

ECONOMIC COMMISSION FOR EUROPE

INLAND TRANSPORT COMMITTEE

**Working Party on the Transport of Dangerous Goods**

**Joint Meeting of the RID Safety Committee and the  
Working Party on the Transport of Dangerous Goods.**  
(Bonn, 13-17 October 2003)

**LIGHTWEIGHT LPG CYLINDERS FOR USE IN HOT AIR BALLOONS**

## **Draft Technical Paper – Hot Air Balloons.**

### **Additional Information**

#### ***Background***

Hot air balloons use hydrocarbon gases, generally UN 1978 propane, as fuel. The fuel is transported by road before and after flights in the cylinders that accompany the balloon in flight. These cylinders are designed, manufactured and inspected to aerospace standards but do not fully meet the requirements of chapter 6.2 of ADR as operational requirements dictate that the cylinder design must minimise empty weight.

Multilateral special agreements M74 and M90 have been developed to permit lightweight cylinders to be used in hot air ballooning. These expire on 1 July 2003 and 1 July 2004 respectively.

New Cylinders are being introduced which comply with the requirements of ADR and TPED to replace the existing cylinder designs by 1 July 2004.

The technical paper is intended to address the problem of the continued use and phased withdrawal of the 'old' cylinders.

#### ***Typical movement of cylinders connected with balloon flights***

Fuel cylinders are filled and transported by road and in some cases by sea to launch sites. Transport by rail is not usual. The flight takes place and the cylinders are transported back to the operational base of the balloon in a partially filled condition. This cycle is repeated 50 – 100 times per year for each balloon. There are approximately 2000 – 3000 active hot air balloons in Europe.

Users generally operate hot air balloons with 3 – 5 cylinders, each with a maximum water capacity of 89 litres. The cylinders are protected by a padded, water resistant cover and transported in the gondola [basket(E), nacelle(F), korbe(D)].

#### ***Maintenance, Handling and Inspection Provisions***

The cylinders remain the property of the pilot or operator. The cylinders are handled by the pilot and trained ground crew.

In addition to inspection at the time of filling, the cylinders are inspected annually by a qualified aviation inspector for leaks and damage and periodically (10 years) by a competent test house in accordance with the requirements of ADR.

The periodic inspection includes the replacement of the Pressure Relief Valve.

## ***Scope of the Draft Technical Paper***

The draft technical paper is intended to allow the continued use of 'old' cylinders designed and manufactured to aerospace standards previously approved by Multilateral Special Agreements M74 and M90.

Acceptance of the paper will implement a phased withdrawal of the cylinders over a period of 25 years from the date of initial test of each cylinder.

## ***Production Data***

Production of Austenitic stainless steel cylinders has varied between 300-500 cylinders per annum since 1983 (total production 7000-9000 cylinders).

Production of titanium cylinders has totalled 700 since 1997.

The cylinders cost between €1000-2000.

The cylinders are exported worldwide. In addition to ADR member states the cylinders are approved for use in the USA and Australia.

Annex A: Civil Aviation Authority Type Approval.

Annex B: Cameron Balloons Maintenance Manual

Mr John Davis  
Cameron Balloons Ltd  
St Johns Street  
Bedminster  
Bristol  
BS3 4NH

29 September 2003

Our Ref 9/30/5B/018  
Your Ref

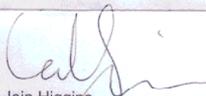
Dear Mr Davis

**List of Approved Cylinders**

Please find below as requested, a current list of approved cylinders.

Part No.	Description	Mod.No.	Date Approved
CB426	Stainless Steel Cylinder 60l	73	30/10/1985
CB497	Stainless Steel Cylinder 40l	80	30/12/1986
CB599	Stainless Steel Cylinder 45l	88	23/12/1987
CB959	Stainless Steel Cylinder 73l	143	11/08/1992
CB2088	Stainless Steel Cylinder 53l	151	18/03/1993
CB2380	Titanium Cylinder 60l	274	06/05/1997
CB2383	Titanium Cylinder 80l	274	06/05/1997
CB2385	Titanium Cylinder 45l	274	06/05/1997
CB2387	Titanium Cylinder 53l	274	06/05/1997

Yours faithfully



Iain Higgins  
Assistant Design Liaison Surveyor

### 6.11 SIDE VENT

If a turning vent style dump is fitted inspect as for a turning vent (section 6.5). For conventional side dumps inspect as follows-

- Check overlying tapes and stitching at ends of flap.
- Check condition of shock cord, pulleys and attachments.
- Ensure that vent line stop is fitted and in good condition.

