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FIRE PERFORMANCE EVALUATION OF *GLASBORD FPAUS* IN ACCORDANCE WITH AUSTRIALIAN STANDARD™ (AS) ISO 9705-2003, *FIRE TESTS-FULL-SCALE ROOM TEST FOR SURFACE PRODUCTS*

FINAL REPORT
Consisting of 20 Pages

SwRI Project No. 01.24102.19.310
Test Date: February 26, 2019
Report Date: March 12, 2019

Prepared for:

Crane Composites
23525 W. Eames Street
Channahon, IL 60410

Dynamic Composites Tech PTY Ltd
171-175 Newton Road Unit 8
P.O. Box 7186
Wetherill Park SNW, 2164
Australia

This test was conducted in accordance with the applicable standard; and to the best of our knowledge, it contains no errors, omissions, or false statements.

Submitted by:

Karen C. Carpenter, M.S., P.E.
Manager
Fire Resistance Section

KH

Approved by:

Matthew S. Blais, Ph.D.
Director
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1.0 INTRODUCTION

This report presents the results of a fire performance evaluation of *Glasbord FPAUS* for Crane Composites, located in Channahon, Illinois and Dynamic Composites Tech PTY Ltd, located in Wetherill Park NSW, Australia. Testing was conducted in accordance with Australian Standard™ (AS) ISO 9705-2003 (Reconfirmed 2016), *Fire Tests–Full-Scale Room Test for Surface Products,* which is identical with and reproduced from International Organization for Standardization (ISO) Test Standard 9705:1993, *Fire Tests–Full-Scale Room Test for Surface Products.* The results of the test were then used to calculate the Group number and smoke growth rate index ($SMOGRA_{RC}$) in accordance with AS 5637-2015, Australian Standard®, *Determination of Fire Hazard Properties.* Testing was conducted by Southwest Research Institute's (SwRI's) Fire Technology Department, located in San Antonio, Texas.

This test methodology is intended to measure and describe the properties of materials or products in response to heat and flame under controlled laboratory conditions. The results should not be used alone to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a complete fire hazard assessment or a fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard or fire risk of a particular end use. The results apply specifically to the specimens tested, in the manner tested, and not to similar materials, nor to the performance when used in combination with other materials.

2.0 TEST METHOD

For the AS ISO 9705 test procedure, specimens are mounted to fully cover both 2.4 × 3.6-m (8 × 12-ft) walls and the 2.4 × 2.4-m (8 × 8-ft) wall that does not have a doorway. In addition, specimens are mounted to fully cover the ceiling area. The walls and ceiling are exposed to a propane gas burner that is placed flush with the intersecting wall surfaces in the right, rear corner of the room, and opposite from the doorway.

One total heat flux gauge is mounted 25 mm above the floor surface facing upward in the geometric center of the room. A Gardon-type gauge with a flat black surface and 180° view angle is used. While in operation, the heat flux gauge is maintained at a constant temperature above the dew point by a heated water supply.

Although not required, bare ½-mm dia. Type K thermocouples (TC) were used in various locations. One TC was located in the interior plane of the door opening, on the door centerline, 25 mm down from the header. In addition, the temperatures at the ceiling surface over the burner and at the following five locations were measured: center of the ceiling, right half, left half, front half, and rear half. Additionally, a thermocouple tree built, in accordance with Figure C.1. of AS ISO 9705, was located 300 mm away from the doorway wall and the wall opposite of the burner.

At the start of the test, the propane gas burner was ignited, and the sample exposed to a 100-kW fire for 10 min, at which point the gas burner was adjusted to an output of 300 kW, by way of a mass flow controller, and run for an additional 10 min.

The products of combustion and entrained air were collected in a hood and extracted through an exhaust duct by a fan. A gas sample was drawn from the exhaust duct and analyzed for oxygen, carbon dioxide, and carbon monoxide concentrations. The gas temperature and differential pressure across a bi-directional probe were measured for calculating the mass flow rate of the exhaust gases. Smoke production rate was determined based on the measured light obscuration in the duct using a white-light extinction photometer located close to the gas sampling point.

3.0 DESCRIPTION OF TEST SPECIMENS

Crane Composites provided the *Glasbord FPAUS* panels for testing, which were received by SwRI on January 29, 2019. Upon arrival, the panels were placed into conditioning (controlled environment of 23 °C ± 3 °C and 50% ± 5% relative humidity) up until installation into the test room on February 26, 2019. Material details provided by the Client are provided in Table 1.

Table 1. Material Details.

Trade Name*	*Glasbord FPAUS*
Description*	*FPAUS fastened to Type X gypsum*
Color*	White
Thickness*	0.085 in.
Dimensions*	96 × 48 in.
Density*	0.643 lb/ft^2
Side Tested*	Pebbled

* Provided by the Client

4.0 CONSTRUCTION DETAILS

The panels were installed into the test room with the pebbled side exposed by SwRI personnel. Each panel was screwed into the studs using #6 1⅝-in. long self-drilling bugle head screws. Each panel was installed vertically and attached using the Client-provided layout shown in Figure 1. When attaching panels to the ceiling, fastener spacing was reduced to 12 in. on center in the length direction. Care was taken to ensure that the butt joints of adjacent panels were as tight as possible. The three "non-doorway" walls and the ceiling were completely covered using the *Glasbord FPAUS.*

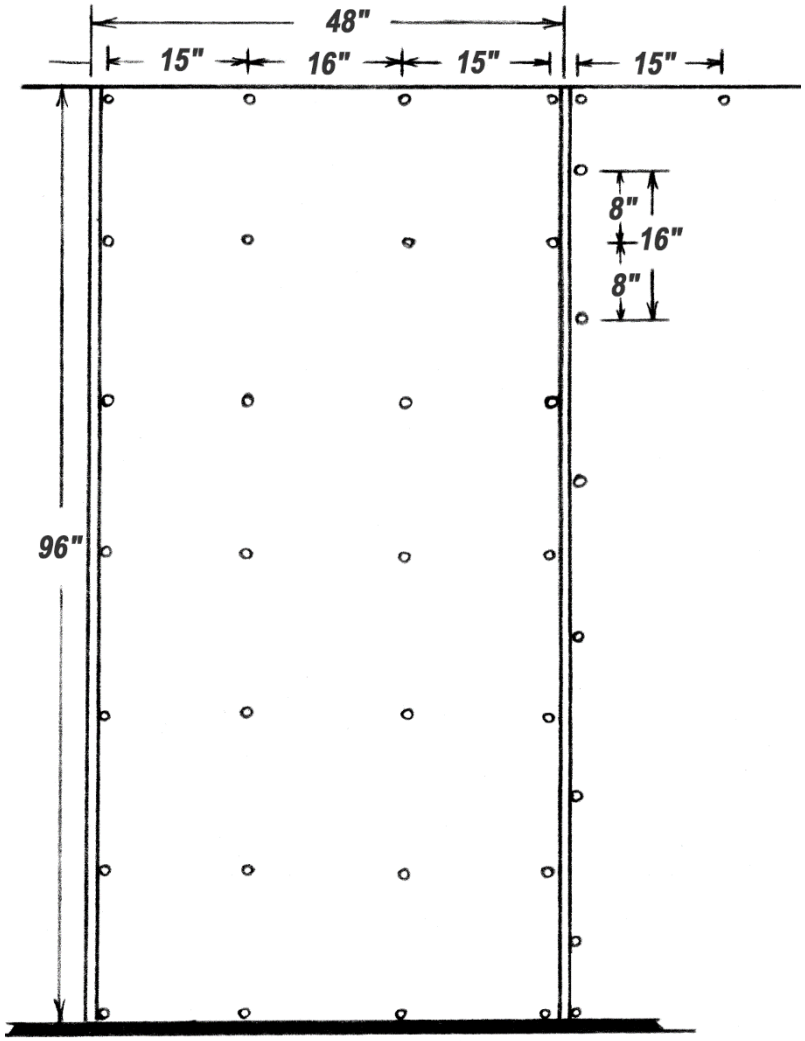


Figure 1. Client-Provided Attachment Layout.

