



A Guide to the Manufacture of Toolfusion® 1 Tooling Laminates

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Guide to Toolfusion 1 Tool Manufacture

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Manufacture of Toolfusion® 1 Tooling Laminates

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1. Introduction

Toolfusion®1 Part A and Toolfusion®1 Part B is a two part, low viscosity epoxy infusion resin formulated to produce pre-preg quality, high temperature moulds at a fraction of their cost.

Standard infusion vacuum bagging is all that is required to produce autoclave quality laminates. Toolfusion®1 Part A and Toolfusion®1 Part B requires room temperature master models and patterns further reducing the cost of composite tooling.

This document is a guide to the manufacture of Toolfusion®1 tooling laminates. The guide outlines the preparations for and the best practise employed during the successful manufacture of a Toolfusion®1 composite tooling laminate.

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2. Master Model Preparation

Master Models for manufacture of composite tooling must provide a stable and inert form, from which the composite tooling laminate can be moulded. Tool manufacture with the Tygavac Toolfusion Resins, employs the Resin Infusion process to draw liquid resin into a dry fabric laminate.

Tygavac Modelmaster Tooling Block Materials combined with Modelmaster Block Adhesives and Surface Sealers are specifically developed for the easy manufacture of Stable, Inert, non-porous & high tolerance Master Models.

The Toolfusion® materials and Resin infusion process create the following requirements for a Master Model;-

2.1. **Vacuum Integrity**, as the process relies on differential pressure created by vacuum to transport the resin, vacuum integrity is vital. In addition, any air drawn through the pattern will create voids in the infused tooling laminate, reducing strength and vacuum integrity of the composite tool. Where master models are not vacuum tight the options of envelope vacuum bagging and vacuum bagging onto a base plate are available.

2.2. **Compressive Strength**, the master model must be capable of withstanding the application of vacuum pressure over the surface to be moulded. This force can crush low density foams and collapse any hollow sections, care must be taken to ensure Model shape will be retained under vacuum application.

Tygavac **Modelmaster A160 & Modelmaster B182** are easily machined epoxy tooling board with excellent vacuum integrity, physical and thermal stability.

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2.3. **Chemically Inert**, some modelling materials and surface finishes contain reactive ingredients which can inhibit the curing of Tygavac Toolfusion® Resins e.g. Polyurethanes & Polyesters. We recommend avoiding the use of such materials or conducting tests to assess their suitability for this application.

2.4. **Surface Porosity**, in addition to potential vacuum loss this can create poor surface finish which may require time consuming refinishing after moulding of the laminate.

Tygavac **Masterseal TK27** is a low viscosity 2 part epoxy developed for sealing Modelmaster Epoxy Tooling Boards and other porous surfaces. It can be applied by spraying or by hand, some light sanding may be required after application.

2.5. **Flange Area**, it is desirable to have a flange area of approximately 100mm around the perimeter of the proposed Tool Laminate. This is to provide enough space for the required vacuum gallery and vacuum bag sealant tape placement. Where insufficient space is available the vacuum gallery can be positioned in a pleat in the vacuum bagging film with some additional preparations.

2.6. **Release Agent**, thoroughly clean the master model surface and degrease. It is desirable to bake the master model at a temperature equal or slightly higher than the tooling laminate cure temperature. This will help to drive off any retained solvent, moisture and volatiles from the master model which could have a detrimental effect on surface finish. Apply a trusted release in accordance with the suppliers guidelines in order to achieve satisfactory cured tool release.

Tygavac recommends selection of Release All®19, Release All® Safelease 30, Tygacote TS151 and Tygacote SP701. Please see Tygavac catalogue for data sheets and application guide.

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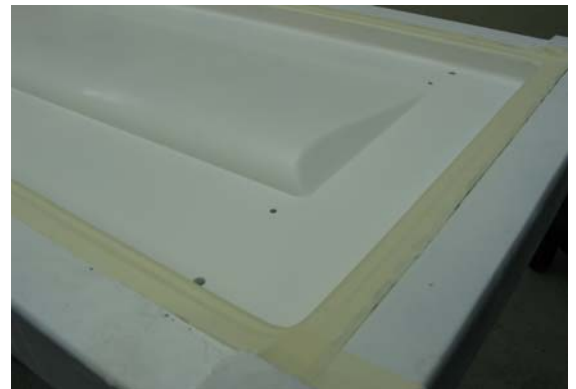
3. Surface Resin Application

Tygavac Infusioncoat® 1A & 1B is a black graphite filled surface resin designed for use with Toolfusion® tooling resin. Infusioncoat is a non-sagging surface resin which offers the multiple benefits of:-

- a. Eliminating the need for surface tacifiers to hold the first ply on the pattern, and the associated surface defects resulting from the use of such tacifiers.
- b. Helps to eliminate pin holing on tool surface.
- c. Provides hard wearing surface which can be scribed and lightly worked to remove defects transferred from pattern.

Method for Application,

3.1. Mask off the Master Model around the perimeter of the proposed Tooling laminate using PS025 pressure sensitive tape or a suitable masking tape.



3.2. Cut down the bristles of a good quality brush to approximately 15mm. Then use PS025 tape to remove any loose bristles to avoid subsequent contamination of the applied surface resin. Tygavac Techshears or Tygashears are perfect tools for cutting down the brushes required.



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3.3. Weigh out Infusioncoat surface resin carefully in the ratio of

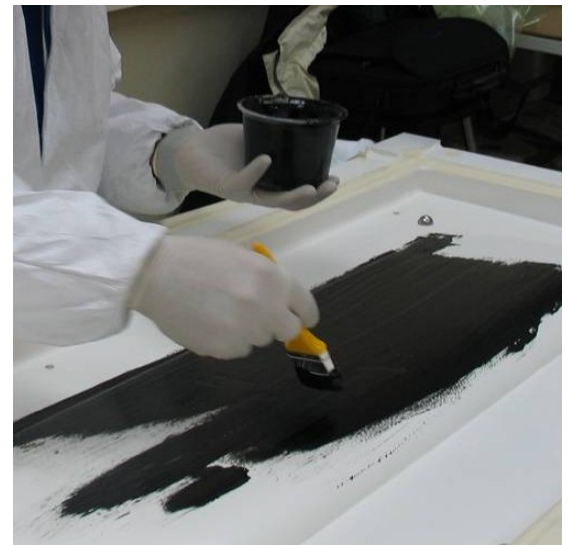
Infusioncoat Part A ~ 100 parts by weight
Infusioncoat Part B ~ 20 parts by weight

3.4. Mix the 2 parts thoroughly with a clean mixing stick.

3.5. Double Cup - remove mixed content into a clean pot and mix again to ensure complete mixing of Part A & Part B.



3.6. Apply Mixed Infusioncoat using the cut down brush to surface of the pattern. Apply the Infusioncoat with the brush held in an upright position all in one direction. Apply sufficient Infusioncoat so the surface of the pattern cannot be seen.



Avoid excessive built up of resin in female corners which can result in subsequent bridging of fibres. This can lead to male corners which are resin rich and weakened on the composite tool. Completely cover the surface of the master model up to the masking around the edge.

Note: excessively low ambient working temperatures can result in stiffening of the mixed Infusioncoat and make application more difficult. Ideal working temperature is about 22°C, working time for 100g mix at this temperature will be between 1 ½ and 2 hours.

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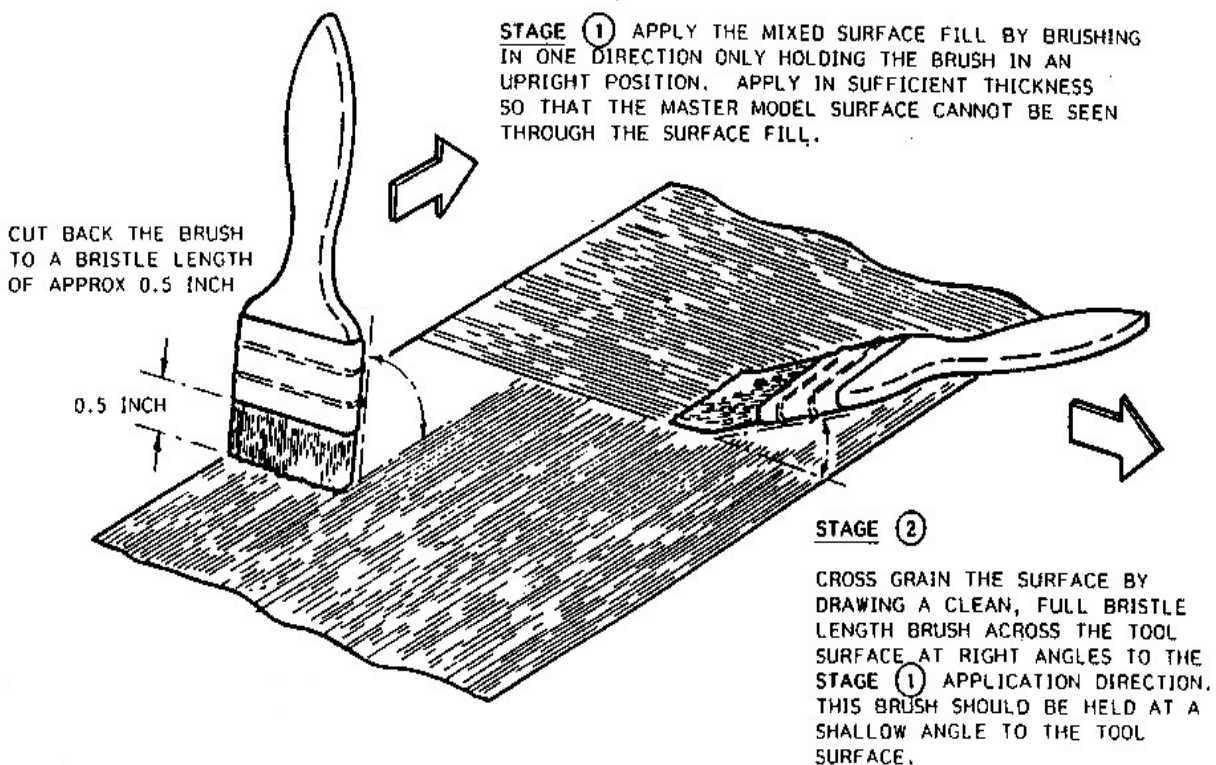
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3.7. Cross grain the surface. Gently draw a clean full bristle brush across the applied Infusioncoat at 90° to the applied direction. Hold the brush at a shallow angle and apply very light pressure.

The cross grain helps to smooth out the Infusioncoat, draw out trapped air and remove excess resin. As the full brush picks up excess resin, remove with a lint free cloth and continue brushing.



