U. S. Department of Justice

Fire Research Laboratory
BUREAU OF ALCOHOL, TOBACCO, FIREARMS AND EXPLOSIVES
6000 Ammendale Road
Beltsville, MD 20705-1250
Phone: 202-648-6200

Project Record

ANAB ISO/IEC 17025:2017
Accredited Forensic Testing Laboratory

Title	Contribution of paint to fire size		
Test Type	Custom		
Lab Number	18FR0006-2	**Author**	
Test dates	8/28/18, 8/30/18	**No. Tests**	2

Introduction

Two experiments were conducted to investigate the contribution of oil based paint to fire size in a two-story structure. The fire was initiated by applying an open flame to standard ignition packages located on top of two upholstered sofas inside the structure. The experiments were documented using thermocouples, heat flux transducers, bi-directional velocity probes, the 4 MW Fire Products Collector (FPC), digital photographs, and video cameras. The test program was conducted in the Medium Burn Room (MBR) of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), Fire Research Laboratory (FRL) in Beltsville, MD.

Table of Contents

NOTE: All dimensional measurements were taken in English units and were later converted to metric units. Any inconsistencies between the two units are due to rounding errors when the English units were converted to metric.

Test Set Up

Tests were conducted inside a two story wood framed structure. A single structure was built with a dividing wall in the middle that created two individual test cells. The test cells were constructed with the same layout and furnished identically. Figure 1, Figure 2 and Figure 3 show photos of the front, side and rear views, respectively.

Figure 1: Structure front side view (294927_1017777.jpg)

Figure 2: Structure side view (294927_1017785.jpg)

Figure 3: Structure rear view (294927_1017783.jpg)

Each test cell was two stories tall, with rooms stacked atop one another and adjacent to an open stairwell on the rear side. The rooms were 2.4 m wide x 4.9 m long (8 ft. x 16 ft.) with 2.4 m (8 ft.) ceilings. The stairwell was 2.4 m wide x 2.4 m long (8 ft. x 8 ft.) and had a 5.2 m (17 ft.) ceiling height. Figure 4 shows a plan view of the ground floor of the test cell. The second floor had the same plan, with the exception that there was no exterior (rear) access to the stairwell.

Each room had a 1.8 m wide x 2.1 m tall (6 ft. x 7 ft.) opening to the exterior (front) and a 0.9 m wide x 2.1 m tall (3 ft. x 7 ft.) opening to the stairwell. The stairwell had a 0.9 m x 2.1 m (3 ft. x 7 ft.) opening to the exterior at ground level. Figure 5 shows an elevation view of one side of the structure.

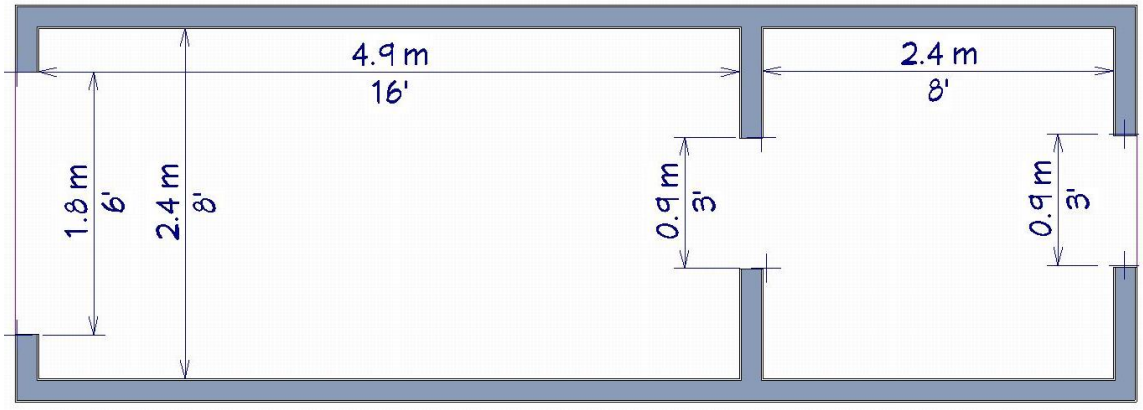

Figure 4: Ground floor plan view

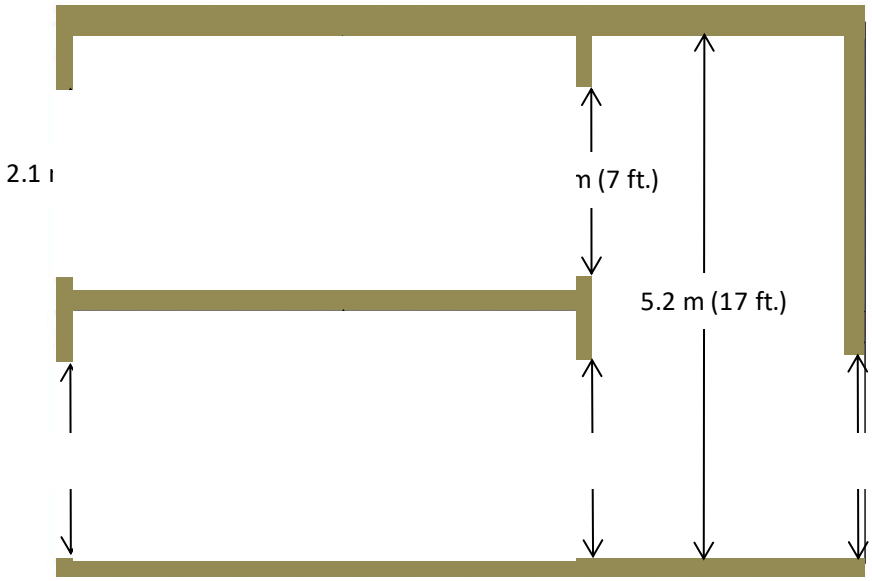

Figure 5: Elevation view

Two experiments were conducted. Table 1 identifies the Test ID that is associated with each individual experiment.

Table 1: Test ID Summary

Experiment	Test ID
1	294927
2	294945

Construction Details

Walls

The walls were framed using 2x6 dimensional lumber, with the wall studs spaced 0.41 m (16 inch) on center. The interior sides were sheathed with one layer of 1.6 cm (5/8 inch) gypsum wallboard. The seams were sealed with gypsum wallboard tape and joint compound. Portions of the exterior surfaces were sheathed in one layer of 1.6 cm (5/8 inch) plywood.

Ceiling

The 1st (ground) and 2nd story ceilings were framed using 25 cm (10 inch) engineered wood I-beams spaced 0.41 m (16 inch) on center. The interior side of the ceilings were sheathed with one layer of 1.6 cm (5/8 inch) thick gypsum wallboard. The seams were sealed with gypsum wallboard tape and joint compound.

Floor

The 1st story floor consisted of one layer of 1.6 cm (5/8 inch) thick gypsum wallboard, which was laid directly on the MBR concrete floor.

The 2nd story floor consisted of one layer of 1.6 cm (5/8 inch) plywood, which was on top of the engineered I-beams. One layer of 1.6 cm (5/8 inch) thick gypsum wallboard, was laid directly on the plywood.

View Ports

View ports were added to the exterior side walls of each test cell. The viewports were created using square 0.3 cm (0.125 in) thick sections of fireplace glass measuring 30 cm (12 in) on a side. Six ports were added to each test cell – two in each room and two in the stairwell. These can be seen in Figure 2.

Paint Details

The interior walls and ceiling of each test cell were coated in paint. One side of the structure was coated in a single layer of latex paint (Sherwin Williams Painters Edge Interior Latex Flat, Extra White, Product Number PE3000451). The other side of the structure was coated in six (6) layers of oil based paint (Sherwin Williams Pro Industrial Urethane Alkyd Enamel, Extra White, Product Number B54W151).

Furnishings

The only furnishings placed inside each test cell were two sofas (IKEA Ektorp, Article number 891.292.07, See FireTOSS Experiment ID 183492). Figure 6 shows a photo of one of the sofas.

Figure 6: Sofa (294927_1017834.jpg)

The sofas were positioned adjacent to each other against the interior wall in the first floor room. The sofas were approximately 218 cm (86 in) wide and 88 cm (35 in) deep. The rear sofa abutted the wall adjacent to the open stairwell, as shown in Figure 7.

Figure 7: Sofa position (294945_1018429.jpg)

Experiment Details

Fuel Details

Two FRL standard ignition packages were used in each experiment. Each ignition package consisted of a roll of gauze placed inside a small plastic bag. Approximately 250 ml (8.5 fl. oz.) gasoline was poured into the bag and the bag was sealed. Figure 8-Figure 9 show this procedure.

Figure 8: Adding gasoline to ignition package (294927_1017873.jpg)

Figure 9: Sealing ignition package (294927_1017881.jpg)

Ignition Details

The ignition packages were placed near the center of the sofas and ignited using the open flame from a propane torch, as shown in Figure 10.

Figure 10: Ignition procedure (294945_1018456.jpg)

Test Procedures

The same general procedure was used in each experiment. After ignition, the fire was allowed to progress for approximately 17 minutes before suppression was initiated with a hand held hose line.

In experiment 1 (Test ID 294927), the test cell coated with a single layer of latex paint was used. In experiment 2 (Test ID 294945), the test cell coated with six layers of oil based paint was used.

Instrumentation

Instrumentation used in the test series included thermocouples, heat flux transducers, bi-directional pressure probes and the 4 MW Fire Products Collector (FPC). Figure 11 shows the location of the thermocouples, heat flux transducers and bi-directional probes.

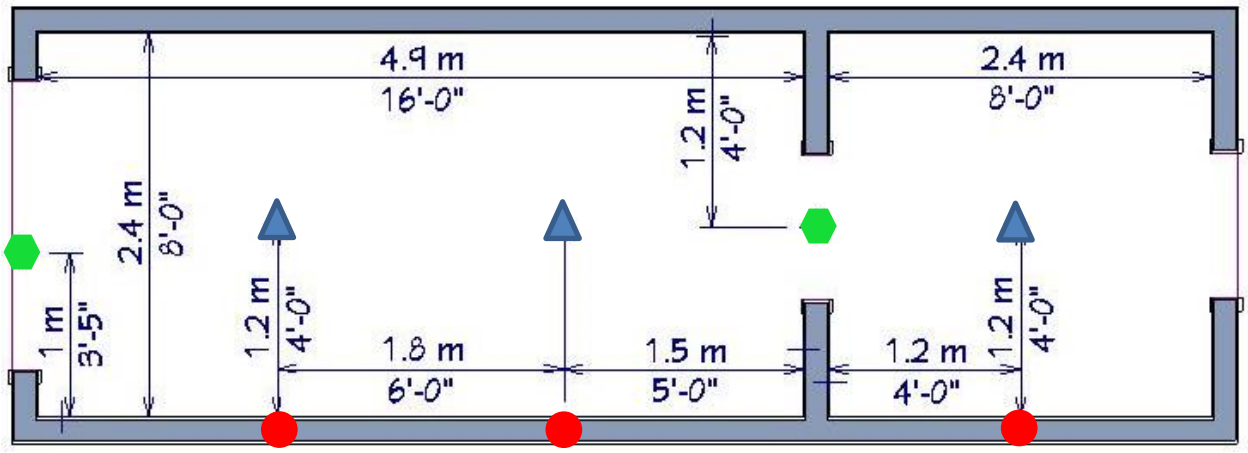

Figure 11: Instrument locations

Thermocouple Bi-directional probe Heat flux gauge

Each thermocouple location represents a tree that included sensors spaced at 0.3 m (12 inch) intervals from floor to ceiling. This resulted in nine sensors on each tree in the rooms, and 18 on the tree in the stairwell. Thermocouple elevations recorded on the FireTOSS data sheet are relative to the floor of their respective location.

Each bi-directional probe location represents a vertical array of three probes. The low, middle and high positions were located approximately 46 cm (18 in), 107 cm (42 in) and 168 cm (66 in) above the floor, respectively. The probes were mounted horizontally, to align with the primary flow direction. A thermocouple was positioned with each bi-directional probe location.

The probes were mounted to the walls on the interior side of the doorways. Due to limitations in length, the probes near the large doorway (to the left in Figure 11) did not

reach the middle of the opening. Bi-directional probe elevations recorded on the FireTOSS data sheet are relative to the floor of their respective location.

Heat flux transducers were mounted in the exterior wall of each test cell. The transducers were mounted such that the sensor elements were approximately 1.2 m (4 ft.) above the floor and were flush with the interior surface of the walls. The exception to this was the high sensor in the open stairwell which was mounted along the same horizontal line the ones in the 2nd floor room. Heat flux transducer elevations recorded on the FireTOSS data sheet are relative to the floor of their respective location.

Laboratory Conditions

The ambient laboratory temperature, barometric pressure, and relative humidity were measured during the experiment(s). The laboratory conditions were measured using an industrial probe and microserver. The probe measures the ambient conditions using capacitive digital sensors. The sensor probe has surface mounted circuitry that responds to changes in the environment and outputs a digital signal. The Laboratory Conditions were measured in accordance with the method defined in FRL Laboratory Instruction "LI017 Laboratory Conditions" [1].

The following table provides a description of the instrumentation used to collect the ambient laboratory conditions measurements during the experiments.

Table 2. Lab Conditions Description

Description	Manufacturer	Model
MBR_01	OMEGA	IBTHX-D

Thermocouples

Thermocouples are temperature measurement sensors that consist of two dissimilar metals joined at one end (a junction) that produces a small thermo-electrical voltage when the wire is heated. The change in voltage is interpreted as a change in temperature [2]. There are many configurations of thermocouples which affect the temperature range, ruggedness, and response time. The information required to identify these factors for the thermocouples that were used during the experiment(s) conducted for this test series is provided in the "Thermocouple Measurement Description" table. Thermocouples used during this test series were used in accordance with the method defined in FRL laboratory instruction "LI001 Thermocouple" [3].

The following table provides a description of the instrumentation used to collect the temperature measurements during the experiments. The "Description" column describes the location of the temperature measurement. The "Z" location is the height of the thermocouple above the floor. The "Thermocouple Type" describes the characteristics of the thermocouple used.

Table 3. Thermocouple Measurement Description

Description	Z (m)	Thermocouple type
Stairs 0	0.000	Type K, Glass Ins., 24 AWG wire
Stairs 1	0.300	Type K, Glass Ins., 24 AWG wire
Stairs 2	0.600	Type K, Glass Ins., 24 AWG wire
Stairs 3	0.900	Type K, Glass Ins., 24 AWG wire
Stairs 4	1.200	Type K, Glass Ins., 24 AWG wire
Stairs 5	1.500	Type K, Glass Ins., 24 AWG wire
Stairs 6	1.800	Type K, Glass Ins., 24 AWG wire
Stairs 7	2.100	Type K, Glass Ins., 24 AWG wire
Stairs 8	2.400	Type K, Glass Ins., 24 AWG wire
Stairs 9	2.700	Type K, Glass Ins., 24 AWG wire
Stairs 10	3.000	Type K, Glass Ins., 24 AWG wire
Stairs 11	3.300	Type K, Glass Ins., 24 AWG wire
Stairs 12	3.600	Type K, Glass Ins., 24 AWG wire
Stairs 13	3.900	Type K, Glass Ins., 24 AWG wire
Stairs 14	4.200	Type K, Glass Ins., 24 AWG wire
Stairs 15	4.500	Type K, Glass Ins., 24 AWG wire
Stairs 16	4.800	Type K, Glass Ins., 24 AWG wire
Stairs 17	5.200	Type K, Glass Ins., 24 AWG wire
1st floor rear 0	0.000	Type K, Glass Ins., 24 AWG wire
1st floor rear 1	0.300	Type K, Glass Ins., 24 AWG wire
1st floor rear 2	0.600	Type K, Glass Ins., 24 AWG wire
1st floor rear 3	0.900	Type K, Glass Ins., 24 AWG wire
1st floor rear 4	1.200	Type K, Glass Ins., 24 AWG wire
1st floor rear 5	1.500	Type K, Glass Ins., 24 AWG wire
1st floor rear 6	1.800	Type K, Glass Ins., 24 AWG wire
1st floor rear 7	2.100	Type K, Glass Ins., 24 AWG wire
1st floor rear 8	2.400	Type K, Glass Ins., 24 AWG wire
1st floor front 0	0.000	Type K, Glass Ins., 24 AWG wire
1st floor front 1	0.300	Type K, Glass Ins., 24 AWG wire
1st floor front 2	0.600	Type K, Glass Ins., 24 AWG wire
1st floor front 3	0.900	Type K, Glass Ins., 24 AWG wire
1st floor front 4	1.200	Type K, Glass Ins., 24 AWG wire
1st floor front 5	1.500	Type K, Glass Ins., 24 AWG wire
1st floor front 6	1.800	Type K, Glass Ins., 24 AWG wire
1st floor front 7	2.100	Type K, Glass Ins., 24 AWG wire
1st floor front 8	2.400	Type K, Glass Ins., 24 AWG wire
2nd floor rear 0	0.000	Type K, Glass Ins., 24 AWG wire
2nd floor rear 1	0.300	Type K, Glass Ins., 24 AWG wire
2nd floor rear 2	0.600	Type K, Glass Ins., 24 AWG wire
2nd floor rear 3	0.900	Type K, Glass Ins., 24 AWG wire
2nd floor rear 4	1.200	Type K, Glass Ins., 24 AWG wire
2nd floor rear 5	1.500	Type K, Glass Ins., 24 AWG wire
2nd floor rear 6	1.800	Type K, Glass Ins., 24 AWG wire
2nd floor rear 7	2.100	Type K, Glass Ins., 24 AWG wire
2nd floor rear 8	2.400	Type K, Glass Ins., 24 AWG wire
2nd floor front 0	0.000	Type K, Glass Ins., 24 AWG wire
2nd floor front 1	0.300	Type K, Glass Ins., 24 AWG wire
2nd floor front 2	0.600	Type K, Glass Ins., 24 AWG wire
2nd floor front 3	0.900	Type K, Glass Ins., 24 AWG wire
2nd floor front 4	1.200	Type K, Glass Ins., 24 AWG wire
2nd floor front 5	1.500	Type K, Glass Ins., 24 AWG wire
2nd floor front 6	1.800	Type K, Glass Ins., 24 AWG wire

Description	Z (m)	Thermocouple type
2nd floor front 7	2.100	Type K, Glass Ins., 24 AWG wire
2nd floor front 8	2.400	Type K, Glass Ins., 24 AWG wire

Velocity

Velocity is commonly measured by application of the principal of conservation of mechanical energy through conservation of fluid velocity to pressure (head). If the fluid is forced to change its velocity a change in pressure will occur [4]. Bernoulli's equation [5] uses differential pressure and density measurements of a fluid to calculate the fluid's velocity. Differential pressure is the difference between the dynamic and static pressure measurements of the fluid and is measured using a differential pressure probe and differential pressure transducer. The density of the fluid is typically calculated from the fluid temperature.

There are various types of differential pressure and temperature probes that can be used to record the measurements necessary to calculate a fluid's velocity. The characteristics of the various types of pressure and temperature probes affect the response and sensitivity of the measurements. The information used to identify these characteristics is provided in the "Velocity Measurement Description" table(s) in the Results section of this report. All devices used to calculate velocity were used in accordance with the method defined in FRL laboratory instruction LI009 "External Velocity – Differential Pressure Probes" [6].

The following table provides a description of the instrumentation used to collect velocity measurements during the experiments. Velocity is calculated from pressure and temperature measurements The orientation defines the mounting position of the velocity probe in the form of three numbers representing the i,j,k vector directions. For example an orientation of 1,0,0 would indicate that the velocity probe was mounted such that positive velocity was in the X-axis direction.

Table 4. Velocity Measurement Description

Description	Tree ID	Probe Description	Thermocouple Type	Location Z (m)	Orientation
BP 1st floor rear_top	1	Bidirectional	Type K, Glass Ins., 24 ga wire	0.50	Horizontal
BP 1st floor rear_middle	1	Bidirectional	Type K, Glass Ins., 24 ga wire	1.10	Horizontal
BP 1st floor rear_bottom	1	Bidirectional	Type K, Glass Ins., 24 ga wire	1.70	Horizontal
BP 1st floor front_top	1	Bidirectional	Type K, Glass Ins., 24 ga wire	0.50	Horizontal
BP 1st floor front_middle	1	Bidirectional	Type K, Glass Ins., 24 ga wire	1.10	Horizontal
BP 1st floor front_bottom	1	Bidirectional	Type K, Glass Ins., 24 ga wire	1.70	Horizontal
BP 2nd floor rear_top	2	Bidirectional	Type K, Glass Ins., 24 ga wire	0.50	Horizontal
BP 2nd floor rear_middle	2	Bidirectional	Type K, Glass Ins., 24 ga wire	1.10	Horizontal
BP 2nd floor rear_bottom	2	Bidirectional	Type K, Glass Ins., 24 ga wire	1.70	Horizontal
BP 2nd floor front_top	2	Bidirectional	Type K, Glass Ins., 24 ga wire	0.50	Horizontal
BP 2nd floor front_middle	2	Bidirectional	Type K, Glass Ins., 24 ga wire	1.10	Horizontal
BP 2nd floor front_bottom	2	Bidirectional	Type K, Glass Ins., 24 ga wire	1.70	Horizontal

Heat Flux Transducers

A heat flux transducer is a device that measures the rate of absorbed incident energy, and expresses it on a per unit area basis. The operating principle of the Schmidt-Boelter heat flux transducer(s) used during this test series is based on one-dimensional heat conduction through a solid. Temperature sensors are placed on a thin, thermally conductive sensor element, and applying heat establishes a temperature gradient across the element. The heat flux is proportional to the temperature difference across the element according to Fourier's Law [7].

There are many configurations of heat flux transducers which affect range, size, mode and sensitivity. The information required to identify these factors for the heat flux transducer(s) that were used during the experiment(s) conducted for this test series is provided in the "Heat Flux Measurement Description" table. Heat flux transducers were used in accordance with the method defined in FRL laboratory instruction "LI002 Heat Flux Transducer" [8].

The following table provides a description of the transducer used to collect heat flux measurements during the experiment(s). The "Description" column typically describes the location of the heat flux transducer. Location Z is the distance from the floor to the centerline of the transducer. Orientation of the heat flux transducer is described as either horizontal, vertical, or other. Heat flux mode indicates whether the total heat flux was measured or just the radiation fraction. Heat flux over range is the maximum measured value reported for this transducer.

Table 5. Heat Flux Measurement Description

Description	Z (m)	Orientation	Heat Flux Mode	Heat Flux Over Range (kW/m^2)
1st floor stairs	1.20	Horizontal	Total	225
2nd floor stairs	4.00	Horizontal	Total	225
1st floor rear	1.20	Horizontal	Total	225
1st floor front	1.20	Horizontal	Total	225
2nd floor rear	1.20	Horizontal	Total	225
2nd floor front	1.20	Horizontal	Total	150

Fire Products Collector

A Fire Products Collector (FPC) measures several characteristics of a fire based upon the measured properties of the fire plume. A FPC consists of a collection hood connected to an exhaust duct placed over a fire as shown in Figure 12. The primary fire characteristics calculated from a FPC include heat release rate (HRR), convective heat release rate (CHRR), gas species production, and smoke production. HRR measurements are based on the principle of oxygen consumption calorimetry. CHRR is calculated as the enthalpy rise of gases flowing through the FPC. Gas species production is calculated based on the measured gas concentrations flowing through the FPC. Smoke production is quantified based on optical smoke measurements, which measure the attenuation of light as it passes through the smoke and fire gases in the FPC.

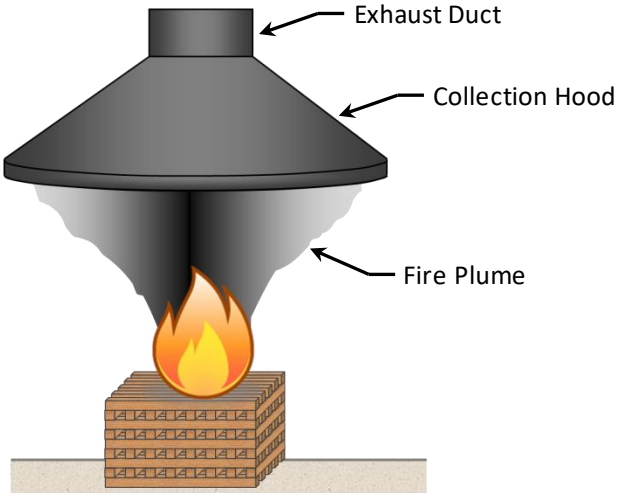

Figure 12. Schematic of a Fire Products Collector

The "Fire Products Collector Description" table identifies which FPC was used in the experiment(s) and summarizes the configuration. Fire Products Collectors were used in accordance with the method defined in FRL Laboratory Instruction "LI011 Fire Products Collectors" [9].

The following table provides a description of the FPC used in the experiment(s). The table includes a description of the FPC, as well as the Calibration factor (C Factor) and E values, which are used to calculate the HRR during an experiment. The C Factor is based on data from a fire with a known HRR. E is the net heat released per unit of oxygen consumed, a property of the fuel being burned.

The maximum HRR used during the C Factor experiment was approximately 5,200 kW. If the HRR measured during an experiment exceeds this maximum HRR, then it may be under predicted, due to smoke spillage from the hood of the FPC.

