Fire Research Laboratory
BUREAU OF ALCOHOL, TOBACCO, FIREARMS AND EXPLOSIVES
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U. S. Department of Justice

Project Record

ANAB ISO/IEC 17025:2017
Accredited Forensic Testing Laboratory

Title	Smoke/CO Alarm Activation on Lower Floor with Smoldering/Flaming Combustion Occurring on Upper Floor		
Test Type	Custom		
Lab Number	22FR0016-1		
Test dates	3/6/23, 3/7/23, 3/8/23, 3/9/23	**No. Tests**	4

Introduction

Four experiments were conducted to evaluate the performance of smoke alarms and carbon monoxide (CO) alarms located on the bottom floor of a two-story structure with respect to combustion on the upper floor. Two types of combustion were considered: smoldering and flaming. In addition to the smoke alarms and CO alarms, instrumentation for the experiments included heat flux transducers, thermocouples, optical density meters, gas analyzers, and a weather station. The experiments were also documented using digital video cameras and a digital still camera. The experiments were conducted in the Large Burn Room (LBR) of the Bureau of Alcohol, Tobacco, Firearms and Explosive Fire Research Laboratory (ATF FRL) located in Beltsville, MD.

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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.

Experiment Setup

Figure 1 shows a plan view of the two-story structure. The overall interior dimension of each floor was approximately 4.88 m long by 3.66 m wide (16 feet long by 12 feet wide). Each floor had a room that measured approximately 4.88 m long by 2.62 m wide by 2.44 m high (16 feet long by 8 feet 7 inch wide by 8 ft high). A stairwell was located on the west side of the structure that connected the two floors. The structure was built on top of a wood platform. An exterior door was located on each floor of the structure, although the door on the bottom floor was sealed with tape during each test. The door on the upper floor was either open or closed, depending on the test being conducted. Figure 2 shows an exterior view of the east side of the structure.

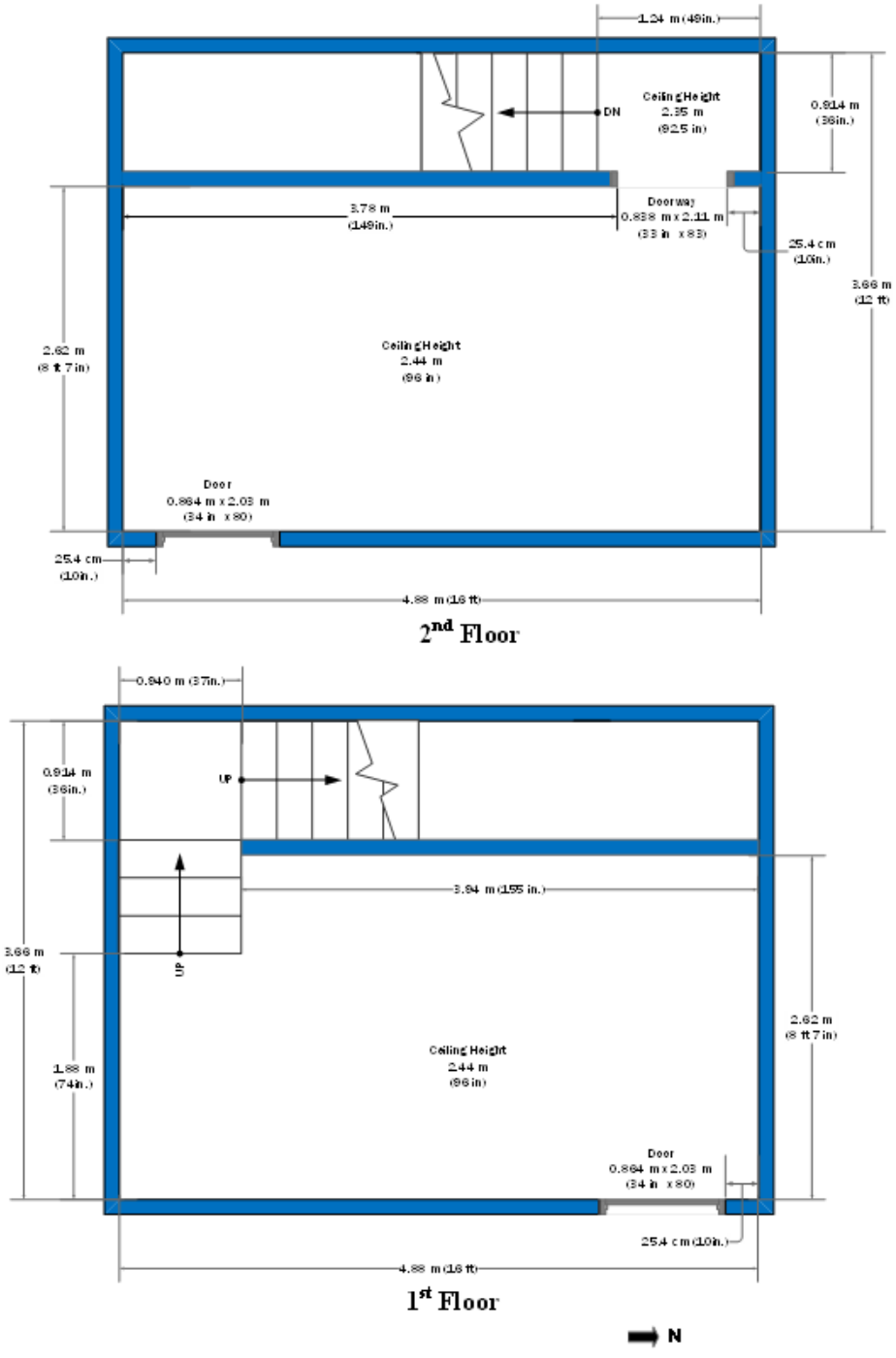


Figure 1. Plane view of test structure

Figure 2. Exterior view of the east side of the structure (360079_1304634.jpg)

Construction Details

Platform

The structure was built on top of a wood platform that was framed using 2 x 6 dimensional lumber[1]. The floor joists were spaced 40.6 cm (16 inch) on center. A single layer of 1.59 cm (5/8 inch) thick plywood was attached to the top of the platform.

Walls

The walls were framed using 2 x 4 dimensional lumber and the studs were spaced 40.6 cm (16 inch) on center. The interior surfaces were sheathed with a single layer of 1.27 cm (1/2 inch) thick gypsum wallboard and the seams were sealed with tape and joint compound. The interior walls were painted with builder's grade interior flat white paint. The exterior surfaces were not finished. However, plywood sheathing that was 1.59 cm (5/8 inch) thick was added at various locations on the exterior walls to help prevent the walls from racking.

Ceiling

The ceiling in each room was framed using 2 x 10 engineered wood I-joist. The I-joists were 24.1 cm (9.5 inch) deep and spaced 40.6 cm (16 inch) on center. The sloped ceiling

[1] Lumber sizes listed in this report (e.g., 2 x 4) are given in terms of their nominal dimensions in inches, which is greater than the dressed size or actual size of the wood.

in the stairwell was framed using 2 x 4 lumber. Each ceiling was sheathed with a single layer of 1.27 cm (1/2 inch) thick gypsum wallboard and the seams were sealed with gypsum wallboard tape and joint compound. The ceilings were then painted with builder's grade interior flat white paint.

For the flaming fire tests, a section of gypsum wall board was attached to the ceiling above the sofa to limit the damage to the ceiling. Figure 3 shows the extra piece of gypsum wall board attached to the ceiling.

Figure 3. Extra section of gypsum wall board attached to ceiling above the sofa for the flaming fire tests (360086_1305181.jpg)

Floor

The floor in the lower level room consisted of a single layer of 1.27 cm (1/2 inch) thick gypsum wallboard that was placed on top of the plywood attached to the platform. The floor in the upper level room consisted of a single layer of 1.27 cm (1/2 inch) thick gypsum wallboard placed on top of 1.59 cm (5/8 inch) thick plywood that was attached to the I-joist.

Stairs

An L-shaped set of stairs was located on the west side of the structure. There were three steps between the first floor and a landing. The stairs turned 90 degrees and an additional 10 steps went from the landing to the second floor. The wood steps were covered with 1.27 cm (1/2 inch) thick gypsum wallboard and had a nominal rise of 17.8 cm (7 inch)

and tread depth of 27.9 cm (11 inch). The width of the stairs was approximately 0.91 m (36 inch). A drawing of the stairs is shown in Figure 4. The ceiling above the stairs was sloped at an angle of approximately 35 degrees, similar to the slope of the stairs. The ceiling started to slope above the landing and then stopped at the second floor landing.

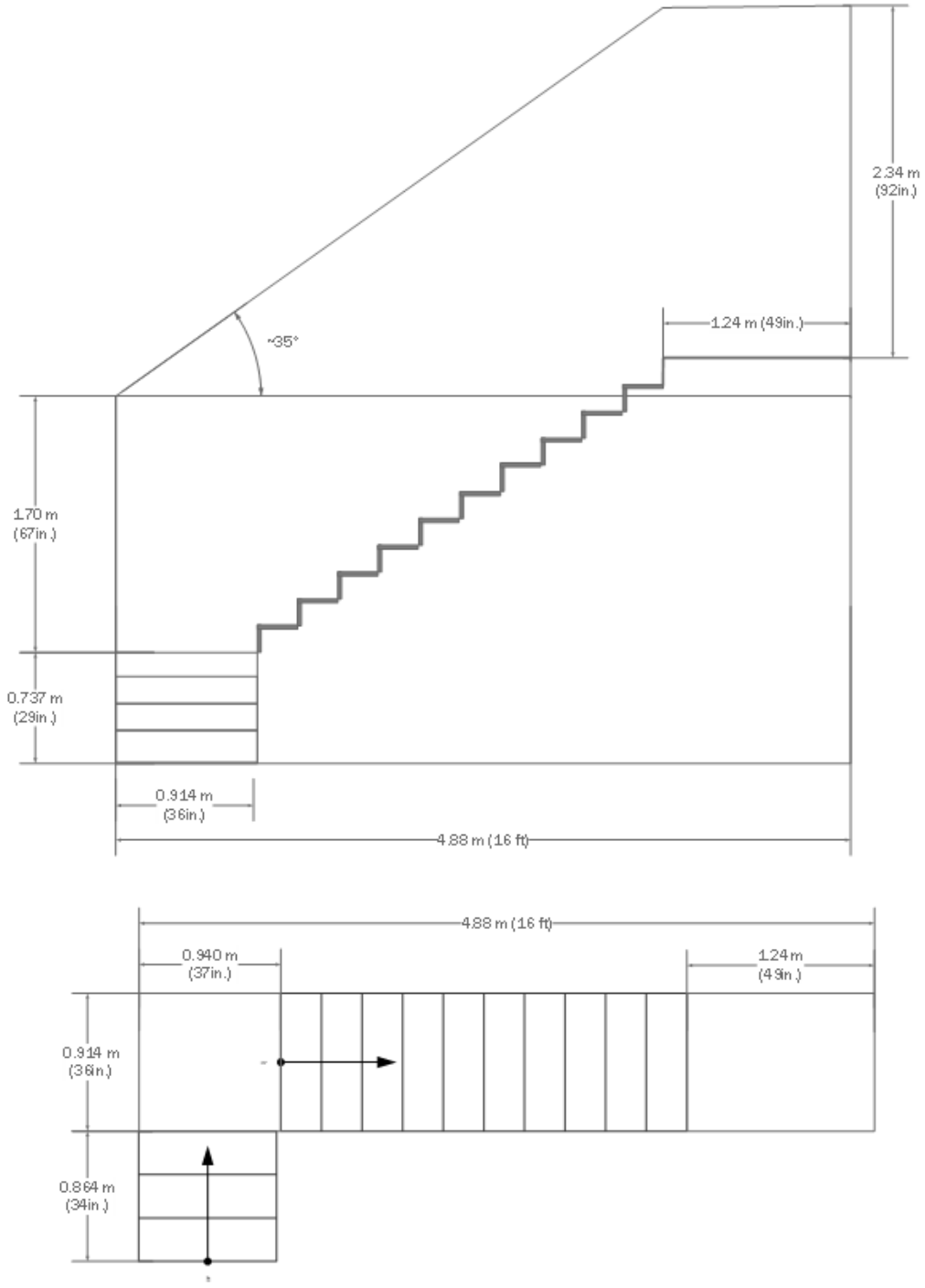


Figure 4. Stairs - elevation and plan view

Doors

The structure had two exterior doors, one on each level. Each door was a standard hollow core door that measured 86.4 cm (34 inch) wide by 2.03 m (80 inch) high. For each test, the door on the first floor was sealed with aluminum tape before the start of the test, as shown in Figure 5. The door on the upper level was either open or closed, depending on the test being conducted. For the flaming fire test, the door on the upper floor was removed from the structure.

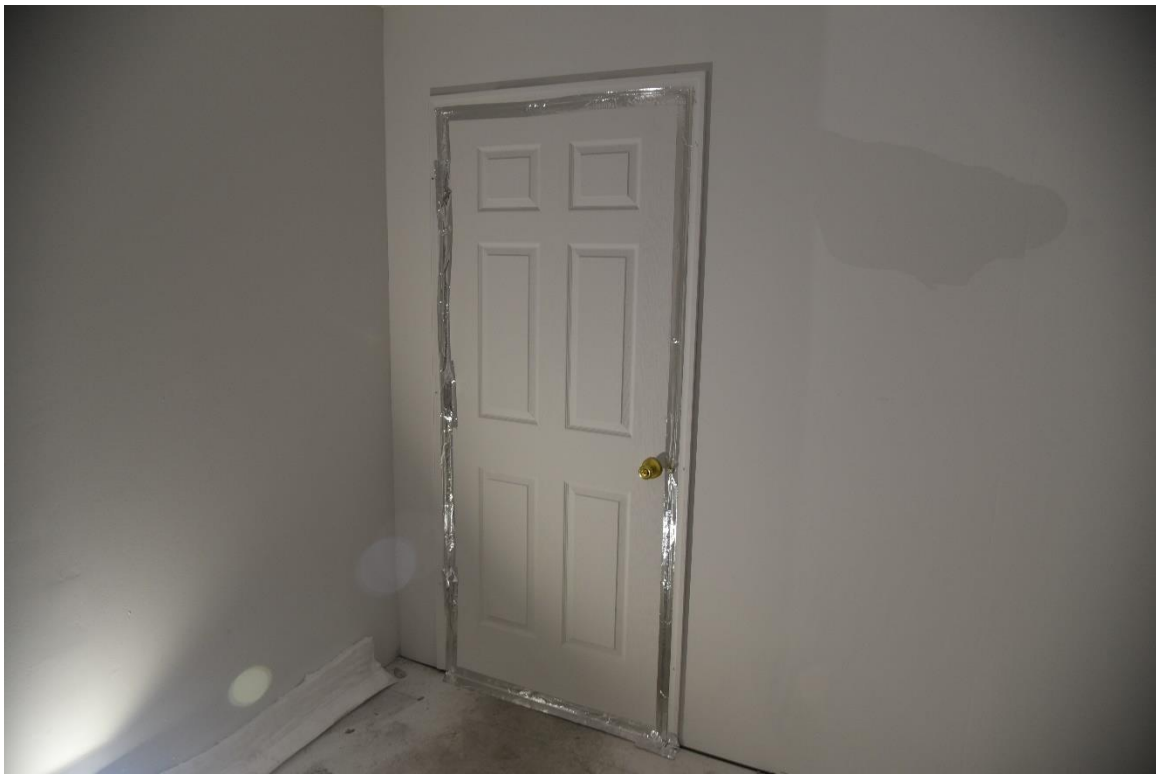


Figure 5. First floor door sealed with aluminum tape (360079_1304764.jpg)

Items for Smoldering Tests

Cotton Batting

Cotton batting from the Warm Company (Warm and Natural, Item 2105A) was used for the smoldering tests. The batting was made of 87.5% cotton and 12.5% polypropylene. The batting measured 1.14 m (45 inch) wide by 36.6 m (40 yards) long and weighed approximately 8.2 kg (18 lbs). The batting arrived in a roll that was approximately 30.5 cm (12 inch) in diameter by 1.14 m (45 inch) long. For each smoldering test, the cotton batting was unrolled and then folded into an approximate rectangular shape, as shown in Figure 6 and Figure 7. For Test 1, the folded shape of the cotton batting measured roughly 0.610 m wide by 0.813 m long by 0.406 m high (24 inch wide by 32 inch long by 16 inch high). For Test 2, the folded shape of the cotton batting measured roughly 1.17 m wide by 0.610 m long by 0.178 m high (46 inch wide by 24 inch long by 7 inch high).

Figure 6. Cotton batting for Test 1 (360079_1304756.jpg)

Figure 7. Cotton batting for Test 2 (360082_1304921.jpg)

After folding the cotton batting, it was placed on a section of gypsum wallboard, which was located in the north-east corner of the room on the 2nd floor.

Cartridge Heater

A cartridge heater from Vulcan (Model TB507A) was placed within the cotton batting to initiate a smoldering combustion reaction. The cartridge heater was 12.7 cm (5 inch) long and had a diameter of 1.27 cm (½ inch). The heater had an output power rating of 500 Watt at a 120 VAC input. The heater was powered using a variable transformer (Staco Energy, model 2510CT). The cartridge heater is shown in Figure 8 and the transformer is shown in Figure 9.

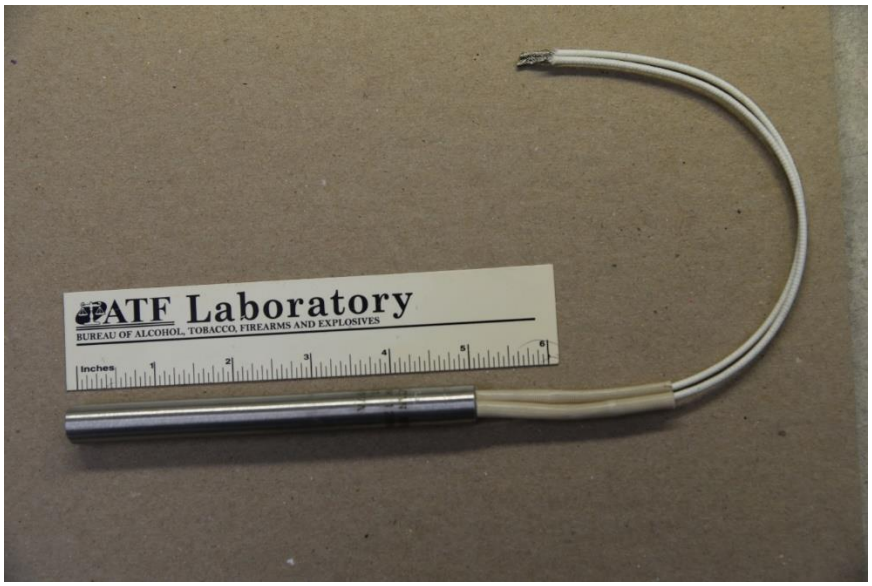


Figure 8. Cartridge heater (360079_1313695.jpg)

Figure 9. Variable transformer (360079_1304639.jpg)

The cartridge heater was placed between the layers of the cotton batting as shown in Figure 10 and Figure 11.

Figure 10. Cartridge heater location for Test 1 (360079_1304744.jpg)

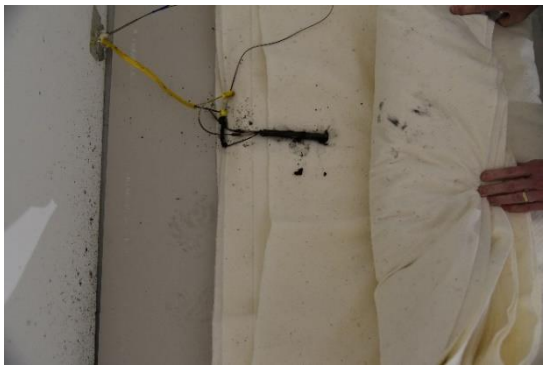


Figure 11. Cartridge heater location for Test 1 (360082_1304928.jpg)

Items for Flaming Fire Tests

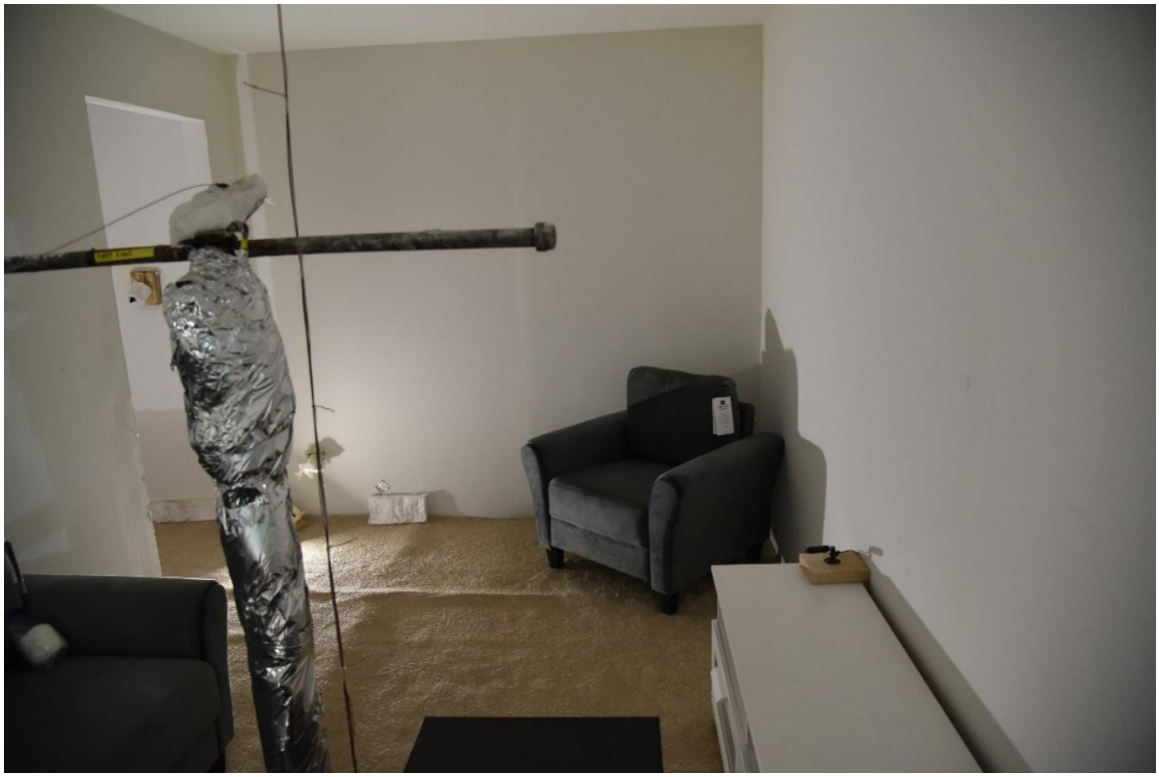
Furniture

The upper room was furnished with an upholstered chair and sofa, a coffee table, a TV stand, and a bookcase. Table 1 contains a summary of the items. The items are shown in Figure 12 and Figure 13. The approximate location of each item is shown in Figure 14.

Table 1. Furnishing items in the Living Room

Item	Brand	Retailer	Part Number
Upholstered Chair	Lifestyle Solutions	Walmart	CC-WEN-KS1-M26-DG-RA
Upholstered Sofa	Lifestyle Solutions	Walmart	CC-WEN-KS3-M26-DG-RA
TV Stand	Brimnes	Ikea	403.376.94
Coffee Table	Lack	Ikea	401.042.94
Bookcase	Billy	Ikea	302.638.44

Figure 12. Upholstered sofa, coffee table, TV stand and bookcase for the flaming fire (360086_1305161.jpg)



Figre 13. Upholstered chair for flaming fire tests (360086_1305151.jpg)

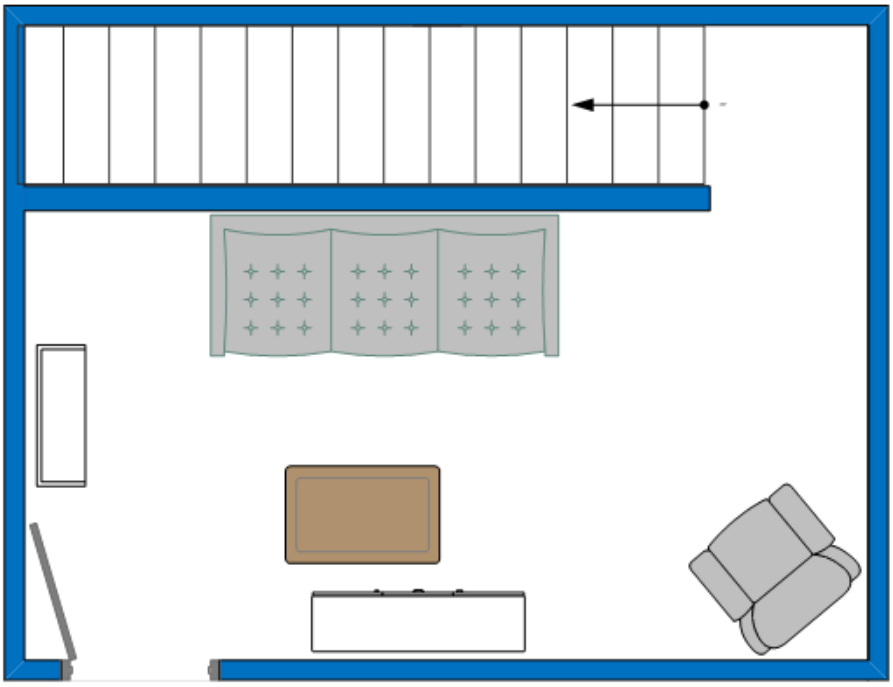


Figure 14. Approximate location of the furniture in the upper room (360086_1305151.jpg)

Carpet

The floor on the upper level was covered with a carpet pad and builder's grade carpet. The stairs and landing were also covered with carpet and carpet pad.

Ignition Package

The fires were initiated on the sofa using an open flame from a butane torch to ignite an ignition package prepared by the FRL staff. The ignition package is shown in Figure 15. The ignition package consisted of a quart-size plastic bag that contained paper towels and medical gauze rolled together and soaked in gasoline. The medical gauze used was a CVS/pharmacy Sterile Premium Rolled Gauze, constructed of a Rayon-polyester blend. The gauze had a listed un-stretched length of 7.62 cm x 1.92 m (3 inches x 2.1 yard). Ten sheets from a paper towel roll were used and each sheet of paper towel measured 22.5 cm x 27.9 cm (8.875 inch x 11 inch).

Each ignition package was assembled by first unrolling the medical gauze and laying it out flat in the un-stretched position. A continuous section of ten (10) paper towel sheets

was then removed from the paper towel roll and folded width wise in a tri-fold manner such that the folded width of the continuous section of paper towels measured approximately 7.3 cm (2.875 inches). The folded continuous section of paper towels was placed on top of the un-stretched medical gauze. They were then rolled together such that the paper towels were on the inside and the medical gauze was on the outside of the roll. The roll was then placed inside the quart-sized plastic bag and approximately 250 ml (8.5 fluid ounces) of gasoline was poured into the bag.

Figure 15. Ignition package (358561_1238921.jpg)

Smoke/CO Alarms

Both AC powered and battered powered smoke alarms and CO alarms were used in the experiments. A summary of each alarm is provided in Table 2. Photographs of the alarms are shown in Figure 16 and Figure 17.

Table 2. Summary of Smoke Alarms and CO Alarms

Alarm ID	Alarm Type	Senor Type	Manufacturer	Model	Power Source
1	Smoke	Ionization	Kidde	21007581	120 VAC
2	Smoke	Photoelectric	Kidde	P4010ACS	120 VAC
3	Carbon Monoxide	Electrochemical	Kidde	900-0121	120 VAC
4	Smoke	Ionization	First Alert	SA303CN3	9 VDC
5	Smoke	Photoelectric	LS Home	GS528A	9 VDC
6	Carbon Monoxide	Electrochemical	First Alert	CO400	9 VDC

Figure 16. AC powered alarms – image annotated (360079_1304666.jpg)

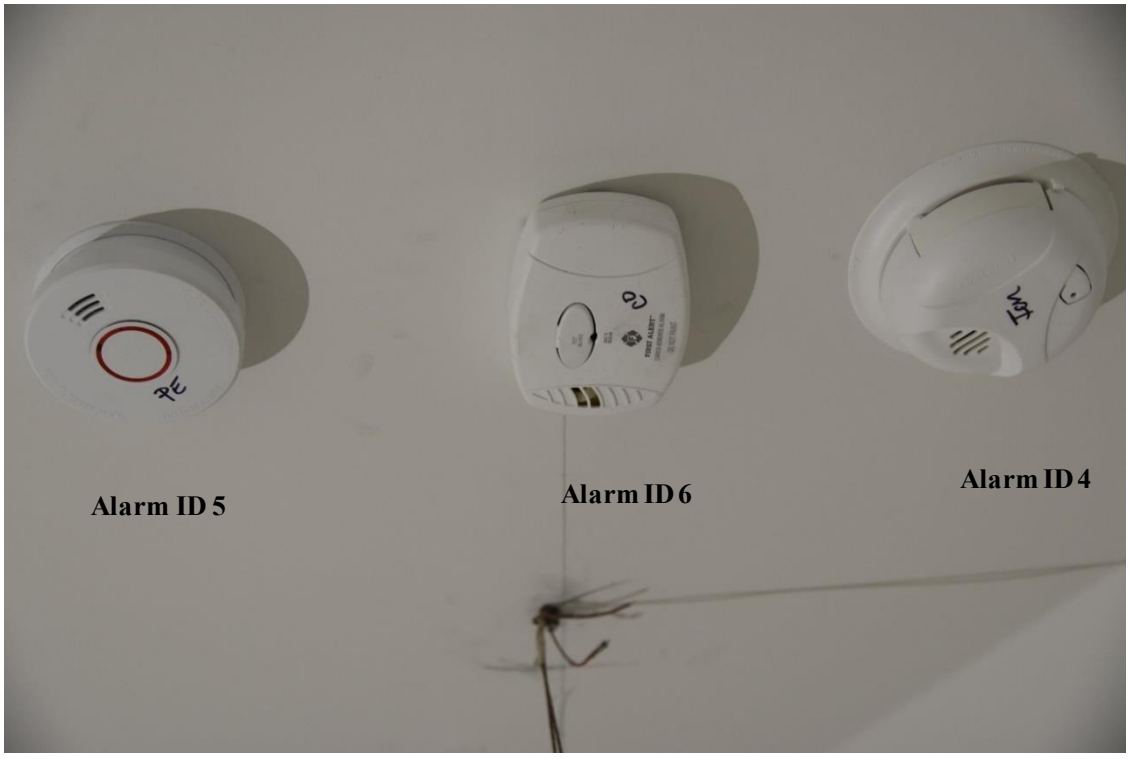


Figure 17. Battery powered alarms - image annotated (360079_1304668.jpg)

Table 3 summarizes which alarms where used during each test and where these devices were located.

Table 3. Summary of Smoke/CO Alarms During Each Test

Test	Type of Combustion	Alarm IDs 1st Floor	Alarm IDs 2nd Floor
1	Smoldering	1-6	1-6
2	Smoldering	1-6	1-6
3	Flaming	1-6	1-3
4	Flaming	1-6	1-3

Experiment Details

Table 4 provides a summary of the four experiments conducted. Two variables were considered: the type of combustion (smoldering/flaming) and the door position on the 2nd floor (open/closed).

Table 4. Summary of Experiments

Test Number	Experiment ID	Type of Combustion	Door Position on 2nd Floor
1	360079	Smoldering	Closed
2	360082	Smoldering	Open
3	360086	Flaming	Closed
4	360089	Flaming	Open*

* Door was removed from structure

Experimental Procedures

Test 1 - Smoldering

The cotton batting was placed in the structure along with the cartridge heater. The door on the 1st floor was sealed shut with tape and the door on the 2nd floor was closed (but not sealed with tape). With the power turned off to the variable transformer, the dial on the variable transformer was set to approximately 50%. The experiment was then started and the power to the variable transformer was turned on. Over approximately the next hour, the transformer was turned off and on and set to other settings in an attempt to generate visible smoke without causing the cotton batting to ignite and transition to a flaming fire. The smoke was being monitored via video cameras located in the test structure on each floor. After approximately 70 minute, the smoke was not visible. Therefore, the door on the 2nd floor was opened and the cotton batting was unfolded in half, causing more smoke to be generated immediately. The door was then closed, and the experiment continued. After a total test time of approximately 3 hours and 15 minutes, the door on the 2nd floor was opened again and water from a fire extinguisher was applied to the cotton batting.

The experiment continued with the door open on the 2nd floor for an additional 20 minutes, after which the experiment was stopped.

Test 2 - Smoldering

The cotton batting was placed in the structure along with the cartridge heater. The cartridge heater was reused from the first test. The cotton batting was not folded as tightly as it was for Test 1, in an attempt to generate more smoke quicker. The door on the 1st floor was sealed shut was taped and the door on the 2nd floor was kept opened. With the power turned off to the variable transformer, the dial on the variable transformer was set to approximately 50%. The experiment was then started and the power to the variable transformer was turned on. Over approximately the next 20 minutes, the transformer was turned off and on to generate visible smoke without causing the cotton batting to ignite and transition to a flaming fire. The variable transformer was then turned off and the test continued. After a total test time of 3 hours, the test was stopped.

Test 3 – Flaming Fire

The door on the 1st floor was sealed shut was tape. The ignition package was placed on the right side of the sofa. The test was then started when the ignition package was ignited with a butane torch, as shown in Figure 18. Test personnel then exited the structure through the door on the 2nd floor and closed the door behind them. The test proceeded for approximately 45 minutes, at which point the door on the 2nd floor was opened and the fire, which had been limited to the sofa, was suppressed. The door on the 1st floor was then opened and the test was stopped.

Figure 18. Ignition package ignited using open flame from butane torch (360086_1305186.jpg)

Test 4 – Flaming Fire

Following Test 3, the damaged sofa was removed from the structure along with the section of carpet that had been damaged. These items were replaced, while the other items remained from Test 3. The door on the 2nd floor was removed from the structure and the door on the 1st floor was sealed shut with tape. The ignition package was placed on the right side of the sofa. The test was started when the ignition package was ignited using a butane torch. Test personnel then exited the structure through the doorway on the 2nd floor. The test proceeded for approximately 14 minutes, and then the fire was suppressed using a deluge water suppression system. The test continued for an additional 8 minutes and then the test was stopped.

Instrumentation

A variety of instrumentation was used during the experiments and included thermocouples (TC) for temperature measurement, heat flux transducers for heat flux measurement, gas analyzers to measure the concentrations of oxygen, carbon monoxide, and carbon dioxide within the structure, optical density meters (ODM) to measure the optical density of the smoke, and a weather station to measure the atmospheric conditions in the laboratory (pressure, temperature, and relative humidity). Figure 19 provides the general location of the instrumentation, which is based on a Cartesian coordinate system (x, y, z). Location *x* and location *y* are both located in the horizontal plane. Location *z* is the vertical distance from the floor to the centerline of the instrument. The specific location of each instrument is provided in the following sections for the individual instrumentation.

For the smoldering tests (Tests 1 and Test 2), two additional thermocouples (TCs) were used during the tests. The thermocouples were placed within the cotton batting: one TC was placed near the cartridge heater to verify the heater was working properly, and the second TC was placed in a location remote from the cartridge heater. For the flaming fire tests (Test 3 and Test 4), the battery powered smoke/CO alarms were not used on the upper floor, nor was the ODM.

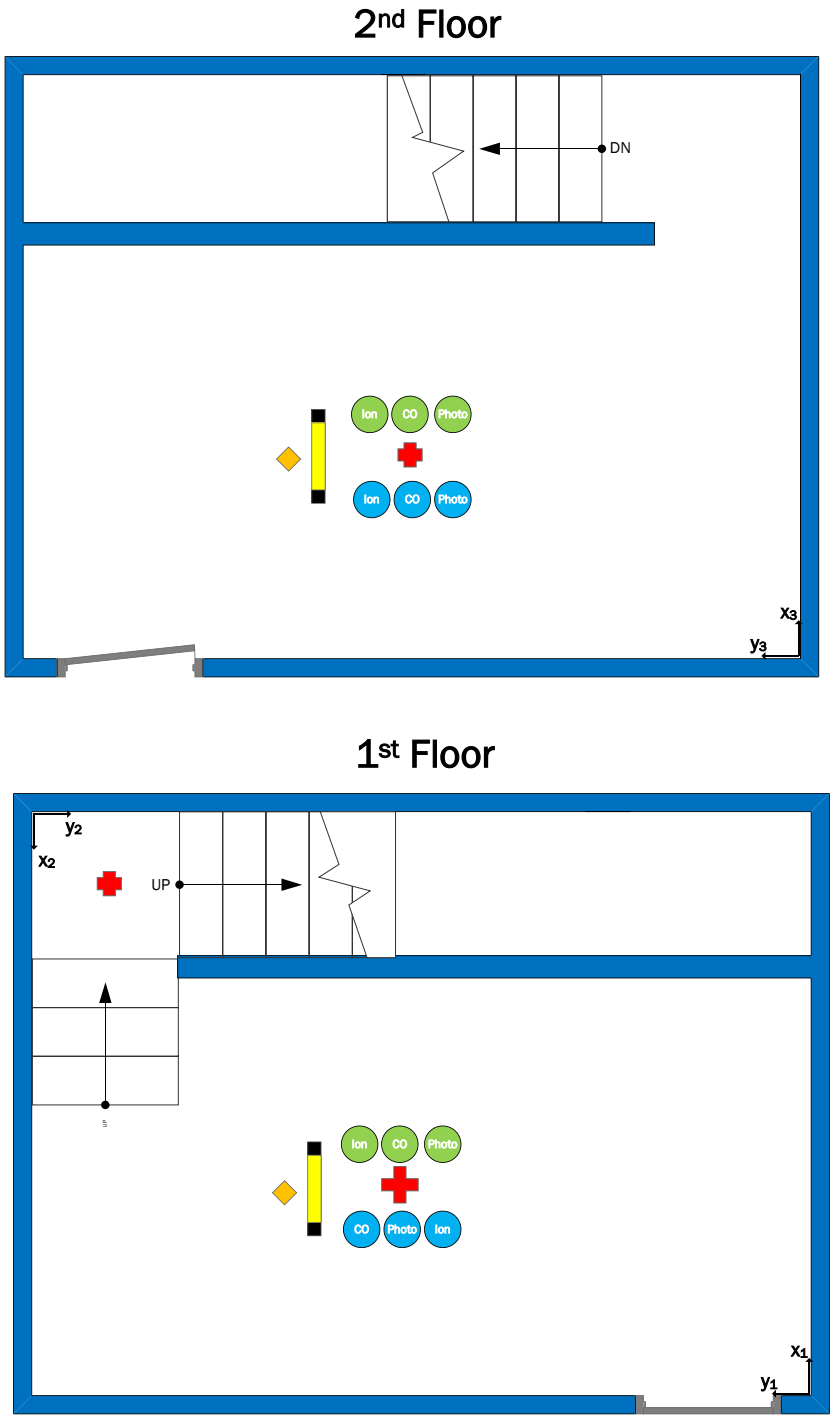


Figure 19. General Instrumentation Layout

The smoke alarms and CO alarms were mounted directly to the ceiling. The exception to this were the 120 VAC powered alarms on the first floor. These alarms were mounted slightly off of the ceiling so that wires for power and data could be run along the ceiling, instead of through the ceiling joist, as shown in Figure 20. These alarms were offset from the ceiling by approximately 2.54 cm (1 inch). The general location of each type of alarm is shown in Figure 19. Note that for Test 3 & 4, the AC powered ion smoke alarm and CO alarm were switched in positions.

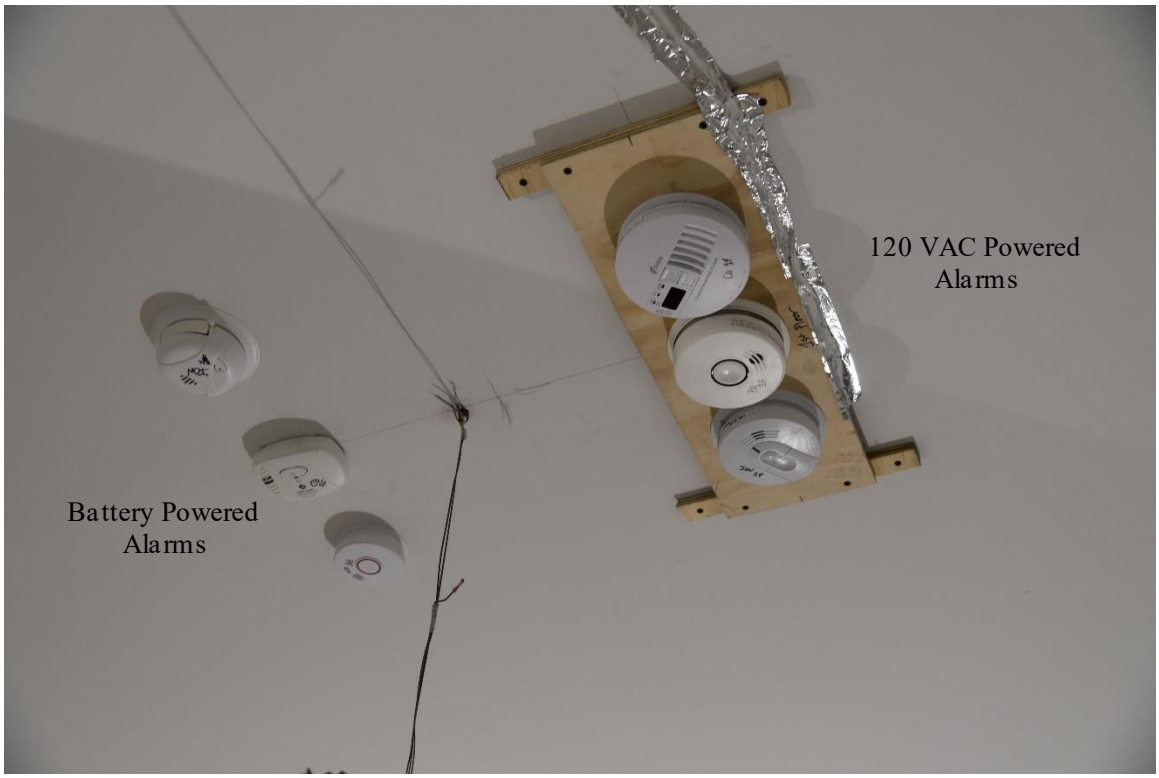


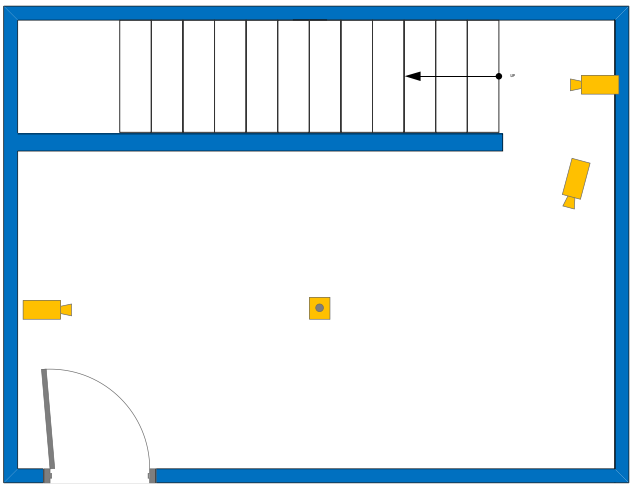
Figure 20. Alarms mounted on first floor ceiling – image annotated (360082_1304945.jpg)

Two methods were used to determine when the smoke/CO alarms activated. For the 120 VAC powered alarms, a voltage signal was obtained using the interconnect wire from these alarms and the voltage was recorded using the data acquisition. For the battery powered alarms, an interconnect wire was not available. Therefore, alarm activation was determined manually by using a video camera pointed at the alarms to detect when the alarm's indicator light started to flash.

