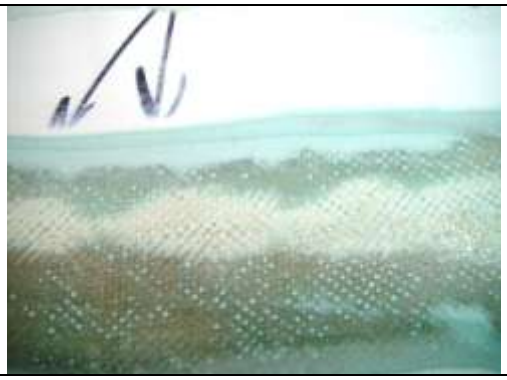
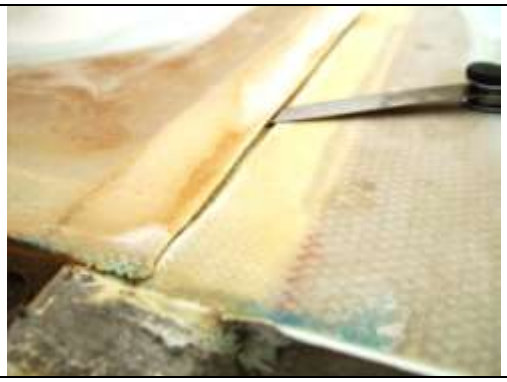
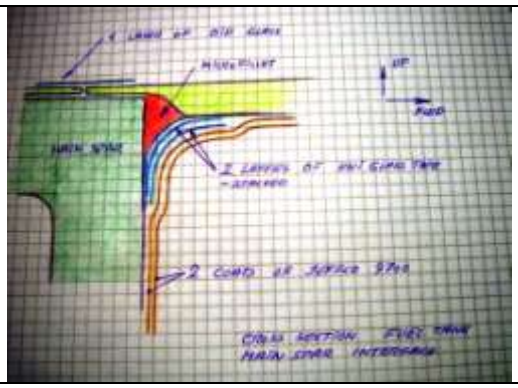
Repair of fuel tanks
Pulsar 912 XP
OY-LLE

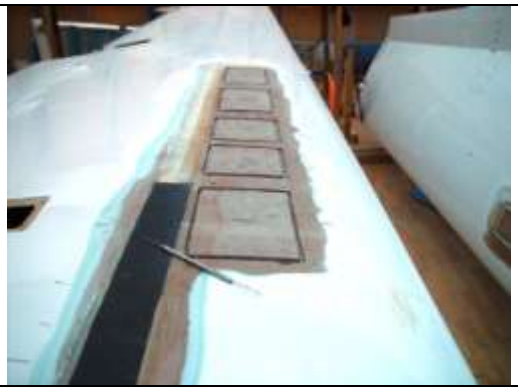
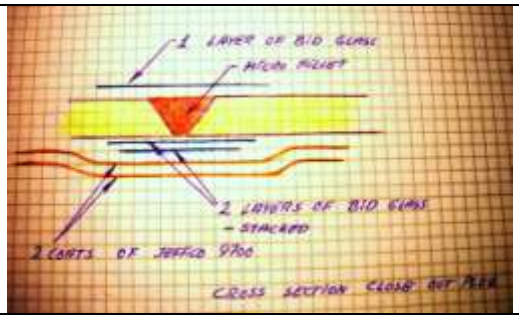
POS	Picture	Comments
1		The plane was removed from service due to what was expected to be the “normal” Pulsar repair. (No visible leaks just gasoline smell and indications) Pulsars with wing tanks are known to develop leaks behind the fuel tank close out panel, due to relative movement between tank skin and an aluminium bracket fixed to the main spar. However upon removal of wings; a number of bubbles and paint failures were found above fuel tank / main spar joint spar of the right hand wing.
2		Upon removal of close-out panels it became clear that the sealant was not at all a sealant, but an unprotected fillet of epoxy mixed with micro balloons. According to AeroDesign construction manual these fillets should have been covered with 2 layers of glass tape, before a protective cover of Jeffco 9700 was added. Unfortunately AeroDesigns – who had manufactured and partly assembled wings – had not followed their own building manual! The part was never questioned as the wing was delivered in a finished state from AeroDesigns. The Micro fillet had become elastic / rubber like as a result of exposure to fuel (Believed to be due to auto fuel, whereas resistant to Avgas) All micro fillets were attacked, although right tank seemed to be in worse condition. All fillets had to be replaced, missing glass tape and a protective cover of fuel tank sealant to be added.
3		Paint, filler and glass reinforcement was sanded down following the joint on the main spar. A number of failures were found under the right hand tank.

