

JAS (Inspection & Testing) Ltd

A

Calibration Report

of the

Heat Soak Process Oven "CS-HST-1808"

For

KXG Dongguan KunXing Glass Co., Ltd.

To

BS EN 14179-1:2016

Prepared by: **JAS (Inspection & Testing) Ltd.**

Test Date: 30th August 2018

Report Date: 3rd September 2018

Our Ref.: J18-117-R01-180903



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1. INTRODUCTION

1.1 Heat Soak Test Process

This test was conducted at the request of the glass manufacturer – **KXG Dongguan KunXing Glass Co., Ltd.** to calibrate their Heat Soak Test Process Oven “CS-HST-1804”, which is located at 東莞市謝崗鎮趙林金川工業區.

The European Standard EN 14179-1:2016 “Glass in building - Heat soaked thermally toughened soda lime silicate safety glass – Part 1: Definition and description” describes the methodology required to calibrate a heat soak test. The procedure adopted for the methodology described herein was taken from the Heat Soak Process calibration method described in this standard. This was used as the test method for all general and particular requirements.

Heat Soak Testing (HST) is a destructive test method for detecting the presence of Nickel Sulphide (NiS) inclusions in tempered glass. NiS is recognized as a major cause of spontaneous fracture that can occur in tempered glass. The process of HST involves holding the temperature of the glass at 260°C for a period of several hours.

KXG Dongguan KunXing Glass Co., Ltd. Heat Soak Oven “CS-HST-1808” manufactured by Foshan Cusen Glass Machinery Co., Ltd. was selected for the calibration.

**KXG Dongguan
KunXing Glass Co.,
Ltd.**

Heat Soak Oven
“CS-HST-1808”

Internal size
2.68m (h) x 1.63m (w) x
5.4m(d)



1.2 Spontaneous Breakage due to NiS

The sudden fracture of tempered glass can be caused by an expansion of NiS stones as a result of the slow allotropic transformation from the α -NiS (high temperature/low volume state) to β -NiS (low temperature/high volume state).

During the tempering process the NiS transforms to the high temperature α state, however when the rapid cooling, necessary to achieve the surface compression for FT glass, takes place the NiS cannot transform to the β status. Instead this reversal process occurs over a long period of time that can take to up to 10 years to complete.

The HST involves the glass being kept at an elevated temperature of 260°C for several hours so that the α to β transformation is accelerated.

The panels of glass that have been subjected to HST and have potentially destructive NiS inclusions should break during the HST process, however until the EN-14179 standard was developed, there was no a firm guarantee that failures would not occur in the installed condition.

2. WITNESSES

Test Consultant

Mr. Sam Lau

Mr. Jin Chen

JAS (Inspection & Testing) Ltd.

Glass Manufacturer

Mr. Xu Likun

KXG Dongguan KunXing Glass Co., Ltd.

Oven Manufacturer

Mr. Liu Chunwah

Foshan Cusen Glass Machinery Co., Ltd.

3. TEST INFORMATION

3.1 Sample and Preparation

**KXG Dongguan
KunXing
Glass Co., Ltd.**

Heat Soak Oven
"CS-HST-1808"

Internal size
2.68m (h) x 1.63m (w) x
5.4m(d)

One Double sided stillage
Classified as 1st category



In order to evaluate the performance of the Heat Soak Oven, test with a full load trial were conducted. As there was 1 double sided stillage in the oven, its category was defined as 1st category.

In this evaluation, JAS was co-operating with **KXG Dongguan KunXing Glass Co., Ltd.** to establish the air temperature and time required for all specified glass surface locations to reach 250°C for a full load operation to fulfill the EN14179-1:2016 requirement.

3.1.2 Full Load

Evaluation Date: 30th August 2018

Width (mm)	Height (mm)	Thickness (mm)	Qty.	Surface Area (m ²)	Weight (kg) Density (2,500kg/m ³)
1200	2440	12	2	5.9	175.7
1160	1040	12	42	50.7	1520.1
5040	1340	15	14	94.6	3545.6
5060	1360	15	2	13.8	516.1
*1100	360	12	5	2.0	59.4
Total:				166.8	5816.9

* Control Panels

3.2 Heat Soak Process System

- a. The maximum internal size of the Oven for the evaluation is 2.68m (h) x 1.63m (w) x 5.4m(d).
- b. Hot air heated by an electric heater is introduced into the oven by means of convection. The heated air in the box is extracted with an air blower.
- c. The air circulation is unhindered around each glass pane.
- d. In the event of glass breakage, the airflow is not hindered.
- e. The airflow in the oven moves from bottom to top and is parallel to the long side of the oven. Due to the ovens configuration, the glass is orientated to this direction, parallel to the long sides.
- f. Distribution of glass temperature was monitored with 20 thermocouples that electronically connected to a data acquisition unit. The temperature figures were shown in 'real time' on the screen and were monitored during the entire process.

3.3 Control Settings

Full Load Setting
1 st Stage Temperature: 130°C
1 st Stage Heating Time: 80 minutes
2 nd Stage Heating Time: 110 minutes
Holding Temperature: 252°C
Control Temperature: 260°C
Holding Time: 130 minutes
Cooling Time: 120 minutes
Finishing Temperature: 70°C

3.4 Separator

20mm thick polyamide cubes were used at the top and bottom edges between glass panels.

4. TEST PROCEDURE

The following procedures as required by EN 14179-1:2016 were carried out.

- a. Check and record the sizes of the glass panels.
- b. Ensure a minimum spacing of 20mm is present, recommended for separation of the glass panels to ensure that the heated air can circulate between the glass panels.
- c. For full load evaluation - Attach 20 nos. thermocouples on the glass panels' surfaces according to BS EN 14179-1:2016, Figure A.2 (1st category – 1 double sided stillage – full load).
- d. Close the oven door and record the start up Temperature of all thermocouples on the indicators.
- e. Start the automatic heating program.
- f. Record all thermocouple readings at 1 minute intervals.
- g. Record the time when the first thermocouple reaches 250°C and note the thermocouple reference number.
- h. Record the time when the last thermocouple reaches 250°C and note the thermocouple reference number.
- i. Record the time when the holding phase begins.
- j. Record the time when the cooling phase begins.
- k. Confirm that the doors of the oven were not allowed to open until the reading of the control element dropped to 70°C.
- l. Check the glass status; record any breakage of the glass panels.
- m. End.

5. OBSERVATION

5.1 Heating Phase

During the Heating Phase, the temperature recorded by each of the thermocouples increased at different rates. This is a normal occurrence in a HST chamber; the temperatures were different because of their respective distances from the hot air inlet, the pattern of air flow through the chamber, the location of the thermocouple on the glass and other variables.

The end of the heating phase (or the beginning of the holding phase) is defined as being when the last thermocouple reaches 250°C. This temperature was reached at 234 minutes for this evaluation.

JAS noted that no thermocouple on the glass surface exceed 290°C during the heating phase. The result was satisfactory.

5.2 Holding Phase

The holding phase was ended on 378 minutes for this evaluation.

JAS noted that the Heat Soak Process Oven of **KXG Dongguan KunXing Glass Co., Ltd.** was very stable, none of the thermocouples fell below 250°C during test. This fulfilled the requirements specified in EN 14179-1:2016.

5.3 Cooling Phase

The Cooling Phase was started when the heaters switched off and the cooling fans switched on automatically to allow the oven temperature to drop as soon as possible. The door was only allowed to be opened when the control temperature was below 70°C.

5.4 Record of the Full Load Test (KXG Dongguan KunXing Glass Co., Ltd.) Weight of Glass = 5,816.9 kg (2,500kg/m³)

Starting Time: 18:00 30th August 2018

Starting Temperature of the control element: 26°C

Heating Phase	Parameters	Records
Temperature of the control element (at any time).	T_c	Refer to Fig.2
Time for the first thermocouple and the glass to reach a temperature of 250°C.	t_1	176 minutes (#15)
Temperature of control element at time t_1 .	T_{c1}	247°C
Time for the last thermocouple and the glass to reach a temperature of 250°C.	t_{2a}	234 minutes (#11)
Maximum temperature of the control element during the heating phase.	T_{cmax}	269°C
Time at which T_{cmax} occurred.	t_{cmax}	314 minutes
Temperature of glass surfaces, measured by thermocouples (at any time).	T_{glass}	Refer to Fig.1b

Holding Phase	Parameters	Records
Started at	t_{2b}	234 minutes
Glass surface temperatures	T_{glass}	Between 250-270°C

Cooling Phase	Parameters	Records
Started at 378 minutes	t_{2b+2h}	Actual Holding time = 144 minutes.
Ended at 506 minutes	T_c	61°C

Results	Parameters	Records
Glass specimens status during HST	-	No Breakage
Fragmentation test Result - No. of crack-free particles in a 50mm x 50mm area	Information Only	64 + 32/2 = 80 pcs

The Heat Soak Process was ended at 2:26 31st August 2018.

Total time 8 hours 26 minutes

6. SUMMARY OF THE TEST RESULT

6.1 Evaluation Summary

In this evaluation, JAS found that if the control settings as listed in section 3.3 were kept unchanged, the holding phase will be started at 234 minutes for a full load heat soaking.

The Heat Soak Process System (CS-HST-1808) of **KXG Dongguan KunXing Glass Co., Ltd.** was calibrated and met the criteria as laid down in EN14179-1:2016 A.1. The time t_2 , in this case 234 minutes (Heating Phase) will be used for all regular production irrespective of actual loading for these production runs.

Typical Time Chart

Loading	Test in August 2018	Comment
	Heating Phase (minutes)	
Full Load	*234	To be used for all production runs

6.2 Heat Soak Temperature Records

Records of Full Load

Location	Heat up time (minute) to 250°C	Remark	Max. Temp. Records	Remark	Max. Heating Rate °C/minute	Occurs Time (minute)
#1	214	-	256	4 th Lowest	1.32	-
#2	210	-	255	3 rd Lowest	1.44	-
#3	207	-	259	-	1.27	-
#4	191	-	262	-	1.45	-
#5	202	-	263	-	1.28	-
#6	194	-	265	-	1.32	-
#7	198	-	264	-	1.37	-
#8	212	-	258	-	1.28	-
#9	180	2 nd to reach	268	3 rd Highest	1.72	-
#10	189	-	265	-	1.35	-
#11	234	Last	250	The Lowest	1.30	-
#12	196	-	259	-	1.37	-
#13	214	-	257	-	1.39	-
#14	197	-	259	-	1.35	-
#15	176	First to reach	272	The Highest	1.75	137 minute
#16	193	-	267	4 th Highest	1.48	-
#17	218	2 nd Last	255	2 nd Lowest	1.24	-
#18	196	-	262	-	1.32	-
#19	180	-	268	2 nd Highest	1.54	-
#20	192	-	265	-	1.34	-

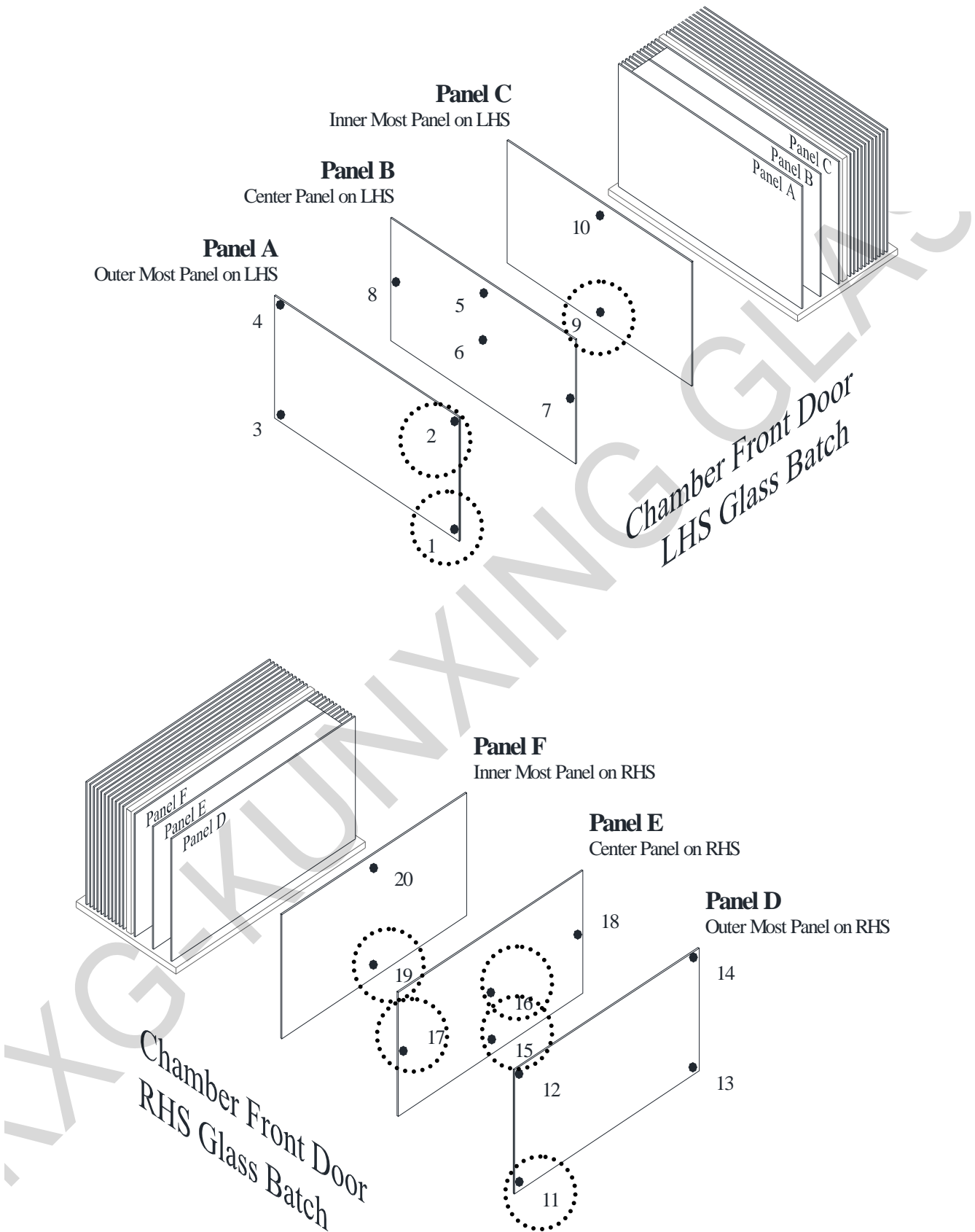
6.3 Records Summary

JAS suggest the 8 thermocouples to be used as follows:

LHS glass batch		RHS glass batch	
#1	4 th Lowest	#11	The Lowest
#2	3 rd Lowest	#15	The Highest
#9	3 rd Highest	#16	4 th Highest
-	-	#17	2 nd Lowest
-	-	#19	2 nd Highest

For recalibrating and checking, all of the thermocouples should be used as required by the test.

6.4 Thermocouples Locations



6.5 Hong Kong Institute of Steel Construction FaG-TG 002-8.2

Calibration of heat soak chamber / furnace

(a) Heat Soak Furnace Calibrate Schedule

The furnace shall be calibrated at least once a year.

(b) Thermocouples Calibrate Schedule

The thermocouples used for the temperature monitoring shall be calibrated at a minimum of every six months.

A minimum no. of 8 monitoring points on the glass surface are required, including the positions where the minimum and maximum surface temperatures for each side stillage during the calibration.

(c) Thermocouples Calibrate Schedule

The rate of heating shall be steadily increased. After an initial 15 minutes of Heating, the rate of heating of all glass panels shall be less than 3°C/min.

The maximum heating rate was recorded as follows:

Max. rate of heating records	Location	Occurred Time (min.)	Allowable <3°C/min	Results
1.75	#15	137	<3°C/min	Satisfactory

7. CONCLUSION

The Heat Soak Process System (CS-HST-1808) of **KXG Dongguan KunXing Glass Co., Ltd.** was tested in accordance to EN 14179-1:2016. With the control settings as listed in section 3.3 kept unchanged, the actual Holding phase will be more than the minimum 2 hours for the full loading test shown in this evaluation trial. Therefore the Result is Satisfactory.

The Heat Soak Process System (CS-HST-1808) of **KXG Dongguan KunXing Glass Co., Ltd.** is capable of achieving, and operating in accordance with, the requirements of the Heat Soak Process to the requirements of EN14179-1:2016 and BD PNAP APP 37 under the following conditions.

1. 1st Stage Temperature: 130°C
2. 1st Stage Heating Time: 80 minutes
3. 2nd Stage Heating Time: 110 minutes
4. Holding Temperature: 252°C
5. Control Temperature: 260°C
6. Holding Time: 130 minutes
7. Cooling Time: 120 minutes
8. Finishing Temperature: 70°C
9. A minimum spacing of 20mm for separation of the glass panels.
10. Full Load = 5.81 Tonnes (< 6 Tonnes defined by Oven Manufacturer at 2,500kg/m³)
11. The maximum height of the tested glass = 2.44m
12. Due to the variation of the weight of glass, the setting parameters may change to achieve a minimum of the 234 minutes heating phase requirement.

I certify this is a true record of the test conducted.