Table 6. Fire Products Collector Description

Experiment: Test Number	Description	C Factor	E Factor (kJ/kg)
1	4 MW	1.0	13100
2	4 MW	1.0	13100

Experiment Photographs

Digital Cameras are used within the FRL to record digital still photographs during experiments. Digital Cameras used during this test series were used in accordance with the method defined in FRL Laboratory Instruction "LI003 Digital Cameras" [10].

Results for Test 1 (ID 294927)

The following table provides a summary of the temperature results. The "Initial" column provides the measured temperature at the beginning of the test. The maximum temperature recorded during the test is provided in the "Max" column. The remaining columns provide the calculated maximum average temperatures.

Table 7. Temperature Value Result Summary

Description	Initial (C)	Max (C)	30 second max average (C)	1 minute max average (C)	5 minute max average (C)	10 minute max average (C)
Stairs 0	27.3	69.3	66.8	66.0	55.5	48.0
Stairs 1	27.3	65.7	63.6	62.6	51.9	43.7
Stairs 2	27.3	63.4	61.0	59.7	50.3	42.8
Stairs 3	27.4	67.7	65.9	65.2	53.3	44.6
Stairs 4	27.6	87.7	80.2	79.8	62.4	50.1
Stairs 5	27.6	165.2	133.2	127.6	94.9	69.6
Stairs 6	27.9	312.2	230.9	210.4	141.5	97.9
Stairs 7	27.6	500.8	386.3	347.2	229.5	159.0
Stairs 8	27.5	722.1	515.7	454.3	299.7	210.1
Stairs 9	27.7	788.3	583.3	512.6	348.3	249.2
Stairs 10	27.9	657.4	539.4	505.8	355.2	258.9
Stairs 11	27.7	584.1	493.3	472.6	343.4	252.2
Stairs 12	27.6	527.7	472.6	454.5	328.2	242.8
Stairs 13	27.6	488.6	442.8	431.7	318.5	237.4
Stairs 14	27.6	473.5	428.8	419.8	314.0	235.2
Stairs 15	27.5	466.5	413.5	406.8	307.8	231.9
Stairs 16	27.6	447.1	398.5	392.5	303.9	230.5
Stairs 17	27.7	408.4	368.6	366.5	290.7	223.2
1st floor rear 0	26.6	782.4	505.2	475.0	392.8	298.3
1st floor rear 1	27.2	552.0	503.8	476.5	357.4	262.0
1st floor rear 2	27.5	587.1	510.9	503.3	367.3	265.9
1st floor rear 3	27.4	610.6	501.9	495.2	358.9	255.1
1st floor rear 4	27.3	731.5	691.9	675.8	550.8	413.1
1st floor rear 5	29.6	950.5	893.8	878.9	709.7	526.1
1st floor rear 6	33.6	1048.5	994.5	967.6	785.6	578.2
1st floor rear 7	30.9	1240.8	1142.5	1095.8	848.9	619.1
1st floor rear 8	29.4	1279.5	1186.9	1142.8	876.9	653.7
1st floor front 0	26.7	679.1	425.6	374.2	284.1	198.6
1st floor front 1	27.1	362.3	352.4	347.6	258.0	181.9
1st floor front 2	27.3	542.2	466.5	431.9	311.0	227.0
1st floor front 3	27.7	678.5	648.6	645.7	513.5	370.5
1st floor front 4	27.6	926.6	844.3	820.5	650.0	464.1
1st floor front 5	27.5	984.1	932.7	907.5	737.9	530.7
1st floor front 6	27.4	1098.7	1043.2	1009.8	811.0	584.2
1st floor front 7	27.5	1233.5	1166.4	1109.0	881.9	631.8
1st floor front 8	27.4	1165.5	1131.8	1102.1	887.4	647.2
2nd floor rear 0	27.9	287.4	254.8	243.0	189.2	142.2
2nd floor rear 1	27.8	305.7	286.8	279.1	218.3	163.6
2nd floor rear 2	27.7	336.3	318.3	312.7	240.5	180.7
2nd floor rear 3	27.7	342.5	332.4	328.4	254.3	191.5
2nd floor rear 4	27.5	361.7	348.3	343.8	267.4	201.3

Description	Initial (C)	Max (C)	30 second max average (C)	1 minute max average (C)	5 minute max average (C)	10 minute max average (C)
2nd floor rear 5	27.5	375.5	360.7	353.4	277.7	209.3
2nd floor rear 6	27.5	385.3	363.8	353.1	281.7	213.4
2nd floor rear 7	27.6	375.4	356.1	344.5	278.0	212.8
2nd floor rear 8	27.7	347.3	327.8	319.7	263.1	205.2
2nd floor front 0	27.7	230.8	217.8	214.0	167.4	126.8
2nd floor front 1	27.9	273.8	265.3	256.1	204.3	156.5
2nd floor front 2	27.7	299.9	289.3	278.1	223.2	171.8
2nd floor front 3	27.7	310.9	303.2	294.6	233.5	179.4
2nd floor front 4	27.6	327.1	318.5	313.0	248.3	190.0
2nd floor front 5	27.5	332.9	325.0	319.9	254.1	194.2
2nd floor front 6	27.5	336.7	330.5	323.6	258.1	198.0
2nd floor front 7	27.5	348.6	335.8	326.8	264.0	202.9
2nd floor front 8	27.6	330.0	317.6	308.8	253.3	197.0

The following table provides a summary of the time when certain temperatures occurred. The time at which the temperature first changed by a pre-determined amount is provided in the "Time of Initial Change" column. A value of -999 indicates that the temperature did not change by the pre-determined amount during the course of the test. The pre-determined amount of change in temperature is provided in the "Initial Change Amount" column. The time at which the maximum temperature was measured is shown in the "Time of Maximum" column. The remaining columns provide the times at which maximum average temperatures were calculated.

Table 8. Temperature Time Result Summary

Description	Time of initial change (s)	Initial change amount (C)	Time of maximum (s)	Start time of 30 second average (s)	Start time of 1 minute max average (s)	Start time of 5 minute max average (s)	Start time of 10 minute max average (s)
Stairs 0	166	5.0	270	254	244	192	184
Stairs 1	162	5.0	212	272	245	183	167
Stairs 2	163	5.0	282	272	250	182	168
Stairs 3	162	5.0	214	252	238	183	166
Stairs 4	151	5.0	214	251	210	182	167
Stairs 5	132	5.0	217	265	238	187	175
Stairs 6	140	5.0	217	211	211	195	184
Stairs 7	126	5.0	216	210	210	197	184
Stairs 8	107	5.0	215	209	209	193	179
Stairs 9	98	5.0	214	208	209	188	169
Stairs 10	80	5.0	215	209	209	189	169
Stairs 11	70	5.0	215	209	210	189	168
Stairs 12	64	5.0	215	209	208	188	168
Stairs 13	64	5.0	216	208	208	188	168
Stairs 14	64	5.0	215	209	209	188	168
Stairs 15	64	5.0	215	210	211	188	168
Stairs 16	64	5.0	215	210	212	186	165
Stairs 17	43	5.0	215	211	212	184	161
1st floor rear 0	71	5.0	210	206	281	204	188
1st floor rear 1	47	5.0	216	212	211	193	175

Description	Time of initial change (s)	Initial change amount (C)	Time of maximum (s)	Start time of 30 second average (s)	Start time of 1 minute max average (s)	Start time of 5 minute max average (s)	Start time of 10 minute max average (s)
1st floor rear 2	35	5.0	215	249	210	186	158
1st floor rear 3	41	5.0	211	206	207	184	164
1st floor rear 4	39	5.0	256	246	247	189	175
1st floor rear 5	47	5.0	261	247	242	180	155
1st floor rear 6	30	5.0	265	254	226	176	135
1st floor rear 7	25	5.0	265	256	235	167	124
1st floor rear 8	9	5.0	265	247	230	161	127
1st floor front 0	99	5.0	213	208	208	205	180
1st floor front 1	75	5.0	274	260	250	203	179
1st floor front 2	71	5.0	260	252	245	207	188
1st floor front 3	7	5.0	299	278	252	202	185
1st floor front 4	37	5.0	299	276	265	190	168
1st floor front 5	41	5.0	301	285	266	179	154
1st floor front 6	29	5.0	301	280	265	175	132
1st floor front 7	17	5.0	287	275	265	168	124
1st floor front 8	11	5.0	287	277	263	166	123
2nd floor rear 0	156	5.0	261	257	235	212	203
2nd floor rear 1	112	5.0	262	257	236	209	193
2nd floor rear 2	105	5.0	261	255	221	204	188
2nd floor rear 3	94	5.0	262	248	219	200	183
2nd floor rear 4	86	5.0	216	256	235	198	179
2nd floor rear 5	85	5.0	216	257	235	193	177
2nd floor rear 6	84	5.0	269	261	236	189	172
2nd floor rear 7	68	5.0	269	262	241	186	162
2nd floor rear 8	55	5.0	269	262	239	182	158
2nd floor front 0	148	5.0	290	265	263	207	204
2nd floor front 1	96	5.0	278	259	253	202	193
2nd floor front 2	85	5.0	262	258	238	201	188
2nd floor front 3	80	5.0	279	257	233	200	184
2nd floor front 4	77	5.0	279	259	232	198	176
2nd floor front 5	77	5.0	279	258	238	197	173
2nd floor front 6	75	5.0	279	261	239	196	171
2nd floor front 7	64	5.0	270	262	239	190	166
2nd floor front 8	70	5.0	269	263	244	188	166

The following chart(s) present a time-dependent representation of the instantaneous temperatures measured during the experiment.

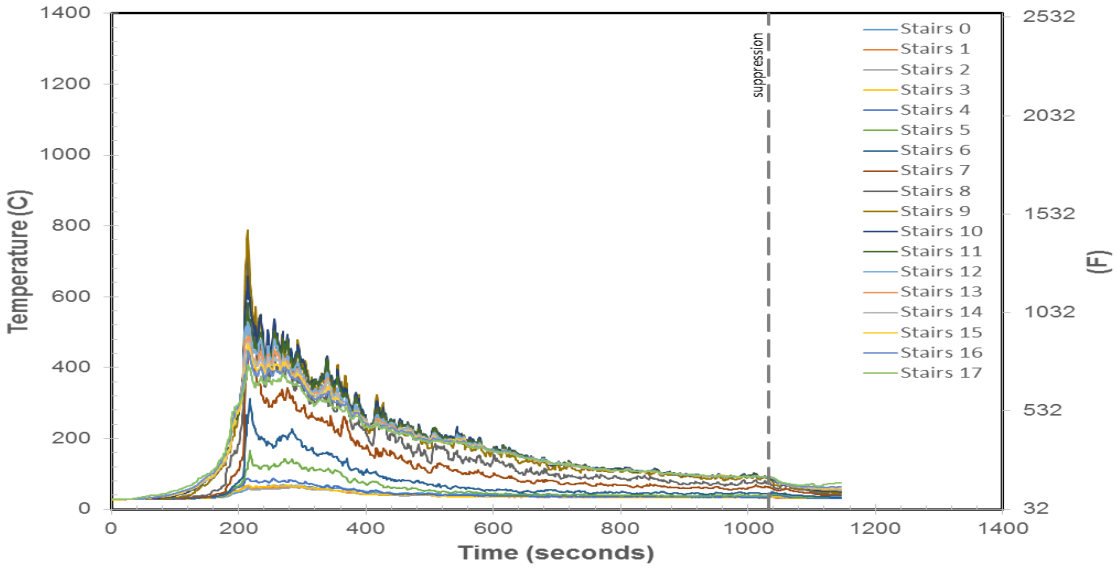

Figure 13. Temperature

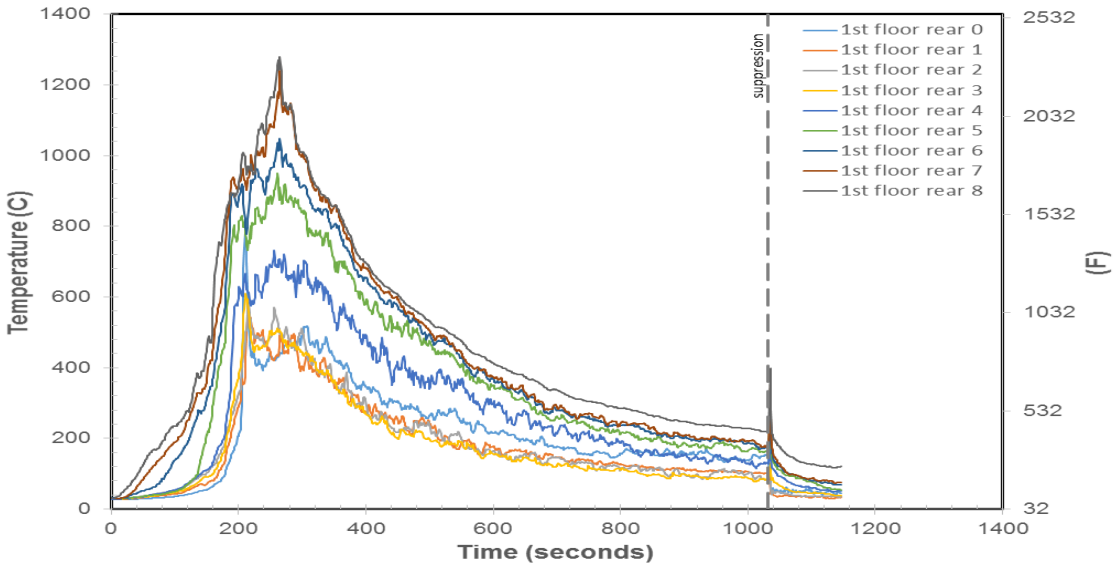

Figure 14. Temperature

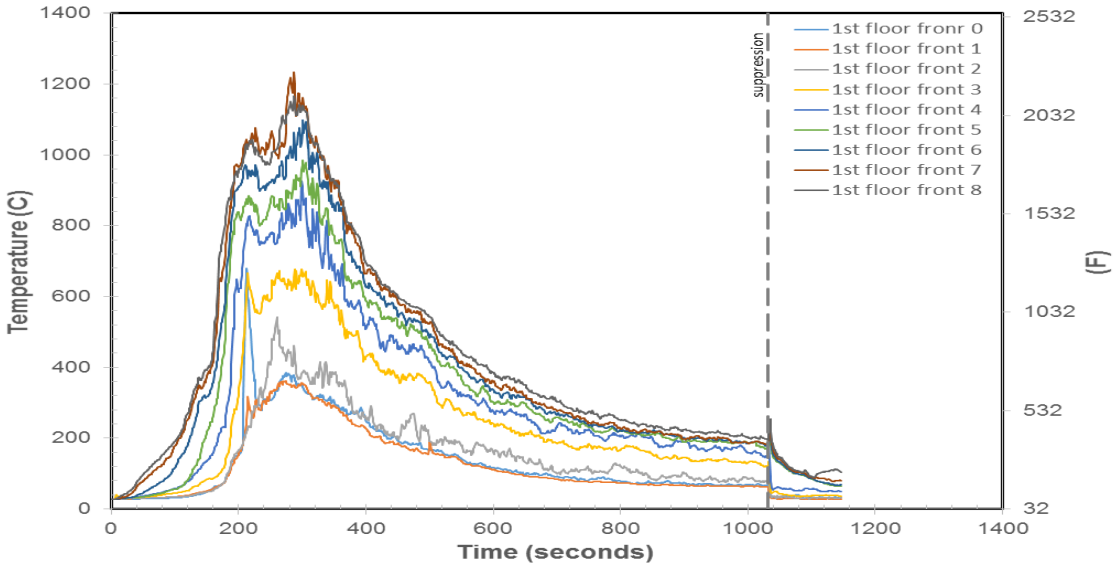

Figure 15. Temperature

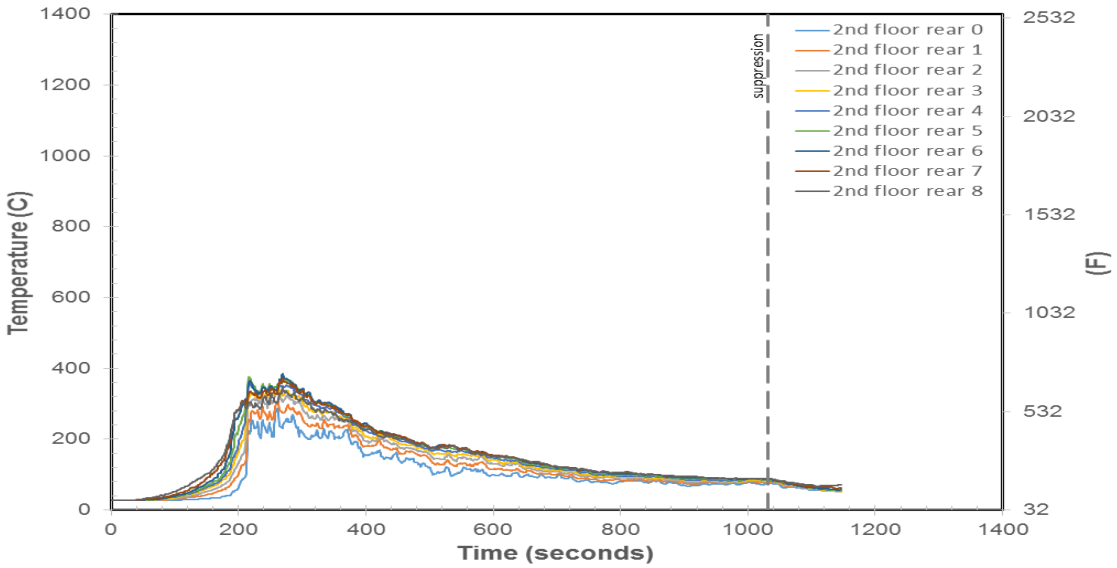

Figure 16. Temperature

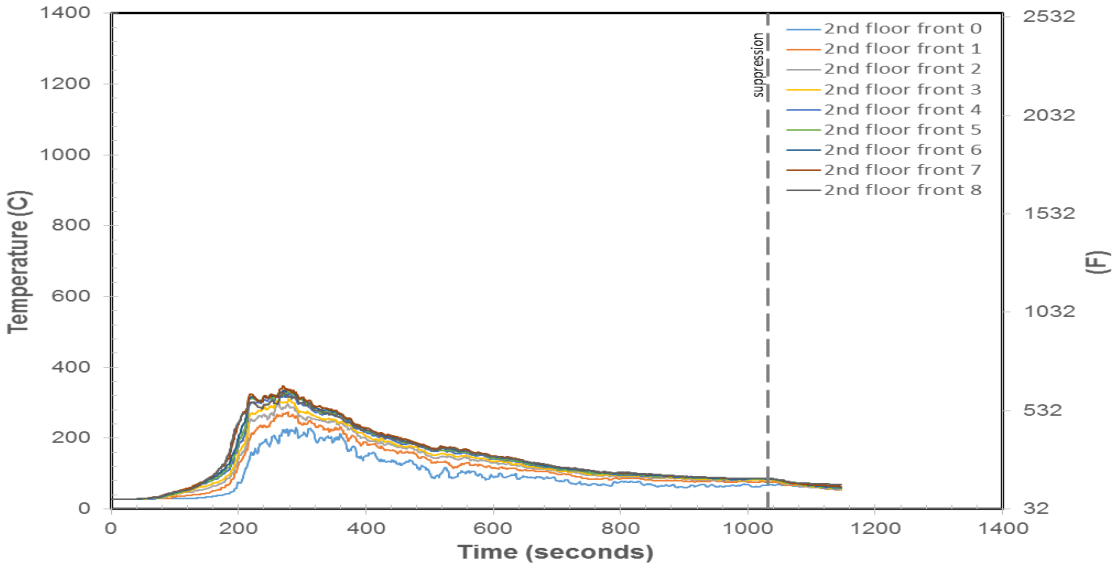

Figure 17. Temperature

The following table provides a summary of the temperatures measured at the velocity probe.

Table 9. Velocity Temperature Summary

Description	Initial temperature (C)	Temperature maximum (C)	Temperature 30 second maximum average (C)	Temperature 1 minute maximum average (C)	Temperature 5 minute maximum average (C)	Temperature 10 minute maximum average (C)
BP 1st floor rear_top	27	1064	1027	999	788	577
BP 1st floor rear_middle	27	607	509	477	359	255
BP 1st floor rear_bottom	27	259	222	208	163	122
BP 1st floor front_top	28	948	901	875	706	515
BP 1st floor front_middle	28	716	614	603	484	345
BP 1st floor front_bottom	27	185	176	169	124	92
BP 2nd floor rear_top	28	436	395	390	306	230
BP 2nd floor rear_middle	28	445	404	396	312	234
BP 2nd floor rear_bottom	28	408	383	376	297	223
BP 2nd floor front_top	28	337	325	315	258	198
BP 2nd floor front_middle	28	316	301	292	242	188
BP 2nd floor front_bottom	28	337	318	300	228	173

The following table summarizes the minimum and maximum velocity values and the times at which they occurred.

Table 10. Velocity Minimum and Maximum

Description	Velocity initial (m/s)	Velocity maximum (m/s)	Velocity 5 Second Maximum Average (m/s)	Velocity 10 Second Maximum Average (m/s)	Velocity 30 second maximum average (m/s)	Velocity 60 second maximum average (m/s)
BP 1st floor rear_top	0.59	8.59	7.41	6.48	5.69	5.41
BP 1st floor rear_middle	0.04	3.34	2.86	2.77	2.57	2.38
BP 1st floor rear_bottom	0.05	4.05	1.78	1.07	0.13	-0.14
BP 1st floor front_top	-0.17	5.54	4.71	4.54	4.34	4.27
BP 1st floor front_middle	-0.26	1.83	1.01	0.58	-0.11	-0.18
BP 1st floor front_bottom	-0.53	3.93	3.46	2.98	2.56	2.25
BP 2nd floor rear_top	0.35	0.56	0.51	0.47	0.37	0.25
BP 2nd floor rear_middle	0.02	0.29	0.13	0.07	0.03	0.03
BP 2nd floor rear_bottom	-0.78	0.74	0.56	0.46	0.24	0.16
BP 2nd floor front_top	0.21	4.10	3.31	3.06	2.77	2.54
BP 2nd floor front_middle	-0.21	2.77	1.48	1.27	0.98	0.89
BP 2nd floor front_bottom	-0.08	2.23	1.07	0.96	0.49	0.31

Description	Initial Velocity (m/s)	Velocity minimum (m/s)	Velocity 30 Second Minimum Average (m/s)	Velocity 1 minute maximum average (m/s)	Velocity 5 minute Minimum Average (m/s)	Velocity 10 minute Minimum Average (m/s)
BP 1st floor rear_top	0.59	-0.76	0.38	5.41	1.39	1.82
BP 1st floor rear_middle	0.04	-1.04	-0.37	2.38	0.13	0.19
BP 1st floor rear_bottom	0.05	-2.24	-1.45	-0.14	-1.15	-0.97
BP 1st floor front_top	-0.17	-0.52	-0.02	4.27	0.97	1.23
BP 1st floor front_middle	-0.26	-2.27	-1.56	-0.18	-1.09	-0.95
BP 1st floor front_bottom	-0.53	-2.06	-1.81	2.25	-1.67	-1.54
BP 2nd floor rear_top	0.35	-7.49	-5.98	0.25	-4.86	-3.92
BP 2nd floor rear_middle	0.02	-0.35	-0.12	0.03	-0.07	-0.05
BP 2nd floor rear_bottom	-0.78	-6.60	-5.04	0.16	-3.77	-2.99
BP 2nd floor front_top	0.21	-1.72	0.21	2.54	0.97	1.08
BP 2nd floor front_middle	-0.21	-2.62	-0.33	0.89	0.18	0.22
BP 2nd floor front_bottom	-0.08	-3.04	-0.57	0.31	-0.09	0.00

The following chart(s) present a time dependent representation of the instantaneous velocities measured during the experiment.

