U. S. Department of Justice

Fire Research Laboratory
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Project Record

ANAB ISO/IEC 17025:2017
Accredited Forensic Testing Laboratory

Title	Contribution of paint to fire size		
Test Type	NFPA 289		
Lab Number	18FR0006-1	**Author**	
Test dates	8/27/18, 8/29/18	**No. Tests**	8

Introduction

Eight experiments were conducted to investigate the contribution of paint to fire size in a wall corner configuration. The fire was initiated by igniting a natural gas burner set to a fixed heat release rate. The experiments were documented using the 1 MW Round Fire Products Collector (FPC), digital photographs, and video cameras. The test program was conducted in the Medium Burn Room (MBR) of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), Fire Research Laboratory (FRL) in Beltsville, MD.

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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.

Test Set Up

Tests were conducted using a wall corner configuration. Two walls were joined along an edge, forming a 90° angle as shown in Figure 1. The walls were 2.4 m (8 ft.) tall x 1.2 m (4 ft.) wide. A natural gas fueled burner was placed in the interior corner and served as the fire source.

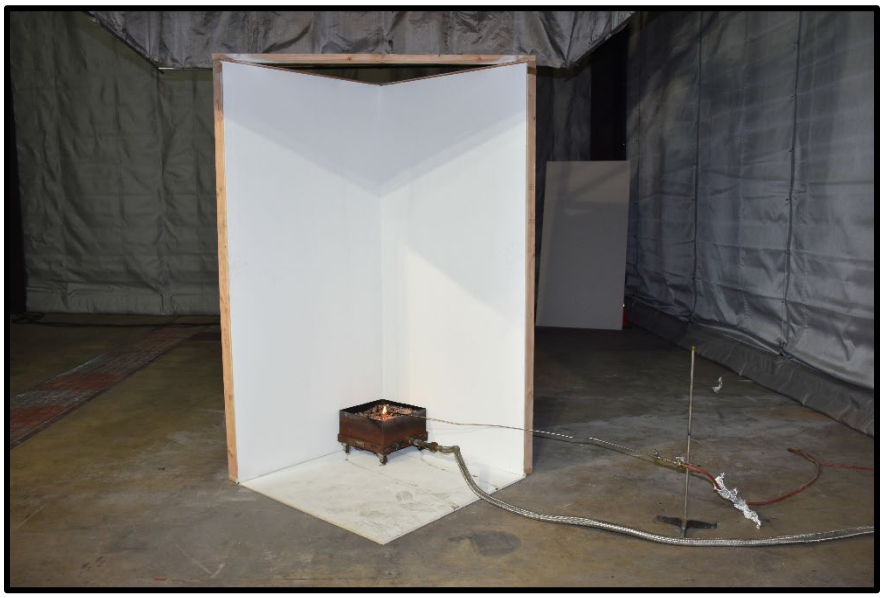

Figure 1: Test setup (294934_1017504.jpg)

A total of eight wall corner configurations were built – one for each experiment. The interior surfaces of each setup were coated in paint, with the number of coats ranging from one (1) to four (4). Both latex and oil based paint were used.

Table 1 identifies the Test ID that is associated with each individual experiment.

Table 1: Test ID Summary

Experiment	Test ID
1	294934
2	294935
3	294936
4	294937
5	294938
6	294939
7	294942
8	294943

Construction Details

The walls were framed using 2x4 dimensional lumber, with the wall studs spaced 0.41 m (16 inch) on center. The interior sides were sheathed with one layer of 1.6 cm (5/8 inch) fire resistant gypsum wallboard (USG Sheetrock Brand Firecode X - UL Type SCX). The seam was sealed with gypsum wallboard tape and joint compound. A section of gypsum wallboard was cut and placed on the floor beneath the burner. The section on the floor was not painted.

Burner Details

The burner used in these experiments was one of the FRL sand burners. The burner was square and measured approximately 41 cm (16 in) on a side, resulting in a surface area of 0.17 m^2 (1.8 ft^2). The top edge of the burner sat approximately 29 cm (11 ¼ in) above the floor.

Natural gas was delivered to the burner through a 2.5 cm (1 in) diameter flexible stainless steel hose. The burner was ignited using a propane pilot flame, which extended from the end of a 6 mm (1/4 in) stainless steel tube that was positioned above the burner. The pilot is visible in Figure 1. Additional burner details can be found in the Instrumentation section below.

Paint Details

The interior surface of the walls were coated in paint. Two types of paint were used: latex (Sherwin Williams Painters Edge Interior Latex Flat, Extra White, Product Number PE3000451), and oil based (Sherwin Williams Pro Industrial Urethane Alkyd Enamel, Extra White, Product Number B54W151). The paint was applied using a pneumatic sprayer and allowed to dry between coats.

Experiment Details

Test Procedures

The same general procedure was used in each experiment. The burner was positioned in the wall corner and natural gas was flowed at a constant rate to produce a 75 kW fire. After ignition, the fire was allowed to progress for approximately 13 minutes before the gas was cut off. No suppression was required.

Test Matrix

Table 2 shows a summary of the paint exposure that was used in each experiment. In the first four experiments, latex paint was exposed to the 75 kW burner fire with the number of coats increasing from one (1) to four (4) successively. Subsequently, in experiments 5 – 8, oil based paint was exposed to the same fire size with the number of coats increasing from one (1) to four (4).

Table 2: Test matrix

Experiment	Paint coats applied	
	Latex	Oil
1	1	
2	2	
3	3	
4	4	
5		1
6		2
7		3
8		4

Instrumentation

Instrumentation used in the test series included 1 MW Round Fire Products Collector (FPC), digital photos and video.

Laboratory Conditions

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

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

Table 3. Lab Conditions Description

Description	Manufacturer	Model
MBR_01	OMEGA	IBTHX-D

Sand Burner

A sand burner, which provides a steady state fire source over a known area, was used during the test. The sand burner was constructed in general accordance with the recommended ignition sources of ISO 97052, ASTM E 15373, and NFPA 2864. Figure 2 shows a diagram of a typical sand burner. Vapor fuel was supplied to the sand burner via the gas inlet located at the base of the sand burner. As shown in Figure 2 the bottom of the sand burner contained a void space. A metal mesh was placed on a steel lip 7.5 cm (3 in) from the bottom of the burner. The burner was then filled with a 2.5 cm (1 in) inch

layer of Fiberfrax, and 7.5 cm (3 in) of small gravel. The Fiberfrax and gravel were used to diffuse the natural gas evenly across the entire opening of the burner.

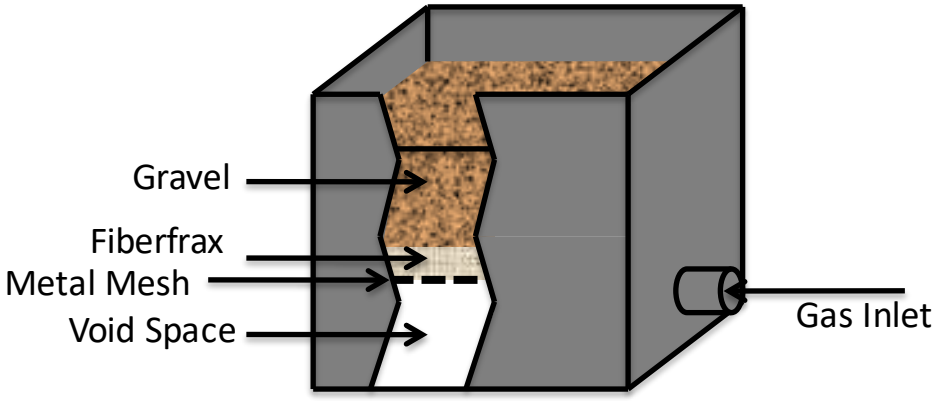

Figure 2 – Diagram of a Typical Sand Burner

The following table provides a description of the burners used during the experiments.

Table 4. Burner Description

Type	Fuel Surface Area (m^2)
Sand Burner 1	0.17

Fire Products Collector

A Fire Products Collector (FPC) measures several characteristics of a fire based upon the measured properties of the fire plume. A FPC consists of a collection hood connected to an exhaust duct placed over a fire as shown in Figure 3. The primary fire characteristics calculated from a FPC include heat release rate (HRR), convective heat release rate (CHRR), gas species production, and smoke production. HRR measurements are based on the principle of oxygen consumption calorimetry. CHRR is calculated as the enthalpy rise of gases flowing through the FPC. Gas species production is calculated based on the measured gas concentrations flowing through the FPC. Smoke production is quantified based on optical smoke measurements, which measure the attenuation of light as it passes through the smoke and fire gases in the FPC.

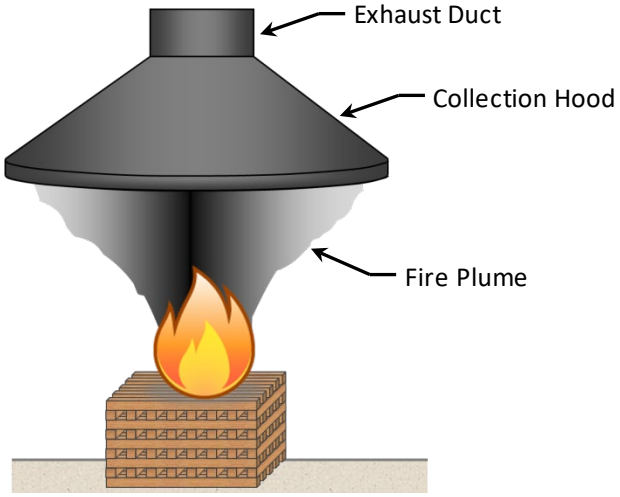

Figure 3. Schematic of a Fire Products Collector

The "Fire Products Collector Description" table identifies which FPC was used in the experiment(s) and summarizes the configuration. Fire Products Collectors were used in accordance with the method defined in FRL Laboratory Instruction "LI011 Fire Products Collectors" [5].

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

Table 5. Fire Products Collector Description

Experiment: Test Number	Description	C Factor	E Factor (kJ/kg)
1	1 MW Round	0.954	12550
2	1 MW Round	0.954	12550
3	1 MW Round	0.954	12550
4	1 MW Round	0.954	12550
5	1 MW Round	0.954	12550
6	1 MW Round	0.954	12550
7	1 MW Round	0.954	12550
8	1 MW Round	0.954	12550

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" [6].

Results for Test 1 (ID 294934)

The following table provides a description of the gas trains used during the experiments.

