

## Introduction

Composite moulds are often required to include tooling bushes and/or threaded inserts for the location/fastening of secondary tooling. The Advanced Composites Group recommend practical, repeatable and reliable methods for including these features within a tooling laminate. Two different design solutions have been successfully developed. Other details such as the quality of laminated corners and the incorporation of leak frames in composite tooling are important to consider. This Technical Data Sheet describes these processes and gives details of the requirements for the production of long-life tooling.

## Background Requirements

One of the main requirements for a composite tool is vacuum integrity. With this in mind, the incorporation of any inserted feature in the tool skin must not compromise the vacuum integrity, otherwise the tool will not function correctly.

Metal inserts should not be incorporated directly into a tool skin laminate due to the mismatch in coefficients of thermal expansion (CTE). Laminating a tool skin around an insert is likely to lead to bridging of the laminate and hence possible leakage. Retro fitting of metallic inserts will involve machining of the tool laminate, thus exposing fibres, which again is likely to cause leakage. To avoid these problems ACG recommends producing a localised composite laminate into which a metallic insert can be fitted. Any subsequent damage caused by differences of CTE is then confined to the laminate inserted, thus retaining vacuum integrity of the tool skin.

## Instructions for use

To incorporate composite inserts within a mould tool, they need to be pre-manufactured and pre-cured prior to the main tool being laminated. Dependent upon the local surface geometry, the composite insert can be either:-

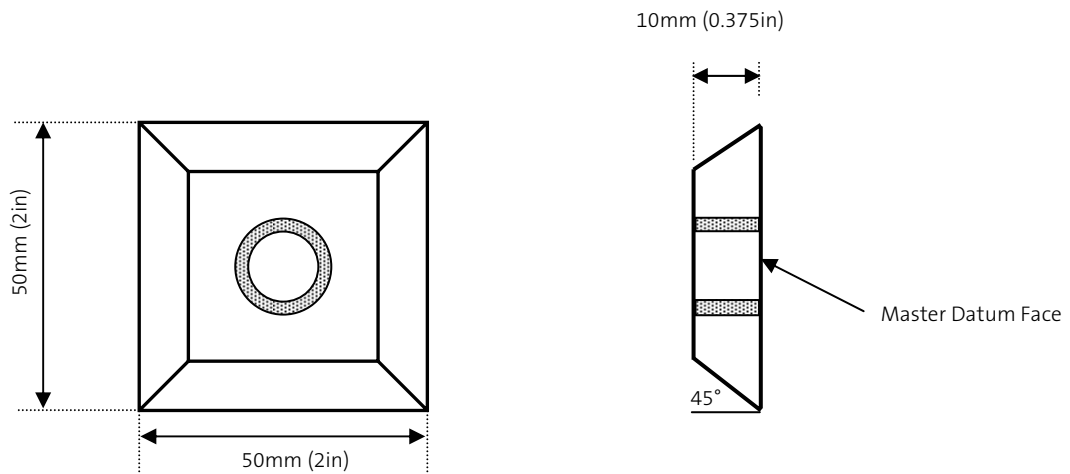
- (i) Manufactured from a flat plate laminate.
- or
- (ii) Manufactured on the master in the specified position - this is to ensure the surface of the insert blends in perfectly with the surrounding mould tool skin.

If an insert is to be laminated on a master model, it should be manufactured oversize to allow for machining back to the required dimensions. For a 50mm (2in) square insert, a 75mm (3in) square blank is normally used. Tooling bushes can be incorporated during the manufacture of the insert, whilst threaded inserts are normally fitted afterwards (to prevent threads filling with resin).

The following sketch shows a typical pre-cured insert. The dimensions indicated can be applied to both flat or shaped inserts whether they are produced as carbon or glass laminates. The insert can accommodate a number of locations or fasteners, e.g. plain tooling bushes, threaded 'Keensert' fittings etc.

The size of the insert can be adjusted to suit many different requirements. For example, if two locations or fasteners are close together a larger single insert can be utilised for both of them.

