1. Machining of The Gill Corporation Composite Products

This guide contains recommendations for cutting, drilling, and routing of laminate and sandwich panels. The information can be useful for the fabrication of the semi-finished material into exact replacement articles.

The laminates are composed of a fiberglass-reinforced/phenolic resin binder. While this is not particularly difficult to drill or cut, certain precautions and tools should be used to prevent delamination, tearing, singeing, or fuzzing of the reinforcing fibers/resin.

The sandwich panels are composed of carbon fiber or fiberglass reinforced/phenolic resin facings bonded to Nomex/ phenolic resin honeycomb core. Care must be taken in the fabrication of replacement panels to avoid disbonding, delamination, tearing, singeing, fuzzing of the fiber, or crushing of the core.

1.1 Drilling

1.1.1 Tooling Recommendations for Drilling

Drill Type	Information
High Speed Steel	Lowest initial cost, readily available. Short drill life, especially in fiberglass. About 500 holes in fiberglass between sharpening. Improved with a hard flash of chrome plating (0.003" - 0.005") is put on the drill bit. Flash chrome is recommended for large drills where carbide is too expensive.
Tungsten Carbide	Higher initial cost but longer life. May be re-sharpened. Up to 3/16" diameter, grind drill to have a slight negative rake on the cutting tip. Over 3/16" diameter, use slow helix dill, ground to 55° point (sharp). Recommended for high production requirements only.
Diamond-Grit Edged Drills	For fiberglass only. Most expensive, but longest lasting, fastest and smoothest cutting. Recommended for high volume only. May be recoated at near initial cost, 40 grit recommended for most Gill fiberglass products. 10,000 surface feet per minute is customarily available on 10,000-20,000 rpm router. Will drill a hole 3 times as fast as a carbide drill. Dust collection system mandatory. Cannot be used with drill bushings or slip-renewables.
Fiberglass Drill/Router	Solid carbide, fairly expensive. Must be returned to manufacturer for sharpening. Produces clean fuzz-free holes in most fiberglass without delamination, especially in thin (less than 0.060") fiberglass. Cuts quickly without tearing, delaminating, or fuzzing the fibers around the hole.

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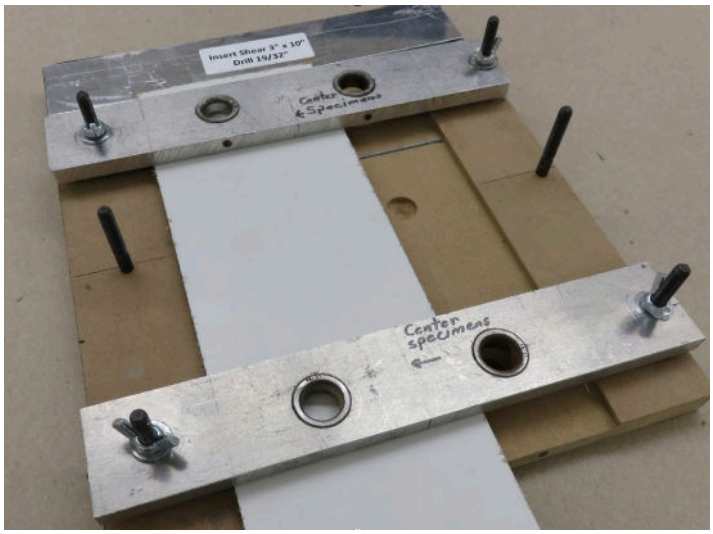
1.1.2 Drilling Template with Bushings

For any work requiring center to center hole tolerance of ± 0.03 inches (0.8 mm) or less, the use of a drill template with hardened steel bushings is recommended. Good tooling will speed production and provide accurate repeatability of the hole pattern. For small jobs (less than 15 holes) a removable bushing (slip renewable) may be used. It is not as accurate as pressed bushings, but the tooling cost will be reduced.



For holes requiring close tolerance diameters ± 0.005 inches (0.13 mm) or less, a pilot hole should first be drilled through a bushing, then the hole counterbored to the final diameter. Sandwich panels with honeycomb cores should also be back-drilled (counterbored through the back skin) since the pilot hole in soft cores will not hold the counterbore pilot steady. Drilling a hole without the use of drill bushing will often produce egg-shaped holes since most drill chucks do not turn in a perfectly circular path, and the operator cannot hold the drill at a perfect 90° angle to the work piece. Using a drill press or a portable drill guide will simplify drilling holes at 90° to the material surface. Whenever possible, many facilities drill holes slightly larger than they are actually needed in order to eliminate the need for tooling and drill bushing.