Table 6. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

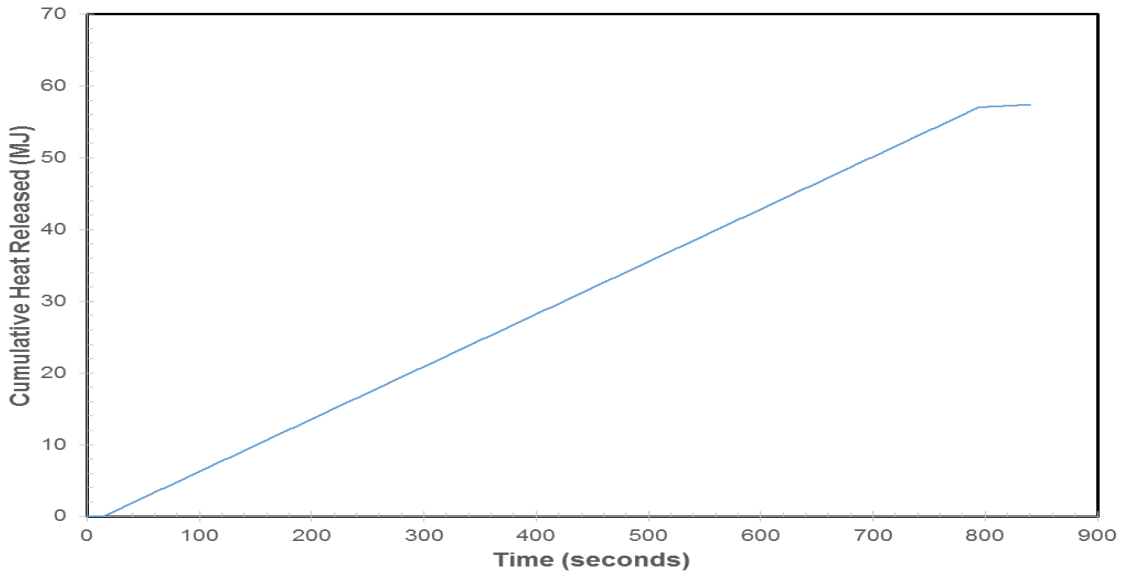

Figure 4. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

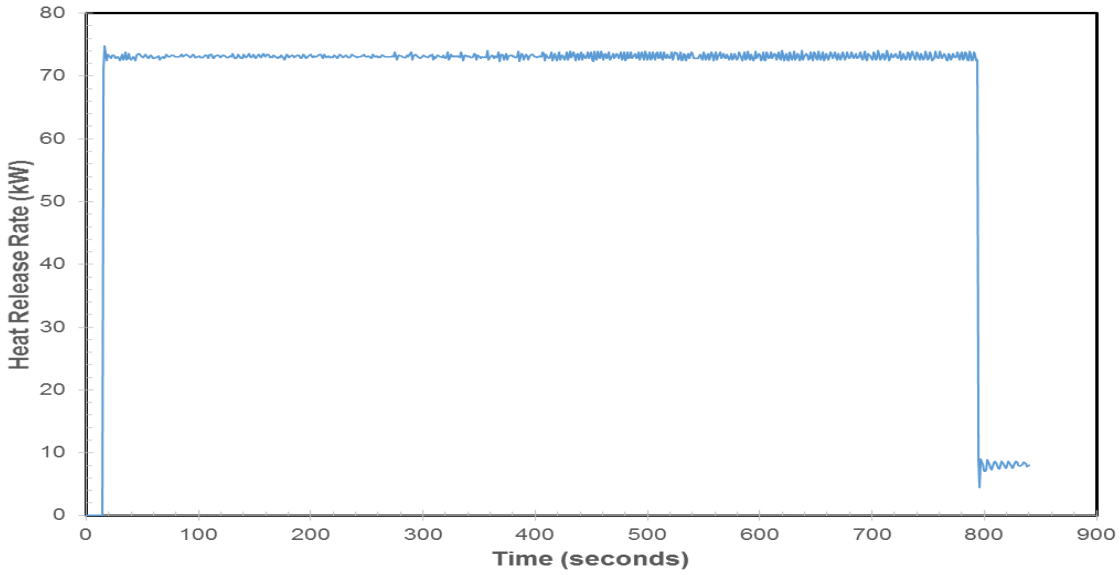

Figure 5. Burner heat release rate

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

Table 7. Experiment Events

Description	Time (s)
Ignition	14

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

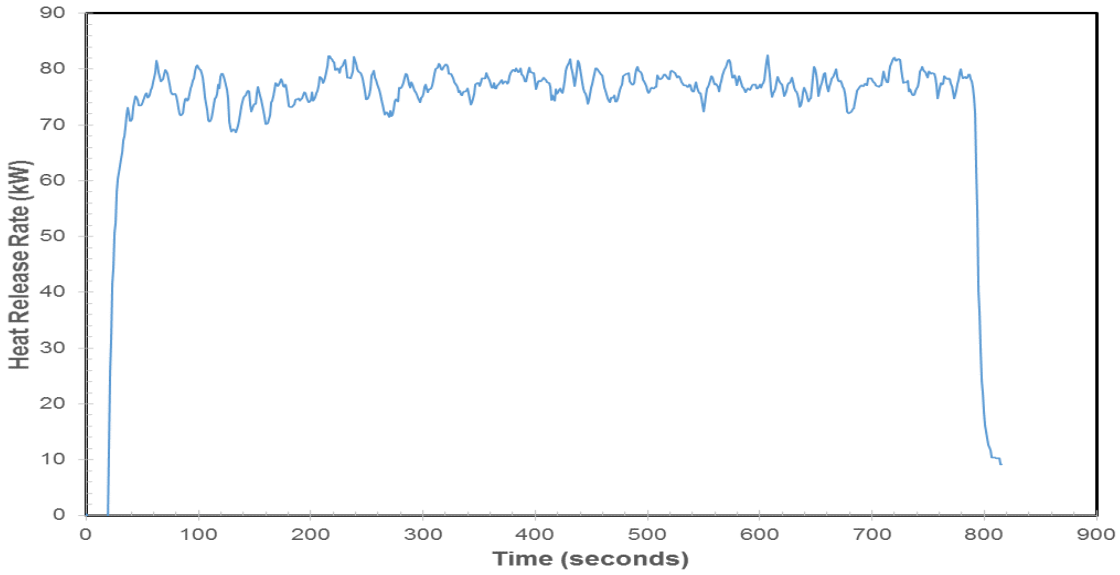

Figure 6. Heat Release Rate

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

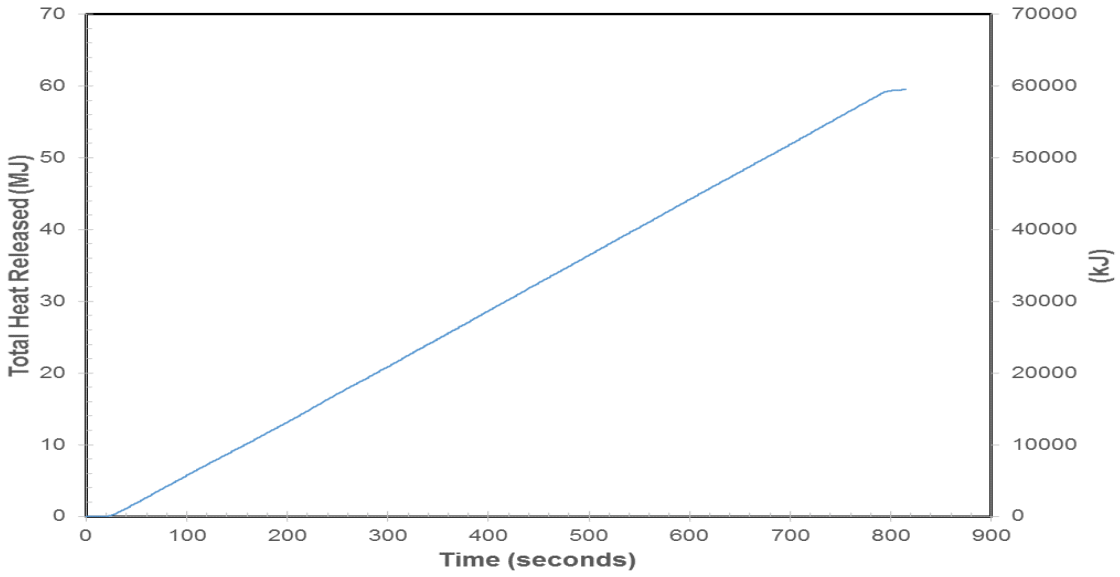

Figure 7. Total Heat Released

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

Table 8. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	10:45:00	869	294934_20180827_104500_1.mov
HD	10:45:01	868	294934_20180827_104501_9.mov
MASTER			294934_1033185.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 8. Pre test 6 minutes (294934_1017504)

Figure 9. Pre test 6 minutes (294934_1017505)

Figure 10. Pre test 6 minutes (294934_1017506)

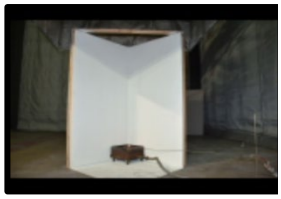

Figure 11. Pre test 6 minutes (294934_1017507)

Figure 12. 31 seconds (294934_1017508)

Figure 13. 35 seconds (294934_1017509)

Figure 14. 87 seconds (294934_1017510)

Figure 15. 93 seconds (294934_1017511)

Figure 16. 123 seconds (294934_1017512)

Figure 17. 141 seconds (294934_1017513)

Figure 18. 229 seconds (294934_1017514)

Figure 19. 237 seconds (294934_1017515)

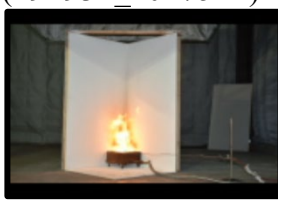

Figure 20. 269 seconds (294934_1017516)

Figure 21. 361 seconds (294934_1017517)

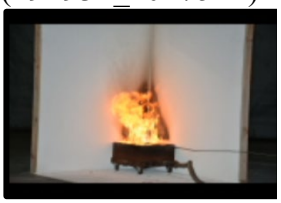

Figure 22. 369 seconds (294934_1017518)

Figure 23. 375 seconds (294934_1017519)

Figure 24. 439 seconds (294934_1017520)

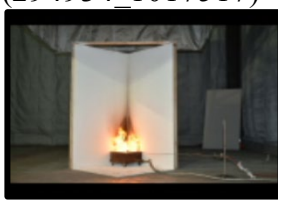

Figure 25. 449 seconds (294934_1017521)

Figure 26. 641 seconds (294934_1017522)

Figure 27. 649 seconds (294934_1017523)

Figure 28. 661 seconds (294934_1017524)

Figure 29. Post test 12 minutes (294934_1017525)

Figure 30. Post test 12 minutes (294934_1017526)

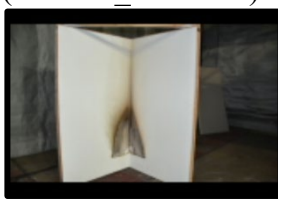

Figure 31. Post test 12 minutes (294934_1017527)

Results for Test 2 (ID 294935)

The following table provides a description of the gas trains used during the experiments.