5.0 ACCEPTANCE CRITERIA

No acceptance criteria is included in the AS ISO 9705 test method however the test results were used in order to calculate the Group number and smoke growth rate index ($SMOGRA_{RC}$) in accordance with procedures and calculations described in AS 5637. AS 5637 is designed to assess internal wall and ceiling linings for their ability to ignite, release heat once ignition has occurred, cause flashover, release smoke, and contribute to fire growth.

5.1. Group Number

The Group number is a measure of the ignitability and heat release rate of a material, expressed as a number from 1 to 4. The Group number was determined using AS ISO 9705. The Group number is assigned using the criteria below:

a) Group 1–material that does not reach flashover when exposed to 100 kW for 600 s followed by exposure to 300 kW for 600s.

b) Group 2–material that reaches flashover following an exposure to 300 kW within 600 s after not reaching flashover when exposed to 100 kW for 600 s.

c) Group 3–material that reaches flashover in more than 120 s but within 600 s when exposed to 100 kW.

d) Group 4–material that reaches flashover within 120 s when exposed to 100 kW.

Flashover is defined by AS 5637 and AS ISO 9705 as a heat release rate of 1000 kW (1 MW) or greater inclusive of the burner output. During testing of the *Glasbord FPAUS,* flashover occurred at 12 min 21 s and, therefore, is assigned a Group number of 2.

5.2. $SMOGRA_{RC}$

The smoke growth rate index or $SMOGRA_{RC}$ is a measure of smoke obscuration determined in accordance with AS ISO 9705, expressed in square meters per second squared (m^2/s^2). $SMOGRA_{RC}$ is determined by using the calculations in Section 6 of AS 5637. In order to determine the $SMOGRA_{RC}$, a 60 s running average (R_{60}) rate of light obscuring smoke (R_{inst}) is calculated. The R_{60} was 4.58 m^2/s and occurred at 686 s (t_{60}), therefore, the $SMOGRA_{RC}$ for the *Glasbord FPAUS* as tested is 6.68 m^2/s^2 based on the following formula:

$$\mathrm{SMOGRA_{RC}} = \frac{1000 \times R_{60}}{t_{60}}$$

6.0 TEST RESULTS

Testing was conducted at SwRI's Fire Technology Department located in San Antonio, Texas on February 26, 2019. The test room and building were approximately 22 °C (72 °F) and 67% relative humidity prior to the test. Section 12.2.5 of AS ISO 9705 states that the test should be ended if flashover occurs, which is defined as a combined heat release rate in excess of 1,000 kW at any point during the test. Due to flashover conditions, the test was stopped at 12 min, and the room extinguished. Selected photographic documentation is provided in Appendix A. The test results are summarized in Appendix B, and visual observations can be found in Appendix C. Video of the test will be provided electronically.

APPENDIX A

INSTALLATION, TEST, AND POST-TEST PHOTOGRAPHS

(CONSISTING OF 5 PAGES)

Figure A-1. Room Construction. Gypsum prior to Sample Installation.

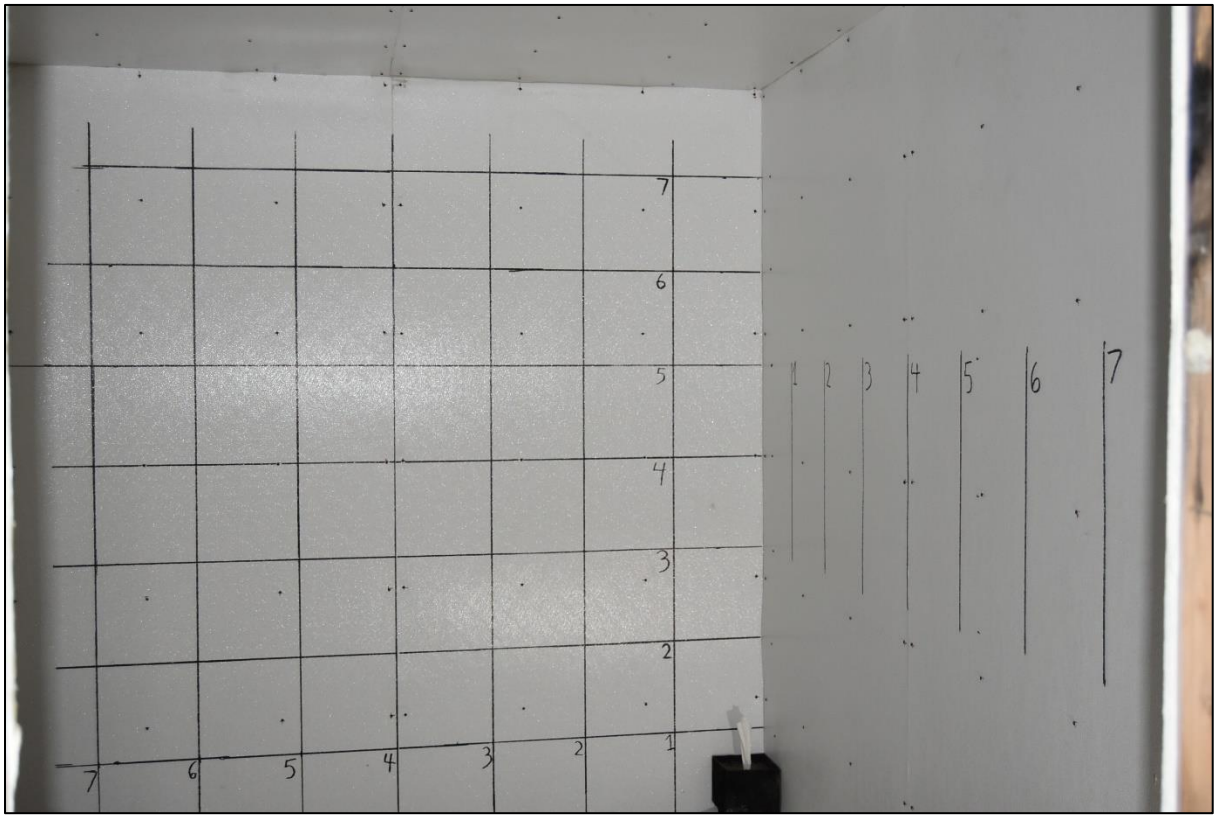


Figure A-2. Pre-Test View of Room.

Figure A-3. Pre-Test View of Ceiling.