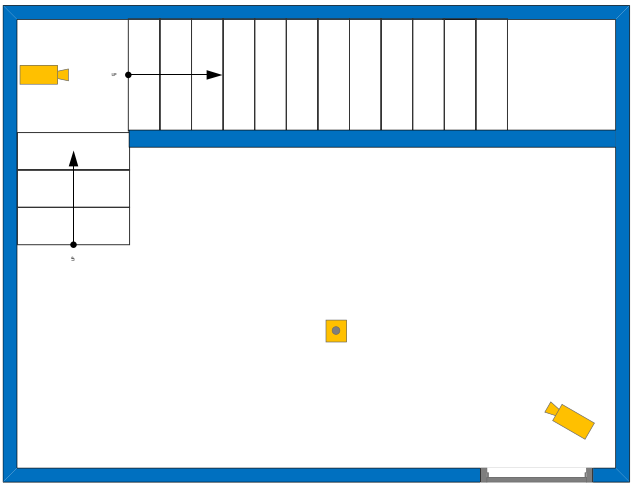
The tenability conditions in each room were determined by measuring the smoke density, the ambient temperature, the radiant heat flux, and the gas concentrations of carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2). Measurements were obtained approximately 1.52 m (5 ft) above the floor and the equipment was mounted to an instrumentation stand, as shown in Figure 21. The smoke density was measured using a white light source, which can be seen in Figure 21.

Figure 21. Instrumentation stand for tenability measurements (360086_1305132.jpg)

The experiments were also documented using a still camera and video cameras. A high definition (HD) video camera was located outside of the structure and multiple standard definition (SD) video cameras were used inside the structure. Figure 22 shows the general layout of the cameras. For the flaming combustion tests (Test 3 and Test 4), the video camera that had been pointed up at the alarms on the 2nd story ceiling for Test 1 and 2 was instead focused on the origin of the fire, which was on the sofa.



2nd Floor



1st Floor

Figure 22. General layout of video cameras

Laboratory Conditions

The ambient laboratory temperature, barometric pressure, and relative humidity were measured during the experiment(s). Barometric pressure measurement is accomplished using a silicon capacitive absolute sensor. The micromechanical sensor uses dimensional changes in its silicon membrane to measure pressure. Humidity measurement is achieved using a capacitive humidity sensor. The capacitance of the thin-film polymer sensor changes as the relative humidity changes. Temperature measurement is attained using a platinum Resistance Temperature Detector (RTD) sensor. The RTD contains a resistor that changes resistance as the temperature changes. 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 5. Lab Conditions Description

Description	Manufacturer	Model	Bar Code
Vaisala LBR	Vaisala	PTU301	99001066

The following table provides a summary of the initial conditions at the start of the experiment(s). The ‘Description’ column shows the location of the measurements.

Table 6. Ambient Laboratory Initial Condition Summary

Test Number	Exp ID	Description	Temperature (C)	Pressure (kPa)	Relative Humidity (%)
1	360079	Vaisala LBR	11	102	36
2	360082	Vaisala LBR	9	101	49
3	360086	Vaisala LBR	8	102	33
4	360089	Vaisala LBR	9	102	39

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 7. Thermocouple Measurement Description

Description	X (m)	Y (m)	Z (m)	Thermocouple type
Landing 0'	1.320	2.570	0.000	Type K, Glass Ins., 24 AWG wire
Landing 1'	1.320	2.570	0.305	Type K, Glass Ins., 24 AWG wire
Landing 2'	1.320	2.740	0.610	Type K, Glass Ins., 24 AWG wire
Landing 3'	1.320	2.740	0.914	Type K, Glass Ins., 24 AWG wire
Landing 4'	0.457	0.457	1.219	Type K, Glass Ins., 24 AWG wire
Landing 5'	0.457	0.457	1.524	Type K, Glass Ins., 24 AWG wire
Landing 6'	0.457	0.457	1.829	Type K, Glass Ins., 24 AWG wire
Landing 7'	0.457	0.457	2.134	Type K, Glass Ins., 24 AWG wire
1st Floor 0'	1.321	2.438	0.000	Type K, Glass Ins., 24 AWG wire
1st Floor 1'	1.321	2.438	0.305	Type K, Glass Ins., 24 AWG wire
1st Floor 2'	1.321	2.438	0.610	Type K, Glass Ins., 24 AWG wire
1st Floor 3'	1.321	2.438	0.914	Type K, Glass Ins., 24 AWG wire
1st Floor 4'	1.321	2.438	1.219	Type K, Glass Ins., 24 AWG wire
1st Floor 5'	1.321	2.438	1.524	Type K, Glass Ins., 24 AWG wire
1st Floor 6'	1.321	2.438	1.829	Type K, Glass Ins., 24 AWG wire
1st Floor 7'	1.321	2.438	2.134	Type K, Glass Ins., 24 AWG wire
1st Floor 8'	1.321	2.438	2.438	Type K, Glass Ins., 24 AWG wire
2nd Floor 0'	1.321	2.438	0.000	Type K, Glass Ins., 24 AWG wire
2nd Floor 1'	1.321	2.438	0.305	Type K, Glass Ins., 24 AWG wire
2nd Floor 2'	1.321	2.438	0.610	Type K, Glass Ins., 24 AWG wire
2nd Floor 3'	1.321	2.438	0.914	Type K, Glass Ins., 24 AWG wire
2nd Floor 4'	1.321	2.438	1.219	Type K, Glass Ins., 24 AWG wire
2nd Floor 5'	1.321	2.438	1.524	Type K, Glass Ins., 24 AWG wire
2nd Floor 6'	1.321	2.438	1.829	Type K, Glass Ins., 24 AWG wire
2nd Floor 7'	1.321	2.438	2.134	Type K, Glass Ins., 24 AWG wire
2nd Floor 8'	1.321	2.438	2.438	Type K, Glass Ins., 24 AWG wire
Tenability 1st Floor 5'	1.372	2.565	1.524	Type K, Glass Ins., 24 AWG wire
Tenability 2nd Floor 5'	1.321	2.743	1.524	Type K, Glass Ins., 24 AWG wire
*Smolder TC 1	No Data	No Data	No Data	Type K, Glass Ins., 24 AWG wire
*Smolder TC 2	No Data	No Data	No Data	Type K, Glass Ins., 24 AWG wire

**Only used during Test 1 and Test 2*

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 [4]. Heat flux transducers were used in accordance with the method defined in FRL laboratory instruction "LI002 Heat Flux Transducer" [5].

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. 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. Location X and Location Y are Cartesian

coordinates generally located in a horizontal plane. Location Z is the distance from the floor to the centerline of the transducer.

Table 8. Heat Flux Measurement Description

Description	Heat Flux Mode	Heat Flux Over Range (kW/m²)	Bar Code	X (m)	Y (m)	Z (m)
1st Floor Total	Total - Dual	37.50	99000074	1.32	2.57	1.52
1st Floor Rad	Radiometer - Dual	37.50	99000661	1.32	2.57	1.52
2nd Floor Total	Total - Dual	37.50	99000059	1.32	2.74	1.52
2nd Floor Rad	Radiometer - Dual	37.50	99000662	1.32	2.74	1.52

Optical Density Meter

Optical density meter(s) were used to measure the smoke obscuration during the experiment(s). Optical density meters consist of two parts: a light source and a photo transducer which responds to the intensity of light from the light source. The photo transducer produces an output voltage that is linear with the amount of light received from the light source. An increase in intensity of light results in an increase in output voltage and a decrease in intensity of light results in a decrease in output voltage. Prior to the start of each test series each optical density meter is functionally verified using neutral density filters.

The following table provides a description of the optical density meter(s) used in the experiment. The extinction beam path length is the distance measured from the light source to the lens of the photo transducer. The Minimum Allowable Measurement is the minimum light transmission (%) measured by the ODM, which is based on the neutral density filter used during calibration.

Table 9. Optical Density Meter Description

Description	Light Source Type	Beam Path Length (m)	Minimum Allowable Measurement (%)	X (m)	Y (m)	Z (m)
1st Floor ODM	White light	0.889	10	1.321	2.565	1.524
2nd Floor ODM	White light	0.889	10	1.321	2.743	1.524

Smoke and Carbon Monoxide Detectors

Smoke and carbon monoxide (CO) detectors are devices used to activate an alarm in the presence of smoke or carbon monoxide. These detectors send notifications in the form of audible, visible, and/or electrical responses. A functionally verified clock is used to record the time of alarm activation during the test.

The following table provides a description of the detectors used in the experiment. The location column describes the mounting position of the detector. For wall-mounted detectors, the distance from ceiling column indicates the vertical distance from the ceiling

to the centerline of the detector. The next few columns provide information about the specifications of the detector.

Table 10. Detectors Summary

Description	Location	Manufacturer	Model	Detector Type	Sensor Type
1F Ion	Ceiling	Kidde	21007581	smoke	ionization
1F Photo	Ceiling	Kidde	P4010ACS	smoke	photoelectric
1F CO	Ceiling	Kidde	900-0121	carbon monoxide	electrochemical
2F Ion	Ceiling	Kidde	21007581	smoke	ionization
2F Photo	Ceiling	Kidde	P4010ACS	smoke	photoelectric
2F CO	Ceiling	Kidde	900-0121	carbon monoxide	electrochemical
1F Photo -Battey	Ceiling	LSHome	GS528A	smoke	photoelectric
1F CO - Battery	Ceiling	First Alert	CO400	carbon monoxide	electrochemical
1F Ion - Battery	Ceiling	First Alert	SA303	smoke	ionization
2F Photo -Battey	Ceiling	LSHome	GS528A	smoke	photoelectric
2F CO - Battery	Ceiling	First Alert	CO400	carbon monoxide	electrochemical
2F Ion - Battery	Ceiling	First Alert	SA303	smoke	ionization

Gas Analyzer-Paramagnetic-O_2

A gas analyzer was used to measure the oxygen (O_2) concentration at one or more point measurement location(s). The oxygen analyzer operates according to the paramagnetic alternating pressure principal. The resolution of the oxygen transducer's output signal is less than 0.1% of the respective output signal span value. The analyzer was zeroed and calibrated prior to each test. Nitrogen was used as the zero gas, and dried ambient air, which is assumed to have an oxygen concentration of 20.95 %, was used as the span gas. The gas concentration point measurements were conducted in accordance with the method defined in FRL laboratory instruction "LI016 - Point Source Gas Analysis" [6].

The following table provides a description of the instrumentation used to collect the O_2 gas concentrations during the experiments.

Table 11. O_2 Analyzer Description

Description	O2 Analyzer Full Scale Range (%)	O_2 Span Gas Value (%)	Bar Code
1st Floor	25	20.95	99000557
2nd Floor	25	20.95	99000555

The following table provides information about the oxygen sampling location(s) and the operating parameters of the analyzer(s). The "Oxygen Delay Time" is the time required for the gas analyzer output to adjust when subjected to a known gas concentration change at the measurement location. The "Exhaust Return" states where the gas sample bypass and analyzer exhaust lines are returned to during the experiment.

Table 12. O_2 Measurement Description

Description	Location X (m)	Location Y (m)	Location Z (m)	Oxygen Delay Time (s)	Exhaust Return Line
1st Floor	1.32	2.57	1.52	12	To Test Chamber
2nd Floor	1.32	2.74	1.52	13	To Test Chamber

Gas Analyzer-NDIR-CO/CO_2

A gas analyzer was used to measure both the carbon monoxide (CO) and carbon dioxide (CO_2) concentrations at one or more point measurement location(s). The CO/CO_2 gas analyzer utilizes two separate Nondispersive Infrared (NDIR) type transducers to measure the concentration of each gas. The resolution of each transducer's output signal is less than 0.1% of the respective output signal span value. The span value is defined as the input value used to test the upper range of the analyzer. The analyzer was zeroed and spanned prior to each test. Nitrogen was used as the zero gas and a pre-mixed calibration gas with known concentrations of CO and CO_2 were used as the span gas. The gas concentration point measurements were conducted in accordance with the method defined in FRL laboratory instruction "LI016 - Point Source Gas Analysis" [6].

The following table provides a description of the instrumentation used to collect the CO and CO_2 gas concentrations during the experiments.

Table 13. CO and CO_2 Analyzer Description

Description	CO Analyzer Full Scale Range (mol/mol)	CO Span Gas Value (mol/mol)	CO2 Analyzer Full Scale Range (mol/mol)	CO2 Span Gas Value (mol/mol)	Bar Code
1st Floor	0.05	0.0452	0.25	0.2229	99000557
2nd Floor	0.05	0.0452	0.25	0.2229	99000555

The following table provides information about the carbon monoxide and carbon dioxide sampling location(s) and the operating parameters of the analyzer(s). The "CO/CO2 delay time" is the time required for the gas analyzer output to adjust when subjected to a known gas concentration change at the measurement location. The "Exhaust Return" states where the gas sample by-pass and analyzer exhaust lines are returned to during the experiment.

Table 14. CO and CO_2 Measurement Descriptions

Description	Location X (m)	Location Y (m)	Location Z (m)	CO/CO2 Delay Time (s)	Exhaust Return
1st Floor	1.32	2.57	1.52	13	To Test Chamber
2nd Floor	1.32	2.74	1.52	13	To Test Chamber

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" [7].

Results for Test 1 (ID 360079)

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

Table 15. Experiment Events

Description	Time (s)
Variable Transformer Setting 50%	0
Variable Transformer Setting 30%	1690
Variable Transformer Off	2011
Variable Transformer Setting 50%	4030
Variable Transformer Off	4390
2nd Story Door Opened/Batting Opened	4470
2nd Story Door Closed	4500
2nd Story Door Opened/Batting Partially Suppressed	11714

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 over pre-determined time spans.

Table 16. 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)
Landing 0'	11.6	13.1	13.1	13.1	13.1	13.1
Landing 1'	11.8	13.2	13.2	13.2	13.2	13.2
Landing 2'	11.7	13.2	13.2	13.2	13.2	13.2
Landing 3'	11.7	13.3	13.2	13.2	13.2	13.2
Landing 4'	11.6	13.4	13.4	13.4	13.4	13.4
Landing 5'	11.6	13.9	13.9	13.9	13.8	13.8
Landing 6'	11.7	16.1	15.5	15.4	15.3	15.3
Landing 7'	11.9	21.5	21.4	21.3	21.2	21.2
1st Floor 0'	11.4	12.6	12.5	12.5	12.5	12.5
1st Floor 1'	11.3	12.6	12.5	12.5	12.5	12.4
1st Floor 2'	11.5	12.8	12.7	12.7	12.7	12.6
1st Floor 3'	11.4	12.7	12.7	12.7	12.6	12.6
1st Floor 4'	11.4	12.8	12.7	12.7	12.7	12.7
1st Floor 5'	11.4	12.9	12.8	12.8	12.8	12.8
1st Floor 6'	11.4	12.9	12.9	12.9	12.9	12.9
1st Floor 7'	11.4	13.0	13.0	13.0	13.0	13.0
1st Floor 8'	11.5	13.2	13.2	13.2	13.2	13.1
2nd Floor 0'	12.4	24.8	24.6	24.5	24.4	24.3
2nd Floor 1'	12.4	28.8	28.7	28.6	28.6	28.5
2nd Floor 2'	12.4	29.5	29.4	29.4	29.4	29.3
2nd Floor 3'	12.4	30.1	30.0	30.0	29.9	29.8
2nd Floor 4'	12.5	30.6	30.6	30.5	30.5	30.4
2nd Floor 5'	12.5	30.9	30.9	30.9	30.9	30.8
2nd Floor 6'	12.6	31.4	31.3	31.2	31.1	31.1
2nd Floor 7'	12.7	32.6	32.5	32.4	32.3	32.2
2nd Floor 8'	12.8	32.6	32.3	32.3	32.2	32.1
Tenability 1st Floor 5'	11.7	13.1	13.0	13.0	13.0	12.9

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)
Tenability 2nd Floor 5'	12.7	30.6	30.5	30.5	30.4	30.4
Smolder TC 1	12.4	870.1	869.7	869.4	866.2	860.3
Smolder TC 2	12.6	491.3	490.6	490.2	488.0	485.1

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

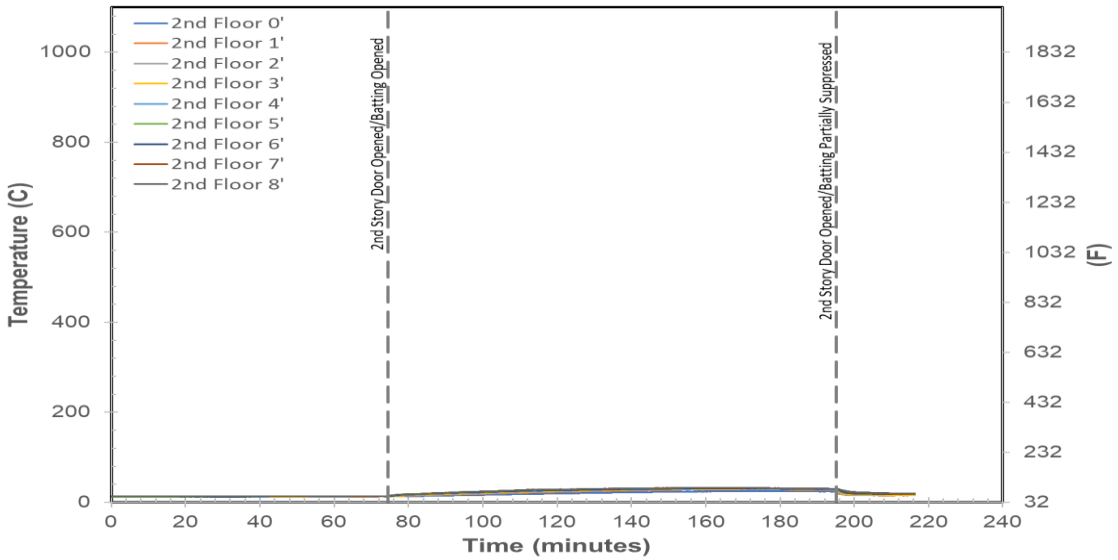


Figure 23. Temperature – 2nd Floor

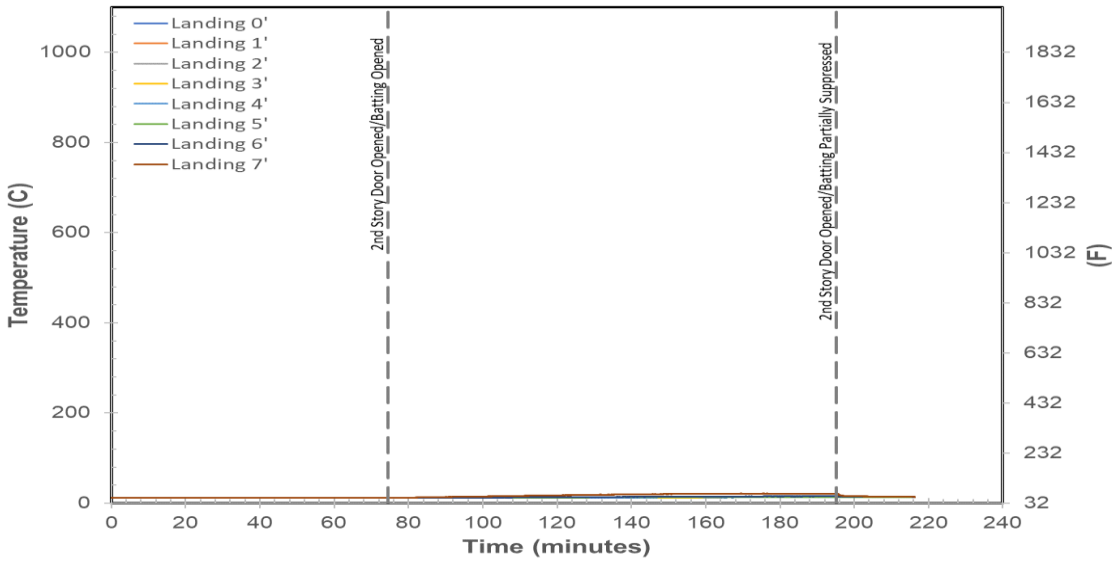


Figure 24. Temperature – Landing

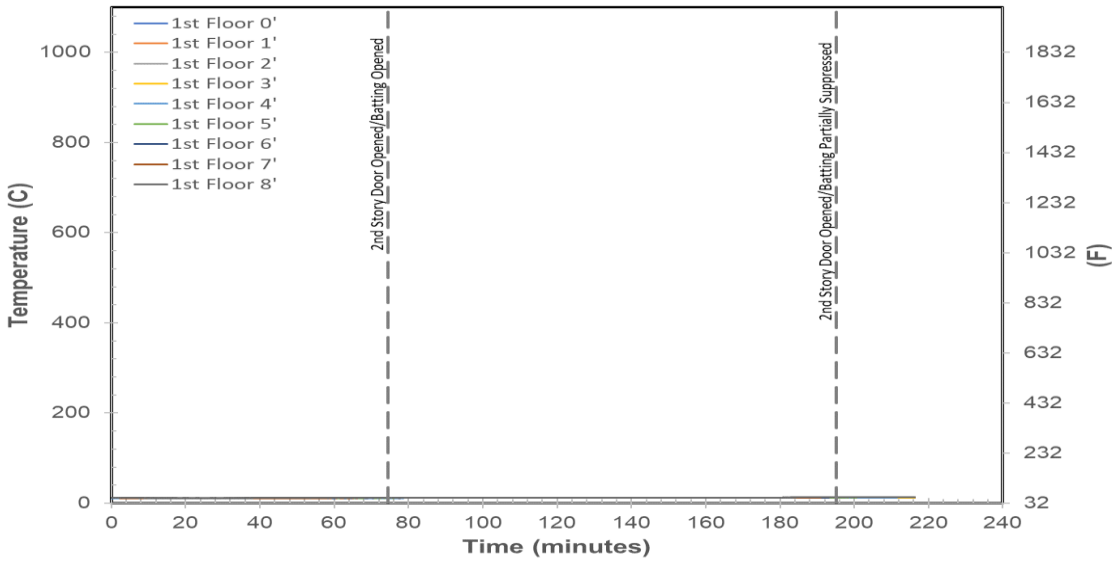


Figure 25. Temperature – 1st Floor

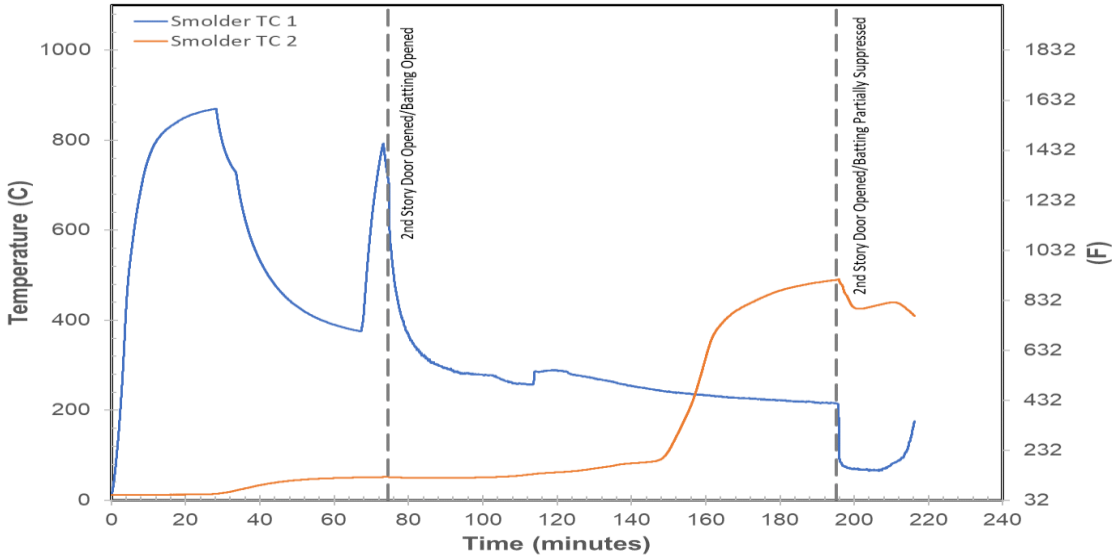


Figure 26. Temperature – Cotton Batting

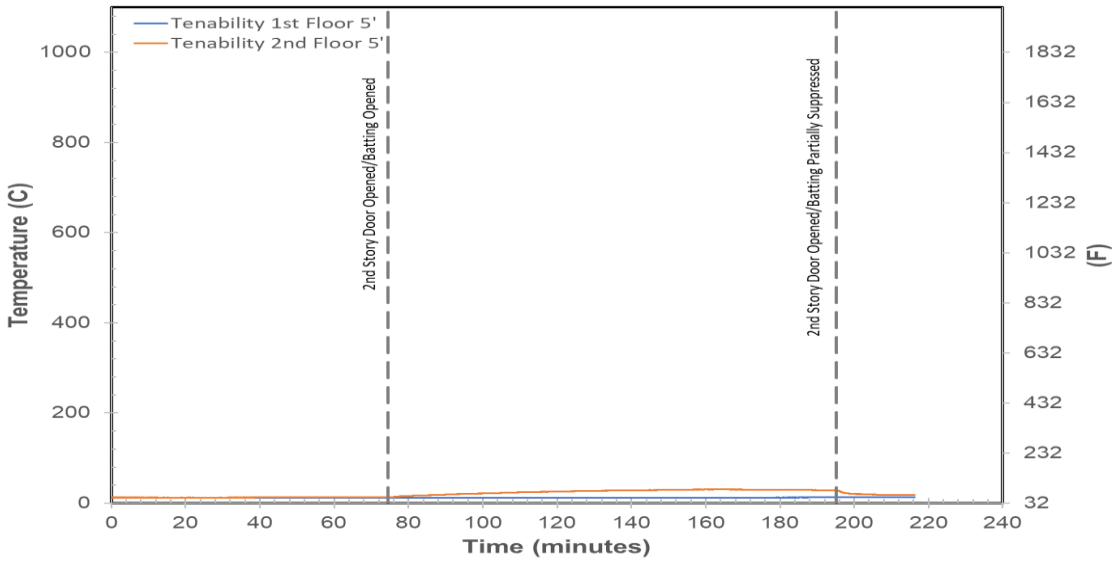


Figure 27. Temperature – Tenability

The following table provides a summary of the heat flux results. 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 pre-determined time spans. A "SC" indicates that the values did not change sufficiently for this value to be calculated.

Table 17. 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 Total	SC	1	0.0	0.0	0.0	0.0	0.0	0.0
1st Floor Rad	SC	1	0.0	0.0	0.0	0.0	0.0	0.0
2nd Floor Total	SC	1	0.2	0.1	0.1	0.1	0.1	0.1
2nd Floor Rad	SC	1	0.0	0.0	0.0	0.0	0.0	0.0

The following chart(s) shows a time dependent representation of the baseline corrected instantaneous heat flux measured during the experiment.

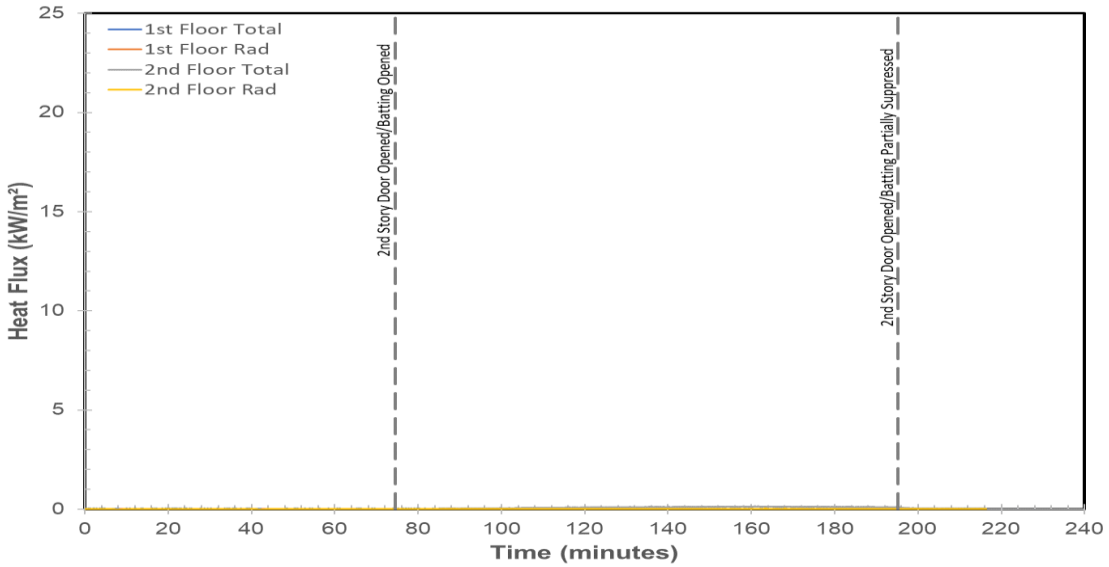


Figure 28. Heat Flux

The following table provides a summary of the optical density.

Table 18. Optical Density Results Summary

Description	Average Optical Density (1/m)	Maximum Optical Density (1/m)
1st Floor ODM	0.09	0.28
2nd Floor ODM	0.60	1.12

The following chart provides a time dependent representation of the optical density measured during the experiment.

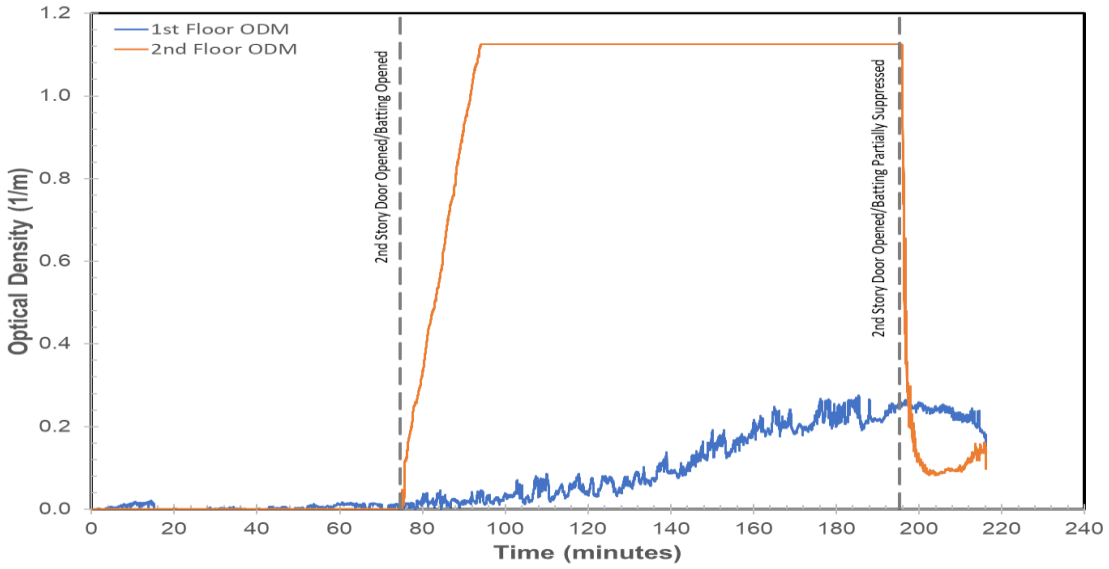


Figure 29. Optical Density

The following chart shows the obscuration during the experiment.

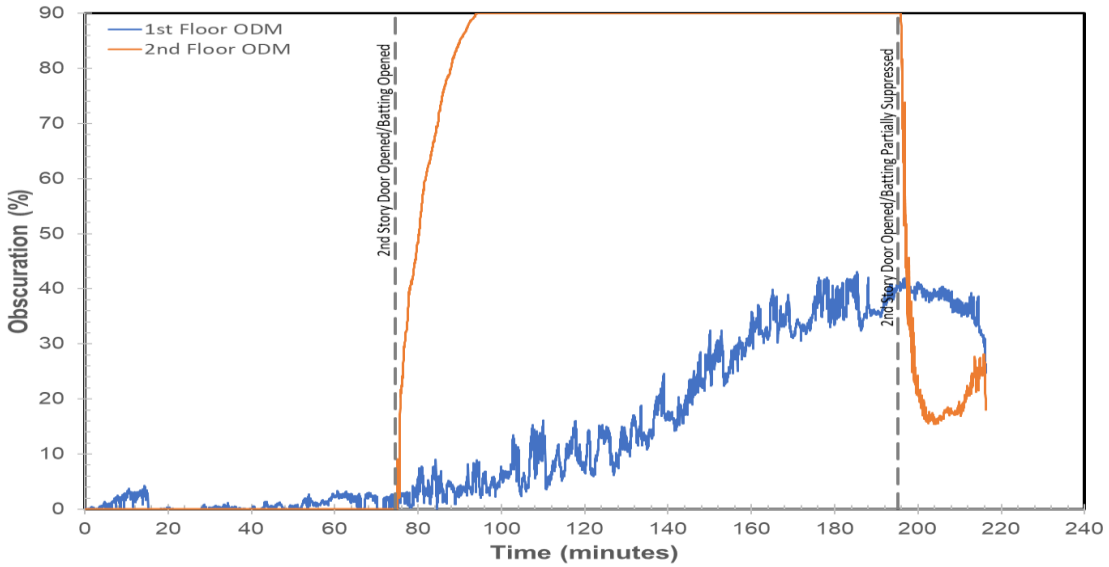


Figure 30. Obscuration

The following table shows which oxygen analyzer(s) were taken out of service during the experiment.

Table 19. Out of Service

Description	Time out of service time (s)	Out of service reason
2nd Floor	0	Air Leak

The following table provides a summary of the oxygen measurement results.

Table 20. Oxygen Measurement Results

Description	Full Scale Range (%)	Minimum Value (%)	Average (%)
1st Floor	25	20.34375	20.70521

The following chart presents the oxygen concentration(s) measured during the test.

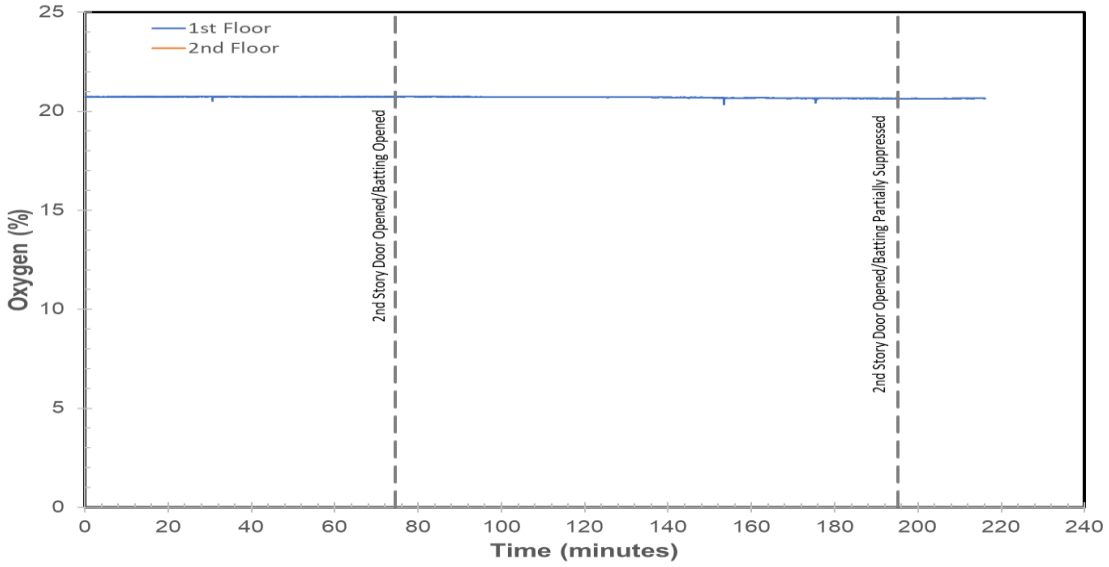


Figure 31. Oxygen Concentration

The following table shows which CO/CO2 gas analyzer(s) were taken out of service (OOS) during the experiment.

Table 21. Out of Service

Description	CO- Time OOS (s)	CO- Reason OOS	CO2- Time OOS (s)	CO2- Reason OOS
2nd Floor	0	Air Leak	0	Air Leak

The following table provides a summary of the carbon monoxide gas measurement results.

Table 22. CO Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
1st Floor	0.05	0.0002	-0.0001

The following table provides a summary of the carbon dioxide gas measurement results.

Table 23. CO2 Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
1st Floor	0.25	0.0014	0.0002

The following chart shows the carbon monoxide concentration(s) measured during the experiment.

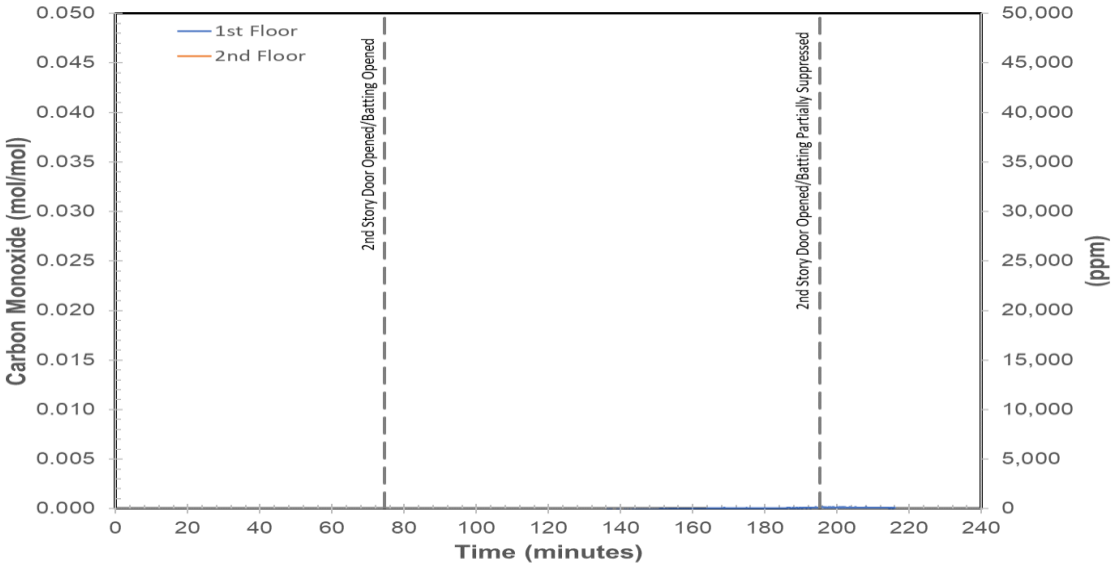


Figure 32. Carbon Monoxide Concentration(s)

The following chart shows the carbon dioxide concentration(s) measured during the experiment.