Table 9. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

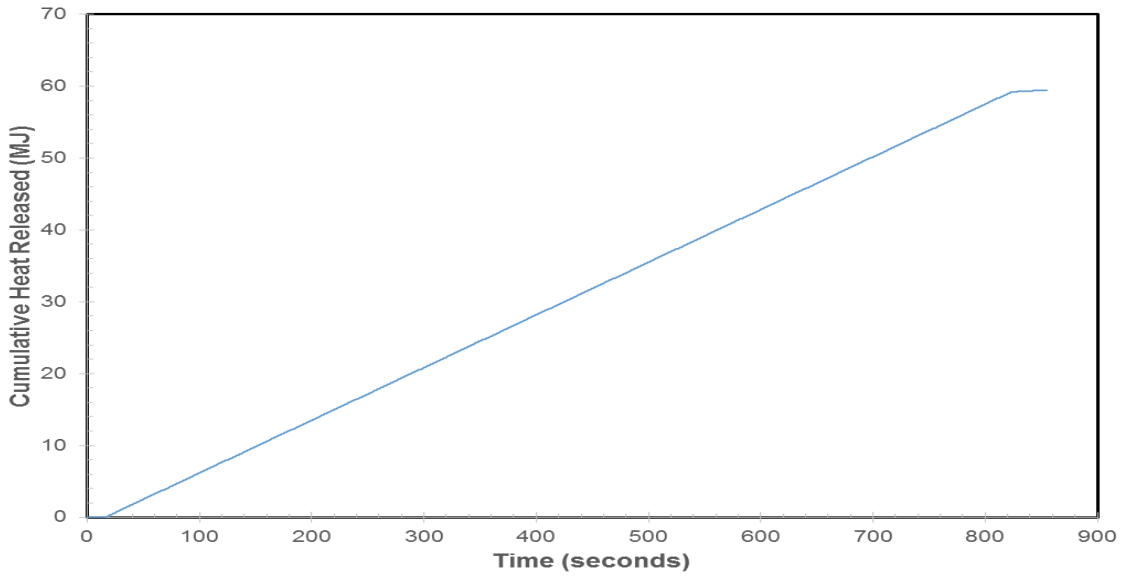

Figure 32. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

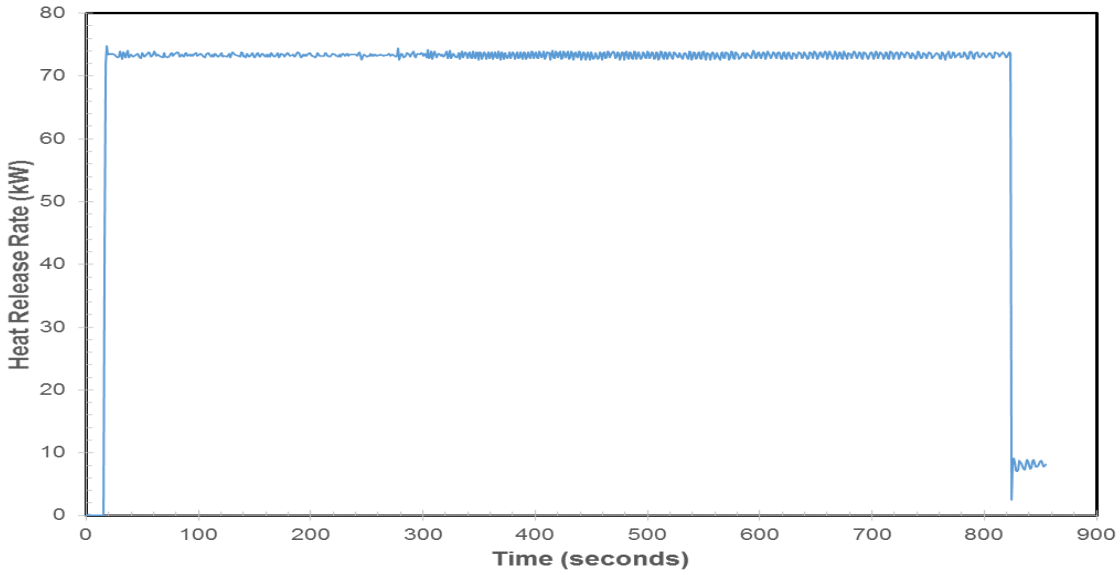

Figure 33. Burner heat release rate

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

Table 10. Experiment Events

Description	Time (s)
Ignition	15

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

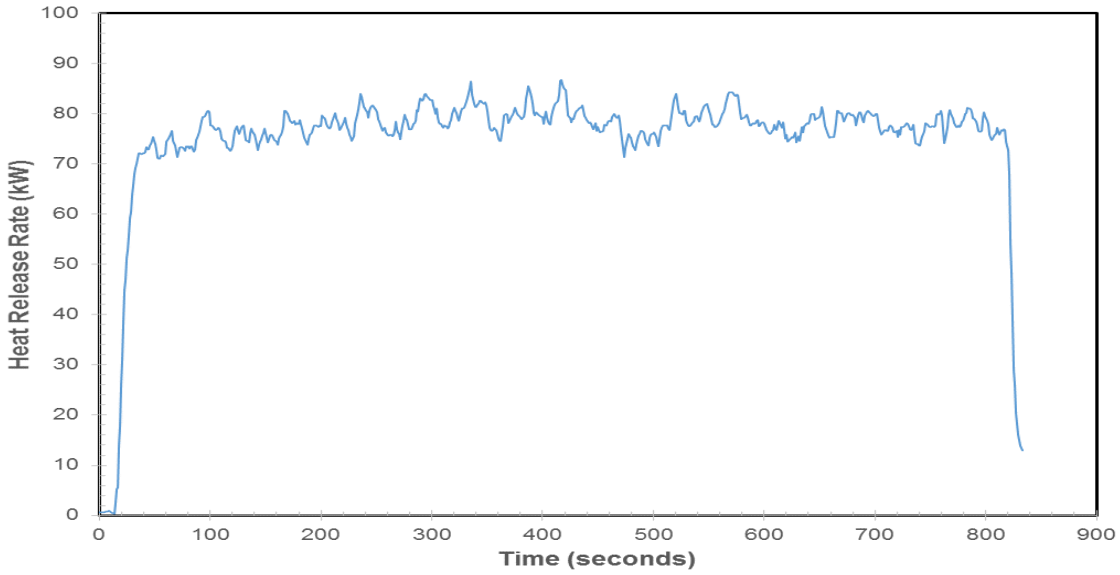

Figure 34. Heat Release Rate

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

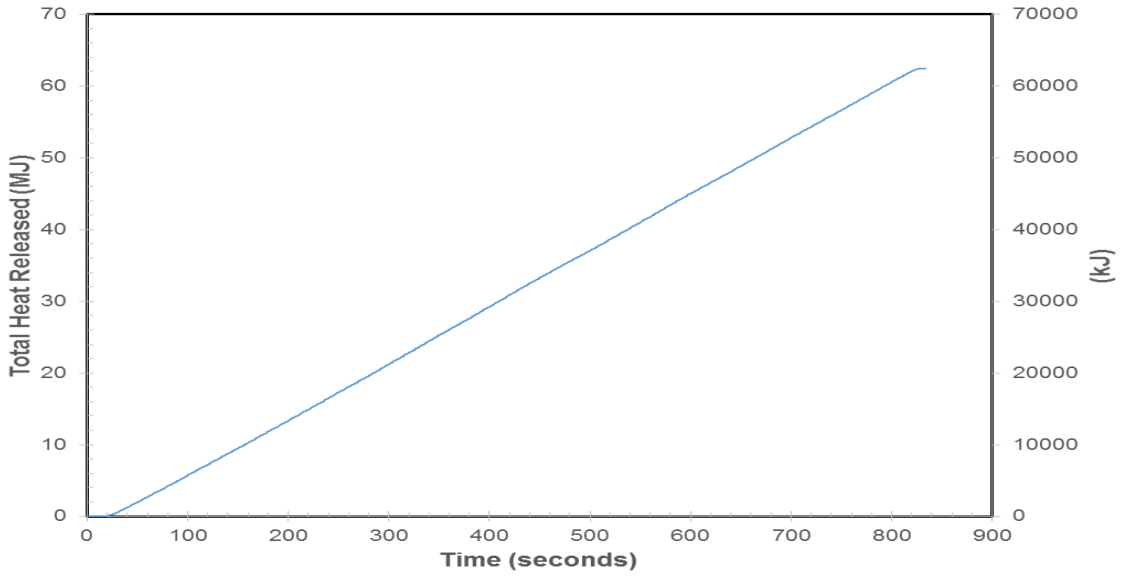

Figure 35. Total Heat Released

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

Table 11. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	11:21:40	819	294935_20180827_112140_1.mov
HD	11:21:42	818	294935_20180827_112142_9.mov
MASTER			294935_1033164.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 36. Pre test 8 minutes (294935_1017549)

Figure 37. Pre test 8 minutes (294935_1017550)

Figure 38. Pre test 8 minutes (294934_1017528)

Figure 39. Pre test 8 minutes (294934_1017529)

Figure 40. 34 seconds (294935_1017535)

Figure 41. 42 seconds (294935_1017536)

Figure 42. 48 seconds (294935_1017537)

Figure 43. 58 seconds (294935_1017538)

Figure 44. 64 seconds (294935_1017539)

Figure 45. 262 seconds (294935_1017540)

Figure 46. 272 seconds (294935_1017541)

Figure 47. 278 seconds (294935_1017542)

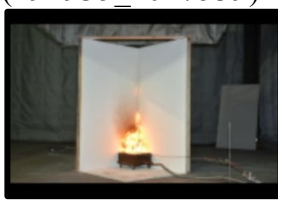

Figure 48. 284 seconds (294935_1017543)

Figure 49. 675 seconds (294935_1017544)

Figure 50. 678 seconds (294935_1017545)

Figure 51. Post test 1 minutes (294935_1017546)

Figure 52. Post test 1 minutes (294935_1017547)

Figure 53. Post test 1 minutes (294935_1017548)

Results for Test 3 (ID 294936)

The following table provides a description of the gas trains used during the experiments.

Table 12. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

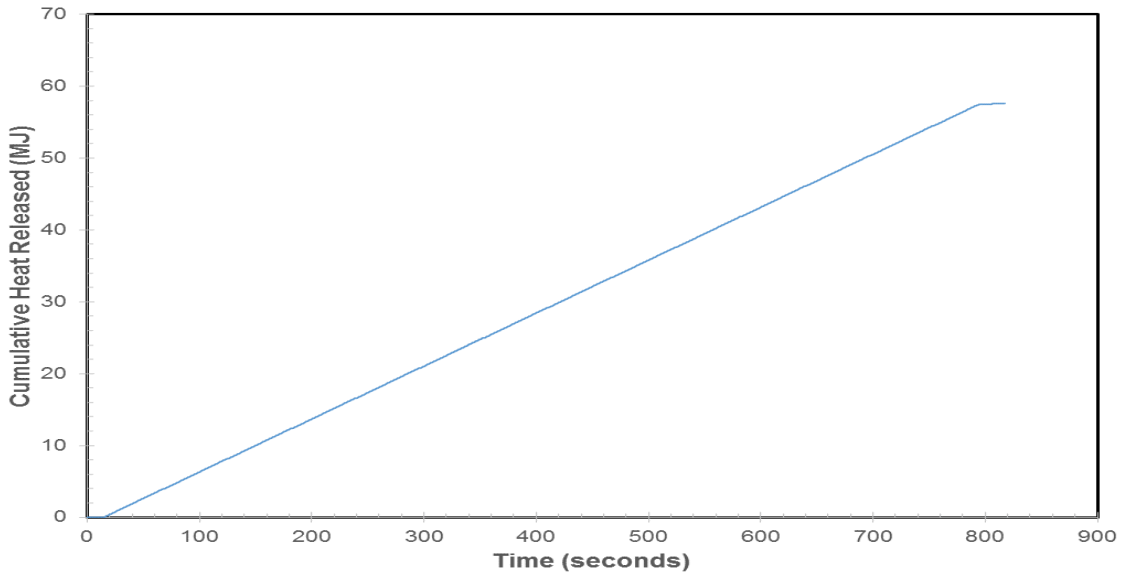

Figure 54. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

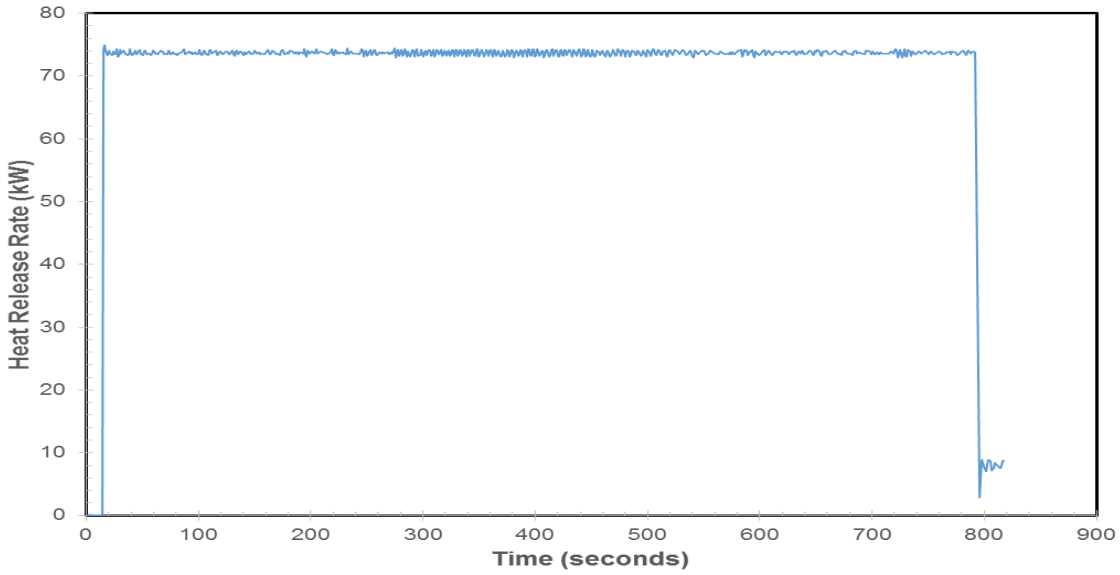

Figure 55. Burner heat release rate

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

Table 13. Experiment Events

Description	Time (s)
Ignition	14

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

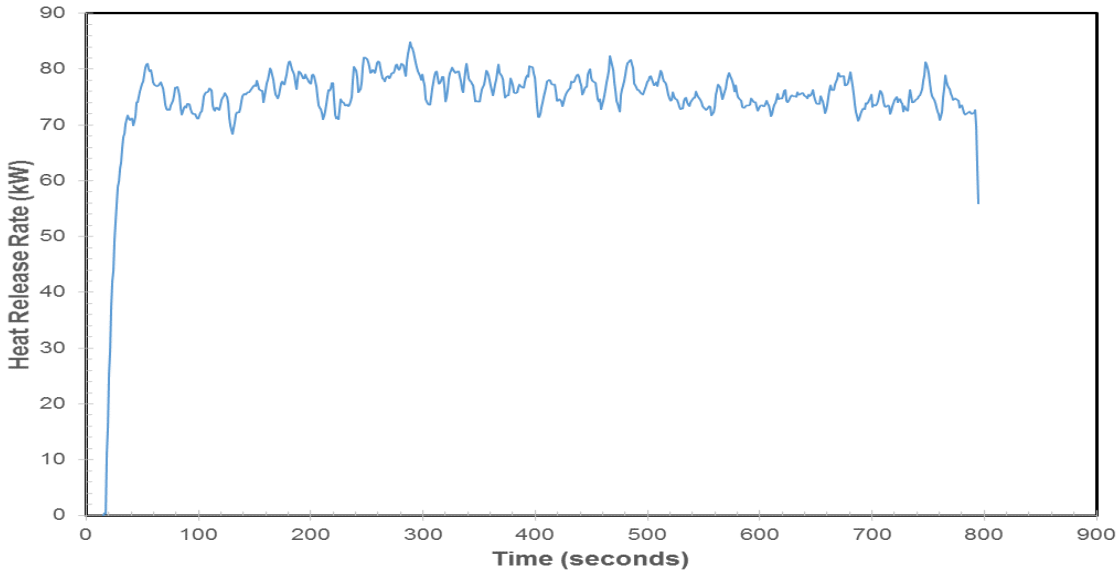

Figure 56. Heat Release Rate

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

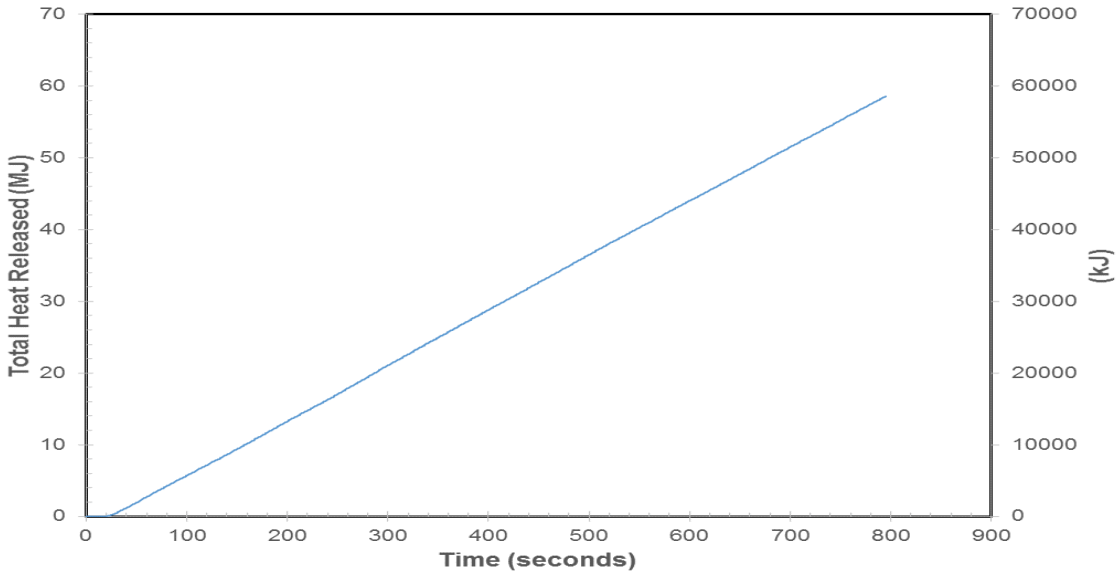

Figure 57. Total Heat Released

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

Table 14. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	01:11:14	844	294936_20180827_131114_1.mov
HD	01:11:15	844	294936_20180827_131115_9.mov
MASTER			294936_1033165.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 58. Pre test 2 minutes (294936_1017559)

Figure 59. Pre test 2 minutes (294936_1017560)

Figure 60. Pre test 113 seconds (294936_1017561)

Figure 61. Pre test 106 seconds (294936_1017562)

Figure 62. 42 seconds (294936_1017563)

Figure 63. 48 seconds (294936_1017564)

Figure 64. 52 seconds (294936_1017565)

Figure 65. 532 seconds (294936_1017566)

Figure 66. 540 seconds (294936_1017567)

Figure 67. 636 seconds (294936_1017568)

Figure 68. 642 seconds (294936_1017569)

Figure 69. Post test 1 minutes (294936_1017570)

Figure 70. Post test 1 minutes (294936_1017571)

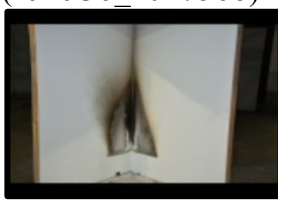

Figure 71. Post test 1 minutes (294936_1017572)

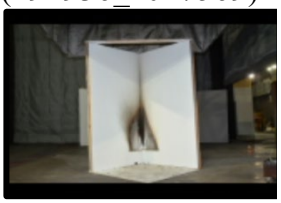

Figure 72. Post test 1 minutes (294936_1017573)

Results for Test 4 (ID 294937)

The following table provides a description of the gas trains used during the experiments.