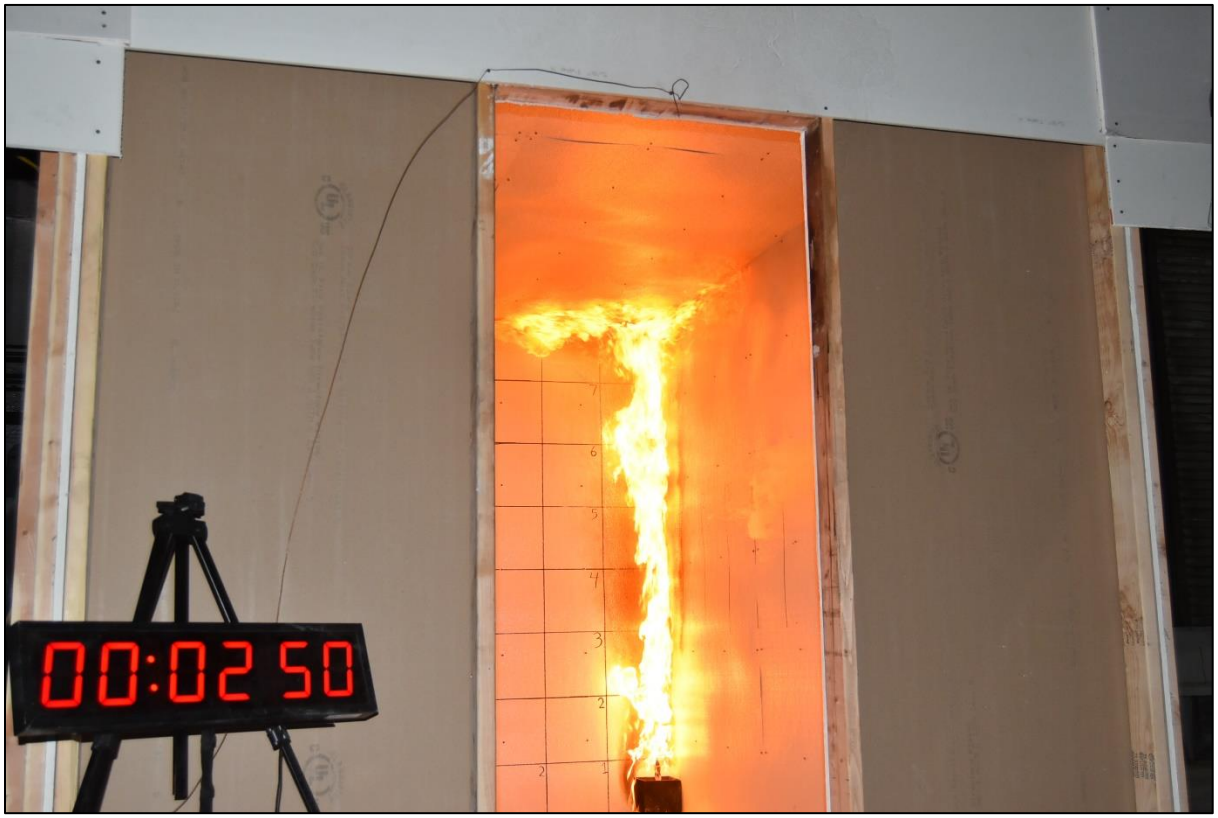


Figure A-4. Test at 2 min 50 s, Burner Output of 100 kW.

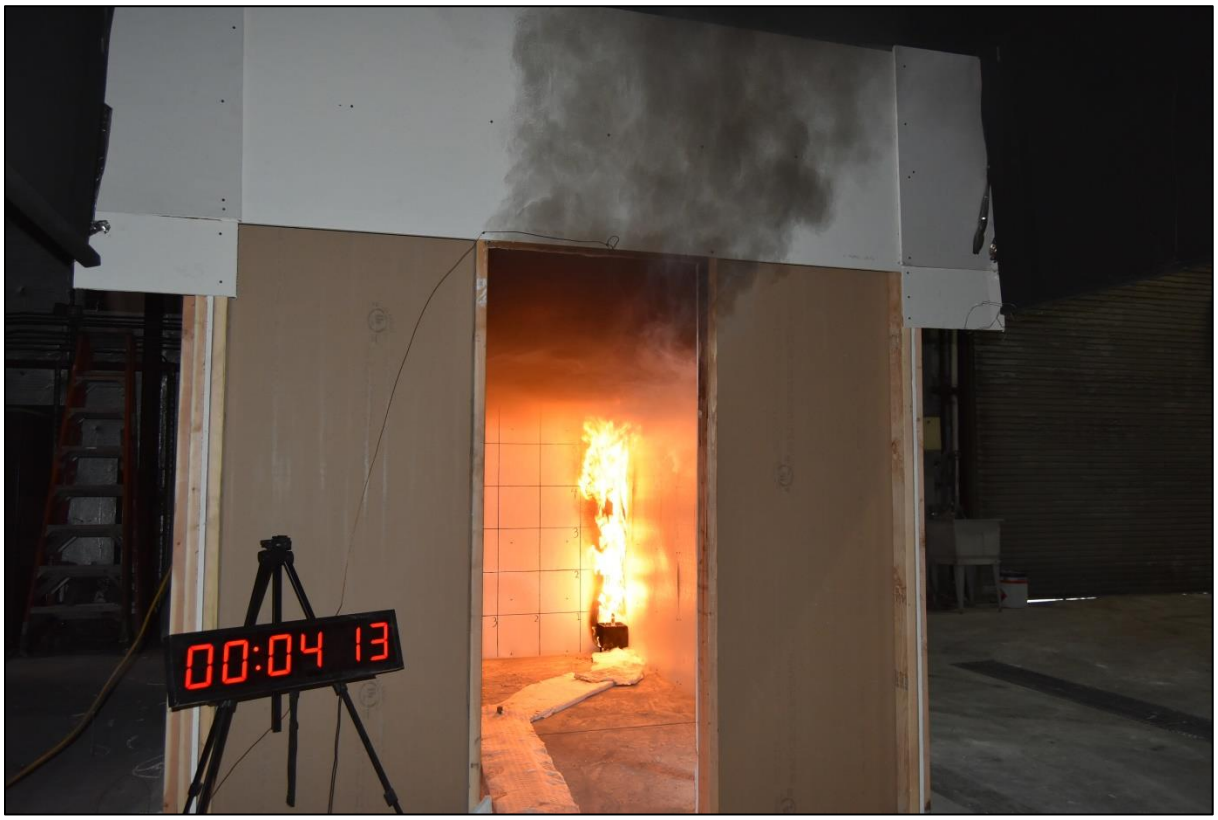


Figure A-5. Test at 4 min 13 s, Burner Output of 100 kW.

Figure A-6. Test at 9 min 2 s, Burner Output of 100 kW.

Figure A-7. Test at 10 min 21 s, Burner Output of 300 kW.

Figure A-8. Test at 11 min 36 s, Burner Output of 300 kW.

Figure A-9. Test at 12 min 6 s, Burner Output of 300 kW. Flashover Conditions.

Figure A-10. Post-Test View of Room.

