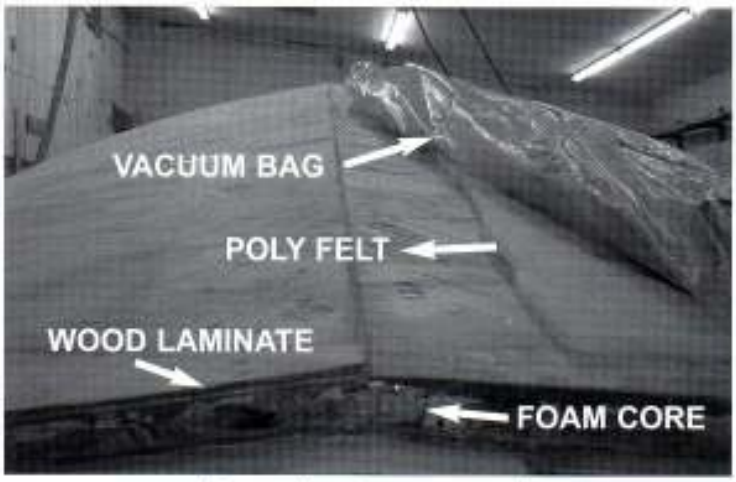
Vacuum Planning

Planning a vacuum bagged repair is the key to success. Time and money may be quickly wasted if an unplanned vacuum repair is executed. Resulting laminates may be dry and airy looking and suffer from low compression fatigue resistance. Dry laminates suffer from fibers buckling out of column. Over vacuumed laminates are dry because all the resin has been sucked/squeezed out of the laminate .

Why vacuum bag a repair that may otherwise be perfectly well executed with standard hand laminating tools? If you cannot come up with an answer like "the laminate was built under vacuum" then you better get reaching for the bubble chaser and squeegee. However with infusion techniques becoming more popular and hand laminated vacuum bagged bulkheads becoming a standard manufacturing technique, we must be aware or check with the OEM as to production techniques employed. If the part was originally vacuum consolidated (i.e. the ba-Jesus squeezed out of it under vacuum) then we must repair the laminate employing a similar fiber consolidation technique. If properly executed a similar resin to fiber volume fraction can be achieved.

"Similar" technique and "similar" volume fraction are the key words. If a professional repairer is rebuilding a vacuum bagged laminate there is a good possibility that there is no documentation as to the vacuum level drawn on the part during the original fabrication. Many defacto vacuum schedules in plants around the country are dependent on how the pump was running that day, how many parts were being built that day and what kind of seal was achieved. Since all of these parameters will likely remain a mystery to the repairer, we will simply try to establish a reasonable norm for a vacuum bagged repair utilizing MAS Epoxy resin and fiber reinforcement.



Preparing to vacuum at Covey Island Boat Works. Note the laminate, the polyester felt, and the peel ply being applied in layers

Step 1:

Cut and weigh (in lbs) all of the fiber reinforcing to be used in the repair laminate.

Step 2:

Divide the weight of the fiber by 20 if glass, 14 if carbon. This will give you the volume in gallons of fiber material to be used in the job. Assuming a 50:50 fiber/resin volume fraction this will also equal the volumetric amount of resin that must be mixed to wet the laminate plus a little extra for the bleeder material once the laminate is consolidated.

Step 3:

Multiply the volumetric amount by 9.19 this will then give you the amount of resin required in pounds for the repair laminate.

The reason for this exercise is to avoid over saturating the laminate and the breather material, which will result in uneven vacuum pressure over the surface of the part. Normally I mix a bit of extra resin for the first batch as this allows for wetting of the laminating table and the tools. Once the laminates are wet and placed the rest is standard vacuum procedure. Stack vacuum materials in the following order top to bottom (the top fiber laminate may be left dry if resin is running thin and the material is light).

Vacuum bag
Bleeder material (polyester felt or baby blanket)
Perforated release ply
Peel Ply
Laminate

Once the vacuum bag is sealed and vacuum is ready to be drawn it is necessary to have a system for accurately regulating the vacuum. I use a bypass needle valve and gage in combination with a pair of plastic T's. The needle valve should be in the fully open position when the vacuum pump is started and then it should be slowly closed until the gage reads 12"-14" of Hg. The ramp should be a steady climb to the set point of 12"-14" (remember that 14" = 2016 pounds/sq. ft.). Caution must be taken not to over consolidate the laminate (i.e. too much vacuum). If this occurs needed resin will be squeezed out through the peel-ply and perforated

release ply. This lost resin will not be able find its way back into the laminate. While all of this is going on the remaining resin must be monitored in a thin film (I use what ever is left on the laminating table). Using a cotton ball simply dab the cotton ball onto the wet resin film.

When the film pulls lots of fiber from the cotton ball the laminate has set.

Additionally, the Cure schedule Table on page 4 may be used to assist in determining the thin film set time. Once the resin has set the needle valve may be fully closed and the bag chased for leaks (vacuum levels will likely be in excess of 29"of Hg depending on your pump set up). This final consolidation will squeeze down any remaining micro bubbles with out driving resin out of the laminate (just like ightening a vice).

Vacuum bagging a 65' boat at Covey Island Boat works