Table 15. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

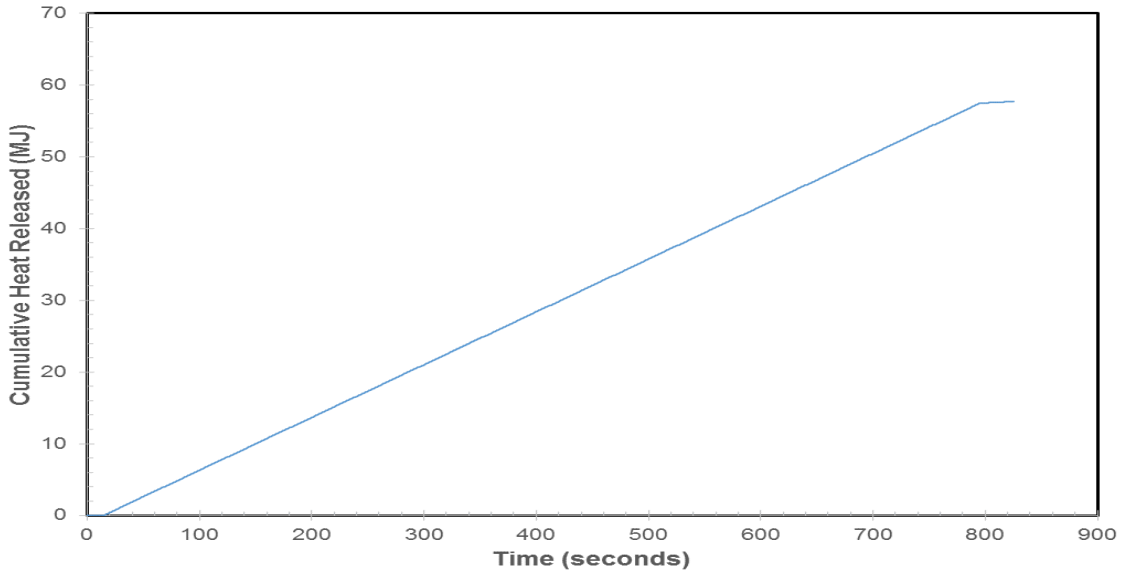

Figure 73. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

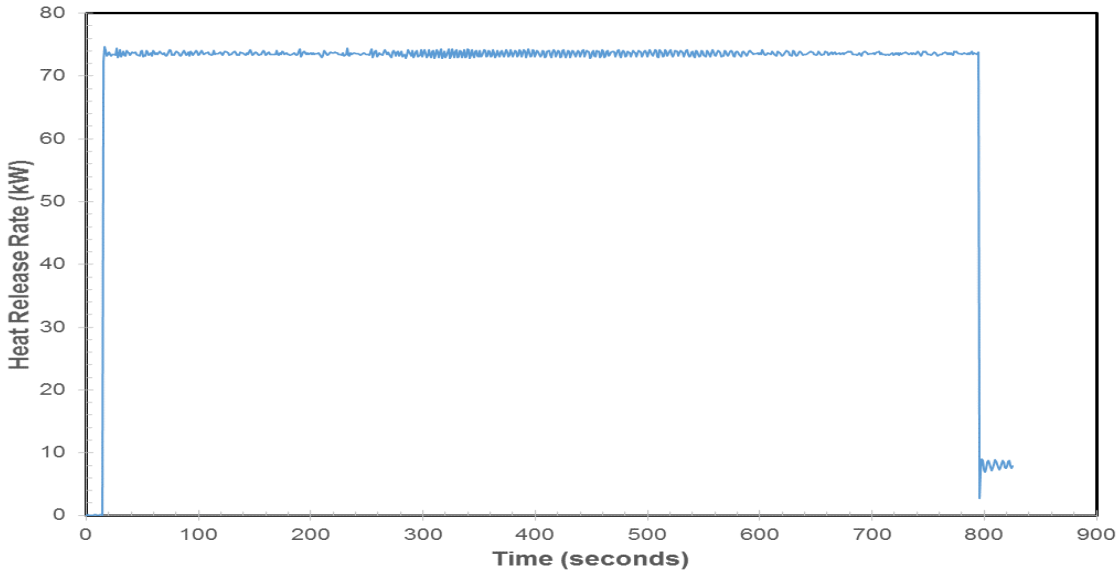

Figure 74. Burner heat release rate

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

Table 16. Experiment Events

Description	Time (s)
Ignition	14

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

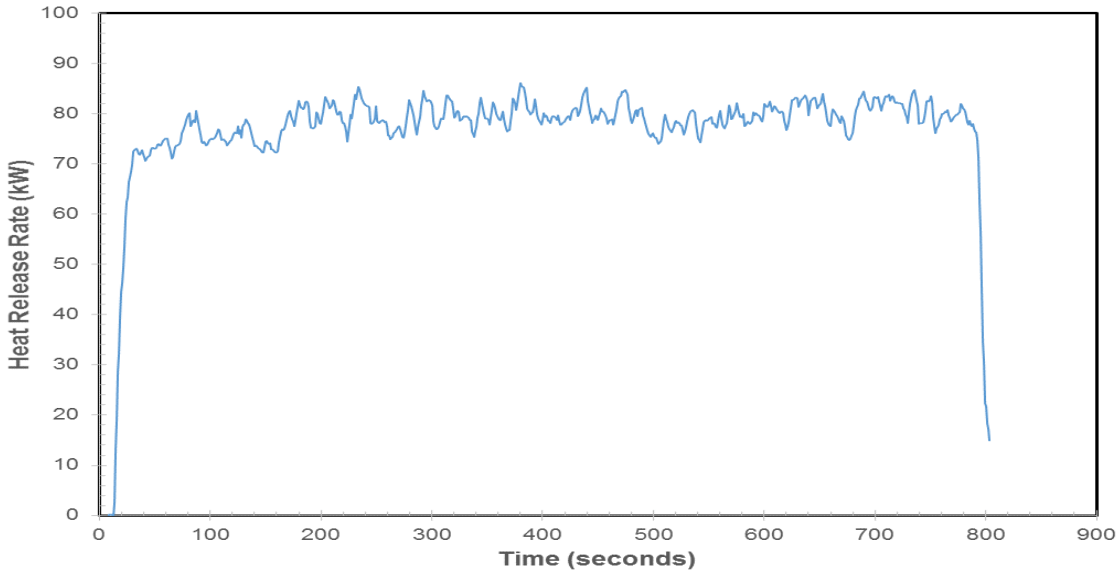

Figure 75. Heat Release Rate

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

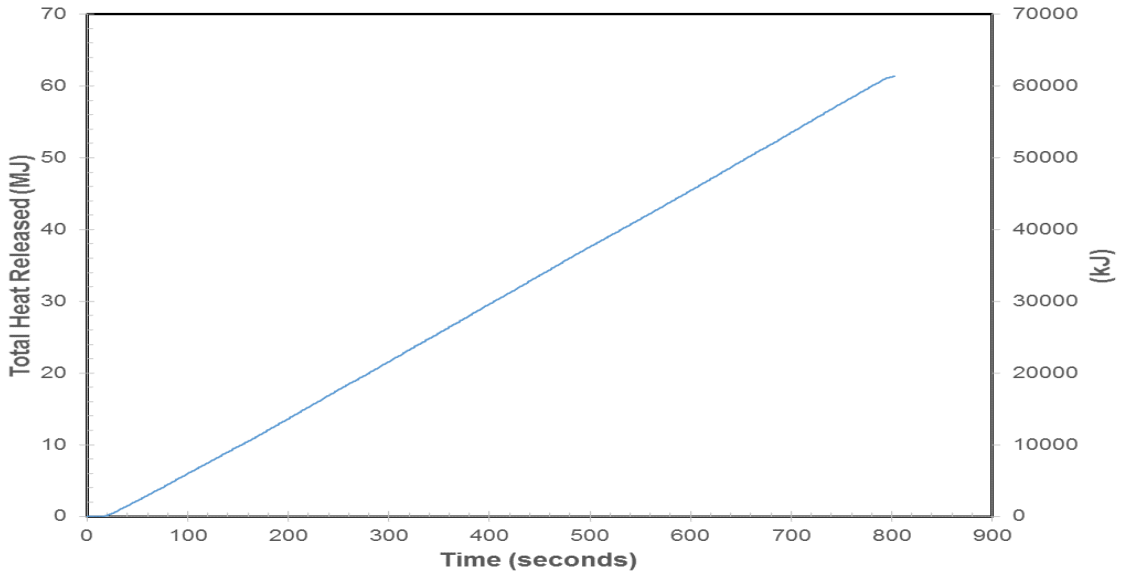

Figure 76. Total Heat Released

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

Table 17. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	01:38:14	859	294937_20180827_133814_1.mov
HD	01:38:15	859	294937_20180827_133815_9.mov
MASTER			294937_1033166.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 77. Pre test 2 minutes (294937_1017582)

Figure 78. Pre test 2 minutes (294937_1017583)

Figure 79. Pre test 2 minutes (294937_1017584)

Figure 80. Pre test 2 minutes (294937_1017585)

Figure 81. Pre test 2 minutes (294937_1017586)

Figure 82. 35 seconds (294937_1017587)

Figure 83. 37 seconds (294937_1017588)

Figure 84. 43 seconds (294937_1017589)

Figure 85. 49 seconds (294937_1017590)

Figure 86. 53 seconds (294937_1017591)

Figure 87. 181 seconds (294937_1017592)

Figure 88. 185 seconds (294937_1017593)

Figure 89. 191 seconds (294937_1017594)

Figure 90. 365 seconds (294937_1017595)

Figure 91. 373 seconds (294937_1017596)

Figure 92. 379 seconds (294937_1017597)

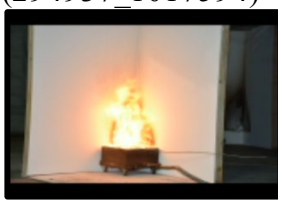

Figure 93. 381 seconds (294937_1017598)

Figure 94. 389 seconds (294937_1017599)

Figure 95. 393 seconds (294937_1017600)

Figure 96. 401 seconds (294937_1017601)

Figure 97. 581 seconds (294937_1017602)

Figure 98. 587 seconds (294937_1017603)

Figure 99. 595 seconds (294937_1017604)

Figure 100. 603 seconds (294937_1017605)

Figure 101. 609 seconds (294937_1017606)

Figure 102. Post test 9 minutes (294937_1017607)

Figure 103. Post test 9 minutes (294937_1017608)

Figure 104. Post test 9 minutes (294937_1017609)

Figure 105. Post test 9 minutes (294937_1017610)

Figure 106. Post test 9 minutes (294937_1017611)

Results for Test 5 (ID 294938)

The following table provides a description of the gas trains used during the experiments.

