

REPAIR MANUAL

FOR SAILPLANES TYPE ASW 12, ASW 15, and ASW 17, ASW-20

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## 2. General Guidelines

Repairs shall only be made by using materials which are suitable for the repair. These materials have to conform to the specifications as established by the civil or military safety authorities and have to be stored according to instructions.

It is, therefore, advisable, prior to entering any contests to stock up on glass fiber cloth and epoxy resin, to obtain the more important lamination diagrams from the manufacturer and to store these repair materials including the glass cloth in an airtight container at approx. 20° Centigrade. It is also recommended to familiarize oneself with the repair possibilities of glass fiber laminates by way of reading all existing technical literature on the subject.

Available are :

German language : preliminary guidelines for the repair of fiberglass ( GFK = FRP ) parts, issued by the DFL, Municipal Airport in Braunschweig.

English language: MIL - Handbook - 23, part 1, issued by the U.S. Government printing office, Washington, D.C.

In order to avoid any extreme concentration of tensile forces, one should avoid abrupt changes in layer thickness and in case of any cut-out areas should make them oval or round rather than rectangular in shape. If at all possible, the transition from the damaged to the sound area should be made gradually.

The scarfing ratio of normal fiberglass laminates is from 1 : 50 to 1 : 100. Thin fiberglass laminates cannot be scarfed. The proper solution here is a lap joint. The recommended length of lap joints is as follows : Normal cross weave ( equal strands for both directions ) - 10 mm for each 100 g/m<sup>2</sup> of weight of cloth. Mono directional weave - 20 mm lap joint in the direction of the more numerous strands per 100 g/m<sup>2</sup> weight of cloth.

The lap joint is not needed in the direction of the less numerous tie strands.

Moisture is harmful to fiberglass laminates. One should, therefore, avoid any wet sanding of repaired areas. Ideally, all repaired areas should be sealed by a coat of laquer after a possible inspection by an examiner.

### 3. Methods of Repair

The following methods of repair pertain only to comparatively minor damages. Extensive damages must be repaired by the factory or by a licensed repair shop and are subject to reinspection by an airworthiness examiner.

Since the repair of sandwich components is - due to their layer composition - especially difficult, emphasis is made on their repair. Obviously, the same repair procedures can be used for simple fiberglass skins.

#### Classification of Repair

It may be advisable in certain instances to make a preliminary repair on the spot and have the same component subjected to a thorough repair at the factory later on.

These temporary repairs are ordinarily of a superficial nature and do not fall within the scope of this manual. The following classification lists all damages in the order of their severity and impact on the airworthiness of the aircraft.

- Class 1 : Extensive damages which require a partial replacement of the component or call for an extensive repair, such as damage to a structural part which would impair the airworthiness. These must be repaired by the factory or a licensed repair shop.
- Class 2 : Smaller breakages or holes which have perforated a sandwich component and have destroyed the fiberglass cover skin on either side.
- Class 3 : Smaller breakages or holes in the outer skin, but where the supporting core and inner skin are undamaged.
- Class 4 : Eroded areas, abrasions, or scratches which are not associated with a break or perforation.

### 4. Repair Materials and Tooling Aids

It is absolutely essential for all repairs to pre-determine the number of fiberglass layers, the weight ( grams/m<sup>2</sup> ) of the used fiberglass and the prevailing direction of the glassfiber threads. This information can be obtained from the factory supplied lamination diagram for the specific component or by double checking with the factory.

In an emergency, one can also determine the fiberglass composition of a laminate by eroding the resin out of a fracture test piece with a blow torch.

All fiberglass cloth used for repairs must be Volan A or I-550 treated and must be kept dry. In case of doubt, it is recommended to dry the fiberglass with an electric heatgun before using. The epoxy resin used should be a mixture of 100 parts ( by weight ) of Epikote 162 and 38 parts ( by weight ) of Epikure 113 hardener.

Only clean containers ( lili tubs ) should be used. It is also important to stir the mixture thoroughly ( approx. 2 minutes ).

The pot life of a 100 gram batch is approx. 25 min. at a room temperature of 23° centigrade.

Once a mix has begun to gel or, in other words, when it becomes very viscous, it is no longer usable. With this stage, the epoxy has lost its ability to penetrate and impregnate the fiberglass properly.

It is also emphasized at this point that the strength of the original component can only be matched in postcuring the repaired area for 12 hours at 60° centigrade. At the same time however, temperatures in excess of 80° centigrade must be avoided.

#### 5. Preparations of the Part for Repair

All damaged parts have to be dismantled from the aircraft prior to repair. They have to be washed with soap and water and dried out thoroughly. The next step is to remove all wax and grease from the area which is to be repaired by using a commercial cleanser ( Trichlorethylene ) or ( Methylethylketone ). Finally, sandpaper of 60-80 grit is used to rough the repair areas. The immediate area adjoining is masked off as a protection against epoxy drippings.

