

# TECHNOTES 6

A TECHNICAL SUPPLEMENT FROM BULLSEYE GLASS CO.

## PREPARING THE SHELF SYSTEM FOR A LARGE KILN



FIGURE 1: PEARL-56 BULLSEYE EDITION KILN WITH FINISHED SHELF SYSTEM

Creating large, finished glasswork that is flat, uniform, and well annealed is highly dependent upon having a reliable shelf system. An ideal shelf system for a large kiln must have a continuous, seamless surface and be level, stable, smooth, durable, flat, and able to transfer heat uniformly. With this TechNote, we recommend one such shelf system and provide the information needed to prepare it.

You will find that preparing this shelf system is not difficult, but it is process intensive and will require several days. Taking your time, without rushing or cutting corners, will help you to establish a reliable firing surface that, with proper care, will last for many years.

The three major steps in preparing the shelf system are: leveling the kiln floor in its operating location, establishing a mullite subshelf system, and preparing a fiberboard shelf.

## STEP 1: LEVELING THE KILN IN ITS OPERATING LOCATION

Ideally, you will be able to position the kiln in a level operating location.

Once the kiln is positioned, you will need to determine how level its floor is. Do this by placing a level on the kiln floor, taking readings from side to side, front to back, and corner to corner. (Figure 2) If your level is short, set it on a long straightedge to evaluate a larger span.

If you find that your kiln floor is not level, you will need to make adjustments. Some slight leveling can be accomplished later, by positioning shims under sections of the mullite subshef (Step 2). But if one side of the kiln floor is 1/8" (3mm) lower than the other, the kiln itself should be leveled. In general, for the sake of stability, it is better to level the kiln than to rely on shims.

Here are two options for leveling the kiln:

- If your kiln has adjustable leveling feet, use them.
- Add washers between the casters and mounting plates on the low side of the kiln.

## STEP 2: ESTABLISHING A MULLITE SUBSHELF SYSTEM

Once the kiln is level, the next step is to establish a mullite subshef system that is stable, level, and flat. Such a subshef system will provide strong support for glasswork and will help to ensure the uniform transfer of heat to glass.

Procedure for establishing the mullite subshef system:

1. Calculate the total shelf size by subtracting 4" (10cm) from both the length and the width of the interior kiln dimensions. This will leave a 2" (5cm) air space between the shelf and sides of kiln, which will help to ensure uniform firing.
2. Using a tile saw, cut the mullite subshef units. We recommend that the units be of an equal size to help provide uniform heat distribution, symmetrical post layout, and subshef stability.
3. Measure the kiln floor (Figure 3) and mark the intersections where support posts for the mullite units should be placed. (Subshef corners will meet in the centers of the posts.)
4. Place one post at each intersection. If your posts are slightly different in height, you can saw or grind off tall ones and add mullite shims to raise short ones. If your posts are narrower than 2.5" (6cm), cover them with 3" x 3" x .5" (8cm x 8cm x 1.3cm) mullite squares to increase subshef stability.
5. Position the mullite subshef units so that their corners meet in the centers of the posts. (Figure 4) The units should fit together evenly but have narrow gaps between them—about 1/16" (1.5mm) in all directions. Gaps will allow the mullite subshef system to expand during firing. If gaps are not present, the expanding system will shift during firing and may become uneven.



FIGURE 2: CHECKING THE KILN FLOOR WITH A LEVEL.

### Materials and tools you will need:

- Mullite subshef units.
- Mullite posts, 2.5" (6cm) wide at minimum and 4" (10cm) tall.
- Stainless-steel shims.
- A level, a square, and a measuring tape.

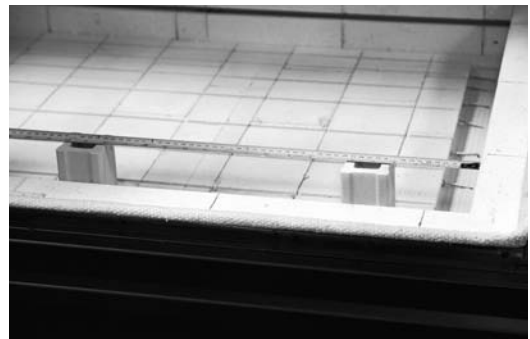


FIGURE 3: EQUIDISTANT POST PLACEMENT.

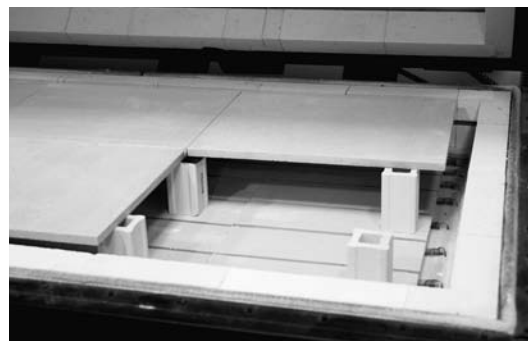


FIGURE 4: POSITIONING THE MULLITE SUBSHELF UNITS.

- Once the subshelf units are laid in, you will need to level the entire subshelf. Measure how level it is by checking it with a level from front to back, side to side, and corner to corner. If you discover areas that are not level, try rotating or flipping the mullite subshelf units to correct the problems. Some units may be slightly bowed and some corners may be thicker than others. If a unit is bowed, always flip it so that the raised corners are facing downward and the bow is arching upward. Sharp, raised corners could dent or scratch the fiberboard shelf.
- Finally, insert stainless steel shims between the posts and the shelving units to raise any areas that are still low. (Figure 5)

If many areas of the shelf need shimming, it may be useful to draw a map of the low areas so that you can plan the number, type, and location of shims you need and insert them in an orderly fashion.

### STEP 3: PREPARING A FIBERBOARD SHELF

The goal of this step is to prepare a fiberboard shelf that is flat, smooth, and durable. To accomplish this, you will need to treat all of the shelf's surfaces with the same materials and processes so that they will have similar properties. Uniform surfaces will help the shelf to remain flat throughout its lifetime.

Note that fiberboard is somewhat fragile, especially when wet, and should be handled with care.

In preparing the fiberboard shelf, you will:

- Cut the shelf to size (if not pre-cut).
- Apply and dry colloidal silica, a fiber-rigidizing agent.
- Apply, dry, and sand multiple layers of Unifrax QF-180, a refractory-surface strengthener.
- Weight the shelf and burn out the product binders.

#### Cutting the shelf to size.

Wear a respirator and work in a well-ventilated area when following this procedure:

- Cut the fiberboard shelf to the same size as the mullite subshelf. (Or order the fiberboard shelf cut to size from the supplier.) For cutting, you can use an ordinary handsaw, recognizing that this will dull the blade significantly. You can also use a handheld tile-cutting saw.
- Once the shelf is cut to size, sand the corners and edges until they are slightly rounded. Rounded corners and edges are less likely to be damaged during use than are sharp ones.

#### Applying and drying colloidal silica.

Colloidal silica is a liquid used to rigidize fibers in the manufacture of high-temperature kiln brick and ceramic-fiber refractories. When applied to your fiberboard, it will saturate and strengthen the material.

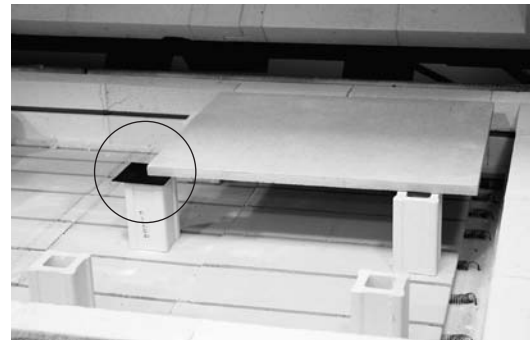


FIGURE 5: STAINLESS STEEL SHIM INSERTED TO RAISE A LOW CORNER.