Table 18. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

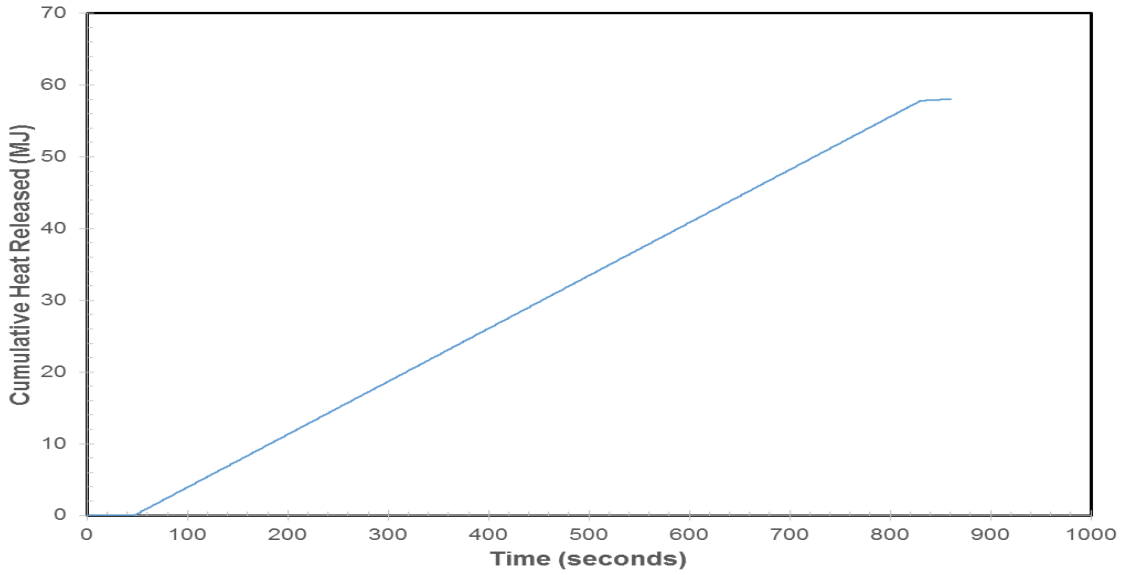

Figure 107. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

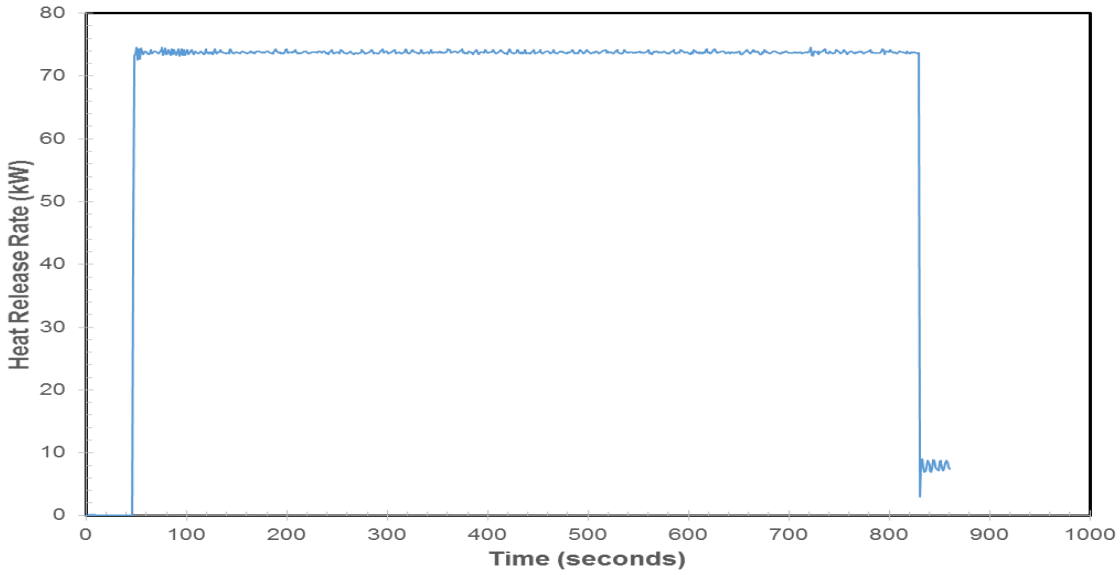

Figure 108. Burner heat release rate

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

Table 19. Experiment Events

Description	Time (s)
Ignition	46

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

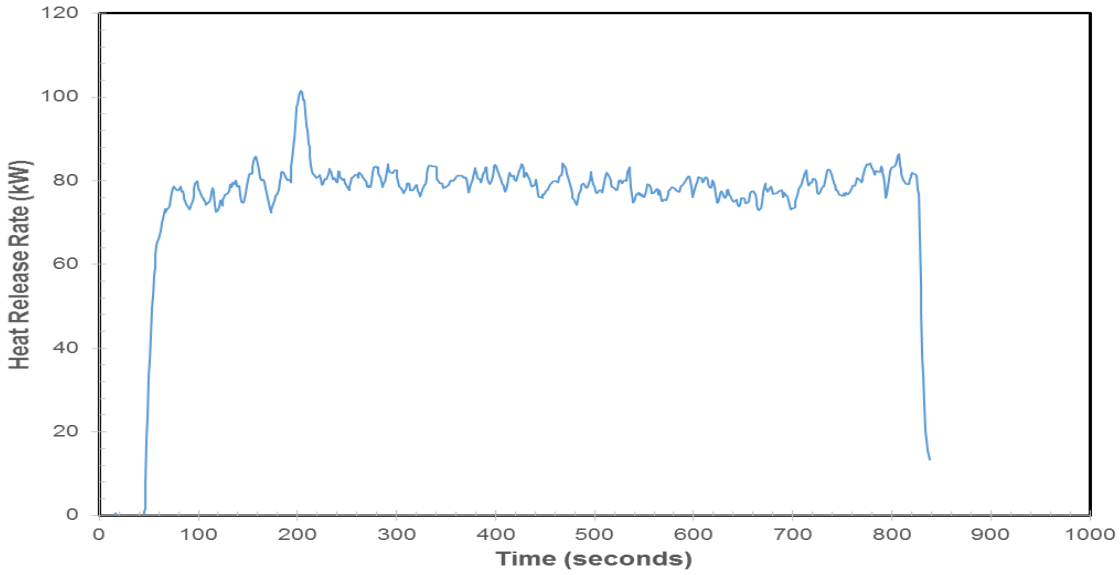

Figure 109. Heat Release Rate

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

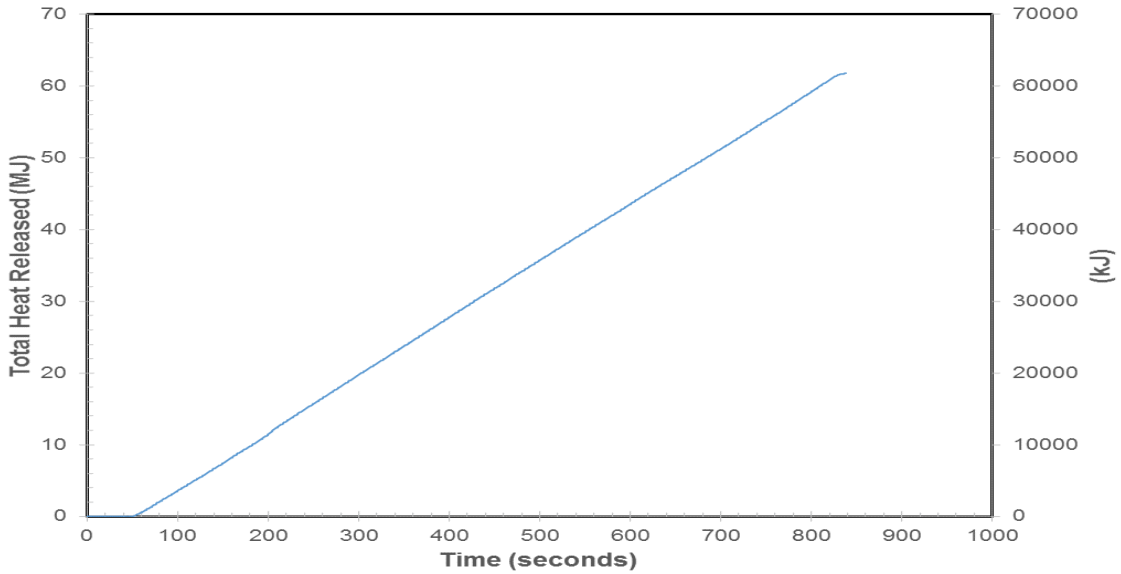

Figure 110. Total Heat Released

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

Table 20. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	02:14:09	889	294938_20180827_141409_1.mov
HD	02:14:11	888	294938_20180827_141411_9.mov
MASTER			294938_1033167.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 111. Pre test 10 minutes (294938_1017620)

Figure 112. Pre test 10 minutes (294938_1017621)

Figure 113. Pre test 10 minutes (294938_1017622)

Figure 114. Pre test 10 minutes (294938_1017623)

Figure 115. Pre test 10 minutes (294938_1017624)

Figure 116. 78 seconds (294938_1017625)

Figure 117. 86 seconds (294938_1017626)

Figure 118. 90 seconds (294938_1017627)

Figure 119. 96 seconds (294938_1017628)

Figure 120. 104 seconds (294938_1017629)

Figure 121. 118 seconds (294938_1017630)

Figure 122. 182 seconds (294938_1017631)

Figure 123. 188 seconds (294938_1017632)

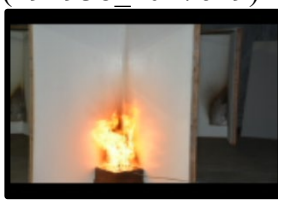

Figure 124. 204 seconds (294938_1017633)

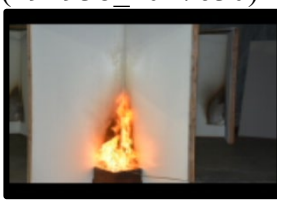

Figure 125. 208 seconds (294938_1017634)

Figure 126. 268 seconds (294938_1017635)

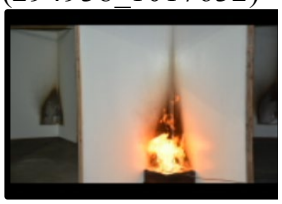

Figure 127. 274 seconds (294938_1017636)

Figure 128. 334 seconds (294938_1017637)

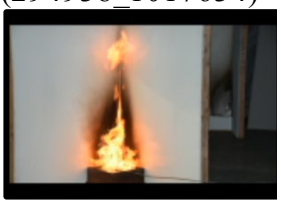

Figure 129. 342 seconds (294938_1017638)

Figure 130. 352 seconds (294938_1017639)

Figure 131. 360 seconds (294938_1017640)

Figure 132. Post test 0 minutes (294938_1017641)

Figure 133. Post test 1 minutes (294938_1017642)

Figure 134. Post test 1 minutes (294938_1017643)

Figure 135. Post test 1 minutes (294938_1017644)

Figure 136. Post test 1 minutes (294938_1017645)

Results for Test 6 (ID 294939)

The following table provides a description of the gas trains used during the experiments.