APPENDIX B

TEST DATA

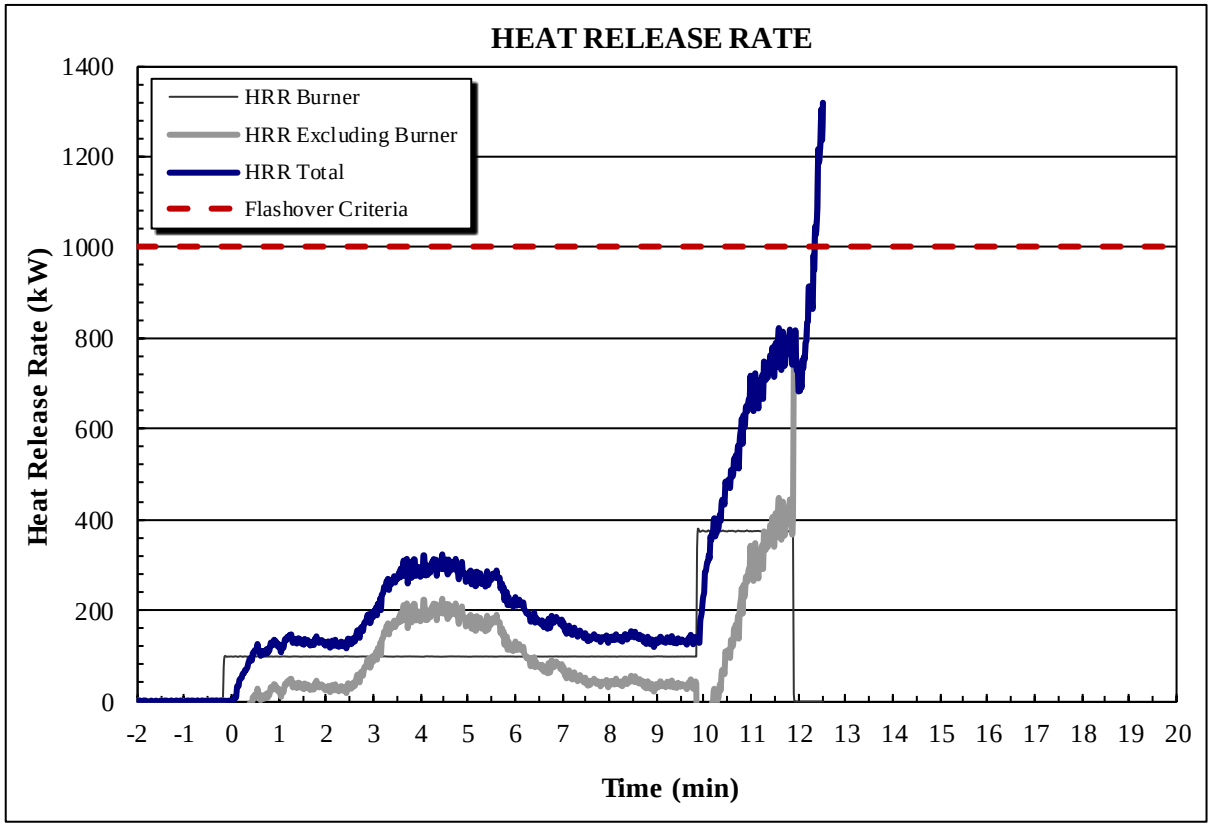
(CONSISTING OF 6 PAGES)