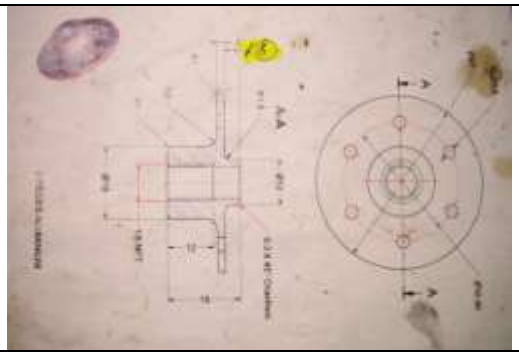
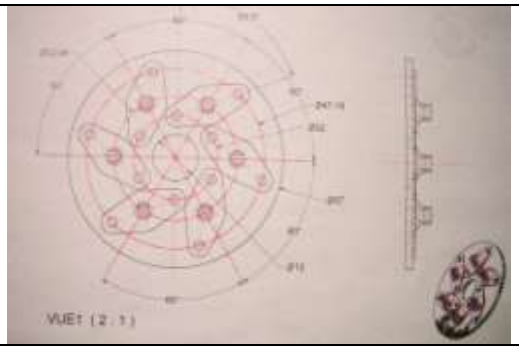
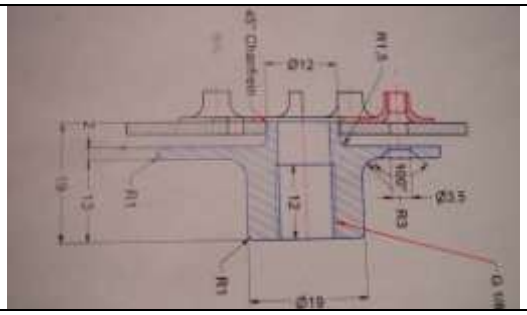
4		As picture 3, but close up. Attacked areas are clearly visible.
5		Top of wing was sanded down following the spar joint, but no failures were found.
6		Close up of interface spar and fuel tank flange with micro partly removed. Note how fuel has penetrated micro down into, and damaged the joint. The micro held fuel which could be smelled when working the micro...but not in liquid phase.

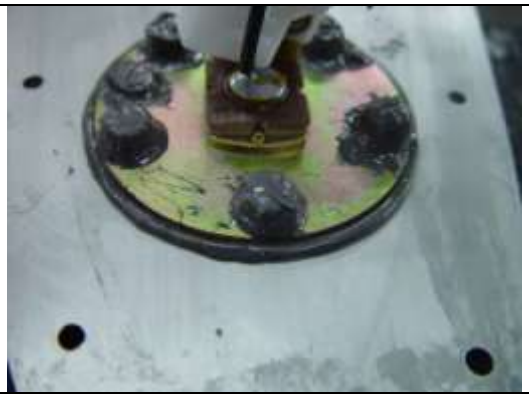
7		The bond main spar to fuel tank flange was non existing, and a feeler gauge passed easily through the slot. This is true for both tanks, but only over a distance of app 300mm from tank close out and outboard. Rest of the flange length the adhesion was OK The main spar and wing skin / epoxy was checked and found unaffected.
8		As picture 7 but right hand wing.
9		Even reinforcement for drain valves – that are bonded on to the wing skin had been attacked due to a surface of a few tenths of a millimetre exposed to fuel. Note miscolouring of micro / epoxy.

10		To gain access to both chambers of fuel tanks a total of 5 openings were made in the underside of each tank.
11		All micro was removed from inside the tank, and below the flange (300mm) Groove sanded and cleaned. Picture shows underside of top skin for left hand tank
12		New micro in place and covered with 2 layers of glass tape, as per AeroDesign original description.

13		All exposed epoxy / glassfiber is covered with 2 coats of Jeffco 9700 fuel tank sealant. Vent tube moved closer to top of tank reducing amount of fuel being vented.
14		Sketch showing a cross section of fuel tank / main spar interface: Red is a fillet made by microbaloons / epoxy mix Blue is 2 internal layer of UNI glass tape delivered by Aerodesigns. Orange illustrates 2 coats of Jeffco 9700 sealant
15		Aluminium angle removed and replaced by a carbon fibre angle interlocking both upper and lower flange as well as main spar. This is the “traditional Pulsar fuel tank fix” ensuring no relative movement. The angle is made from 2 ply BID carbon fiber + 2 ply glasscloth likewise BID.
16		After repair and sealing, openings were plugged with the original cut away. These plugs were glassed in place with a double layer of BID glasscloth..Total 8 pieces per opening. Plugs were kept in correct position by means of aluminium profiles while epoxy hardened. Once hardened 2 coats of Jeffco 9700 were added (inside) to protect epoxy and glasscloth from fuel.