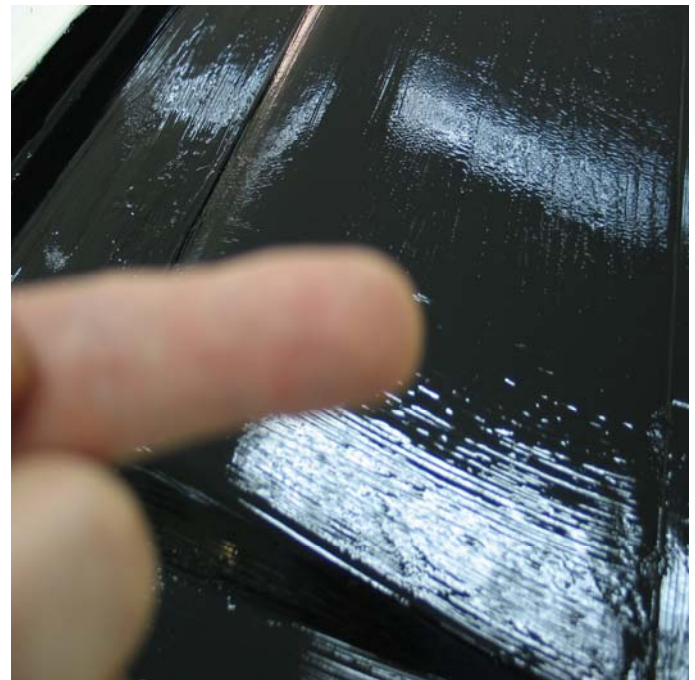
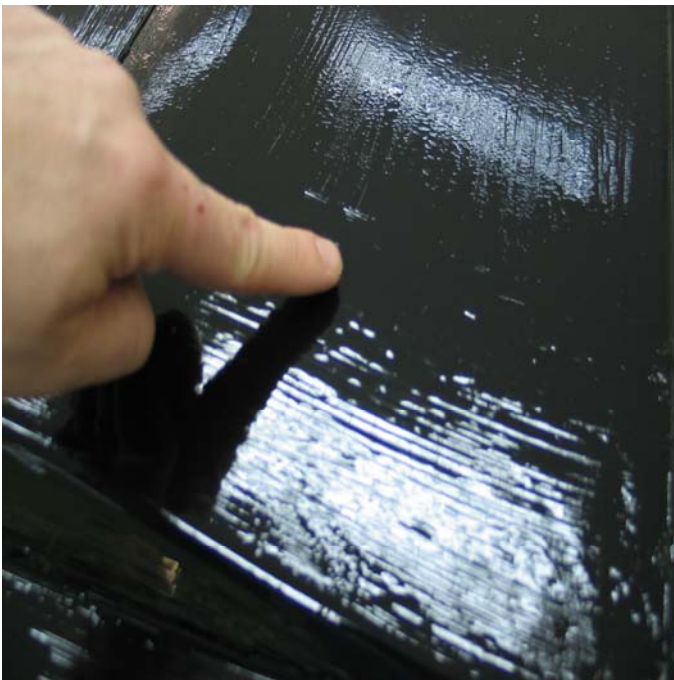
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3.8. Leave until “Tack Free” surface is achieved. This is when a light finger touch will leave a finger print in the Infusioncoat, but no resin transfers onto the end of the finger.



In a work shop with constant ambient temperature of around 22°C this condition should be reached in 2 to 4 hours.

Accelerated “Tack Free” can be achieved in an oven at 49°C in 30 minutes. Please take care not to use fan circulation in the oven which can circulate debris off the oven floor onto the tacky Infusioncoat.

3.9. Remove the PS025 tape masking the edge of tool area to leave Infusioncoat Surface Resin with a clean straight edge. Do not leave this tape in place as it may prevent later release of the moulded laminate.

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4. Dry Fabric Stack Lamination

Dry woven fabrics will be laid in position over the master pattern to build up the desired laminate construction. Unlike pre-preg materials these dry woven fabrics require no freezer storage and therefore no prior extended thawing process.

The Tooling laminate will typically consist of lightweight outer plies and heavier core plies. The lightweight outer plies providing a better surface quality with heavier core plies providing more rapid thickness build up.

Tygavac Toolfusion® Tooling Resins can be used for the infusion of either carbon fibre and glass fibre composite tooling laminates. Slight differences will be seen in the rate of resin infusion. Carbon fibre laminates infusing slower due to smaller fibre diameter allowing denser fibre packing.

The schedule for individual ply orientation can be selected based on consideration of the tooling geometry. Where the tool geometry has features which impart stiffness, such as ribs, corners, right angle flanges, a simple 0°/90° repeating ply orientation may be used. This type of schedule can speed up the lay up procedure and reduce fabric wastage. Where the tool geometry is simpler with little or no stiffening features, a quasi-isotropic lay up may be considered. This type of schedule employs +45° & -45° plies orientations to help avoid warping or twisting of the cured laminate.

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4.1. Typical Ply Schedule for Glass Toolfusion® Tooling Laminate

Ply Number	Fabric Style	Simple Laminate	Quasi-Isotropic Laminate	Thickness
		Orientation	Orientation	
1	TMFC 7500 Plain Weave 325g/m ²	0°	0°	0.28mm
2	TMFC 7500 Plain Weave 325g/m ²	90°	90°	0.28mm
3	TMFC 7544 2 End Plain 617g/m ²	0°	0°	0.48mm
4	TMFC 7544 2 End Plain 617g/m ²	90°	+45°	0.48mm
5	TMFC 7544 2 End Plain 617g/m ²	0°	-45°	0.48mm
6	TMFC 7544 2 End Plain 617g/m ²	90°	90°	0.48mm
7	TMFC 7544 2 End Plain 617g/m ²	90°	90°	0.48mm
8	TMFC 7544 2 End Plain 617g/m ²	0°	-45°	0.48mm
9	TMFC 7544 2 End Plain 617g/m ²	90°	+45°	0.48mm
10	TMFC 7544 2 End Plain 617g/m ²	0°	0°	0.48mm
11	TMFC 7500 Plain Weave 325g/m ²	90°	90°	0.28mm
12	TMFC 7500 Plain Weave 325g/m ²	0°	0°	0.28mm
Total Thickness				4.96 mm

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4.2. Typical Ply Schedule for Carbon Toolfusion® Laminate

Ply Number	Fabric Style	Simple Laminate	Quasi-Isotropic Laminate	Thickness
		Orientation	Orientation	
1	TMGC 6000 3K Plain Weave	0°	0°	0.30mm
2	TMGC 6000 3K Plain Weave	90°	90°	0.30mm
3	TMGC 6003 12K 2x2 Twill	0°	0°	0.66mm
4	TMGC 6003 12K 2x2 Twill	90°	+45°	0.66mm
5	TMGC 6003 12K 2x2 Twill	0°	-45°	0.66mm
6	TMGC 6003 12K 2x2 Twill	90°	90°	0.66mm
7	TMGC 6003 12K 2x2 Twill	90°	90°	0.66mm
8	TMGC 6003 12K 2x2 Twill	0°	-45°	0.66mm
9	TMGC 6003 12K 2x2 Twill	90°	+45°	0.66mm
10	TMGC 6003 12K 2x2 Twill	0°	0°	0.66mm
11	TMGC 6000 3K Plain Weave	90°	90°	0.30mm
12	TMGC 6000 3K Plain Weave	0°	0°	0.30mm
Total Thickness				6.48 mm

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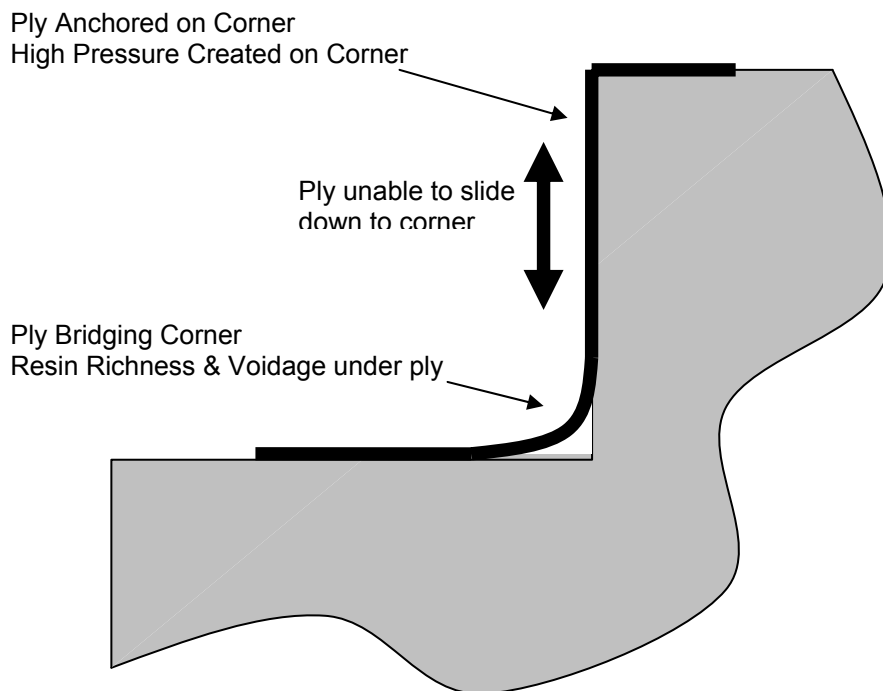
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4.3. Tailoring of Individual Fabric Plies

The layers of dry fabric should be cut and jointed during the lamination process to allow convenient application of the layers, close consolidation to master model shape and continuous strength. The following recommendations can assist in achieving this goal.

4.3.1. One Corner Only, no single piece of dry fabric should be positioned over both a female and male corner. This could cause bridging in the female corner resulting in resin richness and voidage. It could also create high pressure on the male corner and fibre printing through the surface resin.



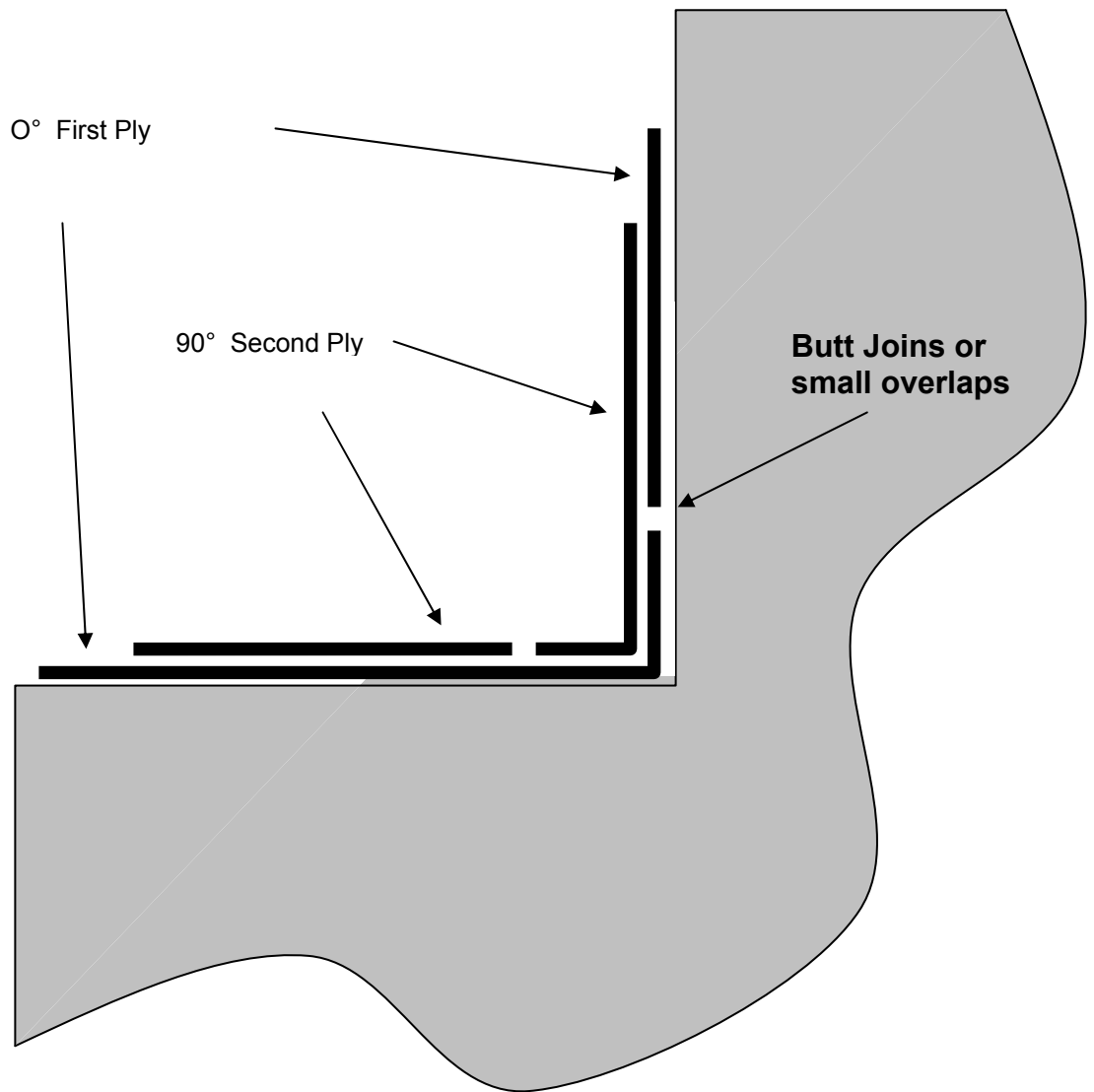
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4.3.2. Female Corner Overlapping, to avoid bridging in female corners plies can be overlapped over the corner.



