



## One Manufacturer's Perspective on Compatibility

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A few years ago our choices in 104 soft glass were limited to Moretti, Lauscha and a few others. Today, there is no Moretti company. Instead we have Effetre, Vetrofond, Lauscha, CIM, Double Helix Glassworks, Precision, TAG, etc. It is both great and frustrating for the 104 soft glass artist. We have new colors, new companies and new effects but we also have to balance all these choices. We have to create a design that is not only aesthetically pleasing but one in which all the components are compatible. What is compatibility? It is the ability of two or more different glasses to seal together without causing so much stress between each other that they break apart.

At Double Helix Glassworks we recognize that compatibility issues have been on our customers' minds. Before releasing our own clear we want to establish reasonable expectations about compatibility. In order to do that we need you to know what it takes to manufacture compatible glasses.

Glasses need to be tested for compatibility to determine if they can seal together without breakage. Even small differences between glass formulas and their melts can affect the compatibility of two glasses. Some differences, like adding potash to soften your glass are intended. Other differences, like how much water the potash absorbed from the atmosphere, are unintended. Manufacturers, no matter how many or how few colors they produce need to check the compatibility of their glasses to solve for these differences.

Some manufacturers solve for these differences by testing the COE of their glasses. COE is an abbreviation for the coefficient of expansion. The coefficient of expansion is a measurement of how much the glass expanded at 0-300 degrees Celsius at a rate of increase of one degree per minute. The expansion is measured with a dilatometer and the result is expressed as  $104 \times 10^{-7}$  or simply 104. Comparing the COE of two glasses does not tell you if the two glasses are compatible. It tells you that the two glasses expanded the same amount at the same temperature range and rate of increase.

Manufacturers also need to establish tolerances. A tolerance is how much leeway for variation a manufacturer will allow from their standard. In order to establish a tolerance a manufacturer needs to know what the safe limit is.

It is a generally accepted rule that +/- 2 points of COE is a safe limit and beyond this limit, breakage may occur. This limit would equal glasses in COEs

from 102 to 106. Some manufactures say that breakage begins below this limit and they keep their tolerances tighter than that. Effetre's tolerance as published in their catalog is +/- 1.5 COE points which gives their glasses COEs of 102.5 to 105.5.

Other manufacturers solve for compatibility issues by measuring the stress that exists between two glasses. This does not tell you what COE the glasses are. It does tell you if the two glasses are compatible. Stress is measured by taking two sample rods of the glass you wish to test and one rod of the transparent glass you are testing against and sealing the three together in the torch or kiln. This is called a Trident seal. After annealing the Trident seal, it is read in a polarimeter to measure the stress between the two glasses. The stress is expressed in pounds per square inch (PSI). The manufacturers of the polarimeter equipment and other respected glass companies state that 1000 PSI is a safe limit. Above this point breakage may occur. The glass being tested can be softer or stiffer than the control glass it is being tested against. This difference can be noted with the use of positive and negative PSIs. A positive PSI is used when the glass being tested is softer, and a negative PSI is used when the glass being tested is stiffer than the control glass it is tested against. The use of positive and negative PSIs splits the safe limit of 1,000 PSI into +/- 500 PSI. It is important to note whether the glass is softer or stiffer because different adjustments must be made to correct the next batch.

