Report Prepared for:	ROLLAC Shutter of Texas, Inc. Houston, TX
Subject:	Measurement of Steady-State Thermal Performance of Exterior Rolling Shutters
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REPORT ON THE MEASUREMENT OF STEADY-STATE THERMAL PERFORMANCE (THERMAL RESISTANCE AND TRANSMITTANCE) OF EXTERIOR ROLLING SHUTTERS

1. Introduction

In September/October 2000 the Thermal Resistance (R-value) and Transmittance (U-value) of the test objects were measured in accordance with the ASTM test method C 236: **Standard Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.** The thermal resistance values of the hot surface, the cold surface, and the shutter were measured for four different types and materials used for construction of the Exterior Rolling Shutters. The total thermal resistance and transmittance were estimated for a combination of the shutter with a standard single pane window.

2. Sample Description

The test specimens were four different types of Exterior Rolling Shutters. The technical specifications are given below:

(i) Exterior Rolling Shutter type **A 150**

Manufacturer:	ROLLAC Shutter of Texas, Inc.
Type:	A 150 – Aluminum Foam-Insulated Slat
Color:	White
Slat-Description:	Double-walled roll formed aluminum (gauge: 0.017 inch / 0.43 mm), with regular-density polyurethane insulating foam core and ALCAN SP80 abrasive resistant paint finish (white). Slat size: 0.35" (9 mm) wide x 1.57" (40 mm) high.

(ii) Exterior Rolling Shutter type **A 200**

Manufacturer:	ROLLAC Shutter of Texas, Inc.
Type:	A 200 – Aluminum Foam-Insulated Slat
Color:	White
Slat-Description:	Double-walled roll formed aluminum (gauge: 0.02 inch / 0.49 mm), with regular-density polyurethane insulating foam core and ALCAN SP80 abrasive resistant paint finish (white). Slat size: 0.55" (14 mm) wide x 2.16" (55 mm) high.

(iii) Exterior Rolling Shutter type **GULF**

Manufacturer:	ROLLAC Shutter of Texas, Inc.
Type:	GULF – PVC Slat
Color:	White
Slat-Description:	Double-walled stiffened cavity extruded mini PVC profile (light gauge: 0.031 inch / 0.80 mm), white. Slat size: 0.31" (8 mm) wide x 1.57" (40 mm) high.

(iv) Exterior Rolling Shutter type **ELITE**

Manufacturer:	ROLLAC Shutter of Texas, Inc.
Type:	ELITE – PVC Slat
Color:	White
Slat-Description:	Double-walled impact resistant extruded maxi PVC profile (heavy gauge: 0.044 inch / 1.13 mm), white. Slat size: 0.55" (14 mm) wide x 2.01" (51 mm) high.

For the thermal tests all shutters were completely closed and framed in aluminum rails.

3. Test Facilities

The thermal performance of the test specimens was measured by means of a guarded hot box (GHB) according to ASTM Designation C 236. The construction of the GHB follows closely the guidelines given in C 236. A Metering Box was placed completely inside a Guard Box. The size of the Metering Box was 18 ft^3 (0.49 m^3), i.e. 3 ft x 3 ft x 2 ft (0.9 m x 0.9 m x 0.6 m). The size of the Guard Box was 44 ft^3 (1.19 m^3), i.e. 4 ft x 4 ft x 2.75 ft (1.2 m x 1.2 m x 0.83 m) leaving a minimum distance of ½ ft (150 mm) between the walls of the Metering and the Guard Box.. The test specimens were mounted to the open front sides of Metering and Guard Box. The edge of the Metering Box in contact with the panel was sealed with a ½ inch (13 mm) wide rubber foam gasket. All other walls of the Metering and Guard Boxes were thermally insulated to reduce heat flow from the Guard Box to the outside area and between the two boxes.

Both, the Metering and the Guard Box, were equipped with an externally regulated heater and fan for distributing the heated air inside the boxes. A baffle parallel to the panel inside the Metering Box supports a homogeneous distribution of the stream of hot air across the metering area of the test panel. Additional slat type baffles in the Metering Box and in the Guard Box improve the homogeneity of the hot air circulation.