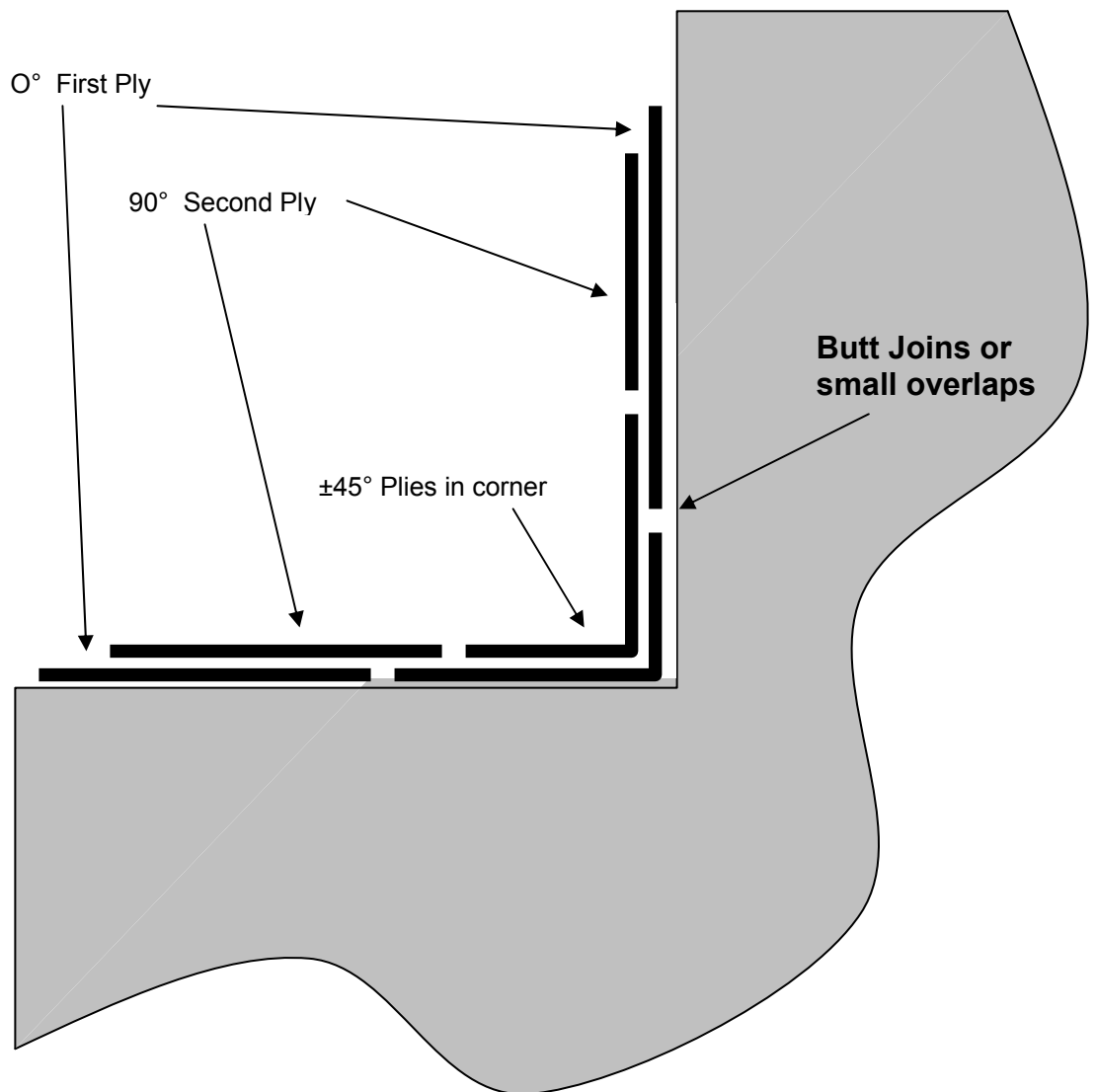
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4.3.3. Female Corner $\pm 45^\circ$ Plies, alternatively, to avoid bridging in female corners $\pm 45^\circ$ Plies plies can be laid in female corners with staggered joints.



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4.3.4. Precut Patches of Fabric, to simplify the lamination procedure, fabrics can be pre-cut from roll stock into smaller patches to aid positioning into the master model.

Pre-cutting of Fabrics away from the lay-up procedure can greatly accelerate the lamination procedure, by allowing laminators to concentrate on positioning of fabric patches only and not cutting.



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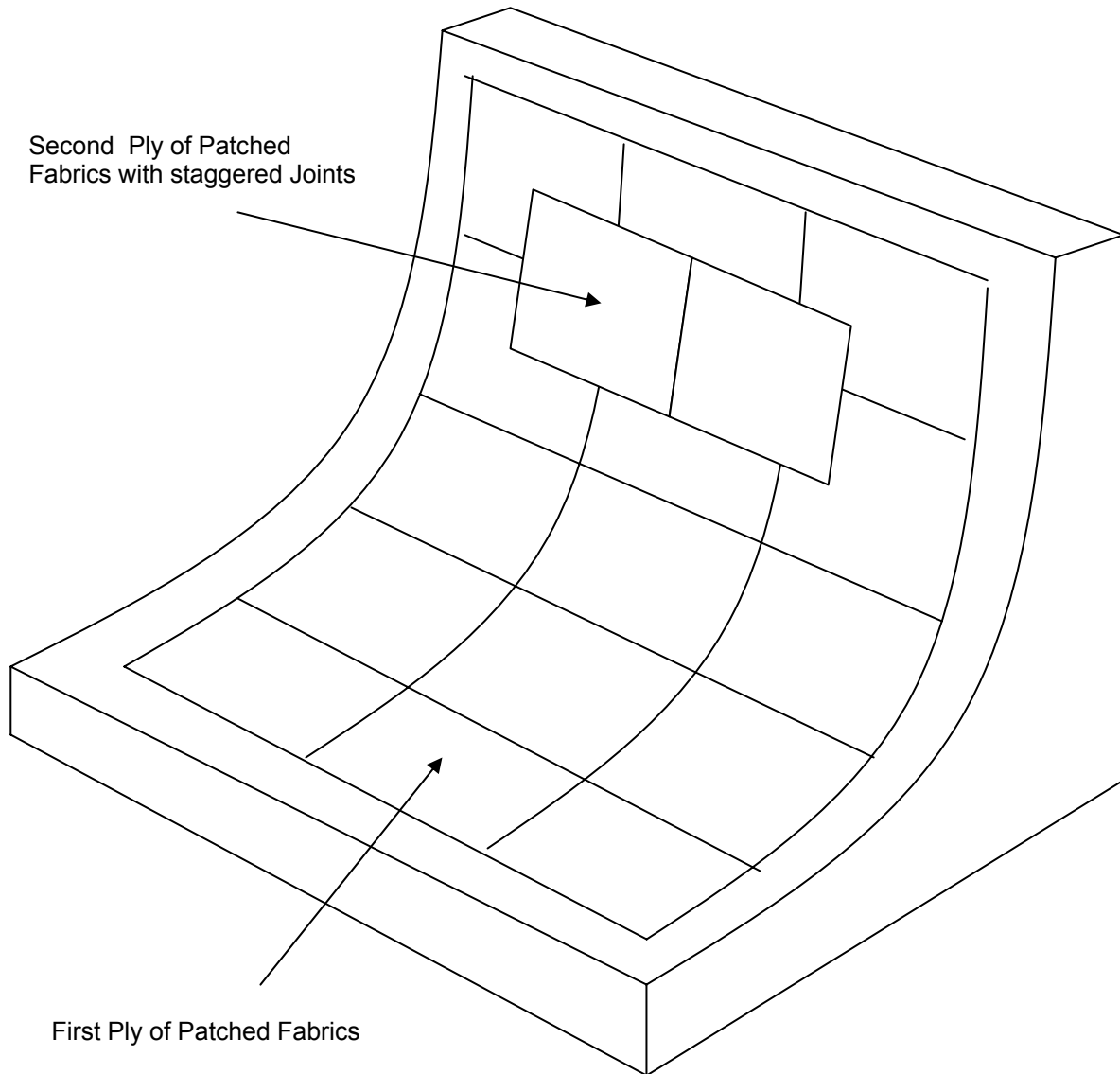
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4.3.5. Stagger Patch Joints, of subsequent plies to avoid through thickness weakness if plies are butted or excessive thickness build up if plies are being overlapped.



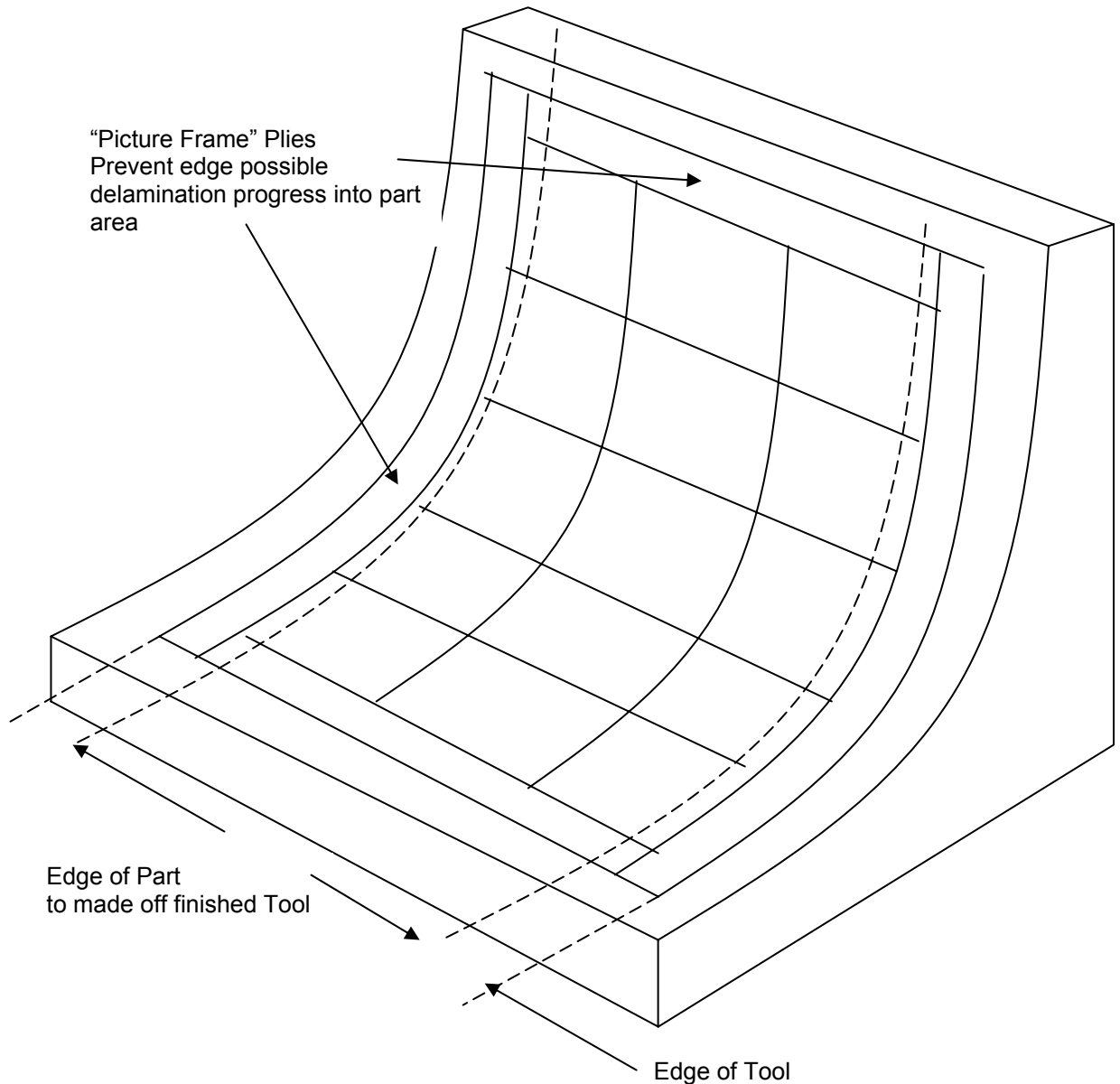
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4.3.6. Picture Framing, of plies outside the part area can minimise the risk of impact damage to the flange area creating a leak path into the part area. This picture framing should be applies to the first six plies only.