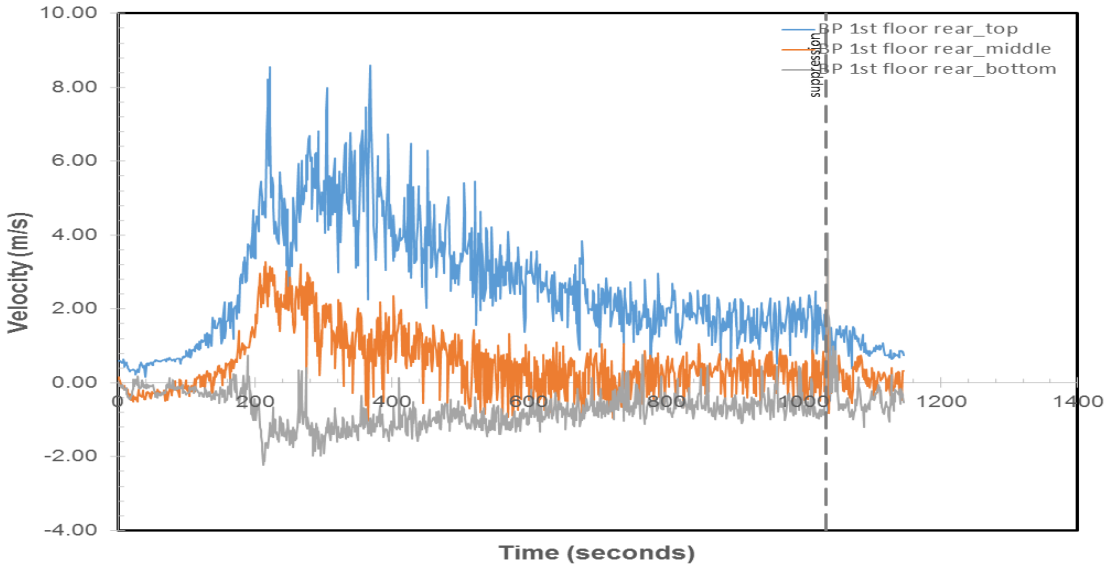

Figure 18. Velocity

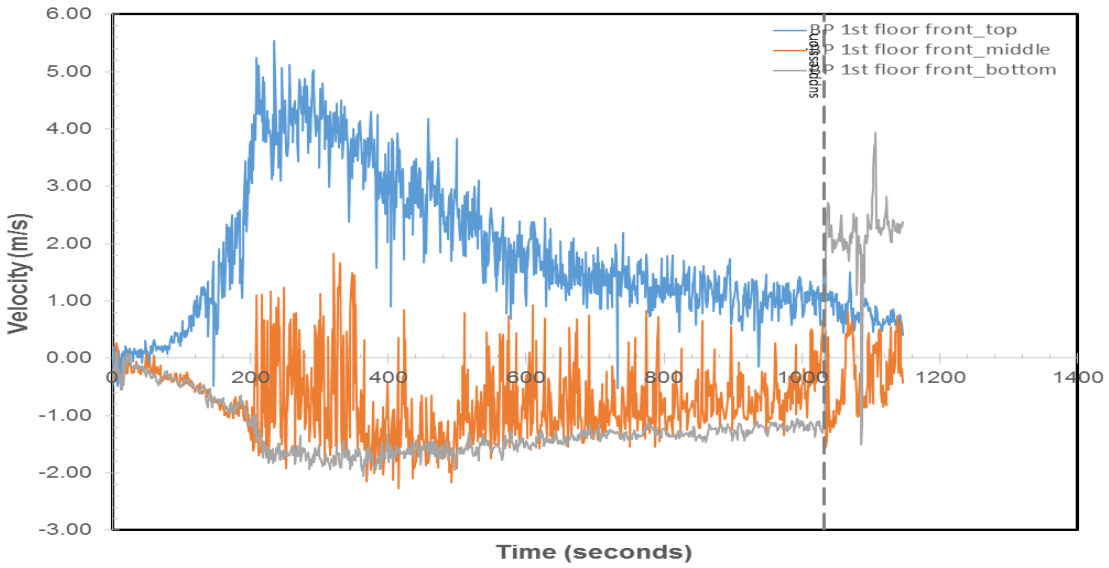

Figure 19. Velocity

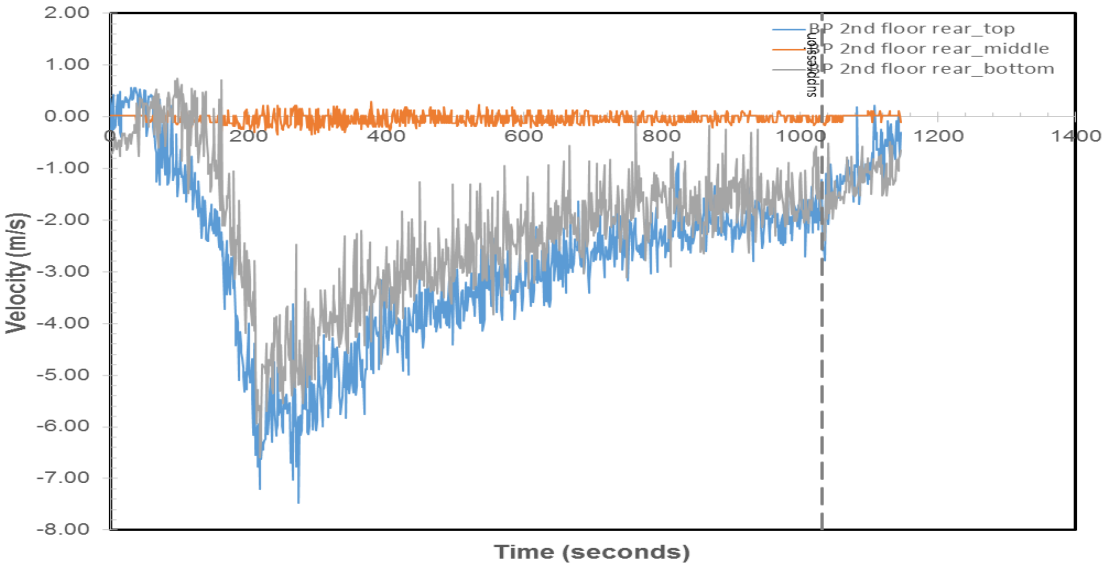

Figure 20. Velocity

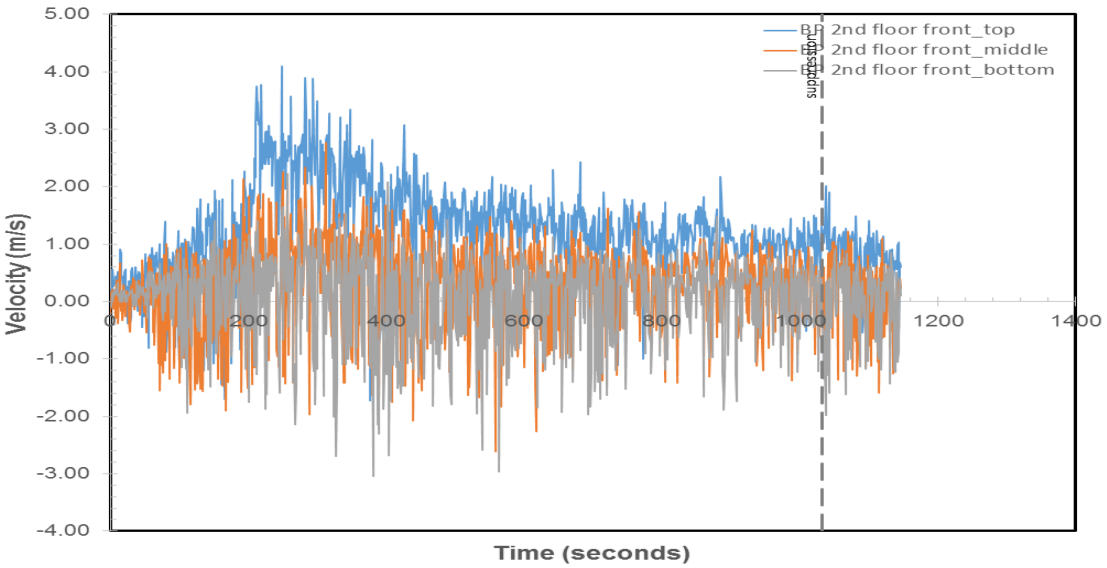

Figure 21. Velocity

The following chart shows the temperature used to calculate the velocity.

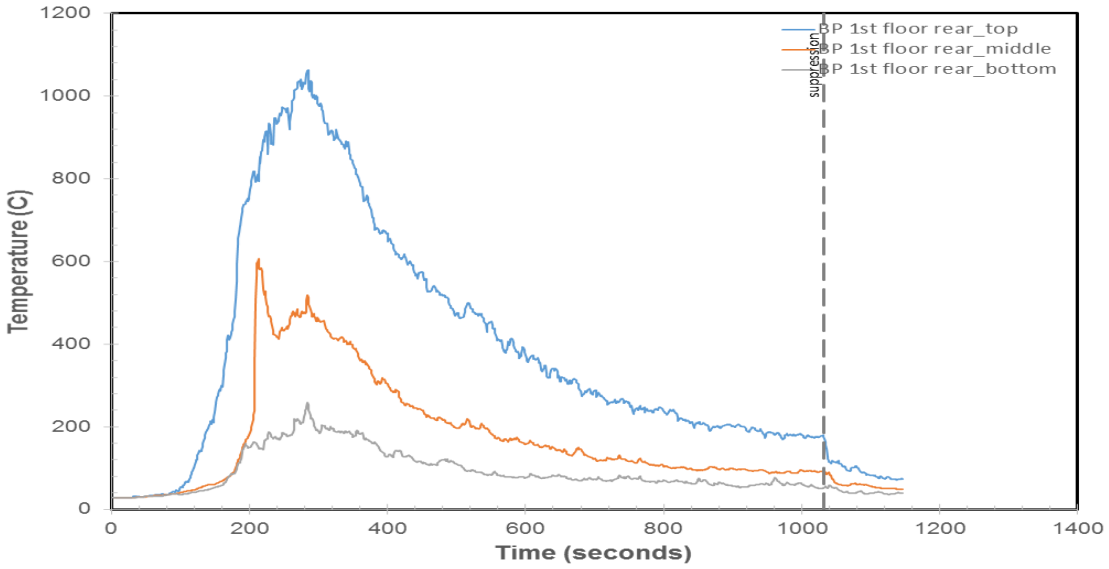

Figure 22. Temperature Chart

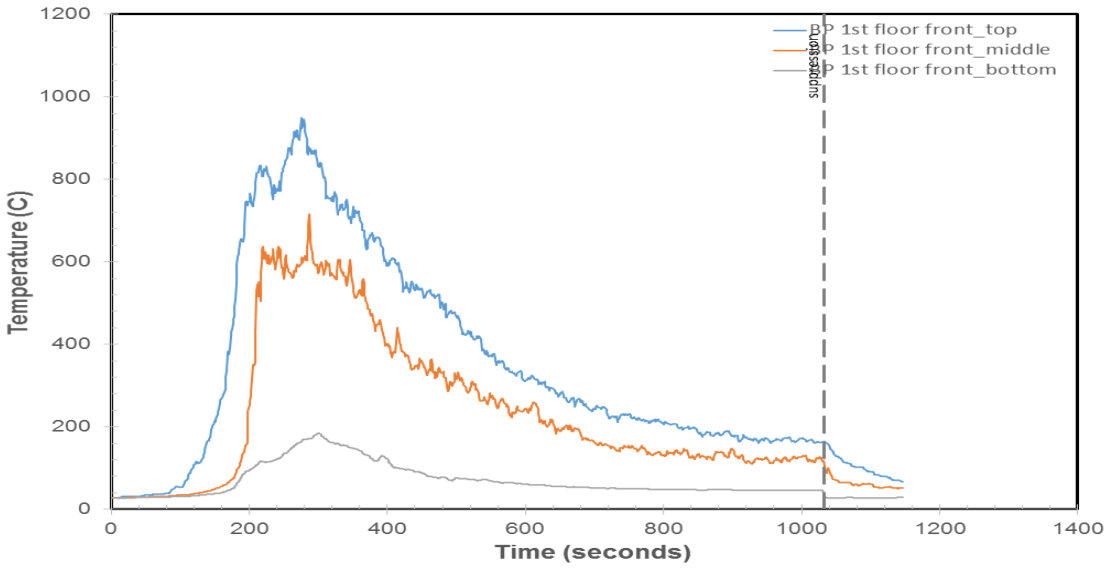

Figure 23. Temperature Chart

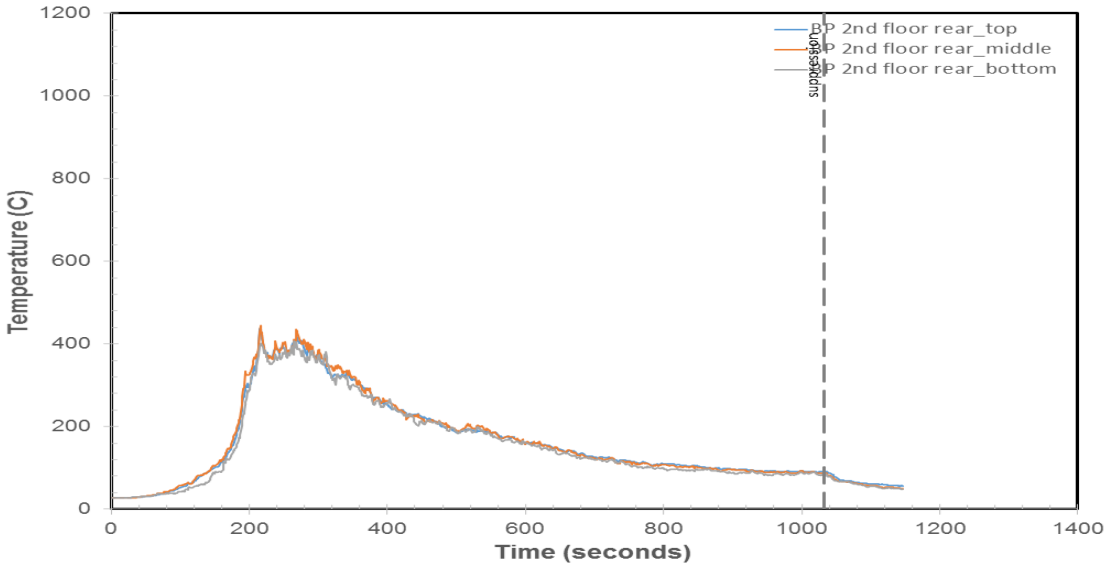

Figure 24. Temperature Chart

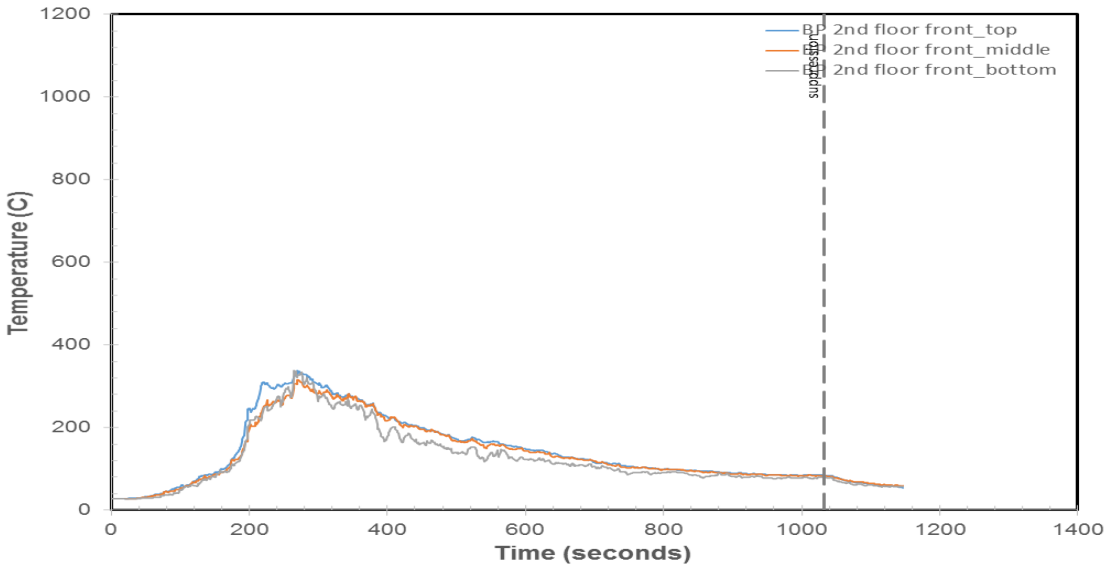

Figure 25. Temperature Chart

The following table provides a summary of the heat flux results. A "SC" in the table indicates that the values did not change sufficiently for this value to be calculated. The "Description" column typically describes the location of the heat flux transducer. The time at which the heat flux first changes by a pre-determined amount is provided in the "Time of Initial Change" column. The pre-determined amount of change in heat flux is provided in the "Initial Change Amount" column. The maximum heat flux recorded during the test is provided in the "Maximum" column. The "Maximum Average" columns are calculated over four pre-determined time spans.

Table 11. Heat Flux Result Summary

Description	Time of Initial Change (s)	Initial Change Value (kW/m²)	Maximum (kW/m²)	10 second maximum average (kW/m²)	30 second maximum average (kW/m²)	1 minute maximum average (kW/m²)	5 minute maximum average (kW/m²)	10 minute maximum average (kW/m²)
1st floor stairs	182	5	21.4	17.4	17.1	16.6	11.0	7.0
2nd floor stairs	183	5	23.2	19.4	17.6	16.5	10.8	6.8
1st floor rear	112	5	116.3	108.2	105.4	100.9	70.7	45.8
1st floor front	120	5	128.8	114.8	112.0	108.5	72.8	46.5
2nd floor rear	194	5	14.9	12.1	11.3	11.1	7.2	4.6
2nd floor front	195	5	14.3	12.2	11.2	11.2	7.1	4.5

The following chart shows a time dependent representation of the instantaneous heat flux measured during the experiment.

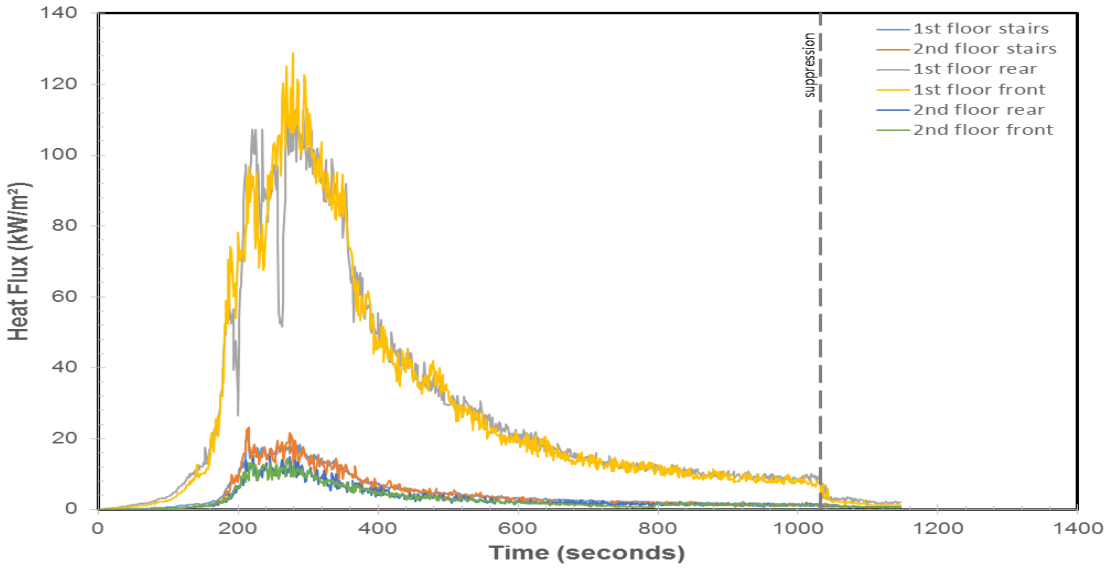

Figure 26. Heat Flux

The following table lists selected events that occurred during the experiment.

Table 12. Experiment Events

Description	Time (s)
suppression	1032

The following chart shows the heat release rate of the fire during the experiment. The heat release rate is calculated based on the principle of oxygen consumption calorimetry.

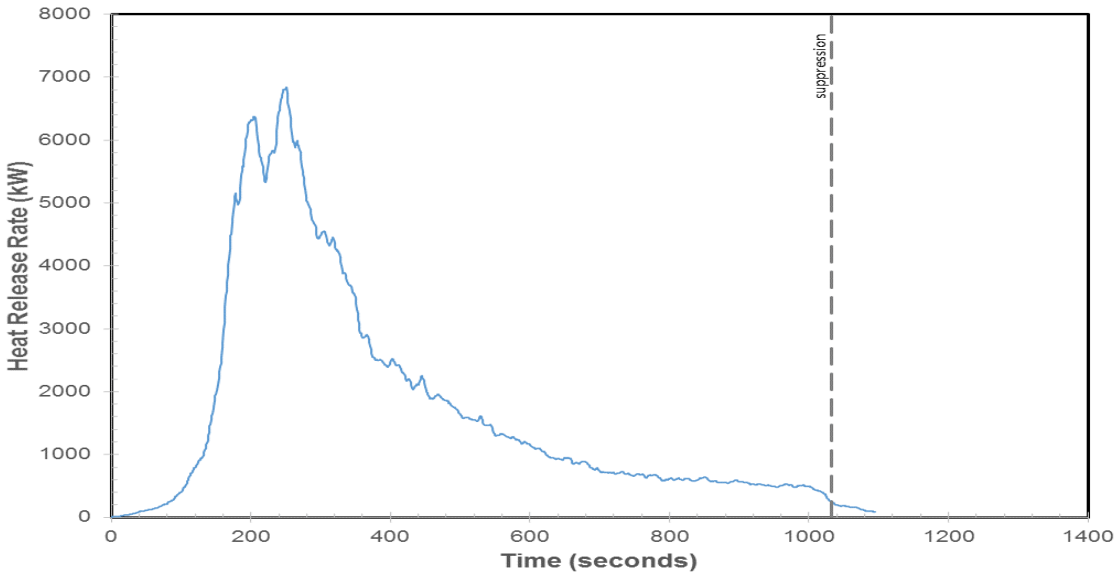

Figure 27. Heat Release Rate

The following chart shows the total heat released from the fire during the experiment. The total heat released is calculated by integrating the heat release rate over time.

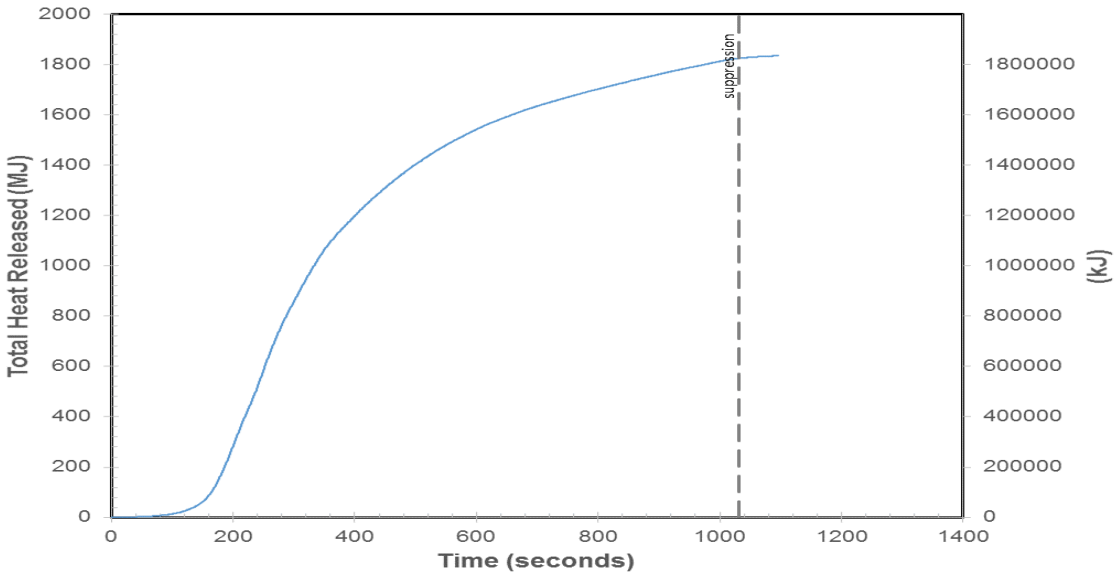

Figure 28. Total Heat Released

The following table provides a description of the video(s) taken during this experiment.

Table 13. Video Log

Description	Start Time	Duration (s)	Filename
FLIR BACK	11:07:14	1165	294927_20180828_110714_1.mov
FLIR FRONT	11:07:16	1164	294927_20180828_110716_2.mov
2ND FLOOR	11:07:17	1164	294927_20180828_110717_3.mov
1ST FLOOR FRONT	11:07:19	1163	294927_20180828_110719_4.mov
1ST FLOOR MID	11:07:21	1162	294927_20180828_110721_5.mov
1ST FLOOR BACK	11:07:22	1162	294927_20180828_110722_6.mov
BACK HD	11:07:24	1161	294927_20180828_110724_9.mov
FRONT HD	11:07:24	1162	294927_20180828_110724_10.mov
SIDE HD	11:07:25	1161	294927_20180828_110725_11.mov
MASTER			294927_1030857.mov

The following figures show all of the still photographs uploaded into the FireTOSS system. The caption below each figure provides the picture's filename as well as any description and elapsed test time associated with the picture.