Table 21. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

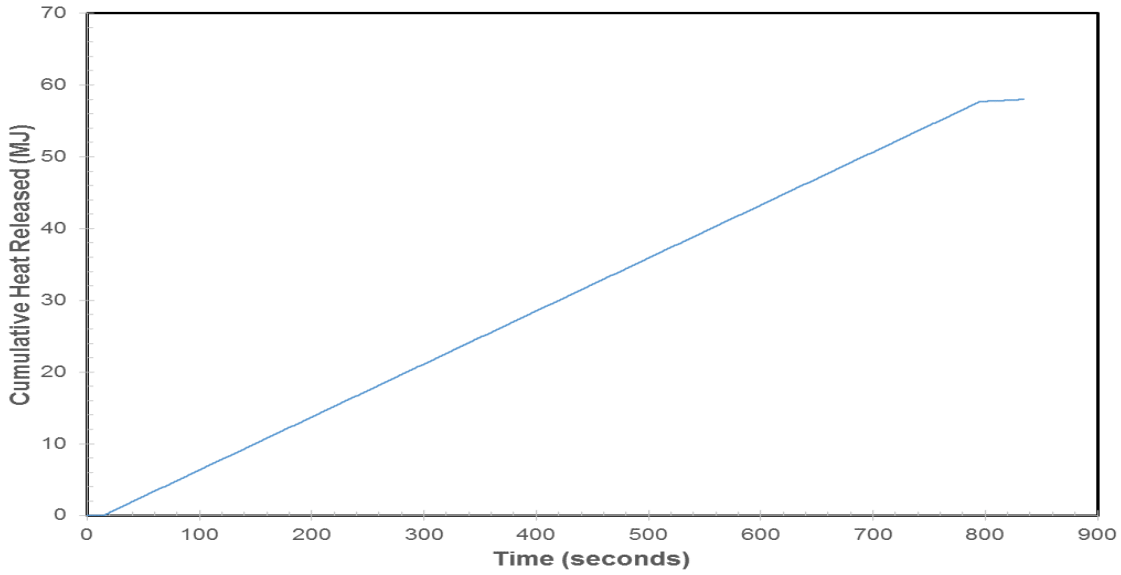

Figure 137. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

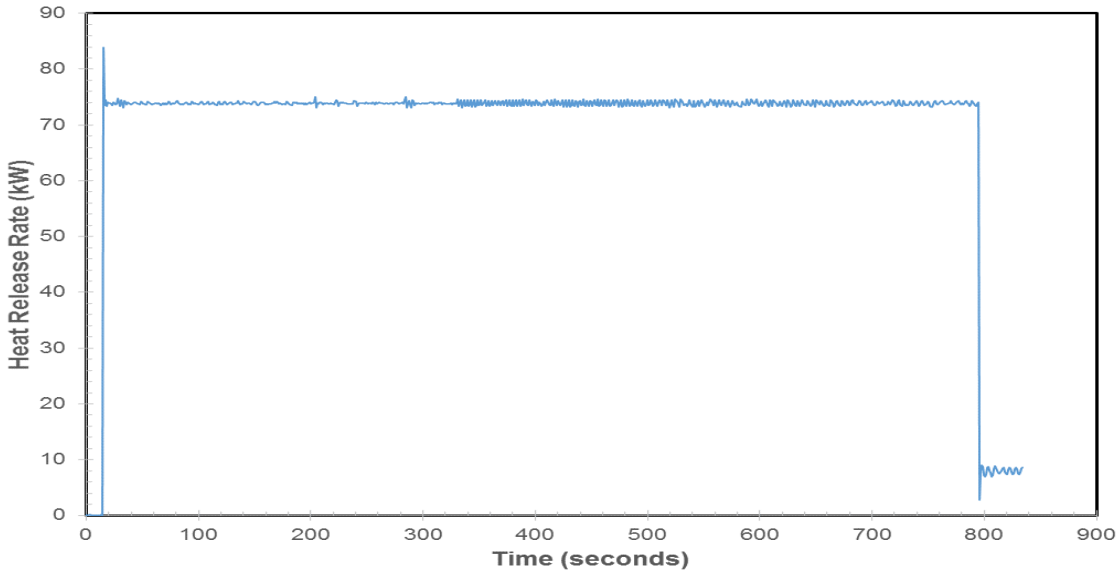

Figure 138. Burner heat release rate

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

Table 22. Experiment Events

Description	Time (s)
Ignition	14

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

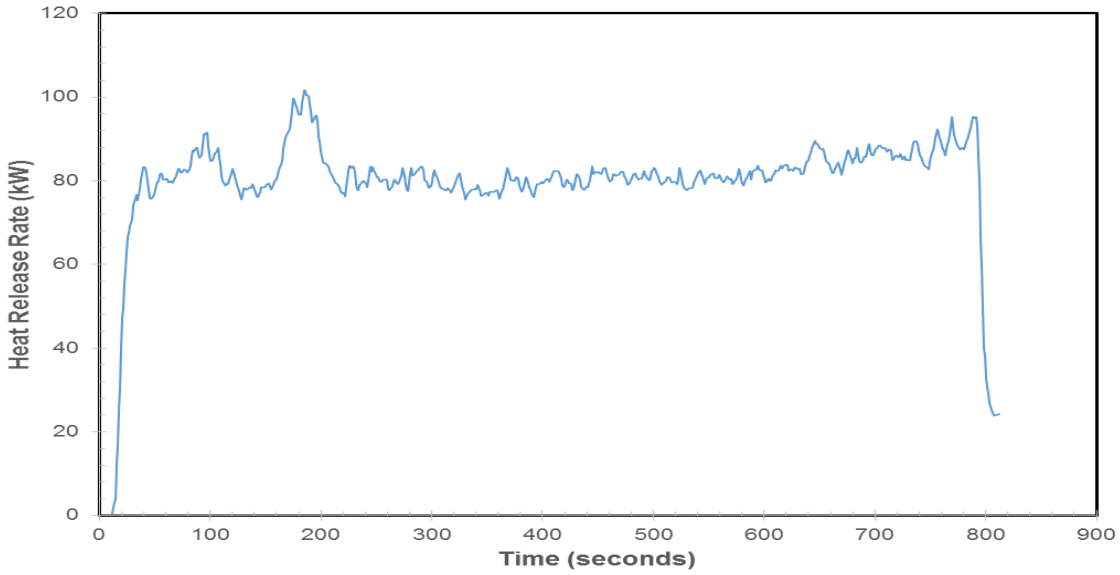

Figure 139. Heat Release Rate

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

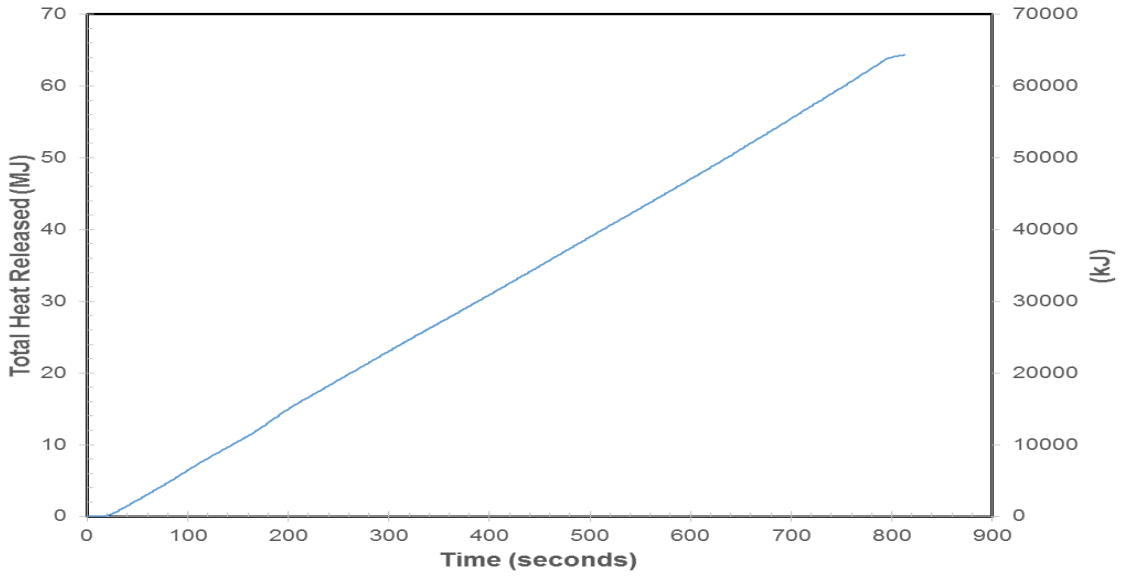

Figure 140. Total Heat Released

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

Table 23. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	02:45:15	854	294939_20180827_144515_1.mov
HD	02:45:16	853	294939_20180827_144516_9.mov
MASTER			294939_1033186.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 141. Pre test 6 minutes (294939_1017654)

Figure 142. Pre test 6 minutes (294939_1017655)

Figure 143. Pre test 4 minutes (294939_1017656)

Figure 144. Pre test 4 minutes (294939_1017657)

Figure 145. Pre test 4 minutes (294939_1017658)

Figure 146. Pre test 4 minutes (294939_1017659)

Figure 147. Pre test 4 minutes (294939_1017660)

Figure 148. 49 seconds (294939_1017661)

Figure 149. 55 seconds (294939_1017662)

Figure 150. 59 seconds (294939_1017663)

Figure 151. 65 seconds (294939_1017664)

Figure 152. 149 seconds (294939_1017665)

Figure 153. 161 seconds (294939_1017666)

Figure 154. 183 seconds (294939_1017667)

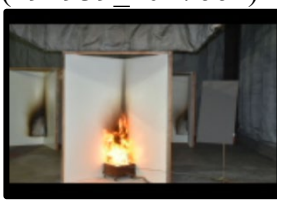

Figure 155. 187 seconds (294939_1017668)

Figure 156. 187 seconds (294939_1017669)

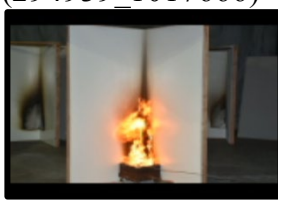

Figure 157. 197 seconds (294939_1017670)

Figure 158. 417 seconds (294939_1017671)

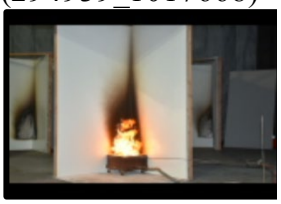

Figure 159. 425 seconds (294939_1017672)

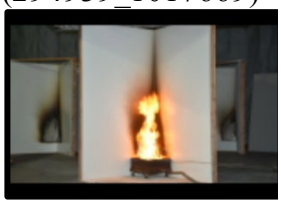

Figure 160. 429 seconds (294939_1017673)

Figure 161. 633 seconds (294939_1017674)

Figure 162. 641 seconds (294939_1017675)

Figure 163. 647 seconds (294939_1017676)

Figure 164. Post test 1 minutes (294939_1017677)

Figure 165. Post test 1 minutes (294939_1017678)

Figure 166. Post test 1 minutes (294939_1017679)

Figure 167. Post test 1 minutes (294939_1017680)

Results for Test 7 (ID 294942)

The following table provides a description of the gas trains used during the experiments.

Table 24. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

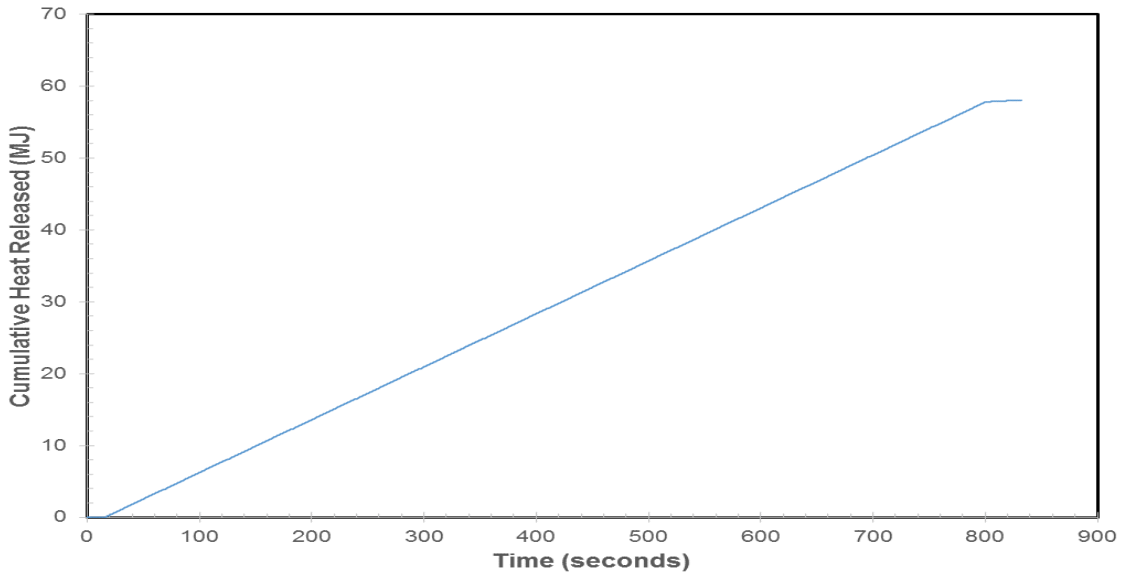

Figure 168. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

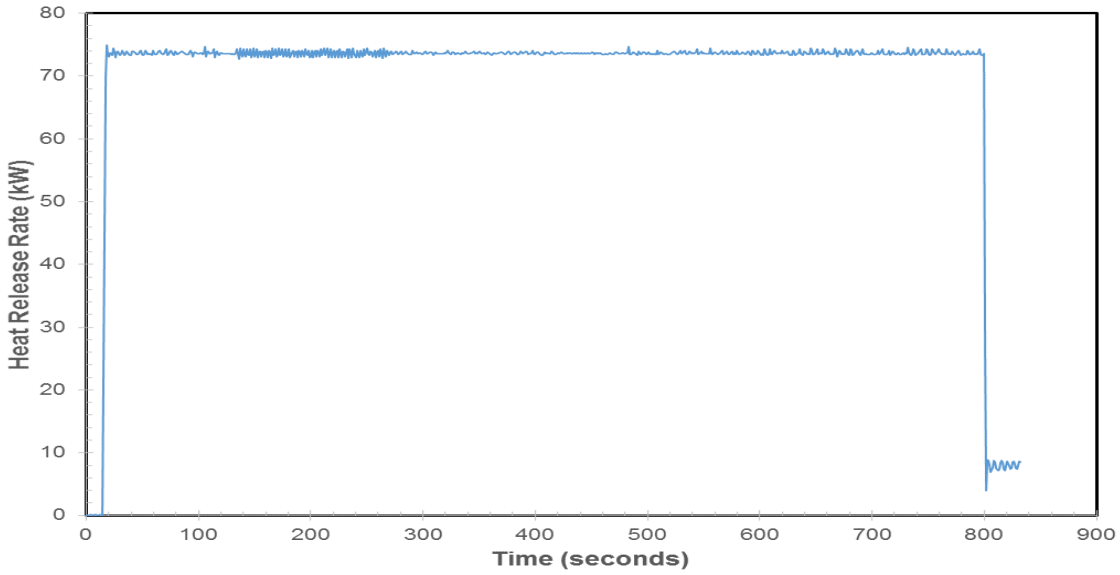

Figure 169. Burner heat release rate

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

Table 25. Experiment Events

Description	Time (s)
Ignition	14

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

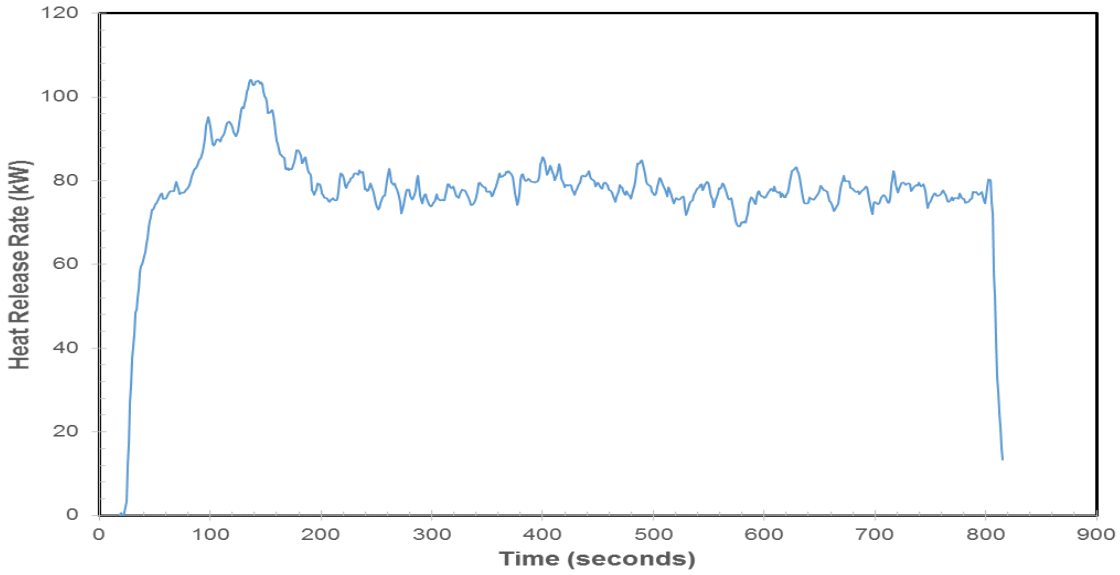

Figure 170. Heat Release Rate

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

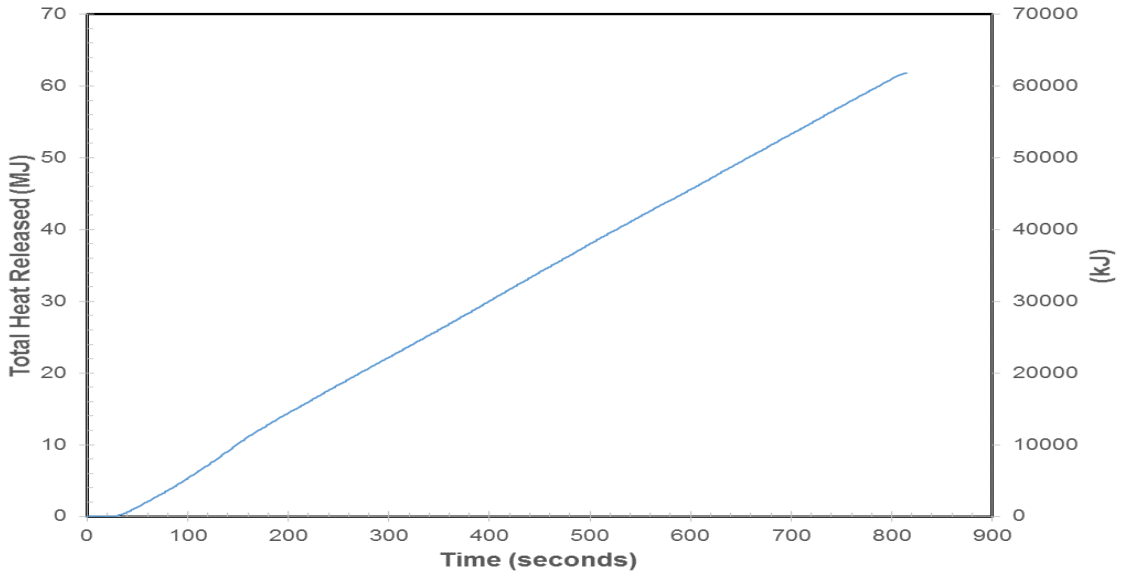

Figure 171. Total Heat Released

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

Table 26. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	09:46:33	854	294942_20180829_094633_1.mov
HD	09:46:34	853	294942_20180829_094634_9.mov
MASTER			294942_1033168.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 172. Pre test 2 minutes (294942_1018065)

Figure 173. Pre test 2 minutes (294942_1018066)

Figure 174. Pre test 2 minutes (294942_1018067)

Figure 175. Pre test 2 minutes (294942_1018068)

Figure 176. 40 seconds (294942_1018069)

Figure 177. 49 seconds (294942_1018070)

Figure 178. 60 seconds (294942_1018071)

Figure 179. 68 seconds (294942_1018072)

Figure 180. 118 seconds (294942_1018073)

Figure 181. 130 seconds (294942_1018074)

Figure 182. 134 seconds (294942_1018075)

Figure 183. 142 seconds (294942_1018076)

Figure 184. 144 seconds (294942_1018077)

Figure 185. 178 seconds (294942_1018078)

Figure 186. 182 seconds (294942_1018079)

Figure 187. 316 seconds (294942_1018080)

Figure 188. 326 seconds (294942_1018081)

Figure 189. 458 seconds (294942_1018082)

Figure 190. 462 seconds (294942_1018083)

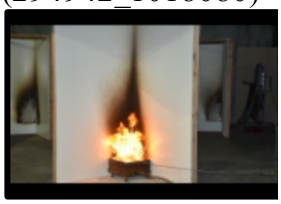

Figure 191. 468 seconds (294942_1018084)

Figure 192. 472 seconds (294942_1018085)

Figure 193. 472 seconds (294942_1018086)

Figure 194. 476 seconds (294942_1018087)

Figure 195. 476 seconds (294942_1018088)

Figure 196. 478 seconds (294942_1018089)

Figure 197. 478 seconds (294942_1018090)

Figure 198. 480 seconds (294942_1018091)

Figure 199. 484 seconds (294942_1018092)

Figure 200. 486 seconds (294942_1018093)

Figure 201. 486 seconds (294942_1018094)

Figure 202. 488 seconds (294942_1018095)

Figure 203. 488 seconds (294942_1018096)

Figure 204. 502 seconds (294942_1018097)

Figure 205. 678 seconds (294942_1018098)

Figure 206. 682 seconds (294942_1018099)

Figure 207. 690 seconds (294942_1018100)

Figure 208. 692 seconds (294942_1018101)

Figure 209. 814 seconds (294942_1018102)

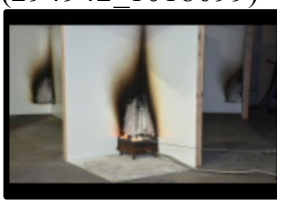

Figure 210. 816 seconds (294942_1018103)

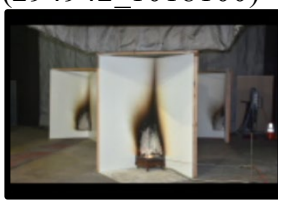

Figure 211. 818 seconds (294942_1018104)

Figure 212. 820 seconds (294942_1018105)

Figure 213. Post test 13 minutes (294942_1018106)

Figure 214. Post test 13 minutes (294942_1018107)

Figure 215. Post test 13 minutes (294942_1018108)

Figure 216. Post test 13 minutes (294942_1018109)

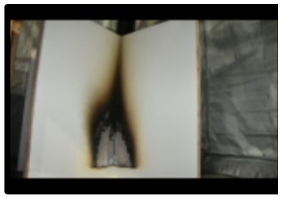

Figure 217. Post test 13 minutes (294942_1018110)

Figure 218. Post test 13 minutes (294942_1018111)

Figure 219. Post test 13 minutes (294942_1018112)

Results for Test 8 (ID 294943)

The following table provides a description of the gas trains used during the experiments.

Table 27. Gas Train Description

	MFC Model Name	Fuel Type
Gas Train B	MCR-1000SLPM-D	Natural Gas

The following chart(s) present a representation of the cumulative burner heat release rate measured during the experiment.

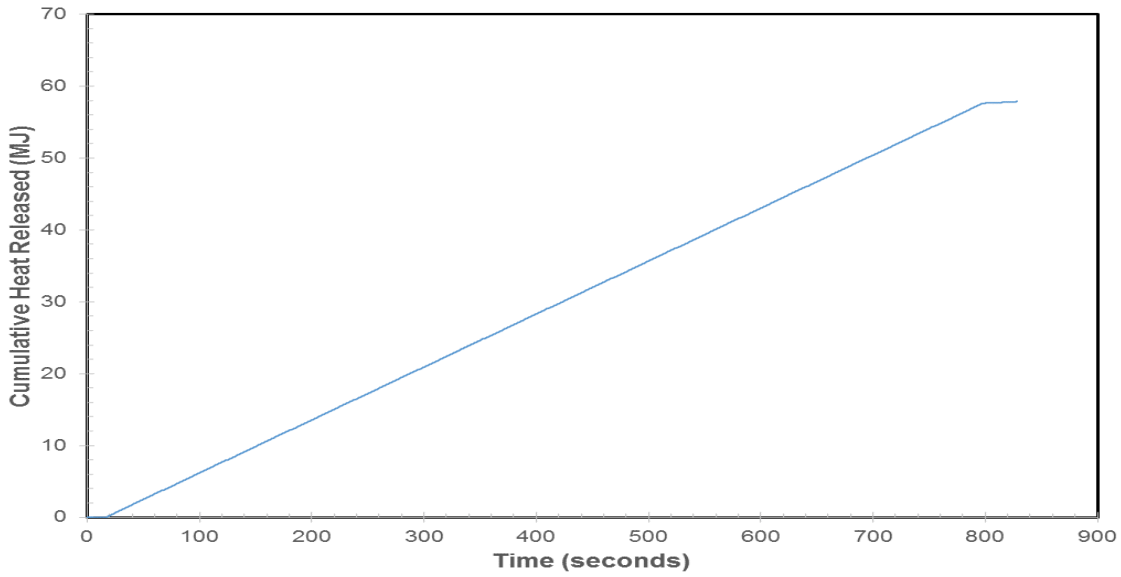

Figure 220. Total Theoretical Burner Energy

The following chart(s) present a time-dependent representation of the instantaneous burner heat release rate measured during the experiment.