### 6.12 BURNER AND FUEL SYSTEM

- Check type and condition of karabiners.
- Check physical condition of burner, burner frame and hoses.
- Check that necessary lubrication has been carried out on the main blast valve and whisper valve of Shadow and Stealth burners, and the main blast valve of Sirocco burners (sections 4.5.1.1, 4.5.1.2 and 4.6.1.1)
- Check that Sky Mistral burners have been modified in accordance with Service Bulletin 10. (The manifold block will be engraved 'SB10' and an entry will have been made in the logbook.)
- Perform a functional check on the burner and fuel system (section 6.16.3).

### 6.13 FUEL CYLINDERS

- Check that the cylinder internal and periodic inspections are current (section 6.17).
- Remove the dust cover and inspect the Pressure Relief Valve (PRV) for contamination and corrosion. Check the date stamp on the PRV (section 6.17.2).
- Remove the cylinder padded covers and perform an external visual inspection (section 6.17.2). All stainless steel and titanium cylinders must be fitted with a padded cover.
- Check all valves and fittings for correct operation, damage and signs of corrosion. Perform a functional check on each fuel cylinder (section 6.17.2).
- Check all pressure holding joints with leak detector (section 4.3, item 1) (all threads into cylinder, all joints between valves / regulators / connectors, valve stems (open and close during this test), the seal around the contents gauge and welds around bosses) (section 6.17.2).

- Inspect the offtake bosses for signs of distortion, misalignment or depression, denoting a heavy impact or misuse (section 6.17.2).
- Check freedom of movement of contents gauges (section 6.17.2).

#### 6.14 BASKET

- Check the condition of the nylon support rods.
- Check the condition of the basket wires.
- Check the condition of the basket frames. No cracking or significant distortion in metal frame or support rod sockets.
- Check the condition of the basket weave. Inspect the weave for excessive damage, dryness, dampness or fungal attack, especially in the base of woven floor baskets.
- Check the condition of the protective rawhide on the lower edge of the basket.
- Check the condition of the rope handles
- Check the condition of the cylinder straps.
- Fire extinguisher maintained according to makers instructions.
- Pilot restraint harness anchor (if fitted) secure and free of wear.
- Check the condition of the basket floor.

#### 6.15 ANCILLARY EQUIPMENT (If fitted)

- Launch restraint- Check function and condition of latch. Check bridle and ropes for wear, fading or damage. Check karabiners for damage and correct operation.
- Pilot restraint harness- Check function of buckle. Check webbing for wear or fading or damage.
- Verify that instruments are operational (if applicable).

strap (if fitted) for signs of wear, cuts, heat damage and UV degradation (UV degradation usually manifests itself as fading of the webbing). If the webbing has any defects it should be replaced. Check the condition of the restraint rope for wear or damage.

**Pilot restraint harness and strap-** Check the condition and function of buckles and fittings. Check the condition of the webbing as for a launch restraint.

## 6.17 FUEL CYLINDERS

If there is any doubt over the nature of any defects found during the inspection of fuel cylinders, the cylinders must be referred to Cameron Balloons for further inspection.

If a cylinder has been deemed unsuitable for further service, it is deemed unsuitable for use in balloons AND unsuitable for the safe storage of liquefied gases.

**Note-** these requirements do not exempt the owner from any local regulations regarding propane cylinders.

Inspection frequency-

Annual- Functional test & external visual inspection.

Periodic- 10 years from the date of manufacture and every 10 years thereafter.  
(Annual inspection, internal inspection and proof pressure test)

Internal- At 15 years from the date of manufacture and every 10 years thereafter (ie. 5 years after every periodic inspection). (Annual inspection and internal inspection).