Figure 29. Pre test 19:32 hr:min (294927_1017776)

Figure 30. Pre test 19:31 hr:min (294927_1017777)

Figure 31. Pre test 19:31 hr:min (294927_1017778)

Figure 32. Pre test 19:31 hr:min (294927_1017779)

Figure 33. Pre test 19:31 hr:min (294927_1017780)

Figure 34. Pre test 19:31 hr:min (294927_1017781)

Figure 35. Pre test 19:31 hr:min (294927_1017782)

Figure 36. Pre test 19:30 hr:min (294927_1017783)

Figure 37. Pre test 19:30 hr:min (294927_1017784)

Figure 38. Pre test 19:30 hr:min (294927_1017785)

Figure 39. Pre test 19:30 hr:min (294927_1017786)

Figure 40. Pre test 19:29 hr:min (294927_1017787)

Figure 41. Pre test 19:29 hr:min (294927_1017788)

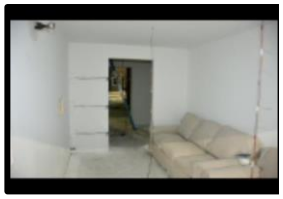

Figure 42. Pre test 19:29 hr:min (294927_1017789)

Figure 43. Pre test 19:29 hr:min (294927_1017790)

Figure 44. Pre test 19:29 hr:min (294927_1017791)

Figure 45. Pre test 19:28 hr:min (294927_1017792)

Figure 46. Pre test 19:28 hr:min (294927_1017793)

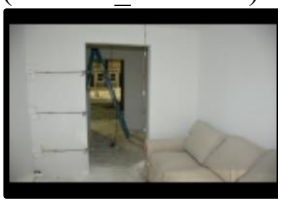

Figure 47. Pre test 19:28 hr:min (294927_1017794)

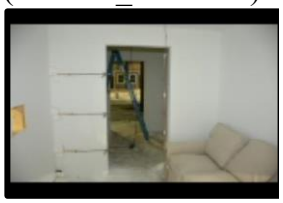

Figure 48. Pre test 19:28 hr:min (294927_1017795)

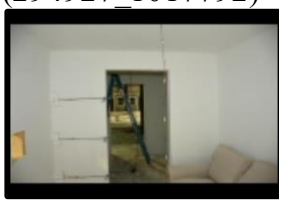

Figure 49. Pre test 19:28 hr:min (294927_1017796)

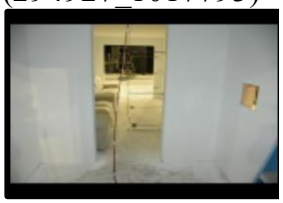

Figure 50. Pre test 19:26 hr:min (294927_1017797)

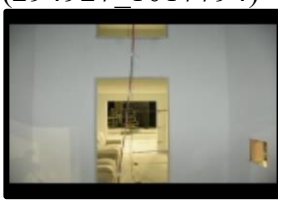

Figure 51. Pre test 19:26 hr:min (294927_1017798)

Figure 52. Pre test 19:26 hr:min (294927_1017799)

Figure 53. Pre test 19:26 hr:min (294927_1017800)

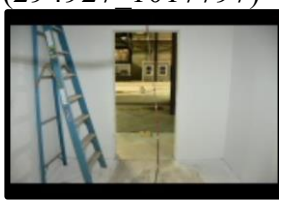

Figure 54. Pre test 19:26 hr:min (294927_1017801)

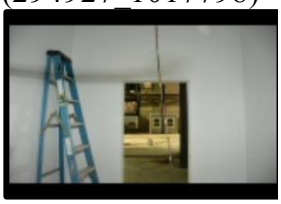

Figure 55. Pre test 19:25 hr:min (294927_1017802)

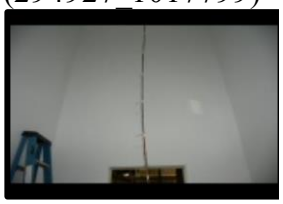

Figure 56. Pre test 19:25 hr:min (294927_1017803)

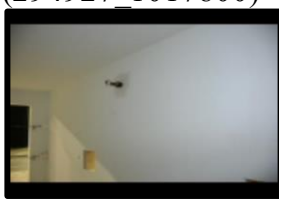

Figure 57. Pre test 19:25 hr:min (294927_1017804)

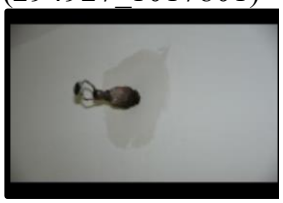

Figure 58. Pre test 19:25 hr:min (294927_1017805)

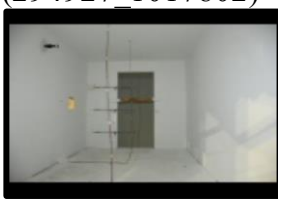

Figure 59. Pre test 19:24 hr:min (294927_1017806)

Figure 60. Pre test 19:24 hr:min (294927_1017807)

Figure 61. Pre test 19:24 hr:min (294927_1017808)

Figure 62. Pre test 19:24 hr:min (294927_1017809)

Figure 63. Pre test 19:24 hr:min (294927_1017810)

Figure 64. Pre test 19:24 hr:min (294927_1017811)

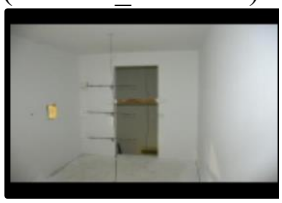

Figure 65. Pre test 19:23 hr:min (294927_1017812)

Figure 66. Pre test 19:23 hr:min (294927_1017813)

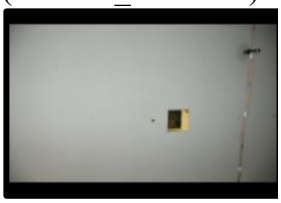

Figure 67. Pre test 19:23 hr:min (294927_1017814)

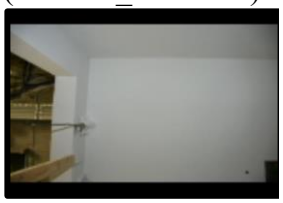

Figure 68. Pre test 19:23 hr:min (294927_1017815)

Figure 69. Pre test 19:23 hr:min (294927_1017816)

Figure 70. Pre test 19:23 hr:min (294927_1017817)

Figure 71. Pre test 19:23 hr:min (294927_1017818)

Figure 72. Pre test 19:23 hr:min (294927_1017819)

Figure 73. Pre test 19:23 hr:min (294927_1017820)

Figure 74. Pre test 19:22 hr:min (294927_1017821)

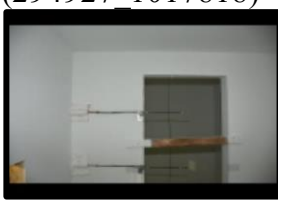

Figure 75. Pre test 19:22 hr:min (294927_1017822)

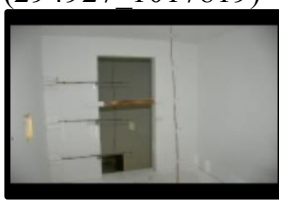

Figure 76. Pre test 19:22 hr:min (294927_1017823)

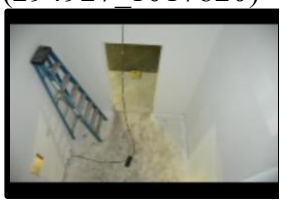

Figure 77. Pre test 19:22 hr:min (294927_1017824)

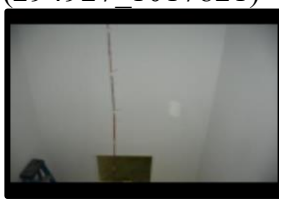

Figure 78. Pre test 19:22 hr:min (294927_1017825)

Figure 79. Pre test 19:22 hr:min (294927_1017826)

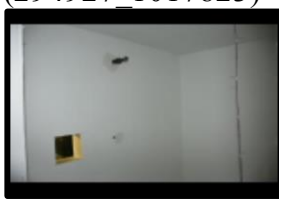

Figure 80. Pre test 19:22 hr:min (294927_1017827)

Figure 81. Pre test 19:22 hr:min (294927_1017828)

Figure 82. Pre test 19:21 hr:min (294927_1017829)

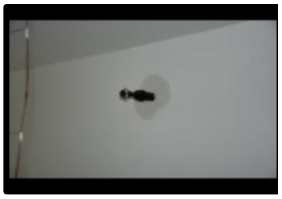

Figure 83. Pre test 19:21 hr:min (294927_1017830)

Figure 84. Pre test 2:21 hr:min (294927_1017831)

Figure 85. Pre test 2:21 hr:min (294927_1017832)

Figure 86. Pre test 2:21 hr:min (294927_1017833)

Figure 87. Pre test 2:21 hr:min (294927_1017834)

Figure 88. Pre test 2:20 hr:min (294927_1017835)

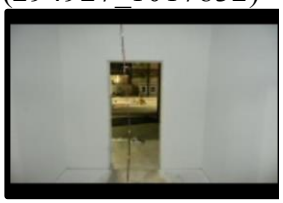

Figure 89. Pre test 2:20 hr:min (294927_1017836)

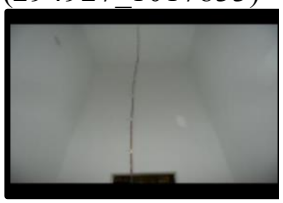

Figure 90. Pre test 2:20 hr:min (294927_1017837)

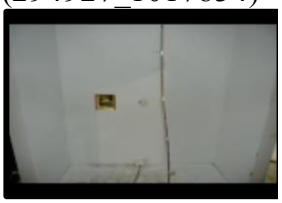

Figure 91. Pre test 2:20 hr:min (294927_1017838)

Figure 92. Pre test 2:20 hr:min (294927_1017839)

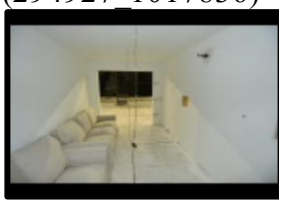

Figure 93. Pre test 2:20 hr:min (294927_1017840)

Figure 94. Pre test 2:20 hr:min (294927_1017841)

Figure 95. Pre test 2:19 hr:min (294927_1017842)

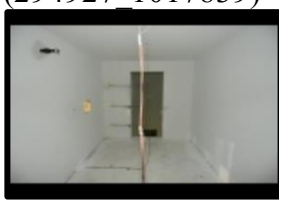

Figure 96. Pre test 2:18 hr:min (294927_1017843)

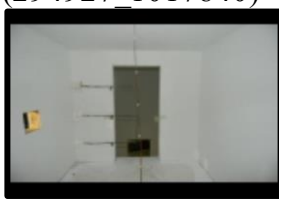

Figure 97. Pre test 2:18 hr:min (294927_1017844)

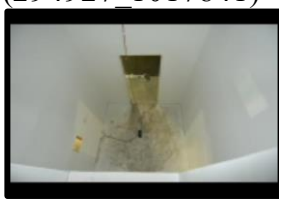

Figure 98. Pre test 2:18 hr:min (294927_1017845)

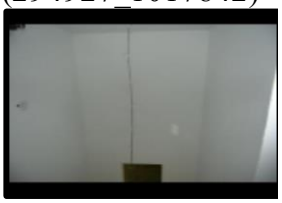

Figure 99. Pre test 2:18 hr:min (294927_1017846)

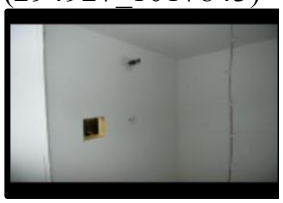

Figure 100. Pre test 2:18 hr:min (294927_1017847)

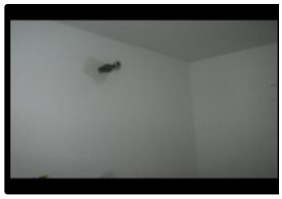

Figure 101. Pre test 2:18 hr:min (294927_1017848)

Figure 102. Pre test 2:18 hr:min (294927_1017849)

Figure 103. Pre test 2:17 hr:min (294927_1017850)

Figure 104. Pre test 2:17 hr:min (294927_1017851)

Figure 105. Pre test 2:17 hr:min (294927_1017852)

Figure 106. Pre test 2:17 hr:min (294927_1017853)

Figure 107. Pre test 2:17 hr:min (294927_1017854)

Figure 108. Pre test 2:16 hr:min (294927_1017855)

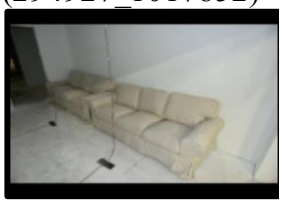

Figure 109. Pre test 2:16 hr:min (294927_1017856)

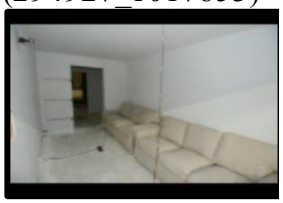

Figure 110. Pre test 2:16 hr:min (294927_1017857)

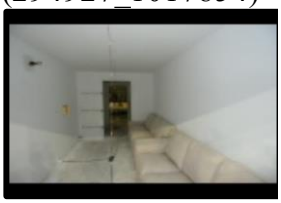

Figure 111. Pre test 2:16 hr:min (294927_1017858)

Figure 112. Pre test 2:15 hr:min (294927_1017859)

Figure 113. Pre test 2:15 hr:min (294927_1017860)

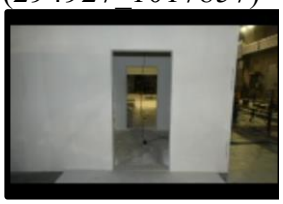

Figure 114. Pre test 2:15 hr:min (294927_1017861)

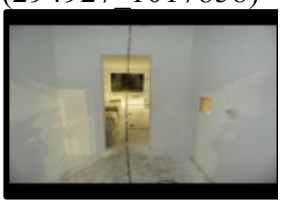

Figure 115. Pre test 2:15 hr:min (294927_1017862)

Figure 116. Pre test 2:15 hr:min (294927_1017863)

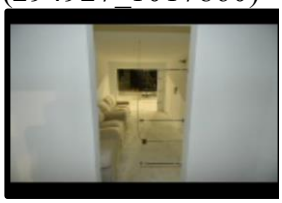

Figure 117. Pre test 2:15 hr:min (294927_1017864)

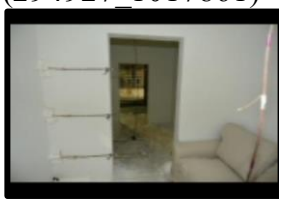

Figure 118. Pre test 2:14 hr:min (294927_1017865)

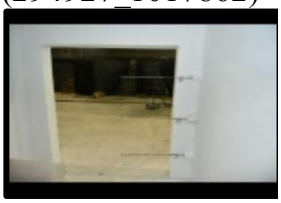

Figure 119. Pre test 2:14 hr:min (294927_1017866)

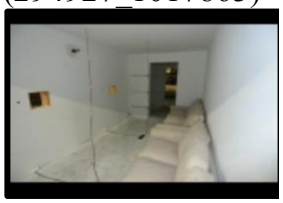

Figure 120. Pre test 2:14 hr:min (294927_1017867)

Figure 121. Pre test 2:14 hr:min (294927_1017868)

Figure 122. Pre test 1:36 hr:min (294927_1017869)

Figure 123. Pre test 1:36 hr:min (294927_1017870)

Figure 124. Pre test 1:36 hr:min (294927_1017871)

Figure 125. Pre test 1:35 hr:min (294927_1017872)

Figure 126. Pre test 1:35 hr:min (294927_1017873)

Figure 127. Pre test 1:35 hr:min (294927_1017874)

Figure 128. Pre test 1:35 hr:min (294927_1017875)

Figure 129. Pre test 1:35 hr:min (294927_1017876)

Figure 130. Pre test 1:34 hr:min (294927_1017877)

Figure 131. Pre test 1:34 hr:min (294927_1017878)

Figure 132. Pre test 1:34 hr:min (294927_1017879)

Figure 133. Pre test 1:34 hr:min (294927_1017880)

Figure 134. Pre test 1:34 hr:min (294927_1017881)

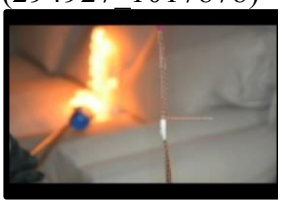

Figure 135. 0 seconds (294927_1017882)

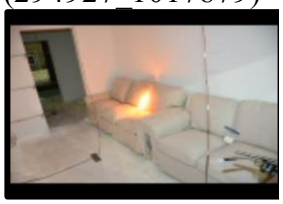

Figure 136. 4 seconds (294927_1017883)

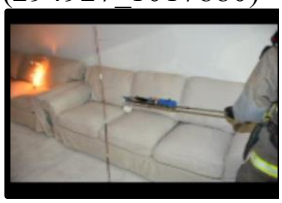

Figure 137. 5 seconds (294927_1017884)

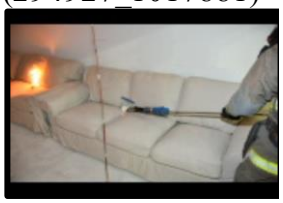

Figure 138. 6 seconds (294927_1017885)

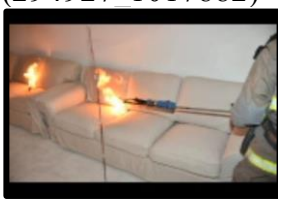

Figure 139. 7 seconds (294927_1017886)

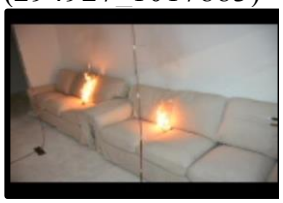

Figure 140. 8 seconds (294927_1017887)

Figure 141. 11 seconds (294927_1017888)

Figure 142. 18 seconds (294927_1017889)

Figure 143. 41 seconds (294927_1017890)

Figure 144. 47 seconds (294927_1017891)

Figure 145. 51 seconds (294927_1017892)

Figure 146. 69 seconds (294927_1017893)

Figure 147. 77 seconds (294927_1017894)

Figure 148. 84 seconds (294927_1017895)

Figure 149. 107 seconds (294927_1017896)

Figure 150. 120 seconds (294927_1017897)

Figure 151. 124 seconds (294927_1017898)

Figure 152. 139 seconds (294927_1017899)

Figure 153. 159 seconds (294927_1017900)

Figure 154. 167 seconds (294927_1017901)

Figure 155. 185 seconds (294927_1017902)

Figure 156. 187 seconds (294927_1017903)

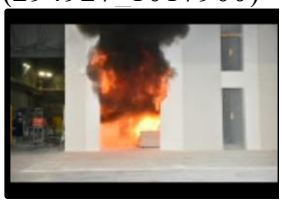

Figure 157. 190 seconds (294927_1017904)

Figure 158. 193 seconds (294927_1017905)

Figure 159. 196 seconds (294927_1017906)

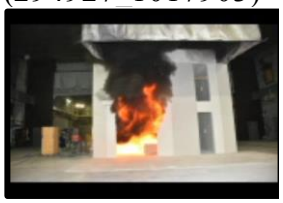

Figure 160. 206 seconds (294927_1017907)

Figure 161. 209 seconds (294927_1017908)

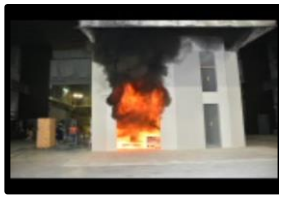

Figure 162. 215 seconds (294927_1017909)

Figure 163. 219 seconds (294927_1017910)

Figure 164. 231 seconds (294927_1017911)

Figure 165. 247 seconds (294927_1017912)

Figure 166. 249 seconds (294927_1017913)

Figure 167. 275 seconds (294927_1017914)

Figure 168. 301 seconds (294927_1017915)

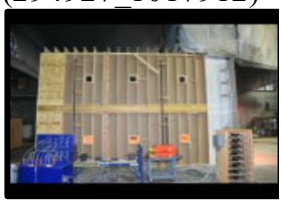

Figure 169. 302 seconds (294927_1017916)

Figure 170. 339 seconds (294927_1017917)

Figure 171. 372 seconds (294927_1017918)

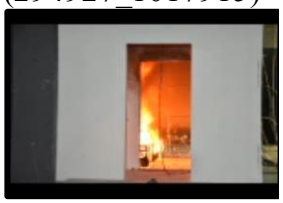

Figure 172. 373 seconds (294927_1017919)

Figure 173. 375 seconds (294927_1017920)

Figure 174. 405 seconds (294927_1017921)

Figure 175. 429 seconds (294927_1017922)

Figure 176. 432 seconds (294927_1017923)

Figure 177. 442 seconds (294927_1017924)

Figure 178. 445 seconds (294927_1017925)

Figure 179. 450 seconds (294927_1017926)

Figure 180. 458 seconds (294927_1017927)

Figure 181. 460 seconds (294927_1017928)

Figure 182. 506 seconds (294927_1017929)

Figure 183. 510 seconds (294927_1017930)

Figure 184. 535 seconds (294927_1017931)

Figure 185. 536 seconds (294927_1017932)

Figure 186. 547 seconds (294927_1017933)

Figure 187. 552 seconds (294927_1017934)

Figure 188. 554 seconds (294927_1017935)

Figure 189. 673 seconds (294927_1017936)

Figure 190. 675 seconds (294927_1017937)

Figure 191. 678 seconds (294927_1017938)

Figure 192. 758 seconds (294927_1017939)

Figure 193. 1055 seconds (294927_1017940)

Figure 194. 1056 seconds (294927_1017941)

Figure 195. 1127 seconds (294927_1017942)

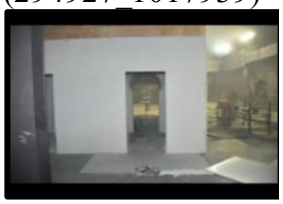

Figure 196. Post test 0 minutes (294927_1017943)

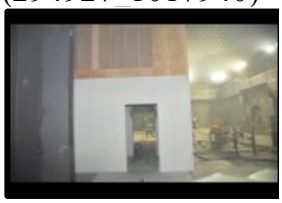

Figure 197. Post test 0 minutes (294927_1017944)

Figure 198. Post test 0 minutes (294927_1017945)

Figure 199. Post test 2:53 hr:min (294927_1017946)

Figure 200. Post test 2:54 hr:min (294927_1017947)

Figure 201. Post test 2:54 hr:min (294927_1017948)

Figure 202. Post test 2:54 hr:min (294927_1017949)

Figure 203. Post test 2:54 hr:min (294927_1017950)

Figure 204. Post test 2:54 hr:min (294927_1017951)

Figure 205. Post test 2:54 hr:min (294927_1017952)

Figure 206. Post test 2:56 hr:min (294927_1017953)

Figure 207. Post test 2:56 hr:min (294927_1017954)

Figure 208. Post test 2:56 hr:min (294927_1017955)

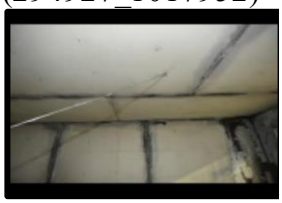

Figure 209. Post test 2:56 hr:min (294927_1017956)

Figure 210. Post test 2:57 hr:min (294927_1017957)

Figure 211. Post test 2:57 hr:min (294927_1017958)

Figure 212. Post test 2:57 hr:min (294927_1017959)

Figure 213. Post test 2:57 hr:min (294927_1017960)

Figure 214. Post test 2:57 hr:min (294927_1017961)

Figure 215. Post test 2:57 hr:min (294927_1017962)

Figure 216. Post test 2:57 hr:min (294927_1017963)

Figure 217. Post test 2:58 hr:min (294927_1017964)

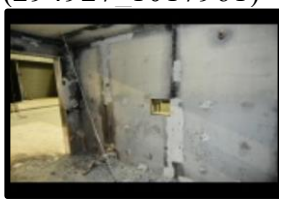

Figure 218. Post test 2:58 hr:min (294927_1017965)

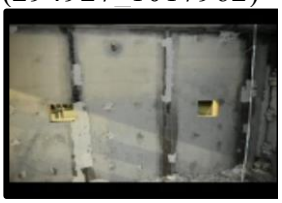

Figure 219. Post test 2:58 hr:min (294927_1017966)

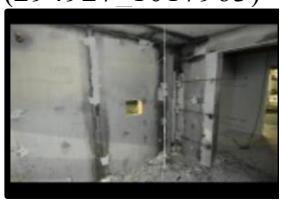

Figure 220. Post test 2:58 hr:min (294927_1017967)

Figure 221. Post test 2:58 hr:min (294927_1017968)

Figure 222. Post test 2:58 hr:min (294927_1017969)

Figure 223. Post test 2:58 hr:min (294927_1017970)

Figure 224. Post test 2:58 hr:min (294927_1017971)

Figure 225. Post test 2:59 hr:min (294927_1017972)

Figure 226. Post test 2:59 hr:min (294927_1017973)

Figure 227. Post test 2:59 hr:min (294927_1017974)

Figure 228. Post test 2:59 hr:min (294927_1017975)

Figure 229. Post test 2:59 hr:min (294927_1017976)

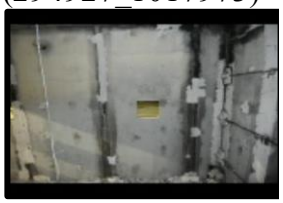

Figure 230. Post test 3:00 hr:min (294927_1017977)

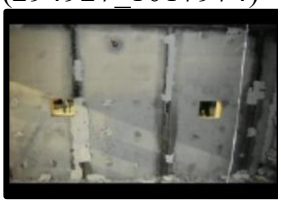

Figure 231. Post test 3:00 hr:min (294927_1017978)

Figure 232. Post test 3:00 hr:min (294927_1017979)

Figure 233. Post test 3:00 hr:min (294927_1017980)

Figure 234. Post test 3:00 hr:min (294927_1017981)

Figure 235. Post test 3:01 hr:min (294927_1017982)

Figure 236. Post test 3:01 hr:min (294927_1017983)

Figure 237. Post test 3:01 hr:min (294927_1017984)

Figure 238. Post test 3:01 hr:min (294927_1017985)

Figure 239. Post test 3:01 hr:min (294927_1017986)

Figure 240. Post test 3:01 hr:min (294927_1017987)

Figure 241. Post test 3:01 hr:min (294927_1017988)

Figure 242. Post test 3:02 hr:min (294927_1017989)

Figure 243. Post test 3:02 hr:min (294927_1017990)

