamic lift. Since the balloon derives its lift from aerostatic forces the aerodynamics never enter the picture.

The airship however is subject to a combination of these forces, the magnitude of each being dependent on flight conditions in each particular case.

This means to stay level at a reduced throttle setting, you will have to add heat to compensate for the loss of aerodynamic lift.

Following this reasoning one realises that low level, high speed approaches to landing must be made with caution in case of a loss of aerodynamic lift due to an engine malfunction or a sudden change of throttle setting.

Fuel Management

It is imperative to maintain an accurate record of the remaining fuel supply.

Propane: Empty the propane tanks in sequence and keep a record of the time the first tank lasted. Each propane tank is fitted with its own contents gauge. If the aircraft has the optional third tank fitted, this should be emptied first.

Petrol: The petrol consumption is monitored on the level gauge in the instrument box.

4.7 PRE-LANDING CHECKS

Landing procedures should be initiated when 50% remains in the last propane tank.

- Check petrol level.
- Overfly landing site to look for changes in the wind direction.
- Alert ground crew by radio or by giving them sign of your intention to land.

4.8 LANDING

- The landing is made into wind.
- The ground crew has an important role to play in the landing phase. It is their task to bring the airship to a stop and catch the nose lines to establish a good tether.
- Unlike a balloon, the airship is normally landed without using the rip panel. This will only cause loss of pressure and impair manoeuvrability at a point in the flight when you most want it. Ensure that sufficient height is maintained passing obstacles on the ground during the approach. This is to avoid entanglement of the nose lines and the tail.
- Shut down the propulsion engine immediately before touchdown. This is to avoid getting gravel and other items sucked into the propeller as well as ensuring that ground crew do not get in contact with the propeller.

4.9 DEFLATION

- Shut down pilot lights.
- Shut down pressurisation fan.
- Vent liquid propane through burner to cool it.
- Close propane supply to burner and vent lines.
- Master switch - OFF.
- Close petrol fuel cock.
- Variometer and temperature gauge - OFF.
- Disconnect temperature cable.
- Disconnect scoop attachment.
- Disconnect rudder lines.
- Open rip panel.
- Open deflation holes in fins.
- Disconnect corner catenary attachments. (When envelope is empty).