Witnessed by

Mr. Sam Lau

Certified by

Mr. Clifford A Bury

Appendices

I) Photographs

II) Time Temperature graphs

a. Fig. 1

b. Fig. 2

c. Fig. 3

III) EN14179-1:2016 (E)

d. Fig. A.2

Appendix I

Photo Records

JAS (Inspection & Testing) Ltd.

Inspection of Work - Photo Record

Project : Heat Soak Test for KXG Dongguan KunXing Glass Co., Ltd.



Photo 1

The KXG Dongguan KunXing Glass Co., Ltd.'s heat soak oven.



Photo 2

Serial No. CS-HST-1808, Manufactured by Foshan Cusen.



Photo 3

The Heat Soak Process Operation System.



Photo 4

Setting Parameters.



Photo 5

Hot Air Inlet.



Photo 6

Hot Air Return.

JAS (Inspection & Testing) Ltd.

Inspection of Work - Photo Record

Project : Heat Soak Test for KXG Dongguan KunXing Glass Co., Ltd



Photo 7

The separators were used to provide min. 20mm spaces between glass panels.



Photo 8

The separators were used to provide min. 20mm spaces between glass panels.



Photo 9

The dimension of the highest pane was checked and recorded.



Photo 10

100% Loading Test



Photo 11

The glass surface temperatures were monitored through the computer.

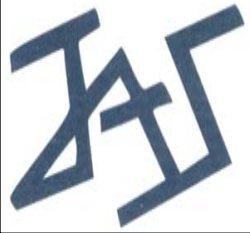


Photo 12

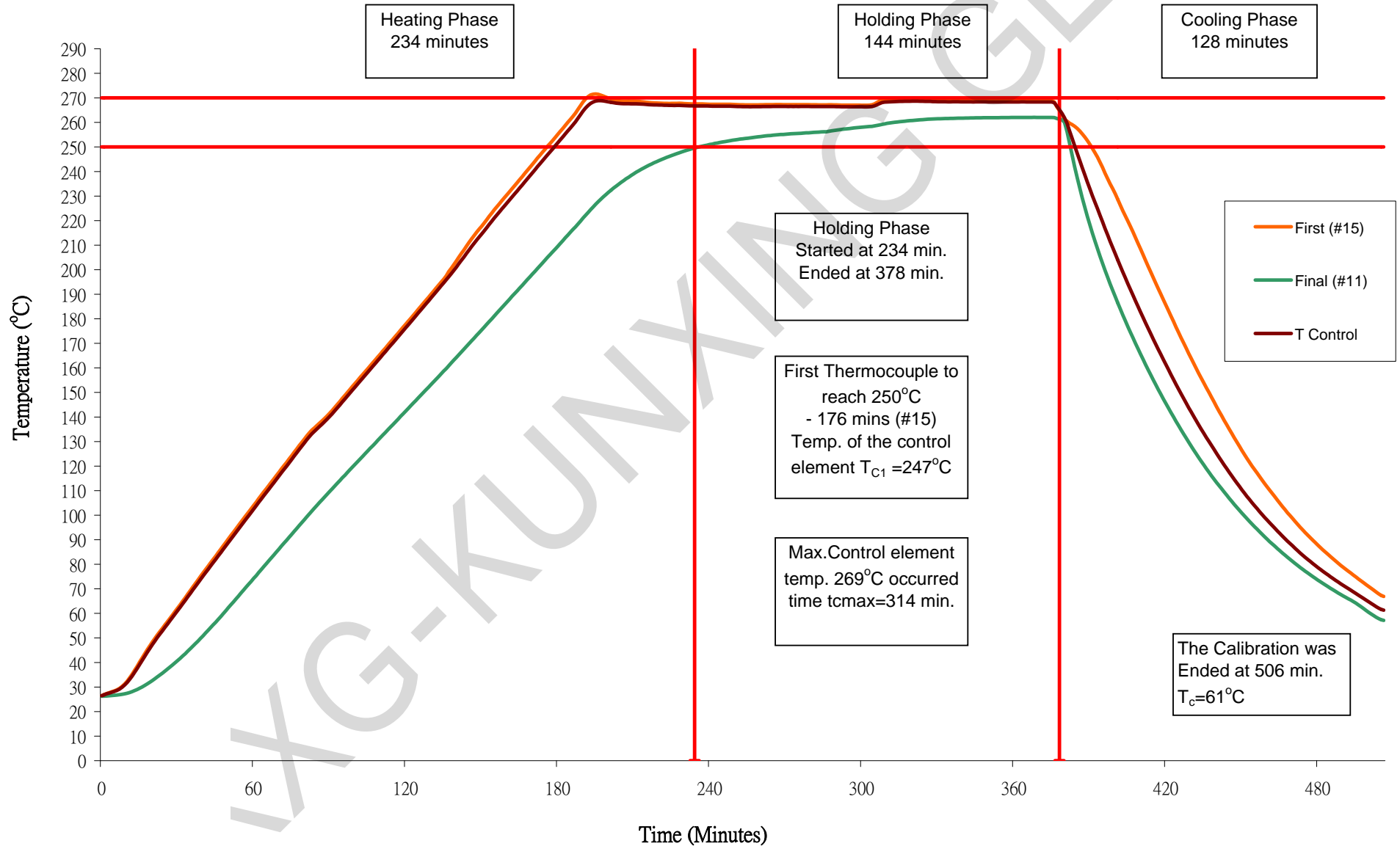
Fragmentation test
The result was Satisfactory

