Dissecting a Firing Schedule

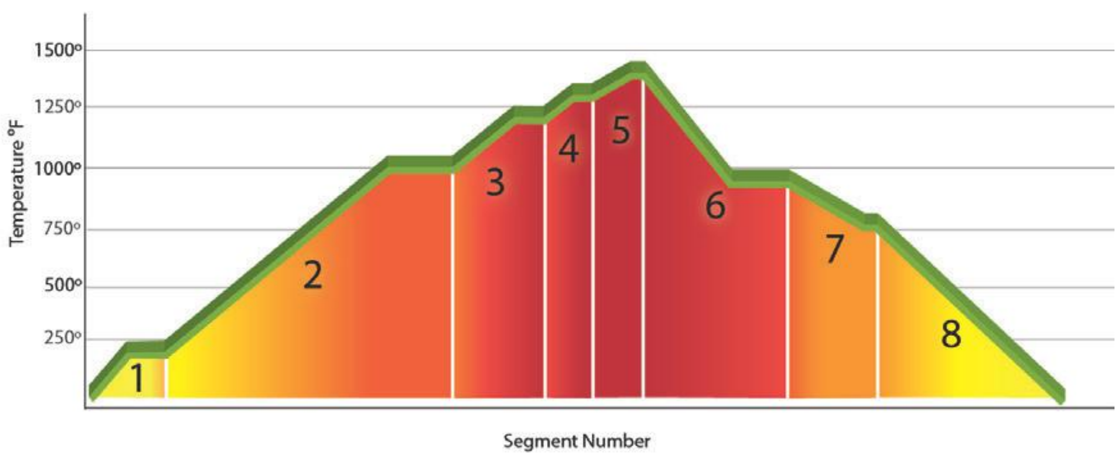
The following is a guide to understanding the glass firing process and what happens during each stage of an 8-segment firing schedule*. Once you fully understand what's going on in each segment, you will have more confidence to know when and how to fine-tune a basic schedule into the perfect one for your particular project.

This is our **Advanced Full Fuse Firing Schedule** in the standard table format:

Advanced Full Fuse Schedule

Segment	Rate	Temp (ºF)	Hold (mins)
1	250	250	30
2	250	1050	30-60
3	100-250	1250	10
4	250	1370	20
5	300	1465*	10*
6	9999	950	60
7	200	800	10
8	300	100	0

But what's happening in the kiln?

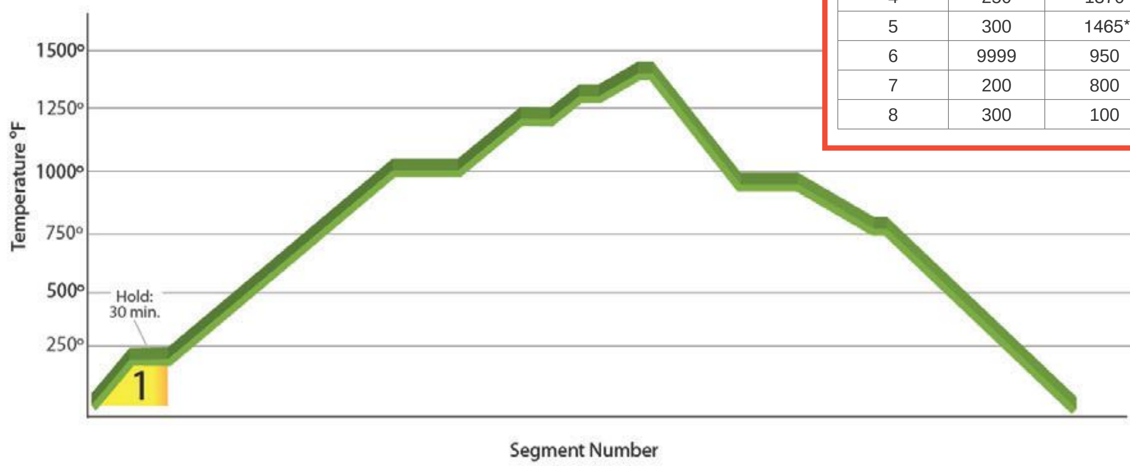


This graph represents what our schedule might look like, making it easier to visualize how the kiln moves to the given temperature in each segment and holds for the specified amount of time. The hold times create the stair-step look in the graph and are very important in glass fusing since they provide the time required for all the layers of glass to reach the temperature goal for each segment.

** This schedule was designed to fire a 2-layer project no more than 3/8-inch thick. Be sure to follow your kiln manufacturer's recommendations for testing and maintaining your kiln so it is operating correctly.*

SEG 1

Initial Heat from Room Temperature



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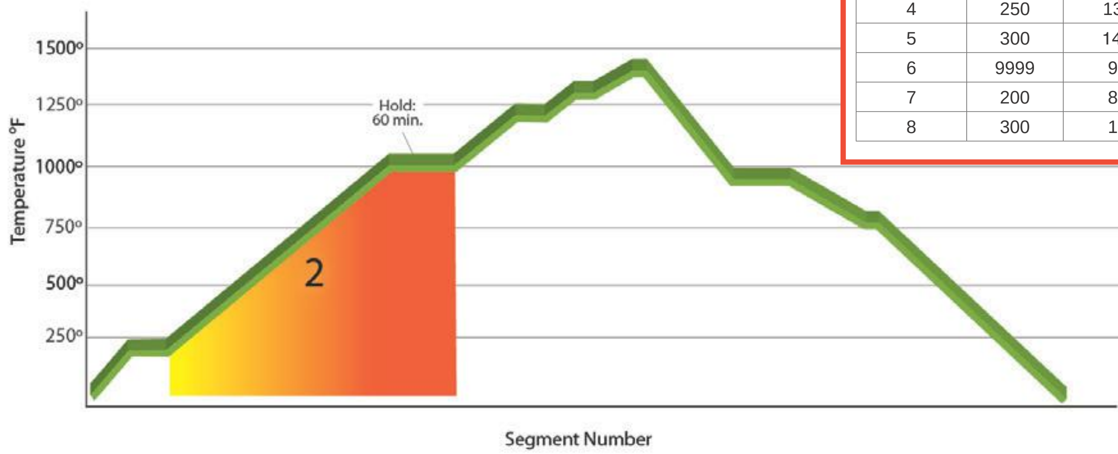
Segment 1: Initial Heat from Room Temperature

The Initial Heating stage takes the glass from room temperature to 250ºF and then holds for thirty minutes. This early hold allows the glass to fully and evenly accept a moderate amount of heat before ramping up to higher temperatures.

Because glass is especially vulnerable to thermal shock at lower temperatures, this cautious initial hold allows ample time for the internal temperature of the glass to match its surface temperature, greatly reducing the risk of shattering.

SEG 2

Heating Past Thermal Shock



Advanced Full Fuse Schedule

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7	200	800	10
8	300	100	0

Segment 2: Heating Past Thermal Shock

Until glass reaches a temperature of around 900°F, it can still shatter. By taking the kiln to 1050°F before holding, we are assured that even the internal layers of glass have been heated past the danger zone for thermal shock. This also represents the beginning of the bubble squeeze process.

The hold in Segment 2 is actually the beginning of a “Bubble Squeeze.” The term Bubble Squeeze means that adjustments are being made to a schedule to allow trapped air (bubbles) the time they need to escape. The hold offers a time range (30-60 minutes) that can be adjusted, depending on the project, to provide more or less time for air trapped between layers to escape. (More on Bubble Squeezes in Segment 3.)

It is important to note that even though we specify several ranges in this schedule, the schedule is still intended as a ***starting point.*** *Every kiln fires differently, every project is unique; most long-time fusers become adept at adjusting a schedule on the fly to suit each and every firing — especially when it comes to refining a Bubble Squeeze.*

SEG 3

Bubble Squeeze Adjustment Zone

Advanced Full Fuse Schedule

Segment	Rate	Temp (ºF)	Hold (mins)
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2	250	1050	30-60
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4	250	1370	20
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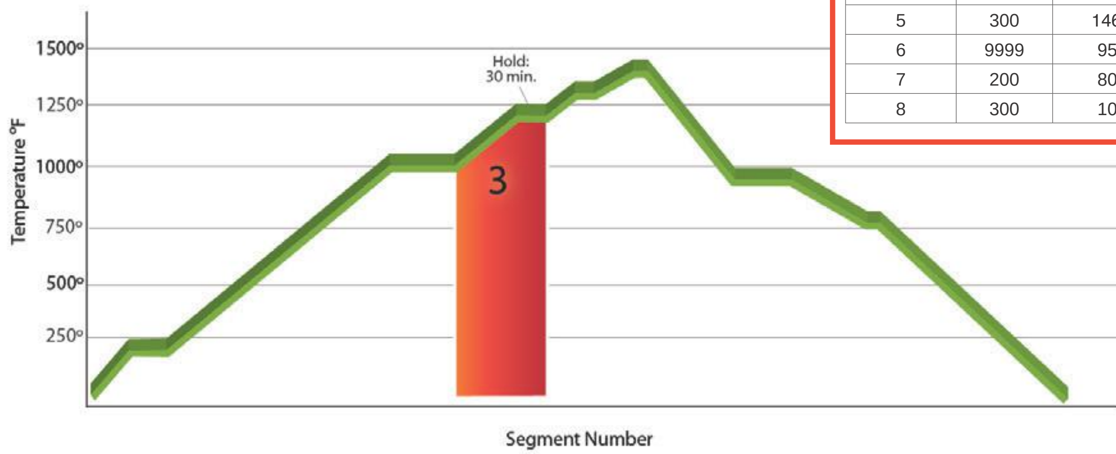
6	9999	950	60
7	200	800	10
8	300	100	0



Segment 3: Bubble Squeeze Adjustment Zone

The intention of a Bubble Squeeze is to increase the overall time glass spends in the temperature zone where layers are beginning to soften but haven't yet sealed together. Longer holds and slower rises are used so layers can relax into each other very slowly, giving trapped air (or bubbles) time to escape. Using a Bubble Squeeze, the finished piece will be less likely to have a bumpy surface or visible bubbles.

After the lengthy hold at 1050°F in the end of Segment 2, the rise to 1250°F is given in a range of 100-250° per hour — choose a *slower* rise for a *more thorough* bubble squeeze — then hold at 1250°F for 30 minutes. And remember, this Segment can be adjusted *even beyond the ranges given*.

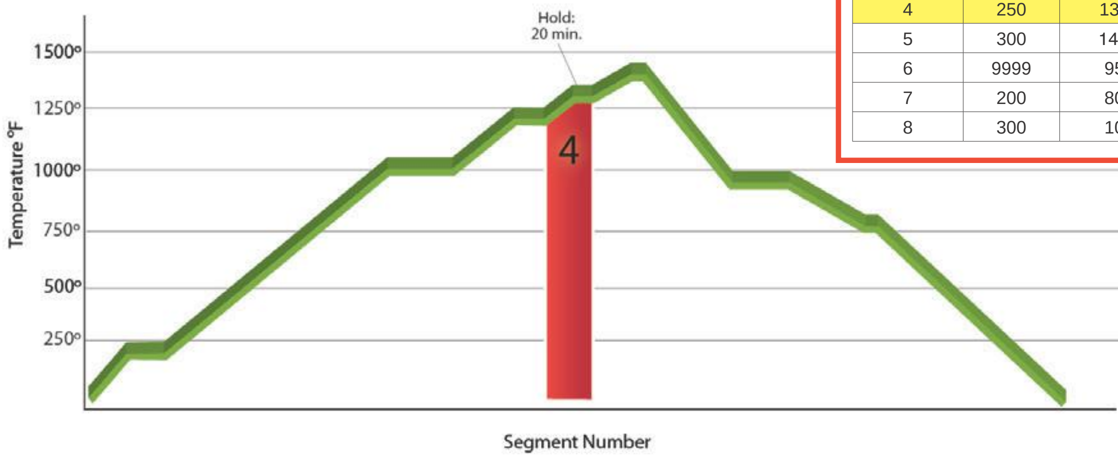
Larger projects, especially those that have uninterrupted layering are more prone to trapping bubbles.

SEG 4

Bubble Squeeze Continued

Advanced Full Fuse Schedule

Segment	Rate	Temp (ºF)	Hold (mins)
1	250	250	30
2	250	1050	30-60
3	100-250	1250	10
4	250	1370	20
5	300	1465*	10*
6	9999	950	60
7	200	800	10
8	300	100	0



Segment 4: Bubble Squeeze Continued

A slow rise and another hold at 1370º F is the last part of the bubble squeeze and gives the glass layers a final opportunity to settle in together and seal before the rise to the final forming stage.

SEG 5

Rise to Full Fuse

Advanced Full Fuse Schedule

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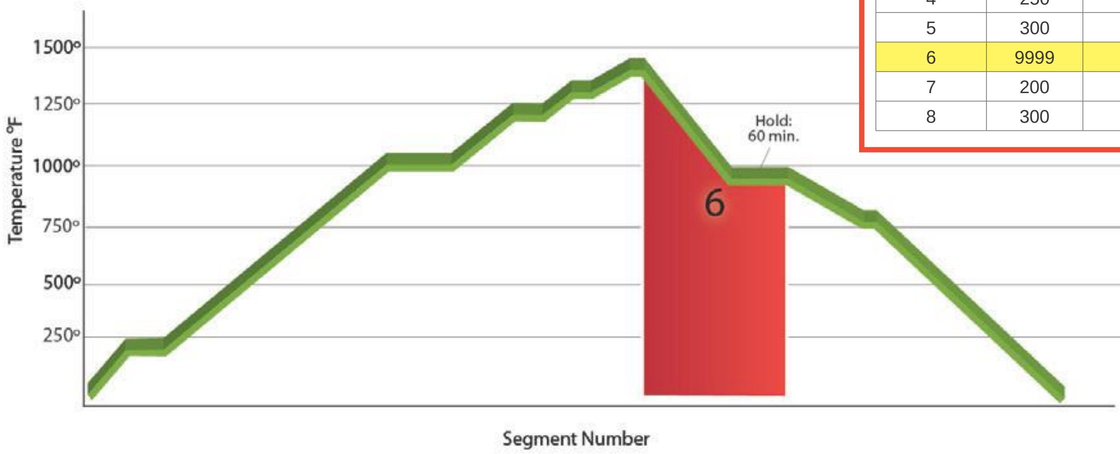
2	250	1050	30-60
3	100-250	1250	10
4	250	1370	20
5	300	1465*	10*
6	9999	950	60
7	200	800	10
8	300	100	0

Segment 5: Heat to Full Fuse

The rise in this segment moves a little quicker (300º/hr) to the Full Fuse temperature of 1465ºF for a 10-minute hold. In any Firing Schedule, the segment where the glass climbs to its highest temperature will determine the degree of "melting" that takes place and is known as the *forming* or *process* stage. The amount of change that takes place in the glass is determined by **both** the temperature achieved and the amount of time the glass is held at that temperature. This is also the temperature zone where devitrification can occur, which is why we speed up the rise slightly through this temperature range.

SEG 6

Rapid Cool to Anneal



Advanced Full Fuse Schedule

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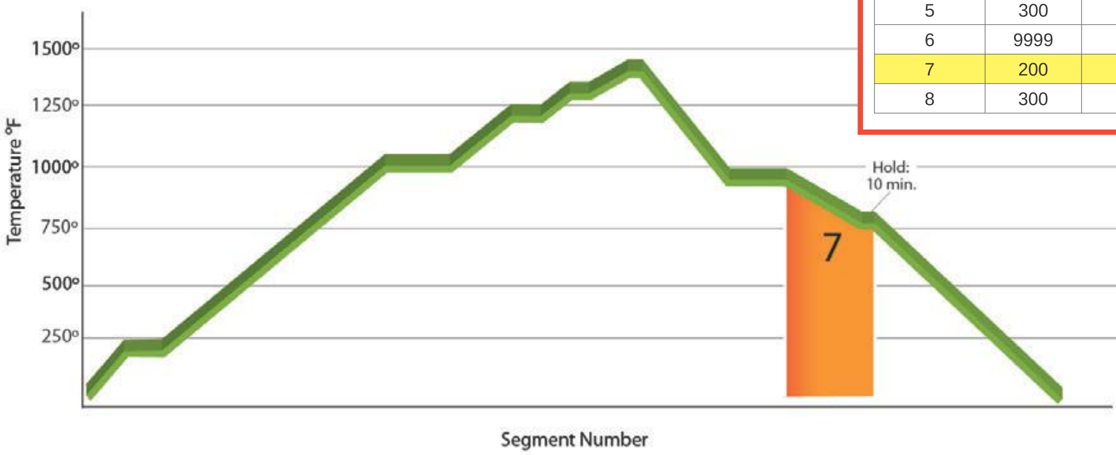
4	250	1370	20
5	300	1465*	10*
6	9999	950	60
7	200	800	10
8	300	100	0

Segment 6: Rapid Cool to Anneal

After reaching a full fuse in Segment 5, the temperature drops rapidly to avoid any further processing of the glass. The rate is given as “9999” which simply tells the kiln to move as fast as it possibly can until it reaches 950ºF, the uppermost temperature in the anneal range. The 60-minute hold provides the time required for the internal temperature of the glass to reach 950ºF before easing through the rest of the anneal zone.

SEG 7

Slow Cool Through Anneal



Advanced Full Fuse Schedule

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7	200	800	10
8	300	100	0

Segment 7: Slow Cool Through Anneal

In Segment 7, we move very slowly down to 800ºF allowing the internal temperature of the glass to get well past the “strain point” and anneal completely. Never open your kiln during ANY of the anneal phases — it can introduce stress and result in breakage. Please note: you cannot “over anneal.” If your project is thicker than 3/8-inch, or is undergoing more than one firinq, it may require *even longer* annealing than what’s given here, but the anneal phase (Segments 6 & 7) should never be shortened.

SEG 8

Slow Cool to Room Temperature

Advanced Full Fuse Schedule			
Segment	Rate	Temp (ºF)	Hold (mins)
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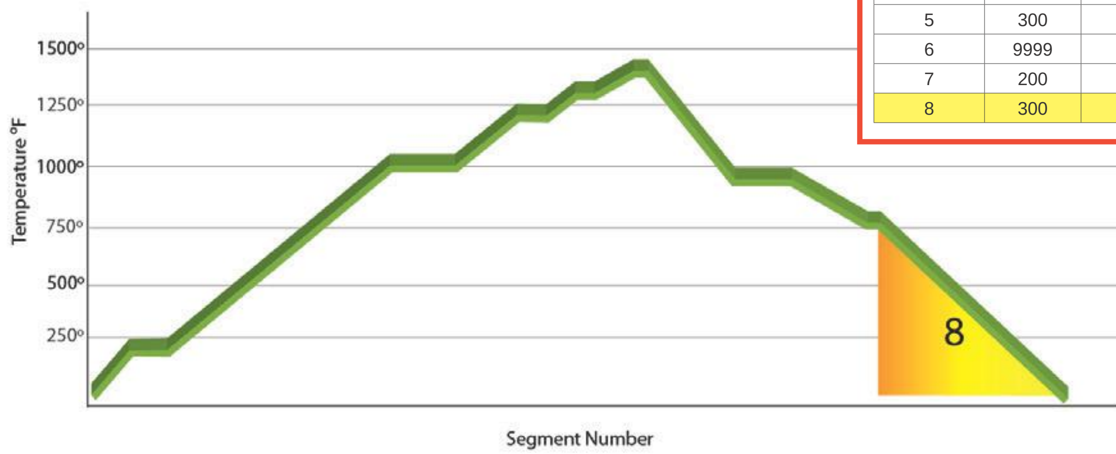
2	250	1050	30-60
3	100-250	1250	10
4	250	1370	20
5	300	1465*	10*
6	9999	950	60
7	200	800	10
8	300	100	0



Segment 8: Slow Cool to Room Temperature

After all stress has been relieved by thorough annealing, the kiln is allowed to cool to room temperature at the rate of 300º/hr. Since the glass is now once again passing through a range where thermal shock can be a danger, the controlled rate of cooling protects the glass from breaking.