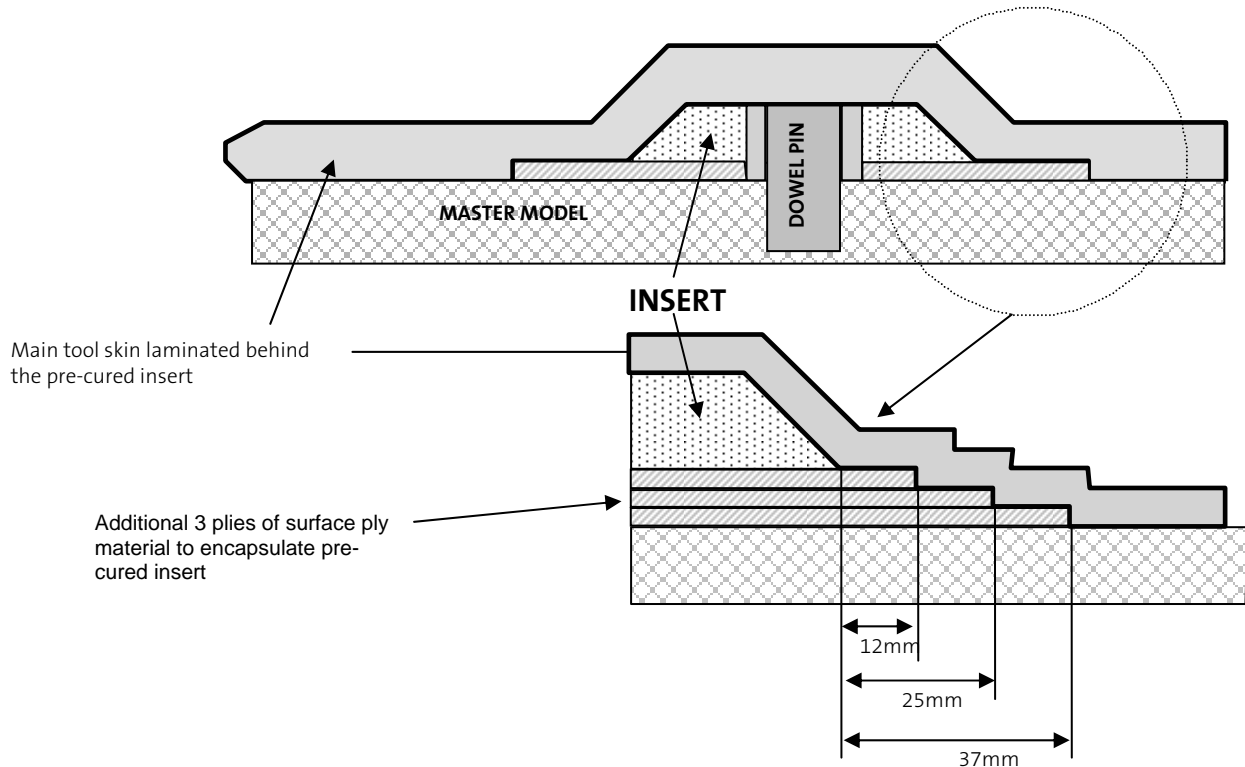
### Sketch 1 – TYPICAL PRE-CURED INSERT



Thickness of insert is dependent upon the depth of steel insert required. Size typically used for a 9.5mm (0.375in) thickness is 50mm (2in)

Sketch 2 details the general configuration for incorporation of a pre-cured insert within the main tool laminate. As can be seen from this, the vacuum integrity of the main tool skin remains unaffected if this procedure is adopted.