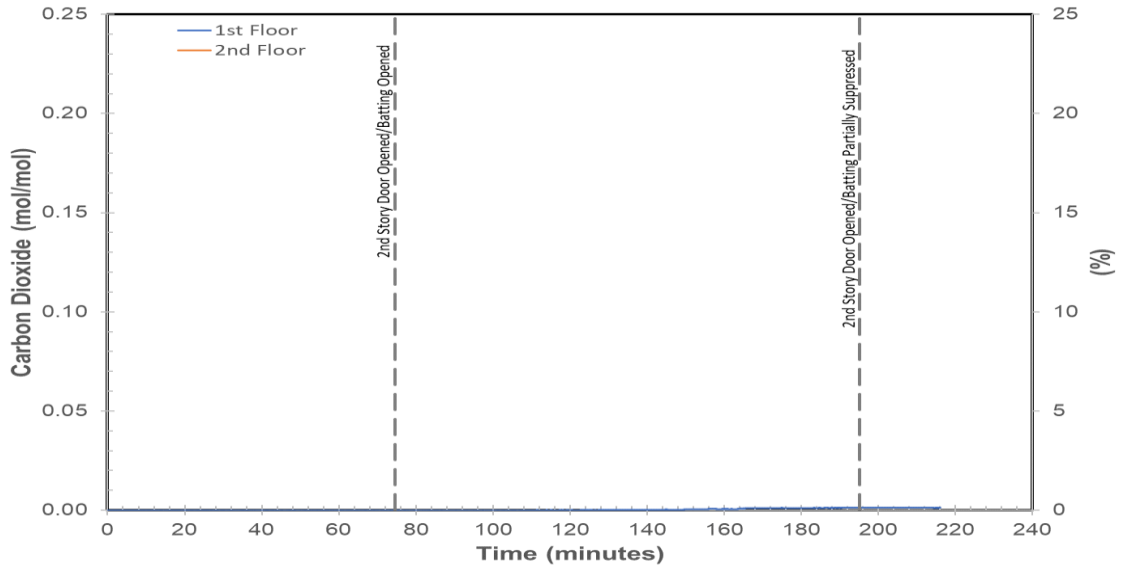


Figure 33. Carbon Dioxide Concentration(s)

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

Table 24. Video Log

Description	Start Time	Duration (s)	Filename
Stairs Looking down	09:56:34	13009	360079_20230306_095628_1A.mov
Ignition	09:56:42	13013	360079_20230306_095635_2A.mov
Stairs looking up	09:56:49	13017	360079_20230306_095643_3A.mov
Wide View 2nd	09:56:56	13081	360079_20230306_095650_4A.mov
Smoke Detector 2nd floor	09:57:04	13084	360079_20230306_095657_5A.mov
Smoke Detector 1st floor	09:57:11	13089	360079_20230306_095705_6A.mov
Wide View 1st	09:57:19	13093	360079_20230306_095712_7A.mov
HD outside view	09:57:26	13097	360079_20230306_095719_8A.mov
Custom - Master Sped Up 60X			360079_1313285.MOV
Master			360079_1313286.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 34. Pre test 1:20 hr:min, 360079_1304634

Figure 35. Pre test 1:20 hr:min, 360079_1304635

Figure 36. Pre test 1:20 hr:min, 360079_1304636

Figure 37. Pre test 1:20 hr:min, 360079_1304637

Figure 38. Pre test 1:19 hr:min, 360079_1304638

Figure 39. Pre test 1:19 hr:min, 360079_1304639

Figure 40. Pre test 1:19 hr:min, 360079_1304640

Figure 41. Pre test 1:19 hr:min, 360079_1304641

Figure 42. Pre test 1:19 hr:min, 360079_1304642

Figure 43. Pre test 1:19 hr:min, 360079_1304643

Figure 44. Pre test 1:19 hr:min, 360079_1304644

Figure 45. Pre test 1:18 hr:min, 360079_1304645

Figure 46. Pre test 1:18 hr:min, 360079_1304646

Figure 47. Pre test 1:18 hr:min, 360079_1304647

Figure 48. Pre test 1:18 hr:min, 360079_1304648

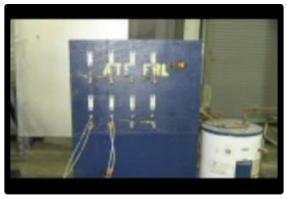


Figure 49. Pre test 1:17 hr:min, 360079_1304649

Figure 50. Pre test 1:17 hr:min, 360079_1304650

Figure 51. Pre test 1:17 hr:min, 360079_1304651

Figure 52. Pre test 1:17 hr:min, 360079_1304652

Figure 53. Pre test 1:17 hr:min, 360079_1304653

Figure 54. Pre test 1:16 hr:min, 360079_1304654

Figure 55. Pre test 1:16 hr:min, 360079_1304655

Figure 56. Pre test 1:16 hr:min, 360079_1304656

Figure 57. Pre test 1:15 hr:min, 360079_1304657

Figure 58. Pre test 1:15 hr:min, 360079_1304658

Figure 59. Pre test 1:15 hr:min, 360079_1304659

Figure 60. Pre test 1:15 hr:min, 360079_1304660

Figure 61. Pre test 1:15 hr:min, 360079_1304661

Figure 62. Pre test 1:15 hr:min, 360079_1304662

Figure 63. Pre test 1:15 hr:min, 360079_1304663

Figure 64. Pre test 1:15 hr:min, 360079_1304664

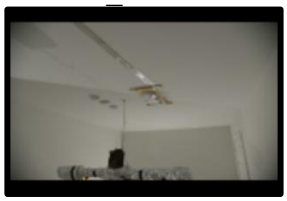


Figure 65. Pre test 1:15 hr:min, 360079_1304665

Figure 66. Pre test 1:15 hr:min, 360079_1304666

Figure 67. Pre test 1:15 hr:min, 360079_1304667

Figure 68. Pre test 1:15 hr:min, 360079_1304668

Figure 69. Pre test 1:15 hr:min, 360079_1304669

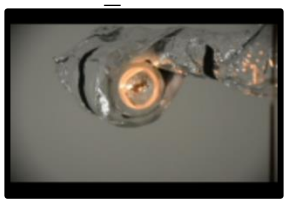


Figure 70. Pre test 1:15 hr:min, 360079_1304670

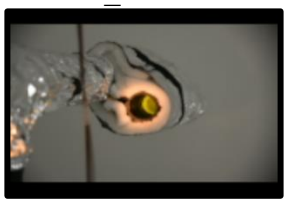


Figure 71. Pre test 1:15 hr:min, 360079_1304671

Figure 72. Pre test 1:14 hr:min, 360079_1304672

Figure 73. Pre test 1:14 hr:min, 360079_1304673

Figure 74. Pre test 1:14 hr:min, 360079_1304674

Figure 75. Pre test 1:14 hr:min, 360079_1304675

Figure 76. Pre test 1:14 hr:min, 360079_1304676

Figure 77. Pre test 1:14 hr:min, 360079_1304677

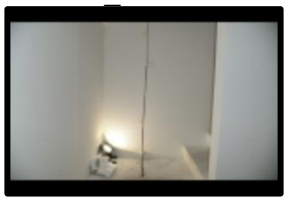


Figure 78. Pre test 1:14 hr:min, 360079_1304678

Figure 79. Pre test 1:14 hr:min, 360079_1304679

Figure 80. Pre test 1:14 hr:min, 360079_1304680

Figure 81. Pre test 1:14 hr:min, 360079_1304681

Figure 82. Pre test 1:14 hr:min, 360079_1304682

Figure 83. Pre test 1:13 hr:min, 360079_1304683

Figure 84. Pre test 1:13 hr:min, 360079_1304684

Figure 85. Pre test 1:13 hr:min, 360079_1304685

Figure 86. Pre test 1:13 hr:min, 360079_1304686

Figure 87. Pre test 1:13 hr:min, 360079_1304687

Figure 88. Pre test 1:13 hr:min, 360079_1304688

Figure 89. Pre test 1:13 hr:min, 360079_1304689

Figure 90. Pre test 1:13 hr:min, 360079_1304690

Figure 91. Pre test 1:13 hr:min, 360079_1304691

Figure 92. Pre test 1:13 hr:min, 360079_1304692

Figure 93. Pre test 1:13 hr:min, 360079_1304693

Figure 94. Pre test 1:13 hr:min, 360079_1304694

Figure 95. Pre test 1:13 hr:min, 360079_1304695

Figure 96. Pre test 1:13 hr:min, 360079_1304696

Figure 97. Pre test 1:13 hr:min, 360079_1304697

Figure 98. Pre test 1:13 hr:min, 360079_1304698

Figure 99. Pre test 1:13 hr:min, 360079_1304699

Figure 100. Pre test 1:12 hr:min, 360079_1304700

Figure 101. Pre test 1:12 hr:min, 360079_1304701

Figure 102. Pre test 1:12 hr:min, 360079_1304702

Figure 103. Pre test 1:12 hr:min, 360079_1304703

Figure 104. Pre test 1:12 hr:min, 360079_1304704

Figure 105. Pre test 1:12 hr:min, 360079_1304705

Figure 106. Pre test 1:12 hr:min, 360079_1304706

Figure 107. Pre test 1:12 hr:min, 360079_1304707

Figure 108. Pre test 1:12 hr:min, 360079_1304708

Figure 109. Pre test 1:12 hr:min, 360079_1304709

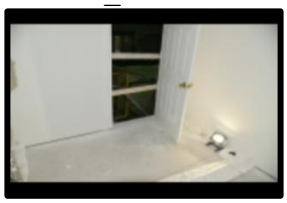


Figure 110. Pre test 1:12 hr:min, 360079_1304710

Figure 111. Pre test 1:12 hr:min, 360079_1304711

Figure 112. Pre test 1:12 hr:min, 360079_1304712

Figure 113. Pre test 1:12 hr:min, 360079_1304713

Figure 114. Pre test 1:12 hr:min, 360079_1304714

Figure 115. Pre test 1:12 hr:min, 360079_1304715

Figure 116. Pre test 1:12 hr:min, 360079_1304716

Figure 117. Pre test 1:11 hr:min, 360079_1304717

Figure 118. Pre test 1:11 hr:min, 360079_1304718

Figure 119. Pre test 1:11 hr:min, 360079_1304719

Figure 120. Pre test 1:11 hr:min, 360079_1304720

Figure 121. Pre test 1:11 hr:min, 360079_1304721

Figure 122. Pre test 1:11 hr:min, 360079_1304722

Figure 123. Pre test 1:11 hr:min, 360079_1304723

Figure 124. Pre test 1:11 hr:min, 360079_1304724

Figure 125. Pre test 1:11 hr:min, 360079_1304725

Figure 126. Pre test 1:10 hr:min, 360079_1304726

Figure 127. Pre test 1:10 hr:min, 360079_1304727

Figure 128. Pre test 1:10 hr:min, 360079_1304728

Figure 129. Pre test 1:10 hr:min, 360079_1304729

Figure 130. Pre test 1:10 hr:min, 360079_1304730

Figure 131. Pre test 1:09 hr:min, 360079_1304731

Figure 132. Pre test 1:09 hr:min, 360079_1304732

Figure 133. Pre test 1:09 hr:min, 360079_1304733

Figure 134. Pre test 1:09 hr:min, 360079_1304734

Figure 135. Pre test 1:08 hr:min, 360079_1304735

Figure 136. Pre test 1:08 hr:min, 360079_1304736

Figure 137. Pre test 1:08 hr:min, 360079_1304737

Figure 138. Pre test 1:08 hr:min, 360079_1304738

Figure 139. Pre test 1:08 hr:min, 360079_1304739

Figure 140. Pre test 1:08 hr:min, 360079_1304740

Figure 141. Pre test 1:08 hr:min, 360079_1304741

Figure 142. Pre test 57 minutes, 360079_1304742

Figure 143. Pre test 57 minutes, 360079_1304743

Figure 144. Pre test 57 minutes, 360079_1304744

Figure 145. Pre test 57 minutes, 360079_1304745

Figure 146. Pre test 57 minutes, 360079_1304746

Figure 147. Pre test 56 minutes, 360079_1304747

Figure 148. Pre test 56 minutes, 360079_1304748

Figure 149. Pre test 56 minutes, 360079_1304749

Figure 150. Pre test 55 minutes, 360079_1304750

Figure 151. Pre test 55 minutes, 360079_1304751

Figure 152. Pre test 55 minutes, 360079_1304752

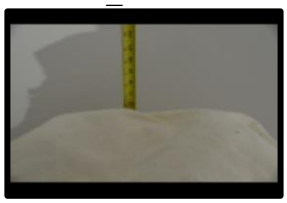


Figure 153. Pre test 55 minutes, 360079_1304753

Figure 154. Pre test 55 minutes, 360079_1304754

Figure 155. Pre test 55 minutes, 360079_1304755

Figure 156. Pre test 55 minutes, 360079_1304756

Figure 157. Pre test 54 minutes, 360079_1304757

Figure 158. Pre test 54 minutes, 360079_1304758

Figure 159. Pre test 54 minutes, 360079_1304759

Figure 160. Pre test 54 minutes, 360079_1304760

Figure 161. Pre test 54 minutes, 360079_1304761

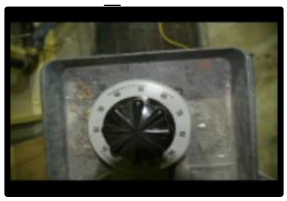


Figure 162. Pre test 16 minutes, 360079_1304762

Figure 163. Pre test 16 minutes, 360079_1304763

Figure 164. Pre test 8 minutes, 360079_1304764

Figure 165. Pre test 8 minutes, 360079_1304765

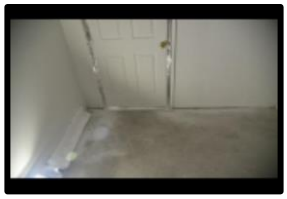


Figure 166. Pre test 7 minutes, 360079_1304766

Figure 167. Pre test 7 minutes, 360079_1304767

Figure 168. Pre test 7 minutes, 360079_1304768

Figure 169. Pre test 3 minutes, 360079_1304769

Figure 170. Pre test 3 minutes, 360079_1304770

Figure 171. Pre test 3 minutes, 360079_1304771

Figure 172. Pre test 3 minutes, 360079_1304772

Figure 173. Post test 49 minutes, 360079_1304773

Figure 174. Post test 49 minutes, 360079_1304774

Figure 175. Post test 49 minutes, 360079_1304775

Figure 176. Post test 49 minutes, 360079_1304776

Figure 177. Post test 49 minutes, 360079_1304777

Figure 178. Post test 49 minutes, 360079_1304778

Figure 179. Post test 49 minutes, 360079_1304779

Figure 180. Post test 50 minutes, 360079_1304780

Figure 181. Post test 50 minutes, 360079_1304781

Figure 182. Post test 1:15 hr:min, 360079_1304782

Figure 183. Post test 1:15 hr:min, 360079_1304783

Figure 184. Post test 1:15 hr:min, 360079_1304784

Figure 185. Post test 1:16 hr:min, 360079_1304785

Figure 186. Post test 1:16 hr:min, 360079_1304786

Figure 187. Post test 1:16 hr:min, 360079_1304787

Figure 188. Post test 1:16 hr:min, 360079_1304788

Figure 189. Post test 1:17 hr:min, 360079_1304789

Figure 190. Post test 1:17 hr:min, 360079_1304790

Figure 191. Post test 1:17 hr:min, 360079_1304791

Figure 192. 360079_1307030

Figure 193. 360079_1307031

Figure 194. 360079_1307032

Figure 195. 360079_1307033

Figure 196. 360079_1307034

Figure 197. 360079_1307035

Figure 198. 360079_1307036

Figure 199. 360079_1307037

Figure 200. 360079_1307038

Figure 201. 360079_1307039

Figure 202. 360079_1307040

Figure 203. 360079_1307041

Figure 204. 360079_1307042

Figure 205. 360079_1307043

Figure 206.
360079_1307044

Figure 207.
360079_1307045

Figure 208.
360079_1307046

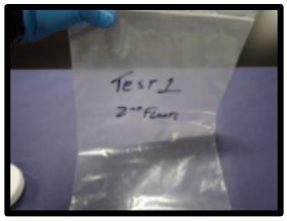


Figure 209.
360079_1307047

Figure 210.
360079_1307048

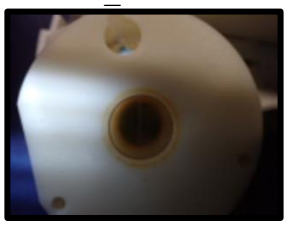


Figure 211.
360079_1307049

Figure 212.
360079_1307050

Figure 213.
360079_1307051

Figure 214.
360079_1307052

Figure 215.
360079_1307053

Figure 216.
360079_1307054

Figure 217.
360079_1307055

Figure 218.
360079_1307056

Figure 219.
360079_1307057

Figure 220.
360079_1307058

Figure 221.
360079_1307059

Figure 222.
360079_1307060

Figure 223.
360079_1307061

Figure 224.
360079_1307062

Figure 225.
360079_1307063

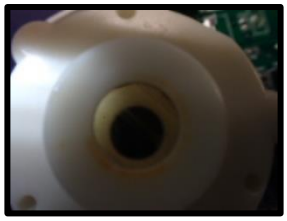
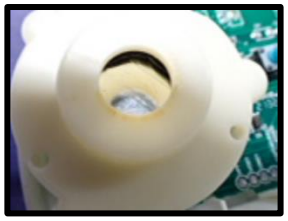


Figure 226.
360079_1307064

Figure 227.
360079_1307065



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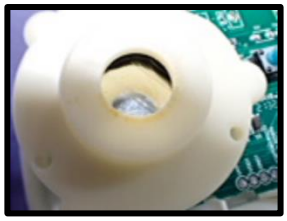


Figure 229.
360079_1307067

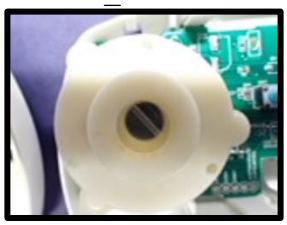


Figure 230.
360079_1307068

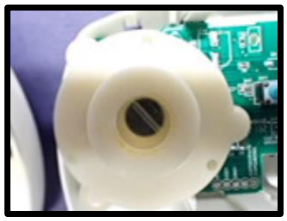


Figure 231.
360079_1307069

Figure 232.
360079_1307070

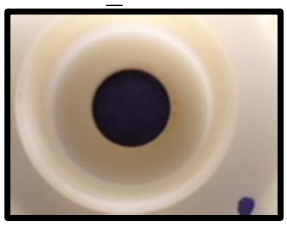


Figure 233.
360079_1307071

Figure 234.
360079_1307072

Figure 235.
360079_1307073

Figure 236.
360079_1307074

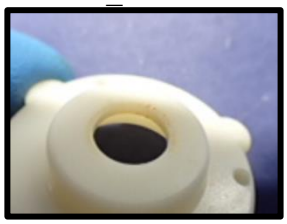
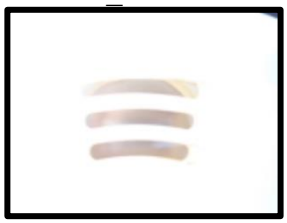


Figure 237.
360079_1307075

Figure 238.
360079_1307076

Figure 239.
360079_1307077

Figure 240.
360079_1307078



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360079_1307079

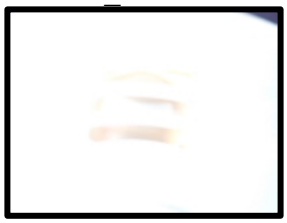


Figure 242.
360079_1307080

Figure 243.
360079_1307081

Figure 244.
360079_1307082

Figure 245.
360079_1307083

Figure 246.
360079_1307084

Figure 247.
360079_1307085

Figure 248.
360079_1307086

Figure 249.
360079_1307087

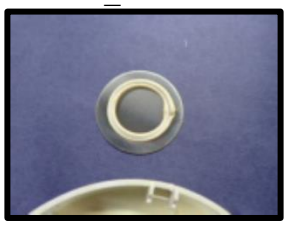


Figure 250.
360079_1307088

Figure 251.
360079_1307089

Figure 252.
360079_1307090

Figure 253.
360079_1307091

Figure 254.
360079_1307092

Figure 255.
360079_1307093

Figure 256.
360079_1307094

Figure 257.
360079_1307095

Figure 258.
360079_1307096

Figure 259.
360079_1307097

Figure 260.
360079_1307098

Figure 261.
360079_1307099

Figure 262.
360079_1307100

Figure 263.
360079_1307101

Figure 264.
360079_1307102

Figure 265.
360079_1307103

Figure 266.
360079_1307104

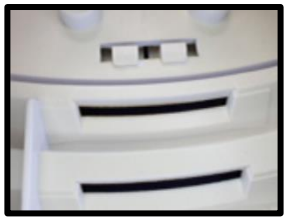


Figure 267.
360079_1307105

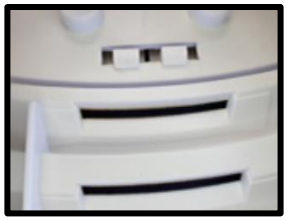


Figure 268.
360079_1307106

Figure 269.
360079_1307107

Figure 270.
360079_1307108

Figure 271.
360079_1307109

Figure 272.
360079_1307110

Figure 273.
360079_1307111

Figure 274.
360079_1307112

Figure 275.
360079_1307113

Figure 276.
360079_1307114

Figure 277.
360079_1307115

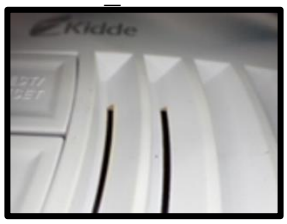


Figure 278.
360079_1307116

Figure 279.
360079_1307117

Figure 280.
360079_1307118

Figure 281.
360079_1307119

Figure 282.
360079_1307120

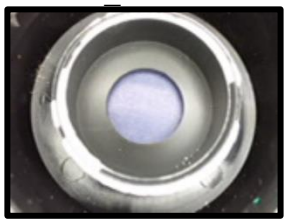


Figure 283.
360079_1307121

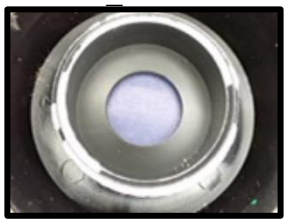


Figure 284.
360079_1307122

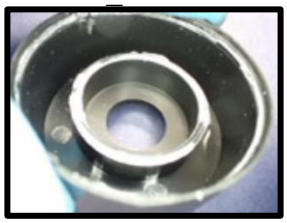


Figure 285.
360079_1307123

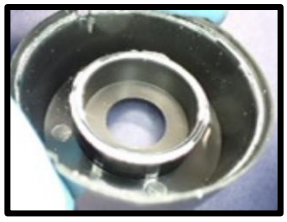


Figure 286.
360079_1307124

Figure 287.
360079_1307125

Figure 288.
360079_1307126

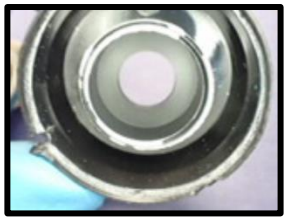


Figure 289.
360079_1307127

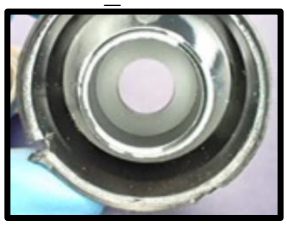


Figure 290.
360079_1307128

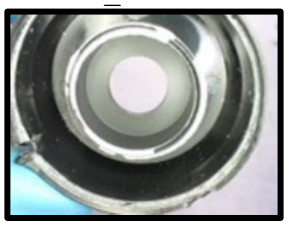


Figure 291.
360079_1307129

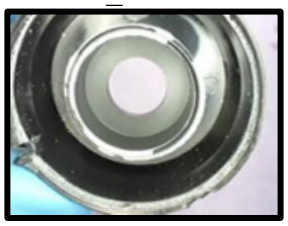


Figure 292.
360079_1307130

Figure 293.
360079_1307131

Figure 294.
360079_1307132

Figure 295.
360079_1307133

Figure 296.
360079_1307134

Figure 297.
360079_1307135

Figure 298.
360079_1307136

Figure 299.
360079_1307137

Figure 300.
360079_1307138

Figure 301.
360079_1307139

Figure 302.
360079_1307140

Figure 303.
360079_1307141

Figure 304.
360079_1307142

Figure 305.
360079_1307143

Figure 306.
360079_1307144

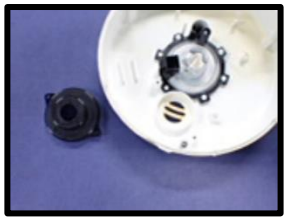
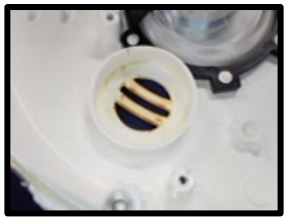


Figure 307.
360079_1307145

Figure 308.
360079_1307146



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360079_1307147

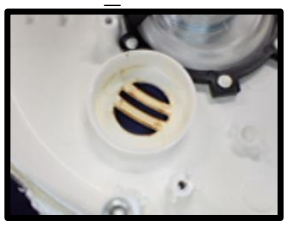


Figure 310.
360079_1307148

Figure 311.
360079_1307149

Figure 312.
360079_1307150

Figure 313.
360079_1307151

Figure 314.
360079_1307152

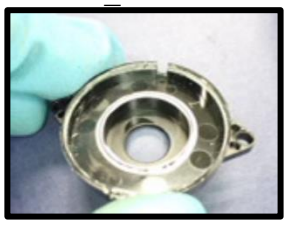
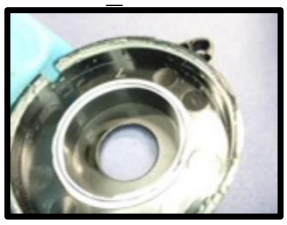


Figure 315.
360079_1307153

Figure 316.
360079_1307154



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360079_1307155

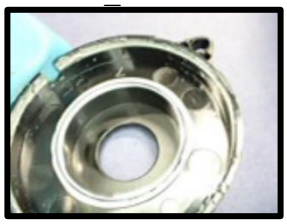


Figure 318.
360079_1307156

Figure 319.
360079_1307157

Figure 320.
360079_1307158

Figure 321.
360079_1307159

Figure 322.
360079_1307160

Figure 323.
360079_1307161

Figure 324.
360079_1307162

Figure 325.
360079_1307163

Figure 326.
360079_1307164

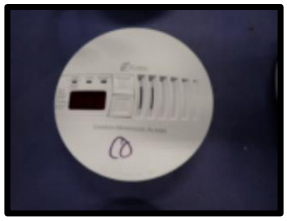


Figure 327.
360079_1307165

Figure 328.
360079_1307166

Figure 329.
360079_1307167

Figure 330.
360079_1307168

Figure 331.
360079_1307169

Figure 332.
360079_1307170

Figure 333.
360079_1307171

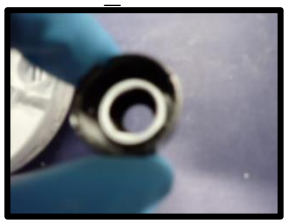


Figure 334.
360079_1307172

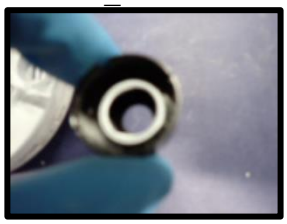


Figure 335.
360079_1307173

Figure 336.
360079_1307174

Figure 337.
360079_1307175

Figure 338.
360079_1307176

Figure 339.
360079_1307177

Figure 340.
360079_1307178

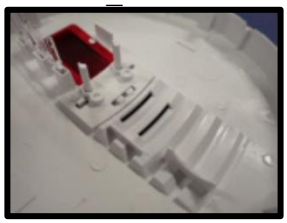


Figure 341.
360079_1307179

Figure 342.
360079_1307180

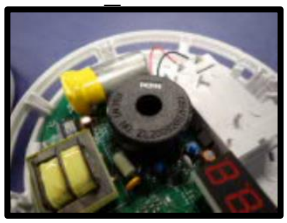


Figure 343.
360079_1307181

Figure 344.
360079_1307182

Figure 345.
360079_1307183


Figure 346.
360079_1307184


Figure 347.
360079_1307185


Figure 348.
360079_1307186


Figure 349.
360079_1307187


Figure 350.
360079_1307188


Figure 351.
360079_1307189


Figure 352.
360079_1307190


Figure 353.
360079_1307191

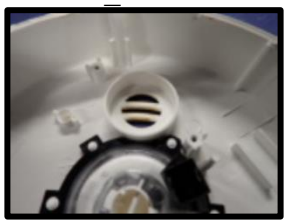


Figure 354.
360079_1307192


Figure 355.
360079_1307193


Figure 356.
360079_1307194


Figure 357.
360079_1307195


Figure 358.
360079_1307196


Figure 359.
360079_1307197


Figure 360.
360079_1307198


Figure 361.
360079_1307199


Figure 362.
360079_1307200

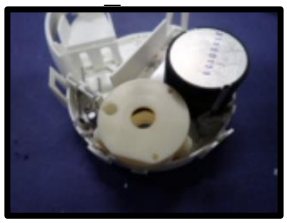
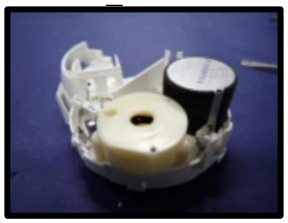


Figure 363.
360079_1307201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360079_1307202


Figure 365.
360079_1307203

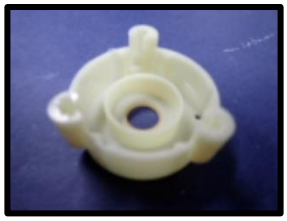


Figure 366.
360079_1307204

Figure 367.
360079_1307205

Figure 368.
360079_1307206

Figure 369.
360079_1307207

Figure 370.
360079_1307208

Figure 371.
360079_1307209

Figure 372.
360079_1307210

Figure 373.
360079_1307211

Figure 374.
360079_1307212

Figure 375.
360079_1307213

Figure 376.
360079_1307214

Figure 377.
360079_1307215

Figure 378.
360079_1307216

Figure 379.
360079_1307217

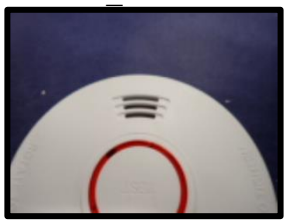


Figure 380.
360079_1307218

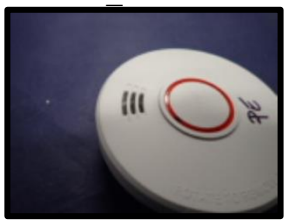


Figure 381.
360079_1307219

Figure 382.
360079_1307220

Figure 383.
360079_1307221

Figure 384.
360079_1307222

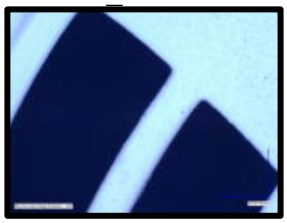


Figure 385.
360079_1307479

Figure 386.
360079_1307480

Figure 387.
360079_1307481

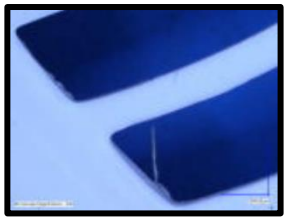


Figure 388.
360079_1307482

Figure 389.
360079_1307483

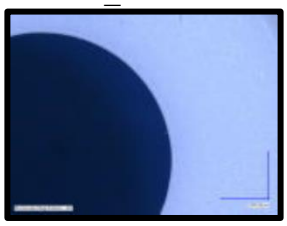


Figure 390.
360079_1307484

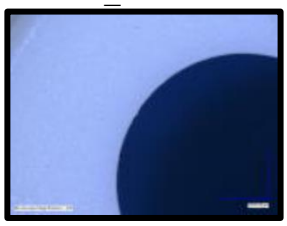


Figure 391.
360079_1307485

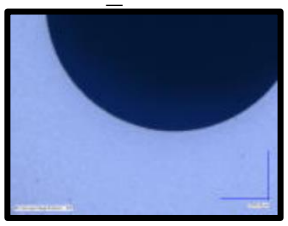


Figure 392.
360079_1307486

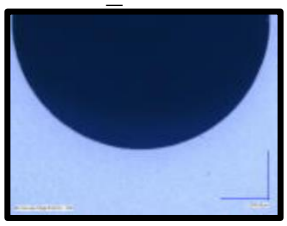


Figure 393.
360079_1307487

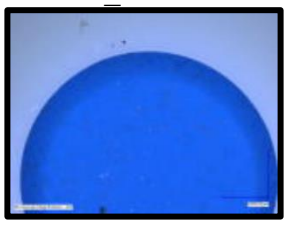


Figure 394.
360079_1307488

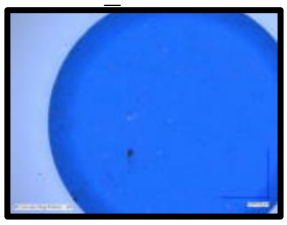


Figure 395.
360079_1307489

Figure 396.
360079_1307490

Figure 397.
360079_1307491

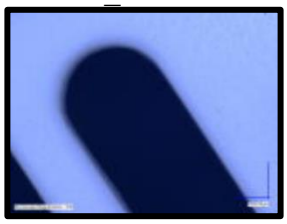


Figure 398.
360079_1307492

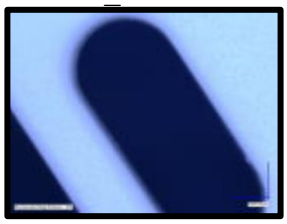


Figure 399.
360079_1307493

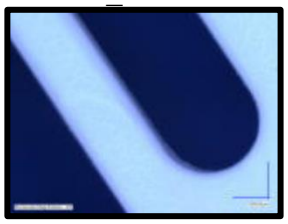


Figure 400.
360079_1307494

Figure 401.
360079_1307495

Figure 402.
360079_1307496

Figure 403.
360079_1307497

Figure 404.
360079_1307498

Figure 405.
360079_1307499

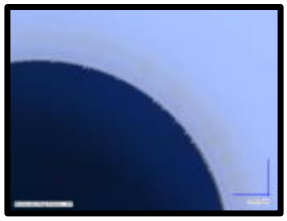


Figure 406.
360079_1307500

Figure 407.
360079_1307501

Figure 408.
360079_1307502

Figure 409.
360079_1307503

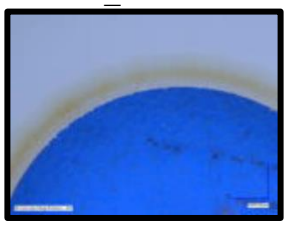


Figure 410.
360079_1307504

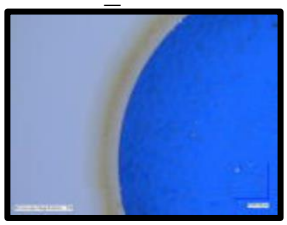


Figure 411.
360079_1307505

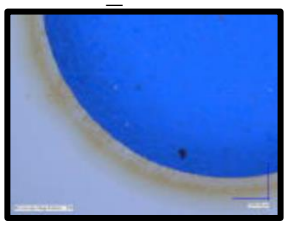


Figure 412.
360079_1307506

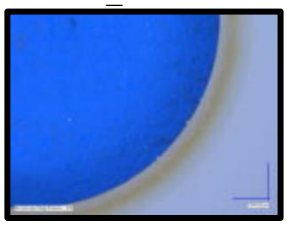


Figure 413.
360079_1307507

Figure 414.
360079_1307508

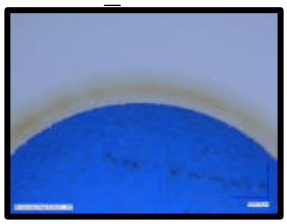


Figure 415.
360079_1307509

Figure 416.
360079_1307510

Figure 417.
360079_1307511

Figure 418.
360079_1307512

Figure 419.
360079_1307513

Figure 420.
360079_1307514

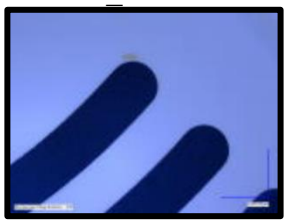


Figure 421.
360079_1307515

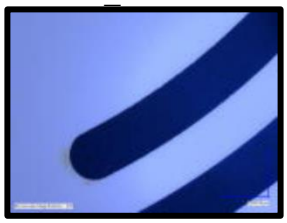


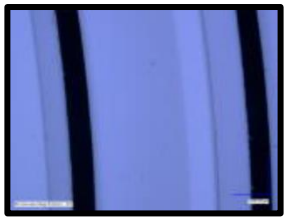
Figure 422.
360079_1307516

Figure 423.
360079_1307517

Figure 424.
360079_1307518

Figure 425.
360079_1307519

Figure 426.
360079_1307520



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360079_1307521

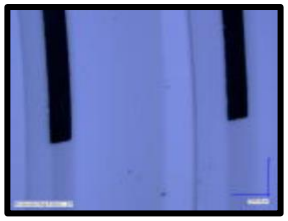


Figure 428.
360079_1307522

Figure 429.
360079_1307523

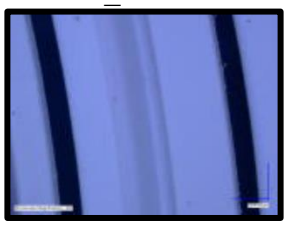


Figure 430.
360079_1307524

Figure 431.
360079_1307525

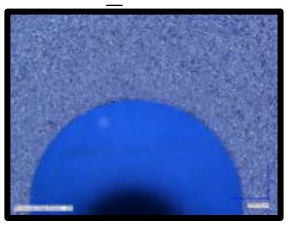


Figure 432.
360079_1307526

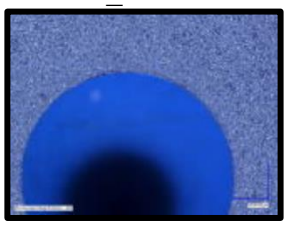
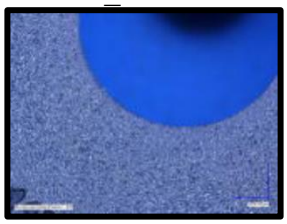


Figure 433.
360079_1307527



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360079_1307528

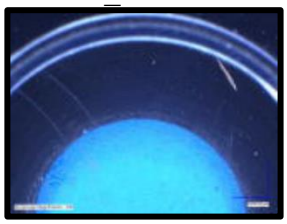


Figure 435.
360079_1307529

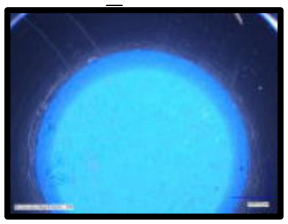


Figure 436.
360079_1307530

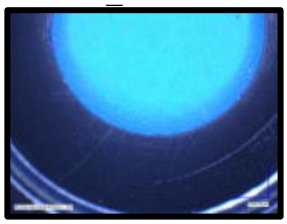


Figure 437.
360079_1307531

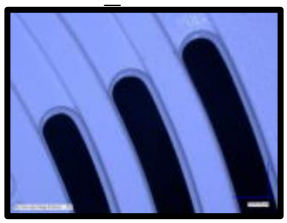


Figure 438.
360079_1307532

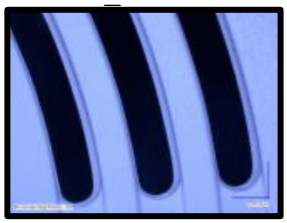


Figure 439.
360079_1307533

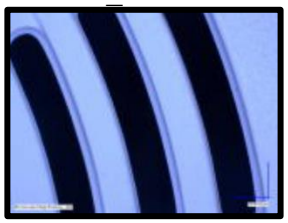


Figure 440.
360079_1307534

Figure 441.
360079_1307535

Figure 442.
360079_1307536

Figure 443.
360079_1307537

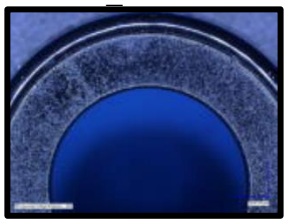


Figure 444.
360079_1307538

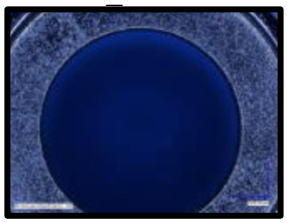
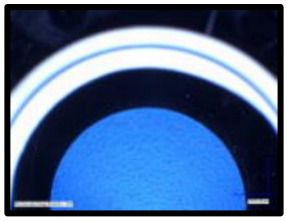


Figure 445.
360079_1307539

Figure 446.
360079_1307540



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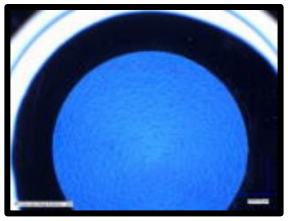
360079_1307541



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360079_1307542

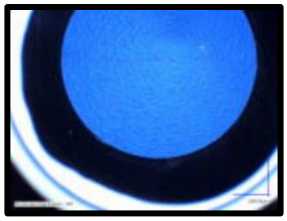


Figure 449.
360079_1307543

Figure 450.
360079_1307544

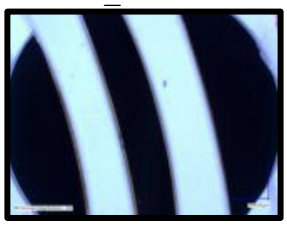


Figure 451.
360079_1307545

Figure 452.
360079_1307546

Figure 453.
360079_1307547

Figure 454.
360079_1307548

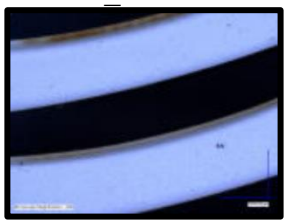


Figure 455.
360079_1307549

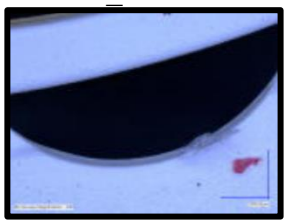


Figure 456.
360079_1307550

Figure 457.
360079_1307551

Figure 458.
360079_1307552

Figure 459.
360079_1307553

Figure 460.
360079_1307554

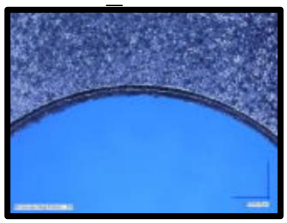


Figure 461.
360079_1307555

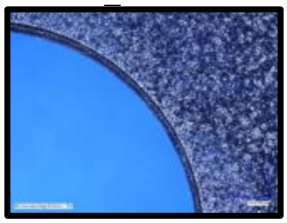


Figure 462.
360079_1307556

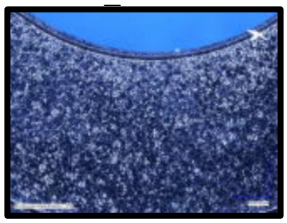


Figure 463.
360079_1307557

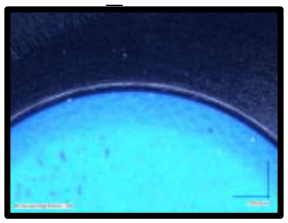


Figure 464.
360079_1307558

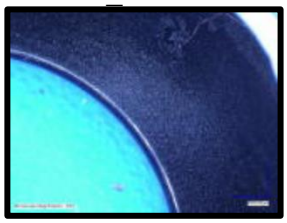


Figure 465.
360079_1307559

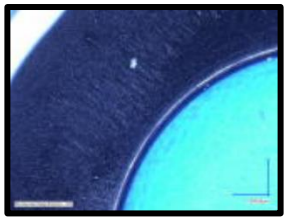


Figure 466.
360079_1307560

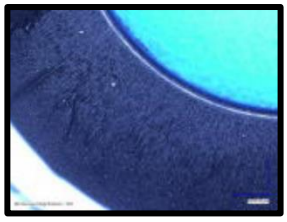


Figure 467.
360079_1307561

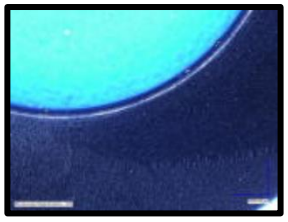


Figure 468.
360079_1307562

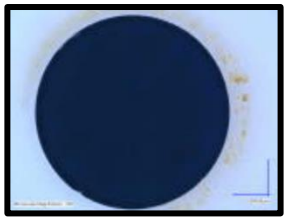


Figure 469.
360079_1307563

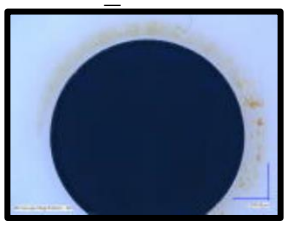


Figure 470.
360079_1307564

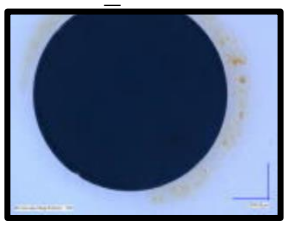


Figure 471.
360079_1307565

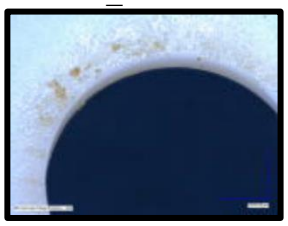


Figure 472.
360079_1307566

Figure 473.
360079_1307567

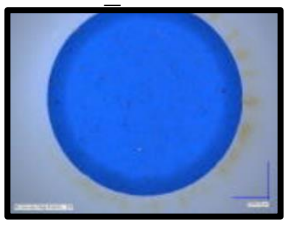


Figure 474.
360079_1307568

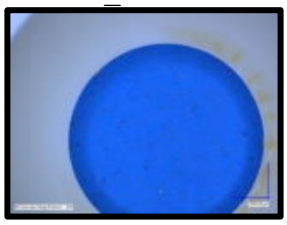


Figure 475.
360079_1307569

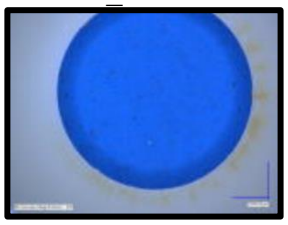


Figure 476.
360079_1307570

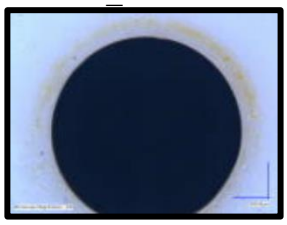


Figure 477.
360079_1307571

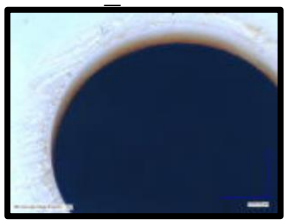


Figure 478.
360079_1307572

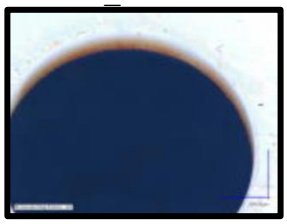


Figure 479.
360079_1307573

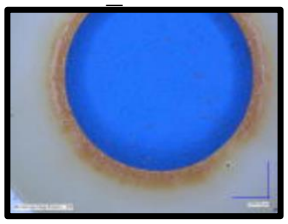


Figure 480.
360079_1307574

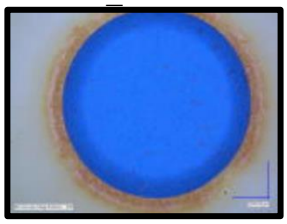


Figure 481.
360079_1307575

Figure 482.
360079_1307576

Figure 483.
360079_1307577

Figure 484.
360079_1307578

Figure 485.
360079_1307579

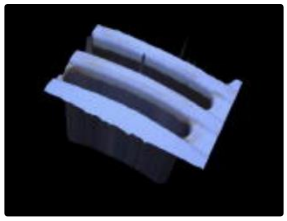


Figure 486.
360079_1307580

Figure 487.
360079_1307581

Figure 488.
360079_1307582

Figure 489.
360079_1307583

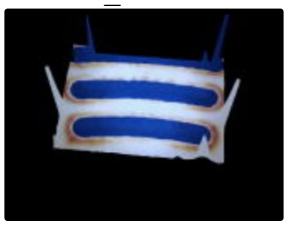


Figure 490.
360079_1307584

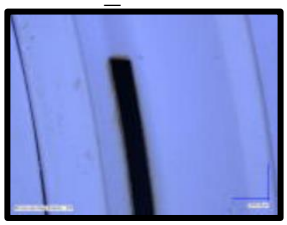


Figure 491.
360079_1307585

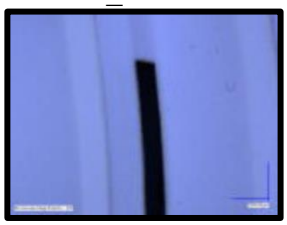


Figure 492.
360079_1307586

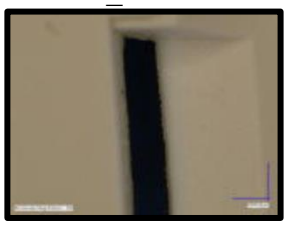


Figure 493.
360079_1307587

Figure 494.
360079_1307588

Figure 495.
360079_1307589

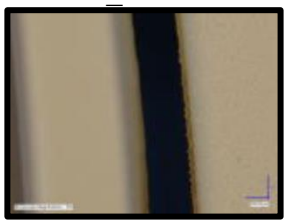


Figure 496.
360079_1307590

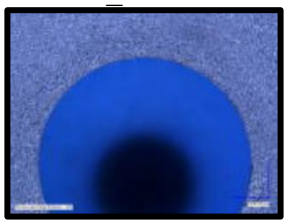


Figure 497.
360079_1307591

Figure 498.
360079_1307592

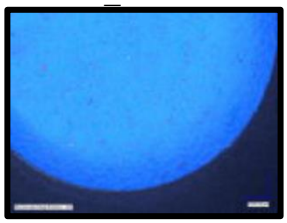


Figure 499.
360079_1307593

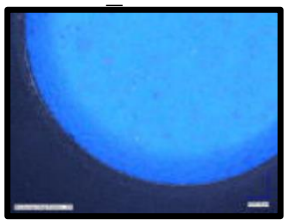


Figure 500.
360079_1307594

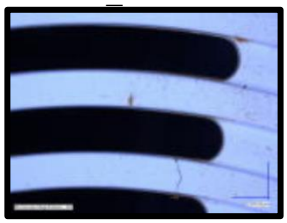


Figure 501.
360079_1307595

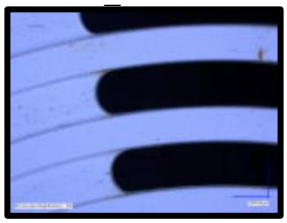


Figure 502.
360079_1307596

Figure 503.
360079_1307597

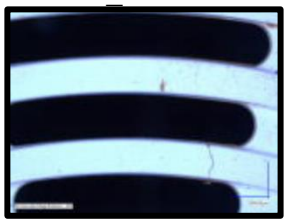


Figure 504.
360079_1307598

Figure 505.
360079_1307599

Figure 506.
360079_1307600

Figure 507.
360079_1307601

Figure 508.
360079_1307602

Figure 509.
360079_1307603

Figure 510.
360079_1307604

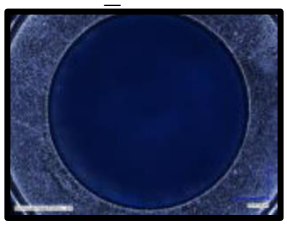


Figure 511.
360079_1307605

Figure 512.
360079_1307606

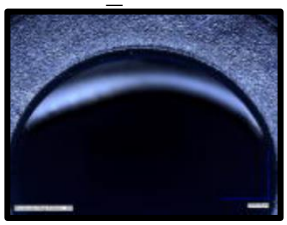


Figure 513.
360079_1307607

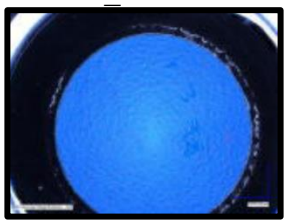


Figure 514.
360079_1307608

Figure 515.
360079_1307609

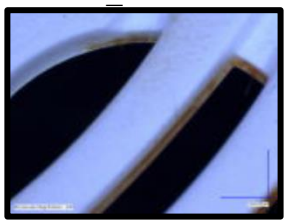


Figure 516.
360079_1307610

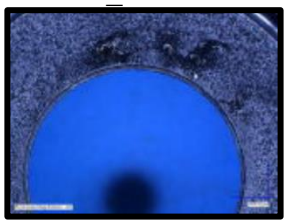


Figure 517.
360079_1307611

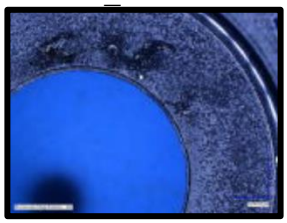


Figure 518.
360079_1307612

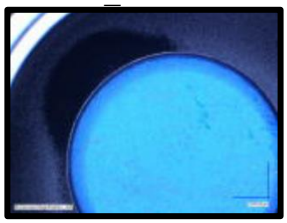


Figure 519.
360079_1307613

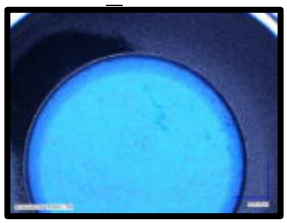


Figure 520.
360079_1307614

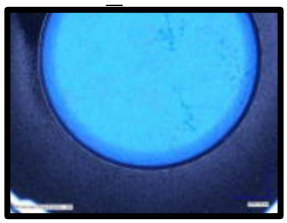


Figure 521.
360079_1307615

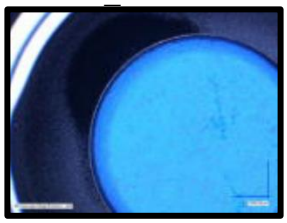


Figure 522.
360079_1307616

Figure 523.
360079_1313694

Figure 524.
360079_1313695

Figure 525.
360079_1313696

Figure 526.
360079_1313697

Figure 527.
360079_1313698

Figure 528.
360079_1313699

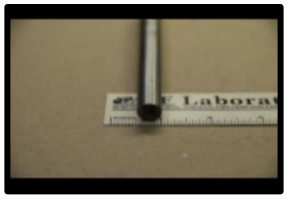


Figure 529.
360079_1313700

Figure 530.
360079_1313701

Results for Test 2 (ID 360082)

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

Table 25. Experiment Events

Description	Time (s)
Variable Transformer Setting 50%	0
Variable Transformer Off	308
Variable Transformer Setting 50%	753
Variable Transformer Off	1402

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 over pre-determined time spans.