17		2 openings have been closed in this picture. Working takes place through the adjacent opening. Hose delivering warm air can be seen to the right of the picture. Epoxy was cured at 50C
18		Once all openings had been closed out, edges were opened in order to check epoxy had penetrated glass, and joint was covered by Jeffco sealant. Note the BID carbon fiber layer covering first app 700mm of skinoverlap on mainspar. This is in accordance with AeroDesigns note from 1996 calling for an reinforcement in the area.
19		All gaps were then filled with micro that after hardening out were covered with one layer of glassfibre BID.
20		Sketch showing a cross section of how plugs are refitted to tank skin: Red is a fillet of micro balloons / epoxy mix Blue are 2 stacked layers of BID glass cloth 200g /m^2 Orange illustrates 2 coats of Jeffco 9700 Outside the plug is held in place by a single BID layer

21		New fuel tank drains were machined from aluminium. They consist of an outer and inner part joined by means of 6 screws, and thus not relying on bonding, with the risk of exposing epoxy to fuel. Sealing between surfaces by means of polysulfide fuel tank sealant.
22		External part turned from billet of aluminium. Note surface area available for sealant.
23		Internal part. The 6 nutplates that joins the internal and external part are clearly visible. As above amble surface is available for sealant
24		Cross section explaining design.

25		Note the doubler made out of BID carbonfiber for the fuel drain fitting. The fitting is secured by means of 6 screws, and sealed by means of polysulfide.
26		Duplicating original openings for fasteners in fuel tank end plate would not be precise. Secondly the hole pattern for new fuel sender was different from the original. Thirdly placement of fuels sender flange inside tank would be preferable to minimize the opening in endplate as well as maximise surface for sealant. Consequently 2 new end plates were manufactured from T2024. On right hand side of plate the anti rotation bracket for the fuel pick up tube can be seen.
27		Fuel sender bolted in place and sealed by means of polysulfide. Note the extra screw added for grounding.
28		Fuel pick up tube supported by antirotation bracket....all well sealed. Antirotation bracket is secured to plate by means of 2 AN 426 AD 3- 3.5rivets Position of pick up tube is 100% identical to original position = same useable amount of fuel.

29		Complete fuel tank end plate before being fitted to tank
30		After fixation to tank by means of countersunk screws into nutplates. Entire assembly / tank flange interface sealed by means of polysulfide.
31		Set up for leakage testing of tank by means of over pressure
32		Pressuer of 200kPa or 2.5 psi were applied for more than 1 week. When compensated for temperature the pressure did not decrease.

33		Lower part of wing after applying Styrene based body filler
34		Same wing, but after 4 light coats of paint. The wing was not fully painted..Only where repair had taken place. New registration letters added – self adhesive letters.
35		As sign close to filler neck had been destroyed 2 new signs were done and positioned. Carrying the original text.

Rhino™

Rhino™ 9700
Novolac Epoxy Coating & Lining
Data Sheet

ISO 9001:2000
FM62236

Part # 9700

DESCRIPTION:

Rhino 9700 Novolac is a high quality Bis-F epoxy novolac coating and lining system which has superior chemical and abrasion resistance versus Bis-A type epoxy resins. This tightly crosslinked epoxy system cures in the presence of moisture and humidity with excellent mechanical properties. Rhino 9700 mixes using the industry standard, 2:1 by volume ratio. Having low odor, Rhino 9700 contains no solvents and is 100% solids that assures ease of application. Rhino 9700 Novolac viscosity is well suited for vertical applications.

FEATURES & BENEFITS:

- Superior chemical and abrasion resistance
- Excellent bonding
- Highly resistant to cratering or blush
- Dries to a high gloss
- Low odor
- 100% solids, no solvents
- Cures in the presence of moisture and humidity with excellent mechanical properties

APPLICATIONS:

- Recommended for vertical applications where increased resistance to acids, bases and solvents is desired.
- Great coating in areas were high concentrations of chemicals are used.
- Primary and secondary containment
- Chemical tanks and disposal pits or tunnels

CONDITIONS TO AVOID:

- Do not apply to concrete less than 28 days old.
- Do not apply to concrete with curing or sealing membranes.
- Do not apply to base concrete at a temperature less than 55°F.

APPLICATION PROPERTIES AT 77°F (25°C):

Solids by Volume (%)	100%
Volatile Organic Content (VOC)	0 lbs./gal
Mixing Ratio	2:1 by volume
Viscosity	Thixotropic (for vertical surfaces)
Pot Life (neat coating)	25 – 30 minutes
Application Temperature	55°F minimum, 100°F maximum
Maximum Re-coat Time	24 hours
Dry To Touch	6 – 8 hours
Light Traffic	14 – 16 hours
Return To Service	24 – 36 hours
Full Cure	7 days

Rhino 9700 Novolac complies with ACI Standard 503.1 - 4 and ASTM C-881-90 Type I, II, IV, V, VI and VII. Grade 2, Class B, C, D, E and F. Rhino 9700 cures in presence of moisture and humidity.

