



REPAIR MANUAL
FOR SAILPLANES AND MOTORGLIDERS

DG-1000

TYPE: DG-1000
VARIANT: DG-1000S
DG-1000T
DG-1000M

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Repair manual DG-1000

0 General

0.1 Amendments

No.	Page	Description	Date
1	all	Combination of the initial repair manuals of the Variants DG-1000S and DG-1000T, inclusion of variant DG-1000M, new standardized format	December 2000
2	2.1, 4.1 – 4.3, 5.1, 5.3, 6.3	Miscellaneous changes to the contents of the latest amendments of the initial repair manuals	December 2010

0.2 List of effective pages

Section	page	issued	replaced /	replaced /	replaced /
0	0.0	December 10			
	0.1	"			
	0.2	"			
	0.3	"			
1	1.1	December 10			
2	2.1	December 10			
3	3.1	December 10			
4	4.1	December 10			
	4.2	"			
	4.3	"			
5	5.1	December 10			
	5.2	"			
	5.3	"			
6	6.1	December 10			
	6.2	"			
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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 repairability 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 section 2.

Major damage which is outside the scope of this manual should only be repaired by a certified repair station or by an approved mechanic 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 Repairs of composite structures, General

Caution: You are only allowed to use the materials specified in section 4. Use only genuine spare parts.

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

For all aircraft under EASA regulations the following applies: According to part 21, subpart M to accomplish major repairs an approved repair instruction is required, see also TN DG-G-01 “Approved repair methods according to EU Commission Regulation 1702/2003 part 21, subpart M”

Definition of minor damage:

- a. All damage to paint and fillers.
- b. Holes on the belly of the fuselage if the maximum diameter does not exceed the following:
 Forward fuselage 80 mm
 Aft boom 40 mm
 Cracks in the belly maximum length:
 Forward fuselage 120 mm
 Aft boom 80 mm
 The blind glue joints of the fuselage boom should not be damaged.
- c. Holes, cracks and blisters in the wings, tail, and control surfaces, not in excess of the following dimensions:

	Diameter	Length
Wings	100 mm	150 mm
Stabilator	50 mm	80 mm
Aileron	50 mm	80 mm
Rudder	50 mm	80 mm

The parts must not be damaged in the spar area.

- d. Replacement of bent fittings (part No.’s see diagrams in the maintenance manual).

Caution: Damaged fittings should not be repaired but must be replaced.

Note: Special hints for handling FRP repairs are found in the Petite Plane Patch Primer (Author U. Hänle).

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

4.1 Resinsystems for repairs

Resin	with Hardener	mixing ratio by weight
Momentive EPIKOTE™	EPIKURE™ Curing	100:28
Resin MGS LR 160 (L 160)	Agent MGS LH 160	
or		
Momentive EPIKOTE™	EPIKURE™ Curing	100:40 ±2
Resin MGS LR 285	Agent MGS LH 286	
or		
Momentive EPIKOTE™	EPIKURE™ Curing	100:35 ±2
Resin MGS LR 385	Agent MGS LH 386	

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

Caution for variant DG-1000M: The engine bay walls shall be repaired only with LR 160/LH 160.

4.2 Fibre glass fabric

Interglas No.	US-No.	Weave	Weight (g/m²)
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

4.3 Fibre Glass Rovings

Gevetex EC-10-2400 K 92 with Silan finish

4.4 Carbonfibre tape

Sigri KDU 1009 7.5 cm (3 in) wide

4.5 Carbonfibre rovings

TOHO or TENAX HTA 24000 or TENAX HTS 24000

4.6 Diolen fabric

C. Cramer style 14 K (158 g/m²)

(as core in the ailerons of the outboard wings and in the trailing edges of the stabilizer and the wings in the aileron region)

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4.7 Carbonfibre fabric

Weight g/m ²	Weave	Manufacturer	Type
fabric with fibres HTA 3000			
appr.205	Linen	Sigri Interglas C. Cramer	KDL 8003 98140 C 450
appr.205	Twill	Sigri Interglas C. Cramer	KDK 8042 98141 C 452
appr.245	Twill	Sigri Interglas C. Cramer	KDK 8043 981541 C 462
appr.120	unidirectional Linen	Interglas C. Cramer	04387 Style 763
fabric with fibres M40JB 6000 (high modulus) (Inboard ailerons)			
appr.200	Linen	Sigri	KDK 8040/T

4.8 Foam

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).

4.9 Tubus – core

Tubus Bauer Tubuswaben B 6 6mm thick, colour grey or white (as core in the fuselage tail boom)

4.10 Paint

UP (Polyester Gelcoats)

AkzoNobel UP Schwabbelack 4292352 (0369066) with hardener
0720510
mixing ratio: 100:2
up to 10 % thinner 0630260 may be used.

or

Momentive T35 with hardener SF 2
mixing ratio: 100:2-3
up to 10 % thinner SF may be used.

or (available in the USA)

Simtec Prestec 2781 Super White Polyester Coating with catalyst
D MEKP UN3105
mixing ratio: 100:2, no thinner

or

PUR paint

if such paint was optionally applied.

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Fire resistant paint for engine bay: see section 5.9

4.11 Glue for Plexiglas

To attach the canopy:

Glue Henkel Teroson	Macroplast	UK 8303 B60
Hardener Henkel Teroson	Macroplast	UK 5400
Mixing ratio:	6 : 1	by weight
	or 4,4 : 1	by volume

thickened with Aerosil.

To repair cracks in the canopy:

Röhm Acrifix 192 which hardens by exposure to light.

4.12 Filler

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

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.

4.13 Sources for material

All materials can be obtained from the DG Flugzeugbau Factory.

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.

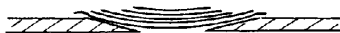
All repairs should be postcured for 20 hours at 54°C (129°F) before the next take off.

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.

Heat the area around the hole to approx. 60°C (140°F). Then tap the outer skin with a round headed hammer so that the foam is somewhat compressed. Apply the new cloth.

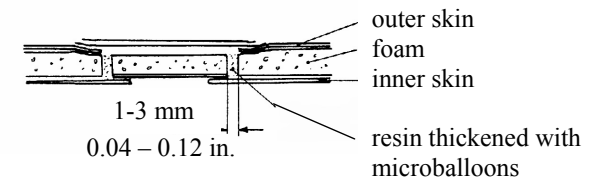
5.4 Repair of outer and inner skin of a sandwich panel

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 5.3.



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.

5.9 Engine bay insulation

Damaged fire resistant paint must be removed and repaired: 2 coats of „Pyroplast ST 100“ must be applied. The paint must dry for 24 hours at min. 20°C after each coat has been applied.

Then apply one coat of top coat:

DG-1000T: „Icosit PUR Color“ (Mixing ratio 92:8 by weight).

DG-1000M: „Pyroplast-ST 120 top“. Let dry for another 24 hours at min. 20°C.

Only DG-1000M: Apply aluminium tape (Tesametall 4504, 100 mm wide) to cover the repaired area.

6 Types of materials and overlap dimensions

The following overlap dimensions are to be maintained. Use the materials given, see also section 4. (Smaller reinforcements on high stressed areas are not given in the table below).

Part	overlap b		fabric type, etc. d=diagonal ± 45° l= 0°, 90°
	(cm)	(in.)	
Inboard wing panel			
Exterior skin	3	1,2	1 x 90070 l outside +1x205g/m ² carbonfibre d whole wing
	3	1,2	+1x205g/m ² carbonfibre d from root up to 3160 mm from root
Core	/		H60 8mm thick up to y= 5240mm, H60 6mm from y= 5240mm up to parting
Inner skin	3	1,2	1x205g/m ² carbonfibre d whole wing +1x carbonfibre 120g/m ² unidirectional l in direction of flight in the tank area
Outboard wing			
Exterior skin	3	1,2	1x90070 l outside +1x205 g/m ² carbonfibre d
Core	/		H 60 3mm thick
Inner skin	1,5	0,6	1x92110 d
Winglet of the outboard wing complete shell			
	4	1,6	1x90070 l outside +3x205 g/m ² carbonfibre d
Ailerons inboard wings			
Exterior skin	2	0,8	1x90070 l outside +1x200 g/m ² carbonfibre M40J d
Core	/		H60 3 mm thick
Inner skin	2	0,8	1x200g/m ² carbonfibre M40J d
Ailerons outboard wings			
Exterior skin	2	0,8	1x90070l +1x205g/m ² carbonfibre d
Core	/		1xDiolen fabric 158g/m ² l
Inner skin	2	0,8	1x205g/m ² carbonfibre d

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Part	overlap b		fabric type, etc. d = diagonal $\pm 45^\circ$ l = $0^\circ, 90^\circ$
	(cm)	(in.)	
Stabilizer			
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
Elevator			
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
Rudder			
Exterior skin	1	0,4	1x90070 d
Core	/		H60 3 mm thick
Inner skin	1	0,4	1x90070 d
Fuselage and fin			
			l means 0° to fuselage centre line
Fin from outside to inside			
			l means 90° 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
Fuselage front part from outside to inside			
	8.5	3.35	1x92110 d 1x92145 l 1x92125 d 1x92140 d 1x92145 l 1x92140 d 1x92145 l

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Part	overlap b		fabric type, etc. d = $\pm 45^\circ$ l = $0^\circ, 90^\circ$
	(cm)	(in.)	
Fuselage centre section from wing leading edge up to 130mm (5,1 in.) behind rear wing suspension			from outside to inside
	8	3.15	1x92110 d 1x92145 l 1x92125 d 3x92140 d 1x92145 l
Fuselage tail boom 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
Engine bay DG-1000T			
Side walls	2 each	0.8 each	1x205g/m ² carbonfibre d inside and outside
Rear engine bay bulkhead	2,5 each	1,0 each	1x245g/m ² carbonfibre d inside and outside
UD-tapes beside the engine bay cut out	10	4.0	4 CFRP-UD-tapes 300 g/m ² 7.5 cm wide
Fuselage shell between engine bay walls additionally	2 each	0.8 each	1x205g/m ² carbonfibre d inside and outside
Engine bay DG-1000M			
Side walls	2 each	0.8 each	2x205g/m ² carbonfibre d inside and 1x205g/m ² outside
Rear engine bay bulkhead	2,5 each	1,0 each	2x245g/m ² carbonfibre d inside and outside
UD-tapes beside the engine bay cut out	25	10	10 CFRP-UD-tapes 300 g/m ² 7.5 cm wide
Fuselage shell between engine bay walls additionally	2 each	0.8 each	1x205g/m ² carbonfibre d inside and outside

Caution: There are several other reinforcements in the fuselage-fin intersection and near the top of the fin and at the engine bay components.