To accurately measure the heat flow through the five walls of the Metering Box into the Guard Box a system of forty (twenty pairs) of differential thermocouples was installed on both sides of the walls. Each pair of thermocouples senses the temperature at the same wall position inside and outside the Metering Box. There were four differential pairs of thermocouples distributed evenly over each wall. The thermocouple wire was flushed and in good thermal contact with the wall for at least 4 inch (100 mm) distance from each junction. All thermocouples were welded together differentially to form a thermopile. The measured emf of the thermopile was used to reduce the total heat flow through the walls of the Metering Box to zero (for the thermopile emf and heat flow relationship see ASTM Designation C 236, Appendix).

Air and panel surface temperatures were measured inside (hot space) and outside (cold space) the Metering Box. Nine different positions evenly distributed over the metering area of the specimen (as indicated in Fig. 1, Appendix 1) were tested. The temperatures at the panel surface were measured using thermocouples attached on both sides to the cold and hot surfaces. Starting from the junction, at least 4 inch (100 mm) of the thermocouple wire was in good thermal contact with the surface. Air temperature of the hot side (inside the Metering Box) was measured by another set of nine thermocouples placed exactly at the same positions, opposite to the hot surface thermocouples, midway between the hot surface and the baffle (the distance to the hot surface was larger than 3 inch / 75 mm). Similarly, the cold space air temperature was measured at nine positions in front of the cold surface of the test specimen. The thermocouples were placed opposite to the cold surface thermocouples in a distance of 3 inch (75 mm) from the panel.

The total of 36 temperatures were measured using a HH506R digital thermometer with RS232C optical interface. The interface to a computer allows the monitoring of the change of temperatures over long time and to determine precisely the time when temperature stability and stationary equilibrium was achieved.

4. Sampling and Test Procedure

The test specimens (Exterior Rolling Shutters, closed) were framed and adapted to the size of the Guard Box, 4 ft x 4 ft (1.2 m x 1.2 m). The metered area was 3 ft x 3 ft (0.9 m x 0.9 m). The edges of the shutter/frame were sealed and thermally insulated to reduce any lateral heat flow. Rubber foam was used to achieve a tight seal of the metered area and the edge of the Metering Box.

The Guarded Hot Box can be used in vertical and horizontal sample position. Both configurations were employed for testing each specimen and the results are identical. The horizontal sample configuration results in a more homogeneous temperature distribution across the metered sample area whereas in the vertical position a small temperature gradient was observed. The measured thermal parameters, however, are averaged over the metering area and the same results are obtained in horizontal and vertical positions within the error limits.

Steady state conditions, characterized by zero heat flow between the Metering and Guard Boxes, stable air and sample surface temperatures, and stable power input, were obtained after a typical time period of four to six ours. After achieving stationary equilibrium data were taken within two four our periods. The average of the data were used to calculate the thermal resistance and transmittance of the samples under test.

The following data were determined:

Q: the total net energy or average power through the specimen (metered area) including meter box heater and fan, W

t_1: area weighted average temperature of hot surface, K

t_2: area weighted average temperature of cold surface, K

t_h: average air temperature inside the Metering Box (75 mm from hot surface), K

t_c: average air temperature of cold space (75 mm from cold surface), K

A: metering area normal to the heat flow

The following parameters were estimated:

$R=(t_1-t_2)*A/Q$	:	thermal resistance of the specimen, Km^2/W
$r_h=(t_h-t_1)*A/Q$	:	hot surface resistance, Km^2/W
$r_c=(t_2-t_c)*A/Q$	:	cold surface resistance, Km^2/W
$R_u=(t_h-t_c)*A/Q$	:	overall thermal resistance, Km^2/W
$U=Q/A(t_h-t_c)$	:	thermal transmittance, W/Km^2
$C=Q/A(t_1-t_2)$	:	thermal conductance of specimen
R_{total}	:	estimated thermal resistance of the shutter in combination with a single pane window
U_{total}	:	estimated thermal transmittance of the shutter in combination with a single pane window

4. Test Results

The detailed test results are listed in Appendix 2. This section gives a summary and the most important parameters for the specimens under test. An estimate of the thermal parameters of the Exterior Rolling Shutters in combination with a single pane window and an assumed air gap between shutter and window of 1.5 inch (38 mm) is given by using standard values for the thermal resistance of the air space (R_{air}), the window glass (R_{glass}), and the inner surface resistance of the window (R_i):

$R_{air} = 0.157\ Km^2/W = 0.890\ F\ ft^2/(Btu/h)$

Note: this value is for cool air (winter conditions),
for warm air (summer conditions) R_{air} is slightly lower

$R_{glass} = 0.0053\ Km^2/W = 0.030\ F\ ft^2/(Btu/h)$

$R_i = 0.120\ Km^2/W = 0.680\ F\ ft^2/(Btu/h)$

The total thermal resistance, R_{total}, and transmittance, U_{total}, for the shutter-window combination were estimated according to the formulas:

$$R_{total} = r_h + R + R_{air} + R_{glass} + R_i \ , \qquad U_{total} = 1/R_{total} \ .$$

(i) Exterior Rolling Shutter type **A 150**

	SI units (K, m, W, …)	US units (F, ft, Btu, …)
Measured values for shutter		
Hot surface resistance, r_h Km^2/W, $F\ ft^2/(Btu/h)$	**0.0365**	**0.207**
Cold surface resistance, r_c Km^2/W, $F\ ft^2/(Btu/h)$	**0.0355**	**0.202**
Specimen resistance, R Km^2/W, $F\ ft^2/(Btu/h)$	**0.0324**	**0.184**
Overall resistance, R_u Km^2/W, $F\ ft^2/(Btu/h)$	**0.105**	**0.592**
Thermal conductance, C W/Km^2, $(Btu/h)/F\ ft^2$	**30.9**	**5.43**
Thermal transmittance, U W/Km^2, $(Btu/h)/F\ ft^2$	**9.52**	**1.69**
Estimated values for shutter and single pane window		
Overall resistance, R_{total} (shutter + window) Km^2/W, $F\ ft^2/(Btu/h)$	**0.351**	**1.99**
Thermal transmittance, U_{total} (shutter + window) W/Km^2, $(Btu/h)/F\ ft^2$	**2.85**	**0.502**

(ii) Exterior Rolling Shutter type **A 200**

	SI units (K, m, W, ...)	US units (F, ft, Btu, ...)
Measured values for shutter		
Hot surface resistance, r_h Km^2/W, $F\ ft^2/(Btu/h)$	**0.0402**	**0.229**
Cold surface resistance, r_c Km^2/W, $F\ ft^2/(Btu/h)$	**0.0394**	**0.224**
Specimen resistance, R Km^2/W, $F\ ft^2/(Btu/h)$	**0.0324**	**0.184**
Overall resistance, R_u Km^2/W, $F\ ft^2/(Btu/h)$	**0.112**	**0.634**
Thermal conductance, C W/Km^2, $(Btu/h)/F\ ft^2$	**30.9**	**5.43**
Thermal transmittance, U W/Km^2, $(Btu/h)/F\ ft^2$	**8.93**	**1.58**
Estimated values for shutter and single pane window		
Overall resistance, R_{total} (shutter + window) Km^2/W, $F\ ft^2/(Btu/h)$	**0.355**	**2.01**
Thermal transmittance, U_{total} (shutter + window) W/Km^2, $(Btu/h)/F\ ft^2$	**2.82**	**0.497**

(iii) Exterior Rolling Shutter type **GULF**

	SI units (K, m, W, …)	US units (F, ft, Btu, …)
Measured values for shutter		
Hot surface resistance, r_h Km^2/W, $F\ ft^2/(Btu/h)$	**0.0448**	**0.254**
Cold surface resistance, r_c Km^2/W, $F\ ft^2/(Btu/h)$	**0.0478**	**0.272**
Specimen resistance, R Km^2/W, $F\ ft^2/(Btu/h)$	**0.0686**	**0.390**
Overall resistance, R_u Km^2/W, $F\ ft^2/(Btu/h)$	**0.161**	**0.916**
Thermal conductance, C W/Km^2, $(Btu/h)/F\ ft^2$	**14.6**	**2.56**
Thermal transmittance, U W/Km^2, $(Btu/h)/F\ ft^2$	**6.21**	**1.09**
Estimated values for shutter and single pane window		
Overall resistance, R_{total} (shutter + window) Km^2/W, $F\ ft^2/(Btu/h)$	**0.395**	**2.25**
Thermal transmittance, U_{total} (shutter + window) W/Km^2, $(Btu/h)/F\ ft^2$	**2.53**	**0.445**

(iv) Exterior Rolling Shutter type **ELITE**

	SI units (K, m, W, …)	US units (F, ft, Btu, …)
Measured values for shutter		
Hot surface resistance, r_h Km^2/W , $F\ ft^2/(Btu/h)$	**0.0478**	**0.272**
Cold surface resistance, r_c Km^2/W , $F\ ft^2/(Btu/h)$	**0.0516**	**0.293**
Specimen resistance, R Km^2/W , $F\ ft^2/(Btu/h)$	**0.0979**	**0.556**
Overall resistance, R_u Km^2/W , $F\ ft^2/(Btu/h)$	**0.198**	**1.12**
Thermal conductance, C W/Km^2 , $(Btu/h)/F\ ft^2$	**10.2**	**1.80**
Thermal transmittance, U W/Km^2 , $(Btu/h)/F\ ft^2$	**5.05**	**0.893**
Estimated values for shutter and single pane window		
Overall resistance, R_{total} (shutter + window) Km^2/W , $F\ ft^2/(Btu/h)$	**0.428**	**2.43**
Thermal transmittance, U_{total} (shutter + window) W/Km^2 , $(Btu/h)/F\ ft^2$	**2.34**	**0.411**

The comparison of the thermal parameters of the different types of Exterior Rolling Shutters reveals some interesting properties.

First of all, the thermal performance of the PVC shutters is far better than the aluminum shutters. This is not surprising because aluminum is one of the best heat conducting materials. The different slat size of type A 150 and type A 200 has almost no influence on the thermal conductance indicating that the major thermal conductor is the aluminum shell of the slats. Type A 200 has a slightly higher surface resistance resulting in a 7 % lower thermal transmittance (U-value). It can be concluded that the effect of the foam core on improving the thermal insulation is very marginal.

A major enhancement of thermal insulation is obtained by replacing the aluminum by PVC. The thermal conductance of the PVC shutters type GULF and type ELITE is reduced by 50 % and 67 %, respectively, if compared with the thermal conductance of the aluminum slats. A clear decrease of thermal conductance is also observed with increasing PVC slat size (GULF to ELITE). The lower thermal conduction results in a decrease of the U-value (thermal transmittance) from about 9 W/Km^2 (A150, A200) to 6.2 W/Km^2 (GULF) and 5 W/Km^2 (ELITE).

Tested by: ____________________

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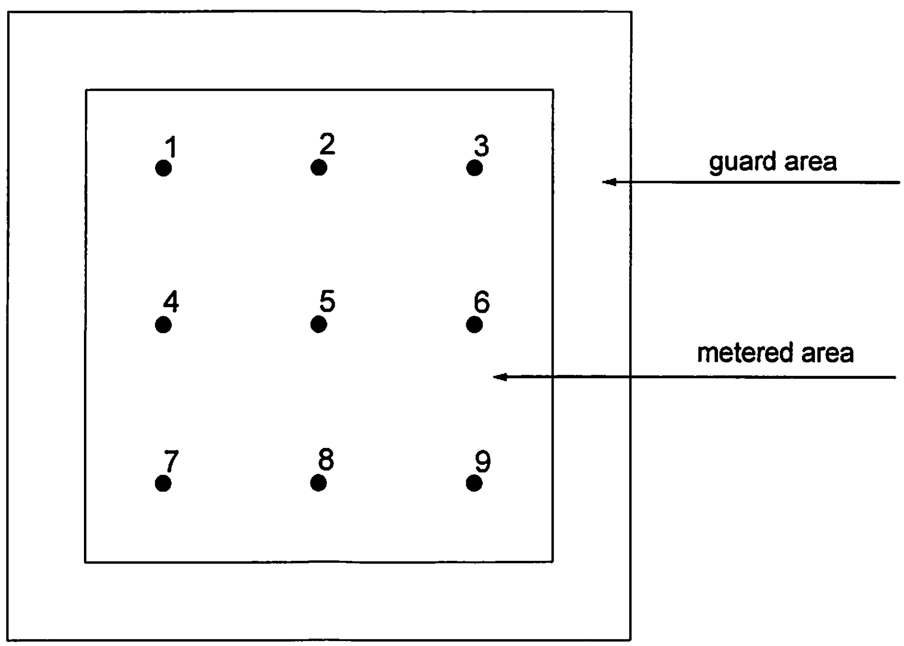
Appendix 1

Position of the temperature sensors at the surface of the test specimen. The numbers 1 to 9 refer to the data given in Appendix 2.



Appendix 2

Detailed presentation of the measured data for the test panels (i) to (iv). The average temperatures numbered from 1 to 9 refer to the positions indicated in Fig. 1. The metered area for all tests is 9 ft^2 (0.81 m^2). All temperatures are given in °C.

Panel (i):

Exterior Rolling Shutter type A 150
Horizontal position

test point	hot air	hot surface	cold surface	cold air
1	**83.2**	**66.9**	**51.9**	**36.5**
2	**84.0**	**67.8**	**53.0**	**37.1**
3	**83.9**	**67.5**	**52.8**	**37.1**
4	**84.7**	**67.9**	**52.6**	**36.4**
5	**84.0**	**67.3**	**52.0**	**37.1**
6	**84.4**	**67.6**	**52.0**	**36.7**
7	**85.0**	**68.0**	**53.4**	**36.6**
8	**84.0**	**67.1**	**52.6**	**36.5**
9	**84.6**	**67.4**	**53.1**	**36.5**
Average temp.	**84.2**	**67.5**	**52.6**	**36.7**
Total power input (heater + fan), W			**368**	

$r_h = 0.0368\ Km^2/W = 0.209\ F\ ft^2/(Btu/h)$

$r_c = 0.0350\ Km^2/W = 0.199\ F\ ft^2/(Btu/h)$

$R = 0.0328\ Km^2/W = 0.186\ F\ ft^2/(Btu/h)$

$R_u = 0.105\ Km^2/W = 0.594\ F\ ft^2/(Btu/h)$

$U = 9.52\ W/Km^2 = 1.68\ (Btu/h)/F\ ft^2$

Exterior Rolling Shutter type A 150

Vertical position

test point	hot air	hot surface	cold surface	cold air
1	**74.1**	**58.9**	**46.5**	**30.9**
2	**72.5**	**58.2**	**46.0**	**30.7**
3	**73.3**	**59.0**	**46.1**	**31.0**
4	**73.5**	**58.7**	**45.4**	**30.6**
5	**72.0**	**58.6**	**45.7**	**30.5**
6	**73.7**	**58.8**	**45.9**	**30.9**
7	**71.5**	**56.3**	**44.0**	**31.2**
8	**70.9**	**56.2**	**43.8**	**30.5**
9	**71.4**	**57.0**	**43.8**	**30.7**
Average temp.	**72.5**	**58.0**	**45.2**	**30.8**
Total power input (heater + fan), W			**325**	

$r_h = 0.0361\ Km^2/W = 0.205\ F\ ft^2/(Btu/h)$

$r_c = 0.0359\ Km^2/W = 0.204\ F\ ft^2/(Btu/h)$

$R = 0.0319\ Km^2/W = 0.181\ F\ ft^2/(Btu/h)$

$R_u = 0.104\ Km^2/W = 0.590\ F\ ft^2/(Btu/h)$

$U = 9.62\ W/Km^2 = 1.69\ (Btu/h)/F\ ft^2$

Panel (ii):

Exterior Rolling Shutter type A 200

Horizontal position

test point	hot air	hot surface	cold surface	cold air
1	**83.9**	**68.1**	**53.5**	**36.9**
2	**83.2**	**67.5**	**53.2**	**37.1**
3	**84.0**	**67.4**	**53.6**	**36.6**
4	**84.5**	**66.8**	**52.9**	**36.2**
5	**83.9**	**65.7**	**53.2**	**35.8**
6	**83.9**	**65.9**	**52.8**	**36.1**
7	**84.9**	**66.0**	**53.0**	**36.3**
8	**82.3**	**66.2**	**53.5**	**35.9**
9	**83.2**	**67.0**	**53.1**	**36.0**
Average temp.	**83.7**	**66.7**	**53.2**	**36.3**
Total power input (heater + fan), W			**345**	

$r_h = 0.0399\ Km^2/W = 0.227\ F\ ft^2/(Btu/h)$

$r_c = 0.0397\ Km^2/W = 0.225\ F\ ft^2/(Btu/h)$

$R = 0.0317\ Km^2/W = 0.180\ F\ ft^2/(Btu/h)$

$R_u = 0.111\ Km^2/W = 0.632\ F\ ft^2/(Btu/h)$

$U = 8.99\ W/Km^2 = 1.58\ (Btu/h)/F\ ft^2$

Exterior Rolling Shutter type A 200

Vertical position

test point	hot air	hot surface	cold surface	cold air
1	**76.2**	**61.0**	**48.1**	**32.8**
2	**76.5**	**61.3**	**48.3**	**32.4**
3	**76.0**	**60.5**	**47.7**	**32.7**
4	**75.9**	**61.0**	**47.6**	**31.9**
5	**76.3**	**61.4**	**48.3**	**31.8**
6	**76.7**	**60.6**	**47.8**	**32.3**
7	**74.5**	**59.0**	**46.3**	**32.6**
8	**75.0**	**58.7**	**46.1**	**32.0**
9	**74.9**	**58.5**	**46.6**	**31.9**
Average temp.	**75.8**	**60.2**	**47.4**	**32.3**
Total power input (heater + fan), W			**313**	

$r_h = 0.0405\ Km^2/W = 0.230\ F\ ft^2/(Btu/h)$

$r_c = 0.0391\ Km^2/W = 0.222\ F\ ft^2/(Btu/h)$

$R = 0.0330\ Km^2/W = 0.187\ F\ ft^2/(Btu/h)$

$R_u = 0.113\ Km^2/W = 0.639\ F\ ft^2/(Btu/h)$

$U = 8.85\ W/Km^2 = 1.56\ (Btu/h)/F\ ft^2$

Panel (iii):

Exterior Rolling Shutter type GULF

Horizontal position

test point	hot air	hot surface	cold surface	cold air
1	**82.8**	**67.9**	**46.2**	**31.0**
2	**81.7**	**68.7**	**46.8**	**31.3**
3	**83.0**	**68.4**	**46.2**	**31.1**
4	**82.2**	**67.9**	**45.9**	**30.8**
5	**81.0**	**68.0**	**45.7**	**30.8**
6	**82.4**	**67.8**	**46.3**	**30.3**
7	**82.1**	**67.5**	**46.1**	**31.1**
8	**81.7**	**68.0**	**46.8**	**31.8**
9	**82.0**	**67.7**	**46.4**	**31.1**
Average temp.	**82.1**	**68.0**	**46.3**	**31.0**
Total power input (heater + fan), W			**258**	