Introduction of proof pressure testing- Cylinders manufactured prior to May 1992 should have their first pressure test at their next due date for internal or periodic inspection (ie. at 15,20 or 25 years from the date of manufacture).

### 6.17.1 Functional Check

**Note-** All leak checks specified in this section are visual checks using leak detector (section 4.3, item 1).

Vapour Valve (If fitted)- Open the vapour valve and check function of the self-seal (with the valve open and no coupling connected no gas should escape). Check for leaks around the valve base and the valve stem.

Connect a vapour hose and ignite the pilot light. Check the joint at the quick connect coupling for leaks. If the regulator is of the adjustable type, check the regulator adjustment over a range of pressures. Turn off the vapour valve with the pilot light valve open to check that the vapour valve shuts off fully.

Liquid Valve- Remove the liquid valve dust cover (if fitted). Open the cylinder valve and check the function of the self-seal (with the valve open and no coupling connected no gas should escape - do not look directly into the outlet). Check for leaks around the valve base and the valve stem. Shut the liquid valve and connect to a burner.

Check that the fuel pressure is in the normal operating range of the burner (normally the green sector of the pressure gauge). For burner operating pressures refer to Flight Manual Issue 9, Section 2.3.

Open the cylinder valve and check leaks at the coupling. Operate the main burner for a minimum of 10 seconds and ensure the fuel pressure does not drop once the blast valve has been opened. Shut off the cylinder valve and open the blast valve to ensure the valve shuts off completely (it may take some time for the residual flame to die away). Disconnect the hose and recheck the function of the self-seal valve.

Fixed level liquid gauge (FLLG or Bleed Valve)- Check for leaks around the base of the valve and the valve outlet. Open and close the valve to check for correct operation.

In addition, if the FLLG is fitted with a "Fuelsafe" system, check for leaks at the quick release coupling with the vent hose connected.

### 6.17.2 External Visual Inspection

Remove the cylinder cover and inspect the cylinder body for external damage or corrosion. Pay particular attention to the cylinder base and welds. Section 6.17.5 gives definitions of cylinder damage and guidance on rejection limits. All stainless steel and Titanium cylinders must be fitted with a padded cover.

Offtake bosses- The offtake bosses may become damaged by an impact on the valves or by careless valve replacement. Ensure that the valves are vertical, that the bosses do not appear to have been pushed into the cylinders and that the welds around the bosses are undamaged.

Contents Gauges- The freedom of movement of the contents gauges may be checked by leaning the cylinder forwards and backwards relative to the orientation of the cylinder gauge. This should cause the reading on the cylinder gauge to change.

Pressure relief valve- Check that the pressure relief valve will not be more than 10 years old at the date of the next annual inspection (refer to Appendix 3). Remove the dust cover and inspect the pressure relief valve for contamination or corrosion. Wear eye protection while looking into the valve.

Leak check- check all pressure holding joints with leak detector (section 4.3, item 1). This includes all threads into the cylinder, all joints between valves / regulators / connectors, valve stems (open & close the valve during this test), the seal around contents gauges and the welds around the bosses.

(2)

### 6.17.3 Internal Inspection

**WARNING - With cylinders used for the carriage of liquefied propane there is a great danger that residual gas mixed with air will cause a fire or explosion hazard. The cylinder must be emptied of propane and depressurised in a safe manner, then properly purged with nitrogen (N<sub>2</sub>) or another inert gas prior to any internal inspection or maintenance.**

In addition to the requirements of the annual inspection (functional check and external visual inspection (6.17.1 & 6.17.2))-

Ensure the cylinder is empty and purged of residual gases.

Remove the contents gauge and perform an internal inspection. If the cylinder is contaminated, it should be cleaned prior to inspection (section 6.17.6). Ensure that any loose debris is removed from the cylinder.

The internal inspection should be carried out in a well lit, well-ventilated area. A suitable hand held inspection light should be used. The light source should be of sufficient intensity to identify any damage or corrosion.

Inspect for internal damage or corrosion. If the cylinder exhibits damage outside the limits detailed in section 6.17.5 it should be rejected for further inspection or in extreme cases it should be scrapped.