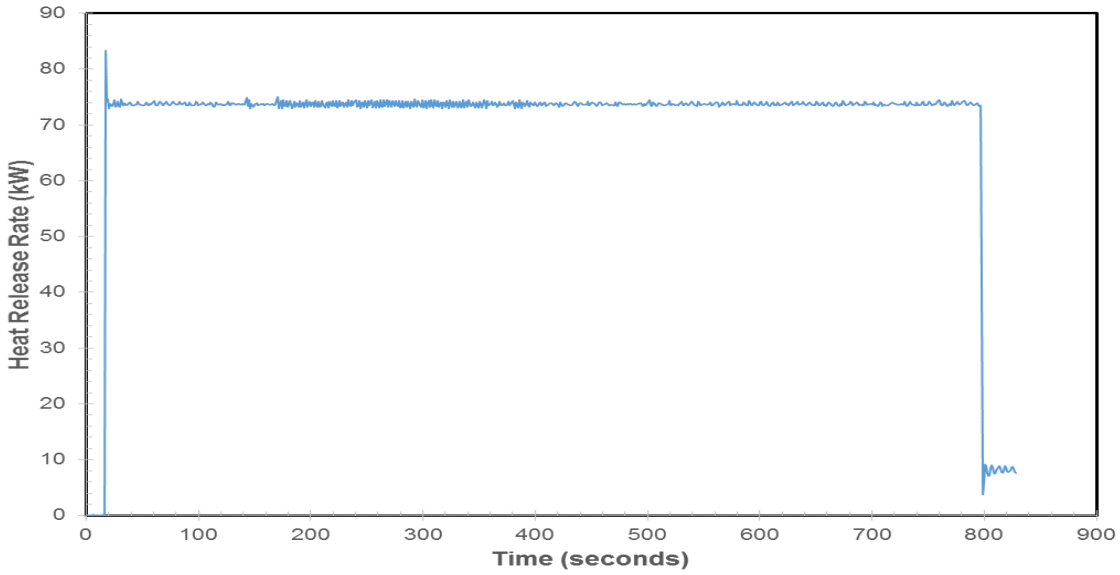

Figure 221. Burner heat release rate

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

Table 28. Experiment Events

Description	Time (s)
Ignition	16

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

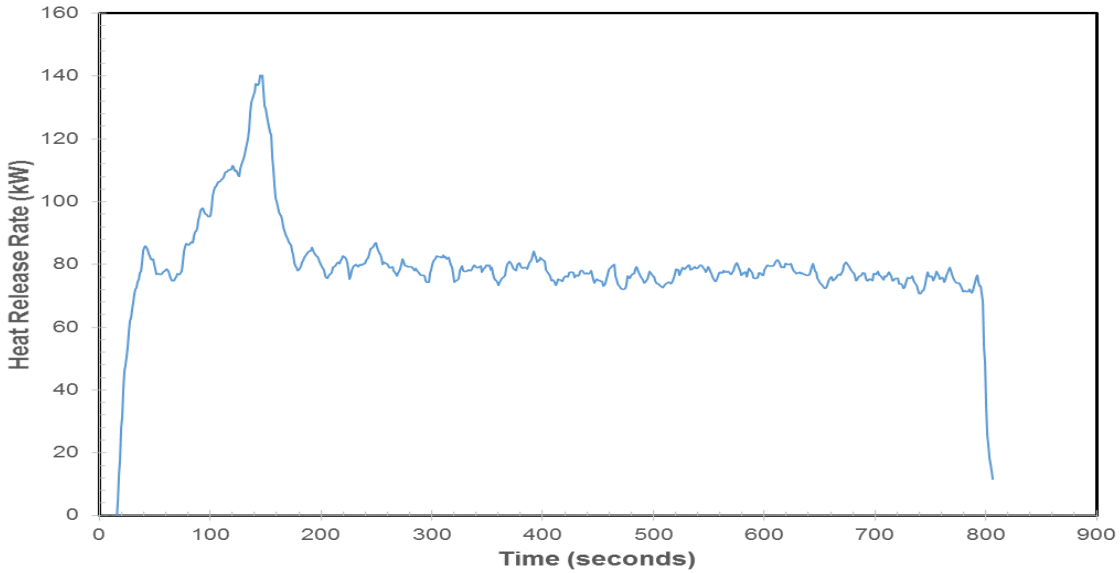

Figure 222. Heat Release Rate

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

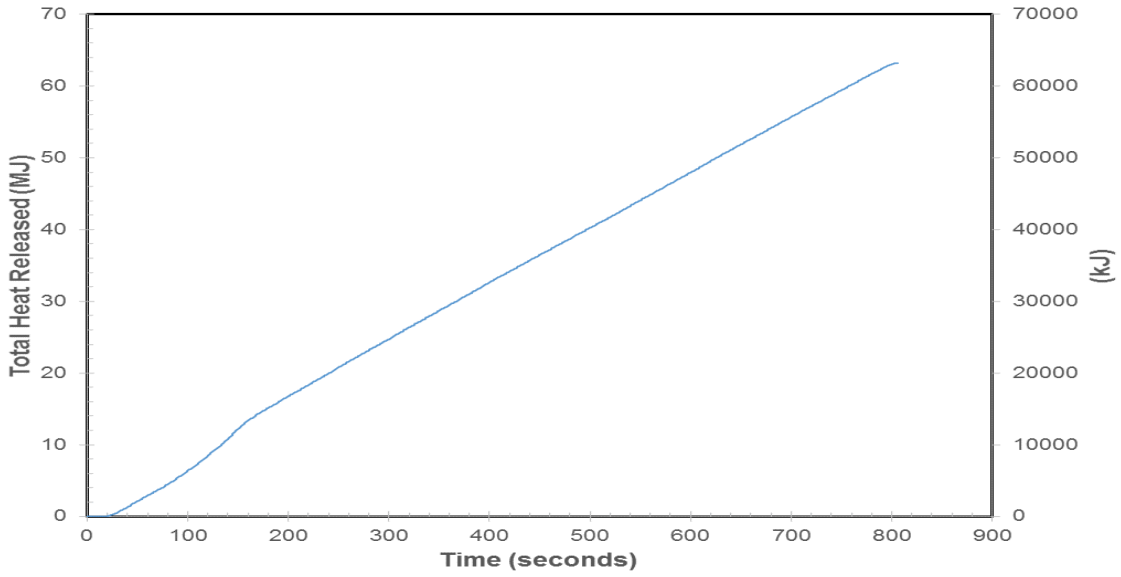

Figure 223. Total Heat Released

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

Table 29. Video Log

Description	Start Time	Duration (s)	Filename
FLIR	10:17:38	859	294943_20180829_101738_1.mov
HD	10:17:40	858	294943_20180829_101740_9.mov
MASTER			294943_1033169.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 224. Pre test 3 minutes (294943_1018113)

Figure 225. Pre test 3 minutes (294943_1018114)

Figure 226. Pre test 3 minutes (294943_1018115)

Figure 227. Pre test 3 minutes (294943_1018116)

Figure 228. Pre test 3 minutes (294943_1018117)

Figure 229. 37 seconds (294943_1018118)

Figure 230. 38 seconds (294943_1018119)

Figure 231. 51 seconds (294943_1018120)

Figure 232. 59 seconds (294943_1018121)

Figure 233. 65 seconds (294943_1018122)

Figure 234. 99 seconds (294943_1018123)

Figure 235. 108 seconds (294943_1018124)

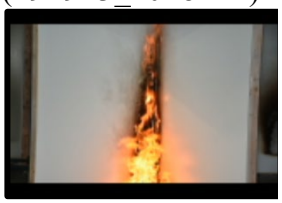

Figure 236. 110 seconds (294943_1018125)

Figure 237. 112 seconds (294943_1018126)

Figure 238. 122 seconds (294943_1018127)

Figure 239. 125 seconds (294943_1018128)

Figure 240. 128 seconds (294943_1018129)

Figure 241. 130 seconds (294943_1018130)

Figure 242. 141 seconds (294943_1018131)

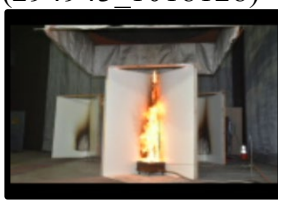

Figure 243. 147 seconds (294943_1018132)

Figure 244. 150 seconds (294943_1018133)

Figure 245. 155 seconds (294943_1018134)

Figure 246. 157 seconds (294943_1018135)

Figure 247. 169 seconds (294943_1018136)

Figure 248. 314 seconds (294943_1018137)

Figure 249. 317 seconds (294943_1018138)

Figure 250. 323 seconds (294943_1018139)

Figure 251. 329 seconds (294943_1018140)

Figure 252. 330 seconds (294943_1018141)

Figure 253. 409 seconds (294943_1018142)

Figure 254. 415 seconds (294943_1018143)

Figure 255. 423 seconds (294943_1018144)

Figure 256. 429 seconds (294943_1018145)

Figure 257. 437 seconds (294943_1018146)

Figure 258. 447 seconds (294943_1018147)

Figure 259. 755 seconds (294943_1018148)

Figure 260. 761 seconds (294943_1018149)

Figure 261. 773 seconds (294943_1018150)

Figure 262. 815 seconds (294943_1018151)

Figure 263. 819 seconds (294943_1018152)

Figure 264. Post test 1 minutes (294943_1018153)

Figure 265. Post test 1 minutes (294943_1018154)

Figure 266. Post test 1 minutes (294943_1018155)

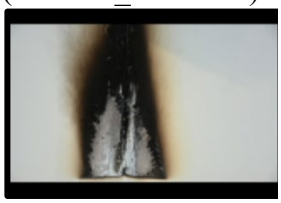

Figure 267. Post test 1 minutes (294943_1018156)

Figure 268. Post test 1 minutes (294943_1018157)

Figure 269. Post test 1 minutes (294943_1018158)

Figure 270. Post test 1 minutes (294943_1018159)

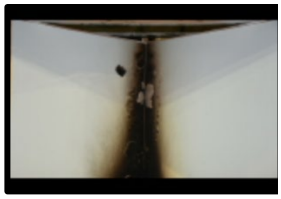

Figure 271. Post test 1 minutes (294943_1018160)

Figure 272. Post test 1 minutes (294943_1018161)

Figure 273. Post test 1 minutes (294943_1018162)

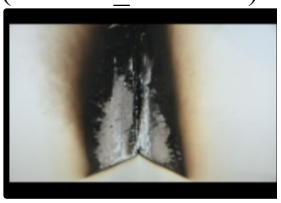

Figure 274. Post test 2 minutes (294943_1018163)

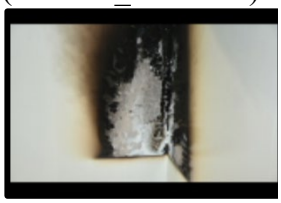

Figure 275. Post test 3 minutes (294943_1018164)

Figure 276. Post test 3 minutes (294943_1018165)

Figure 277. Post test 3 minutes (294943_1018166)

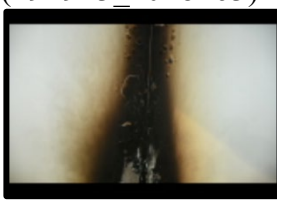

Figure 278. Post test 3 minutes (294943_1018167)

Figure 279. Post test 3 minutes (294943_1018168)

Results Summary

The following table provides a summary of the heat release rate (HRR) results from the experiments. The maximum HRR recorded during the experiment is provided in the "Maximum" column. The "Maximum Average" values, which are calculated from average values of heat release rate over specified time periods, provide a means to compare the severity of different fires over these time spans.

Table 30. Heat Release Rate Result Summary

Experiment: Test Number	Max (kW)	30 sec Maximum Average (kW)	1 min Maximum Average (kW)	5 minute Maximum Average (kW)	10 minute Maximum Average (kW)
1	82	80	79	78	77
2	87	82	81	79	79
3	85	81	80	78	76
4	86	83	82	80	80
5	102	90	85	81	80
6	102	96	90	84	82
7	104	101	96	83	80
8	140	127	117	89	83

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

Table 31. Total Heat Release Summary

Test Number	Total Heat Release (kJ)
1	59517
2	62475
3	58522
4	61317
5	61758
6	64332
7	61763
8	63177

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

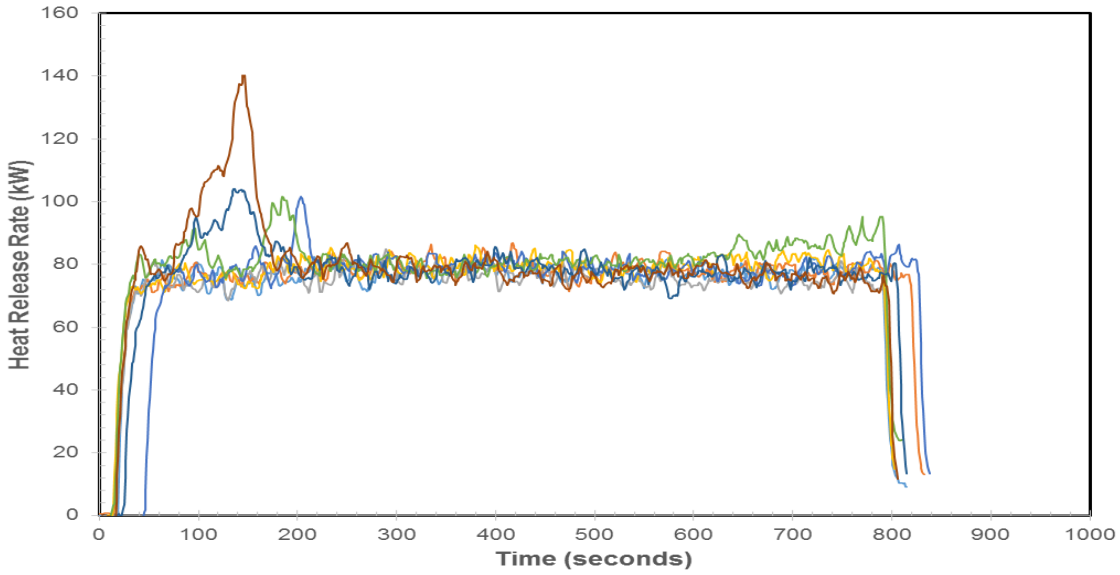

Figure 280. Heat Release Rate Summary

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

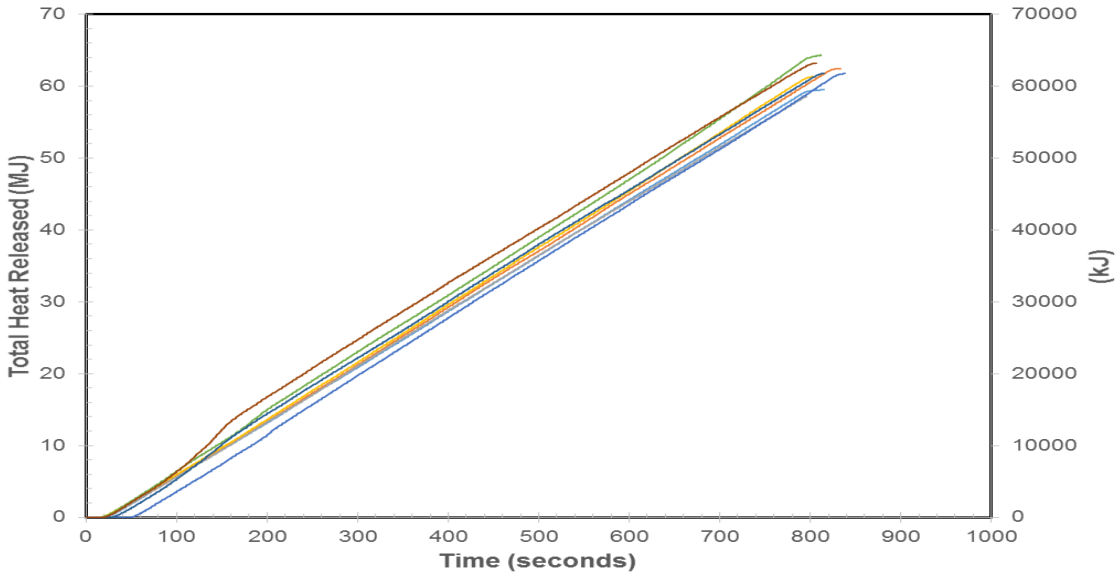

Figure 281. Total Heat Released Summary

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1. Laboratory Instruction LI017 – Laboratory Conditions, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD.

2 International Organization for Standardization, "ISO9705: Fire Tests – Full Scale Room Test for Surface Products," ISO, Geneva, Switzerland, 1993.

3 American Society for Testing and Materials, "ASTM E1537: Standard Test Method for Fire Testing of Upholstered Furniture," ASTM, West Conshohocken, PA, 2002.

4. National Fire Protection Association, "NFPA286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth," NFPA, Quincy, MA, 2000.

5. Laboratory Instruction – Fire Products Collectors – LI011, Bureau of Alcohol, Tobacco, Firearms and Explosives – Fire Research Laboratory, Beltsville, MD.

6. Laboratory Instruction LI003 - Digital Cameras, Bureau of Alcohol, Tobacco, Firearms and Explosives - Fire Research Laboratory, Beltsville, MD