Table 26. 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)
Landing 0'	11.2	11.3	11.3	11.3	11.2	11.2
Landing 1'	11.1	11.3	11.3	11.3	11.3	11.3
Landing 2'	11.0	11.3	11.2	11.2	11.2	11.2
Landing 3'	10.9	11.2	11.2	11.2	11.2	11.2
Landing 4'	10.9	11.2	11.2	11.2	11.2	11.1
Landing 5'	10.9	11.2	11.2	11.2	11.2	11.1
Landing 6'	10.9	11.3	11.3	11.3	11.3	11.3
Landing 7'	11.0	11.6	11.6	11.6	11.5	11.5
1st Floor 0'	10.9	11.3	11.3	11.3	11.2	11.2
1st Floor 1'	10.8	11.0	11.0	11.0	11.0	11.0
1st Floor 2'	11.0	11.2	11.2	11.2	11.1	11.1
1st Floor 3'	10.8	11.0	11.0	11.0	10.9	10.9
1st Floor 4'	10.8	10.9	10.9	10.9	10.9	10.8
1st Floor 5'	10.8	11.0	10.9	10.9	10.9	10.9
1st Floor 6'	10.7	11.0	11.0	11.0	10.9	10.9
1st Floor 7'	10.7	11.0	11.0	11.0	11.0	10.9
1st Floor 8'	10.8	11.0	11.0	11.0	11.0	11.0
2nd Floor 0'	11.0	14.3	14.2	14.2	14.1	13.9
2nd Floor 1'	10.8	14.9	14.8	14.8	14.5	14.3
2nd Floor 2'	10.8	15.5	15.4	15.3	15.2	15.0
2nd Floor 3'	10.8	16.2	16.2	16.1	15.8	15.6
2nd Floor 4'	11.0	18.7	18.6	18.5	18.3	18.1
2nd Floor 5'	11.2	19.8	19.8	19.7	19.6	19.6
2nd Floor 6'	11.3	19.6	19.5	19.4	19.4	19.3
2nd Floor 7'	11.5	19.8	19.7	19.7	19.6	19.6
2nd Floor 8'	11.8	20.3	20.2	20.2	20.1	20.0
Tenability 1st Floor 5'	10.8	11.3	11.3	11.2	11.2	11.2
Tenability 2nd Floor 5'	11.3	18.7	18.6	18.6	18.5	18.5
Smolder TC 1	12.0	932.8	932.3	931.6	917.8	873.8
Smolder TC 2	11.8	526.5	526.4	526.2	524.3	521.7

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

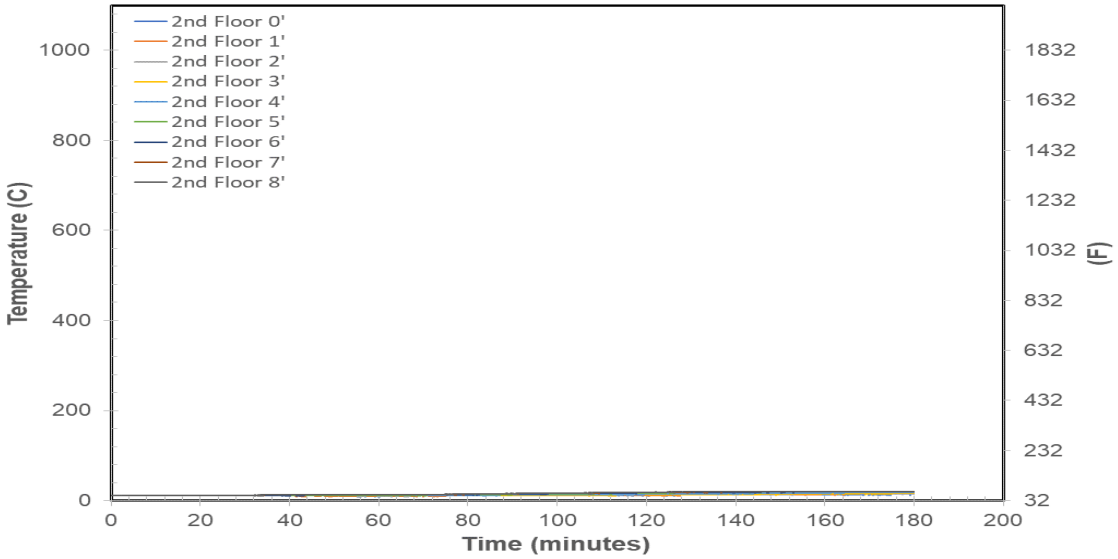


Figure 531. Temperature – 2nd Floor

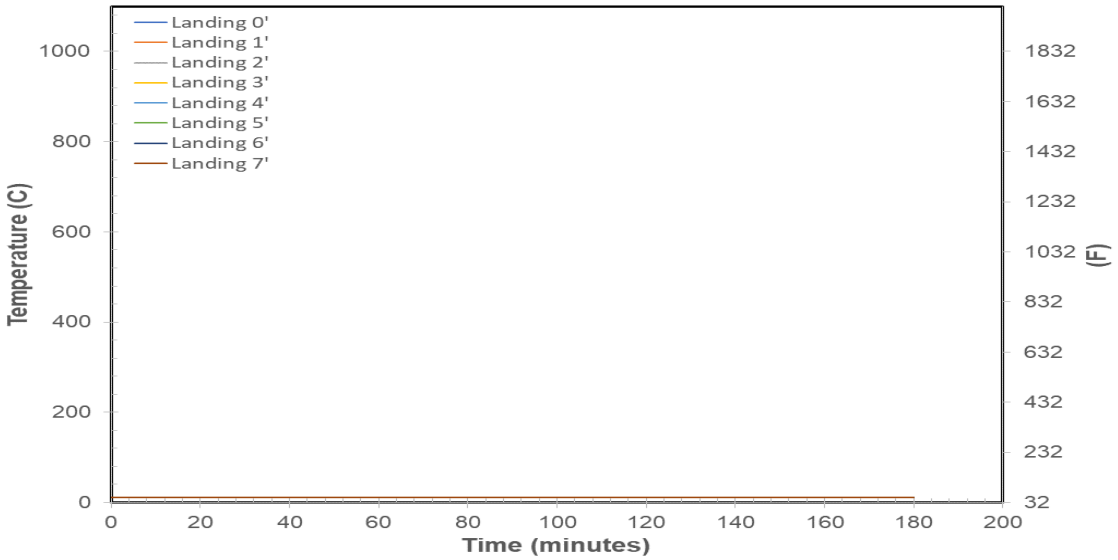


Figure 532. Temperature – Landing

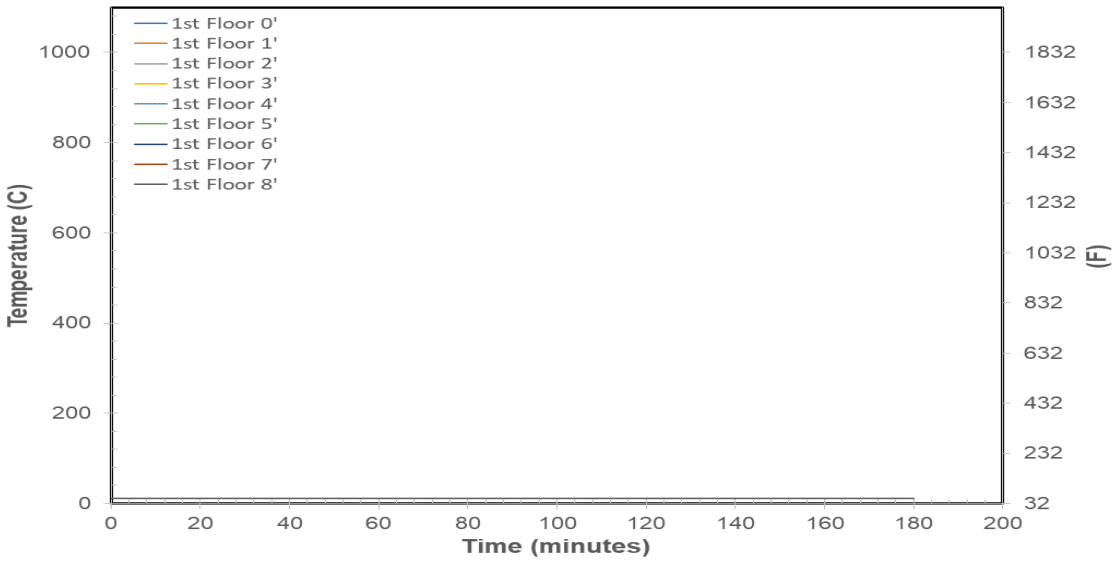


Figure 533. Temperature – 1st Floor

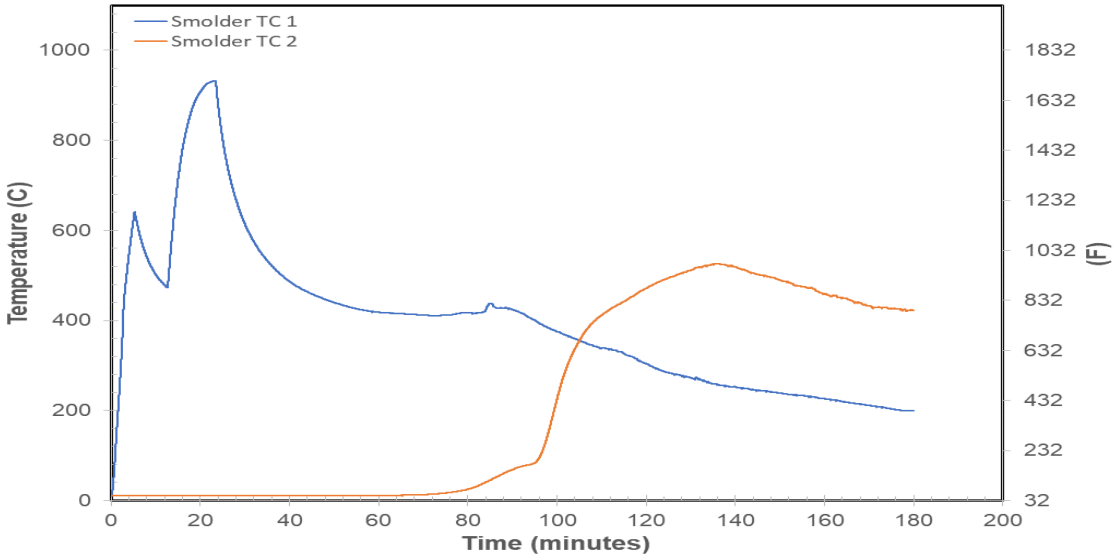


Figure 534. Temperature – Cotton Batting

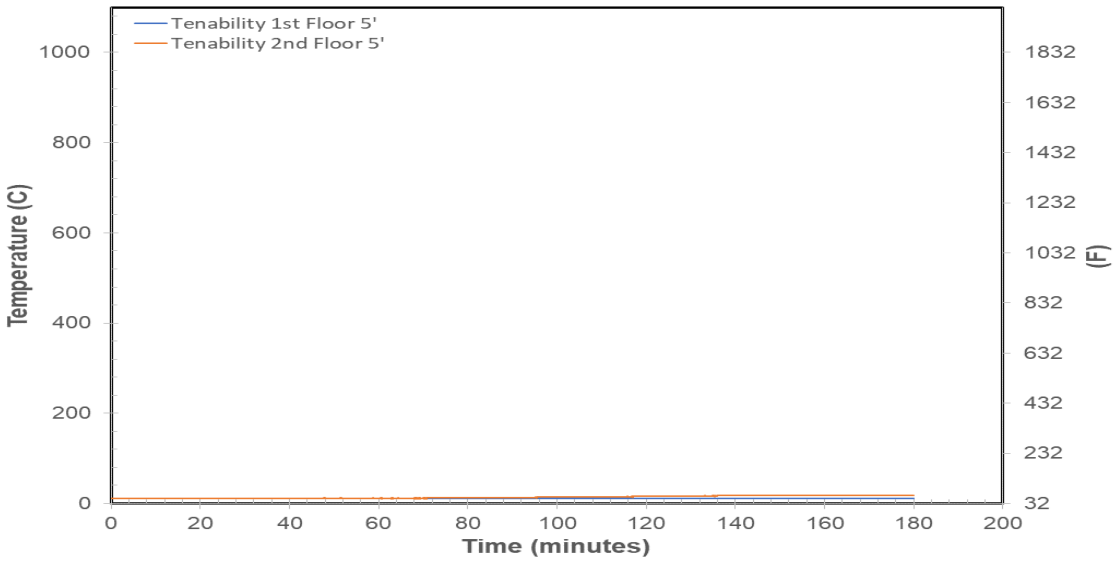


Figure 535. Temperature - Tenability

The following table provides a summary of the heat flux results. 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 pre-determined time spans. A "SC" indicates that the values did not change sufficiently for this value to be calculated.

Table 27. 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 Total	SC	1	0.1	0.0	0.0	0.0	0.0	0.0
1st Floor Rad	SC	1	0.0	0.0	0.0	0.0	0.0	0.0
2nd Floor Total	SC	1	0.1	0.1	0.1	0.1	0.0	0.0
2nd Floor Rad	SC	1	0.0	0.0	0.0	0.0	0.0	0.0

The following chart(s) shows a time dependent representation of the baseline corrected instantaneous heat flux measured during the experiment.

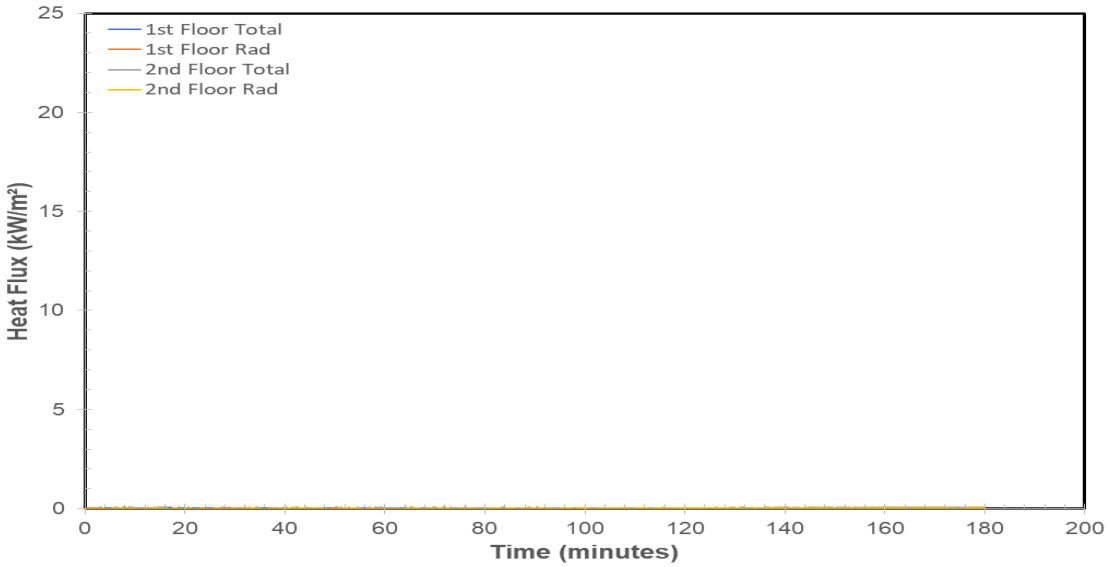


Figure 536. Heat Flux

The following table provides a summary of the optical density.

Table 28. Optical Density Results Summary

Description	Average Optical Density (1/m)	Maximum Optical Density (1/m)
1st Floor ODM	0.00	0.06
2nd Floor ODM	0.08	0.19

The following chart provides a time dependent representation of the optical density measured during the experiment.

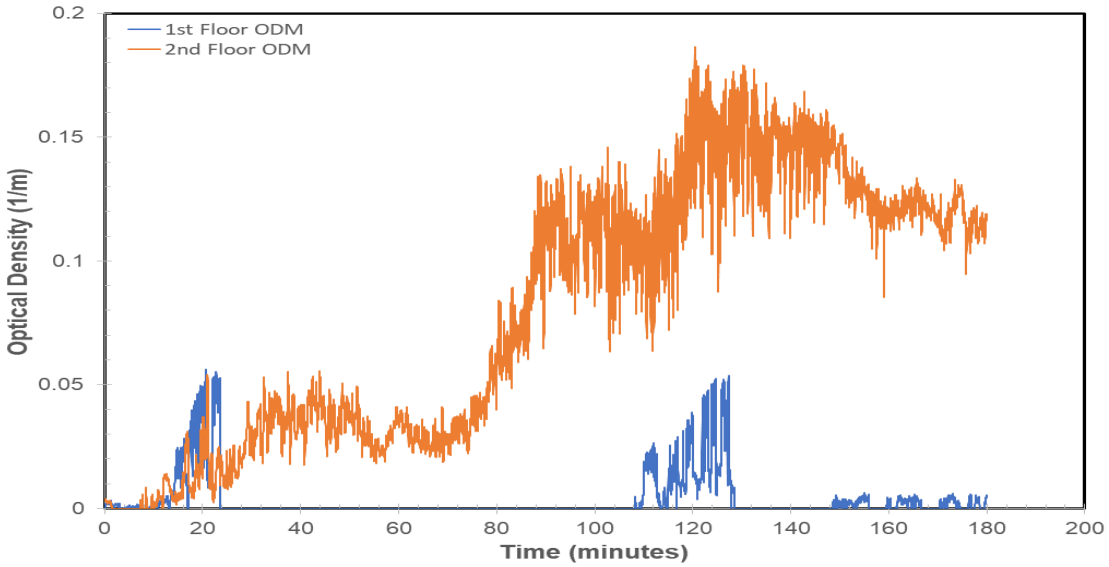


Figure 537. Optical Density

The following chart shows the obscuration during the experiment.

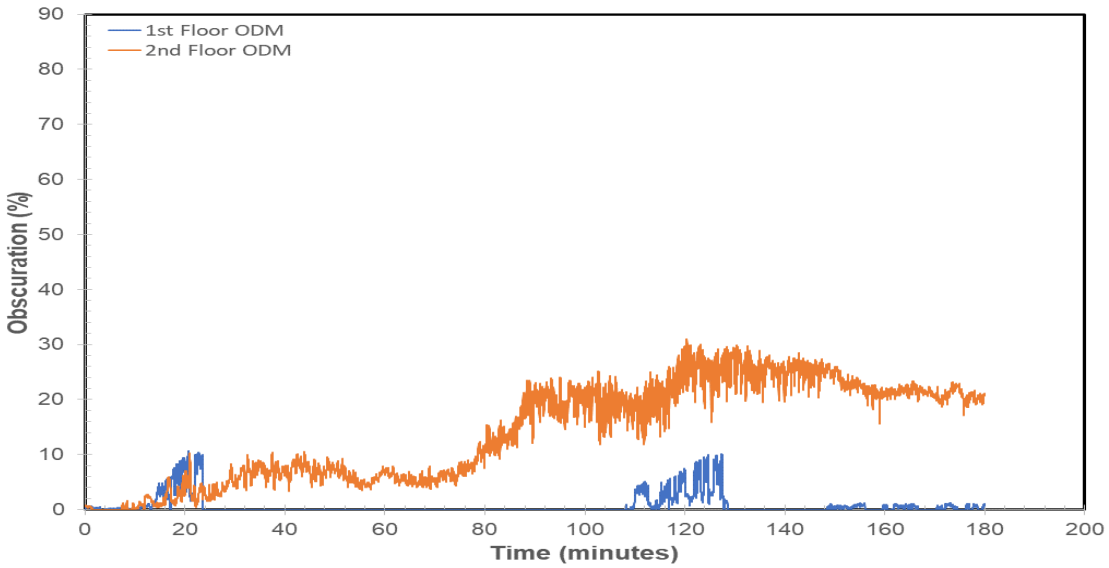


Figure 538. Obscuration

The following table provides a summary of the oxygen measurement results.

Table 29. Oxygen Measurement Results

Description	Full Scale Range (%)	Minimum Value (%)	Average (%)
1st Floor	25	20.43125	20.75863
2nd Floor	25	20.5	20.67812

The following chart presents the oxygen concentration(s) measured during the test.

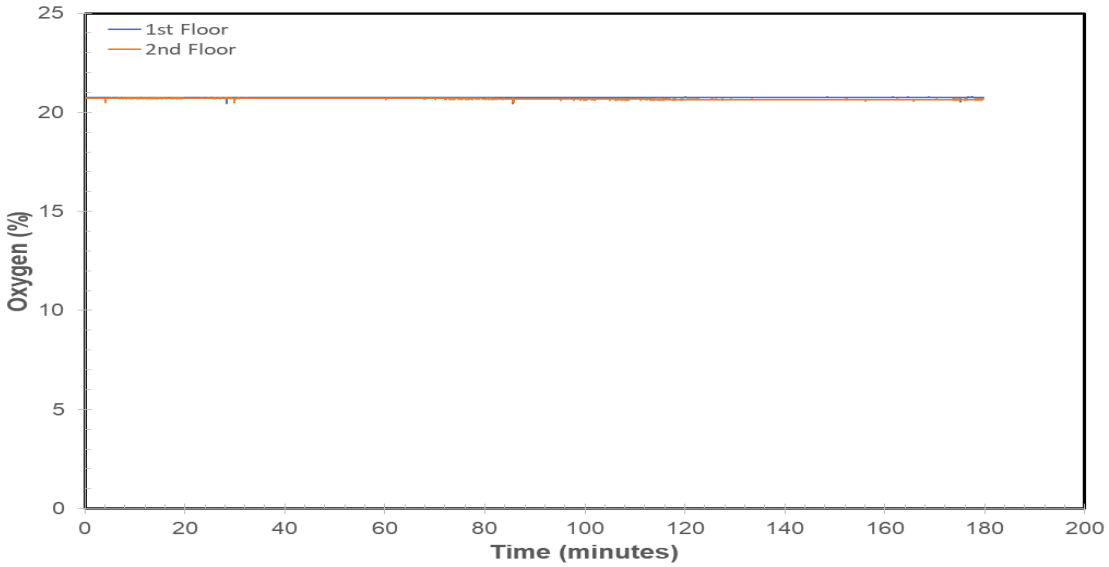


Figure 539. Oxygen Concentration

The following table provides a summary of the carbon monoxide gas measurement results.

Table 30. CO Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
1st Floor	0.05	-0.0003	-0.0004
2nd Floor	0.05	-0.0001	-0.0002

The following table provides a summary of the carbon dioxide gas measurement results.

Table 31. CO2 Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
1st Floor	0.25	-0.0001	-0.0004
2nd Floor	0.25	0.0004	0.0000

The following chart shows the carbon monoxide concentration(s) measured during the experiment.

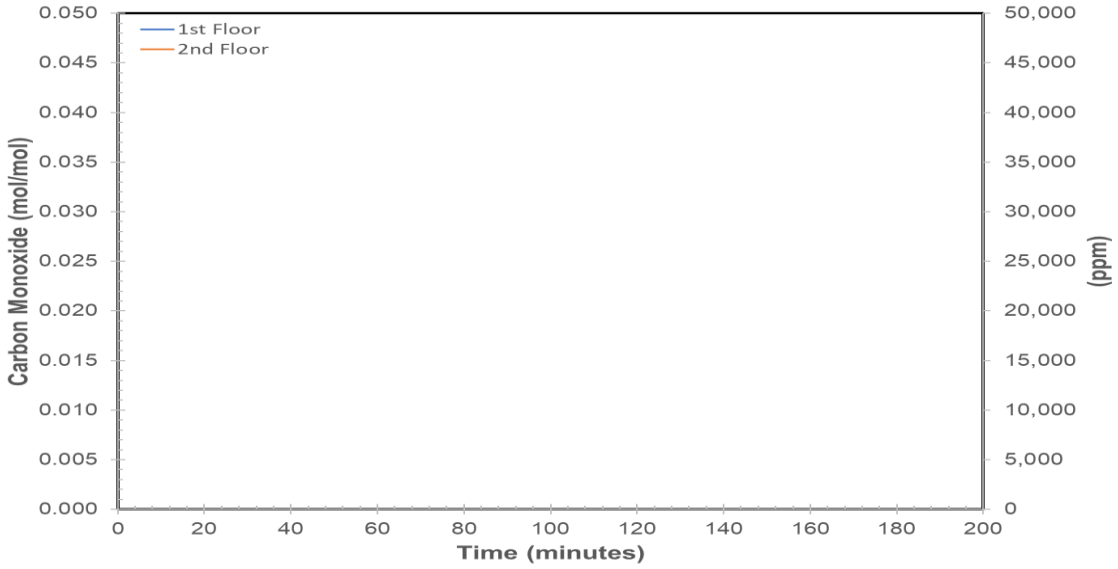


Figure 540. Carbon Monoxide Concentration(s)

The following chart shows the carbon dioxide concentration(s) measured during the experiment.

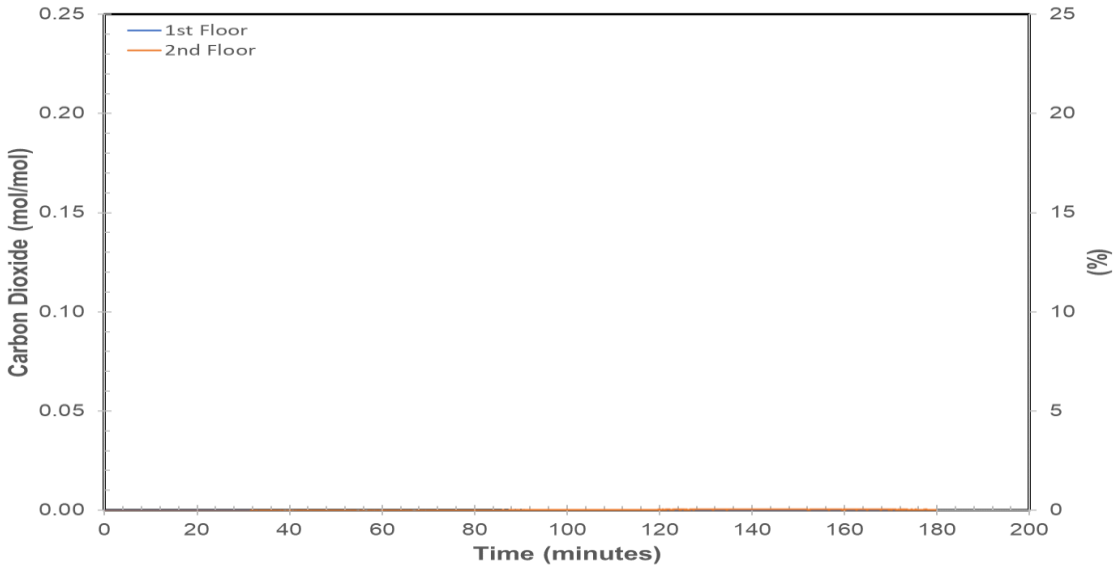


Figure 541. Carbon Dioxide Concentration(s)

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

Table 32. Video Log

Description	Start Time	Duration (s)	Filename
Stairs Looking down	08:58:22	10876	360082_20230307_085816_1A.mov
Ignition	08:58:30	10877	360082_20230307_085823_2A.mov
Stairs looking up	08:58:37	10881	360082_20230307_085831_3A.mov
Wide View 2nd	08:58:45	10884	360082_20230307_085839_4A.mov
Smoke Detector 2nd floor	08:58:53	10885	360082_20230307_085846_5A.mov
Smoke Detector 1st floor	08:59:00	10889	360082_20230307_085854_6A.mov
Wide View 1st	08:59:08	10893	360082_20230307_085901_7A.mov
HD outside view	08:59:15	10897	360082_20230307_085909_8A.mov
Custom - Master Sped Up 60X			360082_1313283.MOV
Master			360082_1313284.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 542. Pre test 48 minutes, 360082_1304914

Figure 543. Pre test 48 minutes, 360082_1304915

Figure 544. Pre test 48 minutes, 360082_1304916

Figure 545. Pre test 48 minutes, 360082_1304917

Figure 546. Pre test 38 minutes, 360082_1304918

Figure 547. Pre test 38 minutes, 360082_1304919

Figure 548. Pre test 38 minutes, 360082_1304920

Figure 549. Pre test 38 minutes, 360082_1304921

Figure 550. Pre test 38 minutes, 360082_1304922

Figure 551. Pre test 38 minutes, 360082_1304923

Figure 552. Pre test 38 minutes, 360082_1304924

Figure 553. Pre test 37 minutes, 360082_1304925

Figure 554. Pre test 37 minutes, 360082_1304926

Figure 555. Pre test 36 minutes, 360082_1304927

Figure 556. Pre test 36 minutes, 360082_1304928

Figure 557. Pre test 36 minutes, 360082_1304929

Figure 558. Pre test 36 minutes, 360082_1304930

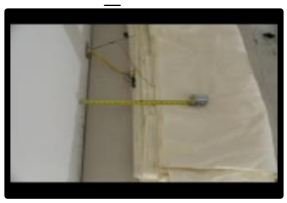


Figure 559. Pre test 35 minutes, 360082_1304931

Figure 560. Pre test 35 minutes, 360082_1304932

Figure 561. Pre test 35 minutes, 360082_1304933

Figure 562. Pre test 31 minutes, 360082_1304934

Figure 563. Pre test 31 minutes, 360082_1304935

Figure 564. Pre test 31 minutes, 360082_1304936

Figure 565. Pre test 30 minutes, 360082_1304937

Figure 566. Pre test 30 minutes, 360082_1304938

Figure 567. Pre test 30 minutes, 360082_1304939

Figure 568. Pre test 30 minutes, 360082_1304940

Figure 569. Pre test 29 minutes, 360082_1304941

Figure 570. Pre test 29 minutes, 360082_1304942

Figure 571. Pre test 29 minutes, 360082_1304943

Figure 572. Pre test 29 minutes, 360082_1304944

Figure 573. Pre test 29 minutes, 360082_1304945

Figure 574. Pre test 29 minutes, 360082_1304946

Figure 575. Pre test 29 minutes, 360082_1304947

Figure 576. Pre test 13 minutes, 360082_1304948

Figure 577. Pre test 7 minutes, 360082_1304949

Figure 578. Pre test 7 minutes, 360082_1304950

Figure 579. Pre test 7 minutes, 360082_1304951

Figure 580. Pre test 6 minutes, 360082_1304952

Figure 581. 27 seconds, 360082_1304953

Figure 582. 49 seconds, 360082_1304954

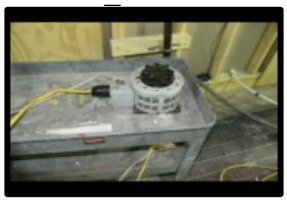


Figure 583. 79 seconds, 360082_1304955

Figure 584. 81 seconds, 360082_1304956

Figure 585. 83 seconds, 360082_1304957

Figure 586. 91 seconds, 360082_1304958

Figure 587. 101 seconds, 360082_1304959

Figure 588. Post test 1:15 hr:min, 360082_1304961

Figure 589. Post test 1:16 hr:min, 360082_1304962

Figure 590. Post test 1:16 hr:min, 360082_1304963

Figure 591. Post test 2:38 hr:min, 360082_1304964

Figure 592. Post test 2:38 hr:min, 360082_1304965

Figure 593. 360082_1307223

Figure 594.
360082_1307224

Figure 595.
360082_1307225

Figure 596.
360082_1307226

Figure 597.
360082_1307227

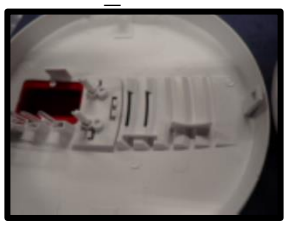


Figure 598.
360082_1307228

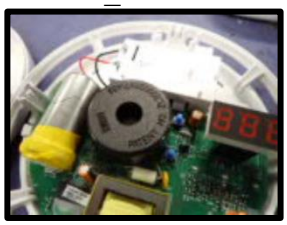


Figure 599.
360082_1307229

Figure 600.
360082_1307230

Figure 601.
360082_1307231

Figure 602.
360082_1307232

Figure 603.
360082_1307233

Figure 604.
360082_1307234

Figure 605.
360082_1307235

Figure 606.
360082_1307236

Figure 607.
360082_1307237

Figure 608.
360082_1307238

Figure 609.
360082_1307239

Figure 610.
360082_1307240

Figure 611.
360082_1307241

Figure 612.
360082_1307242

Figure 613.
360082_1307243

Figure 614.
360082_1307244

Figure 615.
360082_1307245

Figure 616.
360082_1307246

Figure 617.
360082_1307247

Figure 618.
360082_1307248

Figure 619.
360082_1307249

Figure 620.
360082_1307250

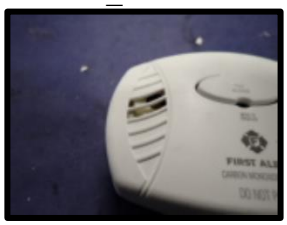


Figure 621.
360082_1307251

Figure 622.
360082_1307252

Figure 623.
360082_1307253

Figure 624.
360082_1307254

Figure 625.
360082_1307255

Figure 626.
360082_1307256

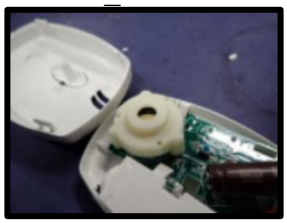


Figure 627.
360082_1307257

Figure 628.
360082_1307258

Figure 629.
360082_1307259

Figure 630.
360082_1307260

Figure 631.
360082_1307261

Figure 632.
360082_1307262

Figure 633.
360082_1307263


Figure 634.
360082_1307264


Figure 635.
360082_1307265


Figure 636.
360082_1307266


Figure 637.
360082_1307267


Figure 638.
360082_1307268


Figure 639.
360082_1307269


Figure 640.
360082_1307270


Figure 641.
360082_1307271


Figure 642.
360082_1307272


Figure 643.
360082_1307273

Figure 644.
360082_1307274


Figure 645.
360082_1307275


Figure 646.
360082_1307276

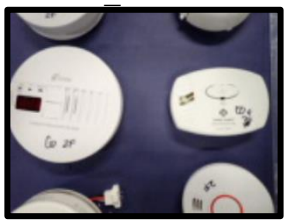


Figure 647.
360082_1307277


Figure 648.
360082_1307278

Figure 649.
360082_1307279


Figure 650.
360082_1307280


Figure 651.
360082_1307281


Figure 652.
360082_1307282


Figure 653.
360082_1307283

Figure 654.
360082_1307284

Figure 655.
360082_1307285

Figure 656.
360082_1307286

Figure 657.
360082_1307287

Figure 658.
360082_1307288

Figure 659.
360082_1307289

Figure 660.
360082_1307290

Figure 661.
360082_1307291

Figure 662.
360082_1307292

Figure 663.
360082_1307293

Figure 664.
360082_1307294

Figure 665.
360082_1307295

Figure 666.
360082_1307296

Figure 667.
360082_1307297

Figure 668.
360082_1307298

Figure 669.
360082_1307299

Figure 670.
360082_1307300

Figure 671.
360082_1307301

Figure 672.
360082_1307302

Figure 673.
360082_1307303

Figure 674.
360082_1307304

Figure 675.
360082_1307305

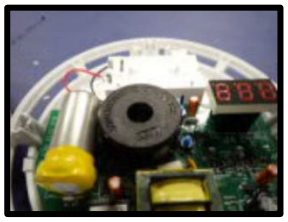


Figure 676.
360082_1307306

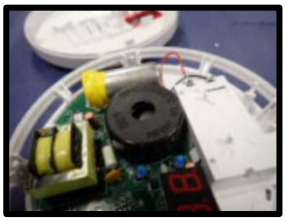


Figure 677.
360082_1307307

Figure 678.
360082_1307308

Figure 679.
360082_1307309

Figure 680.
360082_1307310

Figure 681.
360082_1307311

Figure 682.
360082_1307312

Figure 683.
360082_1307313

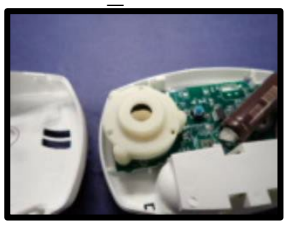


Figure 684.
360082_1307314

Figure 685.
360082_1307315

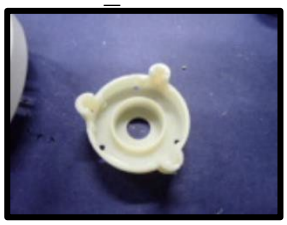


Figure 686.
360082_1307316

Figure 687.
360082_1307317

Figure 688.
360082_1307318

Figure 689.
360082_1307319

Figure 690.
360082_1307320

Figure 691.
360082_1307321

Figure 692.
360082_1307322

Figure 693.
360082_1307323


Figure 694.
360082_1307324


Figure 695.
360082_1307325


Figure 696.
360082_1307326


Figure 697.
360082_1307327

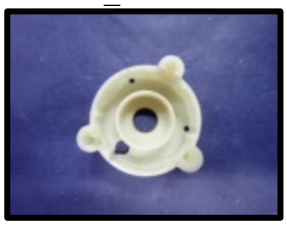


Figure 698.
360082_1307328


Figure 699.
360082_1307329


Figure 700.
360082_1307330


Figure 701.
360082_1307331


Figure 702.
360082_1307332


Figure 703.
360082_1307333


Figure 704.
360082_1307334


Figure 705.
360082_1307335


Figure 706.
360082_1307336

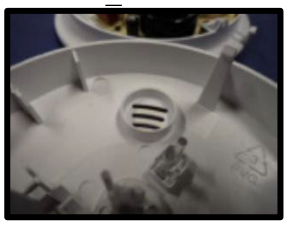


Figure 707.
360082_1307337


Figure 708.
360082_1307338


Figure 709.
360082_1307339


Figure 710.
360082_1307340


Figure 711.
360082_1307341


Figure 712.
360082_1307342


Figure 713.
360082_1307343


Figure 714.
360082_1307344

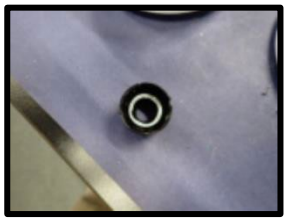


Figure 715.
360082_1307345


Figure 716.
360082_1307346

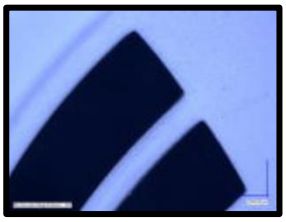


Figure 717.
360082_1308029


Figure 718.
360082_1308030


Figure 719.
360082_1308031

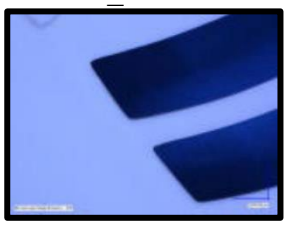
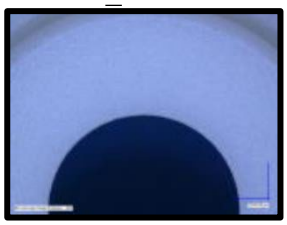


Figure 720.
360082_1308032


Figure 721.
360082_1308033


Figure 722.
360082_1308034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360082_1308035


Figure 724.
360082_1308036

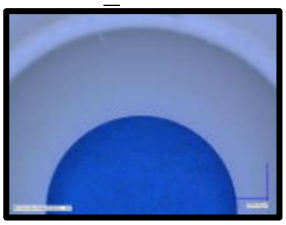


Figure 725.
360082_1308037

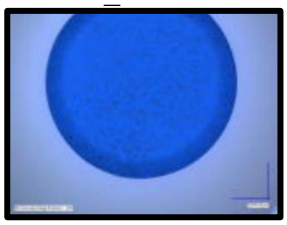


Figure 726.
360082_1308038

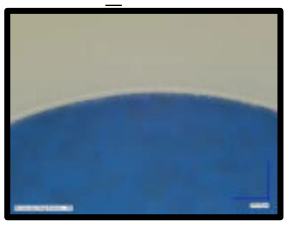


Figure 727.
360082_1308039

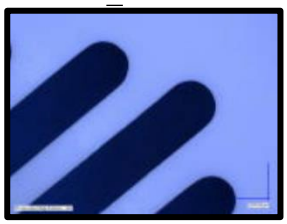

Figure 728.
360082_1308040


Figure 729.
360082_1308041


Figure 730.
360082_1308042


Figure 731.
360082_1308043


Figure 732.
360082_1308044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360082_1308045

