KILN TEST

Research Paper
Partial requirement for
Master of Fine Art
Department of Art

Carol Lyne Livingston
Colorado State University
Fort Collins, Colorado 80523
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PREMISE

This investigation was undertaken for the purpose of discovering at what temperatures water and wax evacuate a solid mold investment. This can better determine proper kiln cycling in the hopes of decreasing resultant metal flashing.

PROCEDURE

In order to remove inconsistencies, the five wax patterns I used for the test had to be identical. Consequently, five wax houses were pulled from the same plaster mold. Each house was approximately 1/4" in wall thickness, 6" wide, 7" deep, and 10" high.

Each house was top poured and vented accordingly. (Photos 1,2, and 3). Two holes were cut close to the apex of each roof to allow the core to fill. (Photo 4). Four core pins were then placed in each wall. (Photo 5).

Next, a cylinder 11" in diameter and 19" high was constructed out of chicken wire and tar paper. This cylinder surrounded house, cup, and sprues. (Photos 6 and 7). Three thermocouple wires approximately three feet long were inserted into the house. Wire one; the internal wire was run through the outer cylinder, into and through the wax, and into the interior of the house 1" up from the bottom edge of the house. The second wire; the wax wire was placed into the wax at the eave of the house. The third wire remains in the exterior cavity of the cylinder. (Photo 8).

Each cylinder required approximately 12 gallons of investment. The investment recipe was consistent for each house test: five quarts each of luto, sand, and plaster in 7 quarts

of water. Luto was added to the water, soaking for 10 minutes and pre-mixed for 30 seconds. Plaster and sand were added and mixed for 30 seconds. This was then poured into the cylinder. (Photo 9).

After the cylinders were filled with investment, they were left to cure:

House #1 cured 48 hours.

House #2 cured 8 days.

House #3 cured 48 hours.

House #4 cured 72 hours.

House #5 cured 48 hours.

The only reason curing time varied was due to kiln availability and does not relate directly to the results of each test. No rehydration took place.

As each investment was put into burn-out kiln (done one at a time, over three month period), the thermocouple wires from the cylinder were unrolled and run through the kiln walls. A fourth wire entered directly into the kiln, to establish consistency with the kiln's air temperature. An Atkins hand held thermocouple thermometer was used to record the different temperatures.

After each burn-out test was completed, each investment was cast in aluminum and poured at 1350°.

DATA

House One: The kiln was loaded and turned on at 5:00 p.m., day 1, at 400°. This temperature was earlier thought to be necessary to establish steam dewaxing of the mold. The kiln was kept at 400° for 14 hours, into day 2. The kiln was increased to 500° because the interior temperature was seen to be too low. The interior temperature was not boiling the wax, merely drying the investment. Test one was kept at 500° until day 3 for 25 hours, when the temperature was increased to 700°. (At 500° investment temperature was still less than the boiling point of water.) The kiln remained at 700° until day 4, 27 hours later when the kiln was increased to 1000° for the normal burn-out cycle. The kiln remained at 1000° for 2 hours per/inch of diameter of the mold (24 hours). On day 5, the cool-down cycle began.

Poured results indicate that severe flashing occurred. (Photo 10). This could be due to any and all of the following conditions:

1) Investment wasn't dewaxed properly.
2) The critical temperature of 700° (stressing at this point can cause cracking) was not maintained long enough.
3) Results indicate critical cool-down temperature is 800° (actual) not 700° as earlier thought.

4) Top internal temperature was only 855° not 1000° as earlier thought necessary.

See Graph 1

House Two and House Three: Houses two and three were burn-out together starting at 1000°. At 1000° and six hours into burn-out, readings indicate water is gone in both investments. Seven hours from start indicates wax is gone in both.

After seven hours, readings in house number three were invalid due to bad wires, therefore, results are based on house number two.

The highest exterior reading was 868° 25 hours into burn-out. Possibly, this is too low. The kiln was turned down to 800° on the second day of burn-out. Third day readings gave interal reading near 700°. This 700° only read for a couple of hours, this is possibly too short. Photo #11 shows casting quality and Photo #12 shows depth of grey matter in investment. See Graphs 2 and 3.

House Four: The kiln was started at 700°for house number four. This was done for wax evacuation in that, every inch of investment is equal to 12 hours of burn-out time. First reading indicates exterior temperature still less than 212°. Day 2, increased temperature to 1000°. Readings at 1000° on day 3 indicate interior and exterior temperatures at 1000° = 988°/907° (inherent heat = heat due to 700° time).

Results from this burn-out make for further testing to be:

1) Increase time at 700° until wax temperature is greater than 220° and interior and exterior temperatures are greater than 212°

2) Down time use 900° instead of 800° because 800° moves through 700° range too quickly. If held at 700°, time would be 1-1/2 hours per inch or temperature greater than 212°. If held temperature increased to 600° range then move up to 800° or 900°, wax and water evacuation will occur at 212°, resulting in less flashing.

3) Also, down temperature should go to 900° first, as opposed to 800°.

House number four did result in the least amount of flashing, but there was still 3/8 inch of grey matter in burn-out investment. (Photo #13). See Graph 4.

House Number Five: The kiln was started at 700° and first reading indicates wax was gone in 14 hours. I continued at 700° for 2 hours for every one inch of investment diameter. Day 2, I increased heat to 800° and held it at 800° until interior and exterior temperatures were close to 800°. Day 3, I increased temperature to 1000° and held there for every 2 hours per one inch in diameter of investment. Day four, I turned down kiln to 900° and held there for 22 hours to allow slow cooling. The following temperatures and times were done purely for slow cooling:

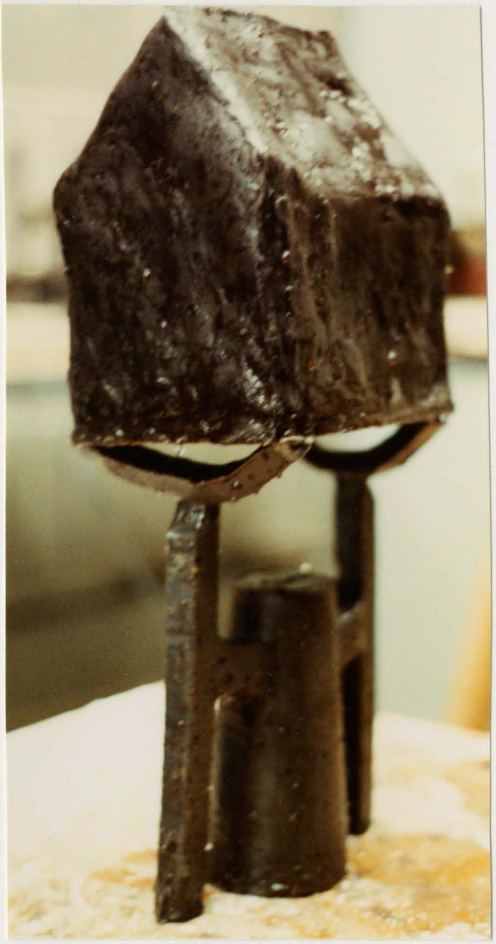
Day 5	800°	held for 13 hours
" 6	700°	held for 11 hours
" 7	600°	held for 14 hours
" 8	500°	held for 11 hours
" 9	400°	held briefly

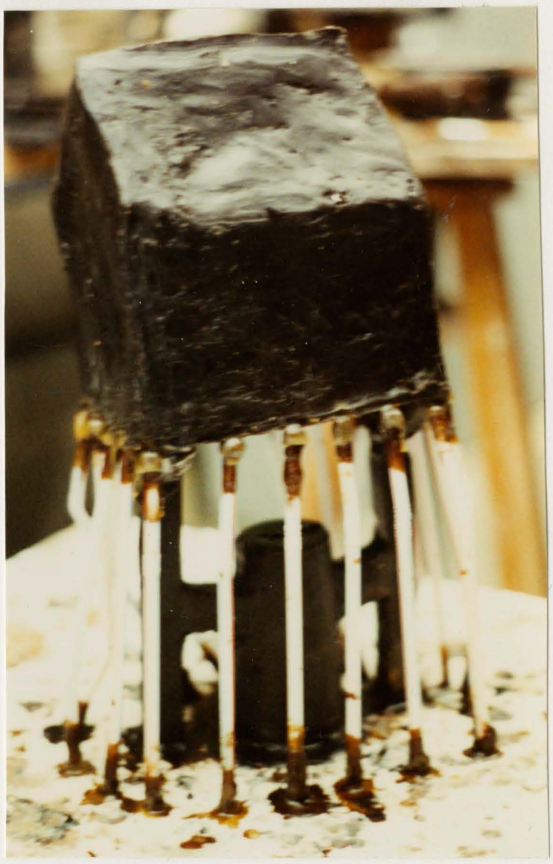
(Photos #14 & 15.) See Graph 5.

CONCLUSION

After evaluating all homes, the best castings that made came in test number four. Based on this information, the following procedures are deemed best for the burn-out cycle:

1) 700° is best for one hour per inch diameter for wax evacuation.
2) Quick temperatures to 1000° is best for burn-out; once wax evacuation has occurred.
3) Down time is best started at 800°, one inch per inch of diameter of investment.





Photos 1,2, and 3

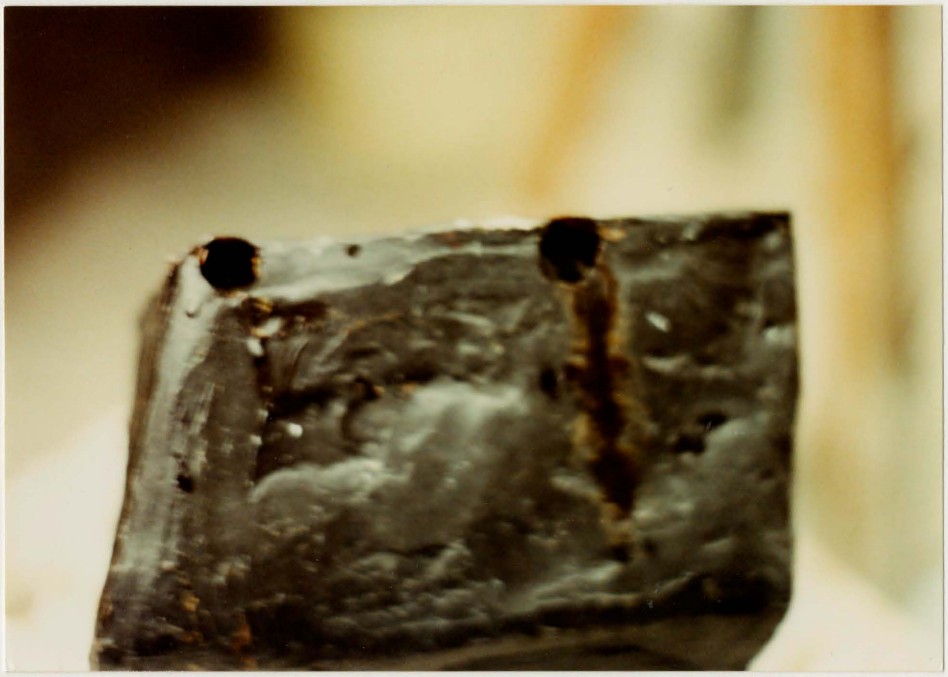


Photo 4

Photo 5

Photos 6 and 7

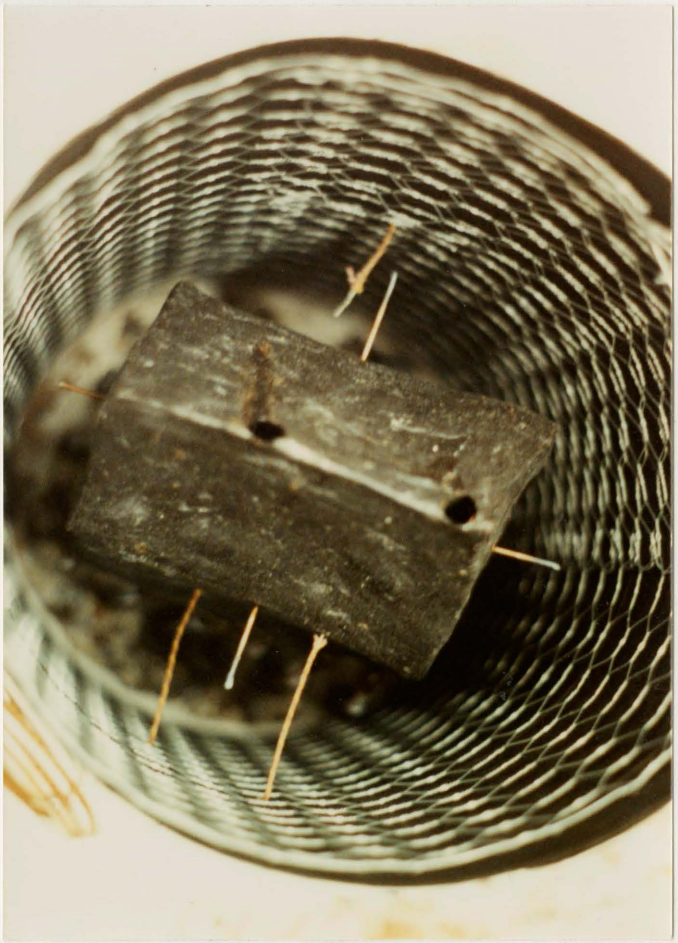


Photo 8

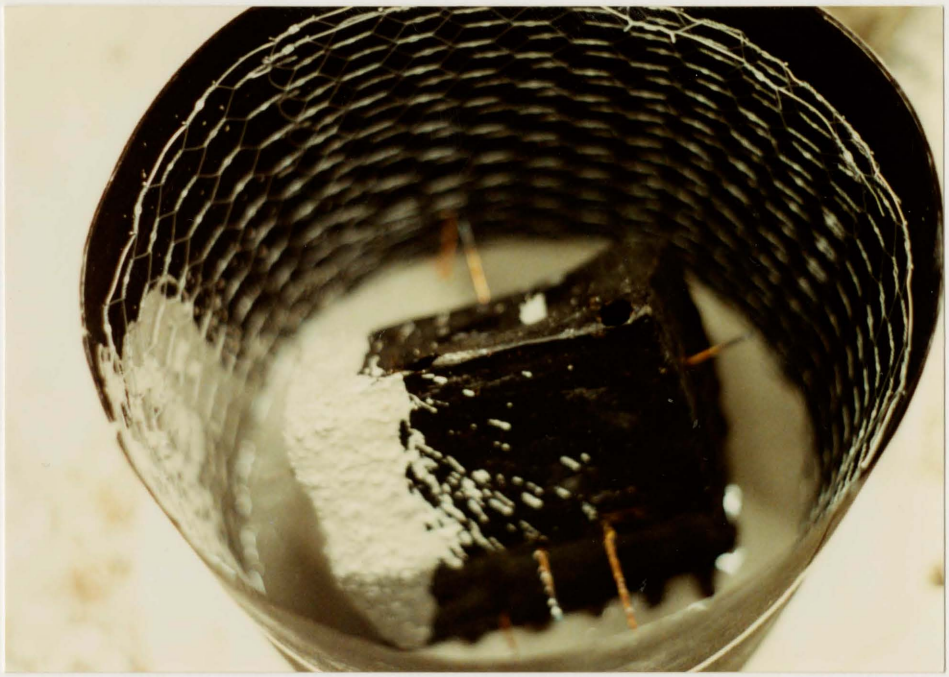
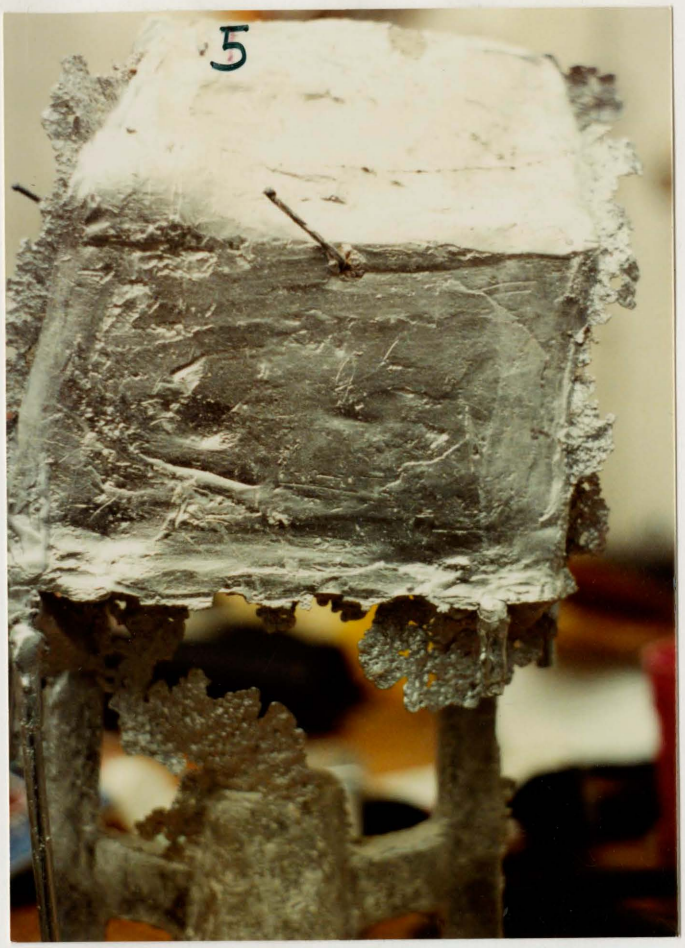


Photo 9

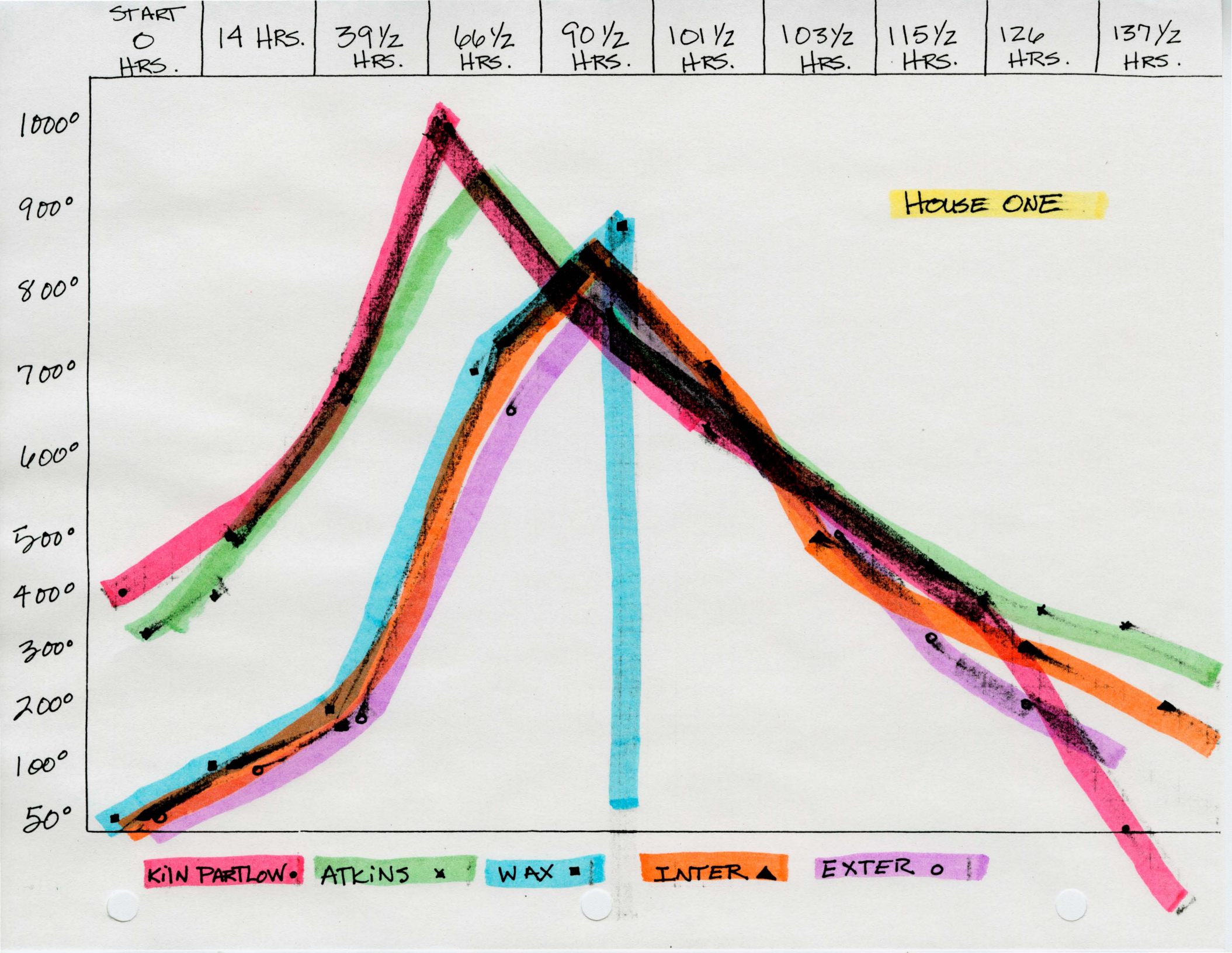
Photo 10

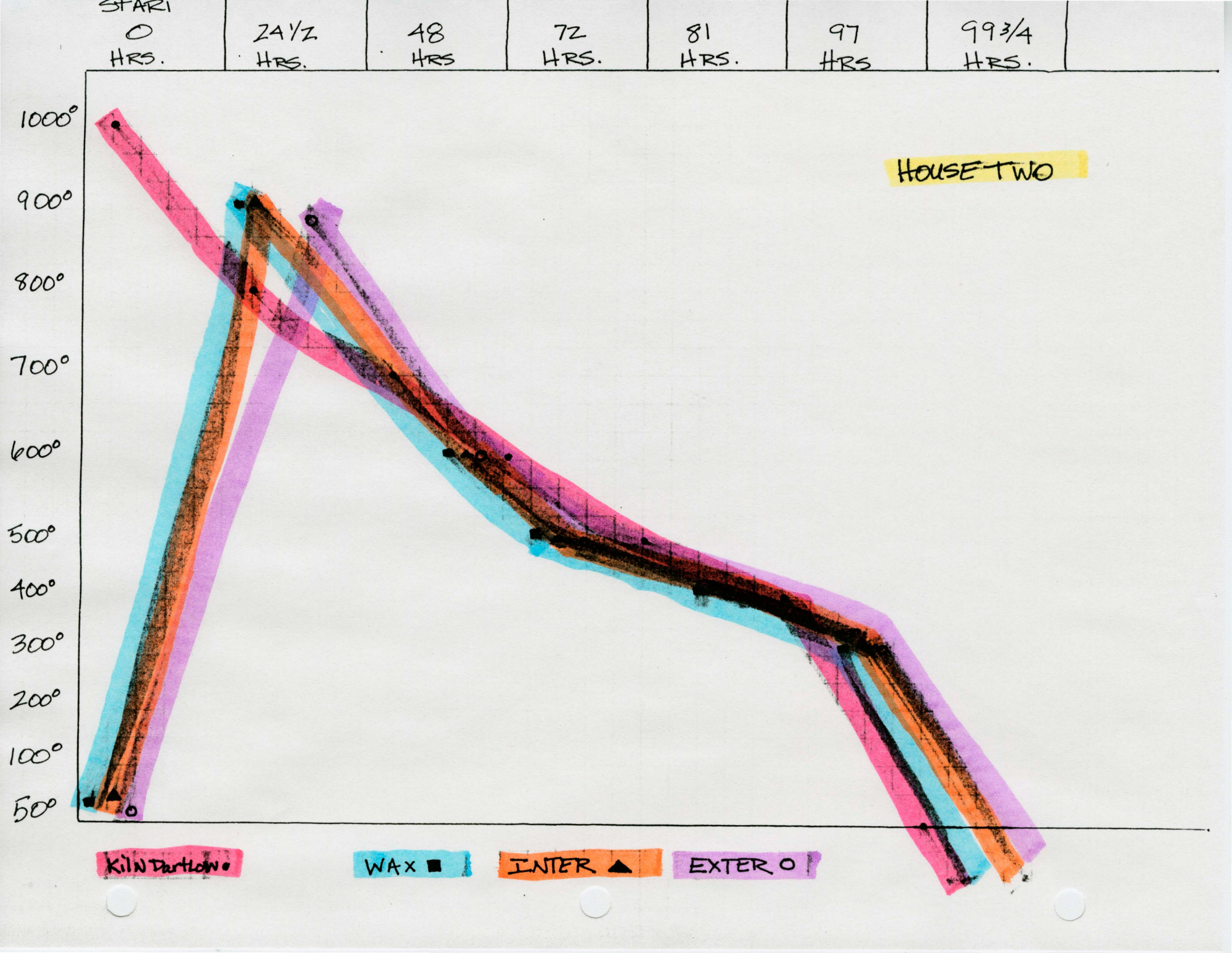
Photos 11 and 12

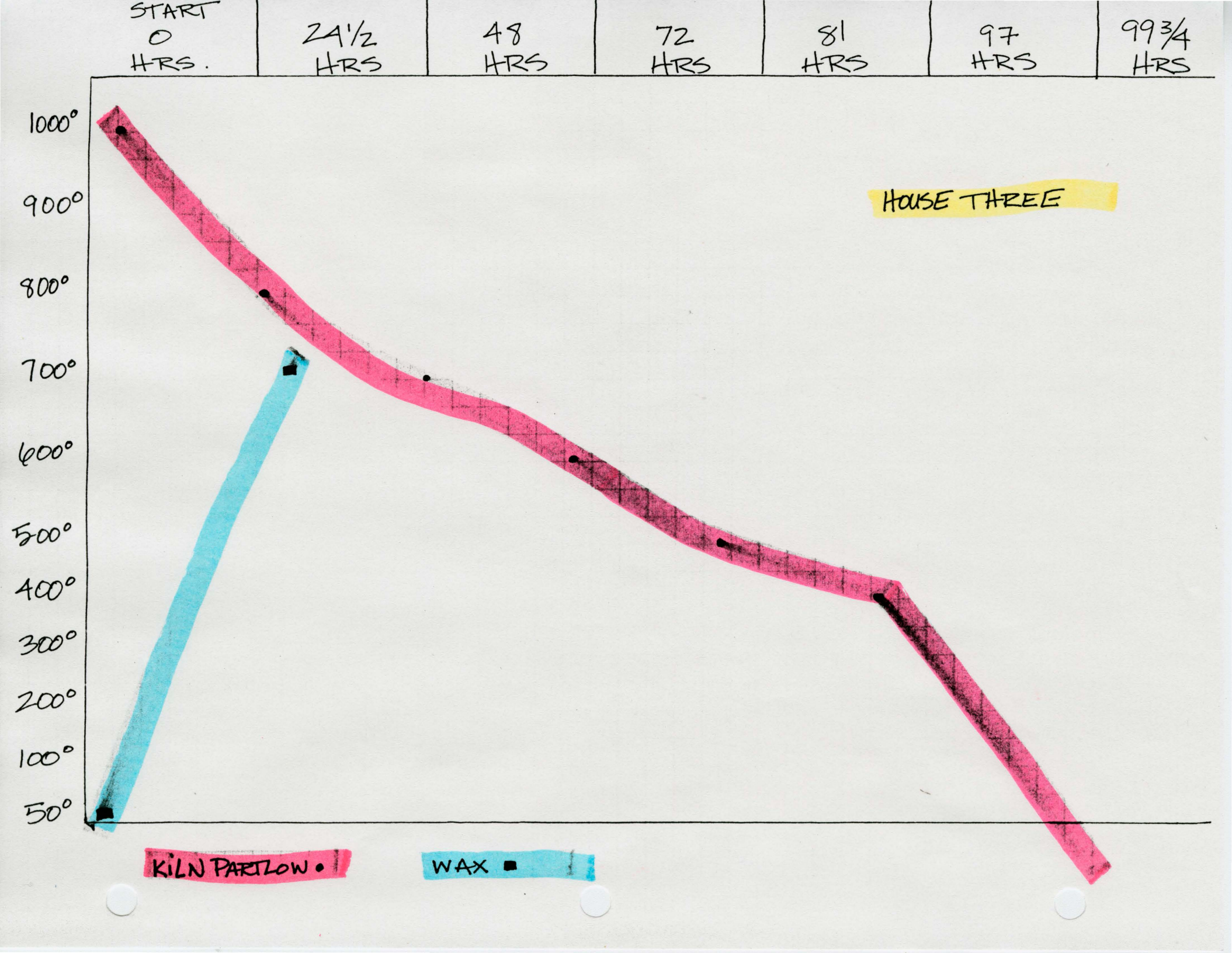
Photo 13

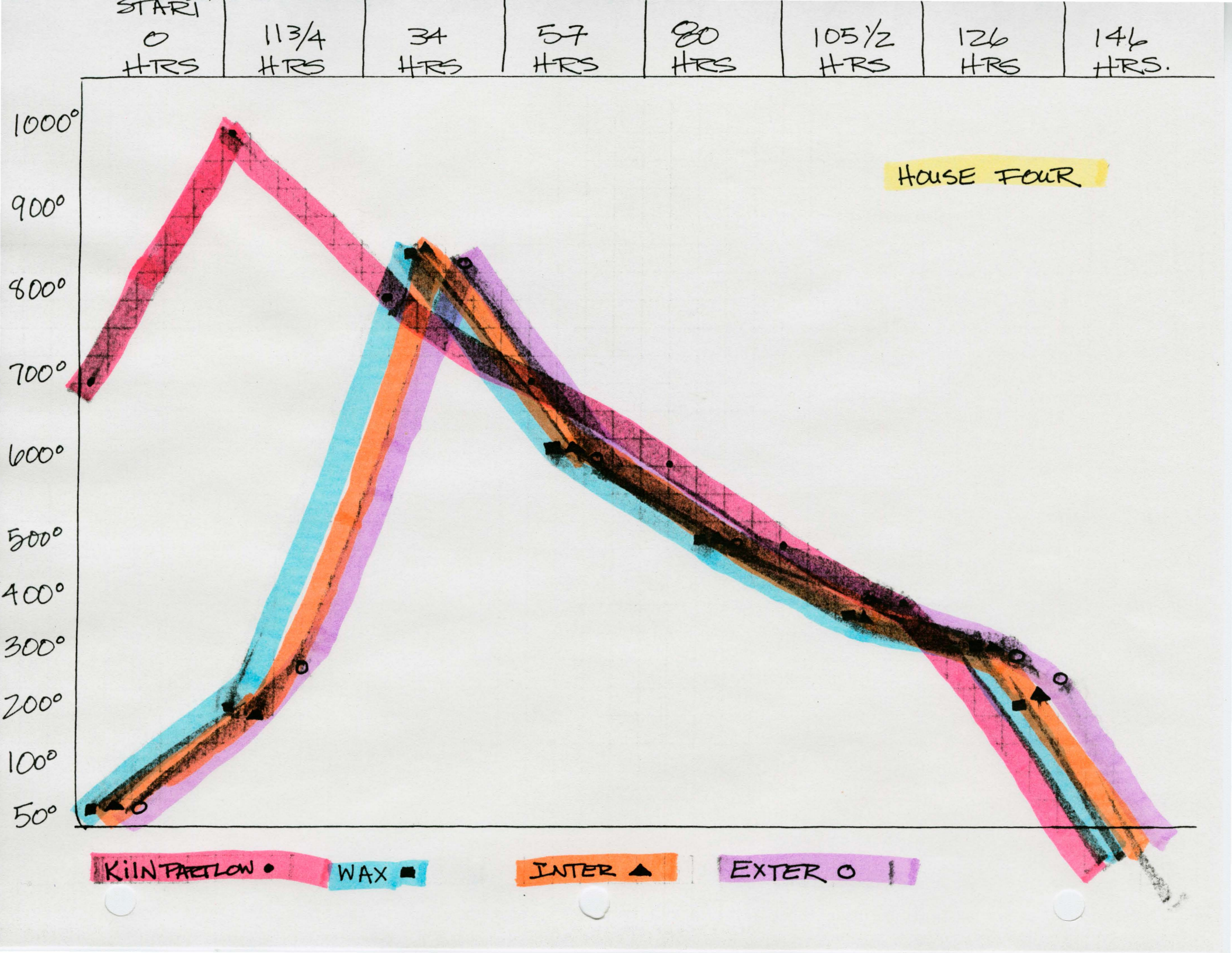


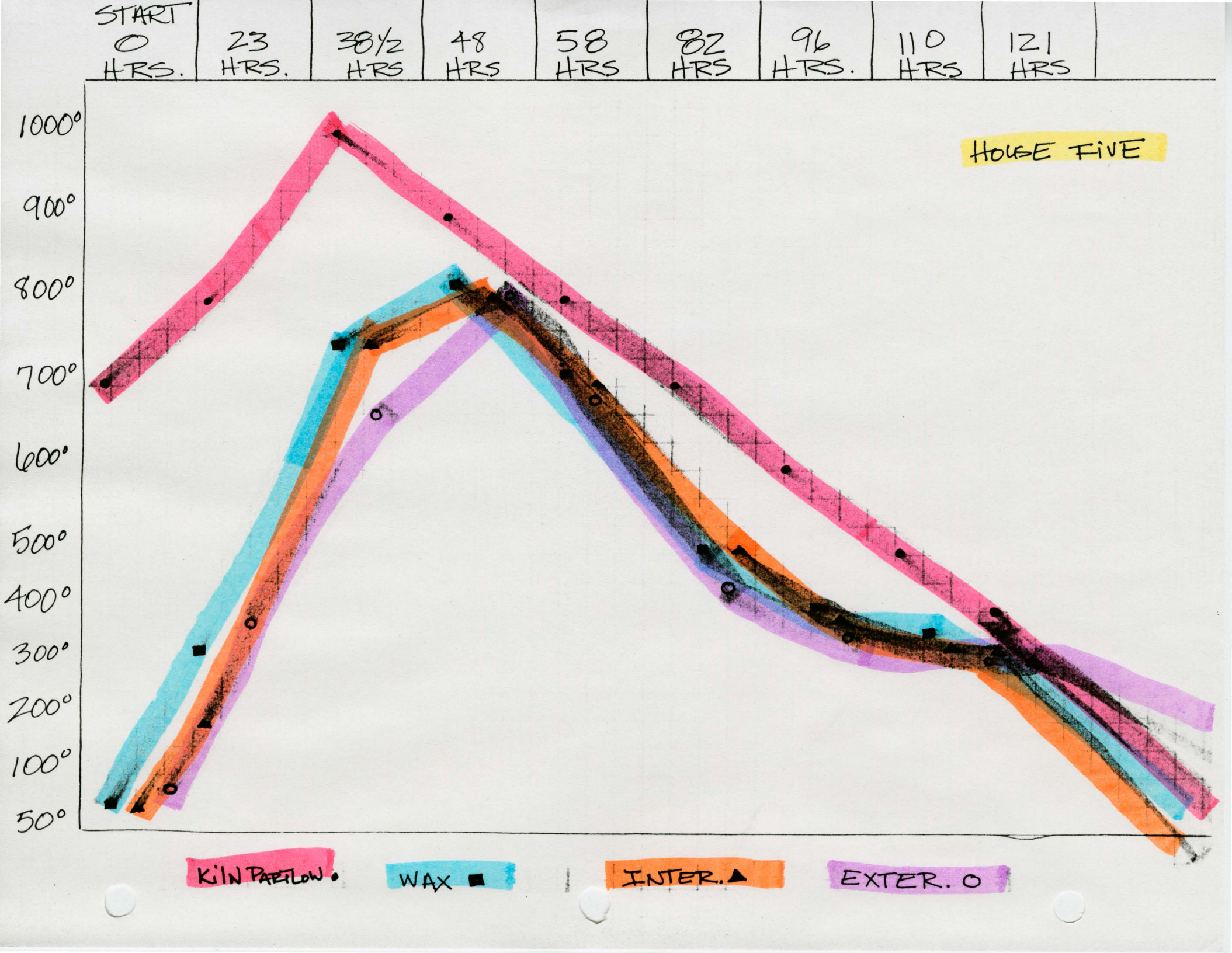
Photos 14 & 15


START 0 HRS.