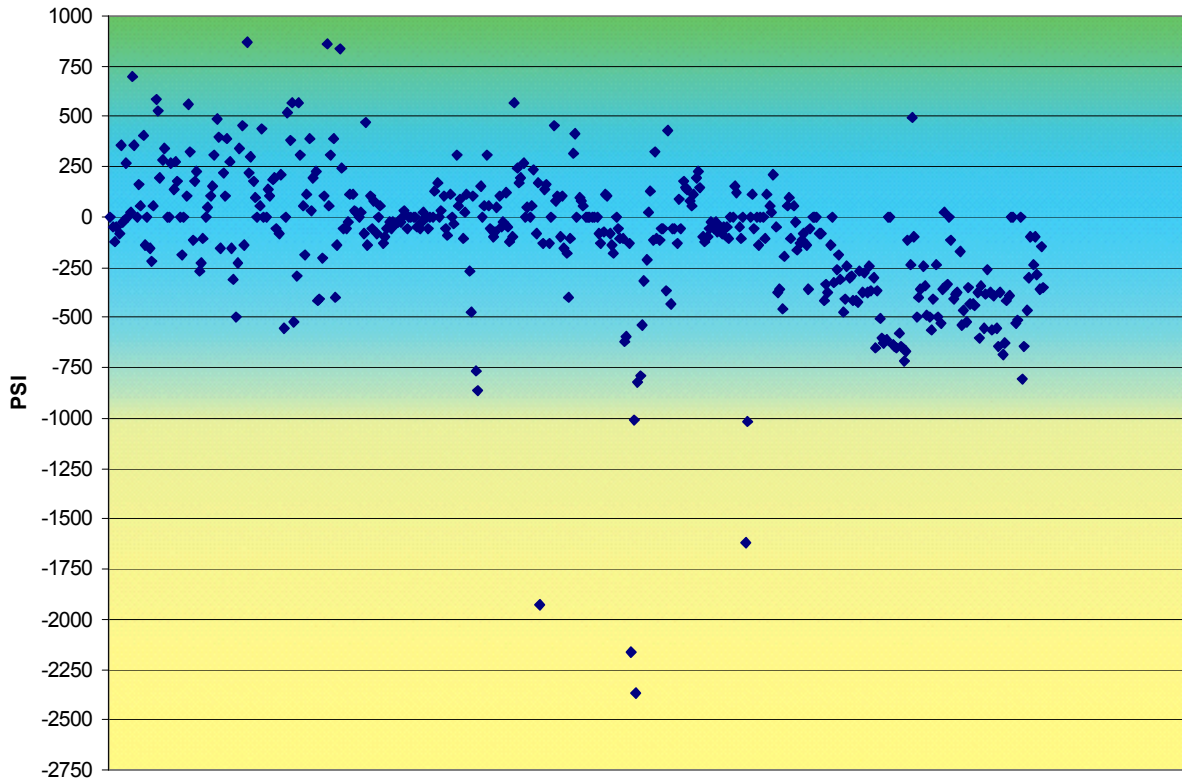
At Double Helix Glassworks we batch and pull multiple small pots of glass each day. Every pot of glass, including Aether, is tested for compatibility against Effetre clear. We take sample rods from each pot of glass and make a Trident seal with Effetre clear. The Trident seal is viewed through our polarimeter and we measure the stress that can be seen between the two different glasses. Our tolerances are +/- 350 PSI, well below the safe limit of +/- 500 PSI. Any glass that measures outside this tolerance is placed on our off-expansion shelf and is not sold to the general public. If you're ever in the area, call ahead and you can come by and visit all the beautiful off-expansion glass!

We have one of the tightest tolerances in the manufacture of 104 soft glasses. Our clear, Aether, is held to these same tight tolerances of +/-350 PSI. Having a tight tolerance is the best action we can take to solve for compatibility issues.

To be sure that we have one of the tightest

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G L A S S W O R K S



Manufacturer's colors sealed to manufacturer's clear

tolerances of 104 soft glass manufacturers, we tested several other manufacturers' 104 soft glass. We took samples of their available colors and tested them against their own clears. You can see the results in the chart above. The total readable spread of stress was 3,031 PSI with a range from 867 PSI to -2,164 PSI. The actual spread is greater because 3 samples broke before they could be read. You can't read a sample once it's broken because the stress has been relieved.

87% of the samples were well within safe limits of +/- 500 PSI.

13% were outside of safe limits

Of the 13% beyond the safe limit

9% fell below -500 PSI

2% fell above 500 PSI

1% fell below -1000 PSI

1% broke

87% of the glasses tested are compatible with the manufacturers' own clear. An additional 11% were also compatible with the manufacturers' clear but may not be compatible with other colors from the same

manufacturer. For example, if you took a glass manufactured by company X that measured -760 PSI and used it with a glass also from company X that measured 700 PSI your total theoretical PSI would be 1,460 PSI. This is beyond the recommended limit of 1,000 PSI and may break. Additionally there were 2% of samples that were beyond the safe limit with the manufacturers' own clear. These glasses may break.

This chart does not tell you which glasses are compatible between different manufacturers. It tells you what the spread among the 104 soft glass manufacturers we tested is. With a spread this broad it is not feasible to manufacture a glass that would be compatible with all 104 soft glass colors. The best that any manufacture can do is to maintain tight tolerances and apply them to every pot of glass they produce. That is what we do at Double Helix Glassworks.