PHYSICAL PROPERTIES FOR CURED SYSTEM (cured 7 days at 77°F (25°C)):

Hardness (Shore D)	86±5	
Tensile Strength (psi)	7000 – 8000	ASTM D-638
Tensile Elongation (%)	3.2	ASTM D-638
Flexural Strength (psi)	13000 – 13800	ASTM D-790
Compressive Strength (psi)	12000 – 14000	ASTM D-695
HDT (F)	140	ASTM D-648-264
Water Absorption (% gain) 24 hrs	<1	
Bond Strength (psi) to concrete	>400, w/ 100% concrete failure	

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Rhino™ 9700

COLOR STANDARD OF RHINO™ 9700:

Light gray

HOW SUPPLIED:

Rhino 9700 is availabe in 1 gallon, 15 gallon and 165 gallon kits.

SURFACE PREPARATION:

Substrate surfaces must be structurally sound and free from contaminants such as dust, oil or dirt. Surfaces must be shot blasted or mechanically abraded to achieve a minimum 5-mil profile. Free-standing water must be removed. Do not apply over previously applied epoxies or coatings.

PRIMING:

Rhino 9700 Novolac Epoxy is self priming. For porous substrates such as concrete or other cementitious materials, best results are obtained using Primer 1500 water based epoxy primer first. Allow Primer 1500 to cure for 4 – 6 hours before applying Rhino 9700 Novolac.

MIXING:

A thorough and complete mixing is critical. First mix each component separately. Proportion each component at the ratio of 2 parts A (resin) to 1 part B (hardener) by volume or if using 1-gallon kits, pour all of Part B (hardener) into Part A (resin). Mix for 3 – 5 minutes, scraping the mixing container sides and bottom regularly. **Mix no more material than may be applied in 20 minutes.**

TANK LININGS AND SECONDARY CONTAINMENT COATINGS:

Apply mixed product by brush or roller at the rate of 15 mils (approx. 100 sq ft per gallon). Once the first coat has tacked, but not fully cured, an additional 15 mil coating may be applied. Allow the material to cure 48 hours minimum before exposure to any chemicals (product will continue to cure for 7 days to full properties).

CHEMICAL RESISTANCE GUIDE (3 week immersion)

Reagent	% weight gain (loss)	Reagent	% weight gain (loss)
Xylene	0.0	Toluene	2.3
1,1,1 Trichloroethane	0.0	MEK	2.3
EB (Ethylene Glycol Monobutyl Ether)	2.4	Ethyl Alcohol	6.9
Water (deionized)	1.2	5% Detergent Solution	0.0
10% Sodium Hydroxide	0.0	50% Sodium Hydroxide	(0.2)
10% Sulfuric Acid	0.0	70% Sulfuric Acid	0.2
10% Hydrochloric Acid	0.1	5% Acetic Acid	2.6
10% Acetic Acid	5.4	Skydrol	(0.03)
Synthetic Gasohol	0.0	Mogas, Diesel	0.0
JP-4, JP-5, JP-7, JP-8	0.0	Diethylene Glycol Monomethyl Ether	0.0

Follow general surface preparation and application procedures specified in ACI 503.1-4.

SAFETY PRECAUTIONS:

Health Considerations: Consult the Rhino Linings® Material Safety Data Sheets.
This chemical system requires the use of proper safety equipment and procedures. Please follow the Rhino Linings® product MSDS and Safety Manual for detailed information and handling guidelines.

For Your Protection:
The information and recommendations in this publication are, to the best of our knowledge, reliable. Suggestions made concerning the products and their uses, applications, storage and handling are only the opinion of Rhino Linings Corporation. Users should conduct their own tests to determine the suitability of these products for their own particular purposes and of the storage and handling methods herein suggested. The toxicity and risk characteristics of products made by Rhino Linings Corporation will necessarily differ from the toxicity and risk characteristics developed when such products are used with other materials during a manufacturing process. The resulting risk characteristics should be determined and made known to ultimate end-users and processors. Because of numerous factors affecting results, **Rhino Linings Corporation makes no warranty of any kind, express or implied,** other than that the material conforms to its applicable current Standard Specifications. Rhino Linings Corporation hereby disclaims any and all other warranties, including but not limited to those of merchantability or fitness for a particular purpose. No statements made herein may be construed as a representation or warranty. The liability of Rhino Linings Corporation for any claims arising from or sounding in breach of warranty, negligence, strict liability, or otherwise shall be limited to the purchase price of the material.