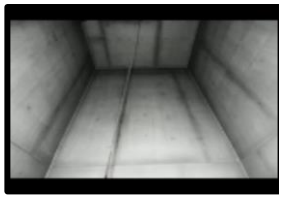

Figure 244. Post test 3:02 hr:min (294927_1017991)

Figure 245. Post test 3:02 hr:min (294927_1017992)

Figure 246. Post test 3:02 hr:min (294927_1017993)

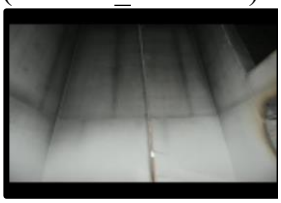

Figure 247. Post test 3:02 hr:min (294927_1017994)

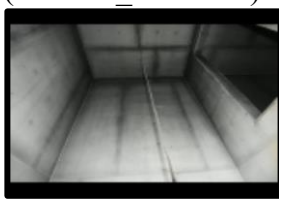

Figure 248. Post test 3:02 hr:min (294927_1017995)

Figure 249. Post test 3:02 hr:min (294927_1017996)

Figure 250. Post test 3:02 hr:min (294927_1017997)

Figure 251. Post test 3:02 hr:min (294927_1017998)

Figure 252. Post test 3:04 hr:min (294927_1017999)

Figure 253. Post test 3:04 hr:min (294927_1018000)

Figure 254. Post test 3:04 hr:min (294927_1018001)

Figure 255. Post test 3:05 hr:min (294927_1018002)

Figure 256. Post test 3:05 hr:min (294927_1018003)

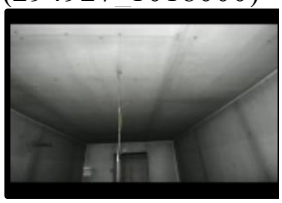

Figure 257. Post test 3:05 hr:min (294927_1018004)

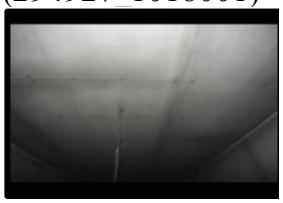

Figure 258. Post test 3:05 hr:min (294927_1018005)

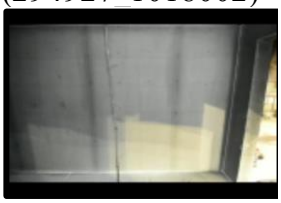

Figure 259. Post test 3:05 hr:min (294927_1018006)

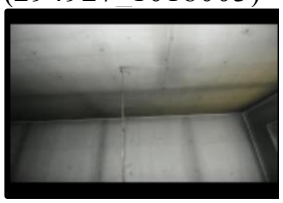

Figure 260. Post test 3:05 hr:min (294927_1018007)

Figure 261. Post test 3:05 hr:min (294927_1018008)

Figure 262. Post test 3:06 hr:min (294927_1018009)

Figure 263. Post test 3:06 hr:min (294927_1018010)

Figure 264. Post test 3:06 hr:min (294927_1018011)

Figure 265. Post test 3:06 hr:min (294927_1018012)

Figure 266. Post test 3:06 hr:min (294927_1018013)

Figure 267. Post test 3:06 hr:min (294927_1018014)

Figure 268. Post test 3:06 hr:min (294927_1018015)

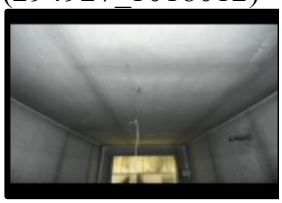

Figure 269. Post test 3:06 hr:min (294927_1018016)

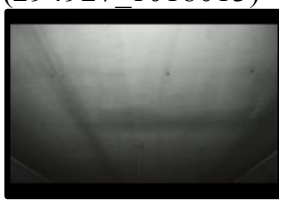

Figure 270. Post test 3:07 hr:min (294927_1018017)

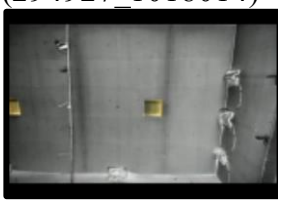

Figure 271. Post test 3:07 hr:min (294927_1018018)

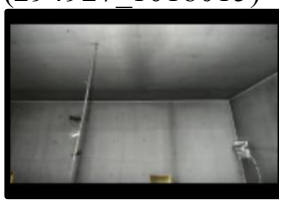

Figure 272. Post test 3:07 hr:min (294927_1018019)

Figure 273. Post test 3:07 hr:min (294927_1018020)

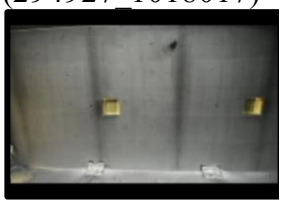

Figure 274. Post test 3:07 hr:min (294927_1018021)

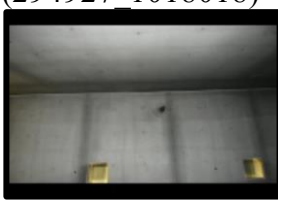

Figure 275. Post test 3:07 hr:min (294927_1018022)

Figure 276. Post test 3:07 hr:min (294927_1018023)

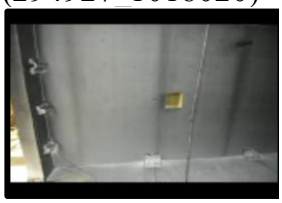

Figure 277. Post test 3:07 hr:min (294927_1018024)

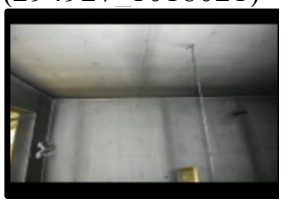

Figure 278. Post test 3:07 hr:min (294927_1018025)

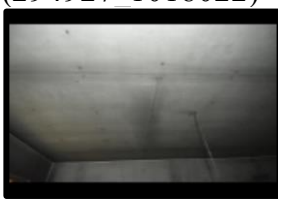

Figure 279. Post test 3:07 hr:min (294927_1018026)

Figure 280. Post test 3:08 hr:min (294927_1018027)

Figure 281. Post test 3:08 hr:min (294927_1018028)

Figure 282. Post test 3:08 hr:min (294927_1018029)

Figure 283. Post test 3:08 hr:min (294927_1018030)

Figure 284. Post test 3:08 hr:min (294927_1018031)

Figure 285. Post test 3:08 hr:min (294927_1018032)

Figure 286. Post test 3:08 hr:min (294927_1018033)

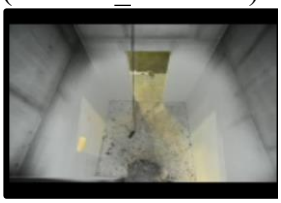

Figure 287. Post test 3:08 hr:min (294927_1018034)

Figure 288. Post test 3:09 hr:min (294927_1018035)

Figure 289. Post test 3:09 hr:min (294927_1018036)

Figure 290. Post test 3:09 hr:min (294927_1018037)

Figure 291. Post test 3:09 hr:min (294927_1018038)

Figure 292. Post test 3:11 hr:min (294927_1018039)

Figure 293. Post test 3:11 hr:min (294927_1018040)

Figure 294. Post test 3:11 hr:min (294927_1018041)

Figure 295. Post test 3:12 hr:min (294927_1018042)

Figure 296. Post test 3:12 hr:min (294927_1018043)

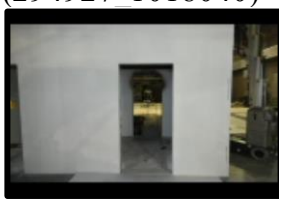

Figure 297. Post test 3:13 hr:min (294927_1018044)

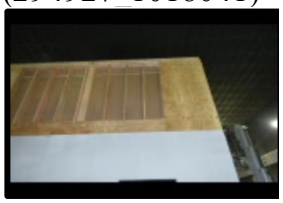

Figure 298. Post test 3:13 hr:min (294927_1018045)

Results for Test 2 (ID 294945)

The following table provides a summary of the temperature results. The "Initial" column provides the measured temperature at the beginning of the test. The maximum temperature recorded during the test is provided in the "Max" column. The remaining columns provide the calculated maximum average temperatures.

Table 14. Temperature Value Result Summary

Description	Initial (C)	Max (C)	30 second max average (C)	1 minute max average (C)	5 minute max average (C)	10 minute max average (C)
Stairs 0	27.5	244.1	161.5	129.3	76.2	56.7
Stairs 1	27.4	134.3	119.7	102.8	64.1	50.3
Stairs 2	27.5	347.1	308.4	245.7	104.4	71.8
Stairs 3	27.4	405.0	362.9	314.3	162.4	104.3
Stairs 4	27.4	477.0	414.5	341.1	191.7	120.0
Stairs 5	27.4	685.1	519.7	394.5	189.2	118.5
Stairs 6	27.5	1004.8	599.3	447.2	249.7	159.9
Stairs 7	27.6	1139.2	746.1	599.1	342.7	219.6
Stairs 8	27.6	1165.9	921.7	756.9	458.6	296.0
Stairs 9	27.7	1262.9	1007.6	842.3	513.7	336.4
Stairs 10	27.9	1287.0	1082.8	904.3	536.2	352.5
Stairs 11	27.7	1326.7	1102.1	930.6	537.6	354.1
Stairs 12	27.6	1171.0	1051.5	900.9	531.4	351.2
Stairs 13	27.5	1350.9	1119.1	952.2	543.7	357.6
Stairs 14	27.5	1211.6	1078.4	928.9	542.9	357.9
Stairs 15	27.5	1221.6	1061.2	909.3	534.0	353.0
Stairs 16	27.5	1130.7	1019.4	889.8	525.8	349.7
Stairs 17	27.6	1273.8	1046.3	895.7	532.5	353.5
1st floor rear 0	27.0	897.9	516.2	436.1	357.6	251.8
1st floor rear 1	27.2	906.0	724.8	657.3	484.7	332.8
1st floor rear 2	27.4	1003.8	846.3	770.1	500.3	335.9
1st floor rear 3	27.3	970.2	879.7	825.5	583.1	399.5
1st floor rear 4	27.2	1001.2	916.9	913.2	656.6	452.5
1st floor rear 5	27.3	1031.7	977.5	974.5	807.2	581.5
1st floor rear 6	27.2	1194.7	1115.3	1094.9	889.3	641.9
1st floor rear 7	27.2	1337.0	1210.3	1167.1	916.4	656.6
1st floor rear 8	27.8	1361.2	1264.1	1211.0	942.7	684.6
1st floor front 0	26.7	668.6	664.9	659.9	584.5	498.3
1st floor front 1	27.1	794.7	638.0	626.8	487.5	339.4
1st floor front 2	27.3	909.8	740.9	702.1	536.3	371.7
1st floor front 3	27.7	975.1	852.2	823.3	614.6	415.7
1st floor front 4	28.3	1039.1	943.8	940.7	726.2	501.2
1st floor front 5	28.3	1161.5	1042.6	1033.0	825.8	579.4
1st floor front 6	28.1	1218.0	1103.5	1099.5	899.6	631.8
1st floor front 7	27.5	1243.3	1125.7	1109.7	917.0	650.4
1st floor front 8	27.9	1393.0	1200.6	1183.2	957.1	678.1
2nd floor rear 0	27.9	988.3	817.0	706.9	387.5	260.8
2nd floor rear 1	27.7	1027.9	906.4	817.1	425.0	282.9
2nd floor rear 2	27.6	1066.8	964.5	883.2	451.4	298.7
2nd floor rear 3	27.5	1133.0	984.1	907.7	461.8	306.1
2nd floor rear 4	27.4	1100.2	978.3	919.3	470.7	311.9

Description	Initial (C)	Max (C)	30 second max average (C)	1 minute max average (C)	5 minute max average (C)	10 minute max average (C)
2nd floor rear 5	27.4	1043.1	971.4	925.7	476.8	315.5
2nd floor rear 6	27.5	1044.4	971.1	919.5	478.5	317.4
2nd floor rear 7	27.5	1150.2	991.8	914.4	476.2	316.7
2nd floor rear 8	27.6	1064.2	952.6	872.5	468.6	312.0
2nd floor front 0	27.6	931.3	759.8	659.7	342.3	229.9
2nd floor front 1	27.8	1019.7	848.4	770.6	392.2	261.9
2nd floor front 2	27.7	1045.4	914.1	839.5	427.4	284.5
2nd floor front 3	27.6	1071.5	951.2	874.5	446.5	296.4
2nd floor front 4	27.5	1111.9	991.6	909.7	461.4	305.7
2nd floor front 5	27.5	1041.9	971.5	906.4	466.1	309.0
2nd floor front 6	27.5	1115.6	976.5	877.3	468.1	311.8
2nd floor front 7	27.5	1085.7	981.0	904.0	471.5	313.1
2nd floor front 8	27.5	1102.1	986.6	914.5	467.9	310.3

The following table provides a summary of the time when certain temperatures occurred. The time at which the temperature first changed by a pre-determined amount is provided in the "Time of Initial Change" column. A value of -999 indicates that the temperature did not change by the pre-determined amount during the course of the test. The pre-determined amount of change in temperature is provided in the "Initial Change Amount" column. The time at which the maximum temperature was measured is shown in the "Time of Maximum" column. The remaining columns provide the times at which maximum average temperatures were calculated.

Table 15. Temperature Time Result Summary

Description	Time of initial change (s)	Initial change amount (C)	Time of maximum (s)	Start time of 30 second average (s)	Start time of 1 minute max average (s)	Start time of 5 minute max average (s)	Start time of 10 minute max average (s)
Stairs 0	189	5.0	239	226	206	196	189
Stairs 1	190	5.0	229	214	207	196	190
Stairs 2	187	5.0	239	222	208	193	189
Stairs 3	186	5.0	238	220	212	195	189
Stairs 4	187	5.0	218	214	212	197	191
Stairs 5	186	5.0	218	213	208	195	190
Stairs 6	186	5.0	217	209	209	197	192
Stairs 7	182	5.0	217	209	208	199	192
Stairs 8	173	5.0	214	206	205	195	191
Stairs 9	149	5.0	213	205	202	195	191
Stairs 10	104	5.0	218	205	200	192	187
Stairs 11	102	5.0	218	205	199	191	187
Stairs 12	97	5.0	220	204	198	190	187
Stairs 13	96	5.0	220	203	199	190	187
Stairs 14	97	5.0	220	203	200	191	188
Stairs 15	98	5.0	220	203	199	190	187
Stairs 16	84	5.0	213	203	198	190	187
Stairs 17	88	5.0	213	206	200	191	188
1st floor rear 0	169	5.0	214	210	286	209	196
1st floor rear 1	157	5.0	220	213	213	209	197
1st floor rear 2	89	5.0	220	212	211	206	190

Description	Time of initial change (s)	Initial change amount (C)	Time of maximum (s)	Start time of 30 second average (s)	Start time of 1 minute max average (s)	Start time of 5 minute max average (s)	Start time of 10 minute max average (s)
1st floor rear 3	69	5.0	220	212	211	204	191
1st floor rear 4	61	5.0	213	235	212	199	185
1st floor rear 5	55	5.0	229	227	213	191	185
1st floor rear 6	32	5.0	254	244	220	190	183
1st floor rear 7	23	5.0	255	234	224	188	180
1st floor rear 8	13	5.0	260	245	225	184	176
1st floor front 0	149	5.0	349	342	325	213	208
1st floor front 1	139	5.0	245	240	211	208	197
1st floor front 2	10	5.0	267	260	256	209	192
1st floor front 3	70	5.0	270	247	236	201	191
1st floor front 4	84	5.0	265	242	213	200	192
1st floor front 5	85	5.0	265	254	213	193	188
1st floor front 6	49	5.0	265	253	214	188	181
1st floor front 7	25	5.0	265	254	213	187	179
1st floor front 8	14	5.0	217	212	213	187	178
2nd floor rear 0	191	5.0	239	227	208	206	203
2nd floor rear 1	162	5.0	238	222	206	202	200
2nd floor rear 2	143	5.0	238	220	204	199	197
2nd floor rear 3	128	5.0	238	219	202	198	196
2nd floor rear 4	123	5.0	238	219	201	197	195
2nd floor rear 5	118	5.0	234	222	201	196	193
2nd floor rear 6	117	5.0	235	222	201	194	191
2nd floor rear 7	100	5.0	238	220	200	191	189
2nd floor rear 8	84	5.0	234	221	202	190	187
2nd floor front 0	194	5.0	250	240	225	206	205
2nd floor front 1	164	5.0	245	234	210	205	202
2nd floor front 2	138	5.0	242	228	208	202	199
2nd floor front 3	113	5.0	242	228	207	201	196
2nd floor front 4	111	5.0	242	227	206	199	195
2nd floor front 5	107	5.0	246	228	205	198	194
2nd floor front 6	100	5.0	242	229	210	191	189
2nd floor front 7	101	5.0	245	229	205	194	191
2nd floor front 8	108	5.0	240	228	205	197	193

The following chart(s) present a time-dependent representation of the instantaneous temperatures measured during the experiment.

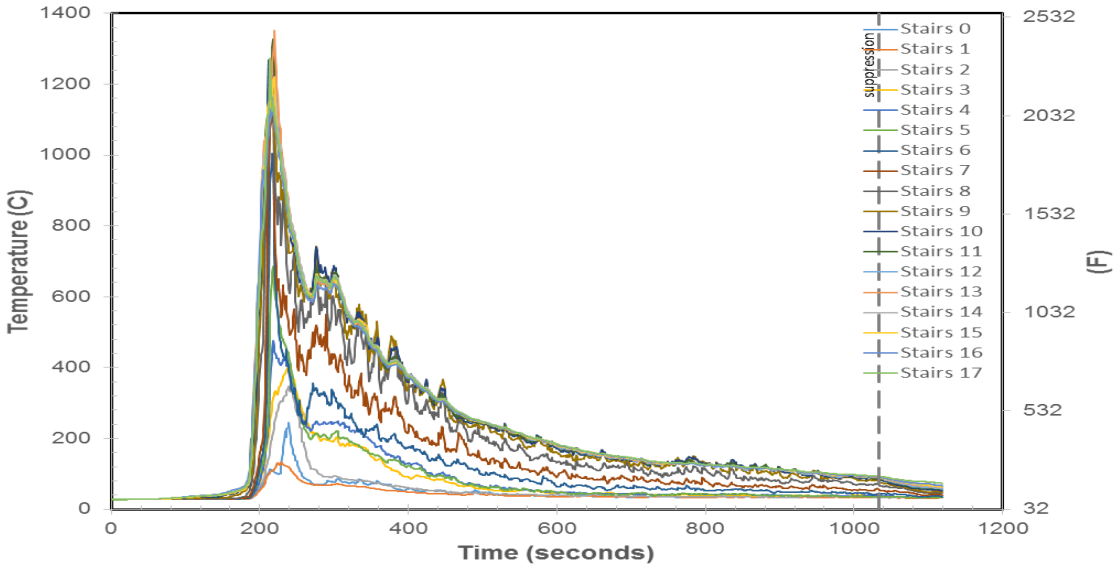

Figure 299. Temperature

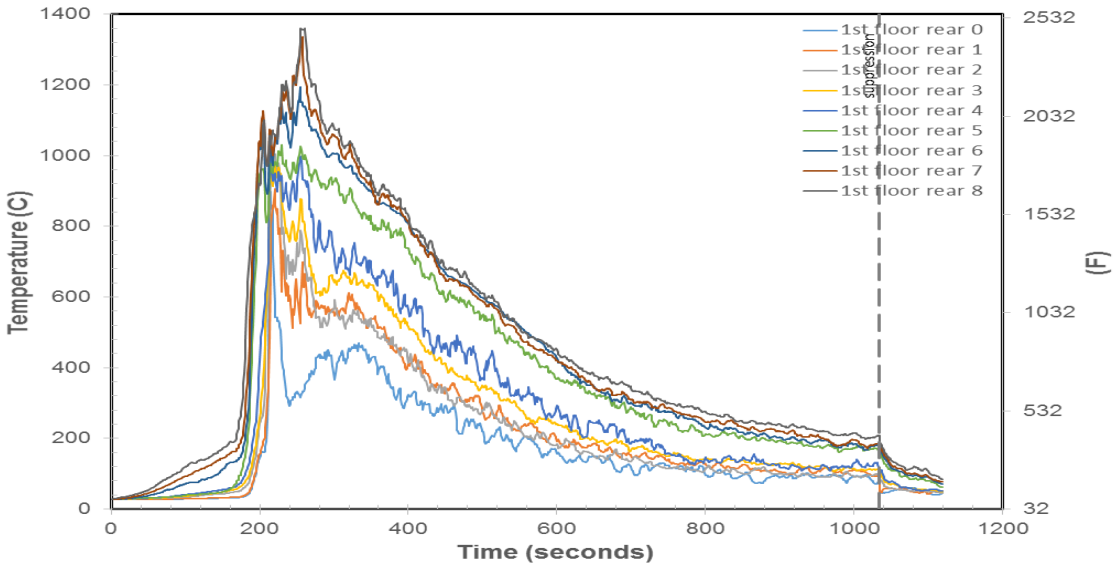

Figure 300. Temperature

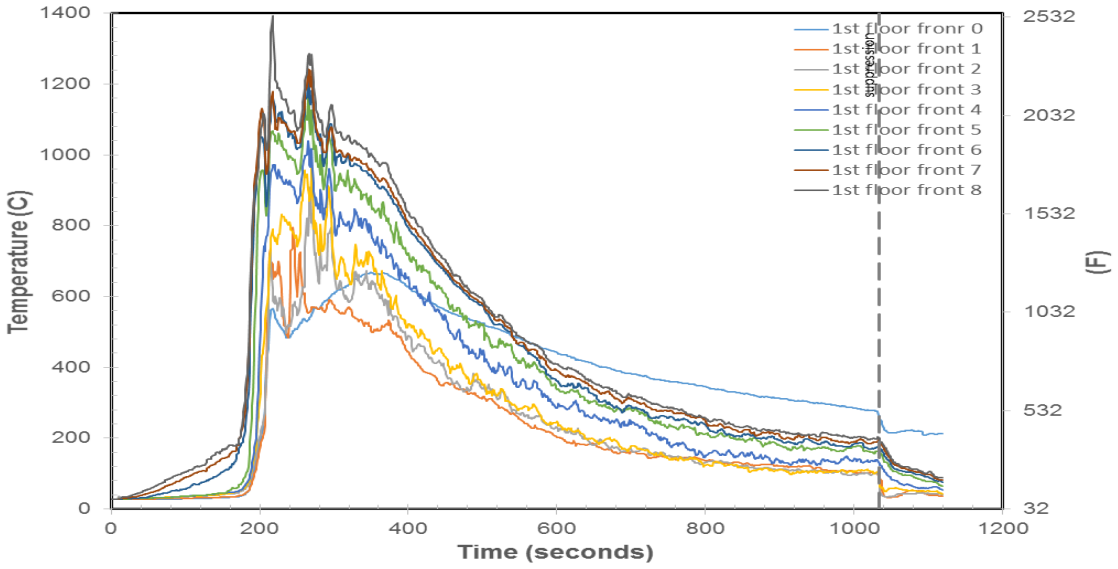

Figure 301. Temperature

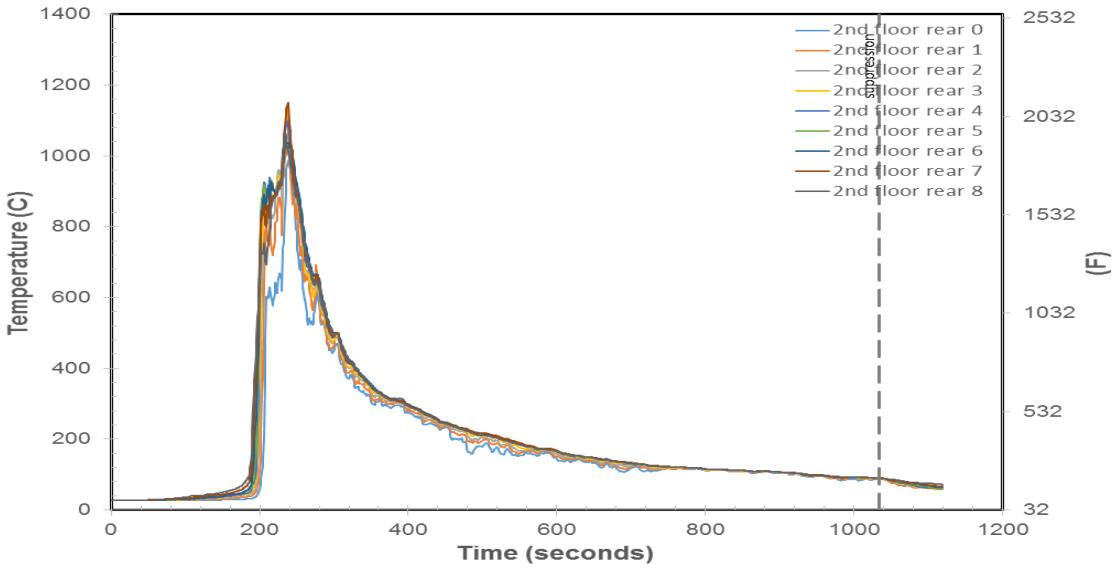

Figure 302. Temperature

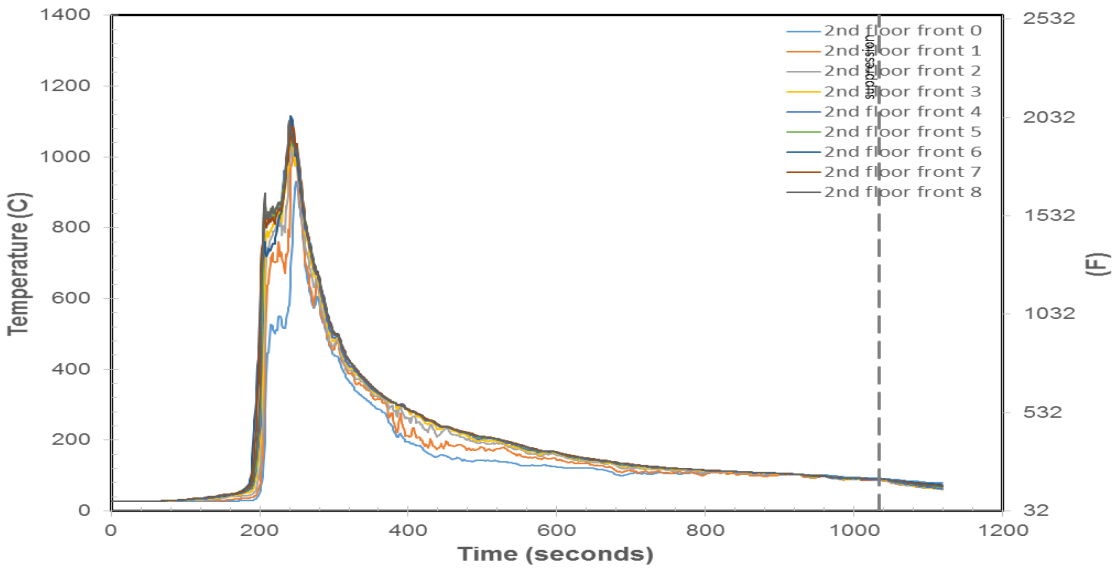

Figure 303. Temperature

The following table provides a summary of the temperatures measured at the velocity probe.

