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**REPAIRMANUAL**

**FOR THE**

**MOTORGLIDER**

***DG-1000T***

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**Repair manual DG-1000T**

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## Repair manual DG-1000T

### 1 Preface

The purpose of this repair manual is to provide basic repair instructions for minor damage to GFRP and CFRP gliders. (Glass and Carbon fibre reinforced plastics). Detailed information regarding all the processing of GFRP and CFRP is not given in this manual assuming that all repair work will only be carried out by people with practical knowledge in the use of these materials.

The repair of gliders should not be used to learn FRP laminating techniques.

Before beginning any repair work carefully determine what materials, tools, jigs and repair methods are to be used. The required information can be found in this manual. To insure that the aircraft performance is maintained, the surface finish of the repair work should be of the same quality as the original finish.

When doubts arise as to the reparability of damage, the DG Flugzeugbau factory should be contacted for further information.

The information in this manual refers only to repairs of minor damage like holes in the underside of the fuselage resulting from a wheel up landing, or damage from hangar accidents etc, see 2.

Major damage which is outside the scope of this manual should only be repaired by a certified repair station rated for composite aircraft structure work.

**Note:** For repair- and servicing work on parts of the equipment and for motorgliders on the power plant, the instructions in the maintenance manual of the aircraft and the manuals belonging to the equipment parts are to be followed.

**2 Definition of minor damage**

Only the damage listed below can be considered as minor damage repairable by oneself.

1. Any damage limited to gelcoat or filler.
2. Holes in the fuselage underside where the average diameter does not exceed:

Forward fuselage	80 mm (3 in.)
Rear fuselage	40 mm (1.5 in.)
Cracks in fuselage underside max.	
Forward fuselage	120 mm (5 in.)
Rear fuselage	80 mm (3 in.)
The fuselage glued joint (rear fuselage) should not be damaged.	

3. Holes, cracks and tears, bubbles etc. in the wings, horizontal stabilizer and control surfaces skins where the damage does not exceed:

	average	diameter	Crack length
Wings	100 mm	(4 in.)	150 mm (6 in.)
Horiz. stabilizer	50 mm	(2 in.)	80 mm (3 in.)
Rudder	50 mm	(2 in.)	80 mm (3 in.)
Wingflaps, Ailerons, Elevator	30 mm	(1.2 in.)	50 mm (2 in.)

The above parts should not be damaged in the spar area.  
When repairing control surface refer to section 5.8 page 13.

4. Replacement of bent fittings: Part numbers, see diagrams in the maintenance manual. Damaged fittings should not be repaired but replaced.

**3 Tools and facilities required**

**Tools**

- Accurate weighing scales for the correct mixing of resin and hardener
- Containers and wood mixing sticks
- Brushes (short hair) to apply the resin
- Metal roller to press down the glass cloth and to force the air out to reduce the formation of bubbles
- Scissors to cut the fabric
- Adhesive tape
- Plastic film for a tempering tent
- Hot air blower
- Abrasive paper - various grades
- Knife
- Saw to cut tough plastic
- Rubber hand gloves
- Accurate thermometer up to 60°C (140° F)

**Facilities**

To insure proper curing, the room temperature during repair work and at least 12 hours afterwards should be maintained at 21°C (70° F). After that the repaired parts are to be tempered. Therefore you may construct a tempering tent, using plastic film or Styrofoam plates.

**4 Material list for FRP repairs**

**Resinsystems for repairs**

Resin	with Hardener	mixing ratio by weight
Bakelite Rütapox L 20 or MGS L 160 or MGS L 285	Bakelite SL 50  MGS H 163  H 286	100:30  100:28  100:38

The repaired areas must be tempered for 20 hours at a min. of 54°C (129°F) before the next take-off.

**Fibre glass fabric**

Interglas No.	US-No.	Weave	Weight (g/m <sup>2</sup> )
90 070	1610	Linen	80
92 110	--	Twill	163
92 125	--	Twill	280
92 130	--	Linen	390
92 140	--	Twill	390
92 145	180-150	unidirectional	220

All fabrics - finish I 550 or FK 144

**Fibre Glass Rovings**

Gevetex EC-10-2400 K 92 with Silan finish

**Carbonfibre fabric**

Weight g/m <sup>2</sup>	Weave	Manufacturer	Type
fabric with fibres HTA 3000 appr.205	Linen	Sigri Interglas	KDL 8003 98140
appr.205	Twill	C. Cramer Sigri Interglas	C 450 KDK 8042 98141
appr.245	Twill	C. Cramer Sigri Interglas	C 452 KDK 8043 981541
appr.120 fabric with fibres M40JB 6000 (high modulus)	unidirectional Linen	Interglas	04387
appr.200	Linen	Sigri	KDK 8040/T

<b>Carbonfibre tape</b>	Sigri KDU 1009 7.5 cm (3 in) wide
<b>Carbonfibre rovings</b>	TOHO or TENAX HTA 24000 or TENAX HTS 24000
<b>Diolen fabric</b>	C. Cramer style 14 K (158 g/m <sup>2</sup> ) (as core in the ailerons of the outboard wings and in the trailing edges of the stabilizer and the wings in the aileron region)
<b>Foam</b>	Diab GmbH - Divinycell H 60 colour green  Röhm GmbH - Rohacell 51 colour white Rohacell 71 colour white, (only for the shear web of the wing spar).
<b>Tubus – core</b>	(as core in the fuselage tail boom) Tubus Bauer Tubuswaben B 6 6mm thick, colour grey or white
<b>Paint</b>	UP (Polyester Gelcoats) Lesonal UP Schwabbellack 0369066 with hardener 0720510 mixing ratio: 100:2 Up to 10 % thinner 0630260 can be used.  or MGS T35 with hardener SF 2 mixing ratio: 100:2-3 Up to 10 % thinner SF can be used.  or PUR paint if such paint was optionally applied.

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### Glue for Plexiglas

To attach the canopy:

glue Casco Nobel	1805	Foss Than 2K
hardener Casco Nobel	1821	Curing Agent
mixing ratio	3 : 1	by weight
	or 2 : 1	by volume

thickened with Aerosil.

Kleber Henkel Teroson	Macroplast	UK 8303 B60
Härter Henkel Teroson	Macroplas	UK 5400
Mischungsverhältnis:	6 : 1	by weight
	oder 4,4 : 1	by volume

thickened with Aerosil.

To repair cracks in the canopy:

Röhm Acrifix 92 which hardens by exposure to light.

### Filler

For glueing, the resin-hardener mix should be thickened with chopped cotton fibres FL 1 f. (add enough so that the resin no longer flows). The surfaces to be glued should be wetted with non-thickened resin + hardener before.

To glue foam pieces into place when repairing sandwich sections and to fill in irregularities and gaps etc. around the repair, Microballoon BJO - 0930 can be used mixed with the resin + hardener. Application and mixing is the same as for the cotton flocks.

### Sources for material

All materials can be obtained from the DG Flugzeugbau Factory.

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### 5 Instructions for FRP repairs

#### 5.1 General

See also section 2 and 3.

Only materials listed in section 4 should be used.

Only damage defined in section 2 should be repaired.

Cut out damaged area, roughen the surrounding area for the overlap required see section 6.

Repairs should be made such that bonding is **wet over dry**. Specific details concerning handling and using fibre reinforced plastics can be obtained from various publications ie. "Petite Plane Patch Primer."

The use of Carbonfibre is the same as for glasfibre, except that the Carbonfibres should not be kinked and only the specified resins are used see section 4.

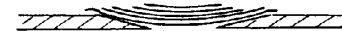
All repairs should be tempered for 20 hours at 54°C (129°F) before the next take off.

#### 5.2 Repairs of a FRP shell

Prepare the repair area as specified above. Scarf the shell so that the individual layers of fabric can be seen like plywood layers. Remove the gelcoat for at least 20 mm (.8 in.) around the damaged area.

New lay-up as shown on the sketch.

outside



### 5.3 Repairing the outer skin of a foam sandwich panel

Cut out the damaged area, remove the gelcoat over the overlap area +10 mm (0.4 in.) around the damaged area. Fill the damaged foam area with resin thickened with microballoons (microballoons-resin), let harden. Sand down. With a round headed hammer tap the outer skin around the hole so that the foam is somewhat compressed, therefore heat this area to ca. 60°C (140°F). Apply the new cloth.

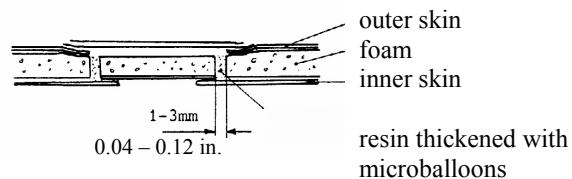
### 5.4 Repair of outer and inner skin of a sandwich panel

See section 5.3. Additionally remove as much foam as is needed so that the entire damage to the inner skin can be seen plus enough undamaged inner skin as is required for overlapping. If the inner skin still holds together, sand properly and lay up the new cloth over it. Insert a suitable cut piece of foam, 1-2 mm (0.04 to 0.08 in.) thinner than the original, glued in with microballoons-resin.

Should the inner skin be so damaged that the above process cannot be used, the inner skin fabric should be applied to the foam first and left to harden before inserting into the repair area. Microballoons-resin should once again be used.

For lay up of the fabric to the foam, a layer of microballoons-resin should be applied first to eliminate the formation of airbubbles.

Apply the outer layers as in section 5.2.



### 5.5 Repair of a sandwich panel with tubus core (fuselage)

The repair method is similar to a foam core with the following differences:

1. The outside skin can't be pressed into the tubus core. An accurate scarf is necessary.
2. To get a good bonding to the skin you have to fill the holes of the tubus core with microballon-resin mixture.

### 5.6 Repairing small dents in a sandwich panel skin (no cracks in the gelcoat)

Small dents can usually be removed by heating up to 60° to 70° C (140° - 158°F). Use a hot air blower to heat the area of the dent. The crushed foam will then spring back to its original form, so that the dent will hardly be seen. Final sanding with wet sandpaper grade 600 should finish the job. In more severe cases, one coat of gelcoat will remove all trace of the dent.

**5.7 Outer skin finish**

Repairs should be such that the area is exactly level or only slightly higher than the surrounding skin surfaces. Sand the hardened repair surface with dry grade 80 sandpaper. Fill with Polyesterfiller, let dry and sand with dry sandpaper. When the surface is smooth, sand the repair area and at least 5 cm (2 in.) of the surrounding gelcoat with wet sandpaper grade 400. Spray the repair area with UP gelcoat. After the gelcoat has hardened, sand with grade 400, 600 and 800 and eventually 1000 wet sandpaper until the surface is smooth.

**Note:** In case of Polyurethane painting, the PU paint will be sprayed onto the UP gelcoat surface after sanding with grade 600. When hardened continue sanding with grade 800 and 1000.

Polish with a power buffer (electric drill or similar with cloth polishing wheel). Apply a block of wax onto the rotating polishing wheel and then polish the repaired area. Do not polish in only one direction, and do not polish one spot for too long so that overheating occurs, see sect. "general maintenance" in the maintenance manual.

**5.8 Repairing control surfaces**

After the repair the mass balance must be checked again with the values given in the maintenance manual. Should the maximum values be exceeded, then the parts have to be replaced.

**6 Types of materials and overlap dimensions**

The following overlap dimensions are to be maintained. Use the materials given, see also pages 6 and 7. (Smaller reinforcements on high stressed areas are not given in the table below).

Part	overlap b		fabric type, etc. d=diagonal $\pm 45^\circ$ l= $\pm 90^\circ$
	(cm)	(in.)	
<b>Inboard wing panel</b>			
Exterior skin	3	1,2	1 x 90070 l outside +1x205g/m <sup>2</sup> carbonfibre d whole wing
Core	/	1,2	+1x205g/m <sup>2</sup> carbonfibre d from root up to 3160 mm from root H60 8mm thick up to y= 5240mm +H60 6mm from y= 5240mm up to parting
Inner skin	3	1,2	1x205g/m <sup>2</sup> carbonfibre d whole wing 1x carbonfibre 120g/m <sup>2</sup> unidirectional l in direction of flight in the tank area
<b>Outboard wing</b>			
Exterior skin	3	1,2	1x90070 l outside +1x205 g/m <sup>2</sup> carbonfibre d
Core	/		H 60 3mm thick
Inner skin	1,5	0,6	1x92110 d
<b>Winglet of the outboard wing</b>			
complete shell	4	1,6	1x90070 l outside +3x205 g/m <sup>2</sup> carbonfibre d
<b>Ailerons inboard wings</b>			
Exterior skin	2	0,8	1x90070 l outside +1x200 g/m <sup>2</sup> carbonfibre M40J d
Core	/		H60 3 mm thick
Inner skin	2	0,8	1x200g/m <sup>2</sup> carbonfibre M40J d

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Part	overlap b		fabric type, etc. d = diagonal $\pm 45^\circ$ l = $\pm 90^\circ$
	(cm)	(in.)	
<b>Ailerons outboard wings</b>			
Exterior skin	2	0,8	1x90070l +1x205g/m <sup>2</sup> carbonfibre d
Core	/		1xDiolen fabric 158g/m <sup>2</sup> l
Inner skin	2	0,8	1x205g/m <sup>2</sup> carbonfibre d
<b>Stabilizer</b>			
Exterior skin	2	0,8	1x90070 d + 1x92110 d
Core	/		H 60 5 mm thick
Inner skin	1	0,4	1x90070 d whole stabilizer
	1	0,4	+1x92110 d in centre 300mm wide
	1	0,4	+1x92110 d in centre 200mm wide
<b>Elevator</b>			
complete shell	3	1,2	1x92110 d + 1x92140 d whole elevator
	2	0,8	+1x92125 d in centre 300mm wide
	2	0,8	+1x92140 d whole elevator
<b>Rudder</b>			
Exterior skin	1	0,4	1 x 90070 d
Core	/		H60 3 mm thick
Inner skin	1	0,4	1x90070 d

Part	overlap b		fabric type, etc. d = $\pm 45^\circ$ l = $\pm 90^\circ$
	(cm)	(in.)	
<b>Fuselage and fin</b>			
			l means $0^\circ$ to fuselage centre line
<b>Front part</b>	8.5	3.35	from outside to inside 1x92110 d 1x92145 l 1x92125 d 1x92140 d 1x92145 l 1x92140 d 1x92145 l

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<b>Centre section</b> from wing leading edge up to 130mm (5,1 in.) behind rear wing suspension			
	8	3.15	from outside to inside 1x92110 d 1x92145 l 1x92125 d 3x92140 d 1x92145 l
<b>fuselage tail boom</b>			
from outside to inside			
Exterior skin	3.5	1.38	1x92110 d 1x92145 l 1x92125 d
Core	/	/	Tubuscore B6 6mm thick
Inner skin	3.5	1.38	1x92140 d 1x92145 l
<b>Engine bay</b>			
Side walls	2	0.8	1x205g/m <sup>2</sup> carbonfibre d inside and outside
Rear engine bay bulkhead	2,5	1,0	1x245g/m <sup>2</sup> carbonfibre d inside and outside
UD-tapes beside the engine bay cut out	10	4.0	4 CFK-Bänder KDU 1009 7,5 cm breit
<b>Fin</b>			
from outside to inside l means $90^\circ$ to fuselage centre line			
Exterior skin	2	0.8	1x92110 d 1x92145 l
Core	/	/	H60-3mm thick
Inner skin	1.5	0.6	1x92110 d + 1x92145 l up to 600mm above fuselage centre line

**Note:** There are several other reinforcements in the fuselage-fin intersection and near the top of the fin.