Appendix II

Time Temperature graphs

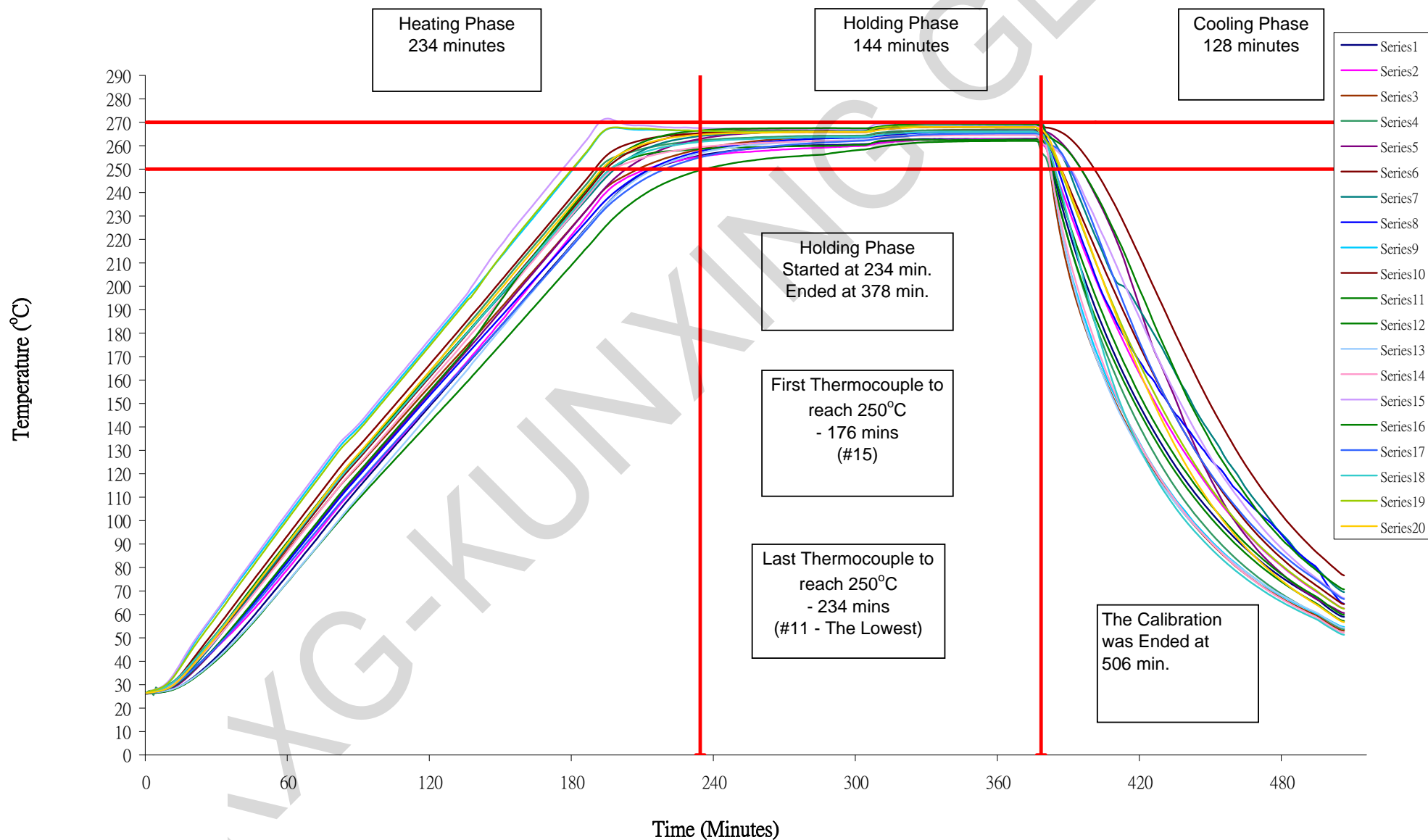


(KXG Dongguan KunXing Glass Co., Ltd.)
Heat Soak Test Oven Full Load Calibration
Fig.1 Control Element Temperature Record



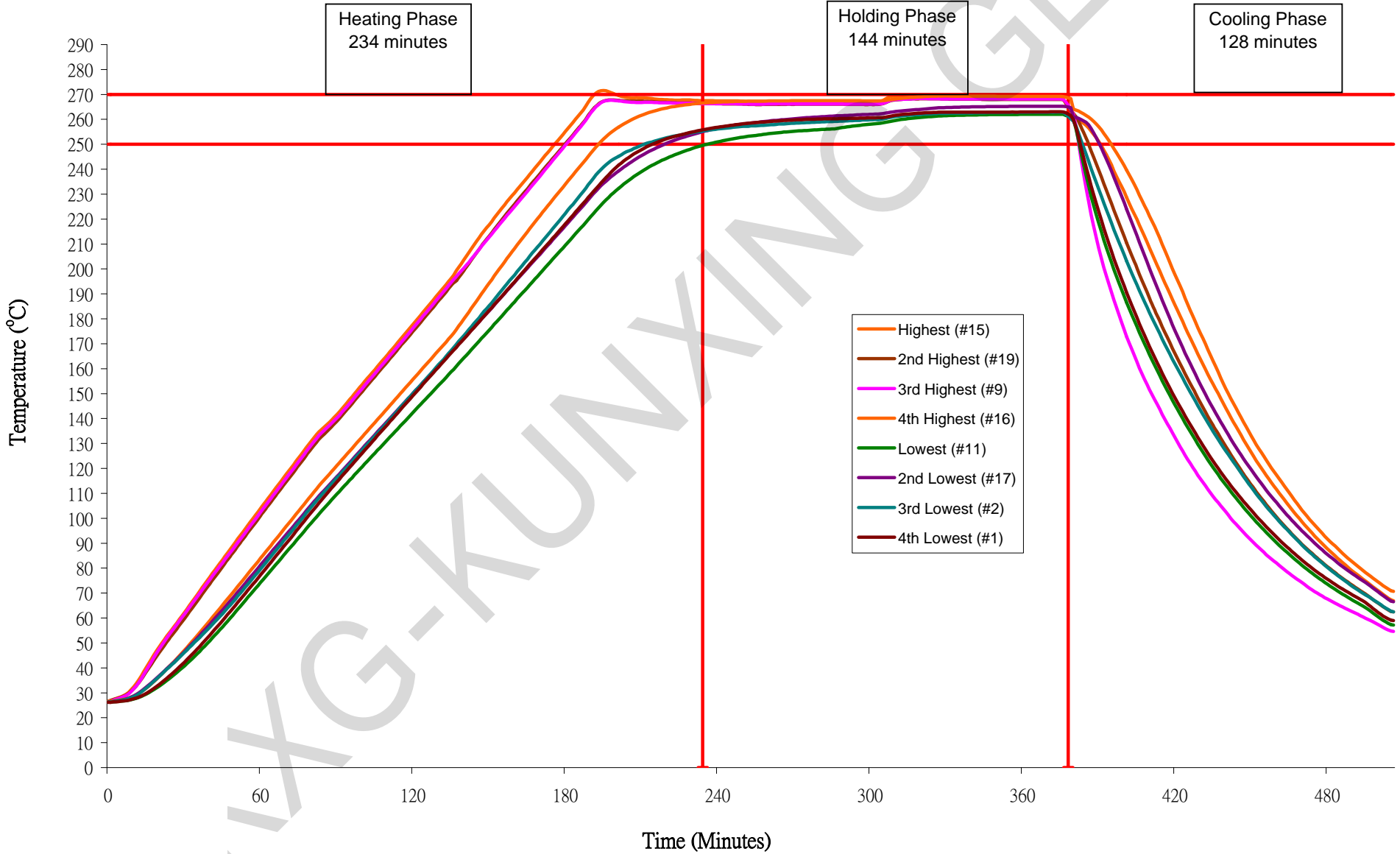


(KXG Dongguan KunXing Glass Co., Ltd.)
Heat Soak Test Oven Full Load Calibration
Fig.2 Glass Surface Temperature Records (T_{glass})