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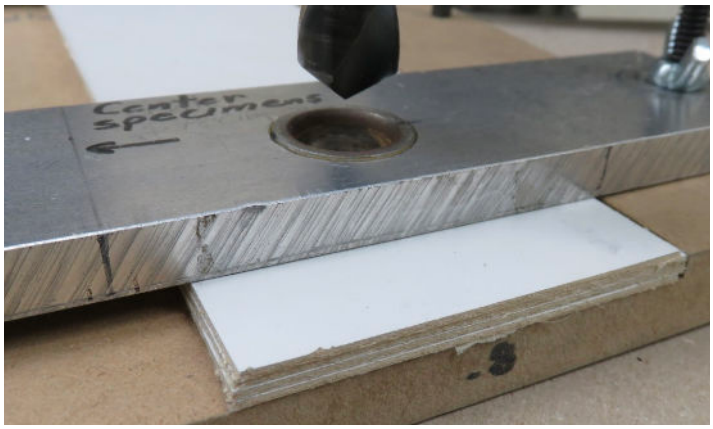
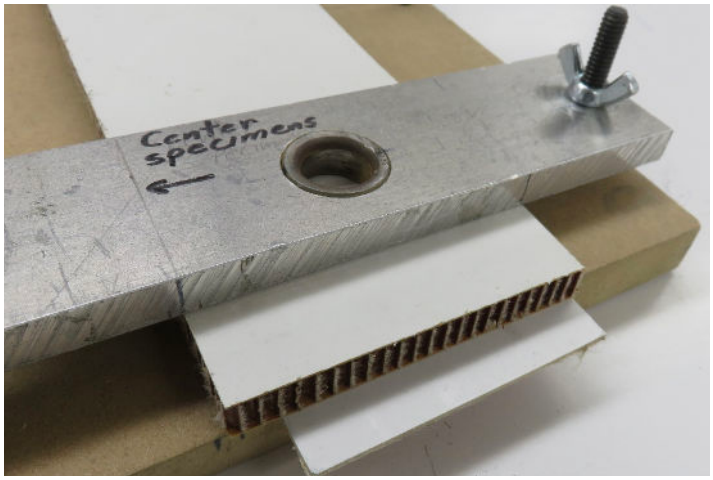
1.1.3 Stacked Drilling of Multiple Laminates

Drilling multiple stacked parts is a fast way to drill many identical holes in several pieces, as long as they are firmly clamped together and to the template. However, center-to-center tolerance will usually suffer, especially on the last part in the stack. When drilling deep holes, lift the drill out occasionally to clear away dust or chips. This will prevent galling or binding and will produce a cleaner, fuzz-free hole.



1.1.4 Backing Material Used to Support the Panel for Drilling

It can also be useful to place an extra layer of undrilled cardboard, chip board, or excess laminate beneath the bottom layer being drilled. This helps prevent fuzzing on the last layer.



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1.2 Cutting and Routing

1.2.1 Tooling Recommendations for Cutting and Routing

Method	Information
Band Saws	Not recommended, slow cut, difficult to control, but can be used for rough cut on loose tolerances. Will dull rapidly, but gives a fair cut even when dull and is inexpensive to replace. Fence should be used to control the cut as much as possible. Most The Gill Corporation products may be cut with a standard 8-10 tooth/inch band saw.
Circular Saw	Typically, 12" to 16" diameter carbide tipped or diamond saw blades are used. Diamond blades are coated 40 grit. Extra care must be taken to ensure that the laminates do not delaminate or singe. For worker comfort and general good housekeeping, a good vacuum system for dust collection is a must. Recommended blade speeds are shown in the table below.
Shearing (Laminates Only)	Laminates can be cut with a mechanical shear, available in many maintenance shops. For the thickest laminates, a heavy-duty, sharp blade shear is required to prevent delamination or tearing. The thinner laminates (0.025" and below) can be cut by means of heavy-duty handheld scissors. Extra care must be taken to tearing, delamination, or fuzzing of the fibers. Reduces the amount of dust generated.
Routing	Recommended Router Bits are as followed: Fiberglass Router – Best, inexpensive, can be sharpened. Best with rigid laminates. Diamond Grit – Will cut and clog; longest life; can be cleaned. Carbide Tip – Dulls rapidly, not recommended.

Circular Saw Recommended Blade Speeds		
Blade Diameter	**Revolutions per Minute**	**Surface Feet per Minute**
8	4500	9400
10	4000	10500
12	3600	11300
16	3450	14500

1.3 Deburring

All machined and cut edges of the panel must be deburred to remove any fibers which might have become exposed during machining operations to ensure a clean, debris-free surface for subsequent bonding or edge filling procedures.

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