$r_h = 0.0443\ Km^2/W = 0.251\ F\ ft^2/(Btu/h)$

$r_c = 0.0480\ Km^2/W = 0.273\ F\ ft^2/(Btu/h)$

$R = 0.0681\ Km^2/W = 0.387\ F\ ft^2/(Btu/h)$

$R_u = 0.160\ Km^2/W = 0.911\ F\ ft^2/(Btu/h)$

$U = 6.25\ W/Km^2 = 1.10\ (Btu/h)/F\ ft^2$

Exterior Rolling Shutter type GULF

Vertical position

test point	hot air	hot surface	cold surface	cold air
1	**79.9**	**66.4**	**45.8**	**31.4**
2	**79.5**	**66.0**	**46.0**	**30.9**
3	**79.6**	**66.3**	**46.1**	**31.1**
4	**79.3**	**65.9**	**45.7**	**31.5**
5	**78.9**	**66.2**	**46.0**	**31.2**
6	**79.0**	**65.9**	**45.2**	**30.9**
7	**78.1**	**64.6**	**44.1**	**31.2**
8	**77.9**	**64.5**	**44.0**	**31.4**
9	**78.2**	**64.7**	**44.2**	**30.9**
Average temp.	**78.9**	**65.6**	**45.2**	**31.2**
Total power input (heater + fan), W			**239**	

$r_h = 0.0452\ Km^2/W = 0.257\ F\ ft^2/(Btu/h)$

$r_c = 0.0475\ Km^2/W = 0.270\ F\ ft^2/(Btu/h)$

$R = 0.0690\ Km^2/W = 0.392\ F\ ft^2/(Btu/h)$

$R_u = 0.162\ Km^2/W = 0.920\ F\ ft^2/(Btu/h)$

$U = 6.17\ W/Km^2 = 1.09\ (Btu/h)/F\ ft^2$

Panel (iv):

Exterior Rolling Shutter type ELITE

Horizontal position

test point	hot air	hot surface	cold surface	cold air
1	**79.0**	**65.6**	**38.2**	**23.2**
2	**78.4**	**65.5**	**37.8**	**23.6**
3	**78.6**	**65.9**	**38.0**	**22.9**
4	**78.9**	**64.9**	**37.6**	**23.2**
5	**78.4**	**64.7**	**37.9**	**23.2**
6	**79.0**	**65.1**	**37.7**	**22.8**
7	**79.1**	**64.8**	**38.1**	**23.0**
8	**78.3**	**65.6**	**37.7**	**22.7**
9	**78.5**	**65.5**	**37.6**	**23.0**
Average temp.	**78.7**	**65.3**	**37.8**	**23.1**
Total power input (heater + fan), W			**229**	

$r_h = 0.0474\ Km^2/W = 0.269\ F\ ft^2/(Btu/h)$

$r_c = 0.0520\ Km^2/W = 0.295\ F\ ft^2/(Btu/h)$

$R = 0.0973\ Km^2/W = 0.552\ F\ ft^2/(Btu/h)$

$R_u = 0.197\ Km^2/W = 1.12\ F\ ft^2/(Btu/h)$

$U = 5.08\ W/Km^2 = 0.895\ (Btu/h)/F\ ft^2$

Exterior Rolling Shutter type ELITE

Vertical position

test point	hot air	hot surface	cold surface	cold air
1	**80.9**	**67.4**	**40.2**	**26.3**
2	**81.2**	**67.6**	**39.8**	**26.2**
3	**81.3**	**67.3**	**40.1**	**25.9**
4	**81.0**	**67.2**	**39.9**	**26.2**
5	**80.7**	**66.9**	**39.7**	**25.9**
6	**80.2**	**67.3**	**40.1**	**26.0**
7	**78.8**	**66.0**	**38.9**	**24.7**
8	**78.3**	**65.7**	**38.6**	**24.2**
9	**78.6**	**65.8**	**38.8**	**23.9**
Average temp.	**80.1**	**66.8**	**39.6**	**25.5**
Total power input (heater + fan), W			**224**	

$r_h = 0.0482\ Km^2/W = 0.274\ F\ ft^2/(Btu/h)$

$r_c = 0.0511\ Km^2/W = 0.290\ F\ ft^2/(Btu/h)$

$R = 0.0985\ Km^2/W = 0.559\ F\ ft^2/(Btu/h)$

$R_u = 0.198\ Km^2/W = 1.12\ F\ ft^2/(Btu/h)$

$U = 5.06\ W/Km^2 = 0.889\ (Btu/h)/F\ ft^2$