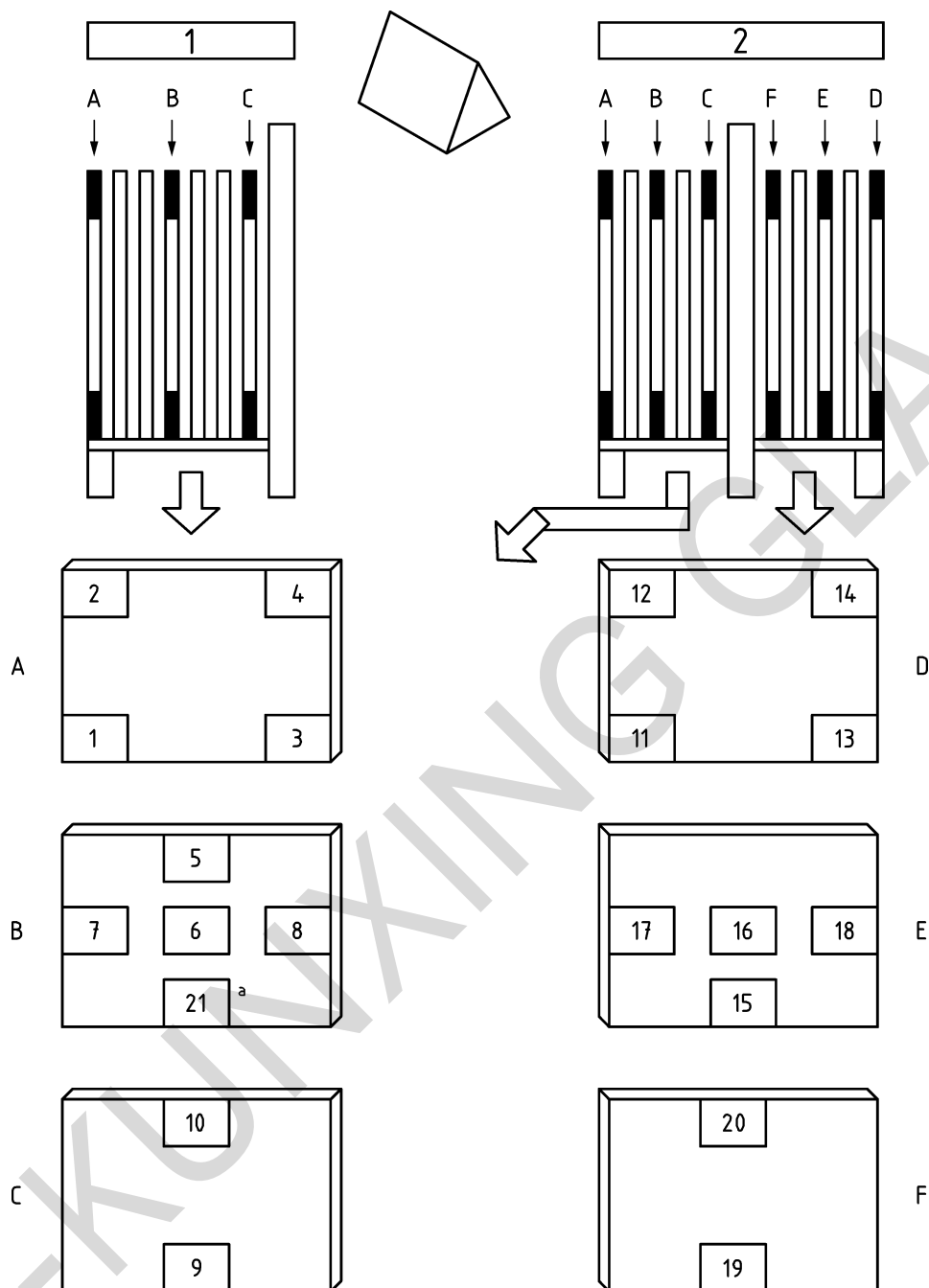


(KXG Dongguan KunXing Glass Co., Ltd.)
Heat Soak Test Oven Full Load Calibration
Fig.3 - 4 x Highest and 4 x Lowest Temperature Records



Appendix III

EN14179-1:2016 (E)



Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

^a is only used for mono side stillages

1 mono side stillage

2 double sided stillage

Figure A.2 — 1st category - 1 stillage - full load