14 HRS.
39½ HRS.
66½ HRS.
90½ HRS.
101½ HRS.
103½ HRS.
115½ HRS.
126 HRS.
137½ HRS.
1000°
900°
800°
700°
600°
500°
400°
300°
200°
100°
50°
HOUSE ONE
KILN PARTLOW •
ATKINS ×
WAX ■
INTER ▲
EXTER o


START
0 HRS.
24½ HRS.
48 HRS
72 HRS.
81 HRS.
97 HRS
99¾ HRS.
1000°
900°
800°
700°
600°
500°
400°
300°
200°
100°
50°
HOUSE TWO
KILN Partlow
WAX
INTER
EXTER


START
0
HRS.
24½
HRS
48
HRS
72
HRS
81
HRS
97
HRS
99¾
HRS
1000°
900°
800°
700°
600°
500°
400°
300°
200°
100°
50°
HOUSE THREE
KILN PARTLOW •
WAX ■


START
0 HRS
113/4 HRS
34 HRS
57 HRS
80 HRS
105½ HRS
126 HRS
146 HRS.
1000°
900°
800°
700°
600°
500°
400°
300°
200°
100°
50°
HOUSE FOUR
KILN PART LOW •
WAX ■
INTER ▲
EXTER O


START 0 HRS.
23 HRS.
38½ HRS
48 HRS
58 HRS
82 HRS
96 HRS.
110 HRS
121 HRS
1000°
900°
800°
700°
600°
500°
400°
300°
200°
100°
50°
HOUSE FIVE
KILN PATTERN
WAX
INTER.
EXTER.