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4.3.7. Tacifiers, enable the dry fabrics to be held in position during the lamination process. In the form of a Spray Adhesives,

Tygavac Aero 2 can be applied over an area of laminated plies in order to adhere the next layer.

Aero 2 should be applied sparingly to provide just enough tack to hold the dry fabrics. A light mist should be applied from a distance of at least 30cm, after approximately 10 seconds to allow volatiles to flash off, the surface will be lightly tacky and able to hold a new dry fabric ply.

Aero 2 is a rubber based adhesive and excessive application could effect laminate quality. Aero 2 is not suitable for holding down the first ply to the Master Model surface.



Tygavac TacStrip, is a Fibreglass fabric mesh both sides coated with a high tack pressure sensitive adhesive. As an alternative to Spray adhesive, TacStrip provides excellent hold for dry fabrics, with no danger of over spray or excessive application.



4.3.8. Vacuum Debulking, this procedure is not required during the lamination of dry fabric plies for Toolfusion® Resin Infusion.

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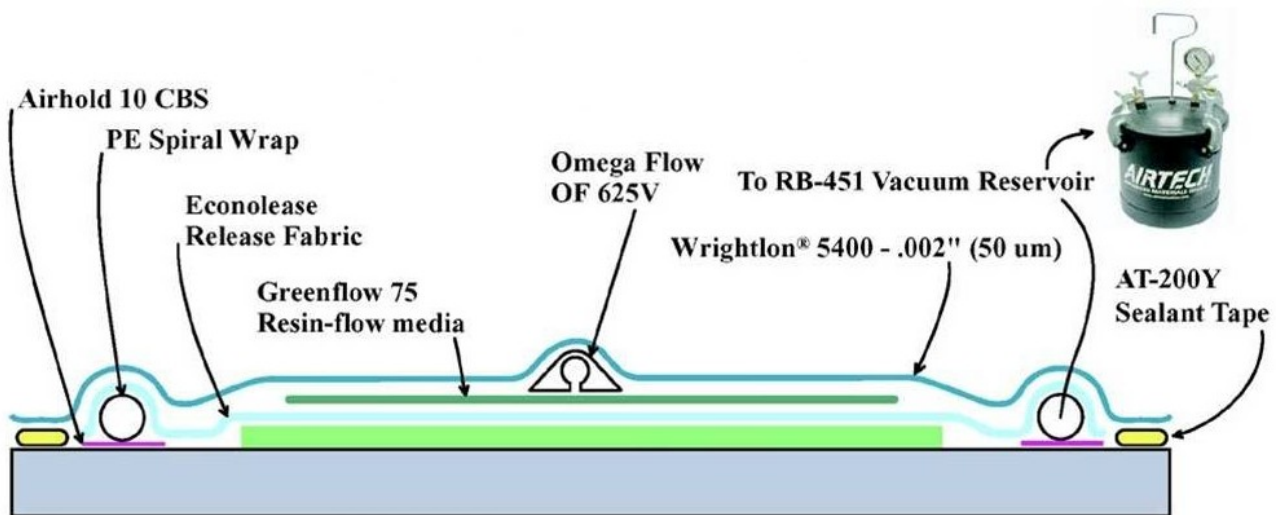
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5. Vacuum Manifold Construction

5.1. The Vacuum Manifolds function is to provide an always open vacuum passage to the dry fabric lay-up. Thus providing the pressure differential required to push the low viscosity Toolfusion® Tooling Resin into the dry fabric and achieve complete fibre wet out. It is typically positioned around the perimeter of the dry fabric lay-up. Tygavac PE Spiral Wrap mounted on Tygavac Airhold 10CBS Double Backed Tape onto the Master model provides a non-crushable open path for the vacuum manifold.



The manifold should be positioned at least 25mm from the edge of the dry laminate. The Manifold, the gap between and the laminate is then covered with a single layer of peel ply. This provides a “vacuum link” from manifold to laminate. It also provides a “resin brake”, preventing resin from a completely saturated section of laminate flooding the vacuum manifold before the entire tool laminate infusion is completed.

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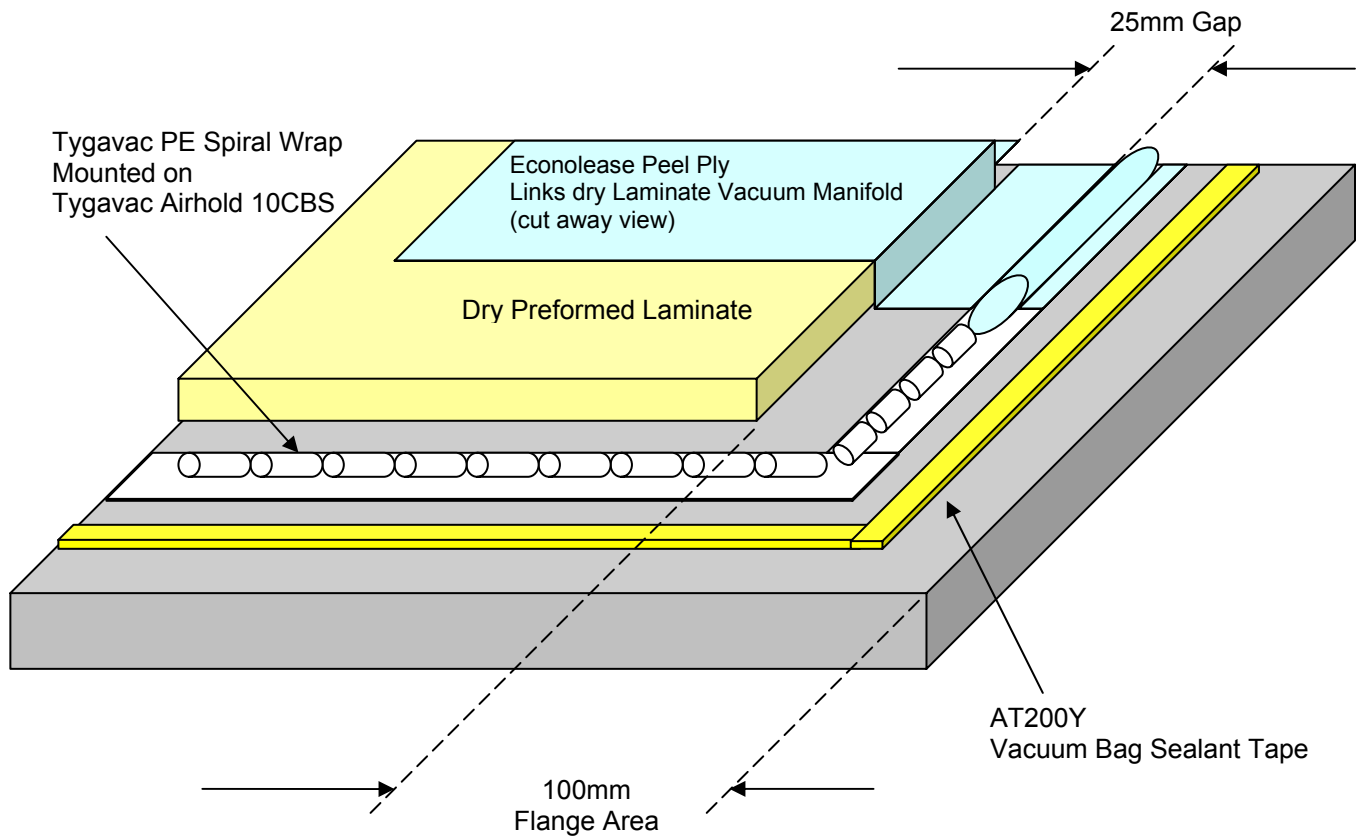
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5.2. The Spiral Wrap of Vacuum Manifold is connected via solid PE Tubing to the Tygavac RB451 Vacuum Reservoir. Providing vacuum control and preventing resin contamination of Vacuum Pump.

Vacuum Manifold Corner Detail



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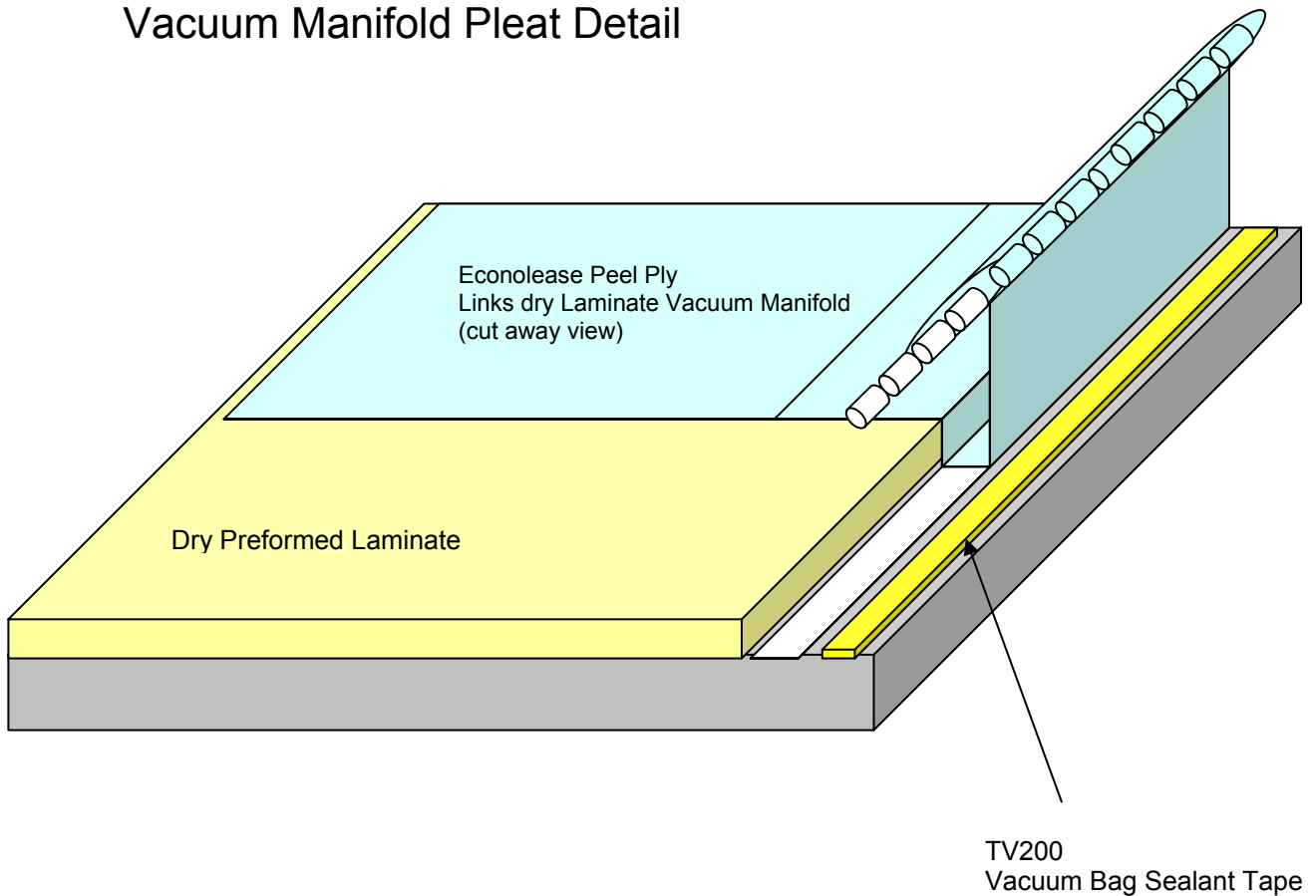
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5.3. Where there is not sufficient flange area to position the vacuum manifold on the Master Model surface it is possible to mount it in wrapped in Peel Ply Fabric in a pleat in the vacuum bag.

Vacuum Manifold Pleat Detail



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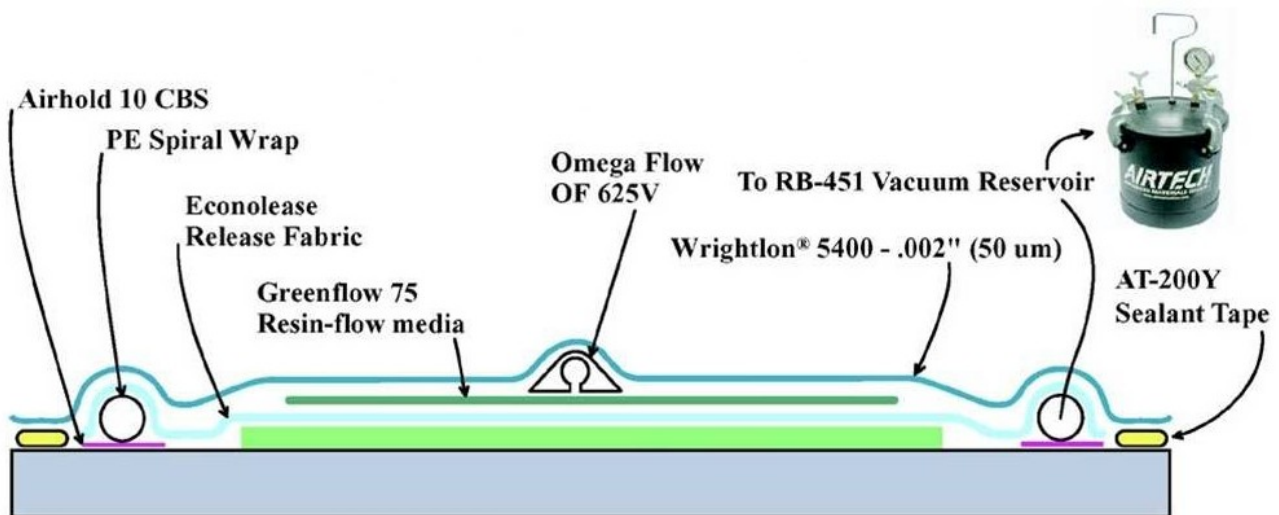
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6. Infusion Mesh Application & Resin Feed Positioning

6.1. Infusion Mesh (a.k.a Resin distribution mesh) performs a vital role in the resin infusion process for Toolfusion® and other monolithic laminates. The Infusion Mesh accelerates the flow of resin into the dry pre-form by providing a layer of increased permeability on the laminate surface. Resin can then flow faster through the mesh layer over the surface of the laminate and then slowly down into the laminate to achieve complete fibre wet-out. This accelerated flow ensures complete fibre wet out can be achieved before resin gelation occurs and flow stops.

6.2. A number of Infusion Mesh's are available offering a variety of characteristics such as handling, flow and size. Particularly well suited to the requirements of Toolfusion® is **Tygavac Greenflow75**, a low profile Rhombic net capable of 161°C. Greenflow 75 handles easily, provides excellent unidirectional flow rate, can be adhered with Tacifier sprays and is available 1m wide.



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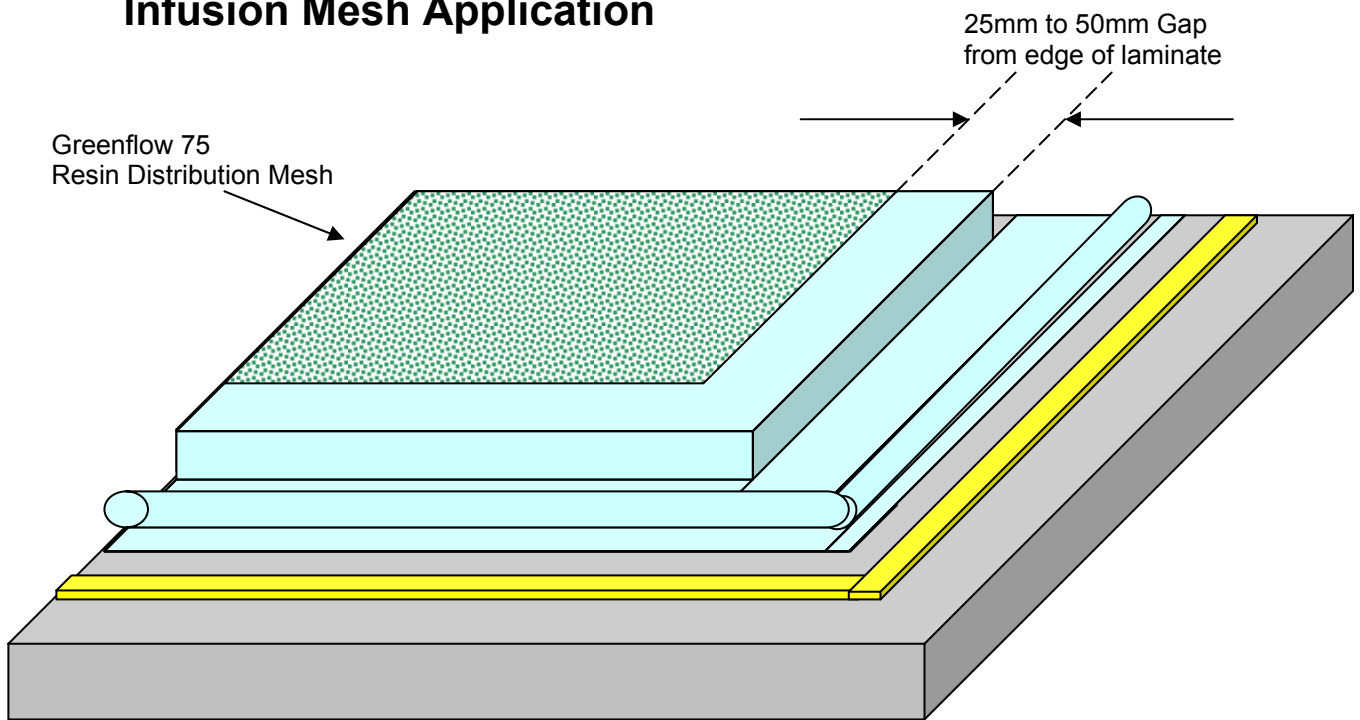
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6.3. The Infusion mesh is placed over the entire surface of the dry fabric preform but short of the laminate edge by 25mm to 50mm. This gap around the perimeter ensures the flow of resin does not bypass the laminate edge by flowing directly into the vacuum manifold.

Infusion Mesh Application



Greenflow 75 applied over entire surface of Aileron Toolfusion® Tooling Laminate, short from edge of laminate.

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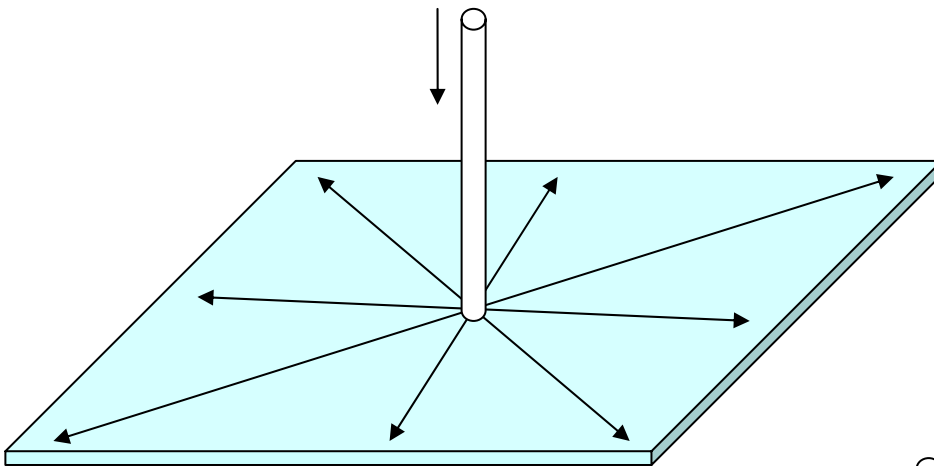
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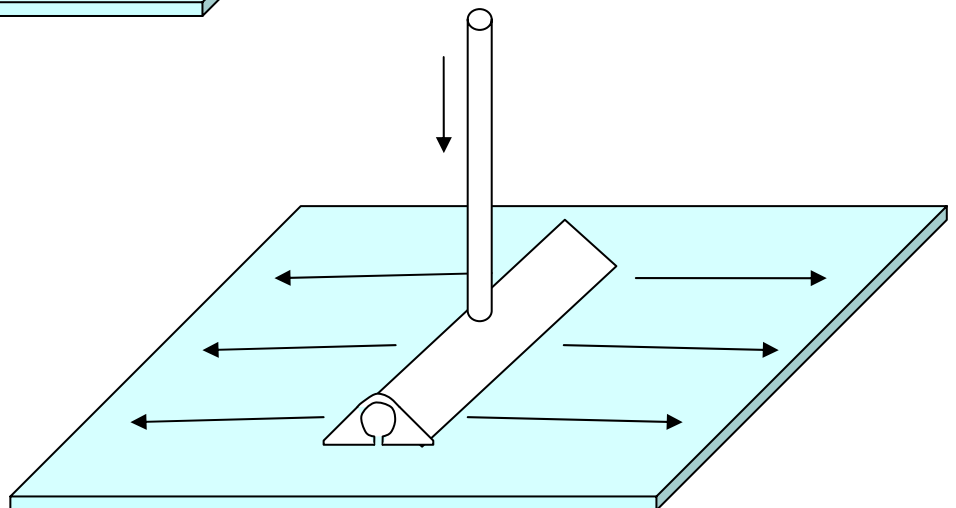
6.4. Resin Feed Positioning, The point of entry for the resin feed will determine whether complete fibre wet out will occur prior to resin gel and warrants careful thought. As resin travels further from this point of entry, it's speed of flow reduces. The area of laminate which can be fed from a single resin feed is therefore limited. To infuse larger Tooling laminates it may be required to introduce multiple resin entry points.

A **single point entry** for the resin is **not desirable** as it only provides only a small initial resin flow front, and a greater required distance for the resin to travel.



small initial resin flow front, and a greater required distance for the resin to travel.

The **Tygavac Omegaflow** provides a line of resin entry over whatever desired length is required. This produces a long continuous resin flow front which will delivery resin much faster and closer to the desired tool shape.

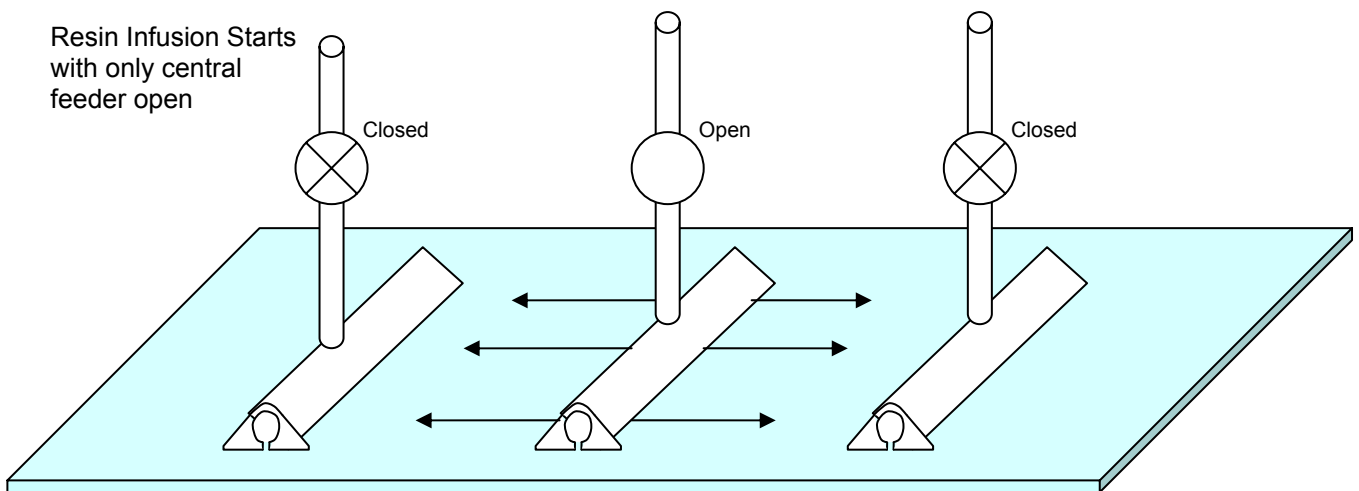


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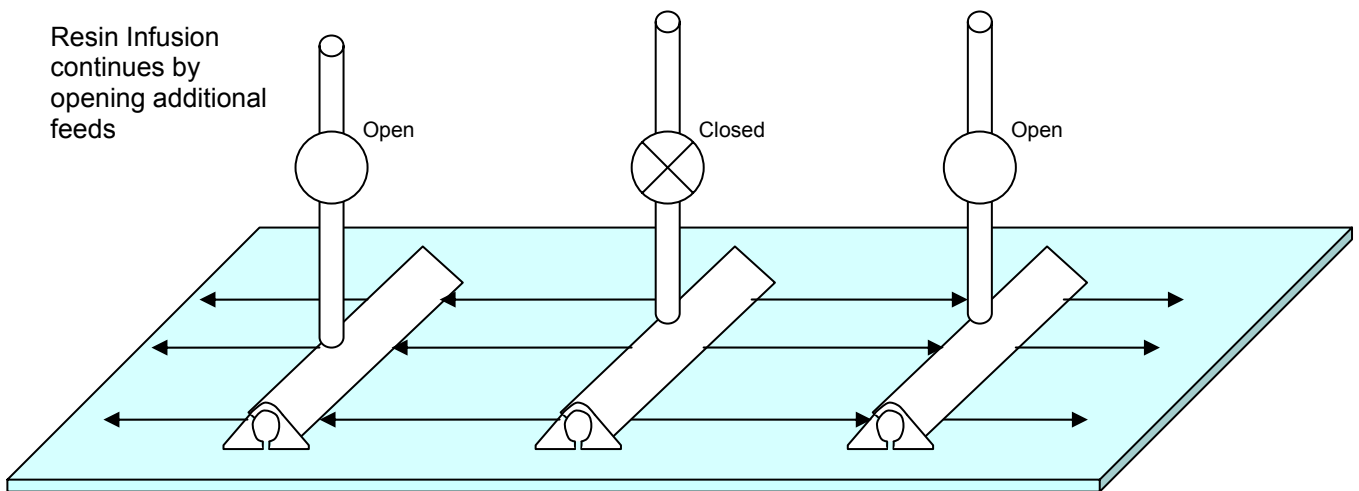


6.5. The flow of resin will slow down as it travels further from its point of entry due to resistance created by the dry fabrics. Tygavac Omegaflow can be employed for multiple Resin Feeders, where larger laminates are to be infused. The use of multiple Omegaflow resin entry positions ensures resin flow is maintained in order to completely wet out the entire laminate.

Resin Infusion Starts with only central feeder open



Resin Infusion continues by opening additional feeds



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6.6. The slowing in speed of resin flow can be predicted using Darcy's Law. Without complicated calculations this can be related to actual practice to help understand and predict successful infusions.

$$Q = \frac{KA}{\eta} \left(\frac{P_1 - P_2}{L} \right)$$

Variable	Description	Actual Practice
K	Permeability of Dry Laminate	TYGAVAC Flow Mesh increases flow rate.
A	Cross Sectional Area available for Flow	Longer Omegaflow Resin Feed Lines deliver more resin faster
L	Length	Distance Between Resin Feed Lines Greater distance = longer time to wet out Shorter distance = shorter time to wet out
P1-P2	Pressure Drop	Vacuum Bag Integrity Good Vacuum = faster resin flow Poor Vacuum = slower resin flow
η	Resin Viscosity	Low Viscosity = faster resin flow High Viscosity = slower resin flow

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6.7. As shown by Darcy's Law, a number of factors affect the flow rate of the resin and therefore the spacing required between the Omegaflow lines to achieve full laminate wet-out before resin gelation occurs. For the manufacture of Toolfusion® 1 Tooling laminates, practical experience shows the following to be a reasonable guide;-

Fibre	Laminate Thickness	Feeder Spacing
Glass Fibre	6mm	12" to 18" (30cm to 45cm)
Carbon Fiber	6mm	9" to 12" (22cm to 30cm)

Note:

Carbon laminates infuse more slowly due to smaller fibre diameter

Resin Feeders prepared using Tygavac Spiral Tubing for Large Glass Fibre Tooling Laminate.

Note:

Spiral Tube feeders directly on top of the laminate may create some mark-off on the laminate.

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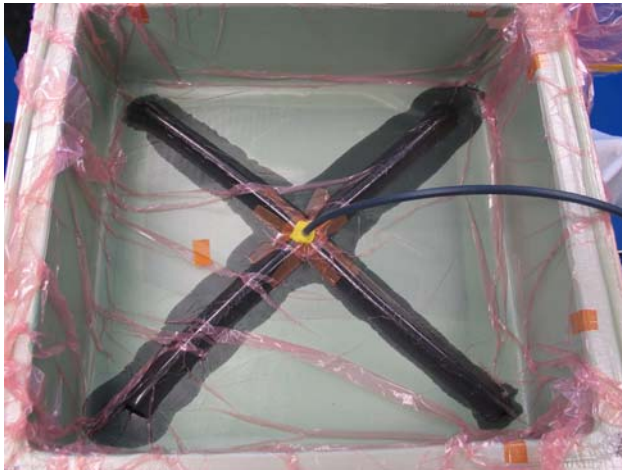
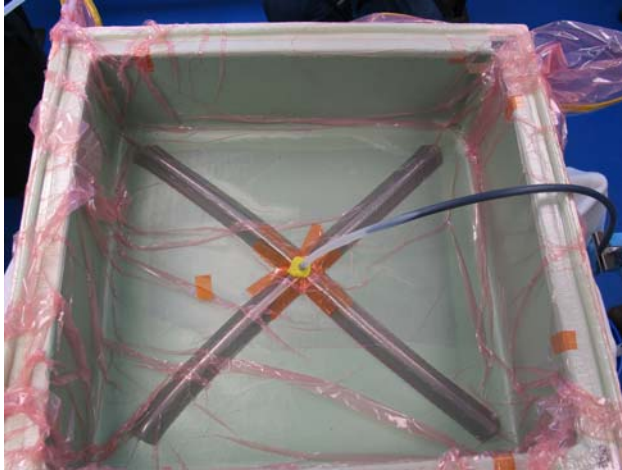
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6.8. Resin Feed Branching

Branching of resin feeder lines can also be employed. As shown here in the infusion of an “open box” tool.

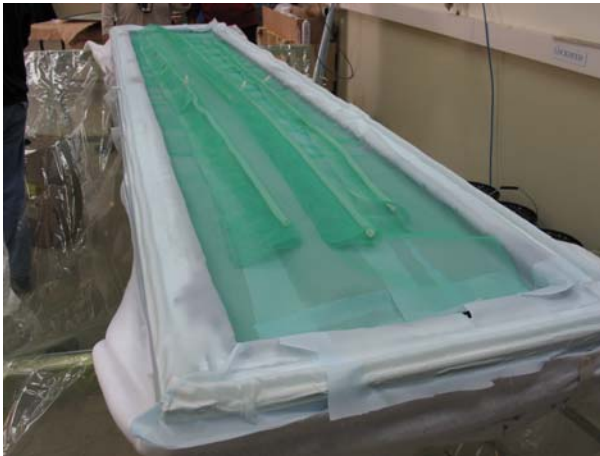
This technique provides for a single resin feed tube, instead of multiple feed tubes for parallel Omegaflow resin feeders.

As shown, the diagonal Omegaflow arrangement ensures resin is fed close to the corners of the box structures.

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On application of the vacuum bag, lift the Mesh wrapped Spiral into a pleat in the vacuum bagging film. Doing this will prevent the spiral creating a mark-off on the surface of the tooling laminate and ease removal after cure. Resin flowing through the Spiral is able to flow down the pleat through the Resin Flow mesh and into the dry laminate.

6.9. Spiral Resin Feeders.

An alternative technique to using Tygavac Omegaflow, is to use Tygavac Spiral Tubing to delivery Toolfusion® Resin into the laminate.

Wrap the Tygavac Spiral Tuber in the Greenflow 75 Resin Infusion Mesh, to the desired length.

Position on the dry laminate in the direction and spacing required for resin delivery to achieve complete wet-out.



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7. Vacuum Bagging

7.1. The vacuum bagging film provides the means for application of pressure over the Toolfusion® laminate. This pressure in turn;-

- Consolidates the laminate plies.
- Forms the laminate to the shape of the Master Model.
- Provides pressure differential for the Resin Infusion.

7.2. The application of the bagging film can be either;-

- **Edge Bagging,**
the vacuum bagging film as adhered to the surface of a vacuum tight Master Model (or vacuum tight base plate with Master Model mounted) using vacuum bag sealant tape. This technique is generally the preferred technique for Toolfusion® Mould manufacturing.
- **Envelope Bagging,**
the Master Model is placed inside a tubular vacuum bagging film and the tube then sealed at both ends using vacuum bag sealant tape. This can be used where Master Models are not vacuum tight but can only be done on Master Models which can be manually lifted into a vacuum bagging tube.

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7.3. Recommended Vacuum Bagging Films are;-

- **NBF540, 0.002” thick (50μ)**
- **NBF740, 0.002” thick (50μ)**
- **NBF130, 0.002” thick (50μ)**

The vacuum bagging film should typically be cut 30% larger than the master model. Then adhered to the Vacuum Bag Sealant Tape, using pleats to close the bag and tailor the shape to provide a loose fit over the master model. This loose fit provides enough vacuum bagging film to ensure full contact with the dry laminate and continuous application of vacuum pressure.

Note:

the use of High Elongation or Elastic Vacuum Bagging Films may stretch into and choke resin distribution mesh and hinder the flow of resin. They may also relax out of sharp corners once infused and create a “Bridged condition”.

Recommended Vacuum Bag Sealant Tapes are;-

- **TV200Y**
- **LTT90B**

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7.4. Resin Feed Tube Connection

Polyethylene tubing can be positioned to enter the vacuum bag through the pleats in the vacuum bag. Using vacuum bag sealant tape to seal all around the tube onto the vacuum bagging film. Positioning the tube off the surface of the laminate in the pleat prevents mark-off.

Alternatively, the Polyethylene Tubing for resin feed can pass through the bagging film directly into the Spiral Tubing or Omegaflow. Tygavac Nylon "T" fittings provide the connection for both methods. Vacuum bag sealant tape should be used to seal tubes onto fittings and bagging films.



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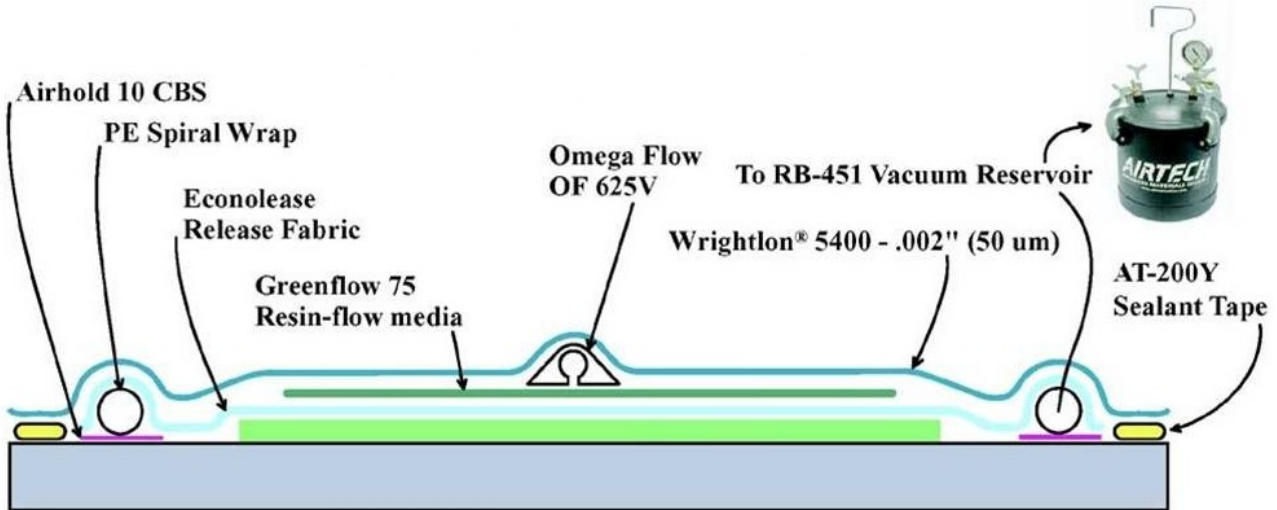
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7.5. Vacuum Manifold Connection

Polyethylene Tubing should also be used to connect the vacuum manifold to the Vacuum Reservoir RB451.



The RB451 prevents any resin pulled into the manifold system, progressing on into the vacuum pump or shop vacuum system.

With a Gauge and regulator it also provides means for vacuum control and drop testing.



Tygavac "T" Fittings provide means of connecting the Polyethylene tubing into the Tygavac Spiral Tubing.

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7.6. Vacuum can be applied once the following are complete;-

- Pleats are all closed
- Resin feed tubes are inserted and clamped off.
- Vacuum Manifold is plumbed into RB451 Vacuum Tank.

Initially apply only a light vacuum, so the film can be easily moved into corner positions and over features and shapes without any bridging. Once the film has been positioned satisfactorily, without bridging, close the regulator on the RB451 and apply full vacuum.

7.7. Once full vacuum has been applied, inspect the vacuum bag perimeter and tubing entries for leakage. Inspect for small leaks with the Tygavac LEQ70 Ultrasonic Leak Detector. Once the vacuum gauge on the RB451 shows a vacuum level equal to the source level (vacuum pump or shop vacuum) disconnect the source and perform a drop test. As small a drop as possible is desired, as leakage can result in air entrainment in the infused laminate and reduced laminate properties.

7.8. An acceptable vacuum drop is approximately ½” Hg. drop in 10 minutes.

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8. Resin Usage & Mixing

8.1. Toolfusion®1 High Temperature Tooling Infusion Resin is a two part Epoxy resin. The Mix Ratio by weight is;-

100 Parts Toolfusion®1 Part A
20 Parts Toolfusion®1 Part B

The Toolfusion®1 Part A and Toolfusion®2 Part B should be weighed out accurately using a spring balance or electronic scale into separate, clean containers. The two parts should not be mixed until later when infusion is about to commence. When large quantities of resin are required, they should be split into multiple smaller mixes to avoid the danger of exotherm of bulk reactive resin, e.g. 3 x 10Kg. rather than 1 x 30Kg. Smaller unmixed batches will also extend the time for infusion by maximising use of mixed resin pot life.

8.2. Resin Usage for Glass Fibre Tooling

Fibre Type		Glass Fibre	
Laminate		2-8-2 TMFC7500 Light Weight & TMFC7544 Heavy Weight	
Laminate Thickness		4.96mm	
Surface Area	Total Mixed Resin	Toolfusion®1 Part A	Toolfusion®1 Part B
1m ²	3.0 Kg.	2.5 Kg.	0.5 Kg.
2m ²	6.0 Kg.	5.0 Kg.	1.0 Kg.
3m ²	9.0 Kg.	7.5 Kg.	1.5 Kg.
4m ²	12.0 Kg.	10.0 Kg.	2.0 Kg.
5m ²	15.0 Kg.	12.5 Kg.	2.5 Kg.
10m ²	30.0 Kg.	25.0 Kg.	5.0 Kg.
15m ²	45.0 Kg.	37.5 Kg.	7.5 Kg.

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8.3. Resin Usage for Carbon Fibre Tooling

Fibre Type		<i>Carbon Fibre</i>	
Laminate		<i>2-8-2 TMGC6000 3K Light Weight & TMGC6003 12K Heavy Weight</i>	
Laminate Thickness		<i>5.88 mm</i>	
Surface Area	Total Mixed Resin	Toolfusion®1 Part A	Toolfusion®1 Part B
1m ²	3.3 Kg.	2.75 Kg.	0.55 Kg.
2m ²	6.6 Kg.	5.50 Kg.	1.10 Kg.
3m ²	9.9 Kg.	8.25 Kg.	1.65 Kg.
4m ²	13.20 Kg.	11.00 Kg.	2.20 Kg.
5m ²	16.50 Kg.	13.75 Kg.	2.75 Kg.
10m ²	33.00 Kg.	27.50 Kg.	5.50 Kg.
15m ²	49.50 Kg.	41.25 Kg.	8.25 Kg.

8.4. Once weighed out separately, Toolfusion®1 Part A and Toolfusion®1 Part B should be positioned readily to hand and safely in preparation for the infusion process. Toolfusion®1 Part A & Part B should be mixed as required to maintain an adequate amount of resin in the resin feed bucket. When required, the Toolfusion® 1 Part A & Part B should be can be mixed by hand with a clean mixing stick or with a mechanic mixer ensuring complete mixing of the 2 parts. Failure to mix completely will result in incomplete curing of the resin once infused.



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9. Resin Infusion

9.1. You should now be ready to start the infusion process, use the check list below to double check everything is prepared;-

- Dry fabric lay-up is complete.
- Laminate is completely covered with Peel ply.
- Greenflow 75 Infusion Mesh is in position.
- Resin Feed Omegaflows (or Spiral Tubes) are in position.
- Resin Feed Tubing is in position through the vacuum bag and in the resin feed bucket and clamped off with Tygavac Resin Line Clamps.
- Vacuum Manifold is in position and connected to Tygavac RB451 Vacuum Reservoir.
- Vacuum bag is leak free and full vacuum is applied.
- Toolfusion®1 Part A and Toolfusion®1 Part B has been pre-weighed into separate batches.

When you are happy with your preparations proceed with the infusion of the Toolfusion®1 Tooling resin into your laminate.

9.2. Mix the first batch of Toolfusion®1 Part A & Part B. Thoroughly mixing the Part A & Part B together by hand or with a mechanical mixer. Make a note of the time when the resin was mixed so the mixed resin pot life can be monitored.

9.3. Pour the mixed resin into the resin feed bucket. Make sure the Polyethylene Resin Feed tubes are fixed at the bottom of the bucket.

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- 9.4. Removed the Resin Line Clamp from the resin feed tube. If multiple resin feed tubes are being used, Remove the clamp from the first feeder tube. Once the clamp has been removed Toolfusion®1 resin will quickly flow through the tube, into the vacuum bag and down into the laminate.
- 9.5. If multiple batches of Toolfusion®1 resin are being used, start to mix the next batch of resin as before. Add to the resin feed bucket before it runs dry and air can be drawn up the resin feeder tubes.
- 9.6. Using a Marker Pen on top of the vacuum bag, trace around the resin flow front at 1 or 2 minute intervals. This is a useful technique to monitor the progress of the resin flow. As the flow of the resin slows down the Marker pen lines on the vacuum bag will get closer and closer together.



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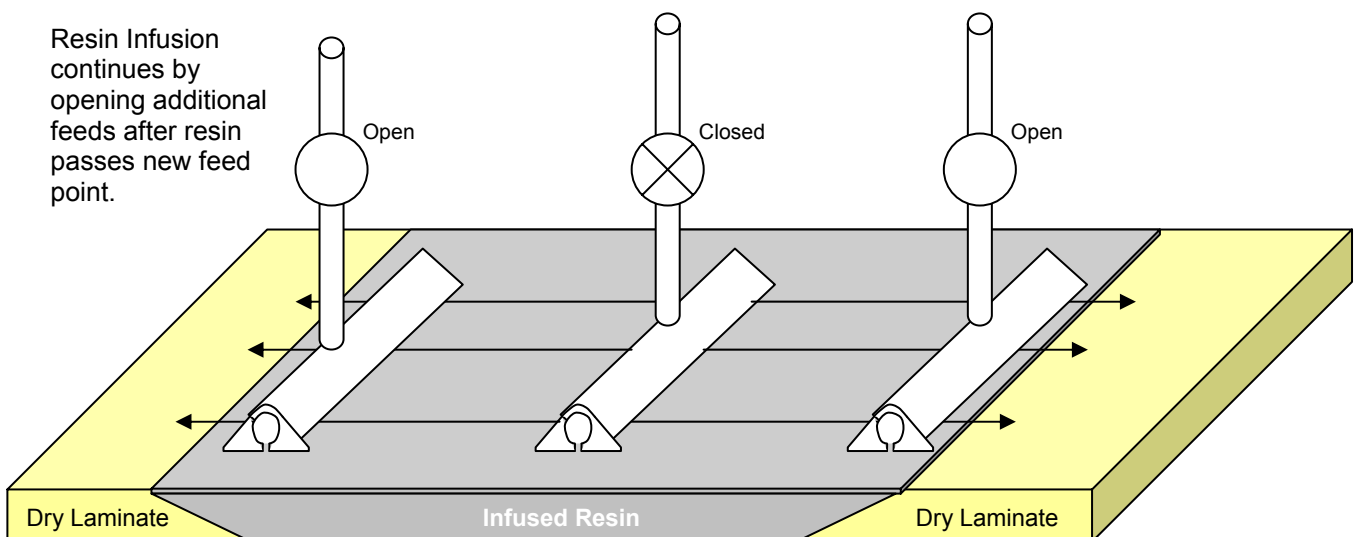
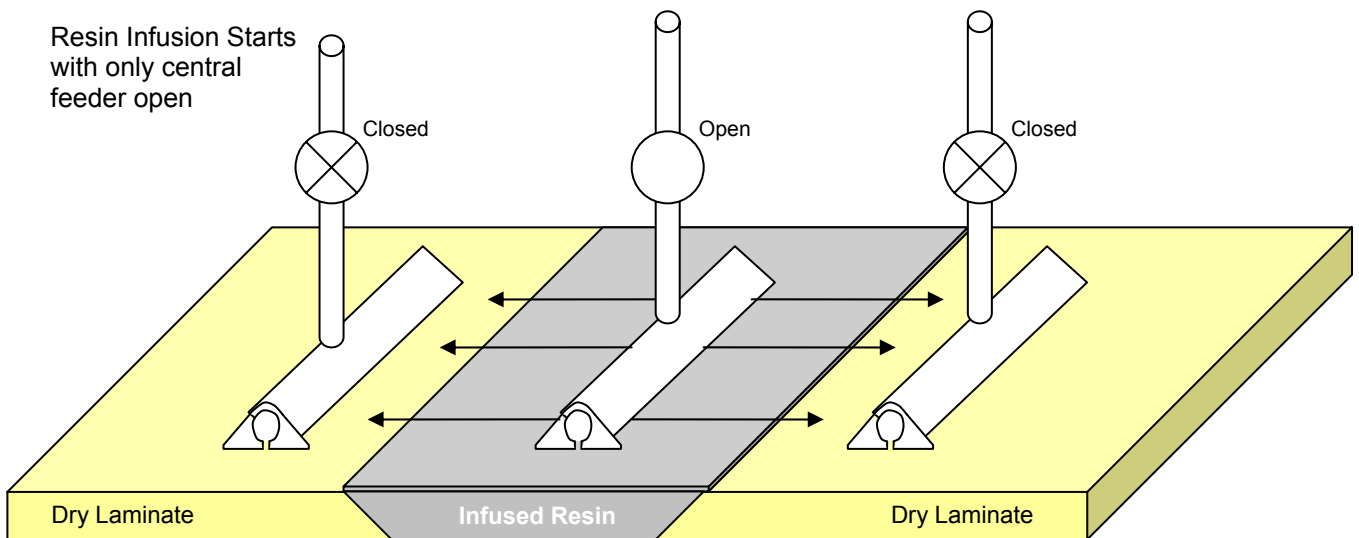
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9.7. If multiple resin feeds are being used, they should be opened just after the resin flow front has passed their position. This will prevent any air becoming trapped behind the resin flow front and avoid air entrainment in the laminate. As new feeders are opened, close previous feeders to prevent excess filling in stage 1 areas.



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- 9.8. Toolfusion®1 mixed resin has a pot life of approximately 75 minutes. Transport of the resin and Infusion of the laminate will continue until resin gelation starts. Batch mixing of the resin extends the infusion time available for larger tooling laminates.
- 9.9. Once the entire laminate has been infused, clamp the remaining open resin feed lines with an Tygavac Resin Line Clamp. Any excess Toolfusion® 1 mixed resin remaining in the resin feed bucket should be batched into smaller quantities to prevent possible exotherm.
- 9.10. Full vacuum should be maintained for the curing process, some excess resin may flow into the vacuum manifold and through the vacuum tubing into the RB451 vacuum reservoir.

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10. Curing

10.1. The Toolfusion®1 Tooling resin will cure at a constant 22°C Room Temperature in 24 hours. Full vacuum should be maintained throughout.

10.2. Remove all vacuum bagging consumables and proceed to attachment of any required backup structure.

11. Post Curing

11.1. Once any required backup structure has been attached. The tool can be removed from the master model. Take care at this stage not to use any form of solvent to clean the tool.

11.2. Post cure the tool to the following schedule.

- 11.2.1. 1 hour at 49°C (120°F)
- 11.2.2. 2 hours at 66°C (150°F)
- 11.2.3. 2 hours at 93°C (200°F)
- 11.2.4. 2 hours at 121°C (250°F)
- 11.2.5. 2 hours at 149°C (300°F)
- 11.2.6. 2 hours at 177°C (350°F)
- 11.2.7. 2 hours at 191°C (375°F)

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12. Appendices

- Glass Lay-Up Check Sheet
- Carbon Lay-Up Check Sheet
- Infusioncoat® Resin Mix Check Sheet
- Toolfusion® 1 Resin Mix Check Sheet
- Infusion Record Sheet
- Bill Of Materials

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12.1. Ply Check Sheet for Glass Toolfusion® Tooling Laminate

Date:		Project Title:			
TMFC 7500 Plain Weave 325g/m ²		Batch#		Tag#	
TMFC 7544 2 End Plain 617g/m ²		Batch#		Tag#	
Ply Number	Fabric Style	Simple Laminate	Check <input checked="" type="checkbox"/>	Quasi-Isotropic Laminate	Check <input checked="" type="checkbox"/>
		Orientation		Orientation	
1	TMFC 7500 Plain Weave 325g/m ²	0°		0°	
2	TMFC 7500 Plain Weave 325g/m ²	90°		90°	
3	TMFC 7544 2 End Plain 617g/m ²	0°		0°	
4	TMFC 7544 2 End Plain 617g/m ²	90°		+45°	
5	TMFC 7544 2 End Plain 617g/m ²	0°		-45°	
6	TMFC 7544 2 End Plain 617g/m ²	90°		90°	
7	TMFC 7544 2 End Plain 617g/m ²	90°		90°	
8	TMFC 7544 2 End Plain 617g/m ²	0°		-45°	
9	TMFC 7544 2 End Plain 617g/m ²	90°		+45°	
10	TMFC 7544 2 End Plain 617g/m ²	0°		0°	
11	TMFC 7500 Plain Weave 325g/m ²	90°		90°	
12	TMFC 7500 Plain Weave 325g/m ²	0°		0°	

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12.2. Ply Check Sheet for Carbon Toolfusion® Tooling Laminate

Date:		Project Title:			
TMGC 6000 ~ 3K Plain Weave		Batch#		Tag#	
TMGC 6003 ~ 12K 2x2 Twill		Batch#		Tag#	
Ply Number	Fabric Style	Simple Laminate	Check <input checked="" type="checkbox"/>	Quasi-Isotropic Laminate	Check <input checked="" type="checkbox"/>
		Orientation		Orientation	
1	TMGC 6000 3K Plain Weave	0°		0°	
2	TMGC 6000 3K Plain Weave	90°		90°	
3	TMGC 6003 12K 2x2 Twill	0°		0°	
4	TMGC 6003 12K 2x2 Twill	90°		+45°	
5	TMGC 6003 12K 2x2 Twill	0°		-45°	
6	TMGC 6003 12K 2x2 Twill	90°		90°	
7	TMGC 6003 12K 2x2 Twill	90°		90°	
8	TMGC 6003 12K 2x2 Twill	0°		-45°	
9	TMGC 6003 12K 2x2 Twill	90°		+45°	
10	TMGC 6003 12K 2x2 Twill	0°		0°	
11	TMGC 6000 3K Plain Weave	90°		90°	
12	TMGC 6000 3K Plain Weave	0°		0°	

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12.3. Surface Resin Mix Check Sheet for Toolfusion® Tooling Laminate

Date:		Project Title:	
Infusioncoat® Part A	Batch#.....	Tag#.....	
Infusioncoat® Part B	Batch#.....	Tag#.....	
Mix Batch #1			
Infusioncoat® Part A	Measured Weight	.....
Infusioncoat® Part B	Measured Weight	.....
Completely mixed		Check <input checked="" type="checkbox"/>	
Double Cup Mixed		Check <input checked="" type="checkbox"/>	
Time of Mixing		.....
Mix Batch #2			
Infusioncoat® Part A	Measured Weight	.....
Infusioncoat® Part B	Measured Weight	
Completely mixed		Check <input checked="" type="checkbox"/>	
Double Cup Mixed		Check <input checked="" type="checkbox"/>	
Time of Mixing		

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12.4. Toolfusion®1 Resin Mix Check Sheet

Date:		Project Title:	
Toolfusion® 1 Part A		Batch#.....	Tag#.....
Toolfusion® 1 Part B		Batch#.....	Tag#.....
Mix Batch #1			
Toolfusion® 1 Part A		Measured Weight	.....
Toolfusion® 1 Part B		Measured Weight	.....
Completely mixed		Check <input checked="" type="checkbox"/>	
Time of Mixing		.....
Mix Batch #2			
Toolfusion® 1 Part A		Measured Weight	.....
Toolfusion® 1 Part B		Measured Weight	.....
Completely mixed		Check <input checked="" type="checkbox"/>	
Time of Mixing		.....
Mix Batch #3			
Toolfusion® 1 Part A		Measured Weight	.....
Toolfusion® 1 Part B		Measured Weight
Completely mixed		Check <input checked="" type="checkbox"/>	
Time of Mixing		

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12.5. Infusion Record Sheet

Date:	Project Title:
Consumables Selection	
Peel Ply	e.g. Econolease.....
Sealant Tape	e.g. TV200Y.....
Infusion Mesh	e.g. Greenflow 75.....
Vacuum Bagging Film	e.g. NBF130.....
Vacuum Drop Test Result	
Inches of Mercury Drop	.....Inches Hg.
Time for Drop	.....Minutes
Ambient Workshop Temperature	.....°C
Time infusion Starts	.....Hours .....Minutes
Time infusion Ends	.....Hours .....Minutes
Curing Method	Oven...../ Workshop.....
Curing Temperature	
Time of Vacuum Bagging RemovalHoursMinutes
Comments	

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12.6 Bill Of Materials

- Resin
 - Toolfusion®1 Part A, see page 36 & 37 for quantity guide
 - Toolfusion®1 Part B, see page 36 & 36 for quantity guide
 - InfusionCoat Part A, Surface Resin
 - InfusionCoat Part B, Surface Resin

- Glass Fabrics
 - TMFC 7500 Plain Weave 325g/m²
 - TMFC 7544 2 End Plain 617g/m²
 - See Appendix 12.1 for lay-up schedule

- Carbon Fabrics
 - TMGC 6000 3K Plain Weave
 - TMGC 6003 12K 2x2 Twill
 - See appendix 12.2 for lay-up schedule

- Vacuum Bagging Consumables & Equipment
 - NBF130 Vacuum Bagging Film
 - Greenflow 75 Resin Infusion Mesh
 - Econolease or Release Ply B Release Fabric
 - Airhold 10CBS Double backed Tape
 - PS025 Pressure Sensitive Tape
 - RB451, Vacuum Reservoir
 - Polyethylene tube ½”
 - Polyethylene spiral ½”
 - Nylon Elbow & “T” fittings 3/8”
 - Aero 2, Temporary Bond Spray Adhesive
 - Tacstrip, Adhesive Mesh
 - Resin Line Clamps
 - Omegaflow 625V

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13. Additional Information Resources

www.resininfusion.com

Online Guides

Online Materials Selections

Online Presentations

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