**Note:** Do not use shims made of wood, tin, iron, aluminum or any material that will be compromised by firing. Use only shims made of stainless steel or refractory materials.

#### Materials and tools you will need:

- A handsaw or handheld tile-cutting saw with a circular blade.
- A half-gallon or larger plastic container.
- A painter's brush with fine bristles.
- Sheet plastic.
- A plastic watering can with showerhead spout.
- A sanding block with carbide sandpaper drywall screen, or diamond-cloth pad.
- A respirator.
- Liquid-proof gloves.
- 1" thick, unfired fiberboard with a minimum heat rating of 2300°F (1260°C).
- Colloidal silica, a fiber-rigidizing agent.
- Unifrax QF-180, a refractory-surface strengthener.
- Dense kiln bricks.
- A HEPA vacuum cleaner.

Note that as long as the colloidal silica in your shelf is wet, the shelf will be quite fragile. You could easily dent or break it with improper handling. A large, wet shelf can weigh more than 30 pounds—enough to cause the shelf to sag and break if it is moved without sufficient support. As a general rule, if your shelf is longer than 60" (152cm) or wider than 30" (76cm), you should prepare the shelf on a plywood support that will allow you to carry it to the kiln and slide it safely onto the mullite subshelf for drying. You could also prepare such a shelf on a worktable at the same height as the mullite subshelf, and then slide the fiberboard shelf onto the mullite from the table. If your wet shelf is less than 60" (152cm) long or less than 30" (76cm) wide, two people should be able to carry and place it into the kiln safely. When in doubt, support the shelf well and slide it rather than picking it up.

Follow this procedure for applying colloidal silica to the fiberboard shelf:

1. Prepare your work surface with sheet plastic to contain the overflow of colloidal silica. Secure the plastic to the work surface with tape to prevent it from sliding.
2. Place your fiberboard shelf on the prepared work surface.
3. Wearing liquid-proof gloves, mix enough colloidal silica and water in a ratio of 1:1 to coat one side of the shelf (16oz / sq ft or .5L / 929 sq cm of mixture). Pour the mixture into a plastic watering can with a showerhead spout.
4. Use the watering can to apply an even coating of rigidizer to the top and edges of the shelf. (Figure 6)
5. Next, with the help of an assistant, load the fiberboard shelf onto the mullite subshelf for drying.
6. With the kiln vented, fire the shelf at 275°F (135°C) until dry, usually 3 to 5 hours. You can check for dryness periodically by holding a mirror over the vent. If condensation appears, the shelf is still drying. If no condensation appears, the shelf is dry. (Figure 7)
7. When the fiberboard shelf is dry and cool enough to handle, remove it from the kiln and place it with the non-rigidized side up on your work surface, which should be covered with clean plastic.
8. Treat the non-rigidized side of the shelf using the method described above.

#### **Applying, drying, and sanding multiple layers of Unifrax QF-180.**

Once the shelf has been rigidized, you will need to apply several layers of Unifrax QF-180, a high-temperature surface strengthener. In manufacturing, QF-180 is used as a coating cement to strengthen the outer surfaces of refractory materials. With several applications, it will provide a durable surface for your fiberboard shelf.

**Note:** If you will not be able to move the fiberboard safely after saturation, the colloidal silica mix can be applied with the shelf inside the kiln. In this case, be sure to protect the kiln's elements and interior surfaces with sheet plastic.

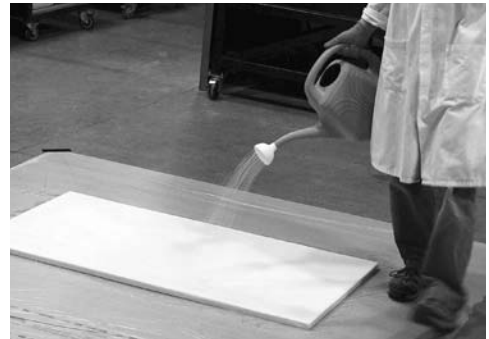


FIGURE 6: A WATERING CAN WITH A SHOWERHEAD SPOUT WILL CONTROL THE FLOW OF COLLOIDAL SILICA.

**Note:** The colloidal silica mixture can be applied with a large, disposable paintbrush rather than a watering can. However, the result may not be as uniform and it will take longer to apply the mixture.



FIGURE 7: USING A MIRROR TO CHECK FOR CONDENSATION.

Follow this procedure for applying, drying, and sanding Unifrax QF-180:

1. Prepare your work surface (the floor or a table) with a clean, dry sheet of plastic. Secure the plastic to the work surface with tape to prevent it from sliding.
2. Place the fiberboard shelf on the plastic-covered work surface.
3. Wearing liquid-proof gloves, stir the QF-180. QF-180 separates easily and will need to be re-mixed frequently throughout this process.
4. After stirring the QF-180, pour about 2 cups (1/2 liter) into a disposable plastic container. If the surface of your shelf is smooth, mix the QF-180 with water in a 1:1 ratio. If the surface of your shelf is textured, use the QF-180 full-strength for the first coating only. (In subsequent coatings, mix it with water in a 1:1 ratio.)
5. Using a good painter's brush with long bristles, apply a single, even coating of the QF-180 mixture to the top surface of the shelf. (Figure 8) Stir the liquid with your brush frequently to keep it well mixed. Coat the edges of the shelf, being careful not to layer excess material onto the top surface.
6. Load the fiberboard shelf onto the mullite subshelf with the coated surface facing up.
7. With the kiln vented, fire the shelf at 275°F (136°C) until it is dry, about 30 to 60 minutes.
8. While the shelf is drying, cover the plastic bucket containing QF-180. Store your paintbrush in a container of water between coatings.
9. Prepare to sand the QF-180 by setting up a worktable out of doors, under a ventilation hood, or in an area where particulates can be safely contained or removed.
10. Prepare a large sanding block with diamond cloth, drywall sanding screen, or carbide sanding paper (60- to 120-grit). Using this block will help to ensure uniform pressure while sanding.
11. When the shelf is dry and cool enough to handle safely, move it to the sanding area. Wearing a respirator, sand the top and edges of the shelf to even out the surfaces. (Figure 9)
12. When you have finished sanding, vacuum the dust from the shelf and work area, using a HEPA vacuum. (Figure 10) Alternatively, wipe up the dust with a damp sponge, rinsing as needed. (Do not use a regular shop vacuum, which will put more particulates into the air.)
13. Repeat the entire process described above until the top and edges of the shelf are as smooth as possible. Typically this requires 3 or 4 coatings of QF-180.
14. Once the top and edges of the shelf are finished, repeat the entire procedure for the untreated side of the shelf.



FIGURE 8: BRUSHING QF-180 ONTO THE FIBERBOARD SHELF.

**Note:** A good brush will ensure a smooth coat and, therefore, less sanding.



FIGURE 9: SANDING THE SHELF USING A LARGE SANDING BLOCK.



FIGURE 10: VACUUMING DUST FROM THE SHELF AFTER SANDING.

### Weighting the shelf and burning out the product binders.

This final procedure will take several hours and will generate a fair amount of smoke. Be sure the kiln area is adequately ventilated for this firing.

Follow this procedure for weighting the shelf and burning out the product binders:

1. Place the fiberboard shelf in the kiln atop the mullite subshelf.
2. Place dense (heavy) kiln bricks at a minimum of 12-inch intervals all along the shelf surface. Stack double bricks at the corners. (Figure 11) The weight of the bricks will flatten the shelf during firing.
3. Once the weights are in place, close the kiln lid and the vents and fire according to the following schedule:

RATE (DEGREES PER HOUR)		TEMPERATURE		HOLD (HR:MIN)
300°F	166°C	1550°F	843°C	2:00
300°F	166°C	70°F	21°C	:00

4. When the shelf has been fired and is cool enough to handle, turn it over and repeat the entire process described above.
5. Once both sides of the fiberboard shelf have been fired, the shelf should be ready to use.

If, however, the shelf shows a tendency to bend at the corners or to bow in the center (both of which can be caused by firing too hot or too fast), repeat the burnout firing. Stack bricks on top of a bowed surface to flatten it. Flip the board and stack double bricks on bent corners to flatten them.

Keep an eye on your shelf's flatness, especially during the first month of firing. If the corners bend up more than 1/8" (3mm), consider weighting them with bricks during firing or repeat the weighting and firing procedure. (Figure 12)

### A Note About Firing Glass on this Shelf:

At Bullseye, we do not fire glass directly on this shelf. Rather, to prevent the possibility of damaging the shelf, we place fiber paper and ThinFire over it before firing.

### REPAIRING A DENTED FIBERBOARD SHELF

If your fiberboard shelf gets dented or gouged, you can repair it:

- Fill the dent or hole with high-temperature caulk. (We recommend Pyroform E-Z Fill, available from Paragon.) Smooth the caulk and allow it to dry. You can speed the drying process by using a heat gun. Sand the caulk and then apply a coating of dilute QF-180 over the repaired surface. Dry that coating with the heat gun and sand. Apply and sand QF-180 on the damaged area until the shelf surface is uniform (usually 2 or 3 coatings).
- OR
- Saturate some ceramic fiber or ceramic wool with QF-180 and pack it tightly into the dent or hole so that it is level with the shelf surface. Allow the patch to dry or speed the process by using a heat gun. Sand the repaired area, then apply and sand QF-180 until the shelf surface is uniform (usually 2 or 3 coatings).



FIGURE 11: WEIGHTING THE FIBERBOARD SHELF WITH BRICKS.

**Warning:** Never fire the kiln at full speed during the shelf-preparation process. Doing so could distort the fiberboard shelf.

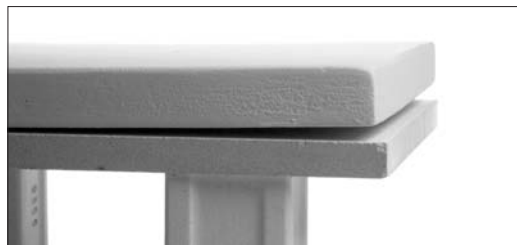


FIGURE 12: EXAMPLE OF A BOWED FIBERBOARD SHELF CORNER.

### PRODUCT SUPPLIERS

#### Pearl-56 Shelf Kit

Bullseye Item #8839 ([www.bullseyeglass.com](http://www.bullseyeglass.com))  
(Available only with purchase of Pearl-56 Bullseye Edition kiln.)

#### Unifrax LD Duraboard

Unifrax ([www.unifrax.com](http://www.unifrax.com))

#### Mullite Kiln Shelf

Bullseye Item #8840 ([www.bullseyeglass.com](http://www.bullseyeglass.com))

#### Kiln Posts (2 1/2" x 4")

Georgies Ceramic & Clay ([www.georgies.com](http://www.georgies.com))

#### Colloidal Silica

Western Industrial ([www.wicinc.com](http://www.wicinc.com))

#### Fiberfrax Coating Cement

Western Industrial ([www.wicinc.com](http://www.wicinc.com))

#### Kiln Brix

Bullseye Item #8896 ([www.bullseyeglass.com](http://www.bullseyeglass.com))

#### Pyroform E-Z Fill

Paragon ([www.paragonweb.com](http://www.paragonweb.com))