Any cylinder exhibiting corrosion should be rejected for further examination. Corrosion can be identified as areas of discolouration (rust colour), isolated pits or chains of pits (which are normally black in colour). Particular attention should be paid to the areas around the welds.

If there is any doubt over the nature of any defects found during the internal inspection, refer the cylinder to the manufacturer for further inspection.

Once the internal inspection has been completed, refit the contents gauge using a new rubber gasket and perform a leak check using compressed air.

1. Close all valves.
2. Connect a compressed air supply to the liquid connector on the cylinder.
3. Open the liquid valve.
4. Open the air supply to fill the cylinder with compressed air. The minimum pressure in the cylinder should be 7 bar (100 psi).
5. Close the liquid valve and the air supply valve.

6. Disconnect the air supply and open the liquid valve.
7. Perform a leak check as detailed in the annual inspection procedure.

Record the internal inspection in the aircraft log book.

**WARNING-** Always vent the cylinder after testing.

**6.17.4 Periodic Inspection (Includes Proof Pressure Test)**

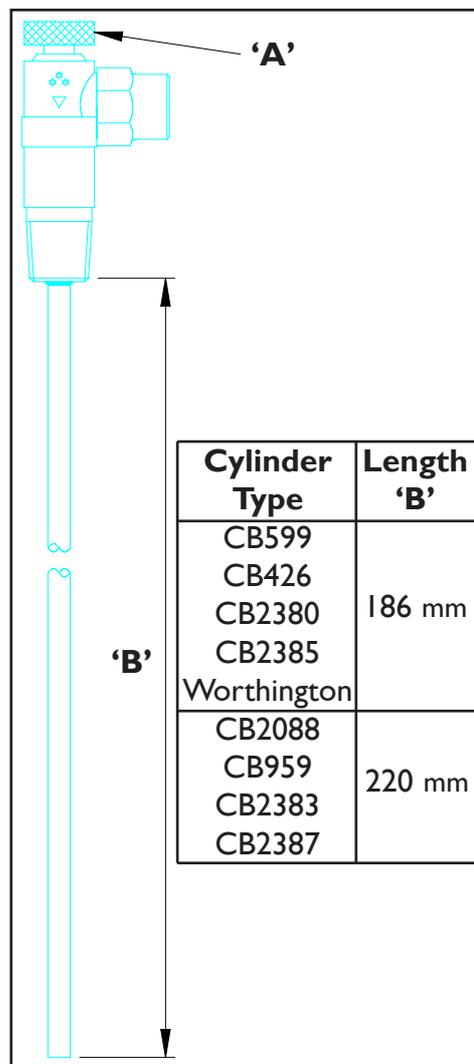
Perform the annual inspection (6.17.1 and 6.17.2) and an internal inspection (6.17.3).

Remove the FLLG, check that the bleed screw 'A' is captive and that the length 'B' is correct for the cylinder. If not, the FLLG must be replaced.

If the cylinder is satisfactory then a hydraulic proof pressure test must be carried out. The test pressure is 3 MPa (30 Bar). Testing should be carried out in accordance with EN 1440. A list of approved pressure test facilities and a pressure test procedure is available from Cameron Balloons Ltd.

After proof testing the valves should be refitted (carefully inspect any old valves that are being refitted) and the compressed air leak check carried out (6.17.3).

Following a satisfactory periodic inspection the cylinder shall be legibly and durably marked with the symbol of the test station or inspection body, the month and year of the inspection, and the month and year of the next periodic inspection.



▲ FLLG Details

**WARNING-** The cylinder must only be marked on either the guard ring or foot ring. The cylinder must not be marked on the pressure vessel.

**Note-** if any unacceptable defects are found during the external or internal inspections the cylinder must be rejected. A satisfactory proof pressure test does not allow other defects to be ignored.

**Note-** Alcohol must not be used to dry Titanium cylinders.

**6.17.5 Annual Inspection Of Fuel Cylinders- Definition Of Cylinder Damage And Guidance On Rejection Limits**

**Note 1-** Consideration of appearance and location also play a part in the evaluation of dents. See especially section 6.17.2, 'Offtake bosses'.

**Note 2-** Stainless steel and Titanium cylinders vary in thickness from 1.2 - 2 mm. The most highly stressed part of the cylinder is in the cylindrical wrapper section. Particular care should be taken when inspecting this area. The thinnest wall sections are in the hemispherical ends. Worthington aluminium cylinders have a minimum wall thickness of 3.5 mm.

As a general rule, if the cut or gouge can be felt with a thumbnail, its depth is in excess of 0.1 mm to 0.2 mm (approximately 10% of the wall thickness at the thinnest point).

**Note 3-** Damage to the upper and lower guard ring is acceptable providing that the distortion has not affected the cylinder body, and that the guard rings still provide protection to the cylinder body and fittings.

**Corrosion-** Any cylinder exhibiting corrosion should be scrapped. Corrosion can be identified as areas of discolouration (rust colour), isolated pits or chains of pits (which are normally black in colour). Particular attention should be paid to the areas around the welds and to the bottom centre of the cylinder base.

Defect	Definition	Rejection Limits
<b>Bulge</b>	Visible Local Swelling of the Cylinder	All
<b>Dent</b>	A depression in the cylinder that has neither penetrated or removed metal	When the depth of the dent exceeds 25% of its width at any point. See Note 1
<b>Cut or Gouge</b>	A sharp impression where metal has been removed or redistributed	When the depth of penetration exceeds 20% of the original minimum wall thickness or the length exceeds 10% of the circumference and the depth exceeds 10% of the original wall thickness. See Note 2
<b>Dent Containing Cut or Gouge</b>	A depression in the container within which there is a cut or gouge	Where the size of the dent or gouge approaches the dimension for rejection on an individual defect
<b>Crack</b>	A split or rift in the container shell	All

**Table I-** Guidance on Rejection Limits relating to Physical and Material Defects in the cylinder shell.

### 6.17.6 Cleaning Of Fuel Cylinders Prior To Internal Inspection

The cylinder may be cleaned by adding a small quantity of kerosene and swilling it around the cylinder, or with a commercially available water-based degreaser. The cleaning process can be assisted by a high pressure water or steam jet. Repeat the process as necessary. Care should be taken to remove all water and dry the cylinder after cleaning.

**WARNING-** Alcohol or commercial alcohol based cleaners must never be used to clean or dry titanium cylinders.

### 6.17.7 Failed Cylinders

**Note-** If a cylinder has been deemed unsuitable for further service, it is deemed unsuitable for use in aircraft AND unsuitable for the safe storage liquefied gases.

The decision to reject a cylinder may be taken at any stage during the requalification procedure. A rejected cylinder shall be rendered unserviceable so that it cannot be reissued into service as a pressure vessel, in accordance with EN 12816 (also in the UK, CAA AN No. 96). The serial number of a failed cylinder should be entered in the aircraft logbook, and in the UK on the IR4.

## 6.18 CROWN TAPE DIMENSIONS - VELCRO RIPS

This check ensures that the crown tapes are shorter than the radius of the Velcro rip panel. If the tapes were longer than the rip panel radius, the Velcro would be stressed and would be likely to open in flight.

**Table 2-** Velcro Rip  
Crown Tape Dimensions

### 6.18.1 Circular Velcro rips

1. Mark the centre point of the circular patch in the centre of the rip panel.
2. From the centre point in the direction of each load tape, mark out the radius 'R' using the appropriate value from Table 2. These points should be permanently marked with a felt tip pen or other means.
3. With the Velcro correctly in place ask an assistant to hold each load tape on the balloon side of the Velcro. Ensure that the relative lengths of the Velcro panel and the free tapes are not distorted.

Type	Radius 'R'	
	cm	inches
O-31	20	8
O-42	22	8.5
O-56	24	9.5
O-65	28	11
O-77	30	12
O-84	30	12
O-105	33	13
O-120	33	13
O-160	37	14.5
A-105	33	13
A-120	33	13
A-140	37	14.5
A-160	36	14
A-180	33	13
A-210	36	14
A-250	36	14
A-300	36	14