Figure 734.
360082_1308046

Figure 735.
360082_1308047

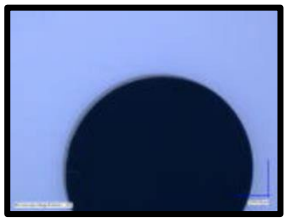


Figure 736.
360082_1308048

Figure 737.
360082_1308049

Figure 738.
360082_1308050

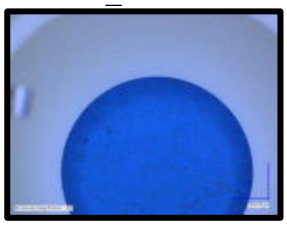


Figure 739.
360082_1308051

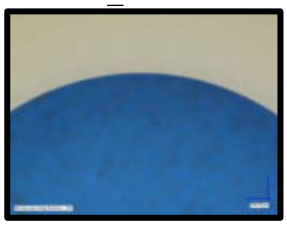


Figure 740.
360082_1308052

Figure 741.
360082_1308053

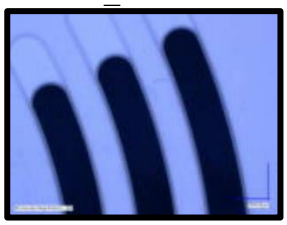


Figure 742.
360082_1308054

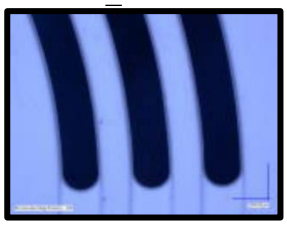


Figure 743.
360082_1308055

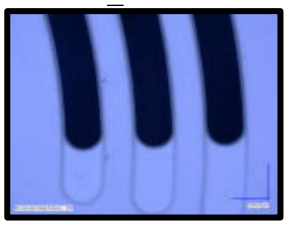


Figure 744.
360082_1308056

Figure 745.
360082_1308057

Figure 746.
360082_1308058

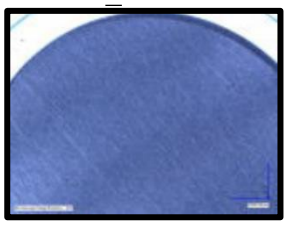


Figure 747.
360082_1308059

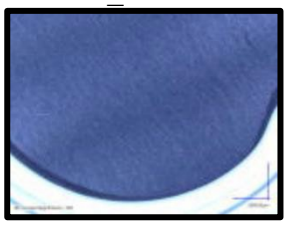


Figure 748.
360082_1308060

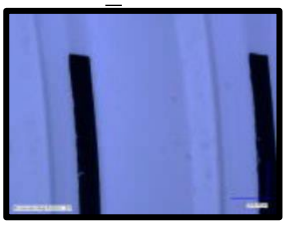


Figure 749.
360082_1308061

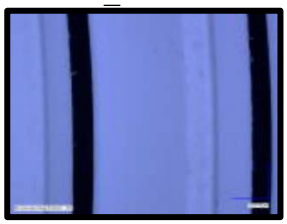


Figure 750.
360082_1308062

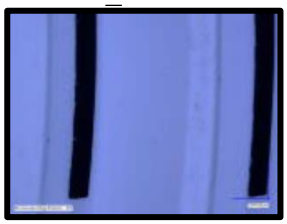


Figure 751.
360082_1308063

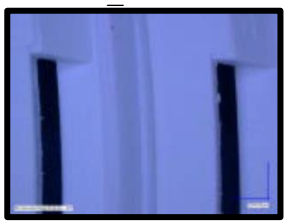


Figure 752.
360082_1308064

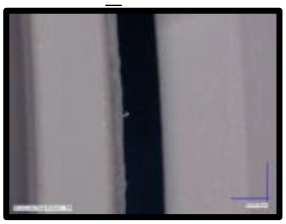


Figure 753.
360082_1308065

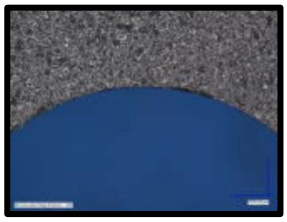


Figure 754.
360082_1308066

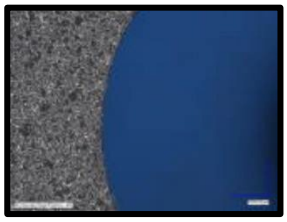


Figure 755.
360082_1308067

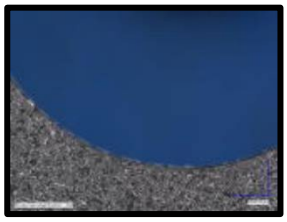
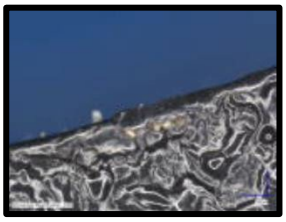


Figure 756.
360082_1308068



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360082_1308069

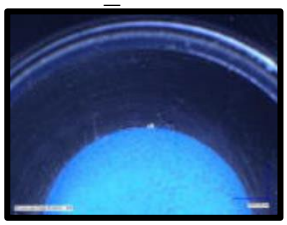


Figure 758.
360082_1308070

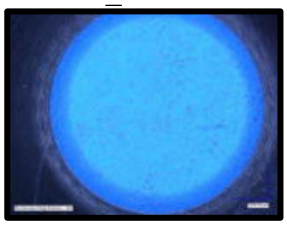


Figure 759.
360082_1308071

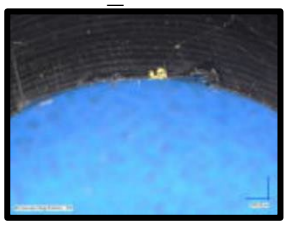


Figure 760.
360082_1308072

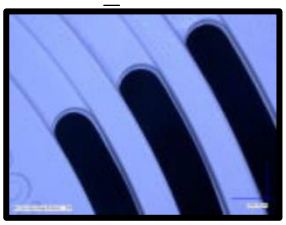


Figure 761.
360082_1308073

Figure 762.
360082_1308074

Figure 763.
360082_1308075

Figure 764.
360082_1308076

Figure 765.
360082_1308077

Figure 766.
360082_1308078

Figure 767.
360082_1308079

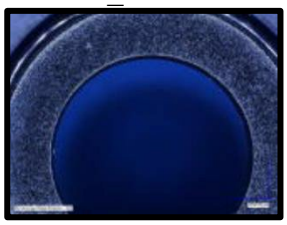


Figure 768.
360082_1308080

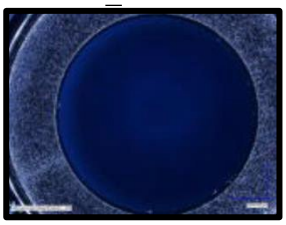


Figure 769.
360082_1308081

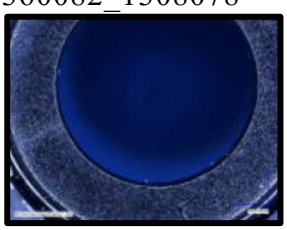


Figure 770.
360082_1308082

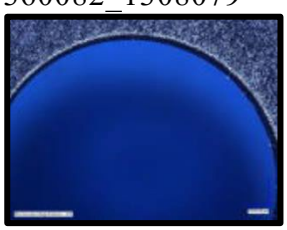


Figure 771.
360082_1308083

Figure 772.
360082_1308084

Figure 773.
360082_1308085

Figure 774.
360082_1308086

Figure 775.
360082_1308087

Figure 776.
360082_1308088

Figure 777.
360082_1308089

Figure 778.
360082_1308090

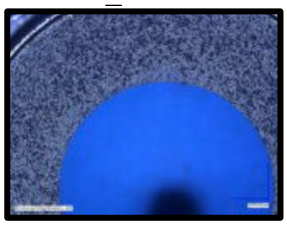


Figure 779.
360082_1308091

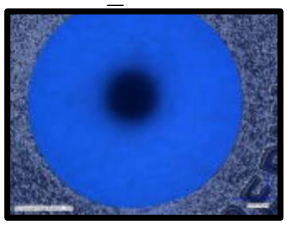


Figure 780.
360082_1308092

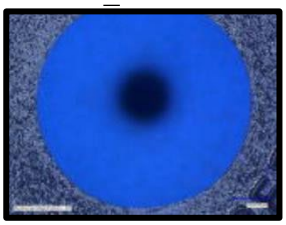


Figure 781.
360082_1308093

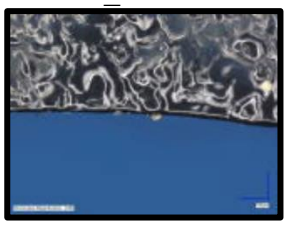


Figure 782.
360082_1308094

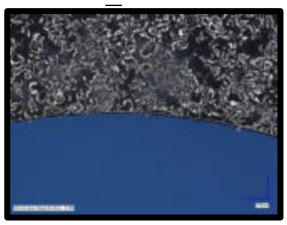


Figure 783.
360082_1308095

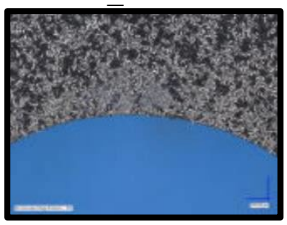


Figure 784.
360082_1308096

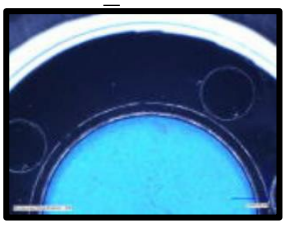


Figure 785.
360082_1308097

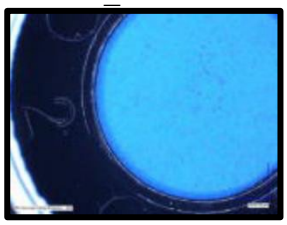


Figure 786.
360082_1308098

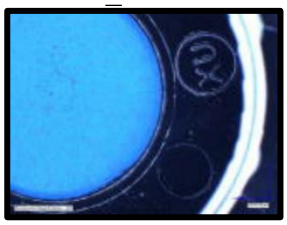


Figure 787.
360082_1308099

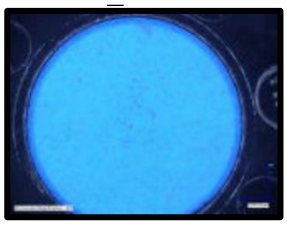


Figure 788.
360082_1308100

Figure 789.
360082_1308101

Figure 790.
360082_1308102

Figure 791.
360082_1308103

Figure 792.
360082_1308104

Figure 793.
360082_1308105

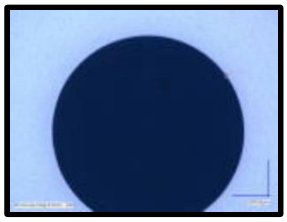


Figure 794.
360082_1308106

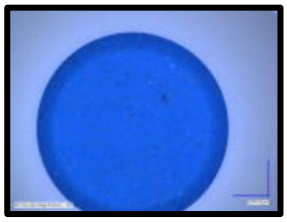


Figure 795.
360082_1308107


Figure 796.
360082_1308108


Figure 797.
360082_1308109


Figure 798.
360082_1308110


Figure 799.
360082_1308111


Figure 800.
360082_1308112


Figure 801.
360082_1308113


Figure 802.
360082_1308114


Figure 803.
360082_1308115

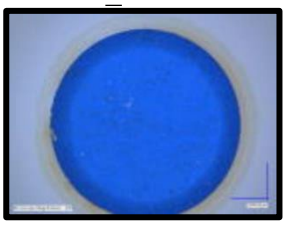

Figure 804.
360082_1308116


Figure 805.
360082_1308117


Figure 806.
360082_1308118


Figure 807.
360082_1308119


Figure 808.
360082_1308120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360082_1308121

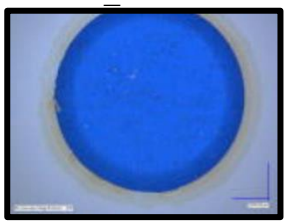


Figure 810.
360082_1308122

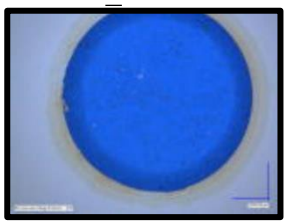
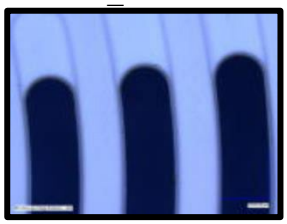


Figure 811.
360082_1308123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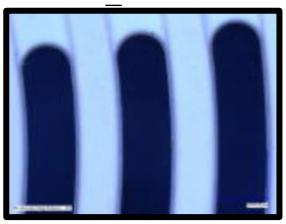
360082_1308124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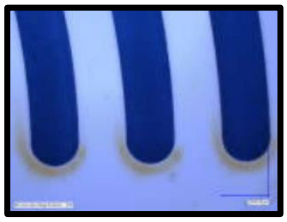
360082_1308125


Figure 814.
360082_1308126


Figure 815.
360082_1308127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360082_1308128


Figure 817.
360082_1308129


Figure 818.
360082_1308130

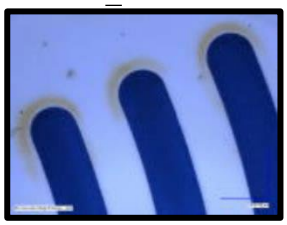


Figure 819.
360082_1308131


Figure 820.
360082_1308132


Figure 821.
360082_1308133


Figure 822.
360082_1308134

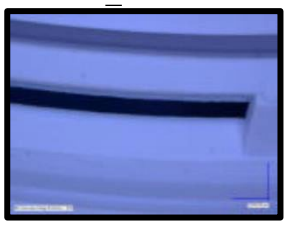
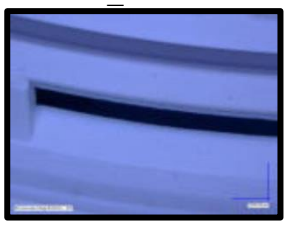


Figure 823.
360082_1308135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360082_1308136


Figure 825.
360082_1308137

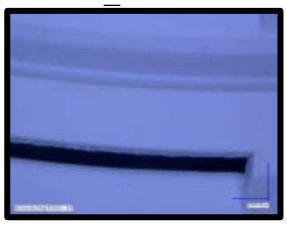


Figure 826.
360082_1308138

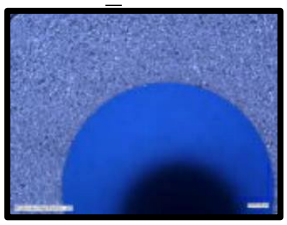
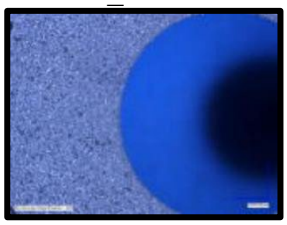


Figure 827.
360082_1308139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360082_1308140

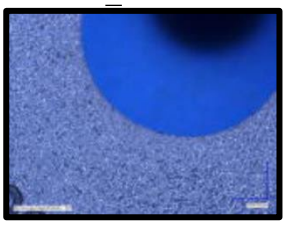
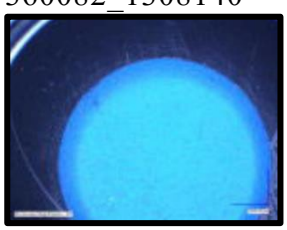


Figure 829.
360082_1308141


Figure 830.
360082_1308142


Figure 831.
360082_1308143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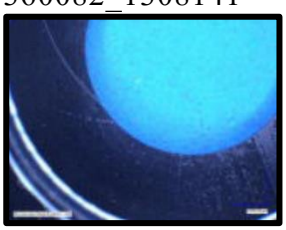
360082_1308144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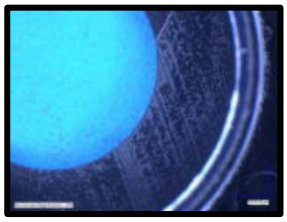
360082_1308145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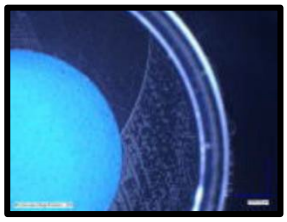
360082_1308146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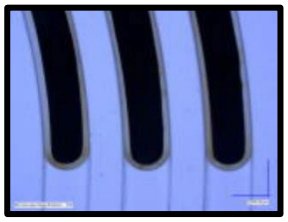
360082_1308147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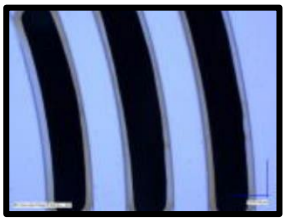
360082_1308148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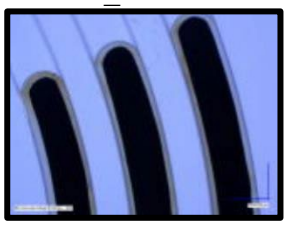
360082_1308149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360082_1308150


Figure 839.
360082_1308151


Figure 840.
360082_1308152

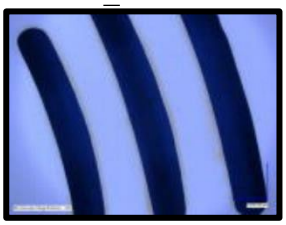


Figure 841.
360082_1308153

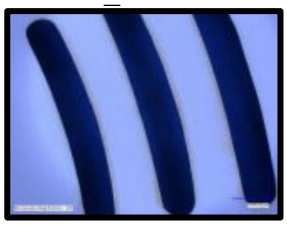


Figure 842.
360082_1308154

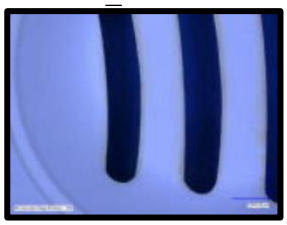
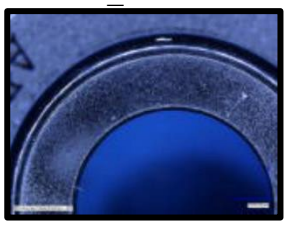


Figure 843.
360082_1308155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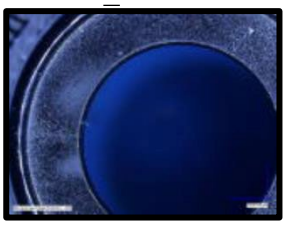
360082_1308156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360082_1308157

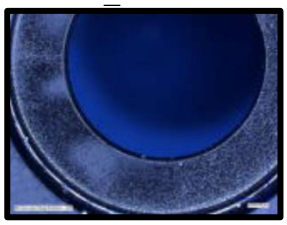
Figure 846.
360082_1308158

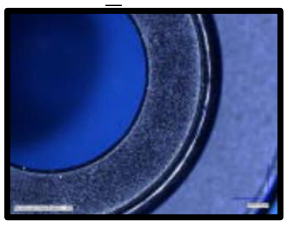
Figure 847.
360082_1308159

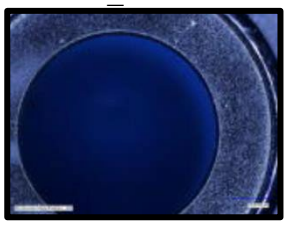
Figure 848.
360082_1308160

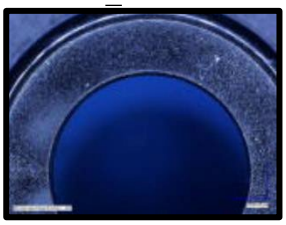
Figure 849.
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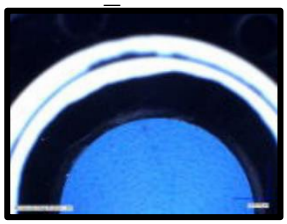
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360082_1308162

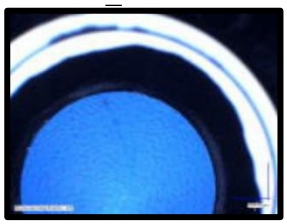


Figure 851.
360082_1308163


Figure 852.
360082_1308164

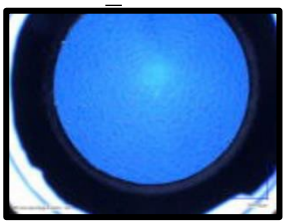


Figure 853.
360082_1308165

Figure 854.
360082_1308166

Figure 855.
360082_1308167

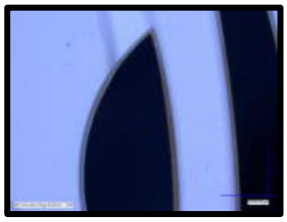


Figure 856.
360082_1308168

Figure 857.
360082_1308169

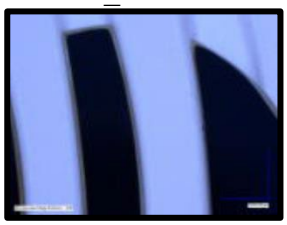


Figure 858.
360082_1308170

Figure 859.
360082_1308171

Figure 860.
360082_1308172

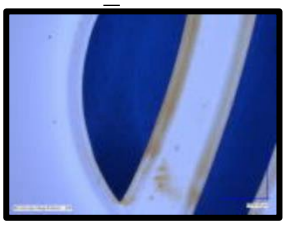


Figure 861.
360082_1308173

Figure 862.
360082_1308174

Figure 863.
360082_1308175

Figure 864.
360082_1308176

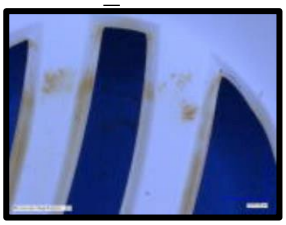


Figure 865.
360082_1308177

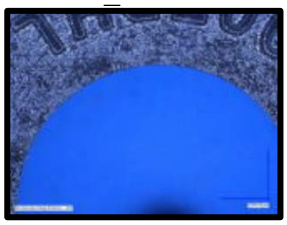


Figure 866.
360082_1308178

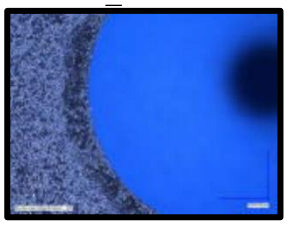


Figure 867.
360082_1308179

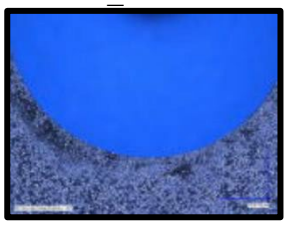


Figure 868.
360082_1308180

Figure 869.
360082_1308181

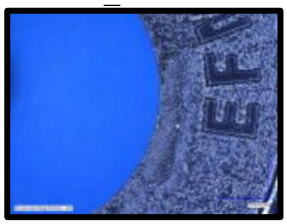


Figure 870.
360082_1308182

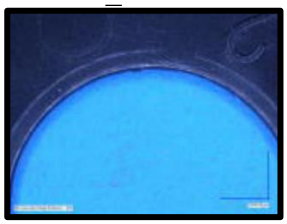


Figure 871.
360082_1308183

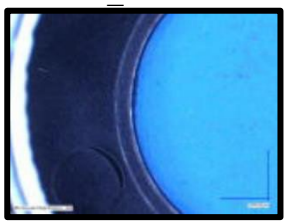


Figure 872.
360082_1308184

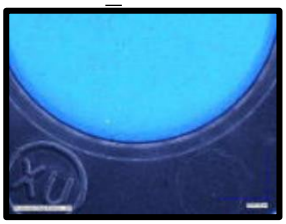


Figure 873.
360082_1308185

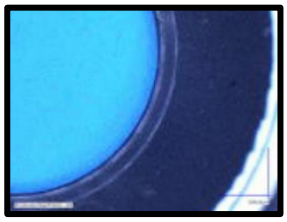


Figure 874.
360082_1308186

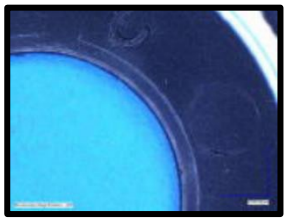


Figure 875.
360082_1308187

Results for Test 3 (ID 360086)

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

Table 33. Experiment Events

Description	Time (s)
Gas Line Reconnected for 2nd floor	429
Gas Pumps Turned Off	2665
2nd Floor Door Opened/Suppression	2759
1st Floor Door Opened	2803

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 over pre-determined time spans.

Table 34. 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)
Landing 0'	9.9	12.1	12.0	12.0	11.8	11.8
Landing 1'	9.7	11.4	11.3	11.3	11.3	11.2
Landing 2'	9.7	11.7	11.6	11.6	11.5	11.5
Landing 3'	9.6	11.9	11.9	11.9	11.8	11.8
Landing 4'	9.5	12.5	12.4	12.4	12.3	12.3
Landing 5'	9.5	13.4	13.3	13.3	13.0	13.0
Landing 6'	9.7	22.1	21.8	20.9	17.2	16.5
Landing 7'	9.9	42.2	41.0	38.8	28.8	27.0
1st Floor 0'	10.1	10.6	10.6	10.6	10.5	10.5
1st Floor 1'	9.6	10.3	10.3	10.3	10.3	10.2
1st Floor 2'	9.8	10.5	10.5	10.5	10.5	10.4
1st Floor 3'	9.6	10.5	10.5	10.5	10.4	10.4
1st Floor 4'	9.5	10.6	10.6	10.6	10.5	10.5
1st Floor 5'	9.5	10.8	10.8	10.8	10.7	10.7
1st Floor 6'	9.4	10.9	10.8	10.8	10.8	10.7
1st Floor 7'	9.4	11.0	10.9	10.9	10.9	10.8
1st Floor 8'	9.5	11.4	11.4	11.4	11.3	11.3
2nd Floor 0'	9.9	66.5	65.9	64.6	50.3	45.5
2nd Floor 1'	9.8	108.5	107.2	103.7	75.6	64.7
2nd Floor 2'	9.6	154.1	150.5	145.8	109.3	90.6
2nd Floor 3'	9.6	182.4	180.4	176.7	133.7	107.8
2nd Floor 4'	9.6	205.9	203.8	198.0	146.8	118.2
2nd Floor 5'	9.7	225.1	222.4	217.7	166.9	133.6
2nd Floor 6'	10.0	242.7	240.3	235.6	179.4	143.6
2nd Floor 7'	10.3	272.3	268.2	263.3	197.3	155.1
2nd Floor 8'	13.0	361.8	353.9	349.6	254.9	190.8
Tenability 1st Floor 5'	9.7	11.0	10.9	10.9	10.8	10.8
Tenability 2nd Floor 5'	10.2	195.2	191.3	188.6	151.2	126.4

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

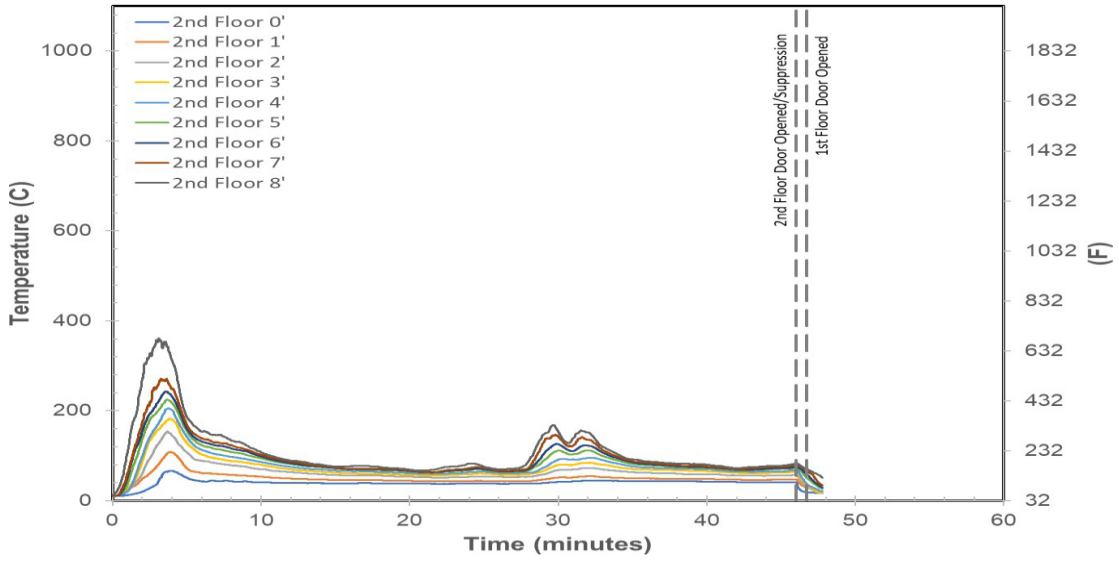


Figure 876. Temperature – 2nd Floor

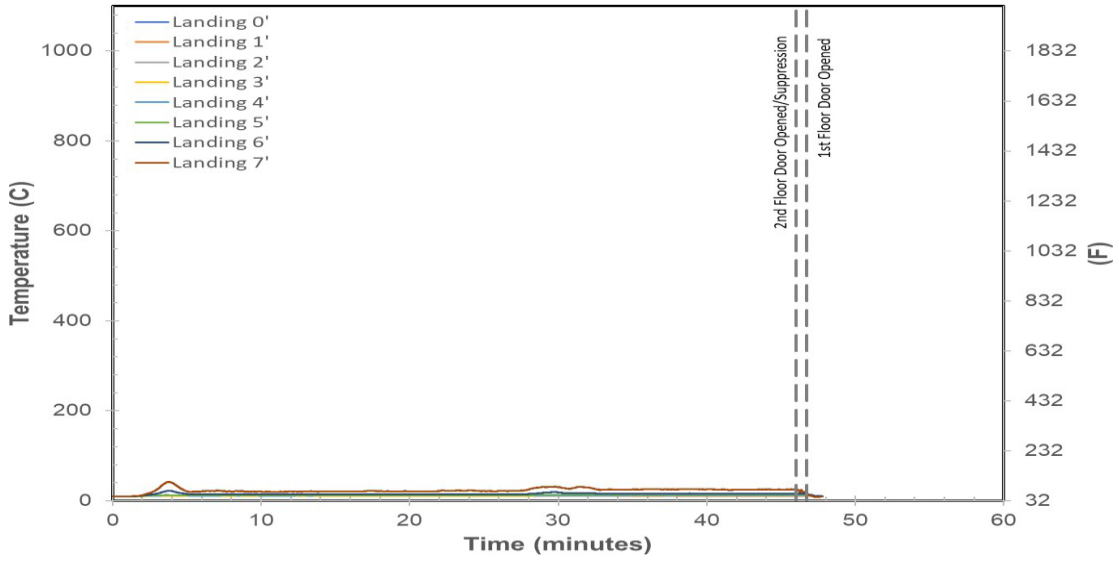


Figure 877. Temperature – Landing

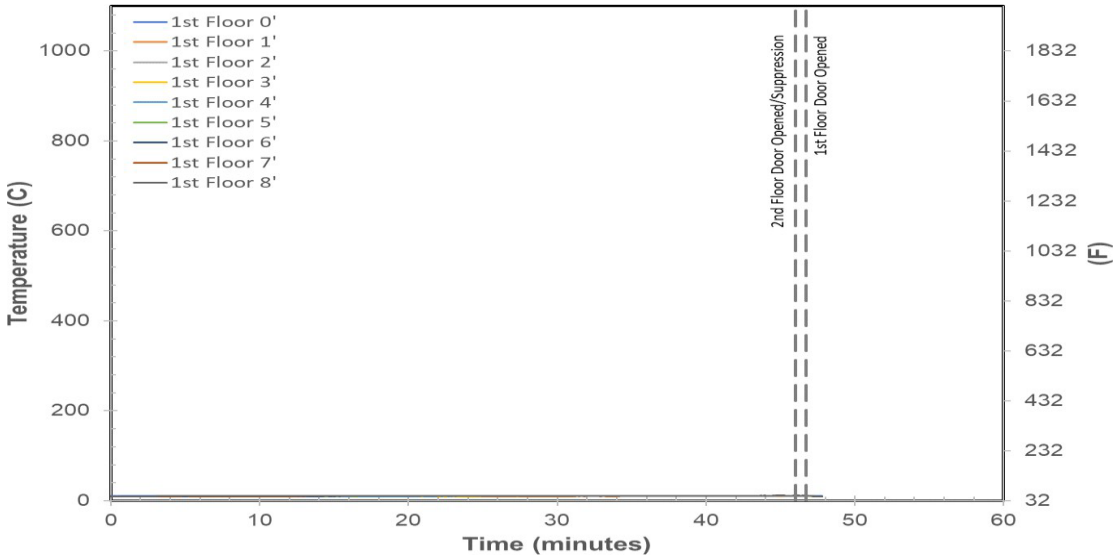


Figure 878. Temperature – 1st Floor

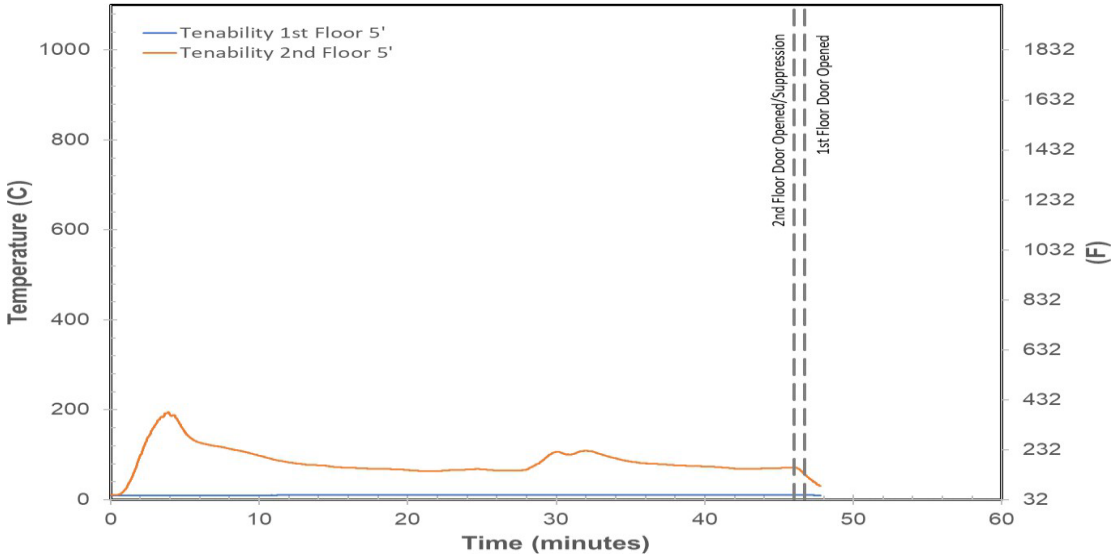


Figure 879. Temperature - Tenability

The following table provides a summary of the heat flux results. 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 pre-determined time spans.

Table 35. 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 Total	SC	1	0.0	0.0	0.0	0.0	0.0	0.0
1st Floor Rad	SC	1	0.0	0.0	0.0	0.0	0.0	0.0
2nd Floor Total	74	1	6.5	6.1	6.0	5.7	3.7	2.8
2nd Floor Rad	215	1	1.0	1.0	1.0	0.9	0.6	0.4

The following chart(s) shows a time dependent representation of the baseline corrected instantaneous heat flux measured during the experiment.

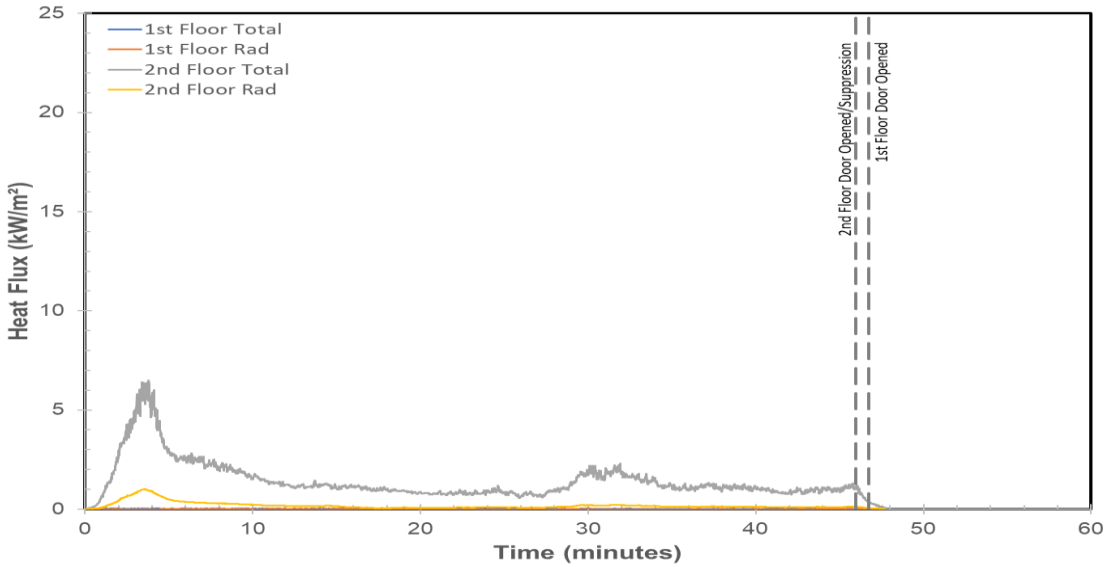


Figure 880. Heat Flux

The following table provides a summary of the optical density.

Table 36. Optical Density Results Summary

Description	Average Optical Density (1/m)	Maximum Optical Density (1/m)
1st Floor ODM	0.08	0.17

The following chart provides a time dependent representation of the optical density measured during the experiment.

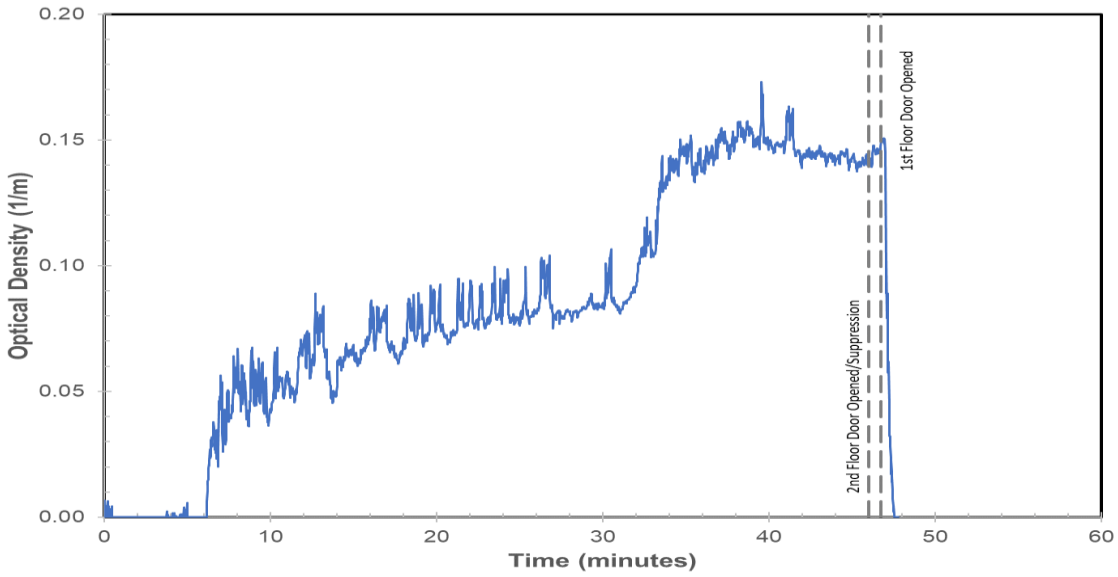


Figure 881. Optical Density

The following chart shows the obscuration during the experiment.

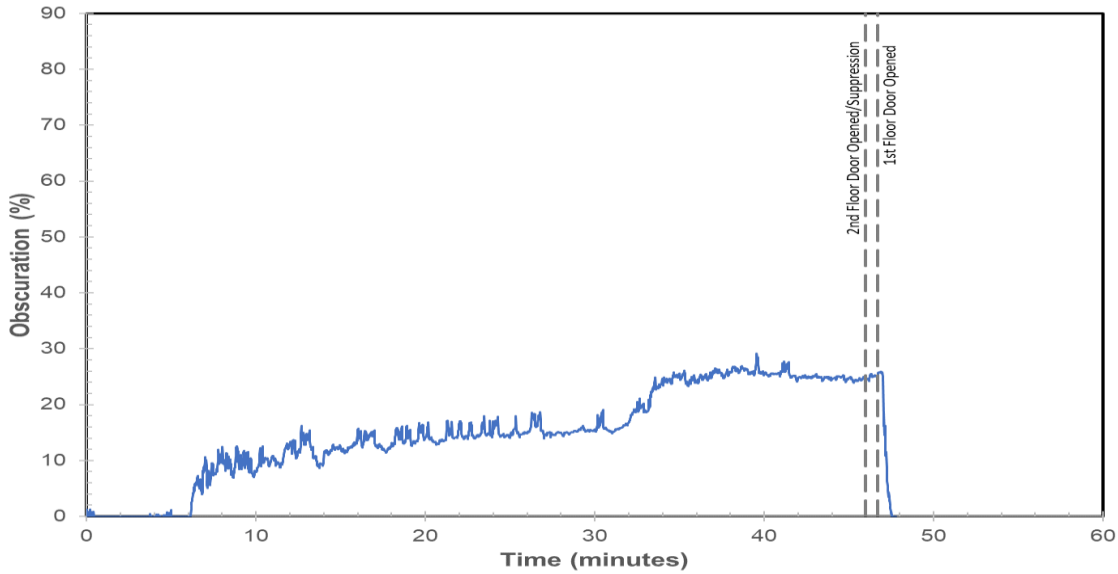


Figure 882. Obscuration

The following table provides a summary of the oxygen measurement results.

Table 37. Oxygen Measurement Results

Description	Full Scale Range (%)	Minimum Value (%)	Average (%)
2nd Floor	25	2.3	15.6871
1st Floor	25	3.43125	20.53035

The following table shows which oxygen analyzer(s) were taken out of service during the experiment.

Table 38. Out of Service

Description	Time out of service time (s)	Out of service reason
1st Floor	2674	Pump Off
2nd Floor	2674	Pump Off

The following chart presents the oxygen concentration(s) measured during the test.

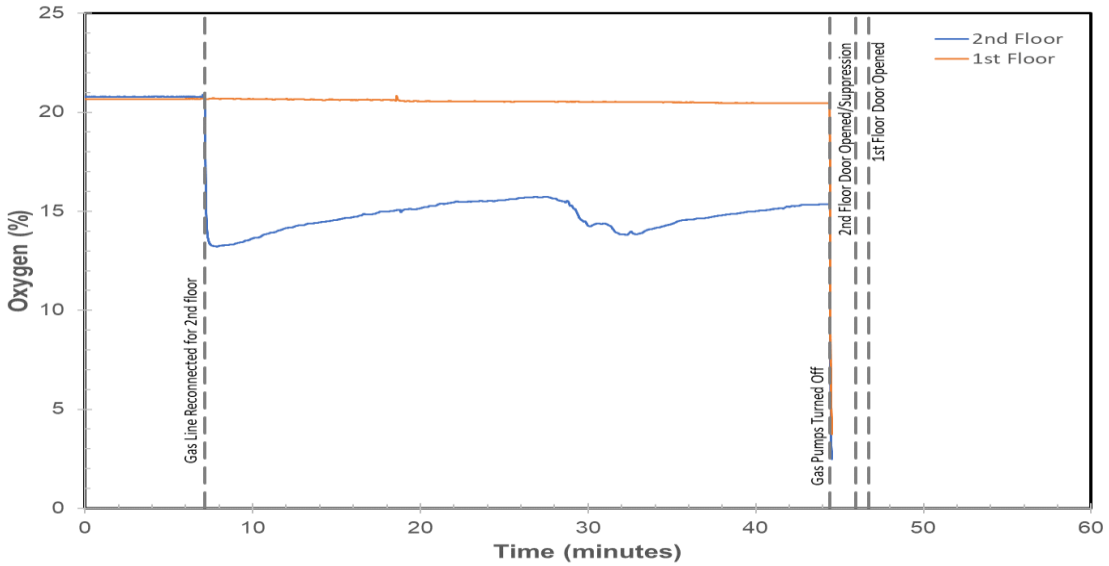


Figure 883. Oxygen Concentration

The following table provides a summary of the carbon monoxide gas measurement results.

Table 39. CO Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
2nd Floor	0.05	0.0022	0.0014
1st Floor	0.05	-0.0002	-0.0002

The following table provides a summary of the carbon dioxide gas measurement results.

Table 40. CO2 Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
2nd Floor	0.25	0.0550	0.0359
1st Floor	0.25	0.0014	0.0005

The following table shows which CO/CO2 gas analyzer(s) were taken out of service (OOS) during the experiment.

Table 41. Out of Service

	CO- Time OOS (s)	CO- Reason OOS
2nd Floor	2674	Pump Turned Off
1st Floor	2674	Pump Turned Off

The following chart shows the carbon monoxide concentration(s) measured during the experiment.