Rhino™
World-Class Protection™

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HEXION™ Specialty Chemicals

Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 10

EPIKOTE™ Resin MGS® LR 285

EPIKURE™ Curing Agent MGS® LH 285, 286, 287

Content

Characteristics

Approval	German Federal Aviation Authority
Application	production of gliders, motor gliders and motor planes, boat and shipbuilding, sports equipment, model airplanes, moulds and tools
Operational temperature	-60 °C up to +50 °C (-76 °F up to 122 °F) without heat treatment -60 °C up to +80 °C (-76 °F up to 176 °F) after heat treatment
Processing	at temperatures between 10 °C and 60 °C (50-122 °F) all usual processing methods
Features	extremly good physiological compatibility, good mechanic and thermic properties, pot life of approx. 45 min. to approx. 4 hours
Special modifications	LR 285 T: thixotropic LR 285 W: white
Storage	shelf life of 24 month in originally sealed containers

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March, 2010

HEXION™
Specialty Chemicals

Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 11

EPIKOTE™ Resin MGS® LR 285

Application

Laminating resin system approved by the **GERMAN FEDERAL AVIATION AUTHORITY** with different pot lifes for processing of glass, carbon and aramide fibres, featuring high static and dynamic loadability.

After heat treatment at 50 - 55 °C (122-131 °F), the system meets the standards for gliders and motor gliders (operational temperatures -60°C (-76°F) to +54°C (129 °F). In order to meet the standards for motor planes (operational temperatures -60°C (-76 °F) to +72 °C (161 °F), heat treatment at 80 °C (176 °F) is necessary.

The range of pot lives is between approx. 45 min and 4 h. The hardeners have the same mixing ratio and can be mixed among themselves in any ratio. This permits a selection of the optimum system for all processing methods. After initial curing at room temperature, the components manufactured are workable and demouldable. You will receive high-gloss and non-tacky surfaces, even with unfavourable precuring conditions, e. g. lower temperatures or high humidities.

The mixing viscosity guarantees fast and complete impregnation of the reinforcement fibres; however, the resin will not spill out of the fabrics on vertical surfaces. In order to obtain special properties, it is also possible to add fillers to the mixture of resin/hardener, such as Aerosil, microballoons, cotton flakes, metal powder, etc.

If high heat resistance or aircraft approval are not necessary, hardener LH 285 can also be used without heat treatment afterwards. However, the indicated properties will only be obtained after heat treatment at temperatures over 50 °C (122 °F).
As a matter of experience LR 285 can be combined with suitable gelcoats on UP, PU and EP basis.

Although our resin systems are very unlikely to crystallize at low temperatures, storage conditions of 15-30 °C (59-86 °F)and low humidity are recommended. After dispensing material, the containers must again be closed carefully, to avoid contamination or absorption of water. All amine hardeners show a chemial reaction when exposed to air, known as „blushing". This reaction is visible as white carbamide crystals, which could make the materials unusable.

Crystallization is visible as a clouding or solidification of the contents of the container. If crystallisation of either component should be observed, it can removed by warming up. Slow warming up to approx. 50-60 °C (122-140 °F) in a water bath or oven and stirring or shaking will clarify the contents of the container without any loss of quality. Use only completely transparent products. Before warming up, open containers slightly to permit equalization of pressure. Caution during warm-up! Do not warm up over an open flame! While stirring up use safety equipment (gloves, eyeglasses, gas mask).

Since the approval of laminating resin LR 285 in 1985, it has been used by nearly all manufacturers of planes and gliders and - especially because of the extremely good physiological combatibility - it is the most commonly used system in the aircraft industry today. It often happens that workers who have experienced problems with some epoxy resins concerning allergies or skin irritation are able to process laminating resin LR 285.

The relevant industrial safety regulations for the handling of epoxy resins and hardeners and our instructions for safe processing are to be observed.

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HEXION™ Specialty Chemicals

Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 12

EPIKOTE™ Resin MGS® LR 285

Specification

		Laminating resin LR 285
Density	[g/cm³]	1,18 - 1,23
Viscosity	[mPas]	600 - 900
Epoxy equivalent	[g/ equivalent]	155 - 170
Epoxy value	[equivalent /100g]	0,59 - 0,65
Refractory index		1,525 - 1,5300

Measuring conditions:
measured at 25 °C / 77 °F

		Hardener LH 285	Hardener LH 286	Hardener LH 287
Density	[g/cm³]	0,94 - 0,97	0,94 - 0,97	0,93 - 0,96
Viscosity	[mPas]	50 - 100	60 - 100	80 - 120
Amine value	[mg KOH/g]	480 - 550	450 - 500	450 - 500
Refractory index		1,5020 - 1,5500	1,4995 - 1,5100	1,4950 - 1,4990

Measuring conditions:
measured at 25 °C / 77 °F

Processing details

	Resin LR 285	Hardener LH 285	Hardener LH 286	Hardener LH 287
Average EP - Value	0,62	-	-	-
Average amine equivalent		64	64	64

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Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 13

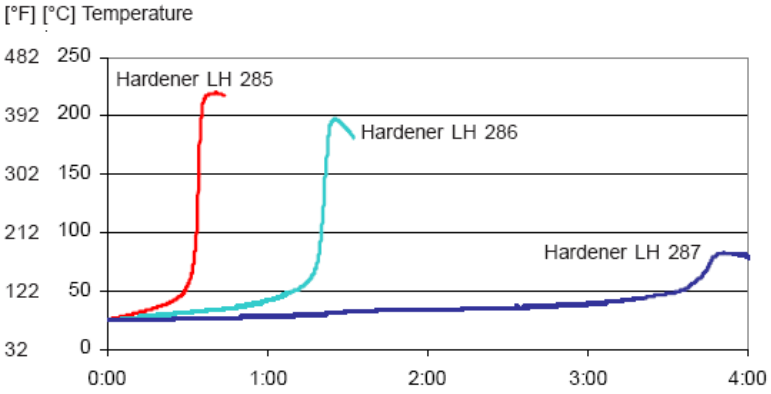
EPIKOTE™ Resin MGS® LR 285

Mixing ratios

	Laminating resin LR 285: Hardeners LH 285, 286, 287
Parts by weight	100 : 40 ± 2
Parts by volume	100 : 50 ± 2

The mixing ratio stated must be observed carefully. Adding more or less hardener will not result in a faster or slower cure, but in incomplete curing with limited performance, that can not be corrected in any way.
Resin and hardener must be mixed carefully. Mix until no clouding is visible in the mixing container. Special attention must be paid to the walls and bottom of the mixing container.

Temperature development



The optimum processing temperature is in the range between 20 and 40°C. Higher processing temperatures are possible, but will shorten pot life. An increase in temperature of 10°C will halve the pot life. Water (for example very high humidity or contained in fabrics or fillers) causes an acceleration of the resin / hardener reaction. Different temperatures and humidities dring processing have no significant effect on the mechanical properties of the cured product.

Gel time

	Resin LR 285 Hardener LH 285	Resin LR 285 Hardener LH 286	Resin LR 285 Hardener LH 287
68 - 77 °F 20 - 25 °C	app. 2-3 hours	app. 3-4 hours	app.5-6 hours
104 - 113 °F 40 - 45 °C	app. 45-60 min	app. 60-90 min	app. 80-120 min

Film thickness 1 mm at different temperatures

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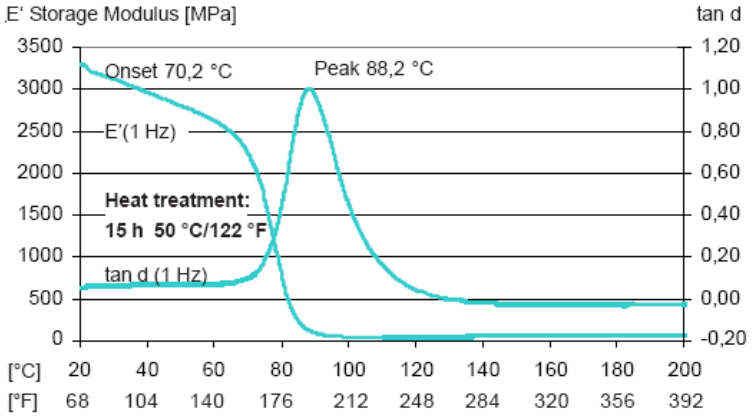
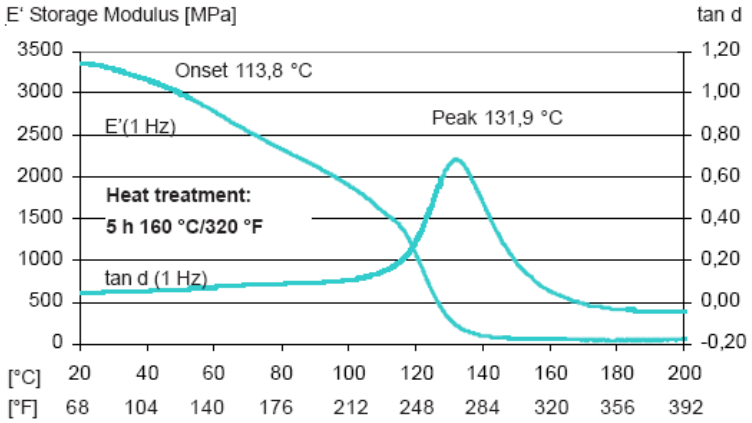
Epoxy and Phenolic Resins Division
Epoxy Resins

EPIKOTE™ Resin MGS® LR 285

DMA - T_G (peak) tan delta laminating resin LR 285 with hardener LH 286 measuring after heat treatment

DMA





Measurement conditions

Coupon thickness:	2 mm
Heating rate:	2 K/min
Frequency:	1 Hz

T_G conditioned

	Hardener LH 285	Hardener LH 286	Hardener LH 287
unconditioned	176-185 °F 80-85 °C	185-194 °F 85-90 °C	194-203 °F 90-95 °C
conditioned	149-158 °F 65-70 °C	172-179 °F 78-82 °C	181-190 °C 83-88 °C

Sample preparation:
Conditioned at 40 °C (104°F) 90 % rel. humidity

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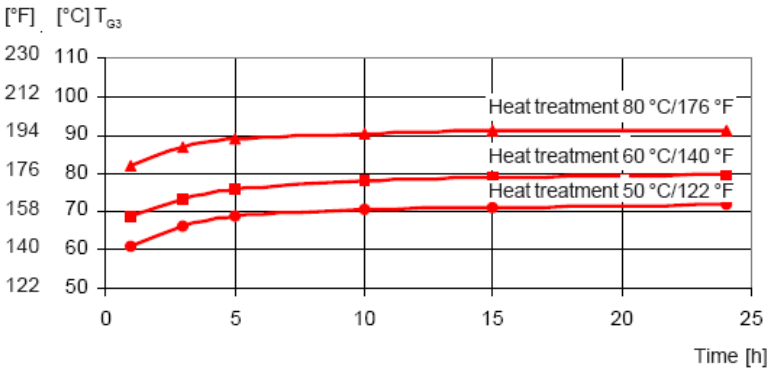
Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 1

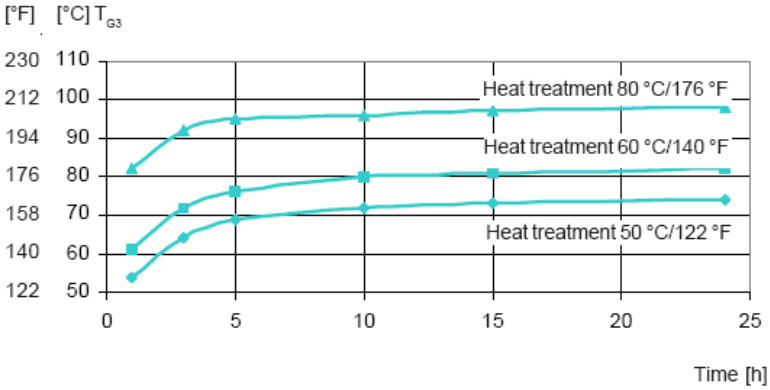
EPIKOTE™ Resin MGS® LR 285

Laminating resin LR 285 Hardener LH 285

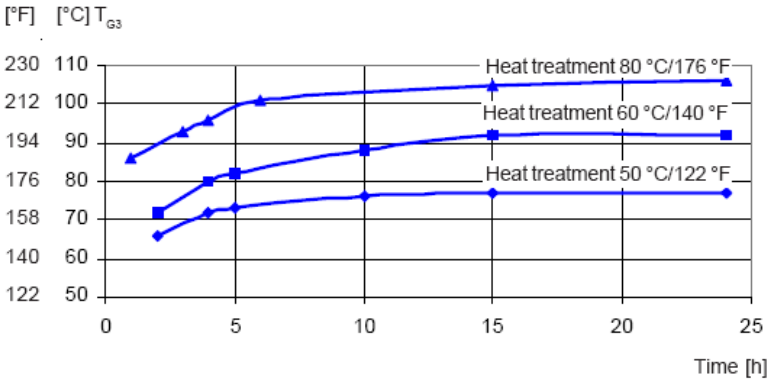
Development of T



Laminating resin LR 285 Hardener LH 286



Laminating resin LR 285 Hardener LH 287



Sample preparation:
Initial curing before heat treatment 24 h at room temperature

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HEXION™ Specialty Chemicals

Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 16

EPIKOTE™ Resin MGS® LR 285

Mechanical data

Mechanical data of neat resin		
Density	[g/cm³]	1,18 - 1,20
Flexural strength	[N/mm²]	110 - 120
Modulus of elasticity	[kN/mm²]	3,0 - 3,3
Tensile strength	[N/mm²]	70 - 80
Compressive strength	[N/mm²]	120 - 140
Elongation of break	[%]	5,0 - 6,5
Impact strength	[KJ/m²]	45 - 55
Water absorption at 23°C	24 h [%] 7 d [%]	0,20 - 0,30 0,60 - 0,80
Fatigue strength under reversed bending stresses acc. to DLR Brunsw.	10 % 90 %	> 2 x 10^4 > 2 x 10^6
Curing: 24 h at 23 °C (74 °F) + 15 h at 60 °C (140 °F)		
Typical data according to **WL 5.3203 Parts 1 and 2** of the German Aviation Materials Manual.		

Advice:
Mechanical data are typical for the combination of laminating resin LR 285 with hardener LH 287. Data can differ in other applications.

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March, 2010

HEXION™ Specialty Chemicals

Technical Information
Epoxy and Phenolic Resins Division
Epoxy Resins

1.1 - 17

EPIKOTE™ Resin MGS® LR 285

Data of reinforced resin
Static tests in standard climate

Mechanical data

Reinforced with		GRC Glass fibre	CRC Carbon fibre	SRC Aramide fibre
Flexural strength	[N/mm²]	510 - 560	720 - 770	350 - 380
Tensile strength	[N/mm²]	460 - 500	510 - 550	400 - 480
Compressive strength	[N/mm²]	410 - 440	460 - 510	140 - 160
Interlaminar shear strength	[N/mm²]	42 - 46	47 - 55	29 - 34
Modulus of elasticity	[kN/mm²]	20 - 24	40 - 45	16 - 19

GRC samples:
16 layers of glass fabric, 8H satin, 296 g/m² (8.5 oz/sq.yd.), 4 mm (0.16 in) thick
CRC samples:
8 layers of carbon fabric, plain, 200 g/m² (5.9 oz/sq.yd.) 2 mm (0.08 in) thick
SRC samples:
15 layers of aramide fabric, 4H satin, 170 g/m² (5.0 oz/sq.yd.), 4 mm (0.16 in) thick

Fibre content of samples during processing/testing: 40 - 45 vol%
Data calculated for fibre content of 43 vol%

Typical data according to WL 5.3203 Parts 1 and 2
of the GERMAN AVIATION MATERIALS MANUAL

Measuring conditions:
Curing: 24 h at 23 °C (74 °F)
+ 15 h at 80 °C (176 °F)

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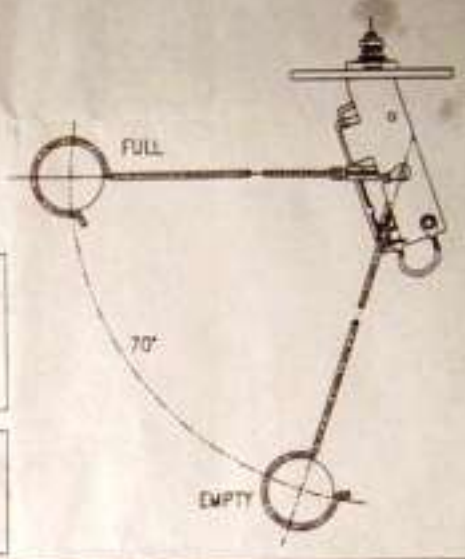
INSTALLATION INSTRUCTIONS

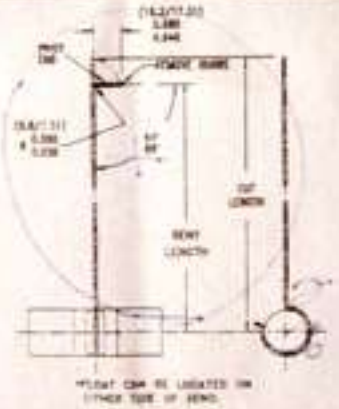
385 LEVER-TYPE FUEL SENDER

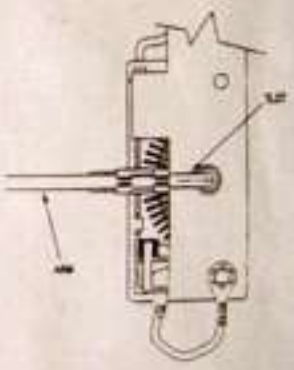


CAUTION
Use extreme caution when working around fuel. Work in well ventilated area and keep all hot materials away. Consult vehicle service manual if fuel tank must be removed.

CAUTION
A new gasket must be placed between the flange of the sender and the flange of the tank during final installation.

TANK DEPTH	CUT LENGTH	BENT LENGTH
6.00	4.78	4.03
6.50	5.31	4.56
7.00	5.84	5.09
7.50	6.37	5.62
8.00	6.91	6.16
8.50	7.44	6.69
9.00	7.97	7.22
9.50	8.50	7.75
10.00	9.03	8.28
10.50	9.57	8.82
11.00	10.10	9.35
11.50	10.63	9.88
12.00	11.16	10.41





FOR PIVOT-END ARM ADJUSTMENT

Determine float arm length required for tank depth and cut float arm wire to cut length shown to table. Bend wire sharply at right angle (90°) to 'Shepherd's Crook.'

Align arm with slot in the bracket. Insert the pivot end of the float arm into the hole and snap The wire into the follower.

When unit is side mounted, the float arm will require additional adjustment.

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Part No. 434833
Rev. 09-03