



FIRING AND ANNEALING GUIDELINES

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The Slumping, Fuse-to-Stick, and Full Fuse guidelines below are conservative and apply to pieces 1/4" (6 mm) to 3/8" (9 mm) thick up to 12" (30 cm) in diameter, even when solid as in second or subsequent firings. Thinner pieces will not fire well above the Fuse-to-Stick range. The final guideline is for Kiln Casting a 15" x 15" x 3/4" (38 cm x 38 cm x 2 cm) slab, in a plaster/silica mold, from either casting billets or sheet pieces. Each table includes annealing information. Faster ramp up rates are possible (particularly for Frit firings), or slower ramps may be necessary depending upon a variety of conditions, including, but not limited to:

- kiln type and shape
- heating element location and how close the glass is to it
- thickness and thermal mass of shelf or molds
- density of pack within the kiln, and available air circulation
- size of the component pieces of glass being heated for fusing
- thickness and diameter of the work
- thickness variations within the work.

Even then, your experience with your own kiln is priceless, so keep good records, and learn from your mistakes! In general, Uroboros will fire similarly to Bullseye or Spectrum fusing glasses, though experienced users will detect variations between the brands, between COE points, or even between colors within one brand.

For comprehensive coverage of these sometimes complex issues, we refer you to the following publications for the studio artist. For unusual situations, please feel free to contact us.

1. *Glass Notes*, by Henry Halem, 1996. This is a good all-around studio reference manual for blowers or fusers. Find out about it at www.glassnotes.com.
2. *The Fused Glass Handbook*, by Gil Reynolds. One of the first books on the subject, still very popular and widely available.
3. *Contemporary Warm Glass*, by Brad Walker. New in 2000, this has lots of good color photos and project ideas, with easy-to-follow information on firing schedules. Available direct from Uroboros, please inquire.
4. *Firing Schedules for Glass*, by Graham Stone. New in 2000, this is the most complete book on the subject, and we think indispensable for the serious studio artist – whether blower, kiln caster or fuser. No photos, lots of firing tables, text, and worksheets. Covers thicknesses up to 6 inches, and all glass types from borosilicate to Uroboros. Available direct from Uroboros, please inquire.

ART GLASS

90 COE FUSIBLE

SYSTEM 96®



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Activity: Slumping (14.8 hour cycle)	Set Point °F/°C	Ramp Rate	Ramp Time in Minutes	Soak Time in Minutes	Elapsed Time Minutes/Hrs
Ramp up from room temp	1000°F/538°C	250°F/hr (139°C/hr)	240	0	240/4
Presoak (distribute that heat!)	1000°F/538°C	n/a	n/a	30	270/4.5
Ramp up to Slump	1200°F/649°C	250°F/hr (139°C/hr)	48	+/- 30	348/5.8
Crash cooling (vent if possible)	1000°F/538°C	As fast as possible	30 or less	0	378/6.3
Pre-Annealing soak	1000°F/538°C	n/a	n/a	60	438/7.3
Annealing ramp	800°F/427°C	60°F/hr (33°C/hr)	200	0	638/10.6
Cooling ramp #1	600°F/316°C	120°F/hr (67°C/hr)	100	0	738/12.3
Cooling ramp #2 (vent kiln to help cool)	100°F/38°C	200°F/hr (111°C/hr)	150	0	888/14.8

Activity: Fuse-to-Stick (14.9 hour cycle)	Set Point °F/°C	Ramp Rate	Ramp Time in Minutes	Soak Time in Minutes	Elapsed Time Minutes/Hrs
Ramp up from room temp	1000°F/538°C	250°F/hr (139°C/hr)	240	0	240/4
Presoak (distribute that heat!)	1000°F/538°C	n/a	n/a	30	270/4.5
Ramp up to Fuse-to-Stick point	1350°F/732°C	250°F/hr (139°C/hr)	84	+/- 45	354/5.9
Crash cooling (vent if possible)	1000°F/538°C	As fast as possible	30 or less	0	384/6.4
Pre-Annealing soak	1000°F/538°C	n/a	n/a	60	444/7.4
Annealing ramp	800°F/427°C	60°F/hr (33°C/hr)	200	0	644/10.7
Cooling ramp #1	600°F/316°C	120°F/hr (67°C/hr)	100	0	744/12.4
Cooling ramp #2 (vent kiln to help cool)	100°F/38°C	200°F/hr (111°C/hr)	150	0	894/14.9

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Soak times at Full Fuse are dependent on peak temperature chosen and on desired look. Two options are shown. Option 1, the slower, is easier to stop at a specific point of progress, and minimizes bubble entrapment when fusing sheet glass. Option 2, the faster, minimizes devitrification.

Activity: Full Fuse Note: An additional 30 min. soak at 1300 will minimize bubble entrapment. (16.1 hour cycle)	Set Point °F/°C	Ramp Rate	Ramp Time in Minutes	Soak Time in Minutes	Elapsed Time Minutes/Hrs
Ramp up from room temp	1000°F/538°C	250°F/hr (139°C/hr)	240	0	240/4
Presoak (distribute that heat!)	1000°F/538°C	n/a	n/a	30	270/4.5
Ramp up to Full Fuse (option 1)	1450°F/788°C	250°F/hr (139°C/hr)	108	+/- 45	423/7.1
<i>Ramp up to Full Fuse (option 2)</i>	<i>1520°F/827°C</i>	<i>250°F/hr (139°C/hr)</i>	<i>125</i>	<i>+/- 15</i>	
Crash cooling (vent if possible)	1000°F/538°C	As fast as possible	30 or less	0	453/7.6
Pre-Annealing soak	1000°F/538°C	n/a	n/a	60	513/8.6
Annealing ramp	800°F/427°C	60°F/hr (33°C/hr)	200	0	713/11.9
Cooling ramp #1	600°F/316°C	120°F/hr (67°C/hr)	100	0	813/13.6
Cooling ramp #2 (vent kiln to help cool)	100°F/38°C	200°F/hr (111°C/hr)	150	0	963/16.1

Activity: Kiln Casting 15"x15"x 3/4" Slab (38 cm x 38 cm x 2 cm) Assumes open face mold filled with casting billets or glass mixtures (35.1 hour cycle)	Set Point °F/°C	Ramp Rate	Ramp Time in Minutes	Soak Time in Minutes	Elapsed Time Minutes/Hrs
Ramp up to Full Fuse	1550°F/843°C	120°F/hr (67°C/hr)	775	n/a	775/12.9
ART GLASS Fuse Soak (to suit design)	1550°F/843°C	n/a	n/a	+/- 60	835/13.9
Crash cooling (vent if possible)	1000°F/538°C	As fast as possible	30 or less	0	865/14.4
Pre-Annealing soak	1000°F/538°C	n/a	n/a	120	985/16.4
90 COE FUSIBLE SYSTEM 96® Annealing ramp	800°F/427°C	20°F/hr (11°C/hr)	600	0	1,585/26.4
Cooling ramp #1	500°F/260°C	50°F/hr (28°C/hr)	360	0	1,945/32.4
Cooling ramp #2	100°F/38°C	150°F/hr (83°C/hr)	160	0	2,105/35.1
Open Kiln	Room Temp.	Take time for this!			