**Sketch 2 - TYPICAL CONFIGURATION OF AN ENCAPSULATED INSERT FOR A CARBON TOOL**

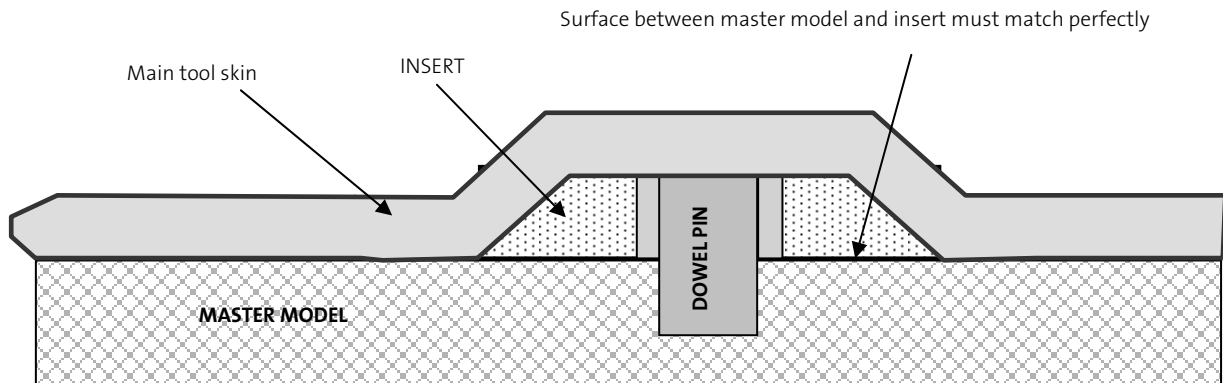


For the configuration as shown in Sketch 2, the insert is manufactured to size and the relevant bush/threaded insert fitted. It is then lightly abraded all over and thoroughly degreased. The three localised surfacing plies are placed in position on the master where the insert is to be situated. The insert is then located in position.

**Note:** Any dowel or location pin used to position the insert must be pre-treated with release agent.

The main tool skin is then laminated over the back of the insert. This method totally encapsulates the insert within the laminate without affecting overall vacuum integrity.

### Sketch 3 - TYPICAL CONSTRUCTION OF SURFACE MOUNTED INSERT



For the configuration shown in Sketch 3, the insert is prepared in very much the same way except it is only abraded on the back faces; the surface **must be left as moulded**. The insert is degreased and located on a released dowel pin and the main tool skin laminate produced over the back of the insert.

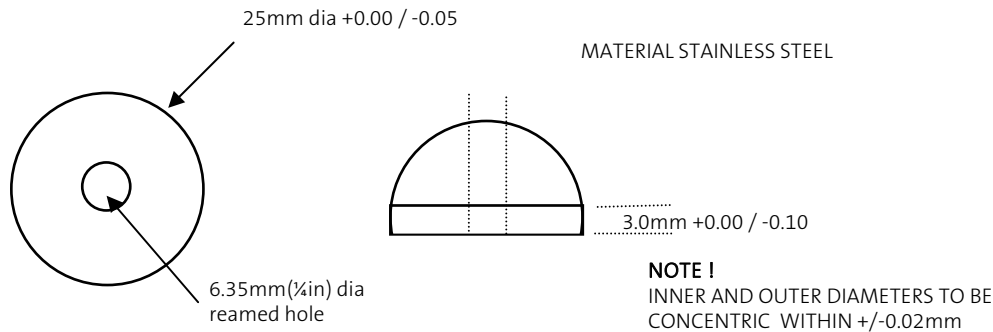
It is extremely important for this configuration that the surface of the insert perfectly matches the surface of the master model, particularly if it is located on the surface of the tool within the component end of part line (EOP). If it is beyond this area, any mark off will not affect the functionality of the tool. It is more appropriate to use this method where the insert has actually been manufactured on the master model

### Location of other Loose Tooling

One of the problems faced by the designer of composite tooling is the accurate and reproducible location of loose tooling, such as joggle plates, trim bars, honeycomb templates etc.

The solution regularly adopted by ACG is to use a hemispherical locator as detailed in the following sketch. The hemisphere has tight tolerances placed upon it, in the interests of interchangeability.

#### Sketch 4 - HEMISPHERE LOCATION TOOLING



Steel hemispheres are positioned on the master model surface. It is wise for these positions to be incorporated into the master as tooling bushes, so that replacement tools will have exactly the same configuration. Each hemisphere should be located on a dowel. The choice of material from which the dowel is made can cause problems; if dowel positions oppose each other a “lock-on” situation will occur. A material must also be selected that will securely locate the hemisphere but which will shear during demoulding without causing any damage to either the tool skin or master model. ACG has found that dowels machined from ACG tooling block meet these requirements.