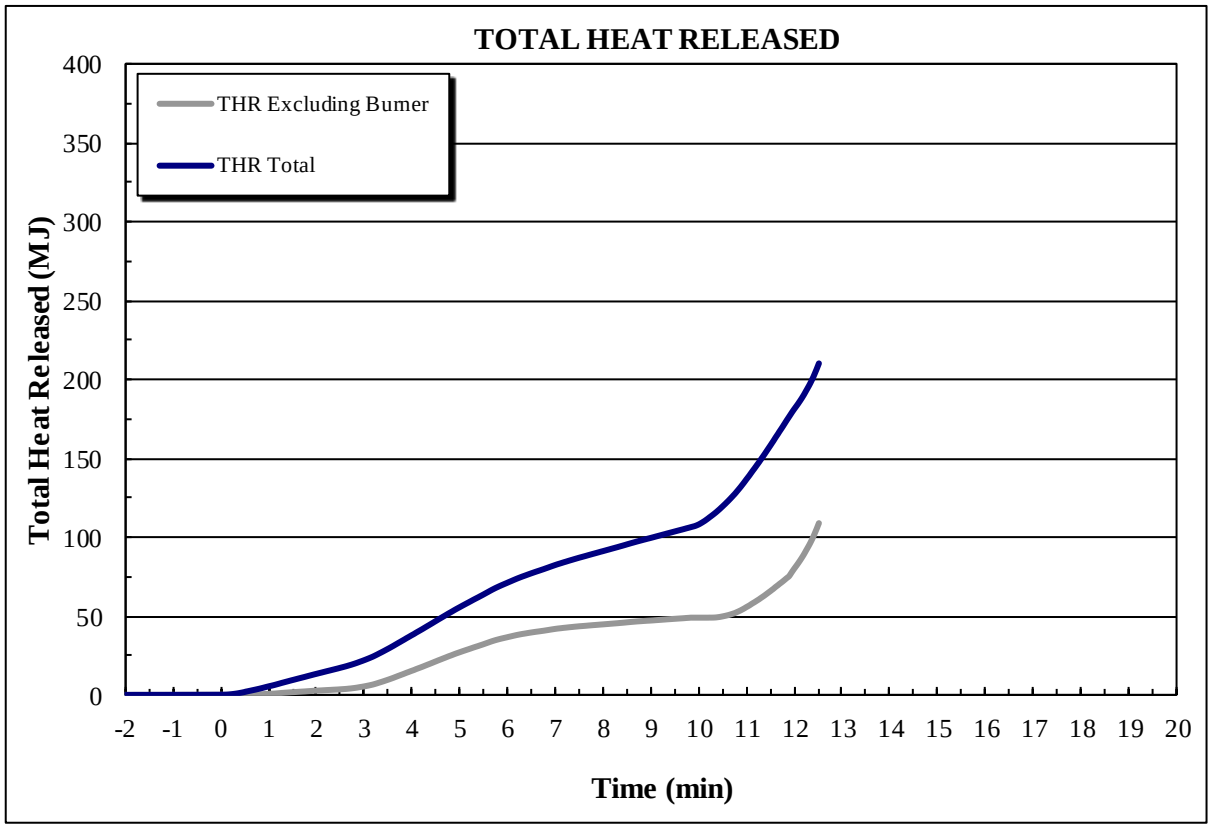
SUMMARY OF

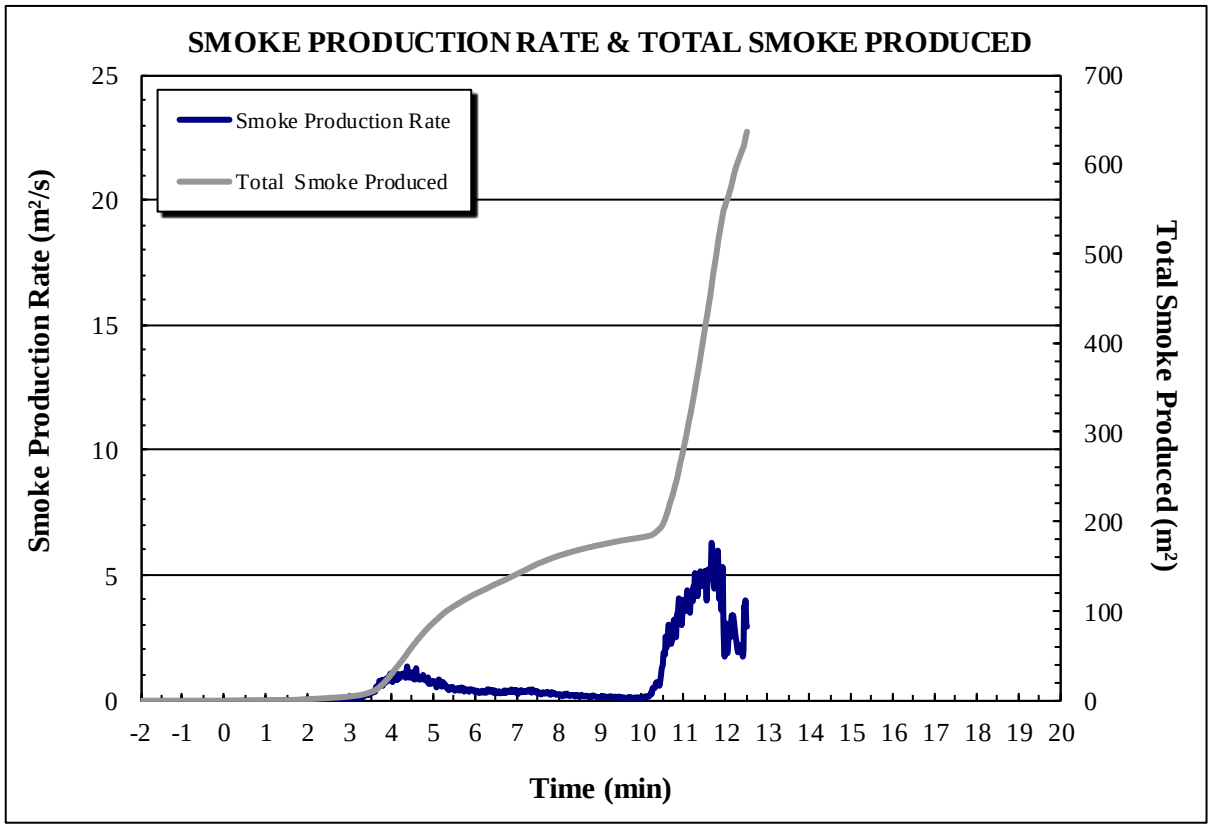
AS 9705 TEST RESULTS

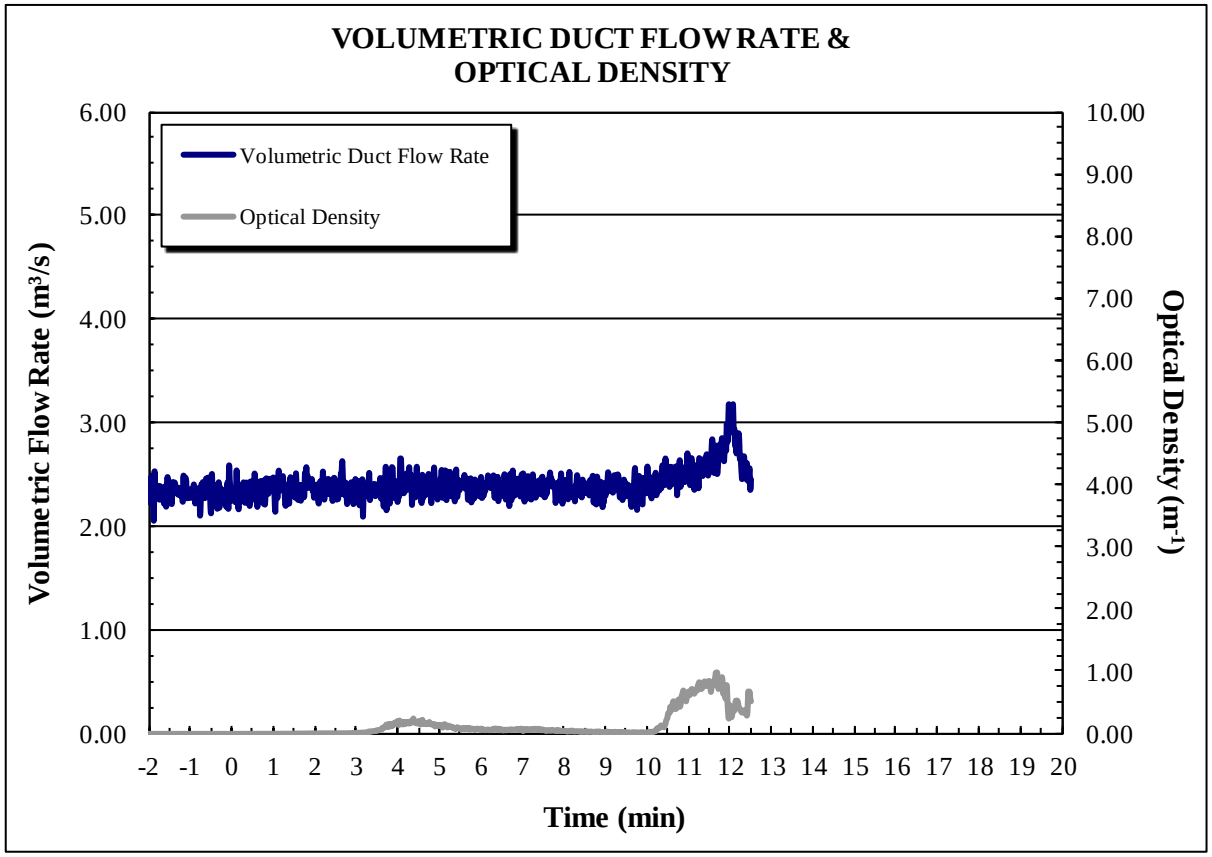
Material: ***Glasboard FPAUS***

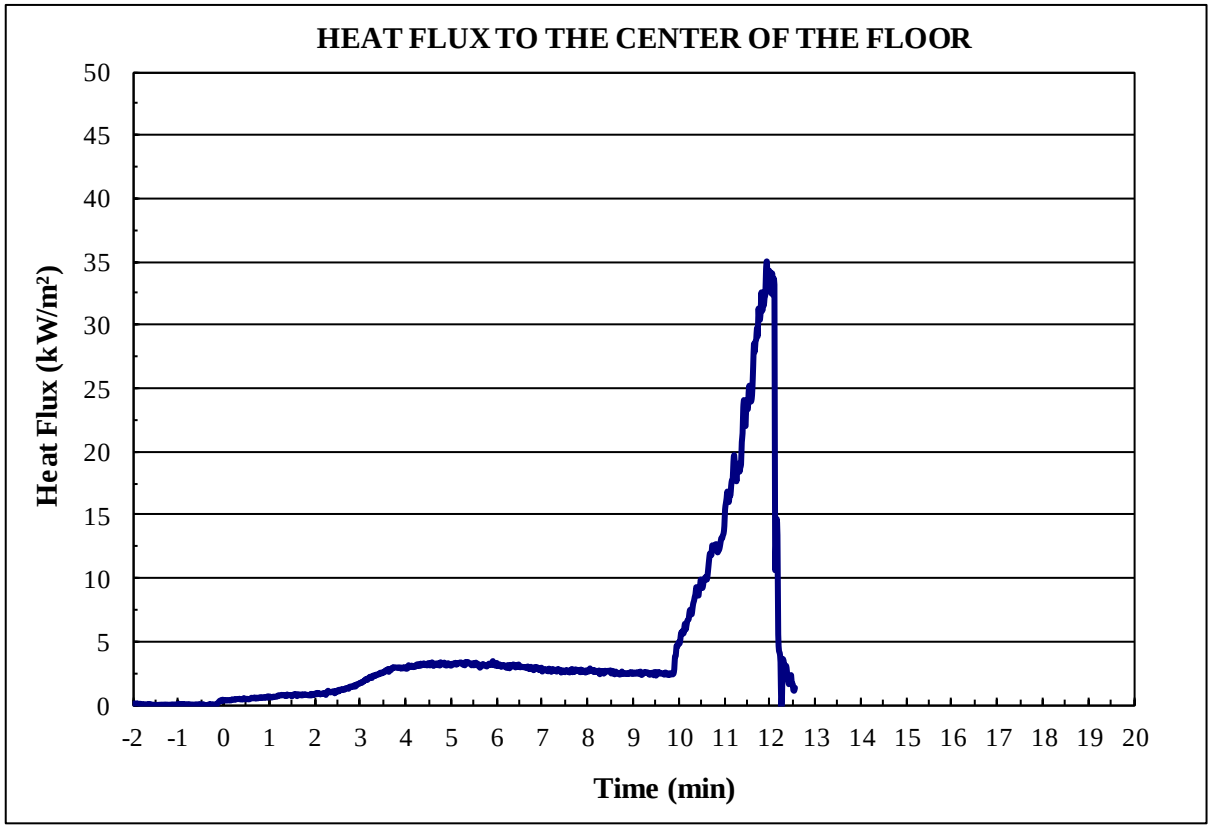
Maximum HRR_{total}	1318 kW	at	12 min 32 s
Average HRR_{total}	318 kW		
Total Heat Released	210 MJ		
Maximum $HRR_{excl.\ burner}$	1318 kW	at	12 min 32 s
Maximum $HRR_{excl.\ burner,\ 30\ sec}$	967 kW		
Average $HRR_{excl.\ burner}$	166 kW		
Total Heat Released (Excluding Burner)	109 MJ		
Maximum Smoke Production Rate	6.27 m²/s	at	11 min 41 s
Maximum Smoke Production Rate $_{60\ sec}$	4.58 m²/s	at	11 min 26 s
Average Smoke Production Rate	0.96 m²/s		
Total Smoke Released	636 m²		
Maximum Optical Density	0.99 1/m	at	11 min 43 s
Exhaust Duct Flow at Maximum O.D.	2.51 m³/s		
Average Optical Density	0.124 1/m		
Average Volumetric Duct Flow Rate	2.40 m³/s		
Maximum Heat Flux to the Floor	35.1 kW/m²	at	11 min 55 s
Max Average Ceiling Temperature	357 °C 675 °F	at	12 min 7 s
Maximum Doorway Temperature	564 °C 1048 °F	at	12 min 6 s
Maximum CO Production Rate	10.15×10^{-3} m³/s	at	12 min 30 s
Maximum CO Release Rate	11.62 g/s		
Maximum CO_2 Production Rate	0.075 m³/s	at	12 min 30 s
Maximum CO_2 Release Rate	135 g/s		