#### 6. Repairs of Class 4

Areas eroded by rain, all kinds of other abrasions, or scratches usually do require no more than a fresh coat of finish paint, provided that the fiberglass reinforcement is not damaged. For this purpose a polyester laquer consisting of 100 parts Rhofina-PE-Hochglanzlack 33760/F and 10 parts Rhofina PE-Hardener 33720/F is very useful. Deeper scratches can be filled by using polyester laquer after it has begun to gel ( approx. 30 min. after mixing ). In case of damage to the reinforcing fiberglass, the area has to be cleaned and smoothed with sandpaper. A layer of fine fiberglass is then applied, after which complete repair area is covered with a foil.

Repairs of Class 3

The damaged area of the fiberglass cover layer is removed ( round or elliptical cut-outs should be made ). It is very important to make these cut-outs large enough so that all fiberglass layers which have separated from the balsa core are removed. By using a sanding tool a very flat scarf joint will be obtained. The various layer lines of the fiberglass ply will become visible and offer a visual check of the scarf joint : Equal spacing of these ply lines are indicative of a good, proportional joint. If the supporting balsa core is also damaged, it will have to be removed, too all the way to the interior fiberglass skin. For the repair of the balsa core it is important to use balsa with a specific weight of 0.15 - 0.19 kilogram/dm<sup>3</sup>.

The scarf ratio of balsa in the direction of long grain is 1 : 5. One need not scarf perpendicular to the woodgrain. Next the fiberglass cloth for the outer skin is cut to size in such a manner that the largest patch just covers the entire scarfed area, whereas the smallest patch should be the size of the removed balsa core patch. All in between layers should be proportional to these two outer patches.

The following technique is very practical :

Epoxy is applied by brush or spatula to fiberglass about the size of the largest patch under which some foil should be laid. Then this impregnated patch is covered up by another foil and all trapped airbubbles are smoothed out. One then cuts the patch and foil to size.

This procedure is repeated for all the other size patches. Next the pre-cut balsa piece for the core is impregnated with epoxy. Then it is set in place. Now the fiberglass patches are applied, beginning with the biggest size patch right over the balsa. One just removes the lower foil, presses the patch in place and then removes the upper foil and so on. All following steps concerning finishing off the repair after the lamination has cured are as described in class 4.

This same technique can be used for laminates which are not supported by a core. To avoid any sagging of wet fiberglass cloth, a piece of foam may have to be glued to the underside of the repair area.

( Picture No. 2 )

Repairs of Class 2

This covers the repair of components, where the complete sandwich structure has been damaged : Outer skin, supporting core, and inner skin. The first step is to cut out the damaged skins and balsa core. Again, only round or oval shaped cut-outs should be made. The cover layers receive a very flat scarf joint ( 1:50 to 1/100) by way of sanding with disc or sanding block; the supporting balsa core will be scarfed 1 : 5 in the direction of the grain. After the balsa core has been glued in, the fiberglass laminations will be applied as described in class 3. The best approach is to lay up and completely cure the skin on one side first, then to turn the component over and laminate the skin on the other side. In cases, where the inside of the sandwich is practically inaccessible, one must prepare the repair area as shown in picture no. 3.

Since the interior skins used in the ASW 12 sandwiches wings and control surfaces are as a rule rather thin, they cannot be scarfed, but must be lap jointed. This simplifies the repair somewhat, as one, therefore, does not need to scarf the inner skin. The fiberglass patches that make up the outer skin are prepared as described in class 3. The next step is to laminate the inner skin to the lower side of the balsa filler, allowing approx. 2 - 3 hours at 20 - 23° centigrade for the epoxy to gel. At this point freshly mixed epoxy is added to the glue joints of the balsa filler block and now the balsa block - with the prelaminated side to the bottom - is gently pressed in place. Finally, the exterior skin is layed up as described in class 3.

In situations, where there is a possibility of sag of the inner skin, especially when large area repairs are made, it will be advisable to support this inner skin with a slab of foam which has been glued in place prior to the actual repair. In case of inaccessible areas, this supporting foam will have to be left right inside the component.

Repairs of Class 1

Should be made at the factory or a licensed repair shop.

It is imperative in any case to contact the manufacturer as well as the local airworthiness authorities.

Repairs of Class 2

This covers the repair of components, where the complete sandwich structure has been damaged : Outer skin, supporting core, and inner skin. The first step is to cut out the damaged skins and balsa core. Again, only round or oval shaped cut-outs should be made. The cover layers receive a very flat scarf joint ( 1:50 to 1/100) by way of sanding with disc or sanding block; the supporting balsa core will be scarfed 1 : 5 in the direction of the grain. After the balsa core has been glued in, the fiberglass laminations will be applied as described in class 3. The best approach is to lay up and completely cure the skin on one side first, then to turn the component over and laminate the skin on the other side. In cases, where the inside of the sandwich is practically inaccessible, one must prepare the repair area as shown in picture no. 3.

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Repairs of Class 1

Should be made at the factory or a licensed repair shop.

It is imperative in any case to contact the manufacturer as well as the local airworthiness authorities.

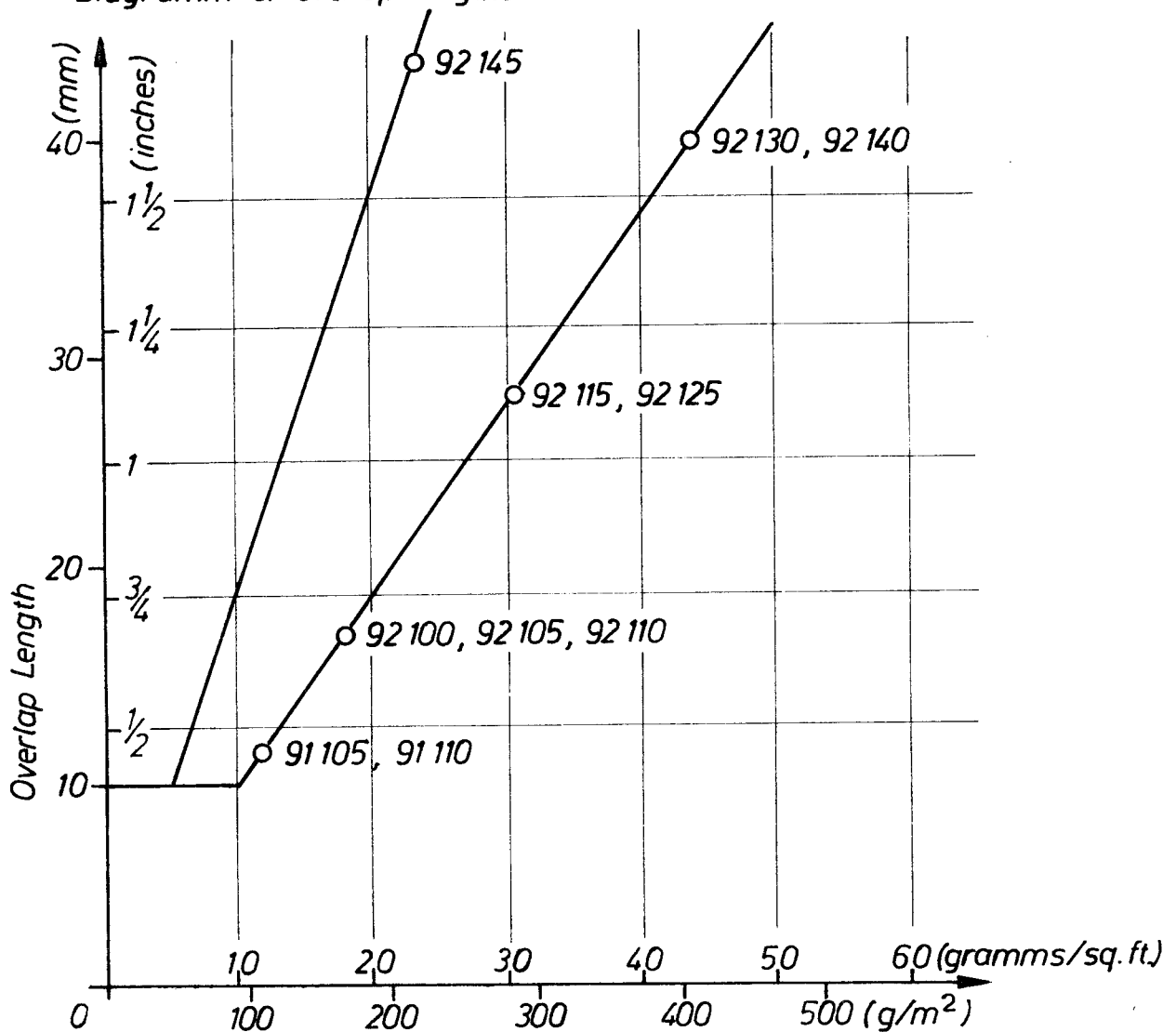
**7. Conclusion**

Important factors for a successful repair are :

1. a well - lighted, warm ( 20° centigrade ), and dry room ( 50 % relative humidity )
2. Keeping scarf and lamination joints free from grease as well as perspiration of one's hand.
3. Using the recommended materials. Epoxy and catalyst should be not older than two years.
4. Using Volan A or I 550 treated fiberglass which has been stored in a dry place.
5. Observing the recommended pot life and curing times ( cristallized hardener can be regenerated by warming it to 30° centigrades ).

**8. Appendix**

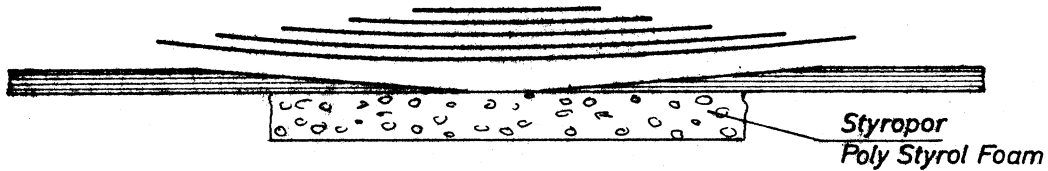
Diagramm of overlap lengths



Scarf joints can be half as long as overlap joints.

31.10.75 L.H. Jumbo

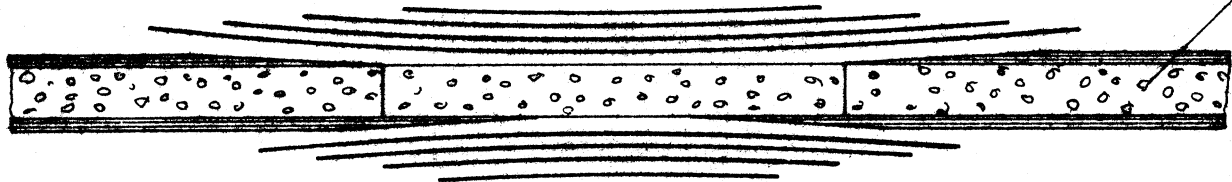
**Bild 1:** Reparatur der Klasse 3  
**Fig. 1:** Repair of Class 3



**Bild 2:** Reparatur der Klasse 2 (Innenseite zugänglich)  
**Fig. 2:** Repair of Class 2 (inside skin accessible)

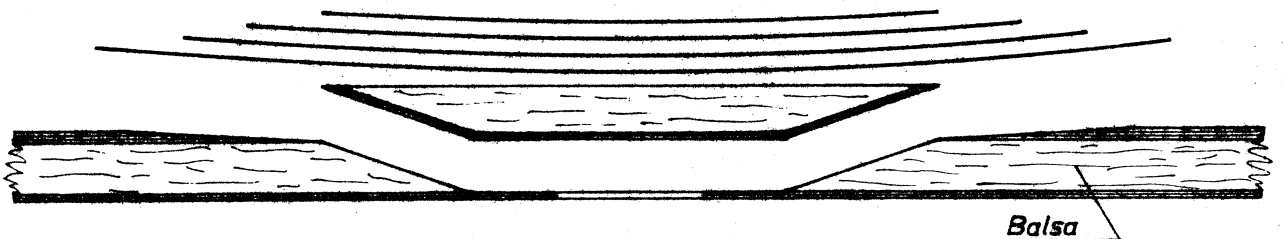


Schaum od. Tubuskern  
Foam or Tubuscore



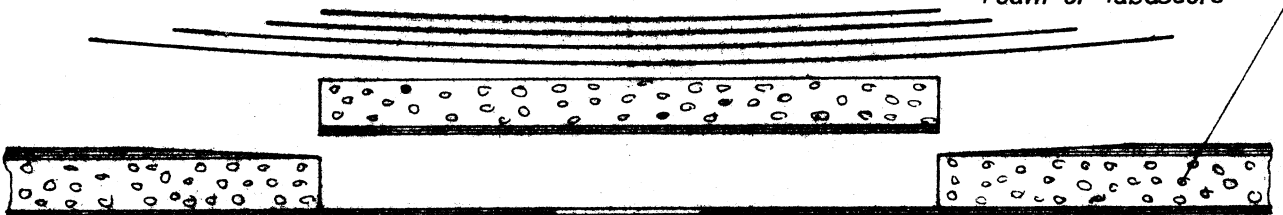
**Bild 3a:** Reparatur der Klasse 2 (Innenseite unzugänglich)  
**Fig. 3a:** Repair of Class 2 (inside skin inaccessible)

Vorbereitung der Reparaturstelle. - Preparation of the repair area.



**Bild 3b:**  
**Fig. 3b:**

Schaum od. Tubuskern  
Foam or Tubuscore



Schäftungen sind stark verkürzt gezeichnet!  
All scarf joints are much shorter in these figures than they must be actually!

Glasgewebe - Bezeichnungen (glass code)

Muster (sample)

Interglas (Werkstoff nach LN) Flächengewicht (g/m<sup>2</sup>)

91 110

8. 4545.

106

92 100

163

92 110

8. 4548.

163

92 115

280

92 125

8. 4551.

280

92 130

395

92 140

8. 4554.

395

92 145

8. 4520.

220

92 146

8. 4525.

440