A small fillet of polyester filler [approximate radius of 3mm (1/8 in)] should be wiped around the hemisphere to break the sharp corner where it meets the master model surface. If the surface of the master does not match with the bottom face of the hemisphere it can be bedded on filler, prior to the fillet being produced.

The mould tool skin should then be laminated over the top of the male hemisphere, thus creating a female hemispherical depression within the tool skin. Any additional tool furniture can then be laminated on the mould tool surface and into the female hemispheres, thus producing a built-in reproducible, permanent location.

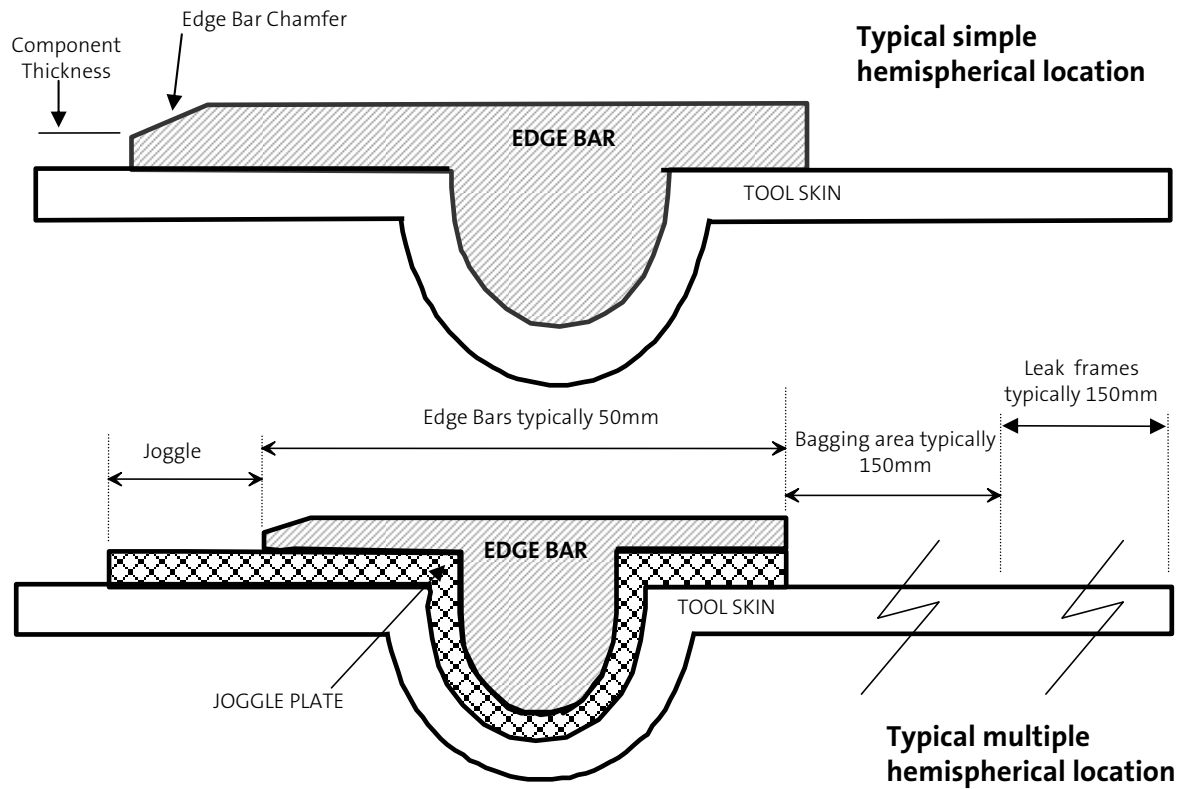
The advantage of this method of location is that there is a perfect match between the female hemisphere in the mould tool and the male hemisphere on the loose tooling. There is also no problem with mismatch of CTE's between mould tool and furniture.

The location of loose tooling on such hemispheres is usually sufficiently tight and additional fasteners are not required.

**Please note - It is essential that the tool skin laminate is very carefully cut and tailored around the hemisphere, as any bridging is likely to cause leakage after thermal cycling.**

The following sketch shows typical applications for hemispherical locations.

### Sketch 5 - TYPICAL HEMISPHERE APPLICATIONS



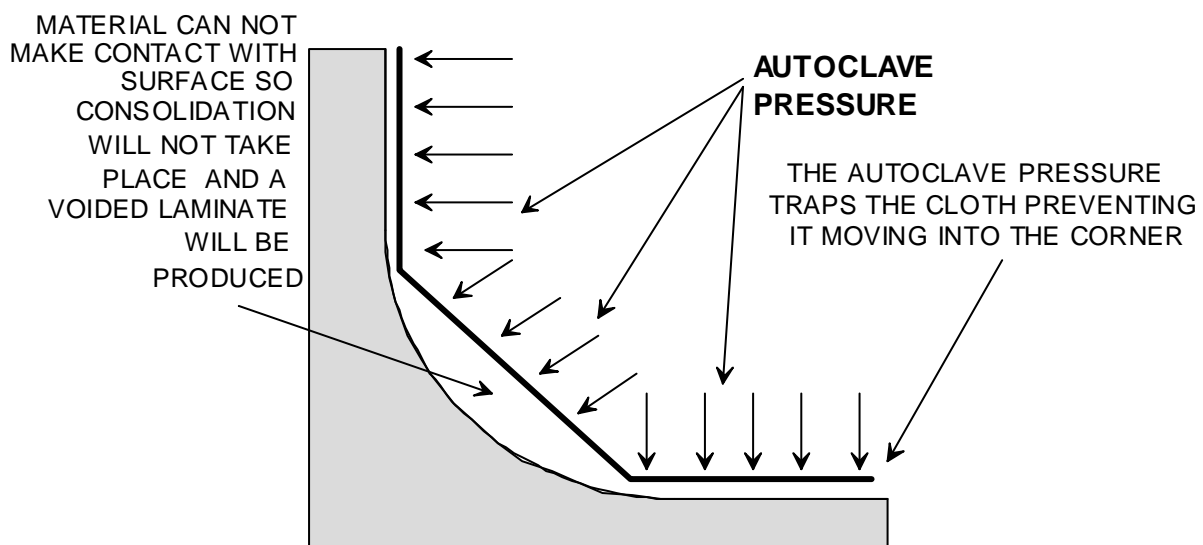
### Additional Features

The Advanced Composites Group has over the years produced many composite mould tools and during this time it has been constantly reviewing and modifying the laminating procedures to progressively improve the performance of composite mould tools. Two such features covering “Female Corners” and “Leak Prevention Frames” are detailed as follows:-

## Female Corners

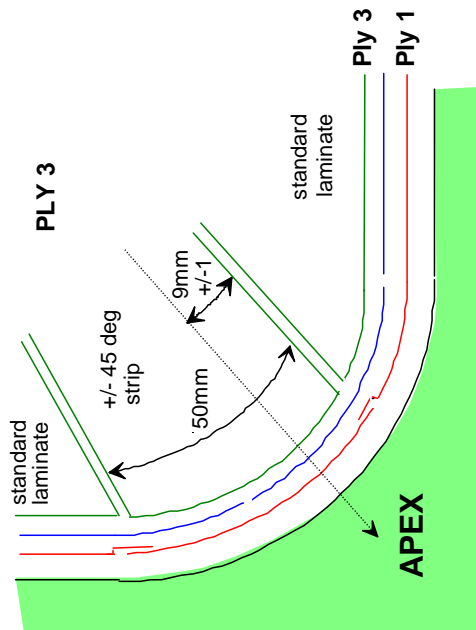
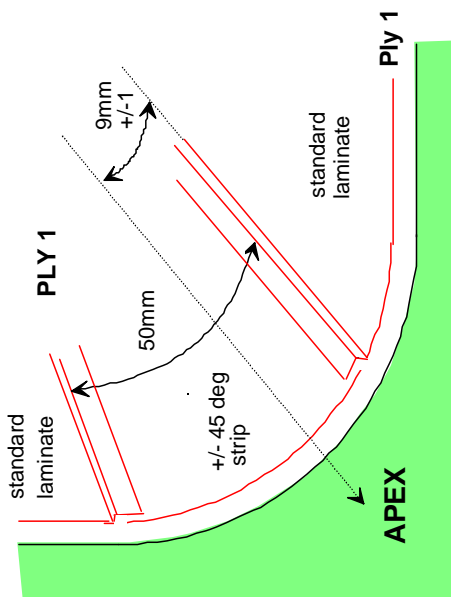
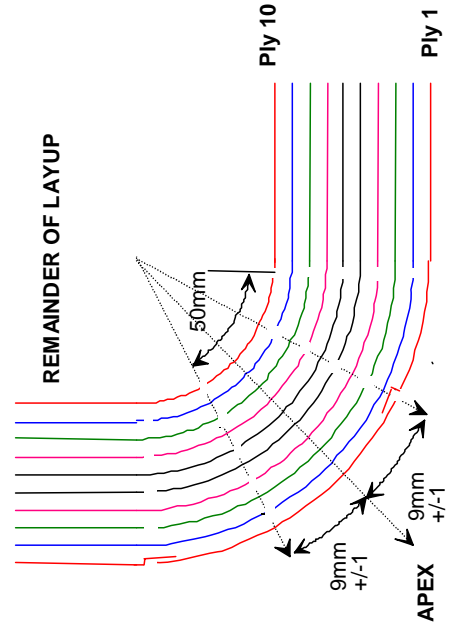
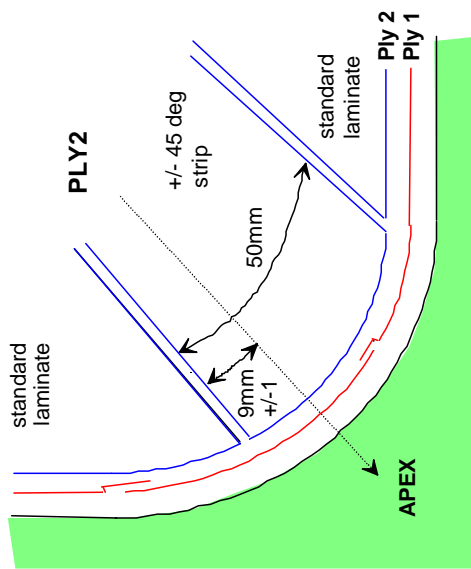
Experience has proved that when laminating into a female feature it is very easy for one of the plies in the laminate to bridge the corner. Subsequently when pressure is applied during the autoclave cure cycle, consolidation cannot take place, resulting in a voided laminate no matter how slight the bridging. It is a common perception that once autoclave pressure is applied it will force the laminate into place, and in some respects this is true providing there is sufficient material to allow such movement to take place. In the specific case of a female corner however, this is not always the case and there is some risk of bridging as shown the sketch 6.

**Sketch 6 – BRIDGING IN FEMALE CORNERS**



This problem is more likely to occur on plies with a 0/90° orientation in the corner because the fibres cannot stretch, even under autoclave pressure. It is recommended therefore that the laminate construction locally around female corners is changed so that it consists of totally  $\pm 45^\circ$  orientated strips. This method, along with careful positioning of joints etc, will allow the laminate to move sufficiently under consolidation by autoclave pressure (see sketch 7).

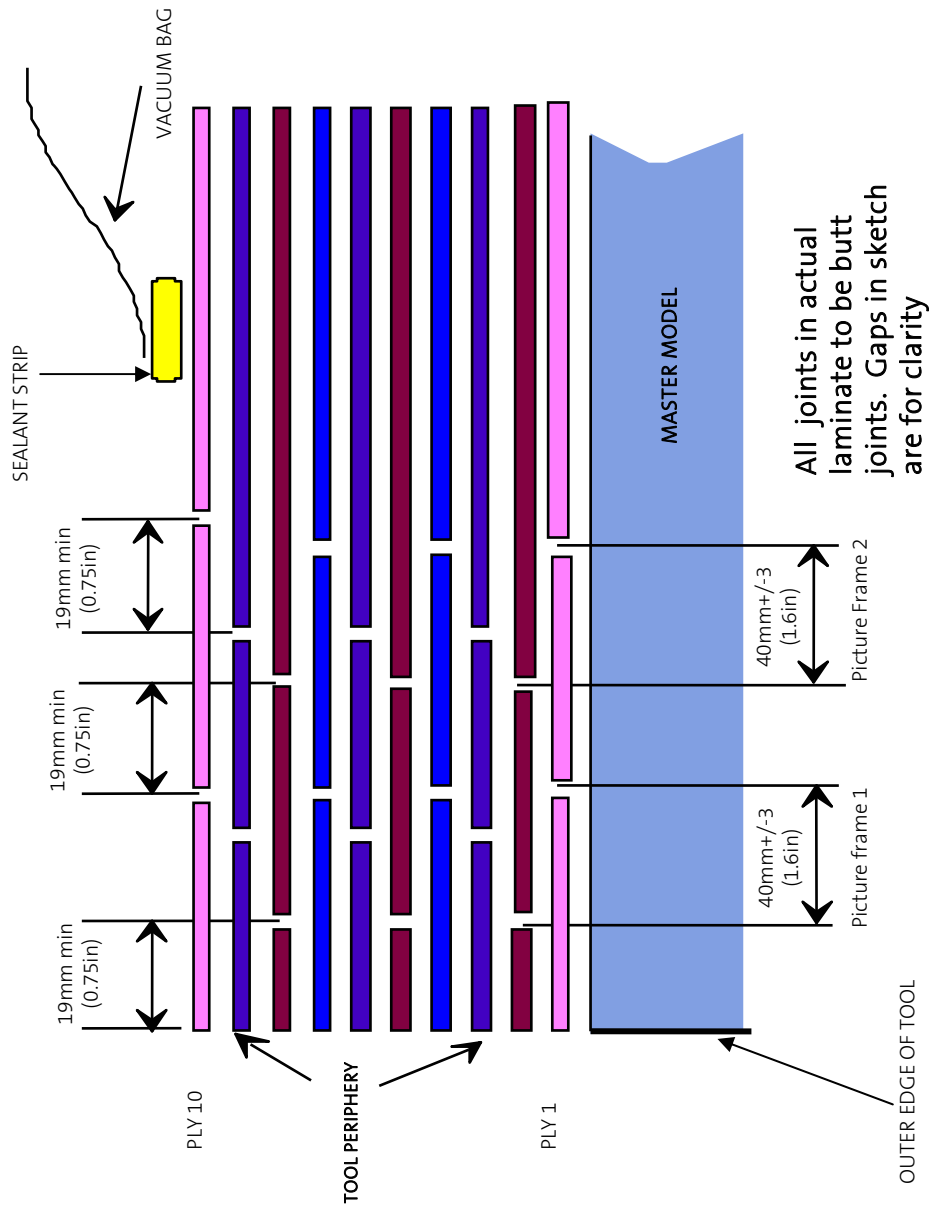
### Sketch 7 – LAMINATING ROUND A FEMALE CORNER



# Leak Prevention Frames

A Leak Prevention Frame is a feature within a composite mould tool laminate that is designed to reduce the risk of loss of vacuum integrity arising from potential laminate edge damage. If damage occurs to the surface or edge of a composite mould tool, it has been proven that air can track along the fibre bundles, causing the tool to lose vacuum integrity. A leak prevention frame avoids this by simply introducing a break in each layer of the laminate. To be effective, the leak prevention frame must be located between the outer edge of the tool and the vacuum bag sealant strip.

Sketch 8 - LEAK PREVENTION FRAMES



## NOTES:

1. All tool laminates, which are required to be vacuum integral, must incorporate Leak Prevention Frames
2. A minimum of one but preferably two 'Frames' are required; these should be positioned between the area to be sealed by a vacuum bag and the Tool periphery.
3. Each Leak Prevention Frame must have a break in each ply; this should be within a 40mm (1.6in) wide strip. The breaks are to be staggered by 19mm (0.75in) minimum and should not be repeated more than four times on the same point in the laminate (see sketch 8).

## Technical Support

For further detailed information related to the subject matter on this Technical Data Sheet, please contact to ACG Technical Department.