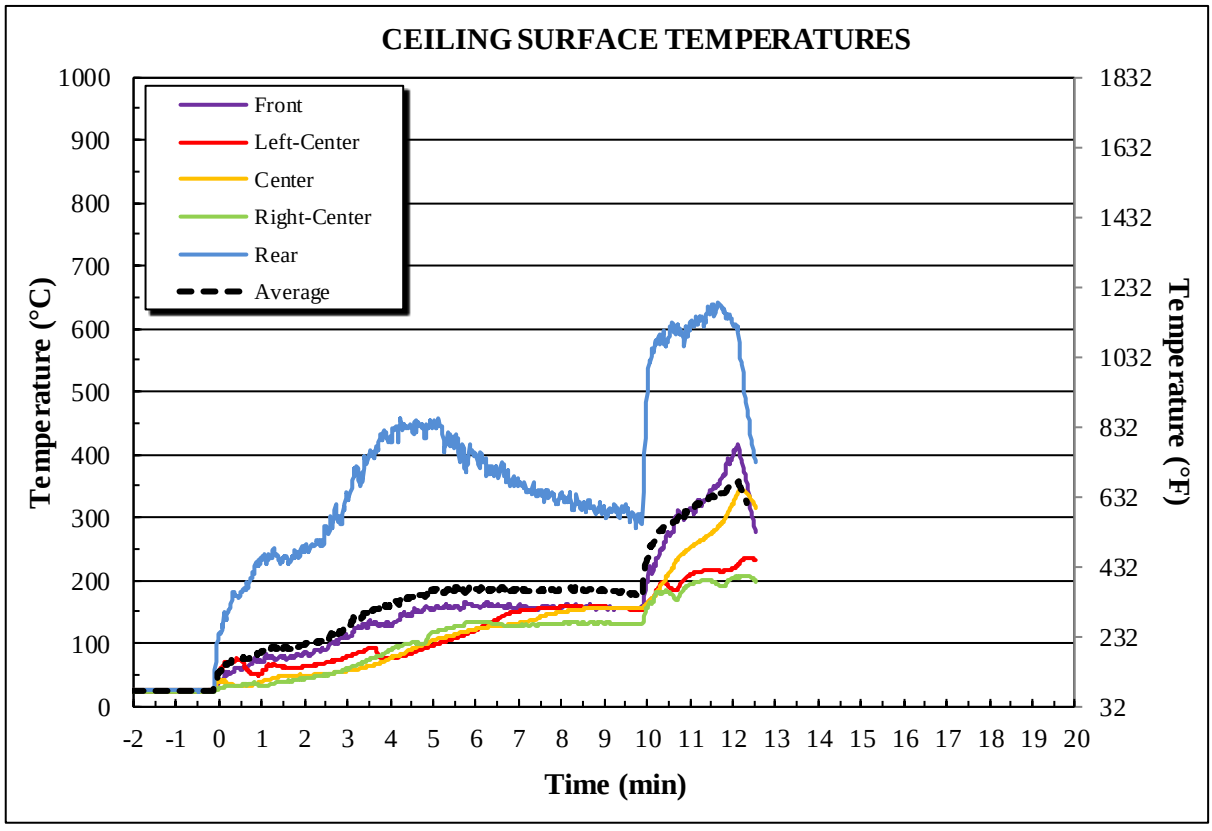

HEAT RELEASE RATE
HRR Burner
HRR Excluding Burner
HRR Total
Flashover Criteria
Heat Release Rate (kW)
1400
1200
1000
800
600
400
200
0
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time (min)

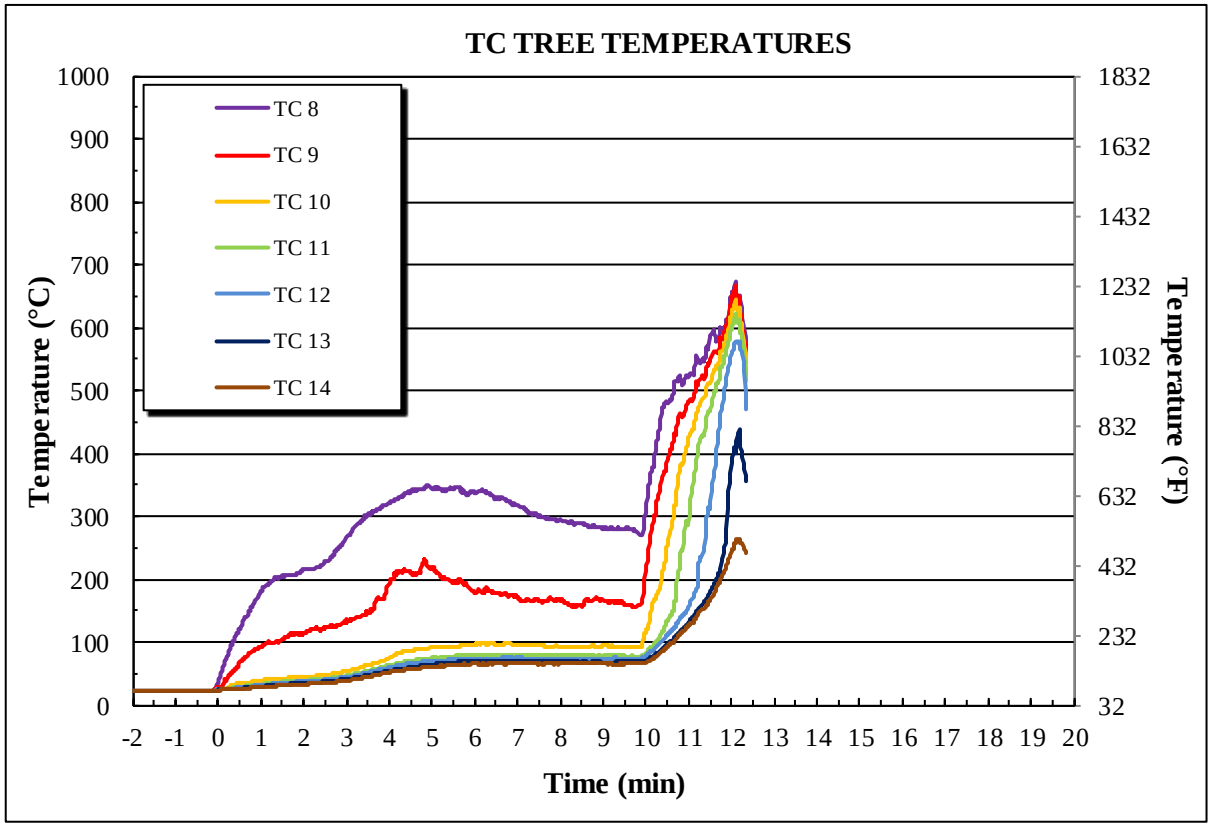

TOTAL HEAT RELEASED
THR Excluding Burner
THR Total
Total Heat Released (MJ)
400
350
300
250
200
150
100
50
0
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time (min)

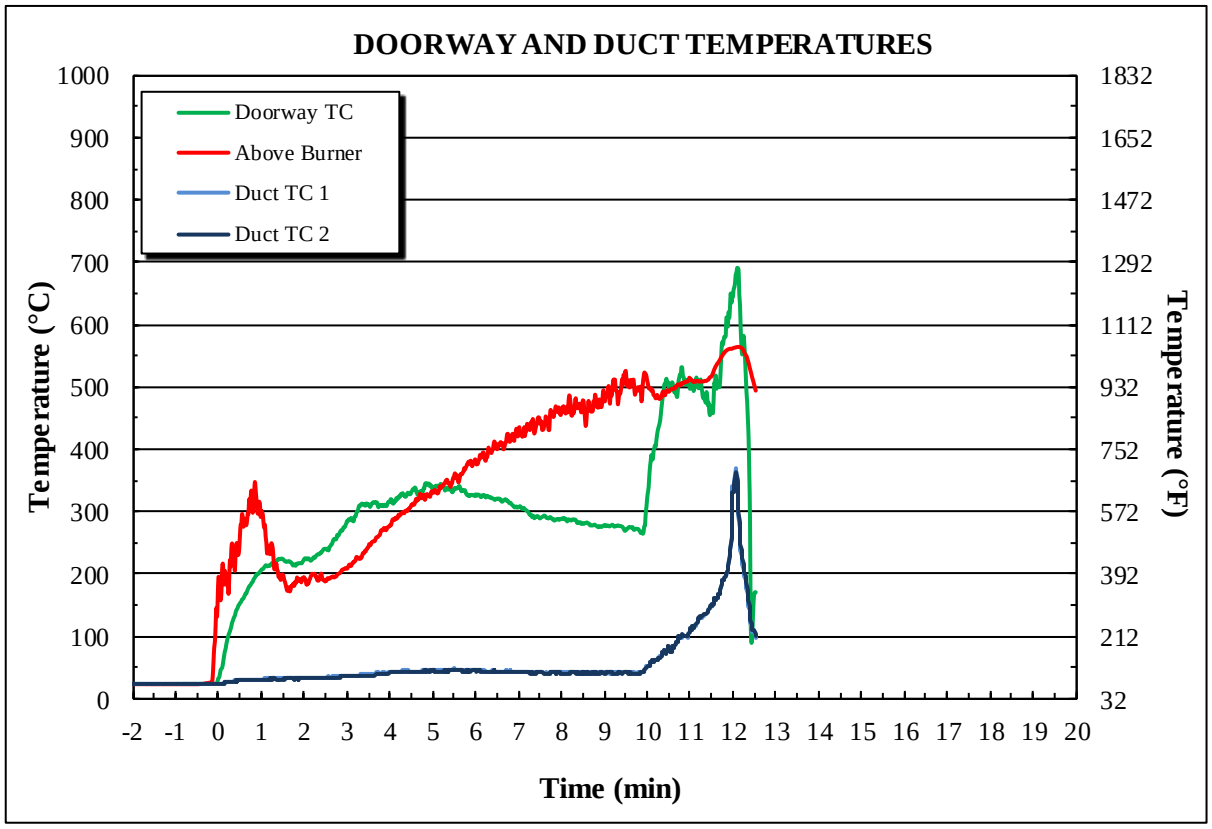

SMOKE PRODUCTION RATE & TOTAL SMOKE PRODUCED
Smoke Production Rate
Total Smoke Produced
Smoke Production Rate (m²/s)
Total Smoke Produced (m²)
Time (min)
0
5
10
15
20
25
0
100
200
300
400
500
600
700
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

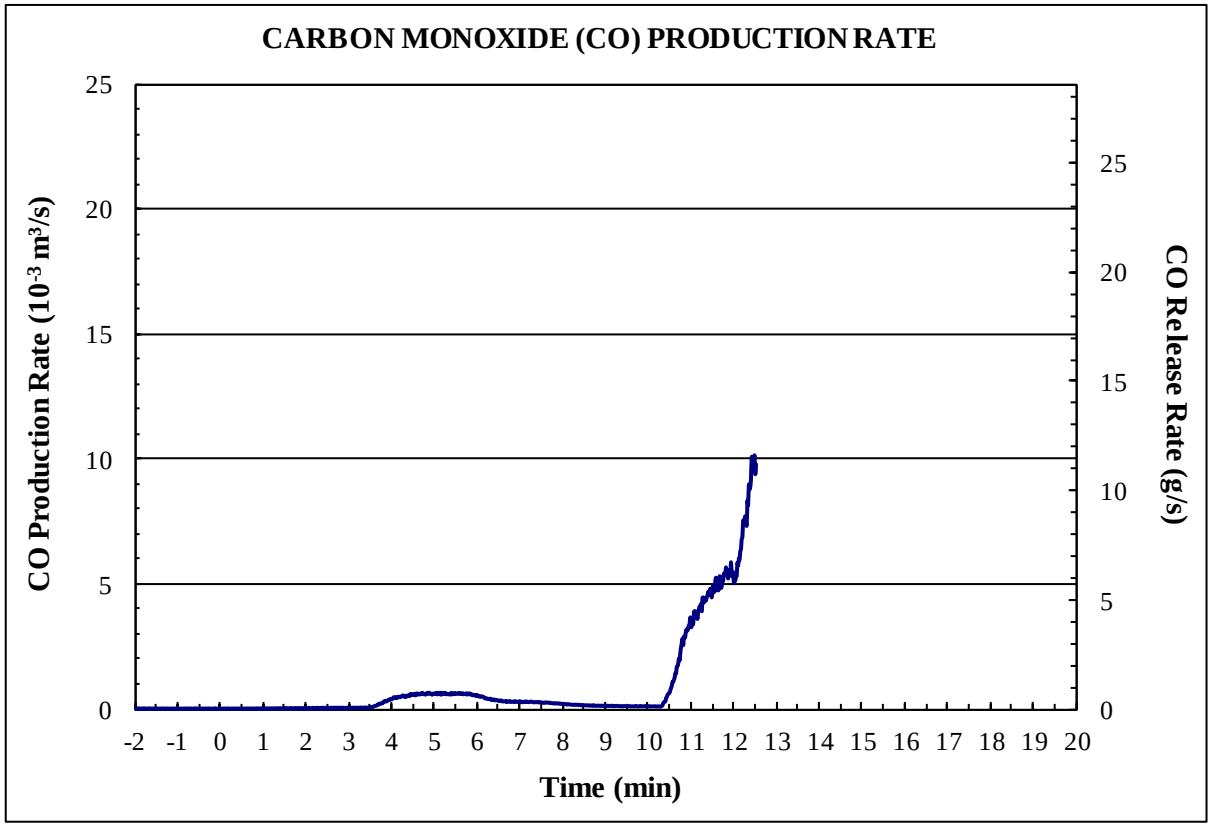

VOLUMETRIC DUCT FLOW RATE &
OPTICAL DENSITY
Volumetric Duct Flow Rate
Optical Density
Volumetric Flow Rate (m³/s)
Optical Density (m⁻¹)
Time (min)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

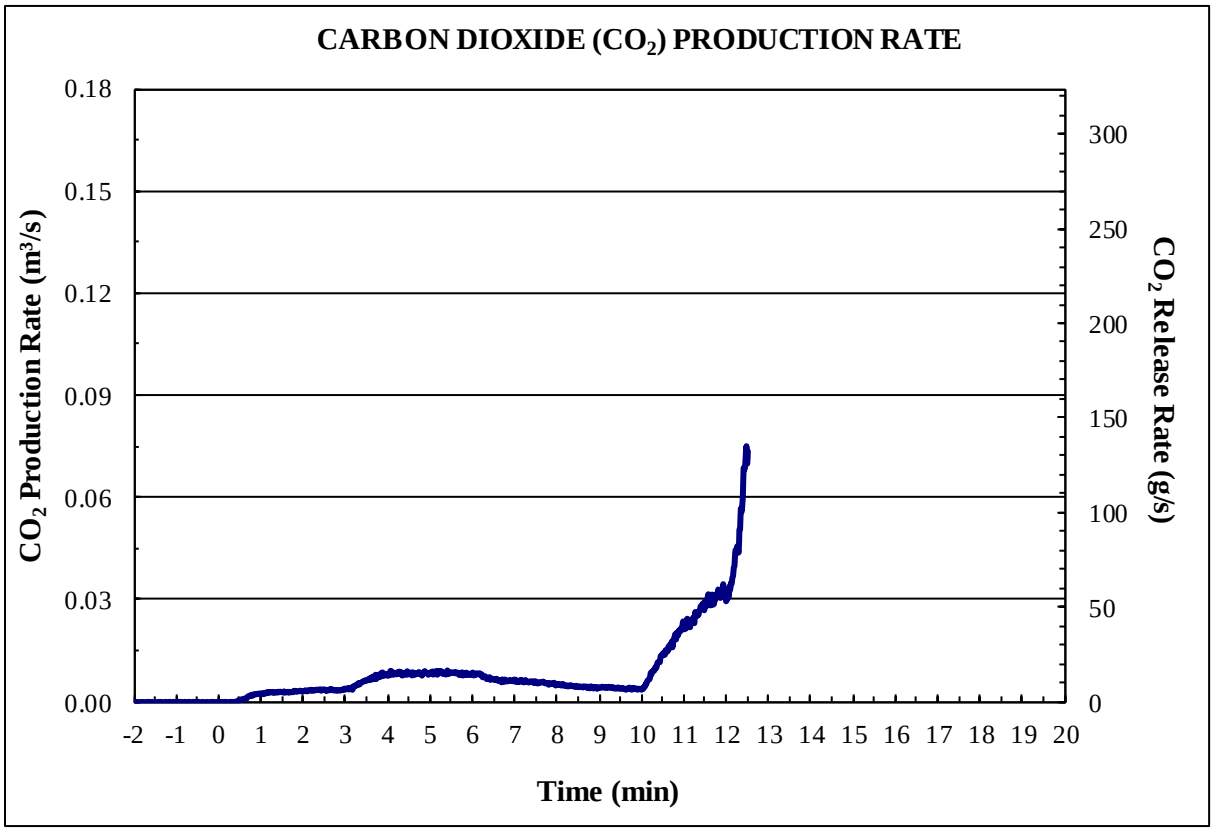

HEAT FLUX TO THE CENTER OF THE FLOOR
Heat Flux (kW/m²)
50
45
40
35
30
25
20
15
10
5
0
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time (min)


CEILING SURFACE TEMPERATURES
Front
Left-Center
Center
Right-Center
Rear
Average
Temperature (°C)
1000
900
800
700
600
500
400
300
200
100
0
Temperature (°F)
1832
1632
1432
1232
1032
832
632
432
232
32
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time (min)


TC TREE TEMPERATURES
TC 8
TC 9
TC 10
TC 11
TC 12
TC 13
TC 14
Temperature (°C)
Temperature (°F)
Time (min)
1000
900
800
700
600
500
400
300
200
100
0
1832
1632
1432
1232
1032
832
632
432
232
32
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20


DOORWAY AND DUCT TEMPERATURES
Doorway TC
Above Burner
Duct TC 1
Duct TC 2
Temperature (°C)
Temperature (°F)
Time (min)
1000
900
800
700
600
500
400
300
200
100
0
1832
1652
1472
1292
1112
932
752
572
392
212
32
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20


CARBON MONOXIDE (CO) PRODUCTION RATE
CO Production Rate (10^{-3} m^3/s)
CO Release Rate (g/s)
Time (min)
0
5
10
15
20
25
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20


CARBON DIOXIDE (CO_2) PRODUCTION RATE
CO_2 Production Rate (m^3/s)
CO_2 Release Rate (g/s)
Time (min)
0.00
0.03
0.06
0.09
0.12
0.15
0.18
0
50
100
150
200
250
300
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

APPENDIX C

VISUAL OBSERVATIONS

(CONSISTING OF 1 PAGE)

Table C-1. Visual Observations.

Time (min:s)	Observation
-02:00	Pre-test baseline.
00:00	**Start of test. Burner located in the right, rear corner. Burner set at 100 kW.**
00:32	Flames from the burner reach the ceiling and spread 1–2 ft.
01:00	Smoke is escaping from the seams between the samples.
01:46	Light smoke is coming from the room.
02:48	Ignition of the ceiling in the area of the burner impingement.
03:10	Flames from the burner reach the ceiling and spread 4–5 ft.
03:32	Darker smoke layer is forming 6 ft from the floor.
04:00	Smoke layer thickens and descends to 5 ft.
05:14	Ignition of the right wall.
05:35	Flames tips on the ceiling reach the left wall.
06:00	Smoke layer has somewhat dissipated.
08:00	Burning only along the charred edges in a “V” area around the burner corner.
09:30	Very little active burner on the walls.
10:00	Burner increased to 300 kW.
10:30	Flames hit the ceiling and spread 6–8 ft across the ceiling.
10:55	Smoke layer had formed at 5 ft.
11:06	Ignition of the read and right side walls at a height of 5 ft.
11:30	Smoke layer has descended to 4 ft.
11:42	Flames exiting the doorway.
12:00	Flashover conditions are present. Burner turned off.
12:23	Test Ended. Room extinguished.