Table 16. Velocity Temperature Summary

Description	Initial temperature (C)	Temperature maximum (C)	Temperature 30 second maximum average (C)	Temperature 1 minute maximum average (C)	Temperature 5 minute maximum average (C)	Temperature 10 minute maximum average (C)
BP 1st floor rear_top	28	1036	929	902	807	592
BP 1st floor rear_middle	27	976	700	547	367	255
BP 1st floor rear_bottom	27	609	494	486	376	249
BP 1st floor front_top	28	1133	973	939	817	585
BP 1st floor front_middle	28	774	674	645	506	344
BP 1st floor front_bottom	28	177	160	156	126	90
BP 2nd floor rear_top	28	1096	1027	905	476	321
BP 2nd floor rear_middle	28	1045	1002	893	465	313
BP 2nd floor rear_bottom	28	1279	1054	903	446	301
BP 2nd floor front_top	28	956	913	867	450	301
BP 2nd floor front_middle	28	1035	951	902	444	295
BP 2nd floor front_bottom	28	991	918	853	382	250

The following table summarizes the minimum and maximum velocity values and the times at which they occurred.

Table 17. Velocity Minimum and Maximum

Description	Velocity initial (m/s)	Velocity maximum (m/s)	Velocity 5 Second Maximum Average (m/s)	Velocity 10 Second Maximum Average (m/s)	Velocity 30 second maximum average (m/s)	Velocity 60 second maximum average (m/s)
BP 1st floor rear_top	0.18	10.35	8.17	7.11	6.37	6.00
BP 1st floor rear_middle	-0.06	3.85	3.21	2.95	2.36	2.16
BP 1st floor rear_bottom	0.09	2.64	1.84	1.54	1.33	0.60
BP 1st floor front_top	-0.45	5.93	5.08	4.97	4.25	4.13
BP 1st floor front_middle	-0.50	2.21	1.84	1.52	0.87	0.29
BP 1st floor front_bottom	0.51	0.51	0.09	0.05	-0.06	-0.08
BP 2nd floor rear_top	-0.70	0.34	-0.03	-0.09	-0.22	-0.30
BP 2nd floor rear_middle	0.02	0.31	0.14	0.09	0.04	0.02
BP 2nd floor rear_bottom	-0.41	0.64	0.39	0.27	0.16	0.01
BP 2nd floor front_top	0.28	6.91	6.28	5.95	5.35	4.94
BP 2nd floor front_middle	-0.12	4.75	4.45	3.96	3.36	3.24
BP 2nd floor front_bottom	0.10	4.37	3.10	2.42	1.84	1.29

Description	Initial Velocity (m/s)	Velocity minimum (m/s)	Velocity 30 Second Minimum Average (m/s)	Velocity 1 minute maximum average (m/s)	Velocity 5 minute Minimum Average (m/s)	Velocity 10 minute Minimum Average (m/s)
BP 1st floor rear_top	0.18	-5.61	-4.36	6.00	-0.32	1.28
BP 1st floor rear_middle	-0.06	-1.48	-0.37	2.16	0.06	0.22
BP 1st floor rear_bottom	0.09	-2.59	-2.03	0.60	-1.57	-1.32
BP 1st floor front_top	-0.45	-0.55	-0.06	4.13	1.00	1.20
BP 1st floor front_middle	-0.50	-2.73	-1.76	0.29	-1.44	-1.19
BP 1st floor front_bottom	0.51	-2.53	-2.03	-0.08	-1.72	-1.51
BP 2nd floor rear_top	-0.70	-11.79	-10.64	-0.30	-6.20	-4.65
BP 2nd floor rear_middle	0.02	-0.46	-0.31	0.02	-0.09	-0.07
BP 2nd floor rear_bottom	-0.41	-10.26	-9.15	0.01	-5.05	-3.73
BP 2nd floor front_top	0.28	-2.34	0.00	4.94	0.87	1.11
BP 2nd floor front_middle	-0.12	-2.90	-0.77	3.24	-0.25	-0.08
BP 2nd floor front_bottom	0.10	-2.90	-0.88	1.29	-0.45	-0.28

The following chart(s) present a time dependent representation of the instantaneous velocities measured during the experiment.

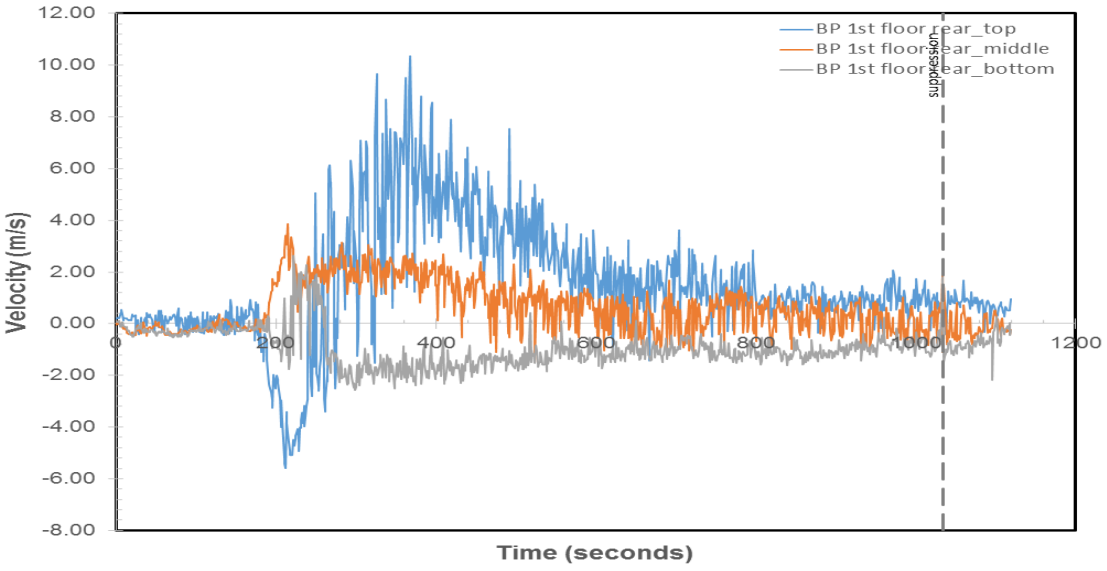

Figure 304. Velocity

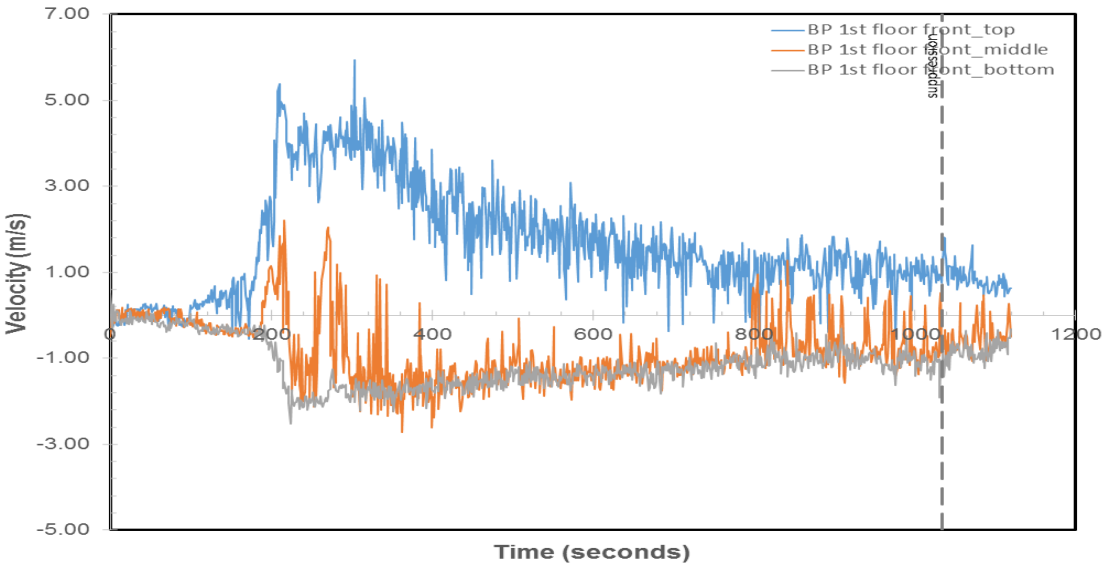

Figure 305. Velocity

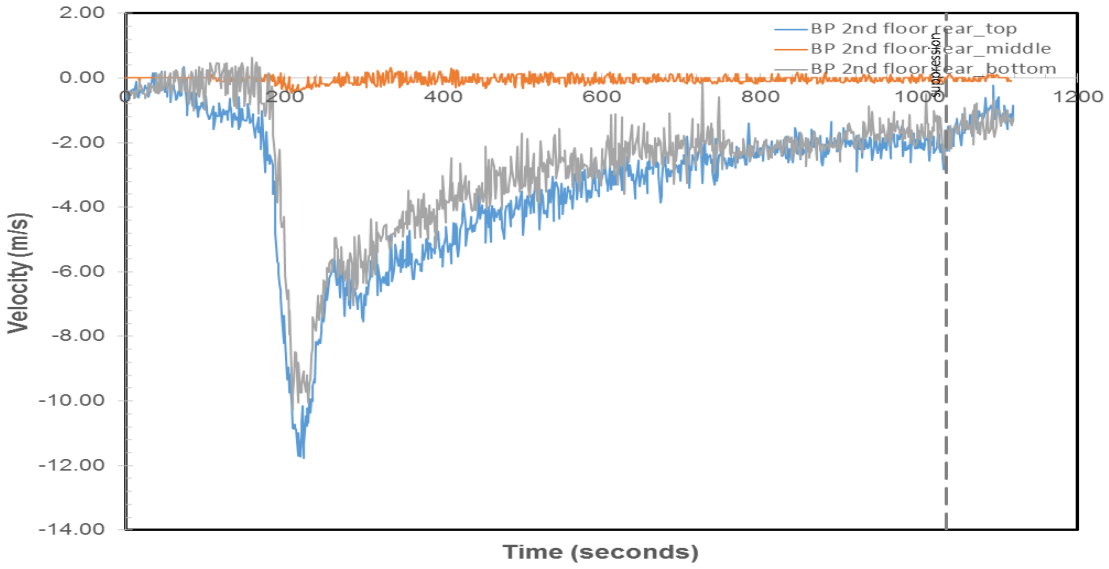

Figure 306. Velocity

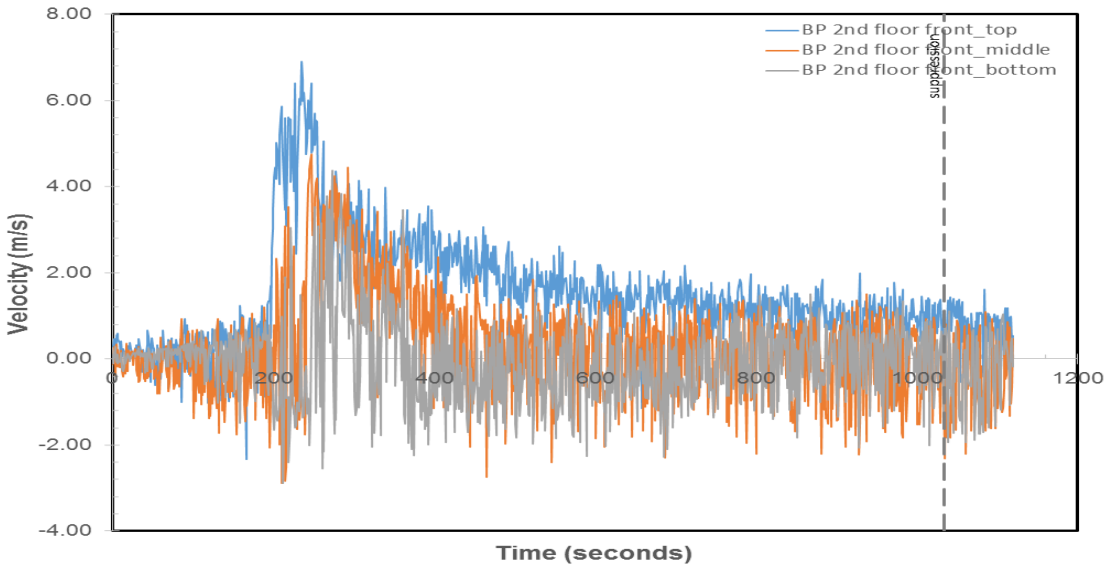

Figure 307. Velocity

The following chart shows the temperature used to calculate the velocity.

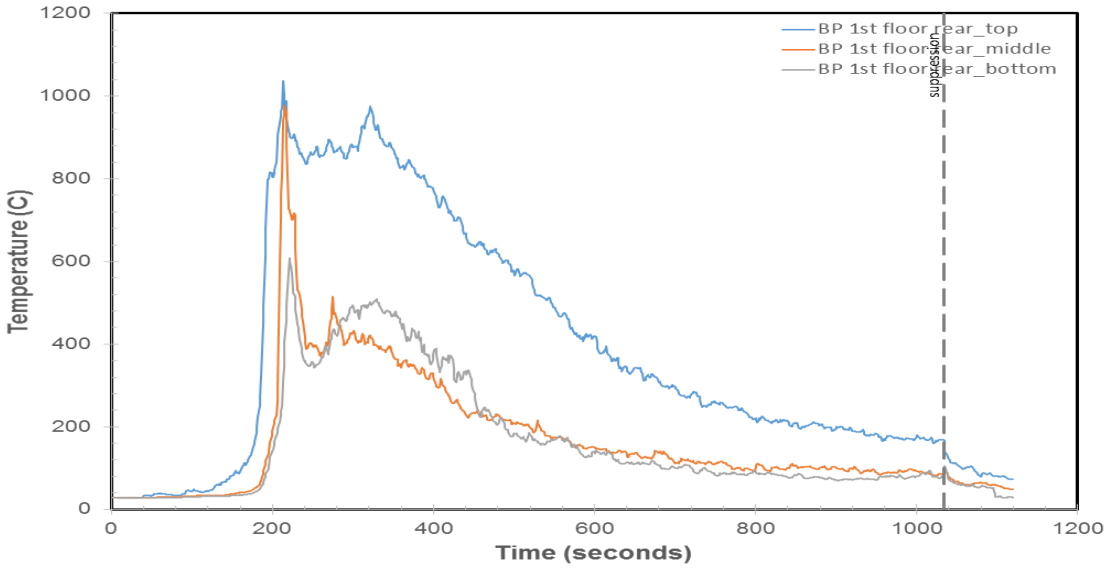

Figure 308. Temperature Chart

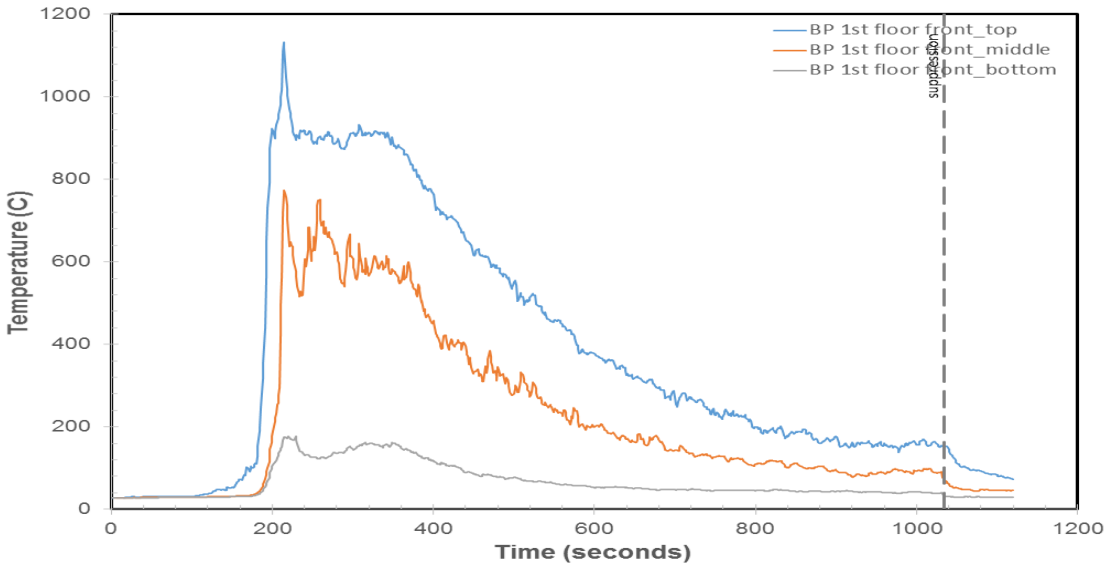

Figure 309. Temperature Chart

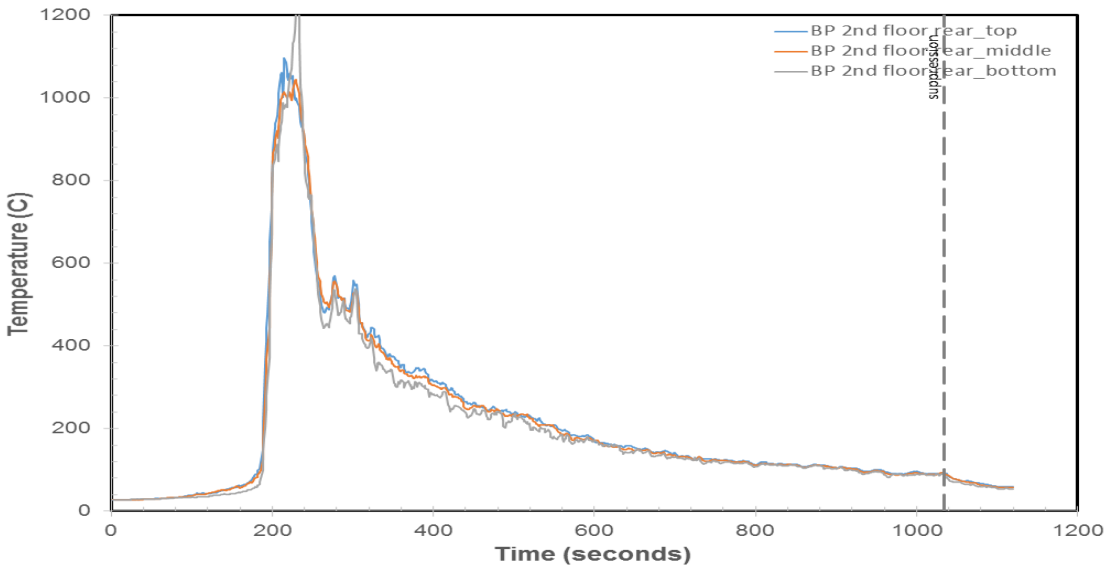

Figure 310. Temperature Chart

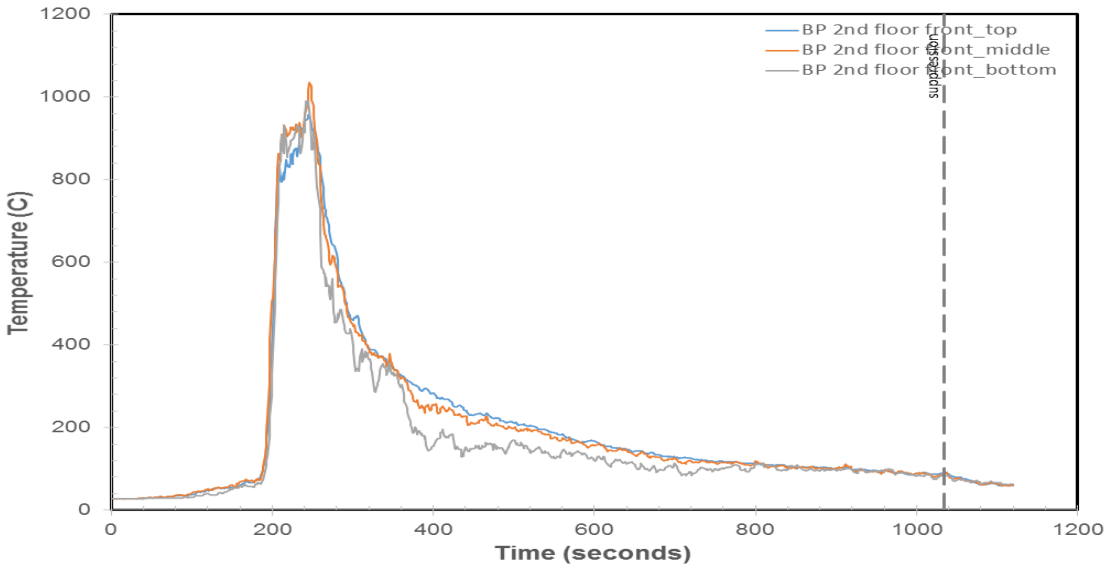

Figure 311. Temperature Chart

The following table provides a summary of the heat flux results. A "SC" in the table indicates that the values did not change sufficiently for this value to be calculated. The "Description" column typically describes the location of the heat flux transducer. The time at which the heat flux first changes by a pre-determined amount is provided in the "Time of Initial Change" column. The pre-determined amount of change in heat flux is provided in the "Initial Change Amount" column. The maximum heat flux recorded during the test is provided in the "Maximum" column. The "Maximum Average" columns are calculated over four pre-determined time spans.

Table 18. Heat Flux Result Summary

Description	Time of Initial Change (s)	Initial Change Value (kW/m²)	Maximum (kW/m²)	10 second maximum average (kW/m²)	30 second maximum average (kW/m²)	1 minute maximum average (kW/m²)	5 minute maximum average (kW/m²)	10 minute maximum average (kW/m²)
1st floor stairs	188	5	93.1	81.4	74.4	56.9	22.4	12.7
2nd floor stairs	188	5	190.5	173.8	145.0	107.2	33.7	18.6
1st floor rear	174	5	142.9	127.9	112.2	106.7	82.7	52.4
1st floor front	176	5	136.3	121.6	118.6	117.8	90.0	55.1
2nd floor rear	191	5	127.5	103.1	93.6	77.9	28.6	15.7
2nd floor front	192	5	142.2	125.2	106.7	84.9	29.0	15.8

The following chart shows a time dependent representation of the instantaneous heat flux measured during the experiment.

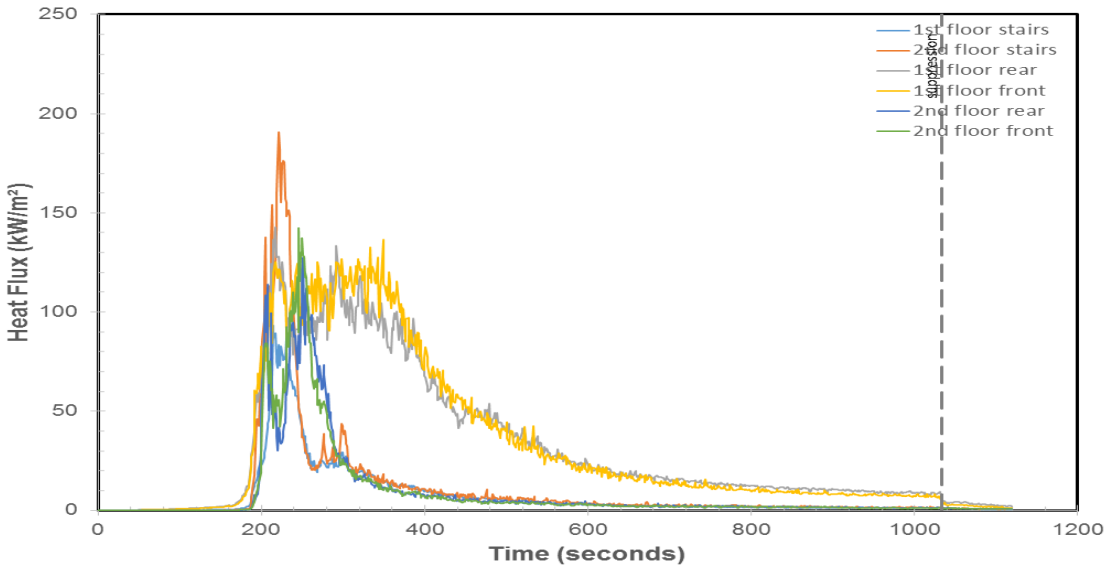

Figure 312. Heat Flux

The following table lists selected events that occurred during the experiment.

Table 19. Experiment Events

Description	Time (s)
suppression	1034

The following chart shows the heat release rate of the fire during the experiment. The heat release rate is calculated based on the principle of oxygen consumption calorimetry.

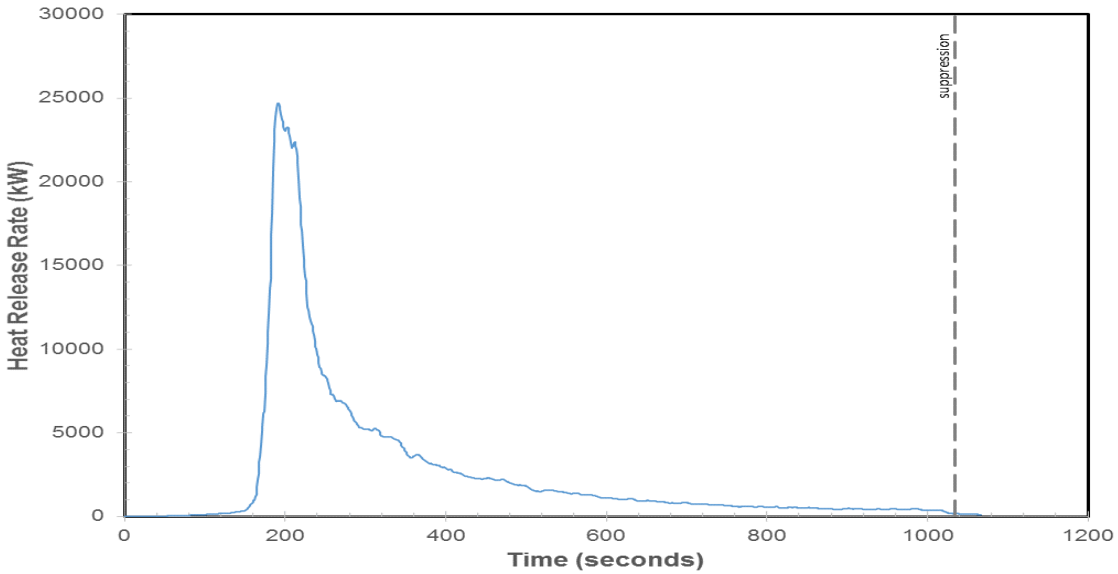

Figure 313. Heat Release Rate

The following chart shows the total heat released from the fire during the experiment. The total heat released is calculated by integrating the heat release rate over time.

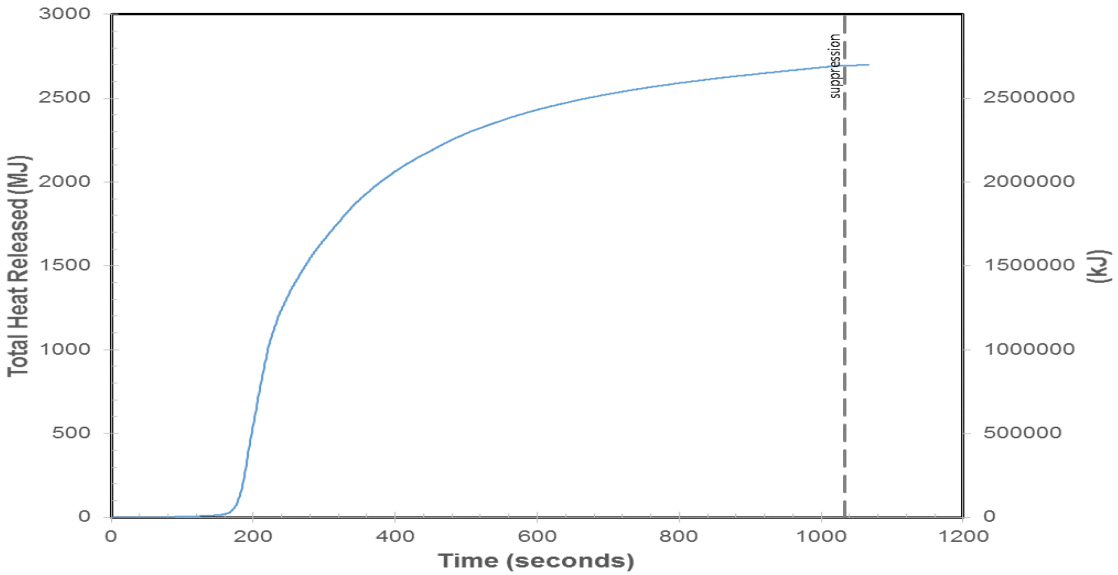

Figure 314. Total Heat Released

The following table provides a description of the video(s) taken during this experiment.

Table 20. Video Log

Description	Start Time	Duration (s)	Filename
FLIR BACK	09:58:42	1340	294945_20180830_095842_1.mov
FLIR FRONT	09:58:44	1339	294945_20180830_095844_2.mov
2ND FLOOR	09:58:45	1339	294945_20180830_095845_3.mov
1ST FLOOR FRONT	09:58:47	1338	294945_20180830_095847_4.mov
1ST FLOOR MID	09:58:48	1338	294945_20180830_095848_5.mov
1ST FLOOR BACK	09:58:50	1338	294945_20180830_095850_6.mov
BACK HD	09:58:52	1336	294945_20180830_095852_9.mov
FRONT HD	09:58:52	1337	294945_20180830_095852_10.mov
SIDE HD	09:58:53	1337	294945_20180830_095853_11.mov
MASTER			294945_1030858.mov

The following figures show all of the still photographs uploaded into the FireTOSS system. The caption below each figure provides the picture's filename as well as any description and elapsed test time associated with the picture.

Figure 315. Pre test 19:17 hr:min (294945_1018334)

Figure 316. Pre test 19:17 hr:min (294945_1018335)

Figure 317. Pre test 19:16 hr:min (294945_1018336)

Figure 318. Pre test 19:16 hr:min (294945_1018337)

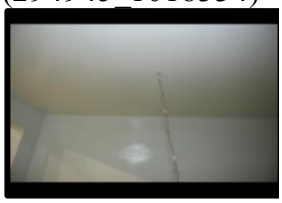

Figure 319. Pre test 19:16 hr:min (294945_1018338)

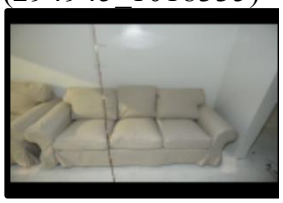

Figure 320. Pre test 19:16 hr:min (294945_1018339)

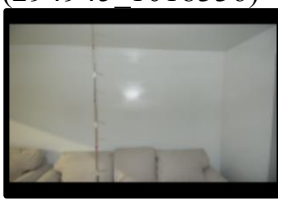

Figure 321. Pre test 19:16 hr:min (294945_1018340)

Figure 322. Pre test 19:16 hr:min (294945_1018341)

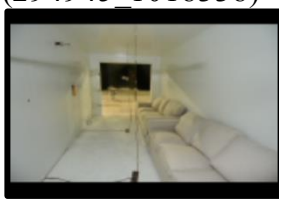

Figure 323. Pre test 19:15 hr:min (294945_1018342)

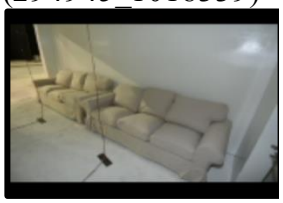

Figure 324. Pre test 19:15 hr:min (294945_1018343)

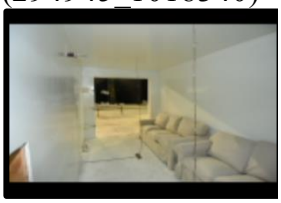

Figure 325. Pre test 19:15 hr:min (294945_1018344)

Figure 326. Pre test 19:14 hr:min (294945_1018345)

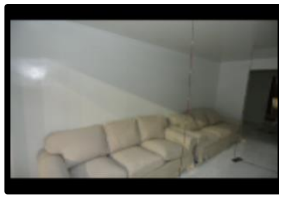

Figure 327. Pre test 19:14 hr:min (294945_1018346)

Figure 328. Pre test 19:14 hr:min (294945_1018347)

Figure 329. Pre test 19:14 hr:min (294945_1018348)

Figure 330. Pre test 19:14 hr:min (294945_1018349)

Figure 331. Pre test 19:14 hr:min (294945_1018350)

Figure 332. Pre test 19:14 hr:min (294945_1018351)

Figure 333. Pre test 19:14 hr:min (294945_1018352)

Figure 334. Pre test 19:13 hr:min (294945_1018353)

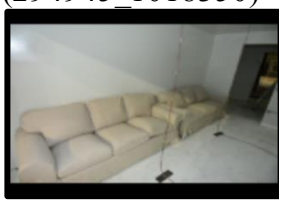

Figure 335. Pre test 19:13 hr:min (294945_1018354)

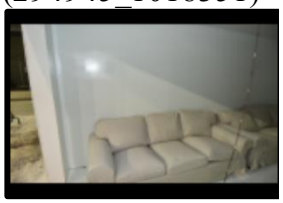

Figure 336. Pre test 19:13 hr:min (294945_1018355)

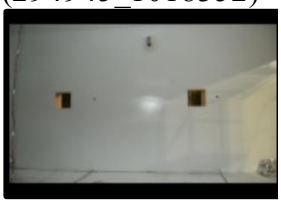

Figure 337. Pre test 19:13 hr:min (294945_1018356)

Figure 338. Pre test 19:13 hr:min (294945_1018357)

Figure 339. Pre test 19:13 hr:min (294945_1018358)

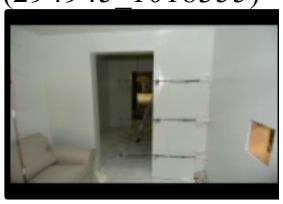

Figure 340. Pre test 19:12 hr:min (294945_1018359)

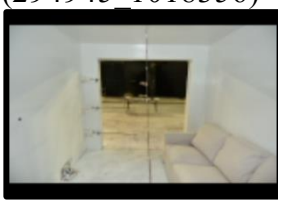

Figure 341. Pre test 19:12 hr:min (294945_1018360)

Figure 342. Pre test 19:12 hr:min (294945_1018361)

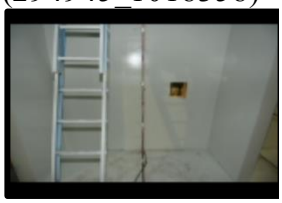

Figure 343. Pre test 19:12 hr:min (294945_1018362)

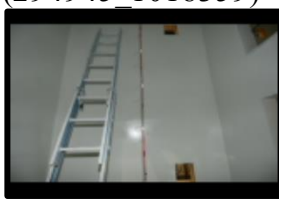

Figure 344. Pre test 19:12 hr:min (294945_1018363)

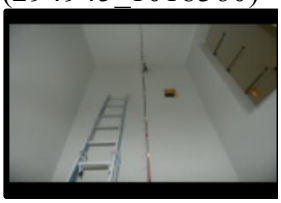

Figure 345. Pre test 19:12 hr:min (294945_1018364)

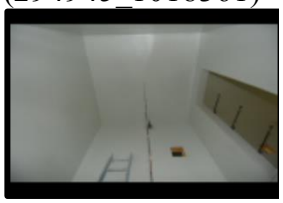

Figure 346. Pre test 19:12 hr:min (294945_1018365)

Figure 347. Pre test 19:11 hr:min (294945_1018366)

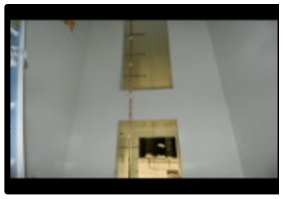

Figure 348. Pre test 19:11 hr:min (294945_1018367)

Figure 349. Pre test 19:11 hr:min (294945_1018368)

Figure 350. Pre test 19:11 hr:min (294945_1018369)

Figure 351. Pre test 19:11 hr:min (294945_1018370)

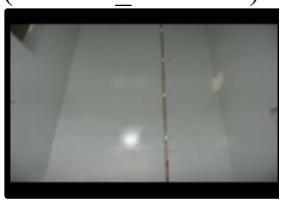

Figure 352. Pre test 19:11 hr:min (294945_1018371)

Figure 353. Pre test 19:11 hr:min (294945_1018372)

Figure 354. Pre test 19:11 hr:min (294945_1018373)

Figure 355. Pre test 19:11 hr:min (294945_1018374)

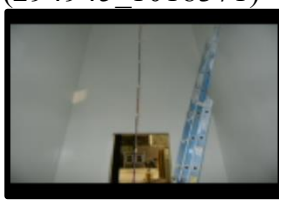

Figure 356. Pre test 19:11 hr:min (294945_1018375)

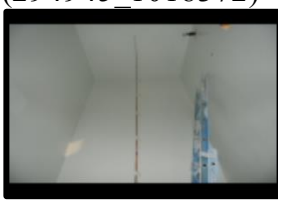

Figure 357. Pre test 19:11 hr:min (294945_1018376)

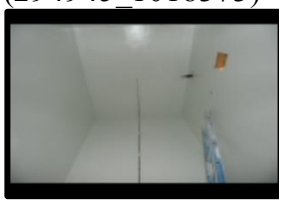

Figure 358. Pre test 19:10 hr:min (294945_1018377)

Figure 359. Pre test 19:10 hr:min (294945_1018378)

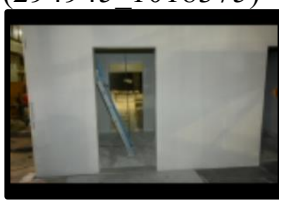

Figure 360. Pre test 19:09 hr:min (294945_1018379)

Figure 361. Pre test 19:09 hr:min (294945_1018380)

Figure 362. Pre test 19:09 hr:min (294945_1018381)

Figure 363. Pre test 19:08 hr:min (294945_1018382)

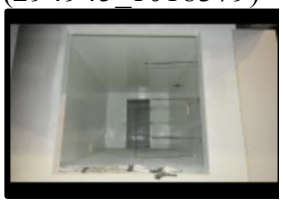

Figure 364. Pre test 19:08 hr:min (294945_1018383)

Figure 365. Pre test 19:07 hr:min (294945_1018384)

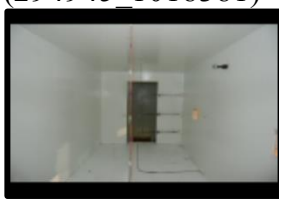

Figure 366. Pre test 19:07 hr:min (294945_1018385)

Figure 367. Pre test 19:07 hr:min (294945_1018386)

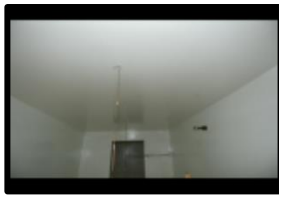

Figure 368. Pre test 19:06 hr:min (294945_1018387)

Figure 369. Pre test 19:06 hr:min (294945_1018388)

Figure 370. Pre test 19:06 hr:min (294945_1018389)

Figure 371. Pre test 19:06 hr:min (294945_1018390)

Figure 372. Pre test 19:06 hr:min (294945_1018391)

Figure 373. Pre test 19:06 hr:min (294945_1018392)

Figure 374. Pre test 19:06 hr:min (294945_1018393)

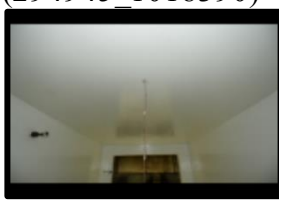

Figure 375. Pre test 19:06 hr:min (294945_1018394)

Figure 376. Pre test 19:06 hr:min (294945_1018395)

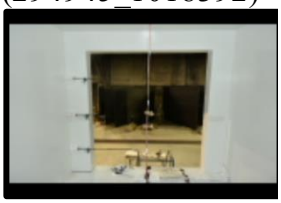

Figure 377. Pre test 19:05 hr:min (294945_1018396)

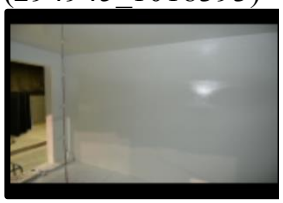

Figure 378. Pre test 19:05 hr:min (294945_1018397)

Figure 379. Pre test 19:05 hr:min (294945_1018398)

Figure 380. Pre test 19:05 hr:min (294945_1018399)

Figure 381. Pre test 19:05 hr:min (294945_1018400)

Figure 382. Pre test 19:04 hr:min (294945_1018401)

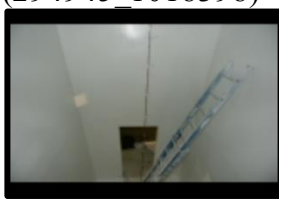

Figure 383. Pre test 19:04 hr:min (294945_1018402)

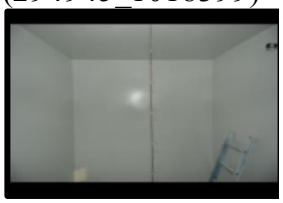

Figure 384. Pre test 19:04 hr:min (294945_1018403)

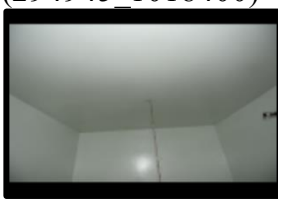

Figure 385. Pre test 19:04 hr:min (294945_1018404)

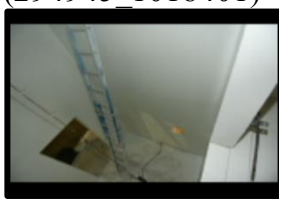

Figure 386. Pre test 19:04 hr:min (294945_1018405)

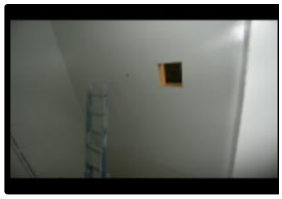

Figure 387. Pre test 19:04 hr:min (294945_1018406)

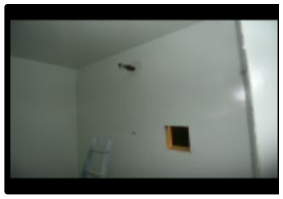

Figure 388. Pre test 19:04 hr:min (294945_1018407)

Figure 389. Pre test 19:04 hr:min (294945_1018408)

Figure 390. Pre test 19:04 hr:min (294945_1018409)

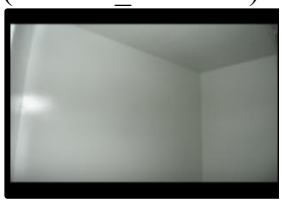

Figure 391. Pre test 19:04 hr:min (294945_1018410)

Figure 392. Pre test 1:47 hr:min (294945_1018411)

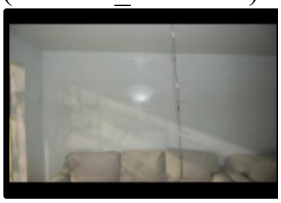

Figure 393. Pre test 1:47 hr:min (294945_1018412)

Figure 394. Pre test 1:47 hr:min (294945_1018413)

Figure 395. Pre test 1:47 hr:min (294945_1018414)

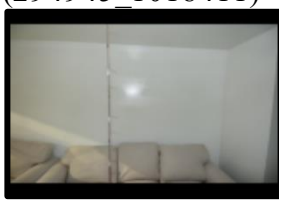

Figure 396. Pre test 1:47 hr:min (294945_1018415)

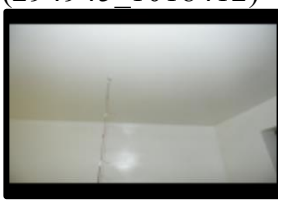

Figure 397. Pre test 1:46 hr:min (294945_1018416)

Figure 398. Pre test 1:46 hr:min (294945_1018417)

Figure 399. Pre test 1:46 hr:min (294945_1018418)

Figure 400. Pre test 1:46 hr:min (294945_1018419)

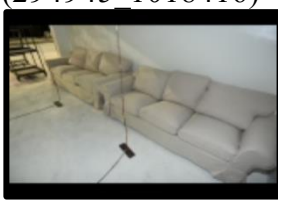

Figure 401. Pre test 1:46 hr:min (294945_1018420)

Figure 402. Pre test 1:46 hr:min (294945_1018421)

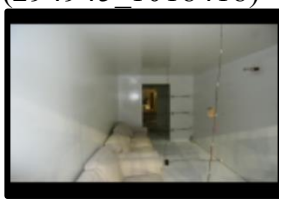

Figure 403. Pre test 1:45 hr:min (294945_1018422)

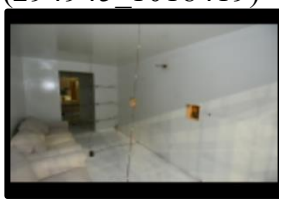

Figure 404. Pre test 1:45 hr:min (294945_1018423)

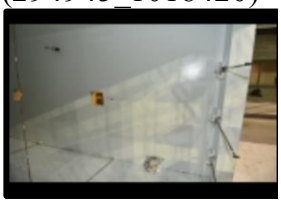

Figure 405. Pre test 1:45 hr:min (294945_1018424)

Figure 406. Pre test 1:45 hr:min (294945_1018425)

Figure 407. Pre test 1:45 hr:min (294945_1018426)

Figure 408. Pre test 1:45 hr:min (294945_1018427)

Figure 409. Pre test 43 minutes (294945_1018428)

Figure 410. Pre test 43 minutes (294945_1018429)

Figure 411. Pre test 43 minutes (294945_1018430)

Figure 412. Pre test 43 minutes (294945_1018431)

Figure 413. Pre test 42 minutes (294945_1018432)

Figure 414. Pre test 42 minutes (294945_1018433)

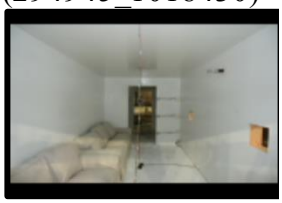

Figure 415. Pre test 42 minutes (294945_1018434)

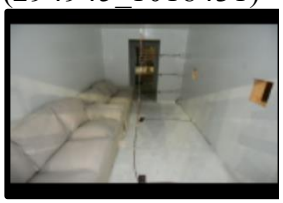

Figure 416. Pre test 42 minutes (294945_1018435)

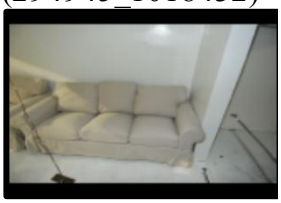

Figure 417. Pre test 42 minutes (294945_1018436)

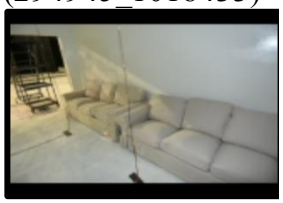

Figure 418. Pre test 42 minutes (294945_1018437)

Figure 419. Pre test 42 minutes (294945_1018438)

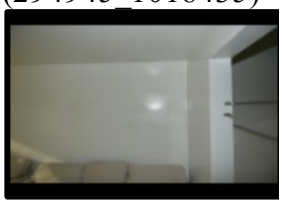

Figure 420. Pre test 42 minutes (294945_1018439)

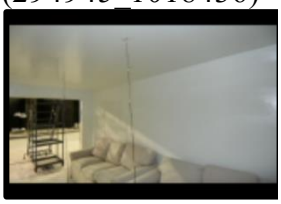

Figure 421. Pre test 42 minutes (294945_1018440)

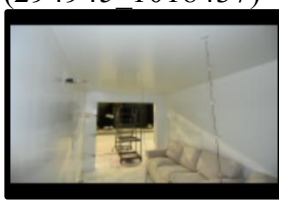

Figure 422. Pre test 42 minutes (294945_1018441)

Figure 423. Pre test 34 minutes (294945_1018442)

Figure 424. Pre test 34 minutes (294945_1018443)

Figure 425. Pre test 33 minutes (294945_1018444)

Figure 426. Pre test 33 minutes (294945_1018445)

Figure 427. Pre test 33 minutes (294945_1018446)

Figure 428. Pre test 33 minutes (294945_1018447)

Figure 429. Pre test 32 minutes (294945_1018449)

Figure 430. Pre test 32 minutes (294945_1018450)

Figure 431. Pre test 32 minutes (294945_1018448)

Figure 432. Pre test 32 minutes (294945_1018451)

Figure 433. Pre test 32 minutes (294945_1018452)

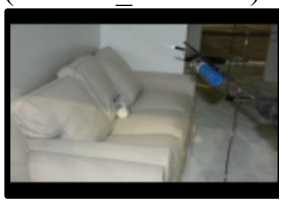

Figure 434. Pre test 3 seconds (294945_1018453)