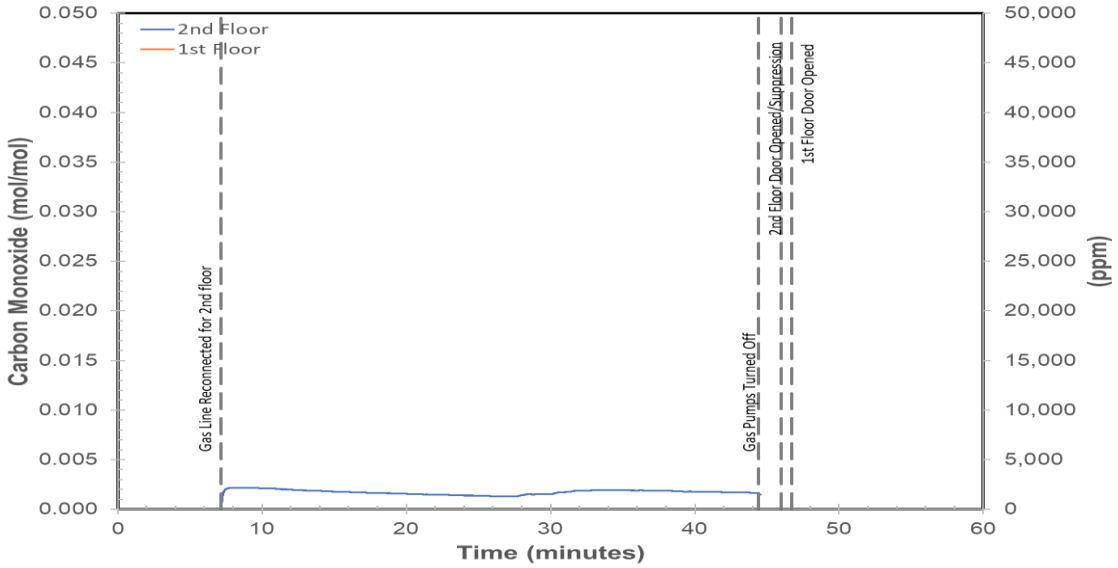


Figure 884. Carbon Monoxide Concentration(s)

The following chart shows the carbon dioxide concentration(s) measured during the experiment.

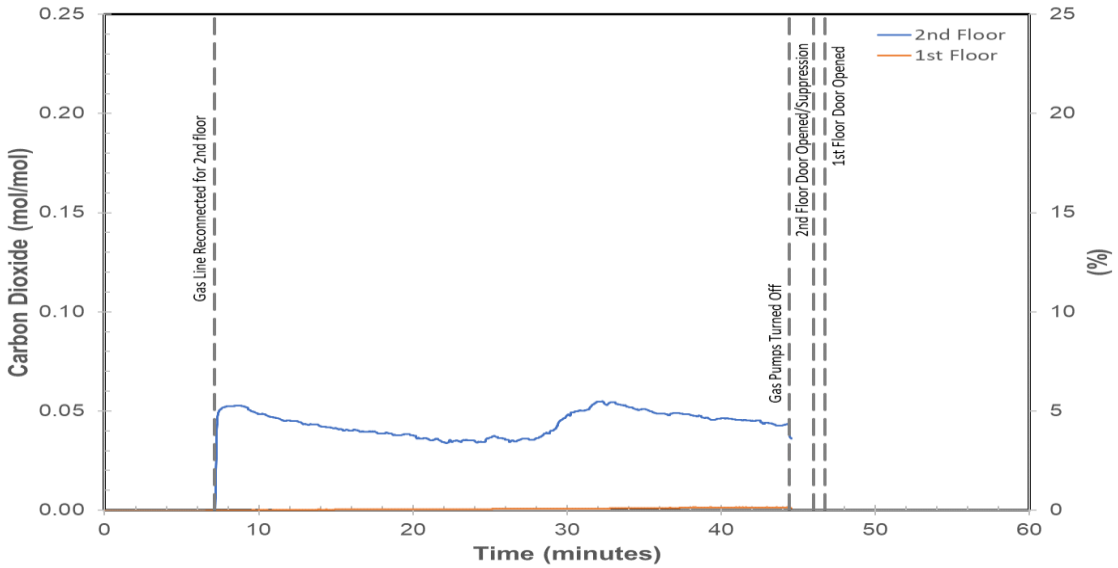


Figure 885. Carbon Dioxide Concentration(s)

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

Table 42. Video Log

Description	Start Time	Duration (s)	Filename
Stairs Looking down	10:29:46	2964	360086_20230308_102939_1A.mov
Chair	10:29:53	2969	360086_20230308_102947_2A.mov
Stairs looking up	10:30:00	2974	360086_20230308_102954_3A.mov
Wide View 2nd	10:30:08	2977	360086_20230308_103001_4A.mov
Ignition	10:30:15	2981	360086_20230308_103009_5A.mov
Smoke Detector 1st floor	10:30:23	2985	360086_20230308_103016_6A.mov
Wide View 1st	10:30:30	2989	360086_20230308_103024_7A.mov
HD outside view	10:30:38	2992	360086_20230308_103031_8A.mov
Data Chart	10:30:50	2992	360086_20230308_103044_17A.mov
Custom - Master Sped Up 60X			360086_1313199.MOV
Master			360086_1313200.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 886. Pre test 25 minutes, 360086_1305120

Figure 887. Pre test 25 minutes, 360086_1305121

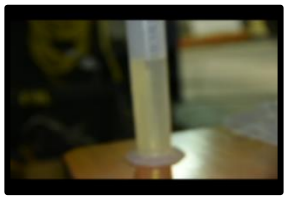


Figure 888. Pre test 24 minutes, 360086_1305122

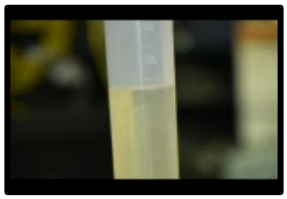


Figure 889. Pre test 24 minutes, 360086_1305123

Figure 890. Pre test 24 minutes, 360086_1305124

Figure 891. Pre test 24 minutes, 360086_1305125

Figure 892. Pre test 24 minutes, 360086_1305126

Figure 893. Pre test 24 minutes, 360086_1305127

Figure 894. Pre test 24 minutes, 360086_1305128

Figure 895. Pre test 24 minutes, 360086_1305129

Figure 896. Pre test 24 minutes, 360086_1305130

Figure 897. Pre test 23 minutes, 360086_1305131

Figure 898. Pre test 23 minutes, 360086_1305132

Figure 899. Pre test 23 minutes, 360086_1305133

Figure 900. Pre test 23 minutes, 360086_1305134

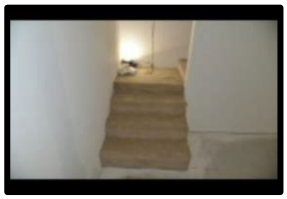


Figure 901. Pre test 23 minutes, 360086_1305135

Figure 902. Pre test 23 minutes, 360086_1305136

Figure 903. Pre test 23 minutes, 360086_1305137

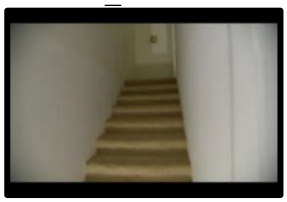


Figure 904. Pre test 23 minutes, 360086_1305138

Figure 905. Pre test 23 minutes, 360086_1305139

Figure 906. Pre test 23 minutes, 360086_1305140

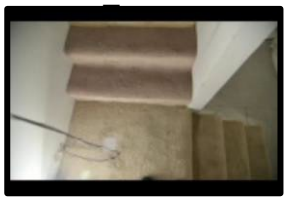


Figure 907. Pre test 23 minutes, 360086_1305141

Figure 908. Pre test 23 minutes, 360086_1305142

Figure 909. Pre test 23 minutes, 360086_1305143

Figure 910. Pre test 22 minutes, 360086_1305144

Figure 911. Pre test 22 minutes, 360086_1305145

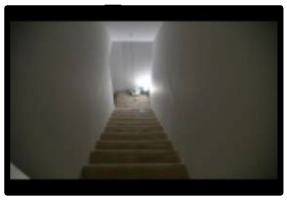


Figure 912. Pre test 22 minutes, 360086_1305146

Figure 913. Pre test 22 minutes, 360086_1305147

Figure 914. Pre test 22 minutes, 360086_1305148

Figure 915. Pre test 22 minutes, 360086_1305149

Figure 916. Pre test 22 minutes, 360086_1305150

Figure 917. Pre test 21 minutes, 360086_1305151

Figure 918. Pre test 21 minutes, 360086_1305152

Figure 919. Pre test 21 minutes, 360086_1305153

Figure 920. Pre test 21 minutes, 360086_1305154

Figure 921. Pre test 21 minutes, 360086_1305155

Figure 922. Pre test 21 minutes, 360086_1305156

Figure 923. Pre test 21 minutes, 360086_1305157

Figure 924. Pre test 21 minutes, 360086_1305158

Figure 925. Pre test 21 minutes, 360086_1305159

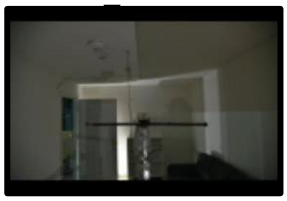


Figure 926. Pre test 21 minutes, 360086_1305160

Figure 927. Pre test 21 minutes, 360086_1305161

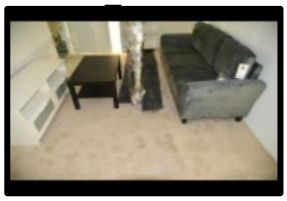


Figure 928. Pre test 21 minutes, 360086_1305162

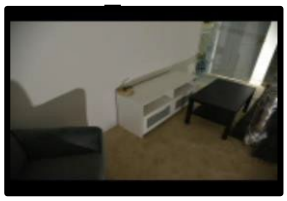


Figure 929. Pre test 21 minutes, 360086_1305163

Figure 930. Pre test 21 minutes, 360086_1305164

Figure 931. Pre test 21 minutes, 360086_1305165

Figure 932. Pre test 21 minutes, 360086_1305166

Figure 933. Pre test 19 minutes, 360086_1305167

Figure 934. Pre test 19 minutes, 360086_1305168

Figure 935. Pre test 19 minutes, 360086_1305169

Figure 936. Pre test 19 minutes, 360086_1305170

Figure 937. Pre test 19 minutes, 360086_1305171

Figure 938. Pre test 19 minutes, 360086_1305172

Figure 939. Pre test 19 minutes, 360086_1305173

Figure 940. Pre test 19 minutes, 360086_1305174

Figure 941. Pre test 19 minutes, 360086_1305175

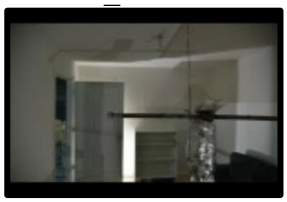


Figure 942. Pre test 19 minutes, 360086_1305176

Figure 943. Pre test 19 minutes, 360086_1305177

Figure 944. Pre test 18 minutes, 360086_1305178

Figure 945. Pre test 18 minutes, 360086_1305179

Figure 946. Pre test 18 minutes, 360086_1305180

Figure 947. Pre test 18 minutes, 360086_1305181

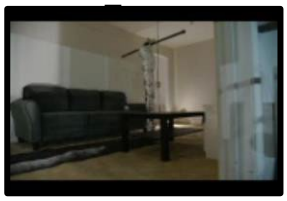


Figure 948. Pre test 18 minutes, 360086_1305182

Figure 949. Pre test 12 seconds, 360086_1305183

Figure 950. Pre test 2 seconds, 360086_1305184

Figure 951. Pre test 2 seconds, 360086_1305185

Figure 952. 0 seconds, 360086_1305186

Figure 953. 0 seconds, 360086_1305187

Figure 954. 2 seconds, 360086_1305188

Figure 955. 4 seconds, 360086_1305189

Figure 956. 6 seconds, 360086_1305190

Figure 957. 48 seconds, 360086_1305191

Figure 958. 50 seconds, 360086_1305192

Figure 959. 1164 seconds, 360086_1305193

Figure 960. 1172 seconds, 360086_1305194

Figure 961. 1178 seconds, 360086_1305195

Figure 962. 1780 seconds, 360086_1305196

Figure 963. 1786 seconds, 360086_1305197

Figure 964. Post test 1:27 hr:min, 360086_1305199

Figure 965. Post test 1:27 hr:min, 360086_1305200

Figure 966. Post test 1:27 hr:min, 360086_1305201

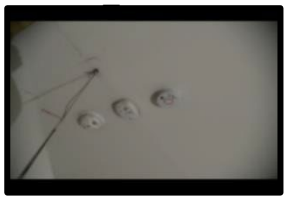


Figure 967. Post test 1:27 hr:min, 360086_1305202

Figure 968. Post test 1:27 hr:min, 360086_1305203

Figure 969. Post test 1:27 hr:min, 360086_1305204

Figure 970. Post test 1:27 hr:min, 360086_1305205

Figure 971. Post test 1:27 hr:min, 360086_1305206

Figure 972. Post test 1:27 hr:min, 360086_1305207

Figure 973. Post test 1:28 hr:min, 360086_1305208

Figure 974. Post test 1:28 hr:min, 360086_1305209

Figure 975. Post test 1:28 hr:min, 360086_1305210

Figure 976. Post test 1:28 hr:min, 360086_1305211

Figure 977. Post test 1:28 hr:min, 360086_1305212

Figure 978. Post test 1:28 hr:min, 360086_1305213

Figure 979. Post test 1:28 hr:min, 360086_1305214

Figure 980. Post test 1:28 hr:min, 360086_1305215

Figure 981. Post test 1:28 hr:min, 360086_1305216

Figure 982. Post test 1:28 hr:min, 360086_1305217

Figure 983. Post test 1:28 hr:min, 360086_1305218

Figure 984. Post test 1:28 hr:min, 360086_1305219

Figure 985. Post test 1:28 hr:min, 360086_1305220

Figure 986. Post test 1:28 hr:min, 360086_1305221

Figure 987. Post test 1:29 hr:min, 360086_1305222

Figure 988. Post test 1:29 hr:min, 360086_1305223

Figure 989. Post test 1:29 hr:min, 360086_1305224

Figure 990. Post test 1:29 hr:min, 360086_1305225

Figure 991. Post test 1:29 hr:min, 360086_1305226

Figure 992. Post test 1:29 hr:min, 360086_1305227

Figure 993. Post test 1:29 hr:min, 360086_1305228

Figure 994. Post test 1:29 hr:min, 360086_1305229

Figure 995. Post test 1:29 hr:min, 360086_1305230

Figure 996. Post test 1:29 hr:min, 360086_1305231

Figure 997. Post test 2:30 hr:min, 360086_1305232

Figure 998. Post test 2:30 hr:min, 360086_1305233

Figure 999. Post test 2:30 hr:min, 360086_1305234

Figure 1000. Post test 2:30 hr:min, 360086_1305235

Figure 1001. Post test 2:30 hr:min, 360086_1305236

Figure 1002. Post test 2:30 hr:min, 360086_1305237

Figure 1003. Post test 2:30 hr:min, 360086_1305238

Figure 1004. Post test 2:30 hr:min, 360086_1305239

Figure 1005. Post test 2:30 hr:min, 360086_1305240

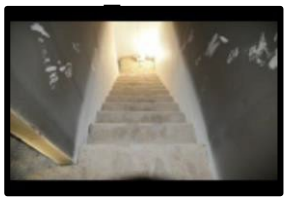


Figure 1006. Post test 2:30 hr:min, 360086_1305241

Figure 1007. Post test 2:31 hr:min, 360086_1305242

Figure 1008. Post test 2:31 hr:min, 360086_1305243

Figure 1009. Post test 2:31 hr:min, 360086_1305244

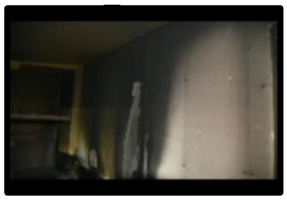


Figure 1010. Post test 2:31 hr:min, 360086_1305245

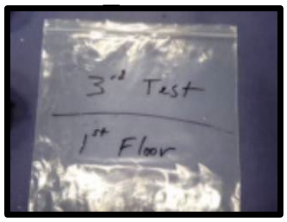


Figure 1011. 360086_1307347

Figure 1012. 360086_1307348

Figure 1013. 360086_1307349

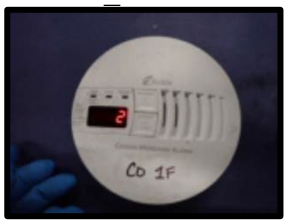


Figure 1014. 360086_1307350

Figure 1015. 360086_1307351

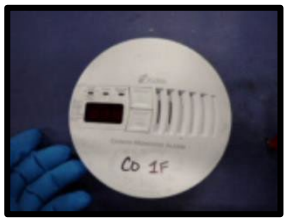


Figure 1016. 360086_1307352

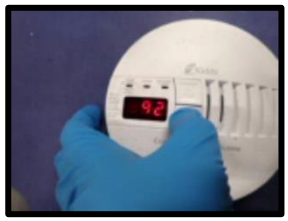


Figure 1017. 360086_1307353

Figure 1018.
360086_1307354


Figure 1019.
360086_1307355


Figure 1020.
360086_1307356

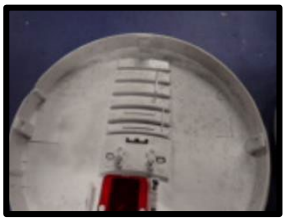


Figure 1021.
360086_1307357

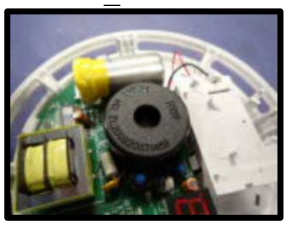


Figure 1022.
360086_1307358


Figure 1023.
360086_1307359


Figure 1024.
360086_1307360


Figure 1025.
360086_1307361

Figure 1026.
360086_1307362


Figure 1027.
360086_1307363


Figure 1028.
360086_1307364


Figure 1029.
360086_1307365


Figure 1030.
360086_1307366

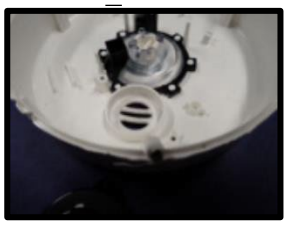


Figure 1031.
360086_1307367


Figure 1032.
360086_1307368


Figure 1033.
360086_1307369

Figure 1034.
360086_1307370


Figure 1035.
360086_1307371


Figure 1036.
360086_1307372

Figure 1037.
360086_1307373


Figure 1038.
360086_1307374


Figure 1039.
360086_1307375


Figure 1040.
360086_1307376

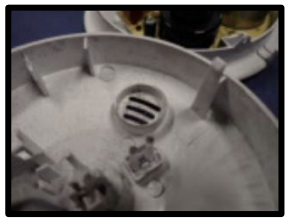


Figure 1041.
360086_1307377

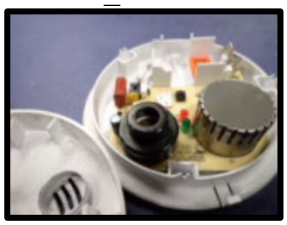


Figure 1042.
360086_1307378


Figure 1043.
360086_1307379


Figure 1044.
360086_1307380


Figure 1045.
360086_1307381


Figure 1046.
360086_1307382

Figure 1047.
360086_1307383

Figure 1048.
360086_1307384

Figure 1049.
360086_1307385


Figure 1050.
360086_1307386


Figure 1051.
360086_1307387


Figure 1052.
360086_1307388

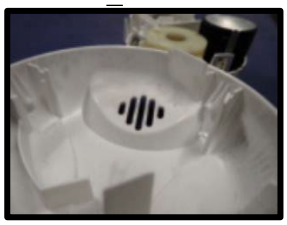


Figure 1053.
360086_1307389


Figure 1054.
360086_1307390


Figure 1055.
360086_1307391

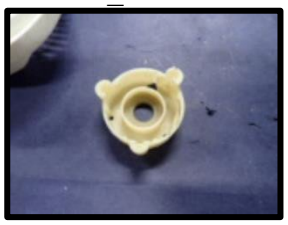


Figure 1056.
360086_1307392


Figure 1057.
360086_1307393

Figure 1058.
360086_1307394

Figure 1059.
360086_1307395

Figure 1060.
360086_1307396

Figure 1061.
360086_1307397

Figure 1062.
360086_1307398

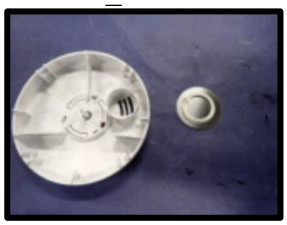


Figure 1063.
360086_1307399

Figure 1064.
360086_1307400

Figure 1065.
360086_1307401

Figure 1066.
360086_1307402

Figure 1067.
360086_1307403

Figure 1068.
360086_1307404

Figure 1069.
360086_1307405

Figure 1070.
360086_1307406

Figure 1071.
360086_1307407

Figure 1072.
360086_1307408

Figure 1073.
360086_1307409

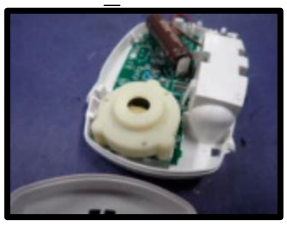


Figure 1074.
360086_1307410

Figure 1075.
360086_1307411

Figure 1076.
360086_1307412

Figure 1077.
360086_1307413

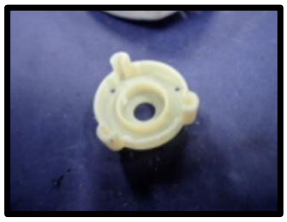


Figure 1078.
360086_1307414

Figure 1079.
360086_1307415

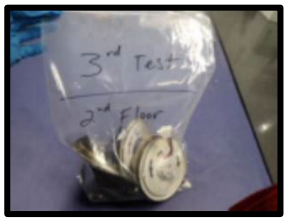


Figure 1080.
360086_1307416

Figure 1081.
360086_1307417

Figure 1082.
360086_1307418

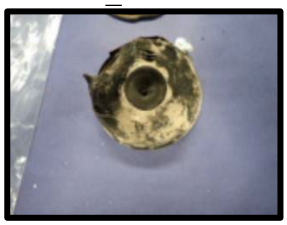


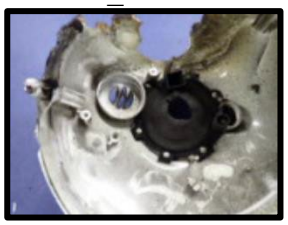
Figure 1083.
360086_1307419

Figure 1084.
360086_1307420

Figure 1085.
360086_1307421

Figure 1086.
360086_1307422

Figure 1087.
360086_1307423



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360086_1307424

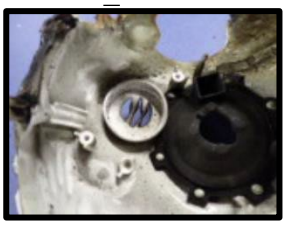


Figure 1089.
360086_1307425

Figure 1090.
360086_1307426

Figure 1091.
360086_1307427

Figure 1092.
360086_1307428

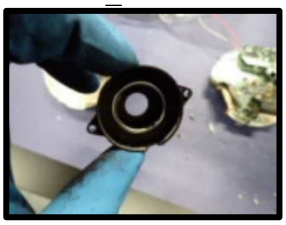


Figure 1093.
360086_1307429

Figure 1094.
360086_1307430

Figure 1095.
360086_1307431

Figure 1096.
360086_1307432

Figure 1097.
360086_1308188


Figure 1098.
360086_1308189


Figure 1099.
360086_1308190


Figure 1100.
360086_1308191

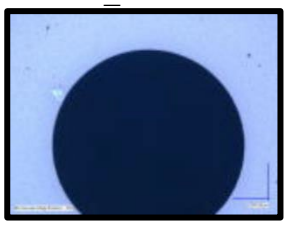

Figure 1101.
360086_1308192


Figure 1102.
360086_1308193


Figure 1103.
360086_1308194


Figure 1104.
360086_1308195


Figure 1105.
360086_1308196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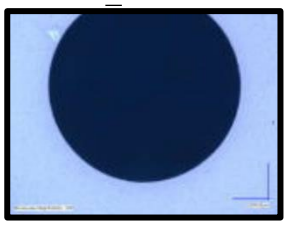
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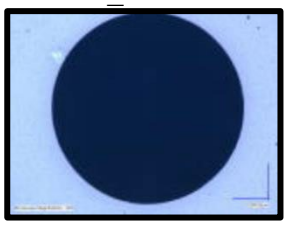
Figure 1108.
360086_1308199


Figure 1109.
360086_1308200


Figure 1110.
360086_1308201


Figure 1111.
360086_1308202

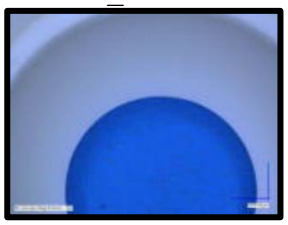
Figure 1112.
360086_1308203


Figure 1113.
360086_1308204


Figure 1114.
360086_1308205


Figure 1115.
360086_1308206

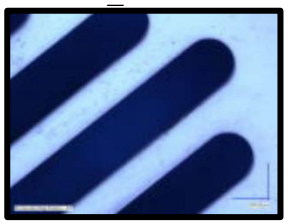
Figure 1116.
360086_1308207


Figure 1117.
360086_1308208

Figure 1118.
360086_1308209

Figure 1119.
360086_1308210

Figure 1120.
360086_1308211

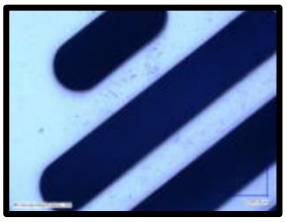

Figure 1121.
360086_1308212

Figure 1122.
360086_1308213

Figure 1123.
360086_1308214

Figure 1124.
360086_1308215

Figure 1125.
360086_1308216

Figure 1126.
360086_1308217

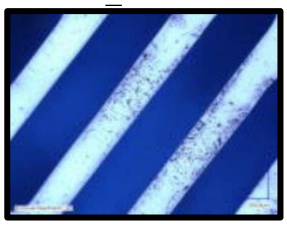

Figure 1127.
360086_1308218

Figure 1128.
360086_1308219

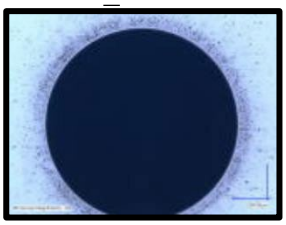

Figure 1129.
360086_1308220

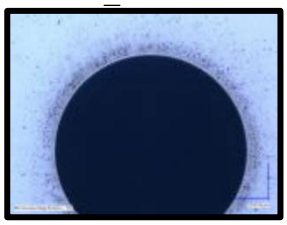

Figure 1130.
360086_1308221

Figure 1131.
360086_1308222

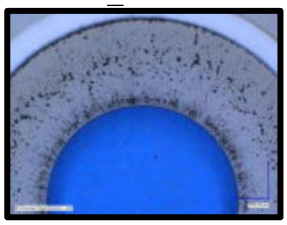

Figure 1132.
360086_1308223

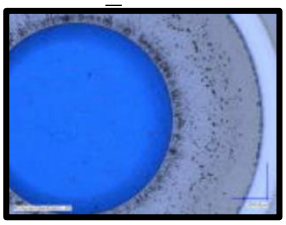

Figure 1133.
360086_1308224

Figure 1134.
360086_1308225

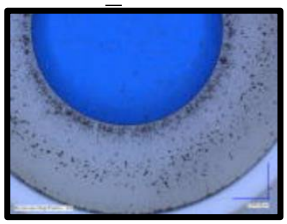

Figure 1135.
360086_1308226

Figure 1136.
360086_1308227

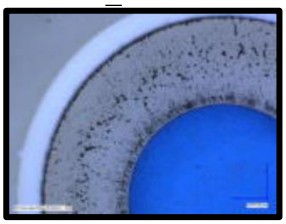

Figure 1137.
360086_1308228

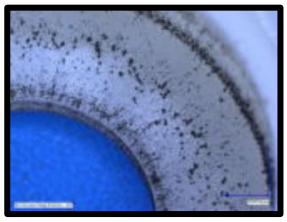

Figure 1138.
360086_1308229

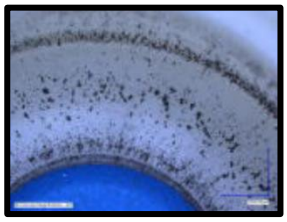

Figure 1139.
360086_1308230

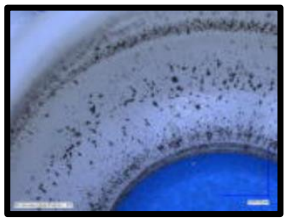

Figure 1140.
360086_1308231

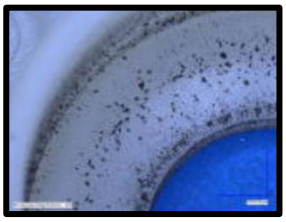

Figure 1141.
360086_1308232

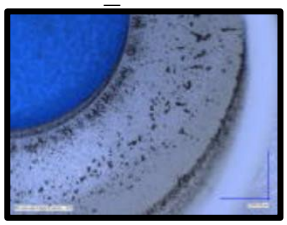

Figure 1142.
360086_1308233

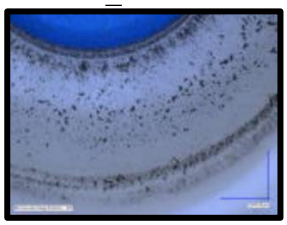

Figure 1143.
360086_1308234

Figure 1144.
360086_1308235

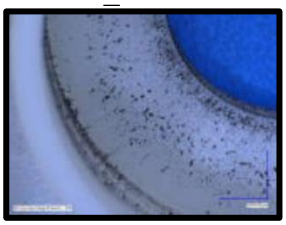

Figure 1145.
360086_1308236

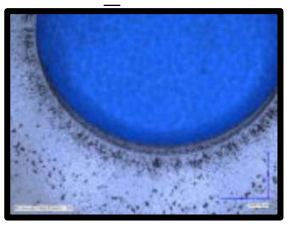

Figure 1146.
360086_1308237

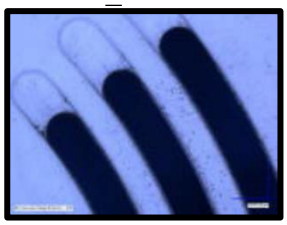

Figure 1147.
360086_1308238

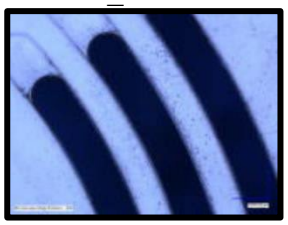

Figure 1148.
360086_1308239

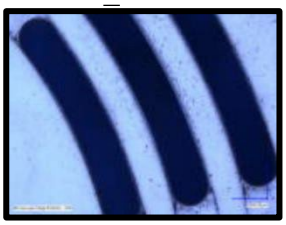

Figure 1149.
360086_1308240

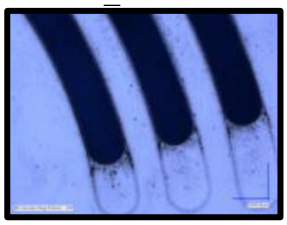

Figure 1150.
360086_1308241

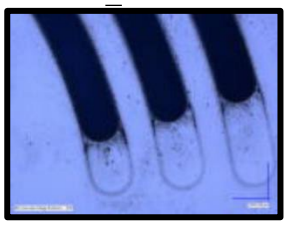

Figure 1151.
360086_1308242

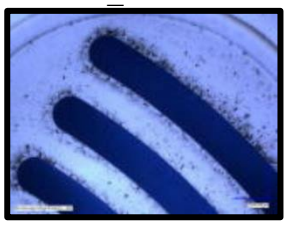

Figure 1152.
360086_1308243

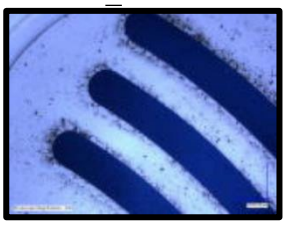

Figure 1153.
360086_1308244

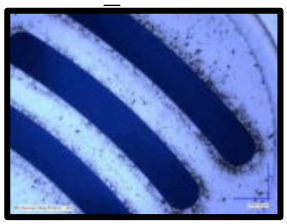

Figure 1154.
360086_1308245

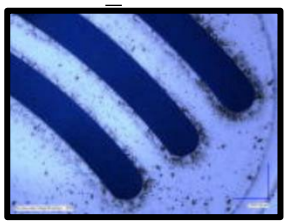

Figure 1155.
360086_1308246

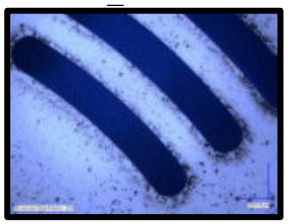

Figure 1156.
360086_1308247

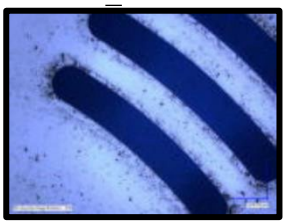

Figure 1157.
360086_1308248

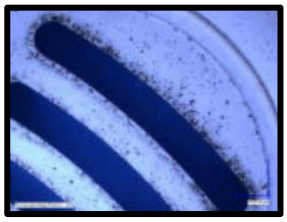
Figure 1158.
360086_1308249

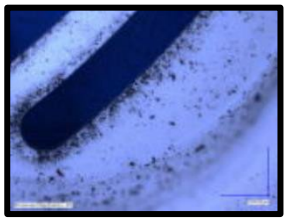
Figure 1159.
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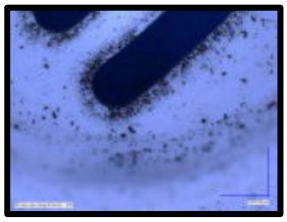
Figure 1160.
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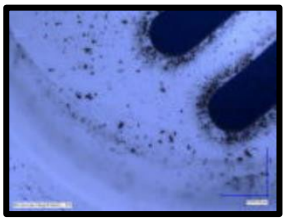


Figure 1161.
360086_1308252

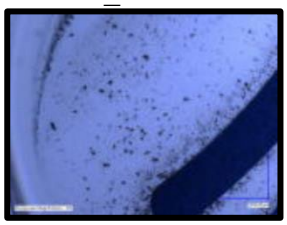


Figure 1162.
360086_1308253

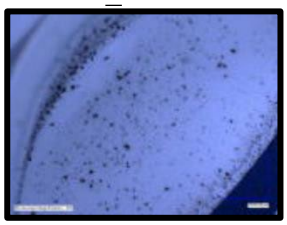


Figure 1163.
360086_1308254

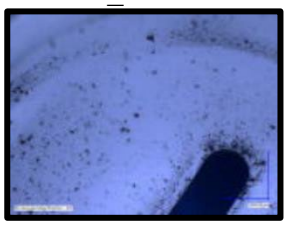
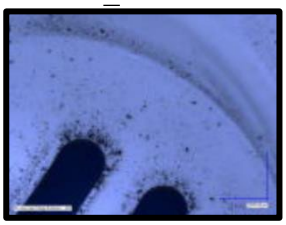


Figure 1164.
360086_1308255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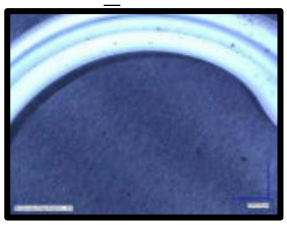
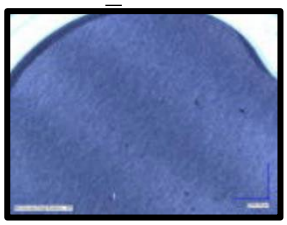


Figure 1166.
360086_1308257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360086_1308258

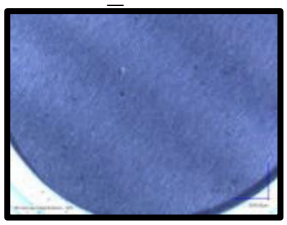
Figure 1168.
360086_1308259

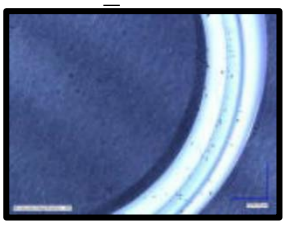
Figure 1169.
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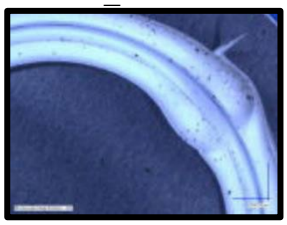
Figure 1170.
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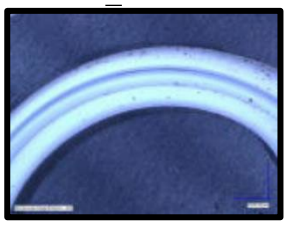
Figure 1171.
360086_1308262

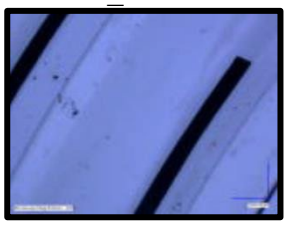
Figure 1172.
360086_1308263

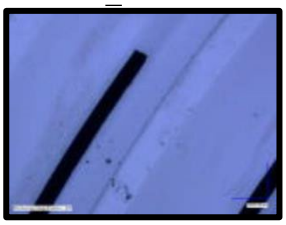
Figure 1173.
360086_1308264

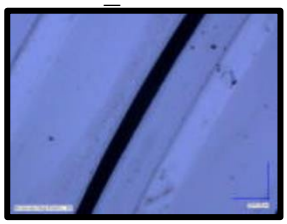
Figure 1174.
360086_1308265

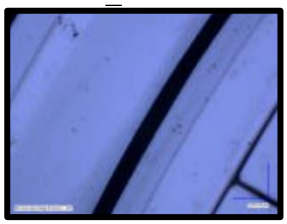
Figure 1175.
360086_1308266


Figure 1176.
360086_1308267


Figure 1177.
360086_1308268

Figure 1178.
360086_1308269

Figure 1179.
360086_1308270

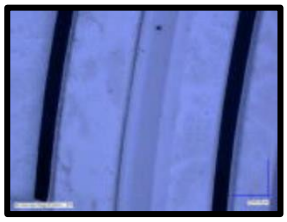

Figure 1180.
360086_1308271

Figure 1181.
360086_1308272

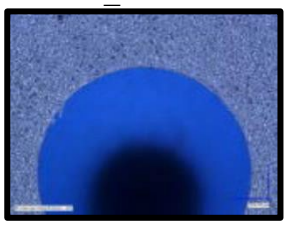

Figure 1182.
360086_1308273

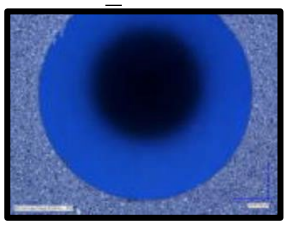

Figure 1183.
360086_1308274

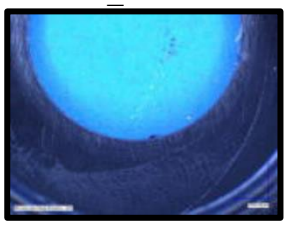

Figure 1184.
360086_1308275

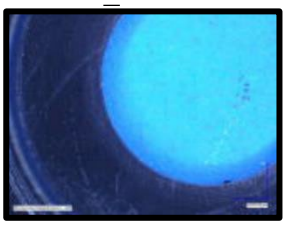

Figure 1185.
360086_1308276

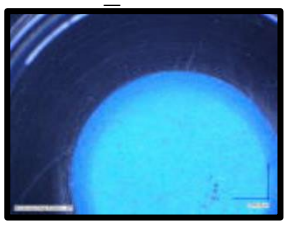

Figure 1186.
360086_1308277

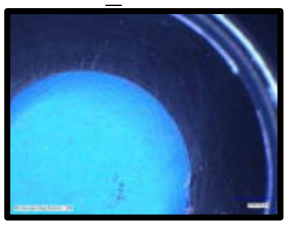

Figure 1187.
360086_1308278

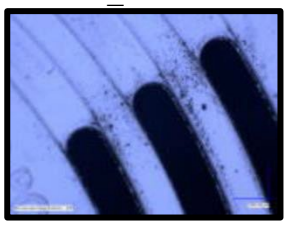

Figure 1188.
360086_1308279

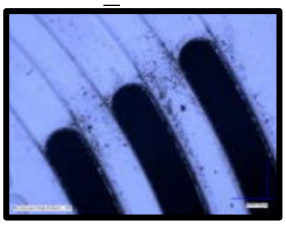

Figure 1189.
360086_1308280

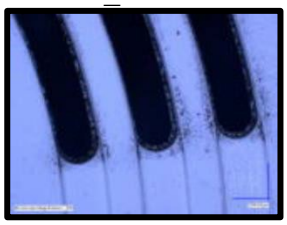

Figure 1190.
360086_1308281

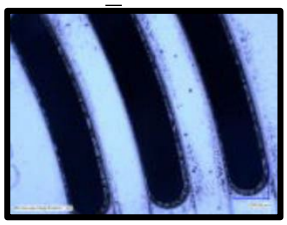

Figure 1191.
360086_1308282

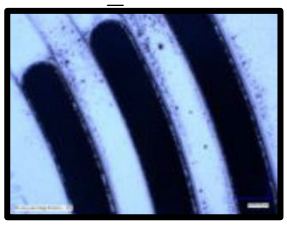

Figure 1192.
360086_1308283

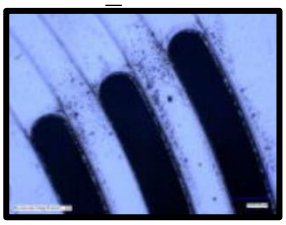

Figure 1193.
360086_1308284

Figure 1194.
360086_1308285

Figure 1195.
360086_1308286

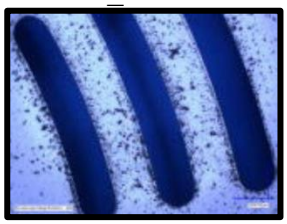

Figure 1196.
360086_1308287

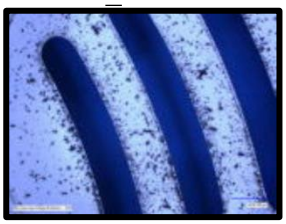

Figure 1197.
360086_1308288

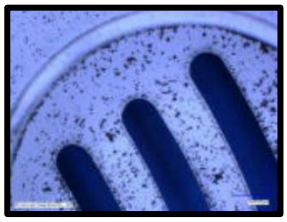
Figure 1198.
360086_1308289

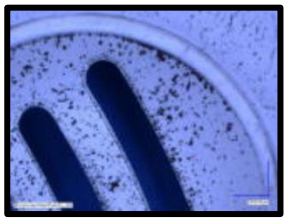
Figure 1199.
360086_1308290

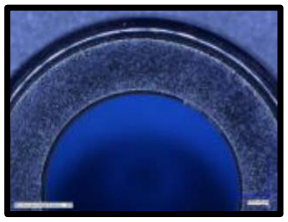
Figure 1200.
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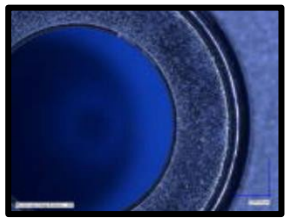
Figure 1201.
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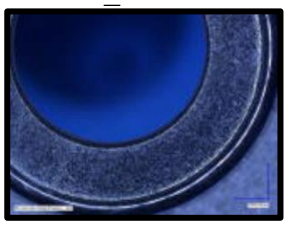


Figure 1202.
360086_1308293

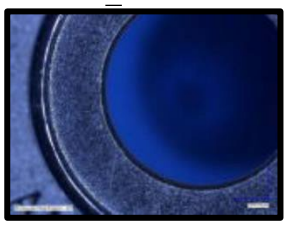


Figure 1203.
360086_1308294

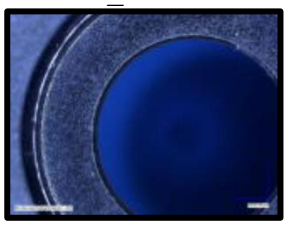
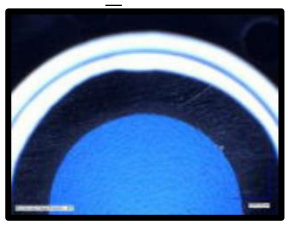


Figure 1204.
360086_1308295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360086_1308296

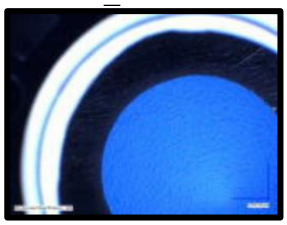
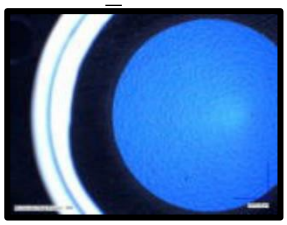


Figure 1206.
360086_1308297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360086_1308298

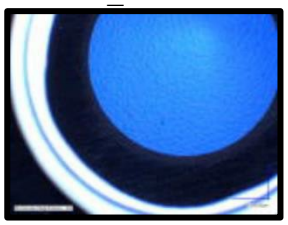


Figure 1208.
360086_1308299

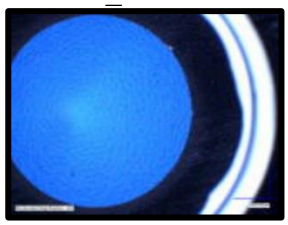


Figure 1209.
360086_1308300

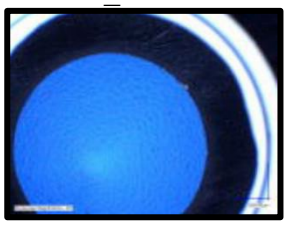


Figure 1210.
360086_1308301

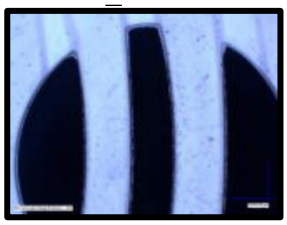


Figure 1211.
360086_1308302

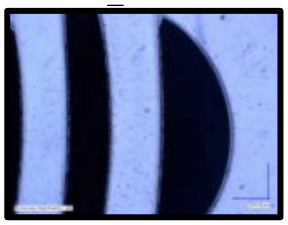


Figure 1212.
360086_1308303


Figure 1213.
360086_1308304


Figure 1214.
360086_1308305

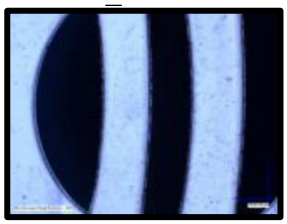


Figure 1215.
360086_1308306

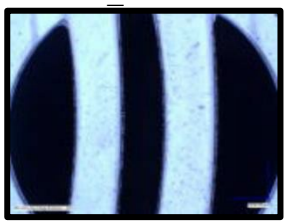


Figure 1216.
360086_1308307


Figure 1217.
360086_1308308

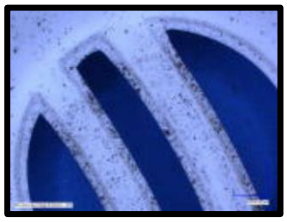


Figure 1218.
360086_1308309


Figure 1219.
360086_1308310


Figure 1220.
360086_1308311

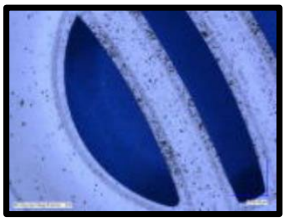
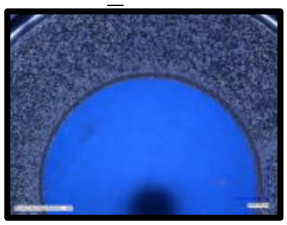


Figure 1221.
360086_1308312


Figure 1222.
360086_1308313


Figure 1223.
360086_1308314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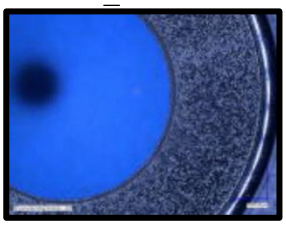
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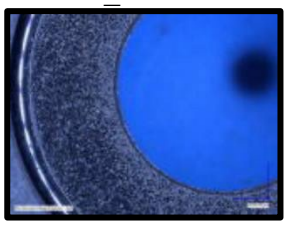
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360086_1308317

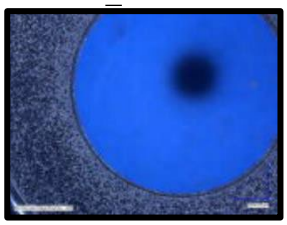


Figure 1227.
360086_1308318

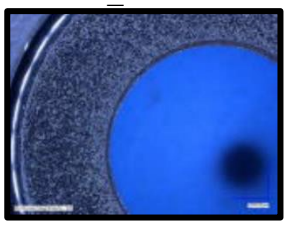


Figure 1228.
360086_1308319

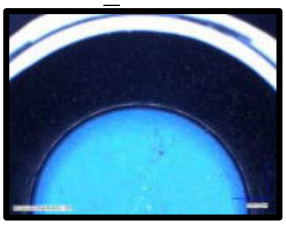


Figure 1229.
360086_1308320

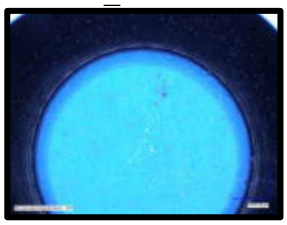


Figure 1230.
360086_1308321

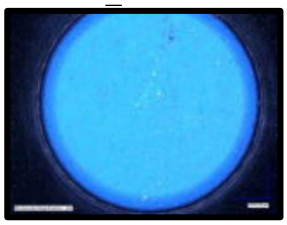


Figure 1231.
360086_1308322

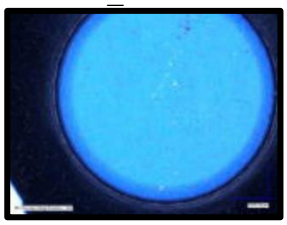
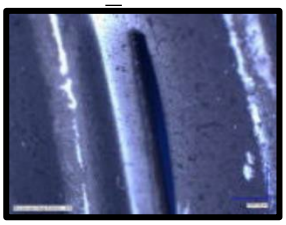


Figure 1232.
360086_1308323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360086_1308324

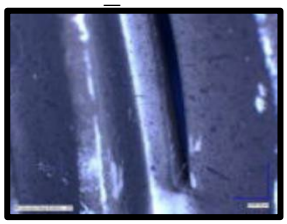


Figure 1234.
360086_1308325


Figure 1235.
360086_1308326


Figure 1236.
360086_1308327

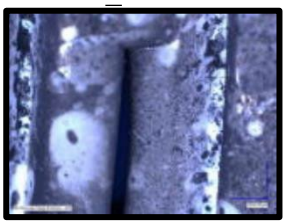


Figure 1237.
360086_1308328

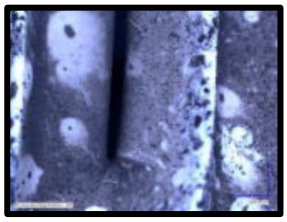


Figure 1238.
360086_1308329

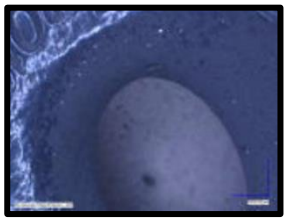


Figure 1239.
360086_1308330

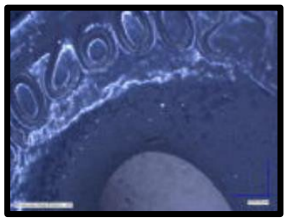


Figure 1240.
360086_1308331

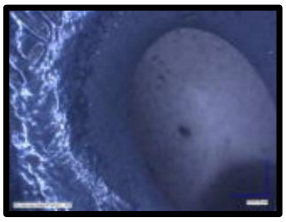
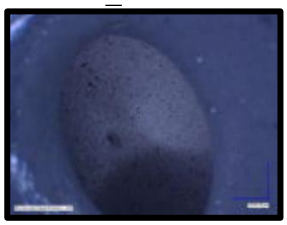


Figure 1241.
360086_1308332


Figure 1242.
360086_1308333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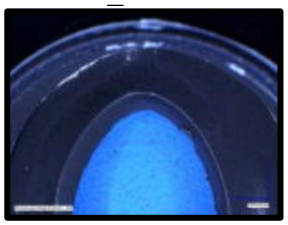
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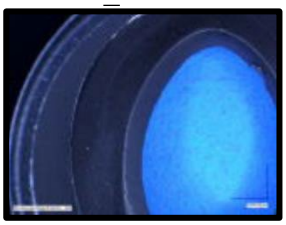
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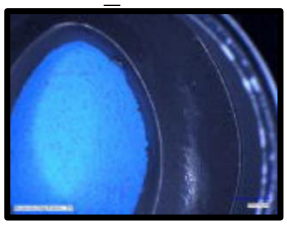
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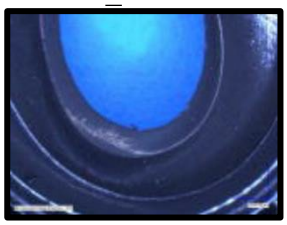
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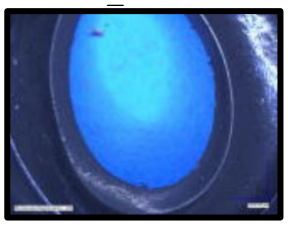
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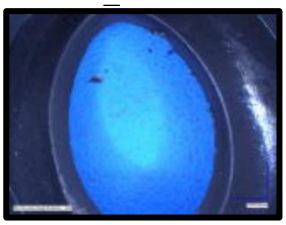
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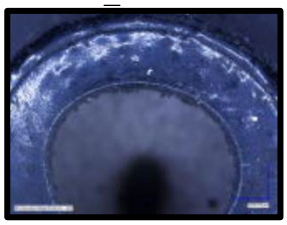
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360086_1308341

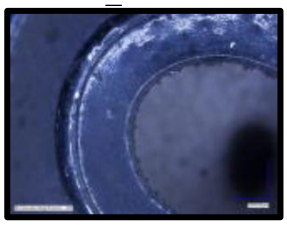
Figure 1251.
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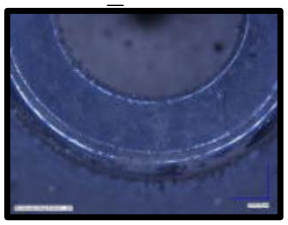
Figure 1252.
360086_1308343

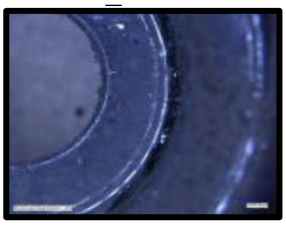
Figure 1253.
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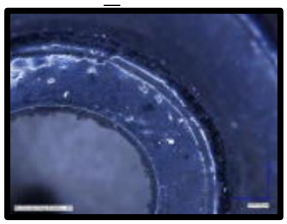
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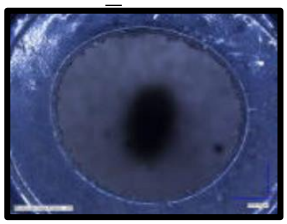
Figure 1255.
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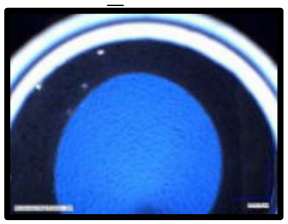
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360086_1308347

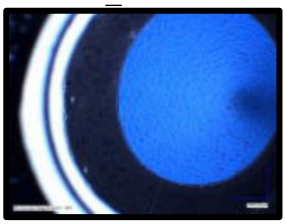
Figure 1257.
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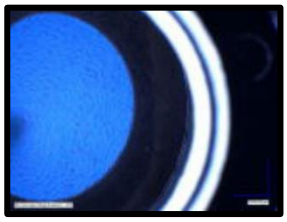

Figure 1258.
360086_1308349

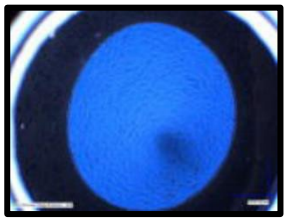

Figure 1259.
360086_1308350

Figure 1260.
360086_1308351

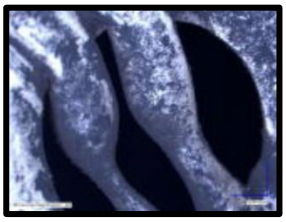

Figure 1261.
360086_1308352

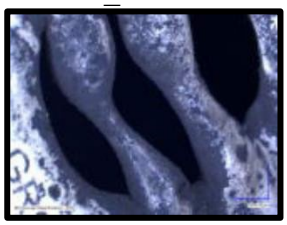

Figure 1262.
360086_1308353

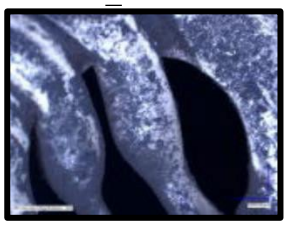

Figure 1263.
360086_1308354

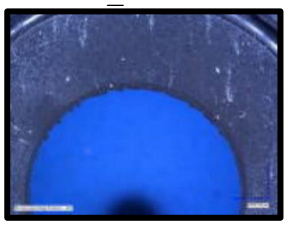

Figure 1264.
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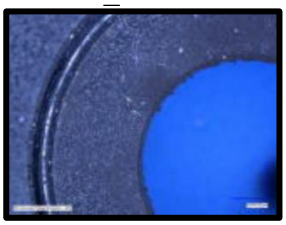


Figure 1265.
360086_1308356

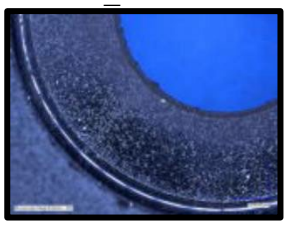


Figure 1266.
360086_1308357

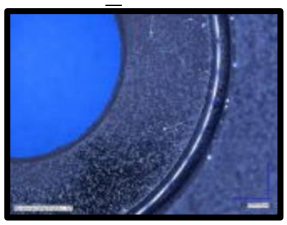


Figure 1267.
360086_1308358

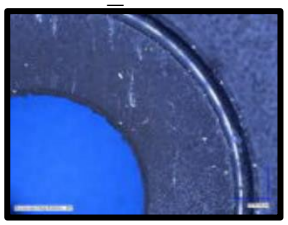


Figure 1268.
360086_1308359

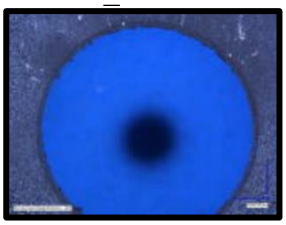


Figure 1269.
360086_1308360

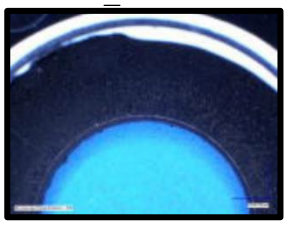


Figure 1270.
360086_1308361

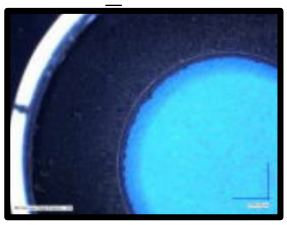


Figure 1271.
360086_1308362

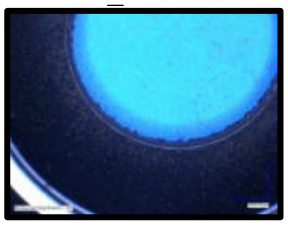


Figure 1272.
360086_1308363

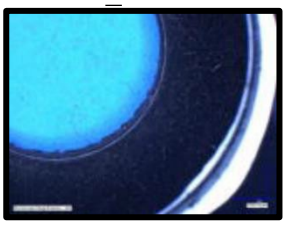


Figure 1273.
360086_1308364

Figure 1274.
360086_1308365

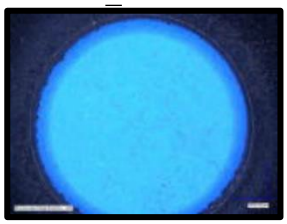


Figure 1275.
360086_1308366

Results for Test 4 (ID 360089)

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

Table 43. Experiment Events

Description	Time (s)
2nd Floor Heat Flux Gauge Covered	232
Gas Pump Off for 2nd floor	445
Suppression	844

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 over pre-determined time spans.

Table 44. 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)
Landing 0'	10.2	66.8	59.4	52.9	35.4	26.6
Landing 1'	10.0	64.0	41.2	36.8	25.2	19.7
Landing 2'	10.0	70.9	58.0	50.6	32.2	24.9
Landing 3'	9.9	76.0	70.4	62.7	40.6	31.6
Landing 4'	9.9	101.6	89.9	79.7	51.9	41.6
Landing 5'	9.9	107.9	95.2	84.2	56.9	45.5
Landing 6'	10.1	387.1	355.5	319.7	145.8	99.4
Landing 7'	10.3	411.8	391.1	365.7	253.0	198.6
1st Floor 0'	10.5	14.6	14.6	14.6	14.5	13.5
1st Floor 1'	10.0	13.9	13.8	13.7	13.6	13.0
1st Floor 2'	10.3	14.8	14.7	14.7	14.5	14.2
1st Floor 3'	10.1	15.9	15.7	15.6	15.0	14.5
1st Floor 4'	10.0	20.8	20.1	19.9	18.6	17.4
1st Floor 5'	9.9	27.6	27.0	26.6	23.6	21.7
1st Floor 6'	9.9	41.4	39.4	38.1	31.8	27.2
1st Floor 7'	10.0	49.3	45.9	45.4	37.9	31.7
1st Floor 8'	10.1	58.3	54.4	52.8	42.9	36.1
2nd Floor 0'	9.4	872.7	868.0	865.5	800.9	618.1
2nd Floor 1'	10.1	945.8	940.6	935.0	910.1	811.8
2nd Floor 2'	9.7	960.7	935.8	928.2	897.3	833.5
2nd Floor 3'	9.7	971.3	935.0	930.6	903.8	851.1
2nd Floor 4'	9.8	958.5	951.2	947.5	917.0	868.3
2nd Floor 5'	9.9	949.4	942.2	937.6	910.7	866.8
2nd Floor 6'	10.1	954.5	951.1	948.6	921.0	891.3
2nd Floor 7'	10.3	961.7	957.8	956.4	922.2	891.4
2nd Floor 8'	10.7	946.3	942.5	940.2	911.2	882.5
Tenability 1st Floor 5'	10.1	23.9	23.6	23.4	22.0	20.6
Tenability 2nd Floor 5'	10.3	1042.9	1016.6	1007.6	965.8	934.7

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

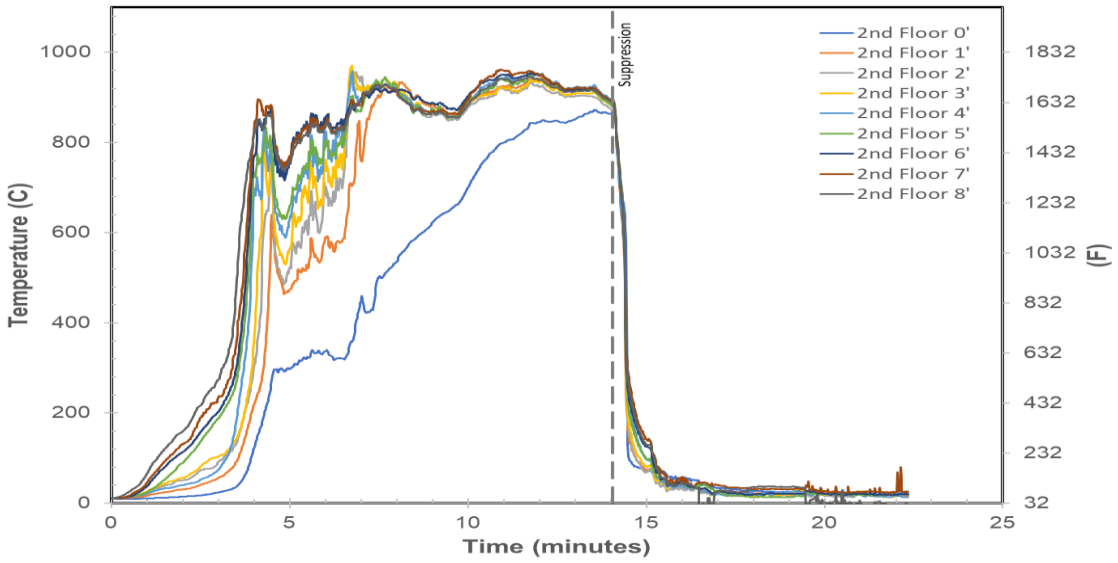


Figure 1276. Temperature – 2nd Floor

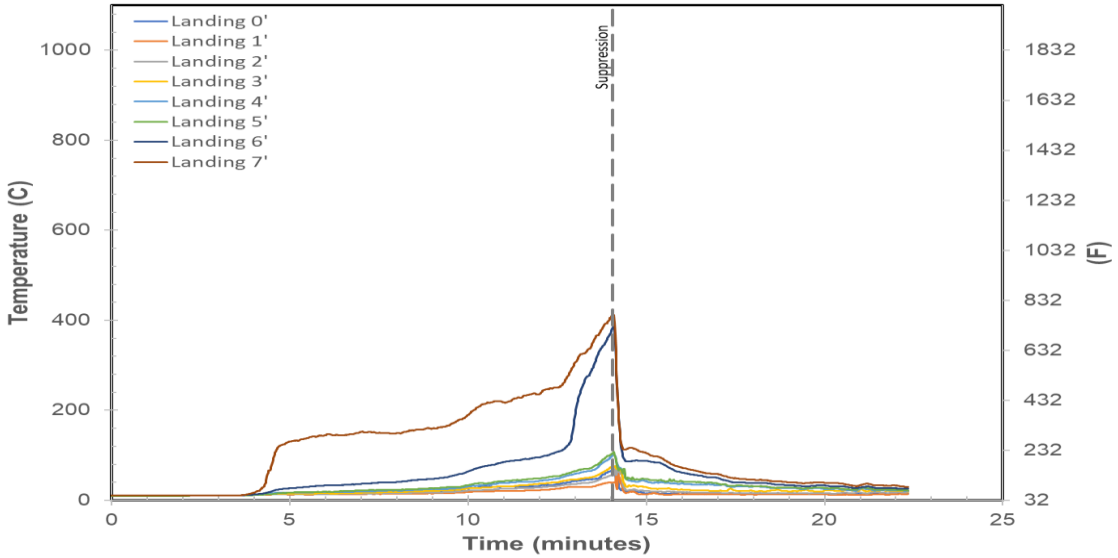


Figure 1277. Temperature – Landing

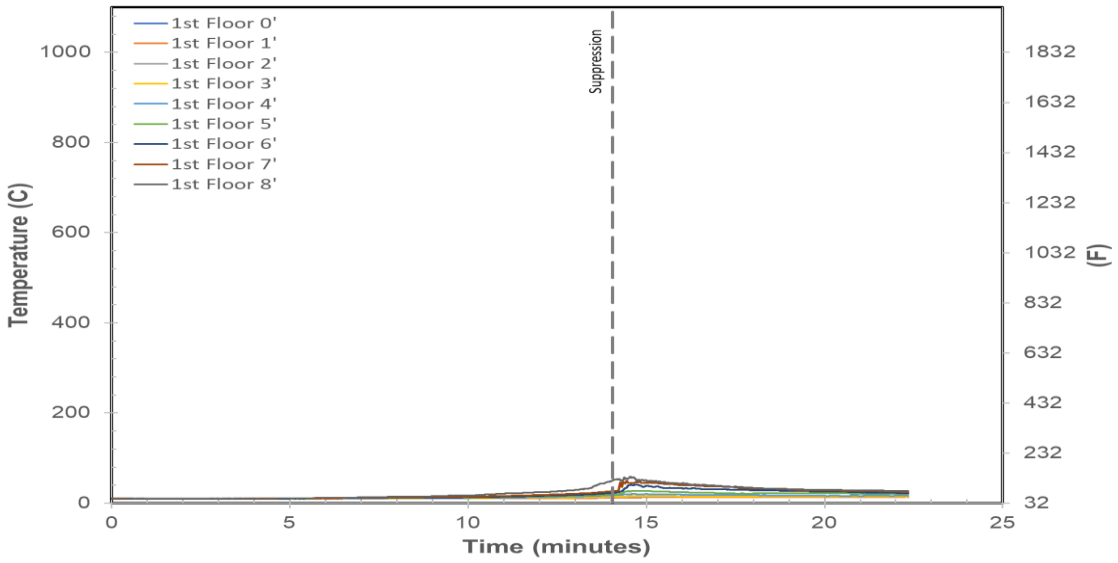


Figure 1278. Temperature – 1st Floor

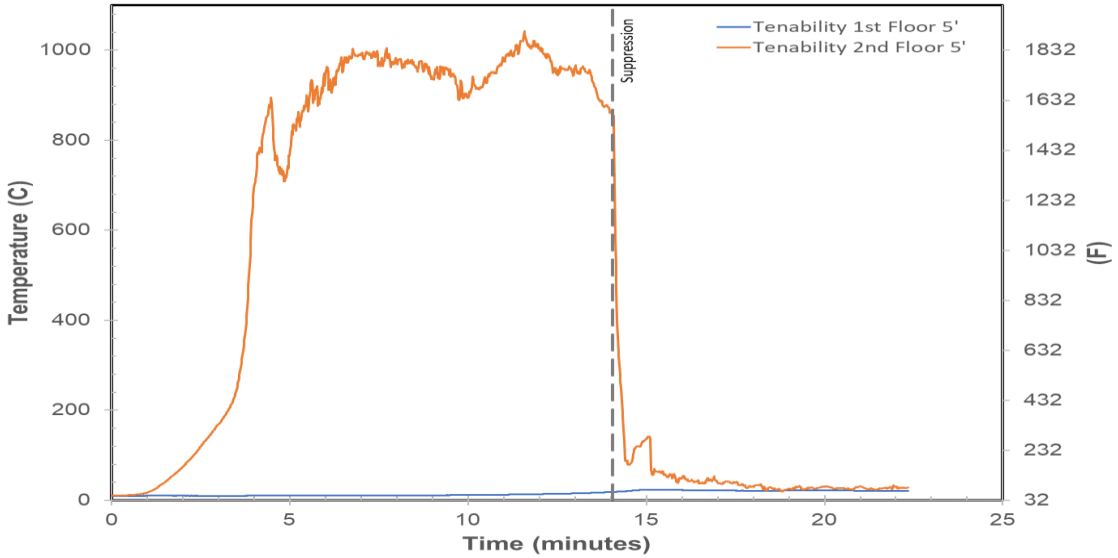


Figure 1279. Temperature - Tenability

The following table shows which heat flux transducers(s) were taken out of service during the experiment(s).The "Description" column typically describes the location of the heat flux transducer. If the heat flux measurement has to be discontinued during a test, the "Out of Service Time" and "Out of Service Reason" columns report the test time and reason why the heat flux measurement was removed, respectively.

Table 45. Out of Service Times

Description	Serial number	Out of service time (s)	Out of service reason
2nd Floor Total	1227941T	228	OverRange
2nd Floor Rad	1227941R	232	Gauge covered to limit heat exposure

The following table provides a summary of the heat flux results. 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 pre-determined time spans. A "SC" indicates that the values did not change sufficiently for this value to be calculated.

Table 46. 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 Total	SC	1	0.2	0.2	0.2	0.2	0.2	0.1
1st Floor Rad	SC	1	0.1	0.1	0.1	0.1	0.1	0.1
2nd Floor Total	121	1	32.3	24.4	15.3	10.0	2.4	1.2
2nd Floor Rad	197	1	10.0	8.7	5.0	3.0	0.7	0.3

The following chart(s) shows a time dependent representation of the baseline corrected instantaneous heat flux measured during the experiment.

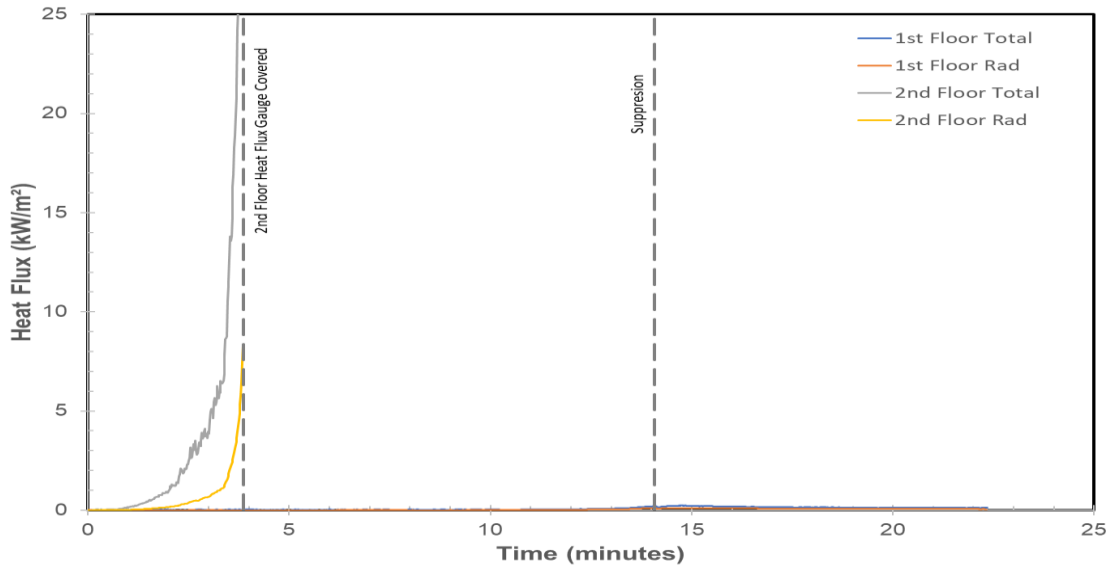


Figure 1280. Heat Flux

The following table provides a summary of the optical density.

Table 47. Optical Density Results Summary

Description	Average Optical Density (1/m)	Maximum Optical Density (1/m)
1st Floor ODM	0.33	1.16

The following chart provides a time dependent representation of the optical density measured during the experiment.

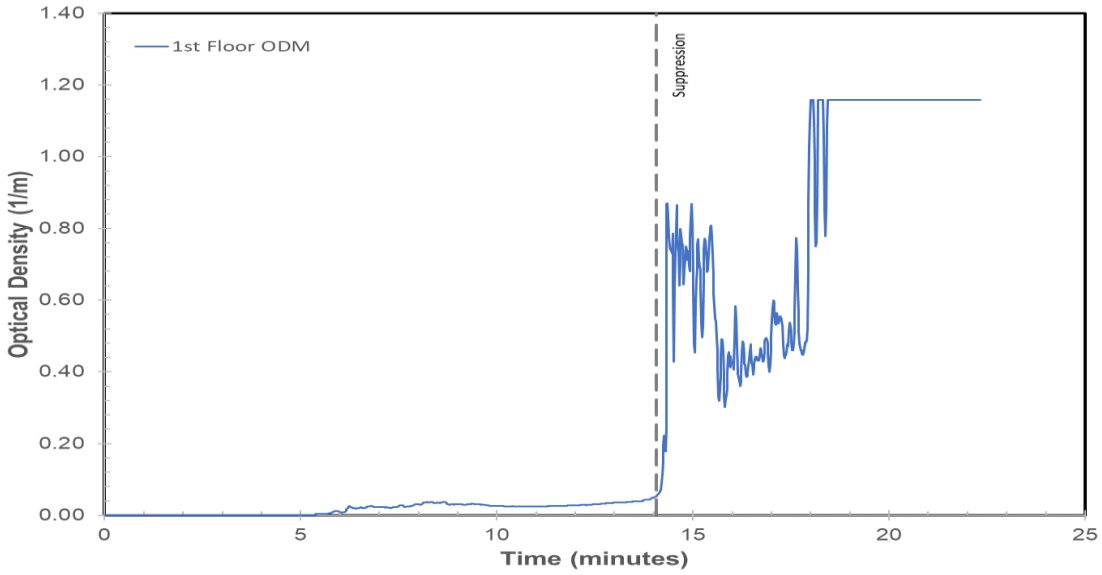


Figure 1281. Optical Density

The following chart shows the obscuration during the experiment.

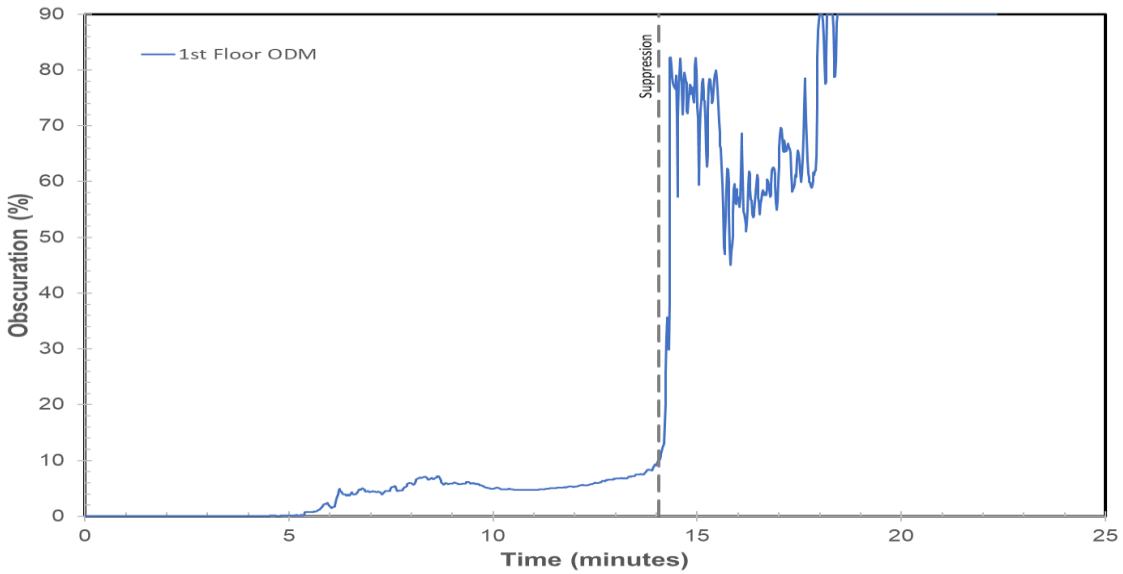


Figure 1282. Obscuration

The following table shows which oxygen analyzer(s) were taken out of service during the experiment.

Table 48. Out of Service

Description	Time out of service time (s)	Out of service reason
2nd Floor	445	Pump Turned Off

The following table provides a summary of the oxygen measurement results.

Table 49. Oxygen Measurement Results

Description	Full Scale Range (%)	Minimum Value (%)	Average (%)
2nd Floor	25	0.875	11.14699
1st Floor	25	19.94375	20.51214

The following chart presents the oxygen concentration(s) measured during the test.

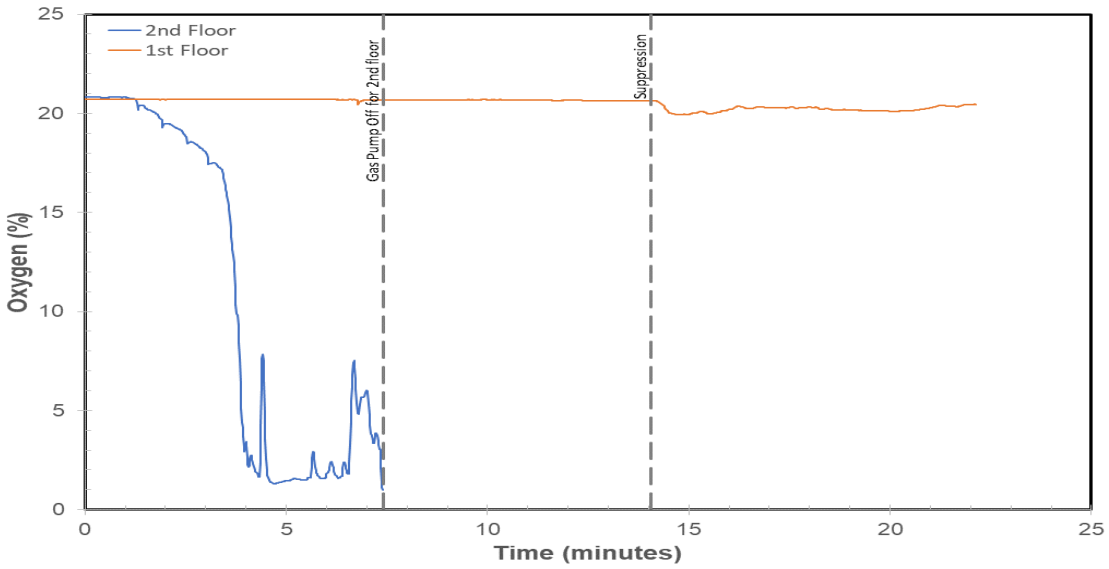


Figure 1283. Oxygen Concentration

The following table shows which CO/CO2 gas analyzer(s) were taken out of service (OOS) during the experiment.

Table 50. Out of Service

Description	CO- Time OOS (s)	CO- Reason OOS	CO2- Time OOS (s)	CO2- Reason OOS
2nd Floor	445	Pump Turned Off	445	Pump Turned Off

The following table provides a summary of the carbon monoxide gas measurement results.

Table 51. CO Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
2nd Floor	0.05	0.0435	0.0093

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
1st Floor	0.05	0.0001	-0.0001

The following table provides a summary of the carbon dioxide gas measurement results.

Table 52. CO_2 Measurement Results

Description	Full Scale Range (mol/mol)	Maximum Value (mol/mol)	Average (mol/mol)
2nd Floor	0.25	0.1494	0.0755
1st Floor	0.25	0.0068	0.0014

The following chart shows the carbon monoxide concentration(s) measured during the experiment.

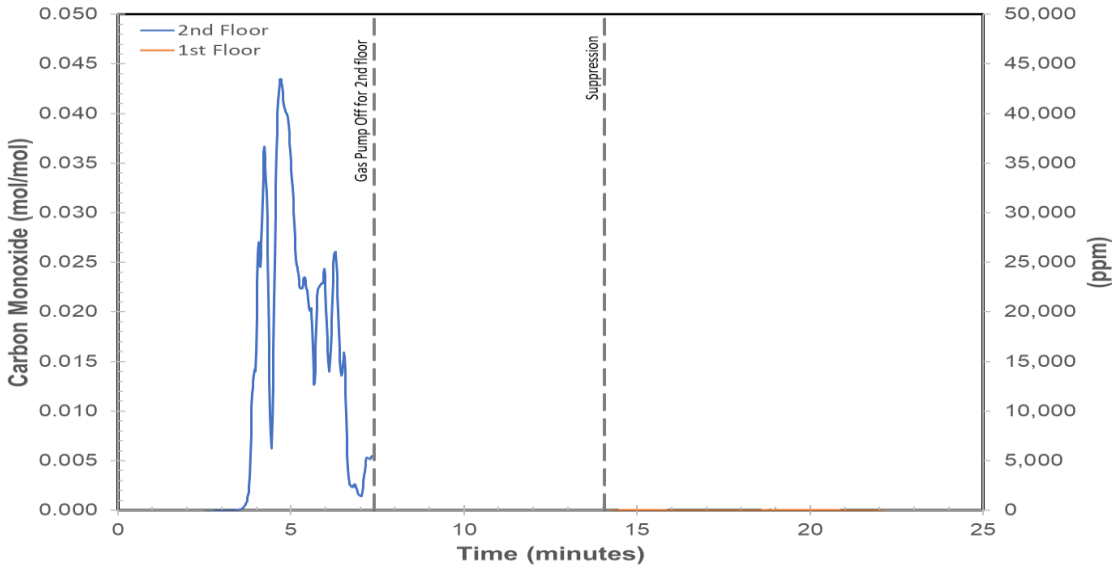


Figure 1284. Carbon Monoxide Concentration(s)

The following chart shows the carbon dioxide concentration(s) measured during the experiment.

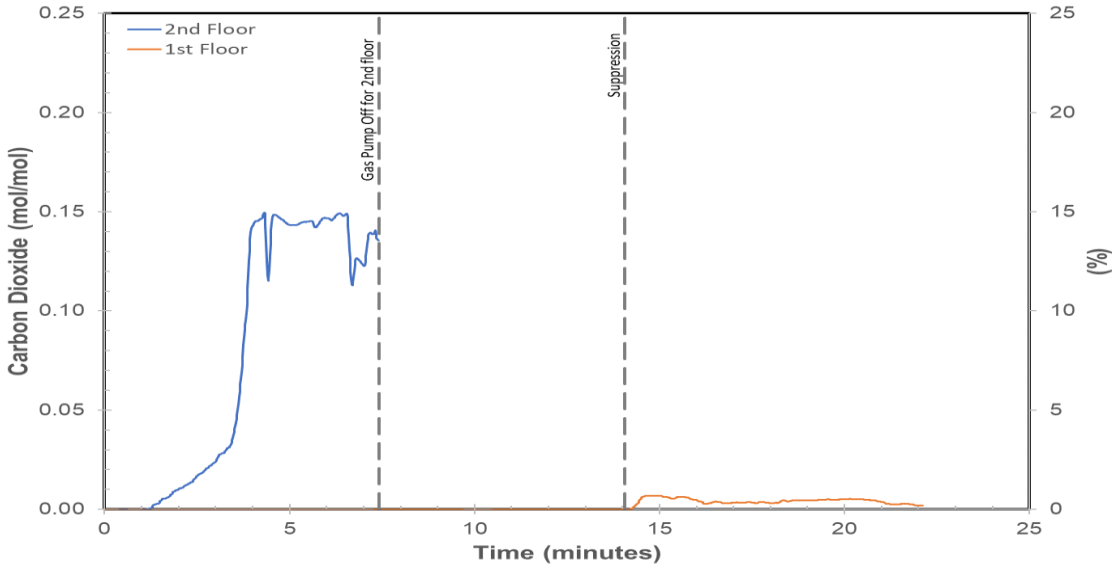


Figure 1285. Carbon Dioxide Concentration(s)

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

Table 53. Video Log

Description	Start Time	Duration (s)	Filename
Stairs Looking down	09:48:46	1438	360089_20230309_094839_1A.mov
Chair	09:48:54	1441	360089_20230309_094847_2A.mov
Stairs looking up	09:49:01	1445	360089_20230309_094854_3A.mov
Wide View 2nd	09:49:08	1449	360089_20230309_094902_4A.mov
Ignition	09:49:16	1452	360089_20230309_094909_5A.mov
Smoke Detector 1st floor	09:49:23	1457	360089_20230309_094917_6A.mov
Wide View 1st	09:49:31	1461	360089_20230309_094924_7A.mov
HD outside view	09:49:39	1464	360089_20230309_094932_8A.mov
Data Chart	09:49:51	1464	360089_20230309_094944_17A.mov
Master			360089_1313197.MOV
Custom - Master Sped Up 60X			360089_1313198.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.

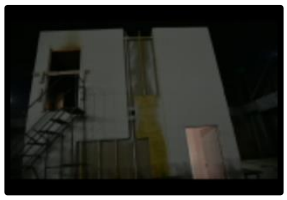


Figure 1286. Pre test 27 minutes, 360089_1305397

Figure 1287. Pre test 27 minutes, 360089_1305398

Figure 1288. Pre test 27 minutes, 360089_1305399

Figure 1289. Pre test 27 minutes, 360089_1305400

Figure 1290. Pre test 27 minutes, 360089_1305401

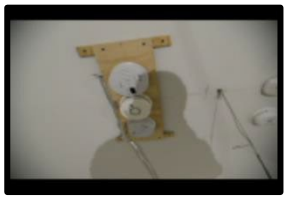


Figure 1291. Pre test 27 minutes, 360089_1305402

Figure 1292. Pre test 27 minutes, 360089_1305403

Figure 1293. Pre test 27 minutes, 360089_1305404

Figure 1294. Pre test 27 minutes, 360089_1305405

Figure 1295. Pre test 27 minutes, 360089_1305406

Figure 1296. Pre test 27 minutes, 360089_1305407

Figure 1297. Pre test 27 minutes, 360089_1305408

Figure 1298. Pre test 27 minutes, 360089_1305409

Figure 1299. Pre test 26 minutes, 360089_1305410

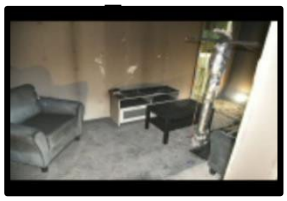


Figure 1300. Pre test 26 minutes, 360089_1305411

Figure 1301. Pre test 26 minutes, 360089_1305412

Figure 1302. Pre test 26 minutes, 360089_1305413

Figure 1303. Pre test 26 minutes, 360089_1305414

Figure 1304. Pre test 26 minutes, 360089_1305415

Figure 1305. Pre test 26 minutes, 360089_1305416

Figure 1306. Pre test 26 minutes, 360089_1305417

Figure 1307. Pre test 26 minutes, 360089_1305418

Figure 1308. Pre test 26 minutes, 360089_1305419

Figure 1309. Pre test 26 minutes, 360089_1305420


Figure 1310. Pre test 26 minutes, 360089_1305421


Figure 1311. Pre test 26 minutes, 360089_1305422


Figure 1312. Pre test 26 minutes, 360089_1305423


Figure 1313. Pre test 26 minutes, 360089_1305424


Figure 1314. Pre test 26 minutes, 360089_1305425


Figure 1315. Pre test 26 minutes, 360089_1305426


Figure 1316. Pre test 25 minutes, 360089_1305427


Figure 1317. Pre test 25 minutes, 360089_1305428


Figure 1318. Pre test 25 minutes, 360089_1305429


Figure 1319. Pre test 24 minutes, 360089_1305430


Figure 1320. Pre test 18 minutes, 360089_1305431


Figure 1321. Pre test 18 minutes, 360089_1305432


Figure 1322. Pre test 18 minutes, 360089_1305433


Figure 1323. Pre test 17 minutes, 360089_1305434


Figure 1324. Pre test 16 minutes, 360089_1305435


Figure 1325. Pre test 16 minutes, 360089_1305436


Figure 1326. Pre test 16 minutes, 360089_1305437


Figure 1327. Pre test 16 minutes, 360089_1305438


Figure 1328. Pre test 14 minutes, 360089_1305439


Figure 1329. Pre test 14 minutes, 360089_1305440

Figure 1330. Pre test 14 minutes, 360089_1305441

Figure 1331. Pre test 14 minutes, 360089_1305442

Figure 1332. Pre test 12 minutes, 360089_1305443

Figure 1333. Pre test 12 minutes, 360089_1305444

Figure 1334. Pre test 12 minutes, 360089_1305445

Figure 1335. Pre test 12 minutes, 360089_1305446

Figure 1336. Pre test 12 minutes, 360089_1305447

Figure 1337. Pre test 11 minutes, 360089_1305448

Figure 1338. Pre test 11 minutes, 360089_1305449

Figure 1339. Pre test 11 minutes, 360089_1305450

Figure 1340. Pre test 11 minutes, 360089_1305451

Figure 1341. Pre test 61 seconds, 360089_1305452

Figure 1342. Pre test 57 seconds, 360089_1305453

Figure 1343. Pre test 1 seconds, 360089_1305454

Figure 1344. 1 seconds, 360089_1305455

Figure 1345. 27 seconds, 360089_1305456

Figure 1346. 29 seconds, 360089_1305457

Figure 1347. 71 seconds, 360089_1305458

Figure 1348. 93 seconds, 360089_1305459

Figure 1349. 97 seconds, 360089_1305460

Figure 1350. 105 seconds, 360089_1305461

Figure 1351. 117 seconds, 360089_1305462

Figure 1352. 121 seconds, 360089_1305463

Figure 1353. 159 seconds, 360089_1305464

Figure 1354. 167 seconds, 360089_1305465

Figure 1355. 169 seconds, 360089_1305466

Figure 1356. 175 seconds, 360089_1305467

Figure 1357. 185 seconds, 360089_1305468

Figure 1358. 193 seconds, 360089_1305469

Figure 1359. 199 seconds, 360089_1305470

Figure 1360. 211 seconds, 360089_1305471

Figure 1361. 211 seconds, 360089_1305472

Figure 1362. 215 seconds, 360089_1305473

Figure 1363. 217 seconds, 360089_1305474

Figure 1364. 281 seconds, 360089_1305475

Figure 1365. 285 seconds, 360089_1305476

Figure 1366. 293 seconds, 360089_1305477

Figure 1367. 303 seconds, 360089_1305478

Figure 1368. 303 seconds, 360089_1305479

Figure 1369. 311 seconds, 360089_1305480

Figure 1370. 313 seconds, 360089_1305481

Figure 1371. 317 seconds, 360089_1305482

Figure 1372. 333 seconds, 360089_1305483

Figure 1373. 335 seconds, 360089_1305484

Figure 1374. 345 seconds, 360089_1305485

Figure 1375. 405 seconds, 360089_1305486

Figure 1376. 413 seconds, 360089_1305487

Figure 1377. 419 seconds, 360089_1305488

Figure 1378. 453 seconds, 360089_1305489

Figure 1379. 465 seconds, 360089_1305490

Figure 1380. 475 seconds, 360089_1305491

Figure 1381. 483 seconds, 360089_1305492

Figure 1382. 551 seconds, 360089_1305493

Figure 1383. 595 seconds, 360089_1305494

Figure 1384. 601 seconds, 360089_1305495

Figure 1385. 607 seconds, 360089_1305496

Figure 1386. 611 seconds, 360089_1305497

Figure 1387. 629 seconds, 360089_1305498

Figure 1388. 635 seconds, 360089_1305499

Figure 1389. 639 seconds, 360089_1305500

Figure 1390. 655 seconds, 360089_1305501

Figure 1391. 663 seconds, 360089_1305502

Figure 1392. 671 seconds, 360089_1305503

Figure 1393. 677 seconds, 360089_1305504

Figure 1394. 699 seconds, 360089_1305505

Figure 1395. 701 seconds, 360089_1305506

Figure 1396. 733 seconds, 360089_1305507

Figure 1397. 737 seconds, 360089_1305508

Figure 1398. 747 seconds, 360089_1305509

Figure 1399. 751 seconds, 360089_1305510

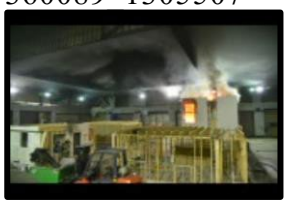


Figure 1400. 805 seconds, 360089_1305511

Figure 1401. 811 seconds, 360089_1305512

Figure 1402. 817 seconds, 360089_1305513

Figure 1403. 831 seconds, 360089_1305514

Figure 1404. 833 seconds, 360089_1305515

Figure 1405. 841 seconds, 360089_1305516

Figure 1406. 843 seconds, 360089_1305517

Figure 1407. 845 seconds, 360089_1305518

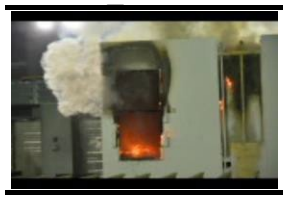


Figure 1408. 847 seconds, 360089_1305519

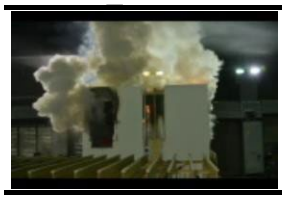


Figure 1409. 847 seconds, 360089_1305520

Figure 1410. 849 seconds, 360089_1305521

Figure 1411. 849 seconds, 360089_1305522

Figure 1412. 851 seconds, 360089_1305523

Figure 1413. 853 seconds, 360089_1305524

Figure 1414. 855 seconds, 360089_1305525

Figure 1415. 883 seconds, 360089_1305526

Figure 1416. 887 seconds, 360089_1305527

Figure 1417. 901 seconds, 360089_1305528

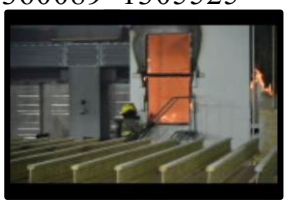


Figure 1418. 903 seconds, 360089_1305529

Figure 1419. 907 seconds, 360089_1305530

Figure 1420. 921 seconds, 360089_1305531

Figure 1421. 923 seconds, 360089_1305532

Figure 1422. 927 seconds, 360089_1305533

Figure 1423. 929 seconds, 360089_1305534

Figure 1424. 931 seconds, 360089_1305535

Figure 1425. 939 seconds, 360089_1305536

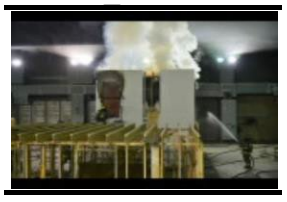


Figure 1426. 945 seconds, 360089_1305537

Figure 1427. 945 seconds, 360089_1305538

Figure 1428. 949 seconds, 360089_1305539

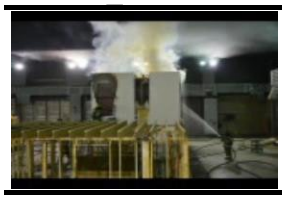


Figure 1429. 951 seconds, 360089_1305540

Figure 1430. 957 seconds, 360089_1305541

Figure 1431. 963 seconds, 360089_1305542

Figure 1432. 981 seconds, 360089_1305543

Figure 1433. 981 seconds, 360089_1305544

Figure 1434. 999 seconds, 360089_1305545

Figure 1435. 1003 seconds, 360089_1305546

Figure 1436. 1005 seconds, 360089_1305547

Figure 1437. 1009 seconds, 360089_1305548

Figure 1438. 1013 seconds, 360089_1305549

Figure 1439. 1043 seconds, 360089_1305550

Figure 1440. 1049 seconds, 360089_1305551

Figure 1441. 1055 seconds, 360089_1305552

Figure 1442. 1065 seconds, 360089_1305553

Figure 1443. 1125 seconds, 360089_1305554

Figure 1444. 1127 seconds, 360089_1305555

Figure 1445. 1157 seconds, 360089_1305556

Figure 1446. 1159 seconds, 360089_1305557

Figure 1447. 1161 seconds, 360089_1305558

Figure 1448. 1163 seconds, 360089_1305559

Figure 1449. 1169 seconds, 360089_1305560

Figure 1450. 1171 seconds, 360089_1305561

Figure 1451. 1201 seconds, 360089_1305562

Figure 1452. 1205 seconds, 360089_1305563

Figure 1453. 1207 seconds, 360089_1305564

Figure 1454. 1247 seconds, 360089_1305565

Figure 1455. 1251 seconds, 360089_1305566

Figure 1456. 1251 seconds, 360089_1305567

Figure 1457. 1255 seconds, 360089_1305568

Figure 1458. Post test 0 minutes, 360089_1305569

Figure 1459. Post test 0 minutes, 360089_1305570

Figure 1460. Post test 0 minutes, 360089_1305571

Figure 1461. Post test 0 minutes, 360089_1305572

Figure 1462. Post test 0 minutes, 360089_1305573

Figure 1463. Post test 0 minutes, 360089_1305574

Figure 1464. Post test 0 minutes, 360089_1305575

Figure 1465. Post test 1 minutes, 360089_1305576

Figure 1466. Post test 1 minutes, 360089_1305577

Figure 1467. Post test 19 minutes, 360089_1306822

Figure 1468. Post test 19 minutes, 360089_1306823

Figure 1469. Post test 19 minutes, 360089_1306824

Figure 1470. Post test 20 minutes, 360089_1306825

Figure 1471. Post test 20 minutes, 360089_1306826

Figure 1472. Post test 20 minutes, 360089_1306827

Figure 1473. Post test 20 minutes, 360089_1306828

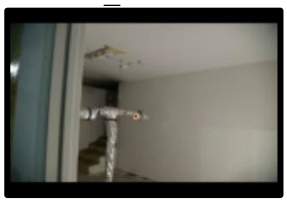


Figure 1474. Post test 22 minutes, 360089_1306829

Figure 1475. Post test 22 minutes, 360089_1306830

Figure 1476. Post test 22 minutes, 360089_1306831

Figure 1477. Post test 22 minutes, 360089_1306832

Figure 1478. Post test 22 minutes, 360089_1306833

Figure 1479. Post test 22 minutes, 360089_1306834

Figure 1480. Post test 22 minutes, 360089_1306835

Figure 1481. Post test 23 minutes, 360089_1306836

Figure 1482. Post test 23 minutes, 360089_1306837

Figure 1483. Post test 23 minutes, 360089_1306838

Figure 1484. Post test 23 minutes, 360089_1306839

Figure 1485. Post test 23 minutes, 360089_1306840

Figure 1486. Post test 23 minutes, 360089_1306841

Figure 1487. Post test 23 minutes, 360089_1306842

Figure 1488. Post test 23 minutes, 360089_1306843

Figure 1489. Post test 23 minutes, 360089_1306844

Figure 1490. Post test 23 minutes, 360089_1306845

Figure 1491. Post test 23 minutes, 360089_1306846

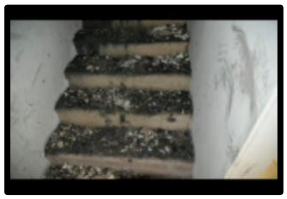


Figure 1492. Post test 23 minutes, 360089_1306847

Figure 1493. Post test 23 minutes, 360089_1306848

Figure 1494. Post test 23 minutes, 360089_1306849

Figure 1495. Post test 23 minutes, 360089_1306850

Figure 1496. Post test 23 minutes, 360089_1306851

Figure 1497. Post test 25 minutes, 360089_1306852

Figure 1498. Post test 25 minutes, 360089_1306853

Figure 1499. Post test 25 minutes, 360089_1306854

Figure 1500. Post test 25 minutes, 360089_1306855

Figure 1501. Post test 25 minutes, 360089_1306856

Figure 1502. Post test 25 minutes, 360089_1306857

Figure 1503. Post test 25 minutes, 360089_1306858

Figure 1504. Post test 25 minutes, 360089_1306859

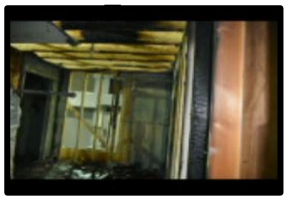


Figure 1505. Post test 25 minutes, 360089_1306860

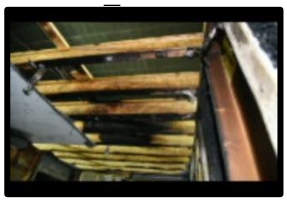


Figure 1506. Post test 25 minutes, 360089_1306861

Figure 1507. Post test 25 minutes, 360089_1306862

Figure 1508. Post test 25 minutes, 360089_1306863

Figure 1509. Post test 25 minutes, 360089_1306864


Figure 1510. Post test 25 minutes, 360089_1306865


Figure 1511. Post test 25 minutes, 360089_1306866


Figure 1512. Post test 26 minutes, 360089_1306867


Figure 1513. Post test 26 minutes, 360089_1306868


Figure 1514. Post test 26 minutes, 360089_1306869


Figure 1515. Post test 26 minutes, 360089_1306870


Figure 1516. Post test 26 minutes, 360089_1306871

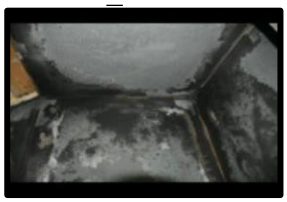


Figure 1517. Post test 26 minutes, 360089_1306872


Figure 1518. Post test 26 minutes, 360089_1306873


Figure 1519. Post test 26 minutes, 360089_1306874


Figure 1520. Post test 26 minutes, 360089_1306875


Figure 1521. Post test 26 minutes, 360089_1306876


Figure 1522. Post test 26 minutes, 360089_1306877


Figure 1523. Post test 27 minutes, 360089_1306878


Figure 1524. Post test 27 minutes, 360089_1306879


Figure 1525. Post test 27 minutes, 360089_1306880


Figure 1526. Post test 27 minutes, 360089_1306881


Figure 1527. Post test 27 minutes, 360089_1306882


Figure 1528. Post test 27 minutes, 360089_1306883


Figure 1529. Post test 27 minutes, 360089_1306884

Figure 1530. Post test 28 minutes, 360089_1306885

Figure 1531. Post test 28 minutes, 360089_1306886

Figure 1532. Post test 28 minutes, 360089_1306887

Figure 1533. Post test 28 minutes, 360089_1306888

Figure 1534. Post test 28 minutes, 360089_1306889

Figure 1535. Post test 28 minutes, 360089_1306890

Figure 1536. Post test 29 minutes, 360089_1306891

Figure 1537. Post test 29 minutes, 360089_1306892

Figure 1538. Post test 29 minutes, 360089_1306893

Figure 1539. 360089_1307433

Figure 1540. 360089_1307434

Figure 1541. 360089_1307435

Figure 1542. 360089_1307436

Figure 1543. 360089_1307437

Figure 1544. 360089_1307438

Figure 1545. 360089_1307439

Figure 1546. 360089_1307440

Figure 1547. 360089_1307441

Figure 1548. 360089_1307442

Figure 1549. 360089_1307443


Figure 1550.
360089_1307444


Figure 1551.
360089_1307445


Figure 1552.
360089_1307446


Figure 1553.
360089_1307447

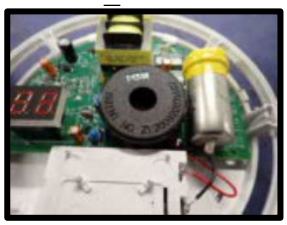


Figure 1554.
360089_1307448


Figure 1555.
360089_1307449


Figure 1556.
360089_1307450


Figure 1557.
360089_1307451


Figure 1558.
360089_1307452


Figure 1559.
360089_1307453

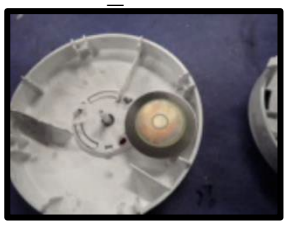


Figure 1560.
360089_1307454

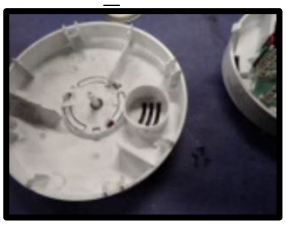


Figure 1561.
360089_1307455

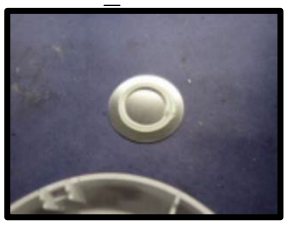


Figure 1562.
360089_1307456


Figure 1563.
360089_1307457


Figure 1564.
360089_1307458


Figure 1565.
360089_1307459


Figure 1566.
360089_1307460


Figure 1567.
360089_1307461


Figure 1568.
360089_1307462


Figure 1569.
360089_1307463


Figure 1570.
360089_1307464


Figure 1571.
360089_1307465

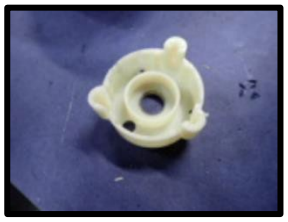


Figure 1572.
360089_1307466

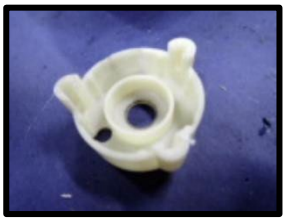
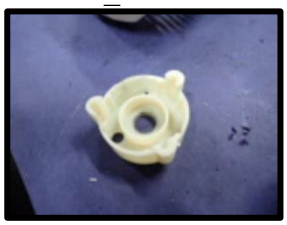


Figure 1573.
360089_1307467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360089_1307468


Figure 1575.
360089_1307469

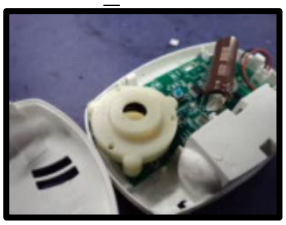

Figure 1576.
360089_1307470


Figure 1577.
360089_1307471


Figure 1578.
360089_1307472


Figure 1579.
360089_1307473


Figure 1580.
360089_1307474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360089_1307475


Figure 1582.
360089_1307476


Figure 1583.
360089_1307477

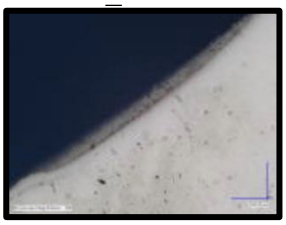

Figure 1584.
360089_1307478


Figure 1585.
360089_1308367


Figure 1586.
360089_1308368


Figure 1587.
360089_1308369


Figure 1588.
360089_1308370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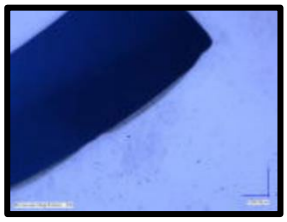
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Figure 1591.
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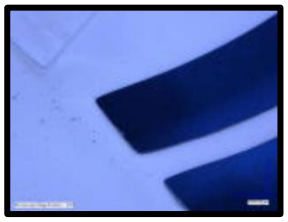
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Figure 1593.
360089_1308375


Figure 1594.
360089_1308376

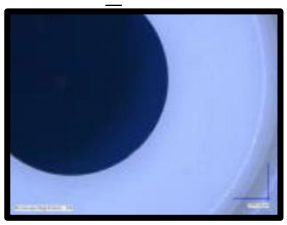
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Figure 1596.
360089_1308378

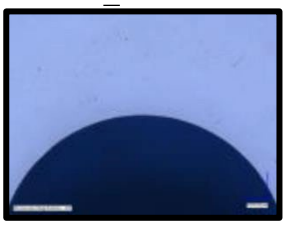
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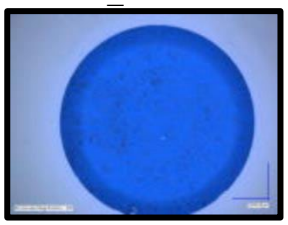
Figure 1598.
360089_1308380


Figure 1599.
360089_1308381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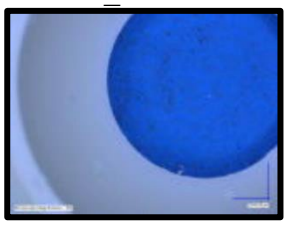
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Figure 1603.
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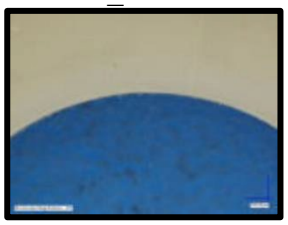
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360089_1308386


Figure 1605.
360089_1308387


Figure 1606.
360089_1308388


Figure 1607.
360089_1308389


Figure 1608.
360089_1308390

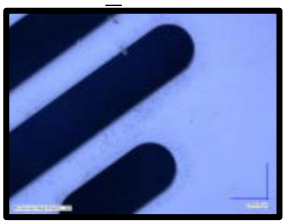


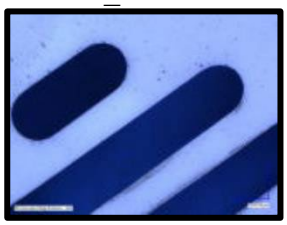
Figure 1609.
360089_1308391


Figure 1610.
360089_1308392


Figure 1611.
360089_1308393


Figure 1612.
360089_1308394


Figure 1613.
360089_1308395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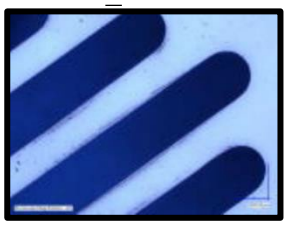
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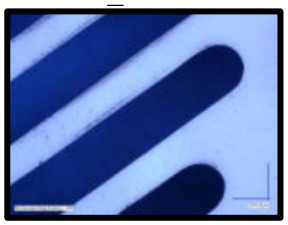
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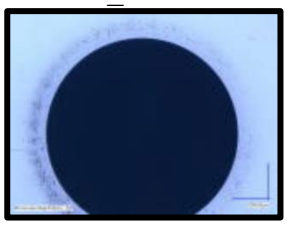
Figure 1617.
360089_1308399


Figure 1618.
360089_1308400


Figure 1619.
360089_1308401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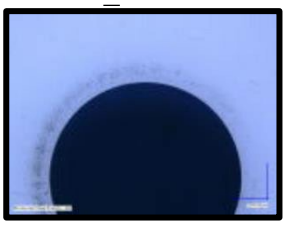
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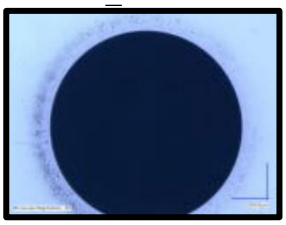
Figure 1622.
360089_1308404


Figure 1623.
360089_1308405


Figure 1624.
360089_1308406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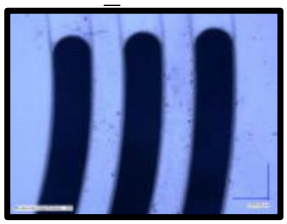
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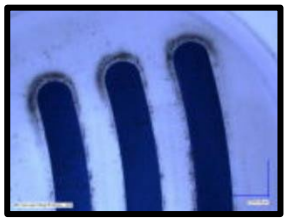
Figure 1627.
360089_1308409


Figure 1628.
360089_1308410


Figure 1629.
360089_1308411



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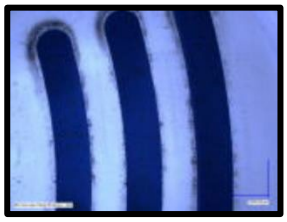

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360089_1308413

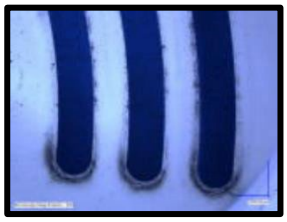
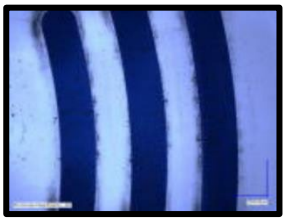


Figure 1632.
360089_1308414



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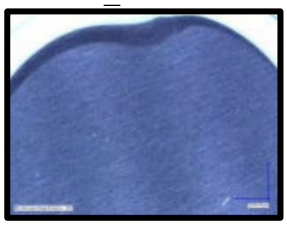

Figure 1634.
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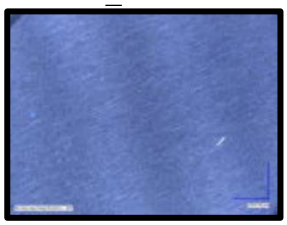

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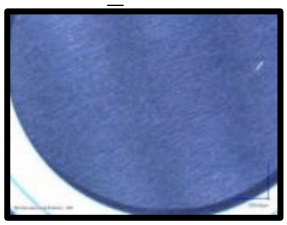
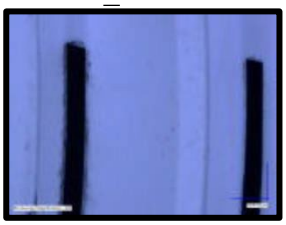


Figure 1636.
360089_1308418



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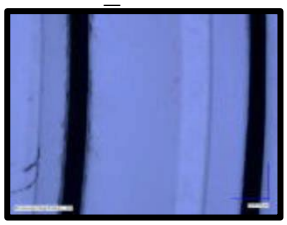
360089_1308419



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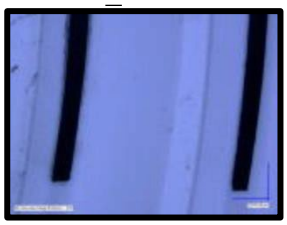

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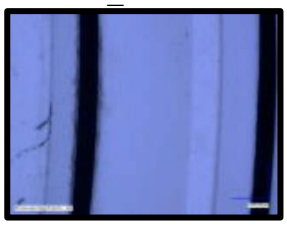

Figure 1640.
360089_1308422

Figure 1641.
360089_1308423

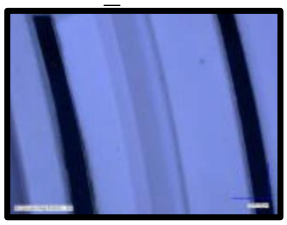

Figure 1642.
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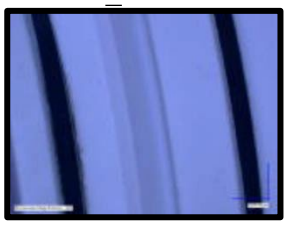


Figure 1643.
360089_1308425

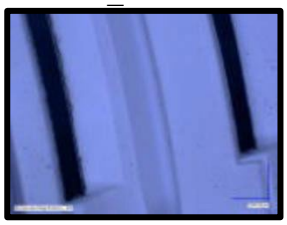
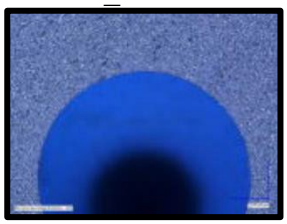


Figure 1644.
360089_1308426

Figure 1645.
360089_1308427



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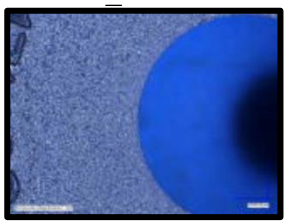

Figure 1647.
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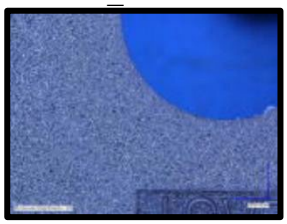

Figure 1648.
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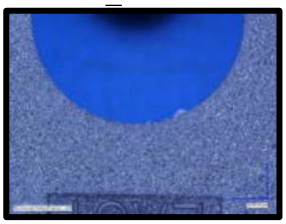

Figure 1649.
360089_1308431

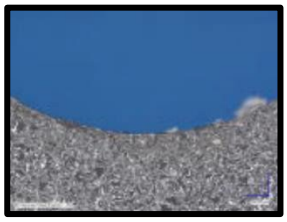

Figure 1650.
360089_1308432

Figure 1651.
360089_1308433

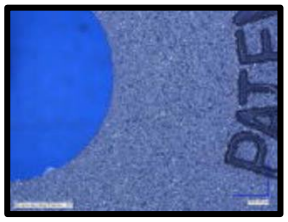

Figure 1652.
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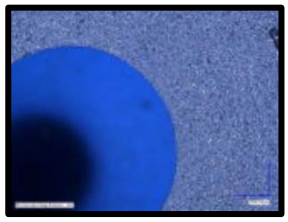

Figure 1653.
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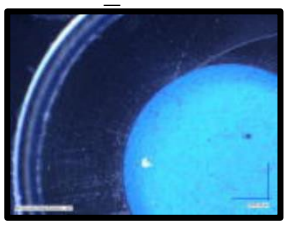

Figure 1654.
360089_1308436

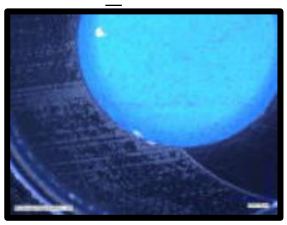

Figure 1655.
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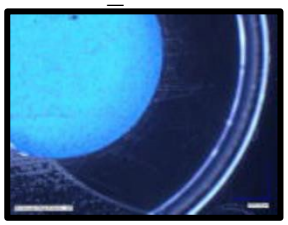


Figure 1656.
360089_1308438

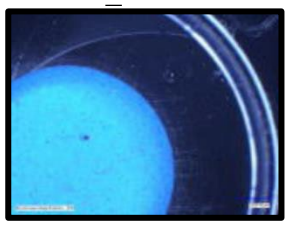


Figure 1657.
360089_1308439

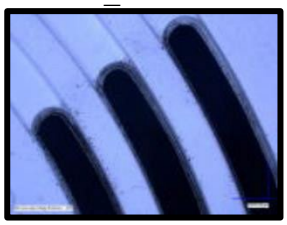


Figure 1658.
360089_1308440

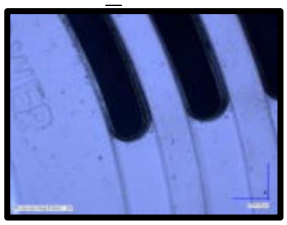


Figure 1659.
360089_1308441

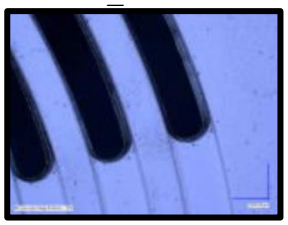


Figure 1660.
360089_1308442

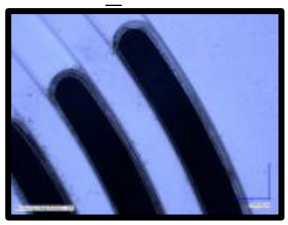


Figure 1661.
360089_1308443

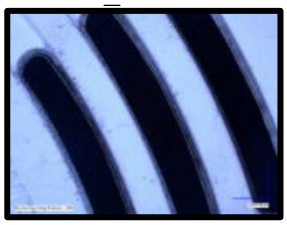


Figure 1662.
360089_1308444

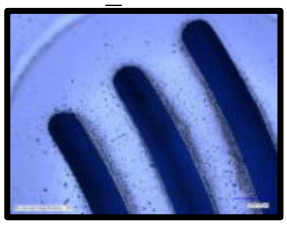


Figure 1663.
360089_1308445

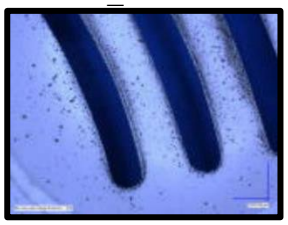


Figure 1664.
360089_1308446

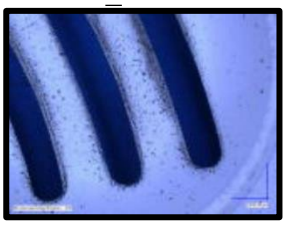


Figure 1665.
360089_1308447

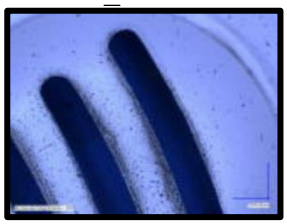


Figure 1666.
360089_1308448

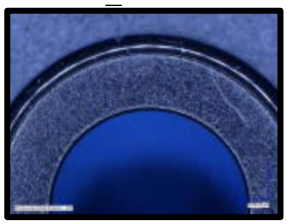


Figure 1667.
360089_1308449

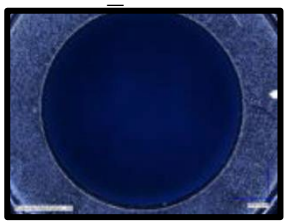


Figure 1668.
360089_1308450

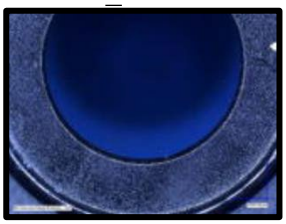


Figure 1669.
360089_1308451

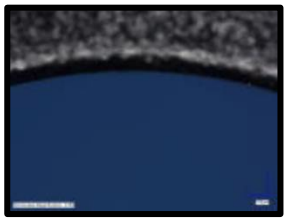
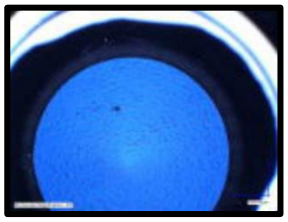


Figure 1670.
360089_1308452


Figure 1671.
360089_1308453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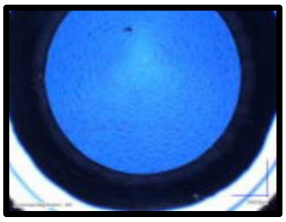
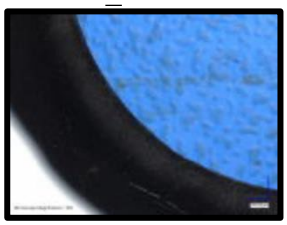


Figure 1673.
360089_1308455


Figure 1674.
360089_1308456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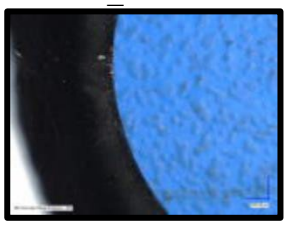
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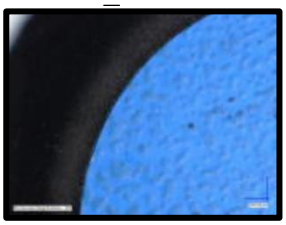
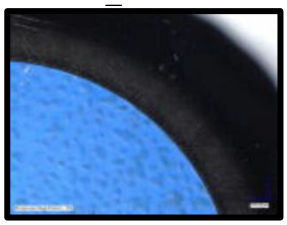


Figure 1677.
360089_1308459


Figure 1678.
360089_1308460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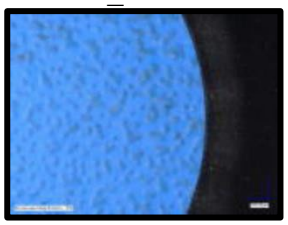
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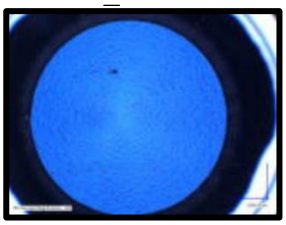
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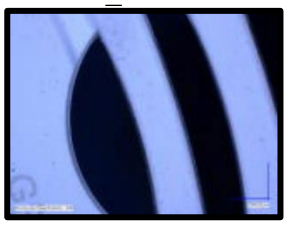
360089_1308463


Figure 1682.
360089_1308464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360089_1308465


Figure 1684.
360089_1308466

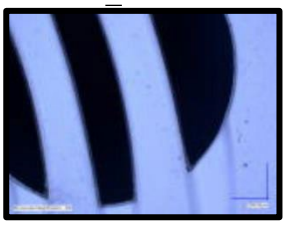


Figure 1685.
360089_1308467


Figure 1686.
360089_1308468

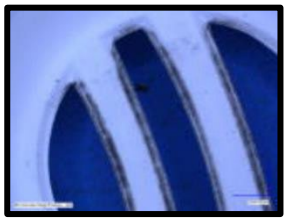

Figure 1687.
360089_1308469


Figure 1688.
360089_1308470


Figure 1689.
360089_1308471


Figure 1690.
360089_1308472


Figure 1691.
360089_1308473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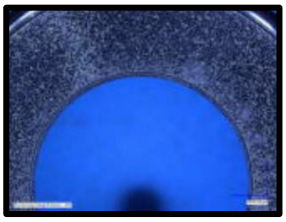
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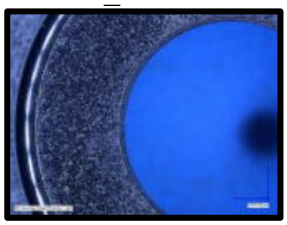
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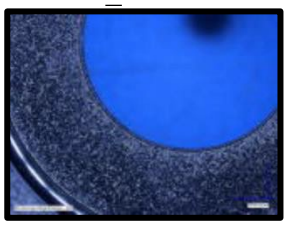
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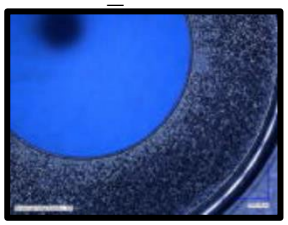
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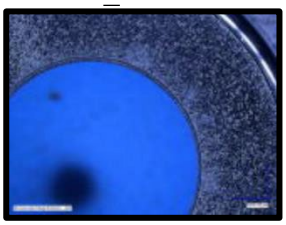
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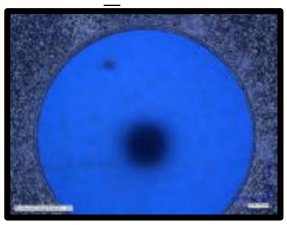
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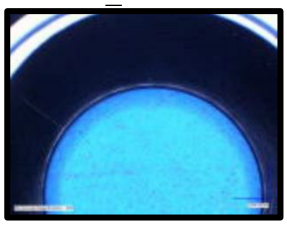
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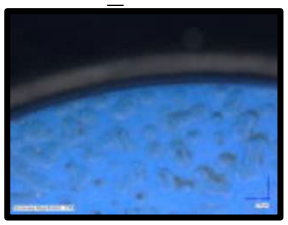
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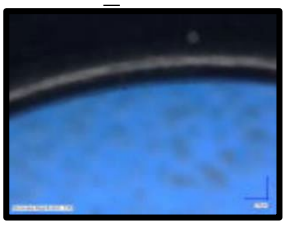
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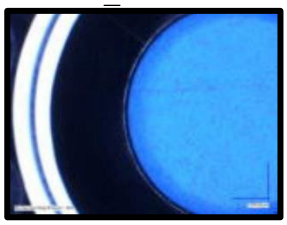
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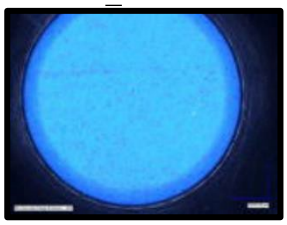
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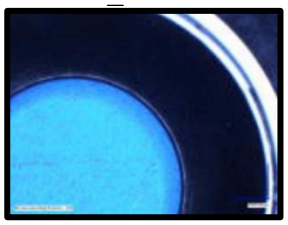
Figure 1704.
360089_1308486

Results Summary

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

Table 54. Multi-Test Heat Flux Summary

Test Number	Experiment ID	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	360079	1st Floor Total	0.04	0.03	0.02	0.02	0.01	0.01
		1st Floor Rad	0.01	0.01	0.01	0.01	0.00	0.00
		2nd Floor Total	0.15	0.14	0.13	0.13	0.12	0.12
		2nd Floor Rad	0.03	0.03	0.03	0.03	0.02	0.02
2	360082	1st Floor Total	0.05	0.04	0.04	0.04	0.03	0.03
		1st Floor Rad	0.02	0.02	0.02	0.02	0.01	0.01
		2nd Floor Total	0.06	0.06	0.05	0.05	0.05	0.05
		2nd Floor Rad	0.02	0.02	0.02	0.02	0.01	0.01
3	360086	1st Floor Total	0.04	0.04	0.03	0.02	0.02	0.02
		1st Floor Rad	0.01	0.00	0.00	0.00	0.00	0.00
		2nd Floor Total	6.49	6.08	5.99	5.66	3.71	2.79
		2nd Floor Rad	1.01	0.99	0.97	0.94	0.60	0.43
4	360089	1st Floor Total	0.24	0.23	0.22	0.21	0.17	0.14
		1st Floor Rad	0.11	0.10	0.10	0.10	0.09	0.07
		2nd Floor Total	32.29	24.44	15.29	9.99	2.44	1.21
		2nd Floor Rad	10.00	8.68	5.00	2.99	0.69	0.34

The following table provides a summary of the optical density for all experiments.

Table 55. Multi-Test ODM Results

Test Number	Experiment ID	Description	Average Optical Density (1/m)	Maximum Optical Density (1/m)
1	360079	1st Floor ODM	0.09	0.28
		2nd Floor ODM	0.60	1.12
2	360082	1st Floor ODM	0.00	0.06
		2nd Floor ODM	0.08	0.19
3	360086	1st Floor ODM	0.08	0.17
4	360089	1st Floor ODM	0.33	1.16

The following table provides a summary of activation times for all smoke detectors and CO detectors in all experiments. For the battery powered detectors, the activation times listed were obtained from reviewing the video of the detectors and determining when the red LED started to flash, which indicated the detector was alarming. If an activation time is not listed in the table for a battery power unit, it means either the detector did not alarm, or the activation time could not be determined from the video.

Table 56. Smoke and CO Detector Activation Summary

Test #	Test Description	Floor Location	Detector Type	AC/Battery Power	Activation Time (s)
1	Smolder Combustion 2nd Floor Door Closed	1st	Smoke - Ion	AC	
		1st	Smoke - Photo	AC	5985
		1st	CO	AC	8859
		1st	Smoke Ion	Battery	
		1st	Smoke - Photo	Battery	6583
		1st	CO	Battery	
		2nd	Smoke - Ion	AC	4506
		2nd	Smoke - Photo	AC	4522
		2nd	CO	AC	2441
		2nd	Smoke Ion	Battery	
		2nd	Smoke - Photo	Battery	4506
		2nd	CO	Battery	
2	Smolder Combustion 2nd Floor Door Open	1st	Smoke - Ion	AC	
		1st	Smoke - Photo	AC	
		1st	CO	AC	
		1st	Smoke - Ion	Battery	
		1st	Smoke - Photo	Battery	
		1st	CO	Battery	
		2nd	Smoke Ion	AC	3687
		2nd	Smoke - Photo	AC	3658
		2nd	CO	AC	1395
		2nd	Smoke Ion	Battery	
		2nd	Smoke - Photo	Battery	1896
		2nd	CO	Battery	
3	Flaming Combustion 2nd Floor Door Closed	1st	Smoke - Ion	AC	206
		1st	Smoke - Photo	AC	240
		1st	CO	AC	
		1st	Smoke - Ion	Battery	209
		1st	Smoke - Photo	Battery	1751
		1st	CO	Battery	
		2nd	Smoke Ion	AC	17
		2nd	Smoke - Photo	AC	44
		2nd	CO	AC	
4	Flaming Combustion 2nd Floor Door Open	1st	Smoke - Ion	AC	304
		1st	Smoke - Photo	AC	351
		1st	CO	AC	879
		1st	Smoke - Ion	Battery	
		1st	Smoke - Photo	Battery	615
		1st	CO	Battery	322
		2nd	Smoke Ion	AC	18
		2nd	Smoke - Photo	AC	40
		2nd	CO	AC	

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. Barnes, A., "Heat Flux Sensors Part 1: Theory," Sensors, January 1999.
5. Laboratory Instruction LI002 - Heat Flux Transducer, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD.
6. Laboratory Instruction LI016 – Point Source Gas Analysis, Bureau of Alcohol, Tobacco, Firearms and Explosives – Fire Research Laboratory, Beltsville, MD.
7. Laboratory Instruction LI003 - Digital Cameras, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD