This technical document is approved by the EASA Major Change approval 10053116

Appendix 2:
Worthington aluminum fuel cylinders distributed by Theo Schroeder fire balloons

1. General

This Maintenance Manual Appendix describes the measures for continuous airworthiness, repair and maintenance of Worthington Aluminum fuel cylinders that were distributed by Theo Schroeder fire balloons in the years 1987 to 1989.

The handling of fuel cylinder equipment must be conducted with greatest care independently of the model. A fuel cylinder must never be operated without the protective cover. The urgent recommendation is to use a 25 mm thick foam material with a density of 30 kg/m³ that absorbs only few water (<5%) after getting in contact with it.

Regular inspections and maintenance are essential to avoid leaks. It is very important to keep all couplings clean.

Independently of the following intervals of checks, the fuel cylinder is to be visually inspected by the pilot or the owner regularly. The following hazardous sources may occur:

- Impurity due to refueling of contaminated fuel. The obstruction of jets and nozzles and damage of sealings and seal surfaces may be the consequence.
- Residue of water in fuel cylinders. A thoroughly dehydration of the fuel cylinders after the pressure test is compulsory. Remaining water drops inside the fuel cylinder may block burner and cylinder valves due to icing (vaporization of liquid fuel).
- Damages to cylinder fitting, especially projecting parts like couplings for the pilot light of the vapor valve. When pulling off the protective cover, the fuel cylinder is set upside down on the ground.
- To avoid leakages, only original parts like O-rings from Schroeder fire balloons must be used.

2. Purging procedure for fuel cylinder:

Before purging the cylinder, the vessel must be emptied according to relevant safety guidelines. Releasing of Porpane should be avoided during the discharging process. After emptying the cylinder, it imust be ensured that the vessel is depressurized. In ordert o purge the vessel it must be pressurized up to 0,2 MPa (2 bar) with nitrogen or some other inert gas. The next step is to depressurize the cylinder to atmospheric pressure. This procedure must be repeated at least 3 times to lower the gas concentration inside the vessel to a level below the explosion range.

3. Equipment

The following equipment can be installed to the fuel cylinder. The components, if installed with the dedicated function can be arbitrarily combined.

Liquid fuel valve:	Böhmer ball valve DN8 PN32
	Ceodeux type 77244 (urgently recommended exchange; TM 8025-28)
Gasphaseventil:	Ceodeux Spindelventil SRG 3-13; Typ 77606
Pressure reducer:	System fb type GR1 of Theo Schroeder fire balloons or
	Pressure reducer type Lorch
Pressure relief valve:	OMECA 660248
	REGO 8545AK
	Ceodeux 071131
	Sherwood PVE 435A
	Important:
	The response pressure must not be lower than 2,3 MPa (23 bar). The response pressure must not be above the testing pressure of 3 MPa (30 bar) to avoid damages to the vessel.
Bleed valve:	Ceodeux type 71600; length 186 mm (refer to picture 1)



Picture 1: Bleed valve length 186 mm

Torque ranges for equipment:

There are torque ranges for the installation of the valves. For each valve a minimum and a maximum torque is given to be able to adjust the outlet direction of the valve on the vessel. This torque range allows to turn the valve on the vessel into a suitable direction.

The torques can vary in the following ranges:

Bleed valve:	28 – 50 Nm
Böhmer ball valve:	100 - 130 Nm
Vapour valve:	100 – 130 Nm
Plugs ¾“ NPT:	110 Nm
Pressure relief valve:	60 Nm
Levvel gauges:	3 Nm – 5 Nm; (4 screws, tighten cross wise)

4. 100-Stunden- bzw. Jahreskontrolle

Die folgenden Kontrollen müssen alle 12 Monate oder nach 100 Betriebsstunden im Rahmen einer 100-Stunden-Kontrolle durchgeführt werden, je nachdem, welches Ereignis zuerst eintritt.

Außerdem muss jeder Gasbehälter alle 10 Jahre einer Druckbehälterprüfung unterzogen werden.

Die Prüfung der Gasbehälter bei der 100-Stunden- bzw. Jahreskontrolle erfolgt folgendermaßen:

Generell:

Gründliche Sichtkontrolle auf Beulen, tiefe Kratzer, Korrosion, Ventile und Anschlüsse durchführen. (Ausschusskriterien siehe DIN EN 1440)

Druckminderer

auf festen Sitz prüfen, ggfs. Überwurfmutter nachziehen. Der Anschlussstecker darf nicht über den Flaschenkragen hinausragen.

Schutzummantelung

Sichtkontrolle auf Risse und Löcher durchführen; Polsterung unbeschädigt

Füllstandanzeiger

Befestigungsschrauben nachziehen und Anzeige überprüfen (z.B.: durch Wiegen, hier ist die Füllmasse an Gas (Gesamtmasse abzüglich Tara) mit der Prozent- oder Literanzeige zu vergleichen.)

Dichtigkeit von Armaturen

Um die Dichtigkeit der Armaturen zu prüfen muss ausreichend Flüssiggas in der Flasche vorhanden sein um den Propan Dampfdruck in der Flasche zu gewährleisten. Der Druck sollte mindestens 0,4 MPa (4 bar) betragen. Der Kugelhahn Hebel in 45°-Stellung bringen und kompletten Hahn mit Lecksuchspray einsprühen. Die übrigen Armaturen auf übliche Art mit Lecksuchspray prüfen. Danach Rückschlagventile der Kupplung entlüften.

Rego-Adapter

sichtbare Dichtungen auf Beschädigung prüfen und ggfs. erneuern.

Anschlüsse und sichtbare Dichtringe

mit geeignetem Gleitmittel (z. B. Silikonspray) behandeln.

5. 10-years-inspection of fuel cylinders

10 Jahresprüfung besteht in groben Zügen aus:

- Externe Sichtkontrolle auf Beschädigungen
- Interne Sichtkontrolle auf Verschmutzungen und Korrosion
- Hydraulischer Drucktest
- Dichtheitsprüfung
- Wartung und Austausch der Ausrüstungsgegenstände

<u>Step 1</u>

- Remove protective cover
- Inspect cylinder body for damages. The cylinder must not be approved for inspection and further use when sharp indentations and clearly visible bulges are present.
- Empty the fuel cylinder ensuring that the instructions for the safe handling of liquefied gas are obeyed.
- Remove fill level gauge
- Remove bleed valve
- Replace TEMA 3800 male coupling if necessary.
- Rego male coupling, replace flat seal and o-ring, check function of check valve

- Remove safety valve
- Remove Ceodeux liquid take-off valve, if still fitted. (Replace with ball valve)
- If a ball valve is fitted, it may not be removed.
- Remove all Teflon®-tape residue from the thread.

Step 2

- Fit new bleed valve (recommendation)
- Screw blanking plug onto thread for safety valve
- Fit blanking flange with integrated vent valve on opening for fill level gauge.
- Maintenance of ball valve
  - Remove yellow operating lever
  - Remove safety screw at the side of the valve body
  - Remove stop pin
  - Unscrew the seal unit using special tooling (available from manufacturer Schroeder fire balloons
  - Unscrew Tema 3820 coupling and double nipple
  - Unscrew upper body and renew Teflon® ball seal (two parts)
  - Apply Klübertemp® YV 93-302 to the seal unit and install with a tightening torque of 19 Nm.
  - Fit NEW stop pin (only original parts from the manufacturer Schroeder fire balloons are to be used)
  - Apply Loctite® 243 to saftey screw and re-install
- screw the ball valve back into the vessel and seal the thread with Teflon band in case it was taken off for maintenance.

Step 3

- Fill the fuel cylinder with water with open vent valve. The water must not contain more than 50ppm chlorine and should be of drinking water quality to avoid unnecessary pollution.
- Stop filling when water is flowing out of the vent valve. Close vent valve
- Measure circumference at the middle of the fuel cylinder (using a steel measure tape)
- Using a hand pump connected to the ball valve, increase water pressure to 30 bar and check the cylinder for leaks. The circumference at the middle of the cylinder is measured before and after pressurizing using a steel measure tape. The circumference must not change significantly at the second measurement. The measured value is to be entered into the data sheet from Schroeder fire balloons.
- Release pressure
- Remove blanking flange and empty fuel cylinder
- Inspect the inside of the fuel cylinder for corrosion and debris using a torch with extension.
- The fuel cylinder must be dried after the test! Especially, the liquid take-off valve is to be cleaned with compressed air, as many water droplets remain in the ball valve and liquid dip tube. Those may block the burner valves due to the evaporation heat of propane. Water droplets also remain on the inside of the cylinder wall.
- At Schroeder fire balloons, warm air with a temperature of 60 °C is blown into the flange of the fill level gauge for one hour. Another method is drying with Methanol.

Step 4

- replace the vapour take-off valve with integrated safety valve and seal with 7 layers of 0,1 mm thick Teflon® tape, certified by DVGW (German Technical & Scientific Association for Gas & Water). Attention! Observe thread direction! No Teflon®-tape shall

project over the end of the thread and no Teflon® particles shall fall in the fuel cylinder, which could cause blockage of jets on the fuel cylinder and burner.
- replace the flat seal of the level gauge. Zinc-coated attachment bolts are to be replaced with stainless steel bolts (if present). Always use bolts with the same length as previously fitted because different flange thicknesses have been installed. (cylinder head screw, material A2)
- perform leak check (minimum pressure 0,6 MPa (6 bar))

Note: The safety valves must be replaced after 10 years of service life within the scope of the regular checks. The limit between the date of manufacture and the expiry date of the previous inspection limit may be 15 years maximum. This means that the safety valves may be stored for up to 5 years after the date of manufacture

Step 5

- A stamp and inspection date is to be stamped onto the type plate. The details of the stamp are determined by the requirements of the relevant authority of the respective country
- The inspection is then valid for another 10 years.
- Caution: For safety reasons, the coupling plug attached to the pressure regulator (outlet to the burner hose) must be installed at all times in such a way that it is not protruding above the guard ring of the fuel cylinder (approx. 45°).

Note: If the 3/8” coupling (double nipple) between ball valve and adapter piece needs to be replaced, it is to be fitted with a tightening torque of 60 Nm.

If damages can be revealed during the inspection or maintenance, it is mandatory to exchange pieces of equipment that is damaged beyond the tolerances or might result in malfunction of components. Theo Schroeder fire balloons recommends exchanging bleed valves every 10 years, due to the fact that the valves with its sealants and nonmetallic elements will at least be 20 years of age at the next inspection of the cylinder. To avoid malfunctions or leaks óf the fuel cylinder this is an urgent recommendation.

Dents, scratches, tears, grooves or other damages to the vessel shell must be evaluated using the DIN EN 1440. The vessel must be rejected and made unserviceable if the damage exceeds a tolerance.

The fuel cylinder must comply to the above mentioned requirements to be serviceable for the next 10 years.

6. Maintenance intervals / Airworthiness limitations

The fuel cylinder equipment must be regularly maintained to assure the required level of safety during operation. Assuring this, it is necessary to exchange some of the equipment that can not be maintained, or the costs of maintenance would exceed its value. The following table linies up the required maintenance measures determined by Schroeder for airworthiness and legal road transportation in Europe.

Maintenance intervals

Subject	**Intervall / works to be conducted**
Worthington DOT 4E 240 Aluminum fuel cylinder	Visual check and leak test every 100 operating hours respectively annually: Check vessel shell for dents, tears, cracks, scratches and other hazardous damages and evaluate according to the provisions stated by the notified body
Cèodeux liquid fuel valve	Visual check and leak test every 100 operating hours respectively annually: Check clear unhindered function of the valve spindle every 100 operating hours respectively annually:
Böhmer ball valve	Visual check and leak test every 100 operating hours respectively annually
Vapour valve	Visual check and leak test every 100 operating hours respectively annually
Bleed valve	Visual check and leak test every 100 operating hours respectively annually
Contents gauge	Visual check and leak test every 100 operating hours respectively annually
Pressure reducer	Visual check and leak test every 100 operating hours respectively annually
Adapter (coupling) for burnerhose	Visual check and leak test every 100 operating hours respectively annually
Pressure relief valve	Visual check and leak test every 100 operating hours respectively annually

Table 1: Maintenance intervals

Airworthiness limitations (EASA approved, approval no. 10053116)

Subject	**Intervall / works to be conducted**
Worthington DOT 4E 240 Aluminum fuel cylinder	Every 10 years: 0,3 MPa (30 bar) pressure test
Cèodeux liquid valve	No airworthiness limitations
Böhmer ball valve	Every 10 years: Exchange all seals and bearing shells
Vapour valve	Every 10 years: Exchange
Bleed valve	Every 10 years: Exchange
Contents gauge	Every 10 years: Exchange flat seal
Pressure reducer	Every 10 years: Exchange all seals
Adapter (coupling) for burnerhose	Every 12 months: Exchange all seals
Pressure relief valve	Every 10 years: exchange Maximum time for storage before installation: 5 years

Table 2: Airworthiness limitations

7. Worthington cylinders sold by Schroeder fire balloons GmbH:

#	serial no.	initial date
1	44997 J	Jul 88
2	46697 J	Jul 88
3	46931 J	Jul 88
4	46968 J	Jul 88
5	47086 J	Jul 88
6	47089 J	Jul 88
7	49482 J	Jul 88
8	49645 J	Jul 88
9	49690 J	Jul 88
10	49819 J	Jul 88
11	50894 J	Jan 88
12	50967 J	Sep 87
13	51076 J	Sep 87
14	53571 J	Sep 87
15	53575 J	Sep 87
16	53577 J	May 87
17	53579 J	Sep 87
18	53581 J	May 87
19	53604 J	May 87
20	53605 J	May 87
21	53606 J	Oct 88
22	53608 J	May 87
23	53611 J	May 87
24	53612 J	May 87
25	53617 J	May 87
26	53618 J	Oct 88
27	53619 J	May 87
28	53622 J	Oct 88
29	53624 J	Oct 88
30	53626 J	May 87
31	53627 J	Sep 87
32	53629 J	May 87
33	53630 J	Sep 87
34	53633 J	Sep 87
35	55098 J	Jun 87
36	55136 J	Jun 87
37	55810 J	Jun 87
38	55811 J	Jun 87
39	55812 J	Jun 87
40	55813 J	Jun 87
41	55814 J	Jun 87
42	55816 J	Jun 87
43	55818 J	Jun 87
44	55819 J	Jun 87
45	55820 J	Jun 87
46	55821 J	Jun 87
47	55822 J	Jun 87
48	55823 J	Jun 87
49	55824 J	Jun 87
50	55825 J	Jun 87
51	55827 J	Jun 87
52	55828 J	Jun 87
53	55829 J	Jun 87
54	55830 J	Jun 87
55	55831 J	Jun 87
56	55832 J	Jun 87
57	55833 J	Jun 87
58	55834 J	Jun 87
59	55835 J	Jun 87
60	55837 J	Jun 87
61	55838 J	Jun 87
62	55839 J	Jun 87
63	55840 J	Jun 87
64	55896 J	Jun 87
65	56513 J	Sep 87
66	56517 J	Sep 87
67	56518 J	Sep 87
68	56520 J	Sep 87
69	56523 J	Sep 87
70	56525 J	Sep 87
71	56526 J	Sep 87
72	56527 J	Sep 87
73	56528 J	Sep 87
74	56531 J	Sep 87
75	56534 J	Sep 87
76	56535 J	Sep 87
77	56537 J	Sep 87
78	56538 J	Sep 87
79	56539 J	Sep 87
80	56540 J	Sep 87
81	56639 J	Sep 87
82	56640 J	Sep 87
83	56641 J	Sep 87
84	56642 J	Sep 87
85	56643 J	Sep 87
86	56645 J	Sep 87
87	56646 J	Sep 87
88	56647 J	Sep 87
89	56648 J	Sep 87
90	56649 J	Sep 87
91	56650 J	Sep 87
92	56651 J	Jan 88
93	56653 J	Sep 87
94	56654 J	Sep 87
95	56655 J	Sep 87
96	56656 J	Sep 87
97	56657 J	Sep 87
98	56658 J	Jan 88
99	56659 J	Jan 88
100	56660 J	Sep 87
101	56661 J	Jan 88
102	56662 J	Sep 87
103	56663 J	Jan 88
104	56667 J	Jan 88
105	56671 J	Sep 87
106	56677 J	Jan 88
107	56679 J	Sep 87
108	56686 J	Sep 87
109	56819 J	Jan 88
110	56829 J	Jan 88
111	57059 J	Jan 88
112	57062 J	Jan 88
113	57065 J	Jan 88
114	57068 J	Jan 88
115	57074 J	Jan 88
116	57093 J	Jan 88
117	57156 J	Jan 88
118	57299 J	Jan 88
119	57344 J	Jan 88
120	57347 J	Jan 88
121	57387 J	Jan 88
122	57935 J	Jan 88
123	58181 J	Jan 88
124	58182 J	Jan 88
125	58183 J	Jan 88
126	58185 J	Jan 88
127	58188 J	Jan 88
128	58190 J	Jan 88
129	58195 J	Jan 88
130	58199 J	Jan 88
131	58200 J	May 88
132	58202 J	May 88
133	58470 J	Apr 88
134	58471 J	Apr 88
135	58472 J	Apr 88
136	58473 J	Apr 88
137	58474 J	Apr 88
138	58475 J	Apr 88
139	58476 J	Apr 88
140	58477 J	Apr 88
141	58478 J	Apr 88
142	58479 J	Apr 88
143	58480 J	Apr 88
144	58481 J	Apr 88
145	58482 J	Apr 88
146	58483 J	Apr 88
147	58484 J	Apr 88

Table 3: Aluminum fuel cylinders sold by Schroeder fire balloons

#	serial no.	Initial date
148	58485 J	Apr 88
149	58486 J	Apr 88
150	58487 J	Apr 88
151	58488 J	Apr 88
152	58489 J	Apr 88
153	58490 J	Apr 88
154	58491 J	Apr 88
155	58492 J	Apr 88
156	58493 J	Apr 88
157	58494 J	Apr 88
158	58495 J	Apr 88
159	58496 J	Apr 88
160	58497 J	Apr 88
161	58498 J	Apr 88
162	58499 J	Apr 88
163	58500 J	Apr 88
164	58501 J	Apr 88
165	58502 J	May 88
166	58504 J	May 88
167	58505 J	Apr 88
168	58506 J	Apr 88
169	58507 J	Apr 88
170	58508 J	Apr 88
171	58509 J	May 88
172	58510 J	Apr 88
173	58511 J	May 88
174	58512 J	Apr 88
175	58513 J	May 88
176	58514 J	May 88
177	58515 J	Apr 88
178	58516 J	May 88
179	58517 J	May 88
180	58518 J	May 88
181	58519 J	Apr 88
182	59631 J	May 88
183	59640 J	May 88
184	59642 J	May 88
185	59652 J	May 88
186	59674 J	May 88
187	59704 J	May 88
188	59712 J	May 88
189	59724 J	May 88
190	59752 J	May 88
191	59753 J	May 88
192	59774 J	May 88
193	59775 J	May 88
194	59801 J	May 88
195	59807 J	May 88
196	59809 J	May 88

#	serial no.	Initial date
197	59825 J	May 88
198	60227 J	Jul 88
199	60229 J	Jul 88
200	60247 J	Jul 88
201	60249 J	Jul 88
202	60251 J	Jul 88
203	60259 J	Jul 88
204	60291 J	Jul 88
205	60292 J	Jul 88
206	60293 J	Jul 88
207	60294 J	Jul 88
208	60296 J	Jul 88
209	60297 J	Jul 88
210	60298 J	Jul 88
211	60299 J	Jul 88
212	60300 J	Jul 88
213	60301 J	Jul 88
214	60302 J	Jul 88
215	60304 J	Jul 88
216	60305 J	Jul 88
217	60306 J	Jul 88
218	60307 J	Jul 88
219	60308 J	Jul 88
220	60309 J	Jul 88
221	60326 J	Jul 88
222	60327 J	Jul 88
223	60328 J	Jul 88
224	60329 J	Jul 88
225	60330 J	Jul 88
226	60331 J	Jul 88
227	60332 J	Jul 88
228	60389 J	Jan 89
229	60391 J	Jan 89
230	60416 J	Oct 88
231	60420 J	Oct 88
232	60423 J	Oct 88
233	60424 J	Oct 88
234	60429 J	Oct 88
235	60430 J	Oct 88
236	60431 J	Oct 88
237	60436 J	Oct 88
238	60437 J	Oct 88
239	60442 J	Oct 88
240	60446 J	Oct 88
241	60447 J	Jan 89
242	60448 J	Oct 88
243	61446 J	Jan 89
244	61447 J	Jan 89
245	61448 J	Jan 89

#	serial no.	Initial date
246	61449 J	Jan 89
247	61450 J	Jan 89
248	61451 J	Jan 89
249	61452 J	Jan 89
250	61457 J	Jan 89
251	61459 J	Jan 89
252	61460 J	Jan 89

Table 3: Aluminum fuel cylinders sold by Schroeder fire balloons