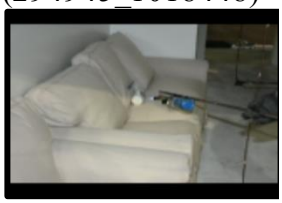

Figure 435. Pre test 1 seconds (294945_1018454)

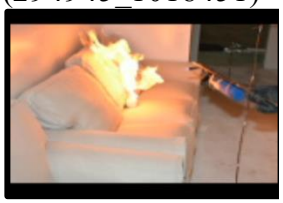

Figure 436. 0 seconds (294945_1018455)

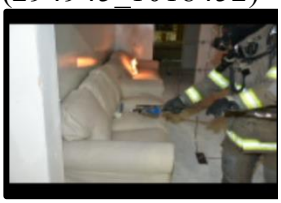

Figure 437. 6 seconds (294945_1018456)

Figure 438. 7 seconds (294945_1018457)

Figure 439. 13 seconds (294945_1018458)

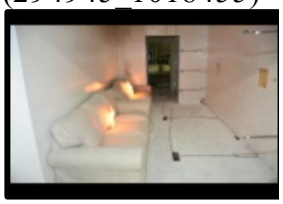

Figure 440. 14 seconds (294945_1018459)

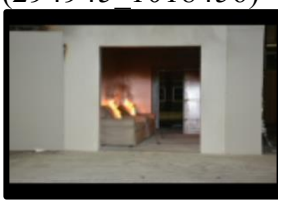

Figure 441. 45 seconds (294945_1018460)

Figure 442. 48 seconds (294945_1018461)

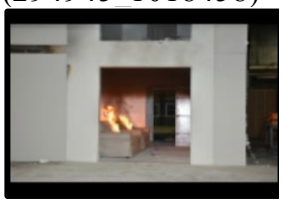

Figure 443. 51 seconds (294945_1018462)

Figure 444. 65 seconds (294945_1018463)

Figure 445. 82 seconds (294945_1018464)

Figure 446. 91 seconds (294945_1018465)

Figure 447. 107 seconds (294945_1018466)

Figure 448. 112 seconds (294945_1018467)

Figure 449. 128 seconds (294945_1018468)

Figure 450. 147 seconds (294945_1018469)

Figure 451. 161 seconds (294945_1018470)

Figure 452. 166 seconds (294945_1018471)

Figure 453. 179 seconds (294945_1018472)

Figure 454. 181 seconds (294945_1018473)

Figure 455. 188 seconds (294945_1018474)

Figure 456. 190 seconds (294945_1018475)

Figure 457. 192 seconds (294945_1018476)

Figure 458. 197 seconds (294945_1018477)

Figure 459. 203 seconds (294945_1018478)

Figure 460. 204 seconds (294945_1018479)

Figure 461. 212 seconds (294945_1018480)

Figure 462. 225 seconds (294945_1018481)

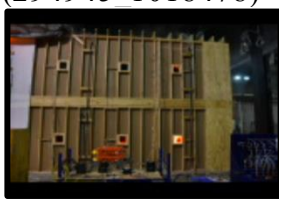

Figure 463. 232 seconds (294945_1018482)

Figure 464. 233 seconds (294945_1018483)

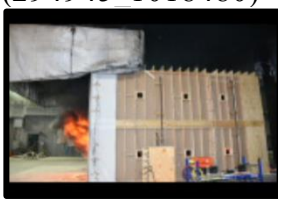

Figure 465. 283 seconds (294945_1018484)

Figure 466. 285 seconds (294945_1018485)

Figure 467. 332 seconds (294945_1018486)

Figure 468. 334 seconds (294945_1018487)

Figure 469. 362 seconds (294945_1018488)

Figure 470. 364 seconds (294945_1018489)

Figure 471. 366 seconds (294945_1018490)

Figure 472. 438 seconds (294945_1018491)

Figure 473. 441 seconds (294945_1018492)

Figure 474. 442 seconds (294945_1018493)

Figure 475. 446 seconds (294945_1018494)

Figure 476. 464 seconds (294945_1018495)

Figure 477. 467 seconds (294945_1018496)

Figure 478. 469 seconds (294945_1018497)

Figure 479. 489 seconds (294945_1018498)

Figure 480. 493 seconds (294945_1018499)

Figure 481. 494 seconds (294945_1018500)

Figure 482. 594 seconds (294945_1018501)

Figure 483. 618 seconds (294945_1018502)

Figure 484. 619 seconds (294945_1018503)

Figure 485. 660 seconds (294945_1018504)

Figure 486. 898 seconds (294945_1018505)

Figure 487. 899 seconds (294945_1018506)

Figure 488. 937 seconds (294945_1018507)

Figure 489. 938 seconds (294945_1018508)

Figure 490. 943 seconds (294945_1018509)

Figure 491. 1005 seconds (294945_1018510)

Figure 492. 1022 seconds (294945_1018511)

Figure 493. 1028 seconds (294945_1018512)

Figure 494. 1030 seconds (294945_1018513)

Figure 495. 1032 seconds (294945_1018514)

Figure 496. Post test 2:36 hr:min (294945_1018515)

Figure 497. Post test 2:36 hr:min (294945_1018516)

Figure 498. Post test 2:37 hr:min (294945_1018517)

Figure 499. Post test 2:37 hr:min (294945_1018518)

Figure 500. Post test 2:37 hr:min (294945_1018519)

Figure 501. Post test 2:38 hr:min (294945_1018520)

Figure 502. Post test 2:38 hr:min (294945_1018521)

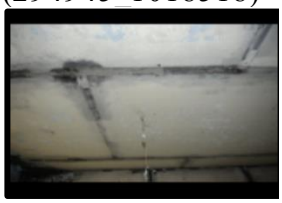

Figure 503. Post test 2:38 hr:min (294945_1018522)

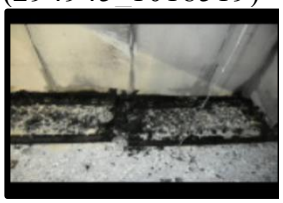

Figure 504. Post test 2:38 hr:min (294945_1018523)

Figure 505. Post test 2:38 hr:min (294945_1018524)

Figure 506. Post test 2:38 hr:min (294945_1018525)

Figure 507. Post test 2:39 hr:min (294945_1018526)

Figure 508. Post test 2:39 hr:min (294945_1018527)

Figure 509. Post test 2:39 hr:min (294945_1018528)

Figure 510. Post test 2:39 hr:min (294945_1018529)

Figure 511. Post test 2:39 hr:min (294945_1018530)

Figure 512. Post test 2:39 hr:min (294945_1018531)

Figure 513. Post test 2:40 hr:min (294945_1018532)

Figure 514. Post test 2:40 hr:min (294945_1018533)

Figure 515. Post test 2:40 hr:min (294945_1018534)

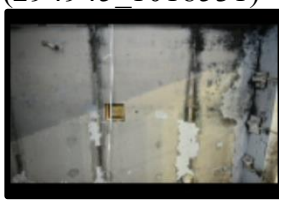

Figure 516. Post test 2:40 hr:min (294945_1018535)

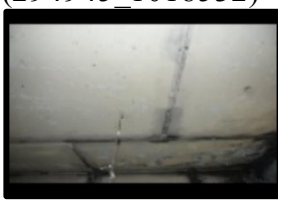

Figure 517. Post test 2:40 hr:min (294945_1018536)

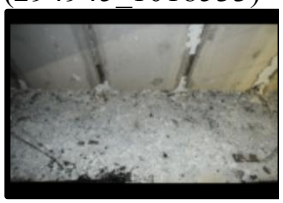

Figure 518. Post test 2:40 hr:min (294945_1018537)

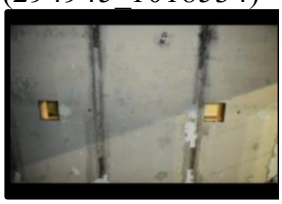

Figure 519. Post test 2:40 hr:min (294945_1018538)

Figure 520. Post test 2:40 hr:min (294945_1018539)

Figure 521. Post test 2:41 hr:min (294945_1018540)

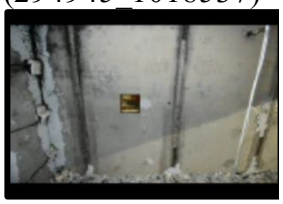

Figure 522. Post test 2:41 hr:min (294945_1018541)

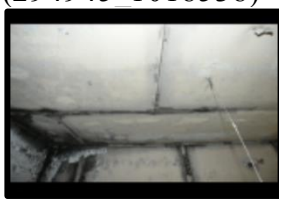

Figure 523. Post test 2:41 hr:min (294945_1018542)

Figure 524. Post test 2:41 hr:min (294945_1018543)

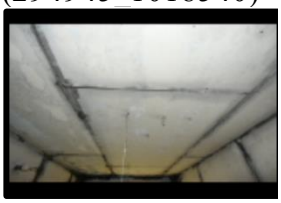

Figure 525. Post test 2:41 hr:min (294945_1018544)

Figure 526. Post test 2:41 hr:min (294945_1018545)

Figure 527. Post test 2:41 hr:min (294945_1018546)

Figure 528. Post test 2:46 hr:min (294945_1018547)

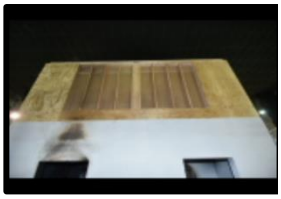

Figure 529. Post test 2:46 hr:min (294945_1018548)

Figure 530. Post test 2:46 hr:min (294945_1018549)

Figure 531. Post test 2:46 hr:min (294945_1018550)

Figure 532. Post test 2:46 hr:min (294945_1018551)

Figure 533. Post test 2:46 hr:min (294945_1018552)

Figure 534. Post test 2:46 hr:min (294945_1018553)

Figure 535. Post test 2:47 hr:min (294945_1018554)

Figure 536. Post test 2:47 hr:min (294945_1018555)

Figure 537. Post test 2:47 hr:min (294945_1018556)

Figure 538. Post test 2:47 hr:min (294945_1018557)

Figure 539. Post test 2:47 hr:min (294945_1018558)

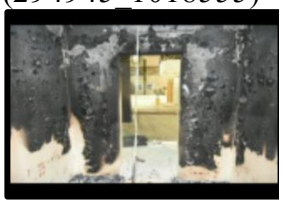

Figure 540. Post test 2:47 hr:min (294945_1018559)

Figure 541. Post test 2:47 hr:min (294945_1018560)

Figure 542. Post test 2:47 hr:min (294945_1018561)

Figure 543. Post test 2:47 hr:min (294945_1018562)

Figure 544. Post test 2:47 hr:min (294945_1018563)

Figure 545. Post test 2:47 hr:min (294945_1018564)

Figure 546. Post test 2:47 hr:min (294945_1018565)

Figure 547. Post test 2:48 hr:min (294945_1018566)

Figure 548. Post test 2:48 hr:min (294945_1018567)

Figure 549. Post test 2:49 hr:min (294945_1018568)

Figure 550. Post test 2:49 hr:min (294945_1018569)

Figure 551. Post test 2:53 hr:min (294945_1018570)

Figure 552. Post test 2:53 hr:min (294945_1018571)

Figure 553. Post test 2:53 hr:min (294945_1018572)

Figure 554. Post test 2:53 hr:min (294945_1018573)

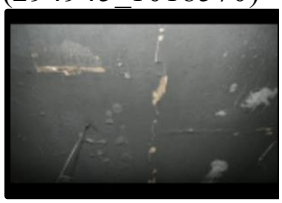

Figure 555. Post test 2:53 hr:min (294945_1018574)

Figure 556. Post test 2:55 hr:min (294945_1018575)

Figure 557. Post test 2:55 hr:min (294945_1018576)

Figure 558. Post test 2:55 hr:min (294945_1018577)

Figure 559. Post test 2:55 hr:min (294945_1018578)

Figure 560. Post test 2:55 hr:min (294945_1018579)

Figure 561. Post test 2:55 hr:min (294945_1018580)

Figure 562. Post test 2:55 hr:min (294945_1018581)

Figure 563. Post test 2:55 hr:min (294945_1018582)

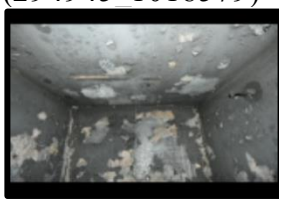

Figure 564. Post test 2:55 hr:min (294945_1018583)

Figure 565. Post test 2:56 hr:min (294945_1018584)

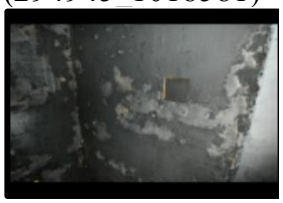

Figure 566. Post test 2:56 hr:min (294945_1018585)

Figure 567. Post test 2:56 hr:min (294945_1018586)

Figure 568. Post test 2:56 hr:min (294945_1018587)

Figure 569. Post test 2:56 hr:min (294945_1018588)

Figure 570. Post test 2:56 hr:min (294945_1018589)

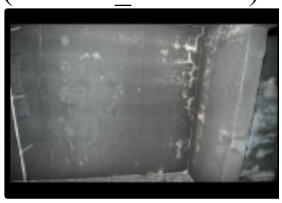

Figure 571. Post test 2:56 hr:min (294945_1018590)

Figure 572. Post test 2:56 hr:min (294945_1018591)

Figure 573. Post test 2:56 hr:min (294945_1018592)

Figure 574. Post test 2:56 hr:min (294945_1018593)

Figure 575. Post test 2:57 hr:min (294945_1018594)

Figure 576. Post test 2:57 hr:min (294945_1018595)

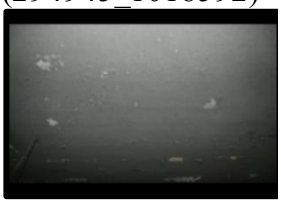

Figure 577. Post test 2:57 hr:min (294945_1018596)

Figure 578. Post test 2:57 hr:min (294945_1018597)

Figure 579. Post test 2:57 hr:min (294945_1018598)

Figure 580. Post test 2:57 hr:min (294945_1018599)

Figure 581. Post test 2:58 hr:min (294945_1018600)

Figure 582. Post test 2:58 hr:min (294945_1018601)

Figure 583. Post test 2:58 hr:min (294945_1018602)

Figure 584. Post test 2:58 hr:min (294945_1018603)

Figure 585. Post test 2:58 hr:min (294945_1018604)

Figure 586. Post test 2:58 hr:min (294945_1018605)

Figure 587. Post test 2:58 hr:min (294945_1018606)

Figure 588. Post test 2:58 hr:min (294945_1018607)

Figure 589. Post test 2:58 hr:min (294945_1018608)

Figure 590. Post test 2:58 hr:min (294945_1018609)

Figure 591. Post test 2:59 hr:min (294945_1018610)

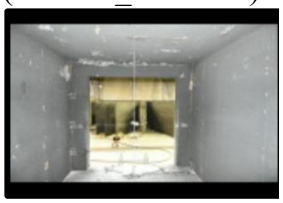

Figure 592. Post test 2:59 hr:min (294945_1018611)

Figure 593. Post test 2:59 hr:min (294945_1018612)

Figure 594. Post test 2:59 hr:min (294945_1018613)

Figure 595. Post test 3:00 hr:min (294945_1018614)

Results Summary

The following table provides a summary of the heat flux results for all experiments conducted during this test series.

Table 21. Multi-Test Heat Flux Summary

Experiment: Test Number	Description	Maximum Heat Flux (kW/m²)	Heat Flux 10 second maximum average (kW/m²)	Heat Flux 30 second maximum average (kW/m²)	Heat Flux 1 minute maximum average (kW/m²)	Heat Flux 5 minute maximum average (kW/m²)	Heat Flux 10 minute maximum average (kW/m²)
1	1st floor stairs	21.40	17.36	17.09	16.63	10.99	7.02
1	2nd floor stairs	23.24	19.38	17.62	16.51	10.83	6.77
1	1st floor rear	116.26	108.22	105.37	100.93	70.65	45.83
1	1st floor front	128.83	114.85	111.98	108.52	72.83	46.49
1	2nd floor rear	14.88	12.06	11.29	11.09	7.21	4.64
1	2nd floor front	14.33	12.23	11.23	11.19	7.13	4.47
2	1st floor stairs	93.06	81.39	74.42	56.85	22.44	12.67
2	2nd floor stairs	190.50	173.78	145.02	107.24	33.66	18.56
2	1st floor rear	142.91	127.95	112.22	106.70	82.65	52.37
2	1st floor front	136.30	121.62	118.61	117.79	90.02	55.14
2	2nd floor rear	127.48	103.08	93.59	77.92	28.62	15.70
2	2nd floor front	142.25	125.20	106.67	84.87	29.03	15.79

The following chart compares the instantaneous heat flux measured during several experiments.

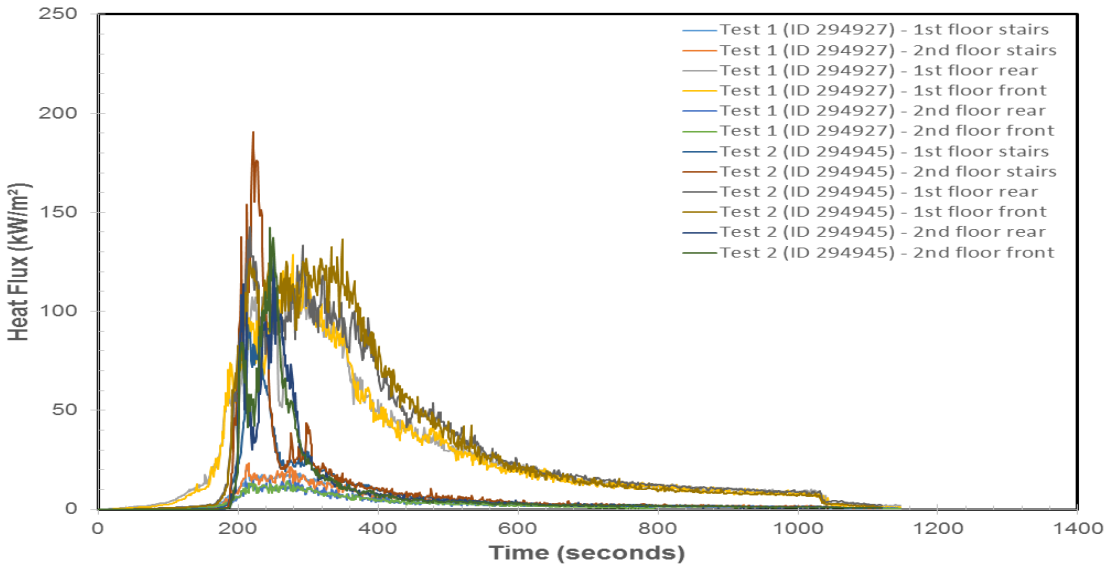

Figure 596. Heat Flux Summary

The following table provides a summary of the heat release rate (HRR) results from the experiments. The maximum HRR recorded during the experiment is provided in the "Maximum" column. The "Maximum Average" values, which are calculated from average values of heat release rate over specified time periods, provide a means to compare the severity of different fires over these time spans. It should be noted that the 4 MW FPC was calibrated for a peak heat release rate of approximately 5,200 kW prior to these experiments. Heat release rates measured during an experiment that exceed this value may be under predicted, due to smoke spillage from the hood of the FPC.

Table 22. Heat Release Rate Result Summary

Experiment: Test Number	Max (kW)	30 sec Maximum Average (kW)	1 min Maximum Average (kW)	5 minute Maximum Average (kW)	10 minute Maximum Average (kW)
1	6839	6404	6125	4163	2707
2	24682	23140	18803	7316	4246

The following chart compares heat release rates measured by the FPC during several experiments.

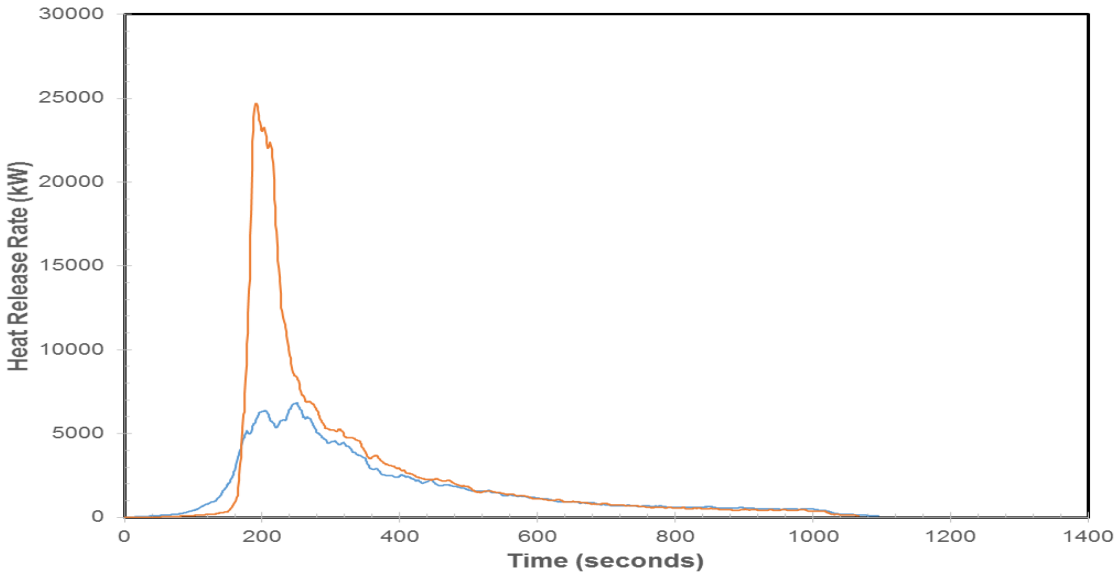

Figure 597. Heat Release Rate Summary

The following table provides a summary of the total heat released (THR) during the experiments. The "Total Heat Released" is calculated by integrating the HRR over time for the duration of the experiment.

Table 23. Total Heat Release Summary

Test Number	Total Heat Release (kJ)
1	1835267
2	2698243

The following chart compares the total heat release measured by the FPC during several experiments.

v

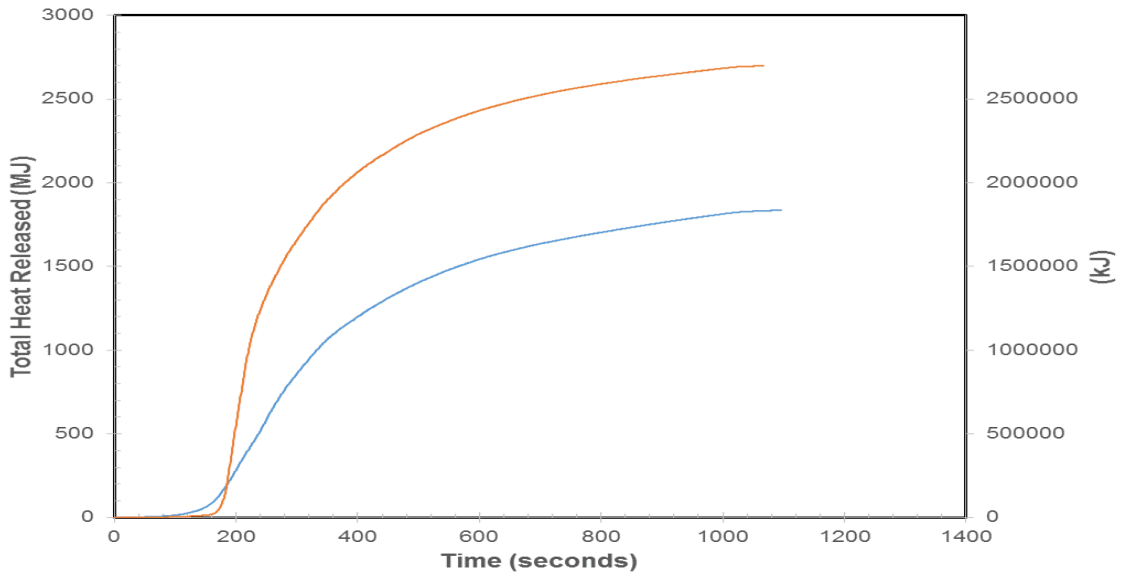

Figure 598. Total Heat Released Summary

References

1. Laboratory Instruction LI017 – Laboratory Conditions, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD.
2. The Temperature Handbook, 2nd edition, Omega Engineering, Stamford, CT, 2000.
3. Laboratory Instruction LI001 - Thermocouple, Bureau of Alcohol, Tobacco, Firearms and Explosives – Fire Research Laboratory, Beltsville, MD.
4. Avallone E.A, Baumeister III T., "Marks' Standard Handbook for Mechanical Engineers", 10th Edition, 1996, pp.16:13-14 .
5. Munson, B.R., Young, D.F., Okiishi, T.H., "Fundamentals of Fluid Mechanics", 5rd Edition, 2006, p. 109.
6. Laboratory Instruction LI009 - External Velocity - Differential Pressure Probes, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD.
7. Barnes, A., "Heat Flux Sensors Part 1: Theory," Sensors, January 1999.
8. Laboratory Instruction LI002 - Heat Flux Transducer, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD.
9. Laboratory Instruction – Fire Products Collectors – LI011, Bureau of Alcohol, Tobacco, Firearms and Explosives – Fire Research Laboratory, Beltsville, MD.
10. Laboratory Instruction LI003 - Digital Cameras, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD