Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001

Electric Power Research Institute
3420 Hillview Avenue
Palo Alto, CA 94304-1338

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at the NRC's Library at www.nrc.gov/reading-rm.html. Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and Title 10, "Energy," in the *Code of Federal Regulations* may also be purchased from one of these two sources:

1. **The Superintendent of Documents**
   U.S. Government Publishing Office
   Washington, DC 20402-0001
   Internet: www.bookstore.gpo.gov
   Telephone: (202) 512-1800
   Fax: (202) 512-2104

2. **The National Technical Information Service**
   5301 Shawnee Road
   Alexandria, VA 22312-0002
   Internet: www.ntis.gov
   1-800-553-6847 or, locally, (703) 605-6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: **U.S. Nuclear Regulatory Commission**
Office of Administration
Multimedia, Graphics, and Storage & Distribution Branch
Washington, DC 20555-0001
E-mail: distribution.resource@nrc.gov
Facsimile: (301) 415-2289

Some publications in the NUREG series that are posted at the NRC's Web site address www.nrc.gov/reading-rm/doc-collections/nuregs are updated periodically and may differ from the last printed version. Although references to material found on a Web site bear the date the material was accessed, the material available on the date cited may subsequently be removed from the site.

Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—

American National Standards Institute
11 West 42nd Street
New York, NY 10036-8002
Internet: www.ansi.org
(212) 642-4900

Legally binding regulatory requirements are stated only in laws; NRC regulations; licenses, including technical specifications; or orders, not in NUREG-series publications. The views expressed in contractor prepared publications in this series are not necessarily those of the NRC.

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG–XXXX) or agency contractors (NUREG/CR–XXXX), (2) proceedings of conferences (NUREG/CP–XXXX), (3) reports resulting from international agreements (NUREG/IA–XXXX),(4) brochures (NUREG/BR–XXXX), and (5) compilations of legal decisions and orders of the Commission and the Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of the NRC's regulations (NUREG–0750).

Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants

March 2020

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research (RES)
Washington, D.C. 20555-0001

U.S. NRC-RES Project Manager
M. Salley

Electric Power Research Institute (EPRI)
3420 Hillview Avenue
Palo Alto, CA 94304-1338

EPRI Project Managers
A. Lindeman
M. Randelovic

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

THIS DOCUMENT WAS PREPARED BY THE ORGANIZATIONS NAMED BELOW AS AN ACCOUNT OF WORK SPONSORED OR COSPONSORED BY THE ELECTRIC POWER RESEARCH INSTITUTE, INC. (EPRI). NEITHER EPRI, ANY MEMBER OF EPRI, ANY COSPONSOR, THE ORGANIZATIONS BELOW, NOR ANY PERSON ACTING ON BEHALF OF ANY OF THEM:

(A) MAKES ANY WARRANTY OR REPRESENTATION WHATSOEVER, EXPRESS OR IMPLIED, (I) WITH RESPECT TO THE USE OF ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR (II) THAT SUCH USE DOES NOT INFRINGE ON OR INTERFERE WITH PRIVATELY OWNED RIGHTS, INCLUDING ANY PARTY'S INTELLECTUAL PROPERTY, OR (III) THAT THIS DOCUMENT IS SUITABLE TO ANY PARTICULAR USER'S CIRCUMSTANCE; OR

(B) ASSUMES RESPONSIBILITY FOR ANY DAMAGES OR OTHER LIABILITY WHATSOEVER (INCLUDING ANY CONSEQUENTIAL DAMAGES, EVEN IF EPRI OR ANY EPRI REPRESENTATIVE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES) RESULTING FROM YOUR SELECTION OR USE OF THIS DOCUMENT OR ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT.

REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE BY ITS TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE, DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY EPRI.

THE FOLLOWING ORGANIZATIONS PREPARED THIS REPORT:

Electric Power Research Institute

Jensen Hughes, Inc.

U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research

THE TECHNICAL CONTENTS OF THIS PRODUCT WERE **NOT** PREPARED IN ACCORDANCE WITH THE EPRI QUALITY PROGRAM MANUAL THAT FULFILLS THE REQUIREMENTS OF 10 CFR 50, APPENDIX B. THIS PRODUCT IS **NOT** SUBJECT TO THE REQUIREMENTS OF 10 CFR PART 21.

NOTE

For further information about EPRI, call the EPRI Customer Assistance Center at 800.313.3774 or e-mail askepri@epri.com.

ABSTRACT

As part of the initial guidance for performing a fire probabilistic risk assessment (FPRA) contained in NUREG/CR-6850, the appendices in Volume 2 provided guidance on modeling the heat release rate of ignition sources. Follow-on research has improved the realism for the heat release rates used for electrical cabinets (NUREG-2178, Volume 1, and NUREG/CR-7197), cables (NUREG/CR-6931 and NUREG/CR-7010), and pumps, motors, and transformers (NUREG-2178, Volume 2). Transient ignition sources have not yet seen additional research targeting the realism of heat release rates. Since transient fires represent a significant fraction of the fire risk at nuclear power plants, there is value to the industry in improving the realism of how these fires are modeled.

This report documents testing performed to address this gap. The report begins by reviewing the existing guidance for transient fires and actual operating experience of U.S. nuclear power plants. These data were used to develop a large experimental program involving 99 transient fuel packages with repeat tests for a total of 290 tests. Data collected during the experimental program included heat release rate, heat of combustion, minor product yields, flame height, plume temperature, and heat flux. Test data were used to determine the vertical and horizontal zones of influence for each test and to assess the performance of the Fire Dynamics Tools (NUREG-1805) correlations for plume temperature, flame height, and heat flux.

A companion report will provide specific guidance on applying the test data to a FPRA.

Keywords

Fire Probabilistic Risk Assessment (FPRA)
Fire Risk
Transient Fires
Fire Testing
Heat Release Rate (HRR)
Zone of Influence (ZOI)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

PRIMARY AUDIENCE: Fire probabilistic risk assessment (FPRA) engineers and fire protection engineers supporting the development or maintenance of FPRAs.

SECONDARY AUDIENCE: Engineers, utility managers, and other stakeholders who review FPRAs and who interface with FPRA methods.

KEY RESEARCH QUESTION

Based upon operational experience, what are the heat release rates (HRRs) and associated thermal hazards from transient fires in commercial nuclear power plants?

RESEARCH OVERVIEW

This report is a product of a joint collaboration between the Electric Power Research Institute (EPRI) and the U.S. Nuclear Regulatory Commission's (NRC's) Office of Nuclear Regulatory Research (RES) under a memorandum of understanding on fire research. Building upon the progress of NUREG-2178 (EPRI 3002005578), *Refining and Characterizing Heat Release Rates from Electrical Enclosures during Fire (RACHELLE-FIRE), Volume 1, Peak Heat Release Rates and Effect of Obstructed Plume*, issued April 2016, on HRRs and obstructed plume, the research continued on other areas related to fire modeling and HRRs. The work documented in this report is an extensive set of fire experiments to support the development of guidance to improve the realism for how transient fires are modeled in FPRAs.

The experimental program consisted of 290 experiments involving 99 fuel packages selected to represent transient fire events in nuclear power plants. The fuel packages and the method of igniting them were selected based on industry experience with transient fires as documented in the EPRI Fire Events Database.

The experiments were performed at two test facilities: the Jensen Hughes fire testing laboratory in Baltimore, MD, and the National Fire Research Laboratory at the National Institute of Standards and Technology in Gaithersburg, MD. Data collected during the experiments included the heat release rate, the production of carbon monoxide (CO) and soot, videos of each test, measurements of plume temperature and heat flux, and the mass loss of the fuel package. The collected data were used to develop a number of derived quantities, including the total energy release, soot and CO yields; flame height and fire diameter at the peak HRR; the vertical (plume temperature) and horizontal (radiative heat flux) zones of influence; and parameters defining the shape of the HRR curve.

KEY FINDINGS

- There is a lack of realism in the test items included in NUREG/CR-6850, *EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities,* issued September 2005, as justification for a 317 kW 98th percentile peak HRR. Some test items are not representative of the operational experience with transient fire events. The range of items is limited and not fully representative of the distribution of items seen in operational experience with transient fire events.
- HRRs from the 290 tests of transient fuel items range from a near zero heat release up to 3 MW. Approximately 50 % of tests had HRRs below 10 kW, 85 % of tests had HRRs below 100 kW, and 6 % of tests had HRRs above 317 kW. It is noted that the distribution of items tested does not directly match the distribution of items seen in industry experience.
- Only a small number of tests resulted in a vertical (temperature) or horizontal (heat flux) zone of influence that is greater than those typically used for screening in current FPRAs. In large part, this is caused by test results that show short durations when the fire is at or near its peak HRR.
- There is a strong correlation between the peak HRR and the total energy released by a fire.
- The heat of combustion is strongly related to the composition of the fuel package. Similarly, there are ranges of soot yield associated with the composition of the fuel package. CO yield does not display clear trends of yield with composition.
- The flame height correlation from NUREG-1805, *Fire Dynamics Tools (FDT^s)—Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program*, issued December 2004; the plume temperature correlation from NUREG-1805; and the adjusted solid flame model from NUREG-2178, Volume 2, *Fire Modeling Guidance for Electrical Cabinets, Electric Motors, Indoor Dry Transformers, and the Main Control Board*, were used to predict the peak values measured during testing. The calculated values match close to the values measured during the tests.
- The growth and decay behavior of the fires during testing exhibits a wide range of growth and decay rates and times over all heat release rates.

WHY THIS MATTERS

The guidance and data in NUREG/CR-6850 resulted from an extensive effort to gather together the knowledge and best practices at that time for modeling fires in FPRAs. In some cases, the level of knowledge was not as mature as needed for supporting realism in FPRAs. For example, the aggregate results of multiple FPRAs showed that transient fires were consequential and high contributors to plant risk, which is a conclusion not wholly supported by operating experience. As a result, the FPRAs developed contain oversimplifications and assumptions that lean in the conservative direction. Over the years, the industry and the NRC have worked to develop methods and data that are more realistic and representative of the operating experience with respect to fire. This report provides data that will be used to support development of transient fire guidance with improved realism.

HOW TO APPLY RESULTS

A companion report will provide guidance on how to apply the test data during the development of industry FPRAs.

LEARNING AND ENGAGEMENT OPPORTUNITIES

Users of this report may be interested in FPRA training, which is sponsored jointly by EPRI and NRC RES. The two modules that may be of interest include Module III, “Fire Analysis,” and Module V, “Advanced Fire Modeling.” The Fire Analysis course is geared towards probabilistic risk assessment practitioners responsible for treating those aspects related to fire growth and damage assessment. This course discusses the basics of plant partitioning, fire frequency analysis, and the development and analysis of fire scenarios from fire ignition to target impact and fire suppression. The Advanced Fire Modeling course covers fundamentals of fire science and guidance on the use of fire models to predict fire-generated conditions that may affect nuclear power plant safety functions.

EPRI CONTACT: Ashley Lindeman, Senior Technical Leader, 704.595.2538, alindeman@epri.com

NRC CONTACT: David Stroup, Senior Fire Protection Engineer, 301.415.1649, david.stroup@nrc.gov

PROGRAM: Risk and Safety Management, Program 41.07.01

IMPLEMENTATION CATEGORY: Plant Optimization

CITATIONS

This report was prepared by the following:

Electric Power Research Institute
3420 Hillview Avenue
Palo Alto, CA 94304

Principal Investigators:
A. Lindeman
M. Randelovic

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research (RES)
Washington, DC 20555-0001

Principal Investigator:
D. Stroup

Under contract to EPRI:

Jensen Hughes, Inc.
3610 Commerce Drive, Suite 817
Baltimore, MD 21227

Principal Investigators:
J. Floyd
M. DiDomizio

Under contract to NRC:

National Institute of Standards and Technology
Engineering Laboratory
Fire Research Division
100 Bureau Drive
Gaithersburg, MD 20899

Principal Investigators:
K. McGrattan
M. Bundy

This publication is a corporate document that should be cited in the literature in the following manner:

Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants. U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC, and Electric Power Research Institute (EPRI), Palo Alto, CA: 2019. NUREG-2232 and EPRI 3002015997 (While the NRC and EPRI reports have different publication dates, they are essentially the same report).

The report should be cited internally in NRC documents in this way:

U.S. Nuclear Regulatory Commission, Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants, NUREG-2232, (Electric Power Research Institute (EPRI) 3002015997), September 2019.

This report describes research sponsored jointly by the U.S. Nuclear Regulatory Commission's Office of Nuclear Regulatory Research and the Electric Power Research Institute.

ACRONYMS

AC	alternating current
ANSI	American National Standards Institute
BWR	boiling water reactor
C	Celsius
CO	carbon monoxide
DAQ	data acquisition
EPRI	Electric Power Research Institute
F	Fahrenheit
FAQ	frequently asked question
FDT^S	Fire Dynamics Tools
FEDB	Fire Events Database
FPRA	fire probabilistic risk assessment
FR	fire retardant
HFG	heat flux gauge
HRR	heat release rate (kW)
HVAC	heating, ventilation, and air conditioning
MPUL	mass per unit length (kg/m)
NFPA	National Fire Protection Association
NFRL	National Fire Research Laboratory
NIST	National Institute of Standards and Technology
NPP	nuclear power plant
NRC	U.S. Nuclear Regulatory Commission
PPE	personal protective equipment
PRA	probabilistic risk assessment
PT	plate thermometer
PWR	pressurized-water reactor
RES	Office of Nuclear Regulatory Research (NRC)

RMS	root mean square
SFPE	Society of Fire Protection Engineers
TC	thermocouple
TER	total energy release
THIEF	Thermally Induced Electrical Failure
TP	thermoplastic
TS	thermoset
U.S.	United States
ZOI	zone of influence

1
INTRODUCTION

1.1 Background

The current recommended characterization of transient fires, which are fires that result from maintenance, hot work, or storage of combustible materials, for a fire probabilistic risk assessment (FPRA) consists of a specified fire growth rate and a specified distribution of heat release rates (HRRs). There is no current recommendation on duration or HRR decay. The HRR distribution is specified in NUREG/CR-6850, *EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities*, *Volume 2, Detailed Methodology*, issued September 2005 [1], as a gamma distribution with a 75th percentile HRR of 142 kW and a 98th percentile HRR of 317 kW. Growth rates are specified in NUREG/CR-6850 Supplement 1 [2] as 2 minutes for unconfined transient fuel packages, 8 minutes for confined fuel packages (i.e., in a container like a trash can), and instantaneous for spills of flammable liquids.

The HRR recommendation in NUREG/CR-6850 is based on 27 experiments. HRRs in the selected tests range from 12 kW to 351 kW. One-third of the experiments included a significant amount of flammable liquid as part of the fuel package. One third of the tests were large trash bags or plastic trash containers, with most of those involving multiple co-located bags or containers. Three of the test experiments were wood cribs, a fuel package specifically designed as a repeatable fire source with rapid growth. The frequency of flammable liquid presence, the fact that most trash fires involved multiple containers, and the inclusion of wood cribs suggests that these fuel packages are not representative of actual transient fire events occurring in nuclear power plants (NPPs).

Actual industry experience with transient fires [3], discussed in Section 2, is not adequately reflected in the experiments used to develop the guidance in NUREG/CR-6850. A much lower incidence of trash containers is seen in the Electric Power Research Institute (EPRI) Fire Events Database (FEDB) than in the tests selected for NUREG/CR-6850. Flammable liquids are rarely seen in the FEDB. Fires with multiple fuel containers (trash bags, trash cans) are extremely rare events.

One significant consequence of the HRR distribution provided in NUREG/CR-6850 is that an expansive zone exists around a fire where damage to cables or equipment might occur. This zone is referred to as the zone of influence (ZOI). Targets in a FPRA are screened by seeing whether they lie within the ZOI for the 98th percentile fire. The impact of having a 98th percentile fire size of 317 kW can be illustrated using the ZOI for thermoplastic (TP) and thermoset (TS) cables. In the absence of a recommended fire duration, a typical FPRA computes the ZOI using a constant fire size of 317 kW and the threshold damage criteria for electrical cables in Table H-1 of NUREG/CR-6850. Since the ZOI is dependent on the fire diameter, a typical assumption is that the fire has a fire Froude number, a dimensionless measure of the burning intensity, of unity [4]. With this assumption, a 317 kW fire would have a 0.61 m (2 ft) diameter and a Heskestad correlation [5] flame height of 1.7 m (5.6 ft). The vertical (fire plume) and horizontal (thermal radiation) ZOIs are determined using the Fire Dynamics Tools (FDT^s) correlations for plume temperature and heat flux [5]. For the 98th percentile fire, the vertical ZOI is 2.9 m (9.5 ft) for TP cables and 2.2 m (7.1 ft) for TS cables.

The radiative ZOI is 0.86 m (2.8 ft) from the edge of the fire for TP and 0.45 m (1.5 ft) for TS. For a fire in a corner, the plume ZOI extends up to 5.0 m (16.5 ft) for TP and 3.8 m (12.4 ft) for TS. In a NPP, it is common for cable trays to run 0.3 to 0.6 m (1 to 2 ft) above electrical cabinets that are 1.8 to 2.1 m (6 to 7 ft) tall, so that a vertical ZOI of 2.2 m (7.3 ft) or more means the 98th percentile fire size is large enough that many cable trays cannot be screened.

In addition to the fire size, the recommended growth rates for transient fires may also lack realism. The growth rate data [2] are solely based on fires representative of refuse (trash in trash bags or trash in a cardboard box). Industry experience (see Section 2) indicates that trash fires represent only a small fraction of all transient material events. These growth rates may not adequately represent the actual hazard posed by transient fuel sources.

The current recommendations for transient fire HRR and growth rate are based upon a collection of test data that does not reflect industry experience. This lack of realism potentially results in the inclusion of a conservative number of targets in FPRAs. The observations on the adequacy of the existing tests used for defining transient fires, combined with the importance of transient fires in FPRAs, demonstrate a need to test fuel packages that are representative of operating experience.

1.2 Approach

A two-phase approach was developed to address improved realism in the modeling of transient fires in a FPRA. The first phase, documented in this report, was a fire testing program. The second phase, documented in a companion report, was the development of recommended approaches for incorporating transient fires in a FPRA.

Since the current practice for characterizing transient fire scenarios is based on experiments that do not reflect industry experience, a testing program was developed to test a wide range of fuel packages selected to reflect industry experience. In addition to selecting representative fuel packages, the ignition sources used during testing were selected to represent ignition sources seen in industry experience. The test program collected data to support better realism in determining the ZOI of transient fires (HRR, heat flux, and plume temperature). The test program also collected data to support improved realism in fire modeling of transient fires (effective heat of combustion, soot yield, and carbon monoxide (CO) yield).

1.3 Report Organization

This report documents the selection of test items, the experimental setup, and a summary of results for the tests. A companion report developed in the second phase of this research provides industry guidance for transient fires in FPRAs. This report is organized as follows:

- Section 2 summarizes prior testing and the industry experience based on transient fire events in the FEDB.
- Section 3 documents the items selected for fire testing and their method of ignition.
- Section 4 discusses the experimental setups.
- Section 5 discusses the methods applied to postprocess the test data.
- Section 6 discusses the results of testing.
- Section 7 lists the references.
- Appendix A summarizes transient fire events in the FEDB.
- Appendix B summarizes the peak HRR, fuel diameter, flame height, heat of combustion, soot and CO yield, and fire Froude number for each test.

- Appendix C summarizes the comparison of peak plume temperature and heat flux data collected during each test to that predicted by the FDTs.
- Appendix D summarizes the computed vertical (plume temperature) and horizontal (heat flux) ZOI for sensitive electronics damage, TP cable damage, Kerite Fire Retardant (FR) cable damage, TS cable damage, and sustained cable tray ignition for each test.
- Appendix E summarizes the fire growth parameters for each test.
- Appendix F contains a brief one-page test summary report for each test. The test data are attached to this report electronically.

2
REVIEW OF NUREG/CR-6850 AND THE EPRI FIRE EVENTS DATABASE

2.1 Review of Transient Fire Tests Used in NUREG/CR-6850

This section provides a review of the 27 transient fire tests listed in NUREG/CR-6850, Table G-7, which are used to establish the 98th percentile transient heat release rate (HRR) of 317 kW. Table 2-1 shows the tests. Two-thirds of the tests have fire sizes over 50 kW. Eight of the tests are substantially similar to events in the Electric Power Research Institute (EPRI) Fire Events Database (FEDB). The remaining tests represent fuel materials, fuel arrangements, or amounts of fuel not seen in the FEDB events. One-third of the tests involve significant quantities of flammable liquid.

Table 2-1
Transient Fire Tests from NUREG/CR-6850

Fuel Package	Peak HRR (kW)	Comments
0.3 m x 0.4 m x 0. 3 m (12” x 16” x 12”) box with 7.6 cm (3”) stack of printer paper and remainder crumpled paper	26	Similar fuel package listed in the FEDB (Fire ID 30459).
0.3 m x 0.4 m x 0. 3 m (12” x 16” x 12”) box with 7.6 cm (3”) stack of printer paper and remainder crumpled paper	21	Similar fuel package listed in the FEDB (Fire ID 30459).
Three 42 L (11 gal.) polyethylene trash bags with 36 polystyrene cups, 51 paper cups, and 2.7 kg (6 lb) of paper towels	351	Test performed for airlines. No multiple trash bag events were noted in the FEDB.
Two 42 L (11 gal.) polyethylene trash bags with 24 polystyrene cups, 38 paper cups, and 1.8 kg (4 lb) of paper towels	297	Test performed for airlines. No multiple trash bag events were noted in the FEDB.
Single 42 L (11 gal.) polyethylene trash bags with 12 polystyrene cups, 17 paper cups, and 0.9 kg (2 lb) of paper towels	159	Test performed for airlines. Similar fuel packages listed in the FEDB (Fire IDs 248, 20376, and 30351).
Single 19 L (5 gal.) polyethylene trash can with polyethylene trash bag, 0.5 kg (1 lb.) of cotton rags, and 0.34 kg (0.7 lb.) of paper	24	Similar fuel packages listed in the FEDB (Fire IDs 248, 20376, and 30351).
Single 19 L (5 gal.) polyethylene trash can with polyethylene trash bag, 0.5 kg (1 lb.) of cotton rags, and 0.3 kg (0.7 lb.) of paper	12	Similar fuel packages listed in the FEDB (Fire IDs 248, 20376, and 30351).

Table 2-1
Transient Fire Tests from NUREG/CR-6850 (continued)

Fuel Package	Peak HRR (kW)	Comments
9.5 L (2.5 gal.) polyethylene bucket with 0.5 kg (1 lb.) box of Kimwipes, 0.9 L (1 qt) of acetone, and a polyethylene wash bottle	145	A plastic bucket with paper or debris is listed in the FEDB (Fire ID 132). Fires with large quantities of flammable liquid are rare.
0.3 m x 0.4 m x 0. 3 m (12” x 16” x 12”) box with 0.5 kg (1 lb.) box of Kimwipes, 0.9 L (1 qt) of acetone, and a polyethylene wash bottle	109	A cardboard box with paper or debris is listed in the FEDB (Fire ID 30459). Fires with large quantities of flammable liquid are rare.
0.3 m x 0.4 m x 0. 3 m (12” x 16” x 12”) box with 0.5 kg (1 lb.) box of Kimwipes, 0.9 L (1 qt) of acetone, and a polyethylene wash bottle	97	A cardboard box with paper or debris is listed in the FEDB (Fire ID 30459). Fires with large quantities of flammable liquid are rare.
9.5 L (2.5 gal.) polyethylene bucket with 0.5 kg (1 lb.) box of Kimwipes, 0.9 L (1 qt) of acetone, and a polyethylene wash bottle	34	A plastic bucket with paper or debris is listed in the FEDB (Fire ID 132). Fires with large quantities of flammable liquid are rare.
9.5 L (2.5 gal.) polyethylene bucket with 0.46 kg (1 lb.) box of Kimwipes, 0.9 L (1 qt) of acetone, and a polyethylene wash bottle	32	A plastic bucket with paper or debris is listed in the FEDB (Fire ID 132). Fires with large quantities of flammable liquid are rare.
0.4 kg (0.9 lb.) of computer paper, 0.5 kg (1 lb.) box of Kimwipes, 0.9 L (1 qt) acetone. Unspecified polyethylene container	32	A plastic bucket with paper or debris is listed in the FEDB (Fire ID 132). Fires with large quantities of flammable liquid are rare.
13.7 kg (29.8 lb) of White Fir, 0.5 (1.1 lb) kg of excelsior, 0.7 kg (1.5 lb) of ethanol	327	Wood was arranged into a wood crib. This does not represent any item listed in the FEDB. The use of ethanol as the ignition source does not represent typical ignition events involving wood fuels in the FEDB.
9 kg (20 lb) of Douglas Fir with 0.1 L (0.1 qt) of JP-4 (jet fuel)	217	Wood was arranged into a crib of 5 sticks x 8 layers. This does not represent any item listed in the FEDB. The use of jet fuel as the ignition source does not represent typical ignition events involving wood fuels in the FEDB.
6.4 kg (14.1 lb) of Douglas Fir with 0.7 kg (1.5 lb) of JP-4	186	Wood was arranged into a crib of 2 sticks x 2 layers plus 4 sticks x 7 layers. This does not represent any item listed in the FEDB. The use of jet fuel as the ignition source does not represent typical ignition events involving wood fuels in the FEDB.
0.30 m (1 ft) tall pile of 4.5 kg (9.9 lb) of clothing (unspecified fiber)	60	While clothing items are listed in the FEDB, they are typically single items being worn by a person performing hot work and not arranged in a stack.

Table 2-1
Transient Fire Tests from NUREG/CR-6850 (continued)

Fuel Package	Peak HRR (kW)	Comments
0.3 m (1 ft) tall pile of 2.7 kg (5.9 lb) of fabric (unspecified fiber)	50	Similar fuel sources are listed in the FEDB (various textiles), but they are generally either fire retardant (FR) material or not arranged in a pile.
113 L (30 gal.) polyethylene trash can with 1.5 kg (3.3 lb) of paper and a polyethylene liner	113	Trash can events listed in the FEDB although the type of can (plastic or metal) is typically not specified.
1.5 kg (3.3 lb) of straw and grass, 2.5 kg (5.5 lb) of eucalyptus duff, 121 L (32 gal.) trash bag	343	Large quantities of combustible fibers are not expected in a trash bag in a nuclear power plant (NPP) setting. No similar event of this quantity is listed in the FEDB. There is one event involving a much smaller quantity of wood fiber—the dust collection bag for a handheld belt sander.
11.4 kg (25.1 lb) of rags, 7.7 kg (17 lb) of paper towels, 5.9 kg (13 lb) of plastic products, 5.9 kg (13 lb) of methanol, two 151 L (40 gal.) polyethylene trash bags	119	Multiple trash bag fires are not listed in the FEDB, nor is there indication of trash bags with that quantity of combustible material. No transient events are listed with such a large quantity of flammable liquid as the ignition source.
11.4 kg (25.1 lb) of rags, 7.7 kg (17 lb) of paper towels, 5.9 kg (13 lb) of plastic products, 5.9 kg (13 lb) of methanol, two 151 L (40 gal.) polyethylene trash bags	119	Multiple trash bag fires are not listed in the FEDB nor is there indication of trash bags with that quantity of combustible material. No transient events are listed with such a large quantity of flammable liquid as the ignition source.
9.1 kg (20 lb) of crumpled paper, two polyethylene trash bags	109	Multiple trash bag fires are not listed in the FEDB.
13.6 kg (30 lb) of crumpled paper, two 189 L (50 gal.) plastic trash cans	109	Multiple trash container fires are not listed in the FEDB.
13.6 kg (30 lb) of crumpled paper, two 189 L (50 gal.) plastic trash cans	109	Multiple trash container fires are not listed in the FEDB.
6.6 L (1.7 gal.) polyethylene trash container, twelve 0.9 L (1 qt) milk cartons	64	While paper milk cartons are an unlikely fuel, plastic buckets with a mix of paper and plastic are seen in the FEDB.
4.6 kg (10.1 lb) of crumpled paper, 31.8 kg (70.1 lb) of computer paper, two polyethylene trash bags	40	Multiple trash bag fires are not seen in the FEDB.

2.2 Review of Transient Fires in the Fire Events Database

Researchers reviewed all events in the EPRI FEDB (1990–2015) in which the combustible group was set to a transient material or the event was noted as a transient event in NUREG-2169, *Nuclear Power Plant Fire Ignition Frequency and Non-Suppression Probability Estimation Using the Updated Fire Events Database*, issued January 2015 [6]. The review included both challenging and nonchallenging events as the population of fuel materials between the two are not substantially different. The review ignored some events in the FEDB, namely fires that occurred in locations not considered in a FPRA. Some examples are cigarette disposal containers with still smoldering cigarettes located outside of buildings (these containers are designed for this) and fires, for example, in the administration building and cafeteria. The result is a list of 682 events. Appendix A summarizes these events.

Ignition sources for transient fires can be grouped into 11 categories, summarized below in Table 2-2. Hot work represents 65 % of transient events. All types of electrical failures represent 15 percent. All types of contact with hot surfaces (includes almost all lighting events) are 10 % of events. Smoking represents 4 % of events. Note that most smoking events were ignored as discussed above; however, some events were not screened out, as the event description either indicated an interior trash can or the location was not clearly outside of a building. Ignition sources for approximately 4 % of events are unknown. The remaining 2 % are a mix of other rare sources of ignition.

Table 2-2
Transient Fire Ignition Sources

Ignition Source	Description	Number of Events
Hot Surface	Electric heater, piping, heat tape, exhaust manifold	50
Hot Work	Welding, cutting, grinding	445
Lighting	Portable or fixed lighting source	21
Lightning	Lightning strike	1
Misc. Electrical	Unknown electrical failure (short, overheated wire, or other failure)	7
Overheated Wire	Excessive current draw on a wire	55
Roofing	Roofing activities (i.e., hot tar use)	3
Self-Heating	Exothermic chemical reactions occurring in the fuel package	10
Short/Arc	Arcing or shorting of electronics or cables	37
Smoking	Improper discarding of smoking materials	26
Unknown	Insufficient information in FEDB to identify the source	27

Table 2-3 breaks down the 445 hot work events into 34 categories based on the fuels ignited. The “unknown” category represents events with little or no description of the fuel source. The other category represents single events for a fuel source or mixes of fuels with no clear predominant fuel. The top four categories of tape, rags, clothing/personal protective equipment (PPE) (almost all were clothes being worn by the individual doing hot work), and fire/welding blanket, represent 36 % of the events. None of these represents a fuel that would result in a fire of any significance (under the size of a small, plastic, office trash can [7] or 30–50 kW).

The next four categories (plastic, other, debris, and cloth) represent 20 % of the events. Some of the plastic and cloth (most cloth events are Herculite®, a manufacturer of fire-resistant, plastic-coated or composite fabrics) might have quantities capable of resulting in a significant fire; however, most of the events in these four categories (the second 20 percent) would not result in a fire larger than 30–50 kW. The table entries in bold represent categories in which testing results show small fires for all fuel packages (see Section 6). The bolded entries represent 56 % of the fire events. The nonbolded entries do not all represent larger fires, only that some of the events could be larger depending on the specific quantity of material. The underlined events had some fuel packages in which the test HRR was over 317 kW; however, most of these events would not have involved sufficient quantities to reach that fire size.

Table 2-3
General Categories of Hot Work Transient Events

Category[1]	Percent[2]	Category	Percent
Tape	10.8%	Trash	2.0%
Rags	9.0%	**Tool bag**	1.8%
Clothing/PPE	8.8%	**Welding machine**	1.8%
Fire/Welding blanket	7.4%	Cardboard	1.6%
Plastic	7.2%	Foam	1.6%
Other	4.7%	Insulation	1.6%
Debris	4.5%	**Mop**	1.3%
Cloth	3.8%	Oily Rag	1.3%
Oxy-acetylene hose	3.6%	**Duct**	1.1%
Unknown	3.4%	PPE bag	0.9%
Paper	3.1%	**Absorbent pad**	0.7%
Tarp	3.1%	Acetylene	0.7%
Wood	2.9%	**Paint**	0.7%
Filter	2.5%	Cable	0.4%
Flammable liquid	2.2%	Chair	0.4%
Plastic bag	2.0%	**Hose**	0.4%
Power cord	2.0%	Rope	0.4%

[1]Note: Bolded items represent categories in which representative items from Table 3-2 all had a peak HRR below 50 kW. Underlined items had some representative items with a peak HRR over 317 kW.

[2]The percentages are rounded to the nearest tenth of a percent. Due to this rounding, the values may not sum to 100%.

Table 2-4 breaks down the 237 non-hot-work events into 27 categories based on the fuels ignited. The “unknown” category includes events with little or no description of the fuel source. The “other” category represents single events for a fuel source or mixes of fuels with no clear predominant fuel. The top four categories (power cord, other, debris, and trash) represent 63 % of the events. Most of these represent fuels that would not result in a fire of any significance (under the size of a small, plastic, office trash can [7] or 30-50 kW). The table entries in bold represent categories in which testing results show small fires (see Section 6). The bolded entries represent 54 % of the fire events. The underlined events had some fuel packages in which the test HRR was over 317 kW. The single italicized event was a fire involving a plastic work cart that contained a laptop, test equipment, instrumentation and power cables, and other combustibles. This fire resulted in sprinkler operation and is the largest transient fire observed in the FEDB. The nonbolded entries do not all represent larger fires, only that some of the events could be larger depending on the specific quantity of material.

Table 2-4
General Categories of Non-Hot-Work Transient Events

Category[1]	Percent[2]	Category	Percent
Power cord	28.7%	Unknown	1.7%
Other	13.5%	Cable	1.3%
Debris	11.0%	Cardboard	1.3%
Trash	10.1%	**Paper**	1.3%
Flammable liquid	3.8%	**Tape**	1.3%
Oily rags	3.4%	**Absorbent pad**	0.8%
Rag	3.4%	Cloth	0.8%
Battery	2.5%	**Mop**	0.8%
Light	2.5%	Vacuum	0.8%
Wood	2.5%	**Filter**	0.4%
Clothing/PPE	1.7%	**Hose**	0.4%
Plastic	1.7%	**Paint**	0.4%
Rope	1.7%	*Plastic cart*	0.4%
Tarp	1.7%		

[1]Note: Bolded items represent categories in which representative items from Table 3-2 all had a peak HRR below 50 kW. Underlined items had some representative items with a peak HRR over 317 kW. The italicized item was the worst event observed in the FEDB.

[2]The percentages are rounded to the nearest tenth of a percent. Due to this rounding, the values may not sum to 100%.

2.3 Observations from NUREG/CR-6850 and the Fire Events Database

Researchers made a number of observations about the tests selected for NUREG/CR-6850 compared with the operating experience seen in the FEDB. Taken together, the following observations demonstrate that the tests selected in NUREG/CR-6850 to define the generic transient fire scenario are not well matched to the industry events:

- Two-thirds of the tests selected for NUREG/CR-6850 have HRRs over 50 kW, whereas the opposite is true for the FEDB.
- One-third of the tests selected for NUREG/CR-6850 involve large quantities of flammable liquid. Only 3 % of transient events in the FEDB involve flammable liquid.
- NUREG/CR-6850 contains multiple tests (e.g., wood cribs) that do not reflect any transient event seen in the FEDB.
- In some cases, the flammable liquids in the NUREG/CR-6850 tests were present to facilitate full involvement of the fuel package (e.g., wood cribs). Such a long-duration, intense-ignition source (multiple minutes of a pool fire) is not representative of transient fire ignition sources seen in the FEDB.
- Approximately one-half of the tests in NUREG/CR-6850 involve large quantities of refuse in trash bags or large trash cans. In the FEDB, this is only seen in 2 % of hot work events and 10 % of other transient events.
- 15 % of the tests in NUREG/CR-6850 involve a cardboard box as part of the fuel. Cardboard appears as a significant part of the fuel in less than 2 % of all events in the FEDB.

3
IGNITION METHODS AND TEST ITEMS

This section of the report details the ignition sources used during testing and describes the fuel packages tested along with their method of ignition.

3.1 Ignition Methods

As discussed in Section 2, the most common ignition methods for fire events involving transient combustible material in the EPRI Fire Events Database (FEDB) were welding and cutting (slag and sparks), overheated wires and shorts, work lights, and smoking materials. To represent these sources, the ignition methods shown in Table 3-1 were used during testing.

Table 3-1
Test Item Ignition Methods

Method	Description
Lighter	Butane fireplace lighter. Used for easily ignited items where the lighter can be safely held to the side of the test item.
Wick	A 7.6 cm (3 in.) piece of 1.2 cm (0.5 in.) diameter nylon rope. The ends of the rope have a 6 mm (0.25 in.) wide double wrap of duct tape to prevent unravelling of the rope. Immediately before placement on the test item, 5 mL of heptane was applied to the wick. The wick was ignited with the lighter immediately after placement. It is used primarily for items that are easily ignited but require ignition inside the test item. The wick burns for 4 to 5 minutes with a peak heat release rate (HRR) of approximately 2 kW.
Flame	A small continuous propane flame approximately 7 to 10 cm (3 to 4 in.) in size from a piece of 6 mm (0.25 in.) metal tubing. It is used for items for which longer ignition times are expected. The propane flame has an HRR of approximately 100 W.
Panel	A flat radiant panel with dimensions approximating a typical halogen work lamp. The panel to test item distance was established to provide a 30 kW/m^2 incident heat flux at the fuel surface.

The justification for the propane flame and nylon wick ignition sources is based on energy fluxes that would be expected from molten metal contact with a combustible (welding slag or arcing debris). Steel melts at temperatures near 1400 °C (2552 °F) [8]; the exact melting point depends on the specific alloy. The flaming ignition sources are all laminar flames with peak flame temperatures around 1800 °C (3272 °F). Most lightweight combustible items have unpiloted ignition temperatures at or below 500 °C (932 °F) [9]. Using the density and specific heat of steel from Reference 4, a 2 cm (0.8 in.) diameter pool of molten steel that is 1 cm (0.4 in.) thick would have an excess energy for heating a flammable material compared to the autoignition temperature on the order of 10 kJ. The continuous flame outputs approximately 6 kJ per minute of usage, and the 5 mL of heptane in the wick ignition source has an energy content of 170 kJ based on its heat of combustion [5].

The most common ignition source in the FEDB for non-hot-work transient events is a power cord as listed in Table 2-2. The flame ignition sources listed in Table 3-1 are expected to characterize a generic power cord ignition event. To meet listing requirements, most alternating current (AC) power cords are thermoset (TS) jacketed wires. From the data in NUREG/CR-6850, the jacket would be expected to quickly fail at elevated temperatures because of degradation of the plastic jacket. Cord temperatures much beyond 400 to 500 °C (752 to 932 °F), caused by an overcurrent, for example, would not be expected for lengthy periods of time because of rapid insulation and jacket degradation. Once the insulation and jacket have degraded, the likely result would be a short that trips a circuit breaker or creates an open circuit from a break in the wire. All the flame ignition sources listed in Table 3-1 have flame temperatures that are much higher than the maximum expected cord surface temperature (caused by overcurrent). A shorted wire would result in a spark with significantly higher temperatures; however, the power would be limited to a small region and the total energy would be a small fraction of the instantaneous electrical power within the wiring. A lengthy duration of arcing would not be expected before either failure of the wire or tripping of the circuit. While flame temperatures are lower than the arc temperature, the duration of flame is measured in minutes versus, at most, seconds for a hot short.

Another common ignition source listed in the FEDB for transient events is portable lighting (hot surface). A typical work halogen light has a bulb with a rated power of 500 to 1,000 W and a size on the order of 0.2 m x 0.2 m (8 in. x 8 in.). If all the power output were to heat the glass face, this would be the equivalent of a 25 kW/m^2 radiant panel. While a large fraction of the heat is directed to the glass face, there are heat losses through the sides and back. A minimum radiant panel flux of 30 kW/m^2 would be a conservative representation of a work lamp.

The above discussion shows that for items that require more than a very brief exposure to an ignition source, the experimental sources are reasonable surrogates for the actual ignition sources.

3.2 Test Items

A total of 99 fuel packages were selected for testing. Each fuel package was tested multiple times, with most packages having three tests. A total of 290 tests were performed. Researchers selected packages with the following factors:

- The fuel package represents a common item in the FEDB. For example, power cords represent 11 % of all transient events and wood represents 3 % of all transient events.
- The fuel package represents a potentially significant event in the FEDB. For example, FEDB Event 50749, which involved a plastic work cart (the italicized event in Table 2-4) resulted in sprinkler operation and thus was potentially a high HRR event.
- The fuel package represents an item known to be regularly present but that has not yet seen an event. For example, small personal electronic devices (phones and tablets) do not yet have a fire event listed in the FEDB; however, they are known to be present and have a history of fire outside of the nuclear industry.

Table 3-2 shows a complete list of the items tested. The table gives a short descriptive name of the test item, a detailed description of the item, the size of the calorimeter used (hood size in terms of the maximum fire size), the ignition method, and the number of tests. The ignition source was selected based on the discussions in Table 3-1. Some detailed descriptions contain

notes on the rationale for selecting the item or other fuel packages the item might represent. A few test items were tested using two hood sizes. EPRI sponsored the tests performed using the 100 kW hood, and the Nuclear Regulatory Commission (NRC) sponsored the tests performed using the 1 MW and 3 MW hoods.

Table 3-2
Test Item Descriptions

Test Item	Description	Hood Size	Ignition Method	# Tests
Single Rag	Single cotton rag in loose ball on the floor	100 kW	Lighter	4
Single Rag w/Heptane	Single cotton rag with 25 mL of heptane in a loose ball on the floor. Heptane is used as a surrogate for any flammable solvent that might be used for cleaning and degreasing.	100 kW	Lighter	4
Five Rags	Five cotton rags in loose pile on the floor	100 kW	Lighter	4
Five Rags w/Heptane	Five cotton rags with 25 mL of heptane per rag in a loose pile on the floor	100 kW + 1 MW	Lighter	3 + 3
Rags w/Oil	Three to four cotton rags with linseed oil (from cleanup of residual oil from the oil bottle tests).	1 MW	Flame	2
Bag of Rags	0.5 kg (1.1 lb) plastic bag of 12 cotton rags	100 kW	Lighter	3
Single Oil Pad	38 cm x 48 cm (15 in. x 19 in.) polypropylene sorbent pad	100 kW	Wick	3
Single Oil Pad w/Oil	38 cm x 48 cm (15 in. x 19 in.) polypropylene sorbent pad with ~80 g linseed oil	100 kW	Wick	3
Four Oil Pads	Stack of four 38 cm x 48 cm (15 in. x 19 in.) polypropylene sorbent pads	100 kW	Wick	3
Four Oil Pads w/Oil	Stack of four 38 cm x 48 cm (15 in. x 19 in.) polypropylene sorbent pads with ~400 g linseed oil	100 kW	Wick	2
Cardstock Wall	Single sheet of cardstock paper taped to cement board	100 kW	Lighter	3
Cardstock Air	Single sheet of cardstock paper suspended in air	100 kW	Lighter	3
Small Binder Closed	2.5 cm (1 in.) three-ring binder filled with paper, binder closed	100 kW	Lighter	1
Small Binder Open	2.5 cm (1 in.) three-ring binder filled with paper, binder open	100 kW	Lighter	2
Large Binder Closed	7.6 cm (3 in.) three-ring binder filled with paper, binder closed	100 kW	Lighter	3
Large Binder Open	7.6 cm (3 in.) three-ring binder filled with paper, binder open	100 kW	Lighter	2
Pad of Paper	ANSI letter-size pad of paper	100 kW	Lighter	3

Table 3-2
Test Item Descriptions (continued)

Test Item	Description	Hood Size	Ignition Method	# Tests
Uncoiled 120 V Cord	3 m (10 ft) length of contractor grade extension cord (12 gauge/3 conductor) uncoiled	100 kW	Flame	1
3 m Coil 120 V Cord	3 m (10 ft) length of contractor grade extension cord (12 gauge/3 conductor) coiled	100 kW	Flame	3
7.6 m Coil 120 V Cord	7.6 m (25 ft) length of contractor grade extension cord (12 gauge/3 conductor) coiled	100 kW	Flame	3
15.2 m Coil 120 V Cord	15.2 m (50 ft) length of contractor grade extension cord (12 gauge/3 conductor) coiled	1 MW	Flame	3
7.6 m Coil 250 V Cord	7.6 m (25 ft) coil of 250 V extension cord (8 gauge/3 conductor)	1 MW	Flame	3
Oxy-Acetylene Hose	Uncoiled oxy-acetylene hose	100 kW	Flame	2
Empty Bucket	Empty 3.8 L (2 gal.) plastic bucket	100 kW	Flame	4
Bucket w/Debris	3.8 L (2 gal.) plastic bucket filled 50 % with equal parts by weight of shredded packing paper, pine animal litter, and sweeping compound	100 kW	Wick	3
Debris Pile	200 g each of shredded packing paper, pine animal litter, and sweeping compound in thin pile on floor	100 kW	Wick	3
Mop + Bucket	Wooden handled rag mop in plastic bucket 38 cm x 46 cm x 28 cm (15 in. x 18 in. x 11 in.)	1 MW	Wick	2
Tablet	25 cm (10 in.) tablet computer	100 kW	Flame	3
Tablet + Plastic Case	25 cm (10 in.) tablet computer in plastic clipboard case with a pad of paper	100 kW	Flame	2
Tablet + Metal Case	25 cm (10 in.) tablet computer in metal clipboard case with a pad of paper	100 kW	Flame	1
Laptop	36 cm (14 in.) laptop computer with plastic case	100 kW	Flame	3
Power Spider	6-outlet, 250 VAC, 30 A power spider	100 kW	Flame	2
Small Box Empty	6.3 L (0.22 ft^3) 10 cm x 21 cm x 30 cm (4 in. x 8 in. x 12 in.) cardboard box, empty. This size is representative of a typical flat-rate box used by express delivery services.	100 kW	Wick	4
Small Box w/Paper	6.3 L (0.22 ft^3) 10 cm x 21 cm x 30 cm (4 in. x 8 in. x 12 in.) cardboard box, 50 % filled with crumpled paper. Crumpled paper is representative of packing paper or packaging materials.	100 kW	Wick	3

Table 3-2
Test Item Descriptions (continued)

Test Item	Description	Hood Size	Ignition Method	# Tests
Small Box w/Peanuts	6.3 L (0.22 ft^3) 10 cm x 21 cm x 30 cm (4 in. x 8 in. x 12 in.) cardboard box, 50 % filled with polystyrene packing peanuts. Peanuts are representative of the mass of foam packaging materials or plastic air pouches.	100 kW	Wick	3
Medium Box Empty	28 L (1 ft^3) box, empty. This box size is representative of a printer paper box or typical box size used in shipping fluid containers (e.g. case of 3.8 L (1 gal.) containers).	100 kW + 1 MW	Wick	3+3
Medium Box w/Paper	28 L (1 ft^3) box, 50 % filled with crumpled paper	100 kW	Wick	3
Medium Box w/Peanuts	28 L (1 ft^3) box, 50 % filled with polystyrene packing peanuts	100 kW	Wick	3
Large Box Empty	227 L (8 ft^3) box, empty. This box is representative of a typical box size for bulk paper products, light bulbs, etc.	1 MW	Wick	4
Large Box w/Paper	227 L (8 ft^3) box, 50 % filled with shredded paper	1 MW	Wick	3
Large Box w/Peanuts	227 L (8 ft^3) box, 50 % filled with polystyrene packing peanuts	1 MW	Wick	3
HVAC Filter	51 cm x 51 cm (20 in. x 20 in.) filter with 50 g of sweeping compound	100 kW	Wick	3
Blower Duct	20 cm (8 in.) diameter, PVC, flexible blower duct	1 MW	Wick	3
Duct Tape Roll	Roll of duct tape	100 kW	Wick	3
Duct Tape Wall	13 cm (5 in.) strip of duct tape attached to cement board	100 kW	Lighter	1
Short Duct Tape Air	13 cm (5 in.) strip of duct tape suspended in air	100 kW	Lighter	2
Long Duct Tape Air	1.5 m (5 ft) strip of duct tape suspended in air	100 kW	Lighter	3
Uncoiled Tubing	3.0 m (10 ft) Tygon tubing uncoiled	100 kW	Flame	3
7.6 m Coil Tubing	7.6 m (25 ft) coil of Tygon tubing	100 kW	Flame	3
15.2 m Coil Tubing	15.2 m (50 ft) coil of Tygon tubing	100 kW	Flame	3

Table 3-2
Test Item Descriptions (continued)

Test Item	Description	Hood Size	Ignition Method	# Tests
Tool Bag	Canvas tool bag w/ hand tools, wires, wire nuts, multimeter (AAA batteries), flashlight (AA batteries), cordless drill (lithium ion batteries)	100 kW	Flame	2
Metal Trash Quarter	113 L (30 gal.) metal can, trash bag, five 0.48 L (16 oz) plastic water bottles, 300 g paper	100 kW	Wick	3
Metal Trash Half	113 L (30 gal.) metal can, trash bag, ten 0.48 L (16 oz) plastic water bottles, 600 g paper	100 kW	Wick	3
Metal Trash Full	113 L (30 gal.) metal can, trash bag, twenty 0.48 L (16 oz) plastic water bottles, 1200 g paper	100 kW	Wick	3
Metal Trash Full Lid	113 L (30 gal.) metal can with lid with 25 cm (10 in.) hole, trash bag, twenty 0.48 L (16 oz) plastic water bottles, 1200 g paper. The lid with a hole represents the typical opening on trash cans with flame arrestor lids.	100 kW	Wick	2
Plastic Trash Quarter	132 L (35 gal.) plastic can, trash bag, five 0.48 L (16 oz) plastic water bottles, 300 g paper	1 MW	Wick	3
Plastic Trash Half	132 L (35 gal.) plastic can, trash bag, ten 0.48 L (16 oz) plastic water bottles, 600 g paper	1 MW	Wick	3
Plastic Trash Full	132 L (35 gal.) plastic can, trash bag, twenty 0.48 L (16 oz) plastic water bottles, 1200 g paper	1 MW	Wick	3
Scissor Stand Quarter	Metal scissor stand with plastic trash bag containing two sets of personal protective equipment (PPE) (Tyvek suit, gloves)	1 MW	Wick	3
Scissor Stand Half	Metal scissor stand with plastic trash bag containing four sets of PPE (Tyvek suit, gloves)	1 MW	Wick	3
Scissor Stand Full	Metal scissor stand with plastic trash bag containing eight sets of PPE (Tyvek suit, gloves)	1 MW	Wick	3
Plastic Tarp Folded	3 m x 3.7 m (10 ft x 12 ft.) non-fire retardant (FR) plastic tarp folded into ~ 0.6 m x 0.6 m (2 ft x 2 ft)	100 kW	Wick	3
Plastic Tarp Draped	1.5 m x 3.7 m (5 ft x 12 ft),1 test, or 1.8 m x 3.7 m (6 ft x 12 ft), three tests, plastic tarp folded twice and draped over a metal rod	1 MW	Wick	4
FR Plastic Tarp Folded	3 m x 4.8 m (10 ft x 15 ft) FR plastic tarp folded into ~0.6 m x 0.9 m (2 ft x 3 ft)	1 MW	Wick	1
FR Plastic Tarp Draped	3 m x 4.8 m (10 ft x 15 ft) FR plastic tarp draped over a metal rod	1 MW	Wick	2
Canvas Tarp Folded	3.7 m x 4.8 m (12 ft x 15 ft) canvas tarp folded	100 kW + 1 MW	Wick	3 + 1

Table 3-2
Test Item Descriptions (continued)

Test Item	Description	Hood Size	Ignition Method	# Tests
Canvas Tarp Draped	3.7 m x 4.8 m (12 ft x 15 ft) canvas tarp draped on a metal rod	1 MW	Wick	2
Welding Blanket Folded	Folded fiberglass welding blanket	100 kW	Wick	3
Welding Blanket Draped	0.6 m x 1.2 m (3 ft x 6 ft) fiberglass welding blanket draped over a metal rod	1 MW	Wick	3
Uncoiled Small Rope	3.0 m (10 ft) of small diameter polypropylene rope. Uncoiled.	100 kW	Wick	3
7.6 m Coil Small Rope	7.6 m (25 ft) coil of small diameter polypropylene rope	100 kW	Wick	3
15.2 m Coil Small Rope	15.2 m (50 ft) coil of small diameter polypropylene rope	100 kW	Wick	3
Uncoiled Large Rope	3.0 m (10 ft) of 1.9 cm (3/4 in.) nylon rope. Uncoiled.	100 kW	Wick	3
7.6 m Coil Large Rope	7.6 m (25 ft) coil of 1.9 cm (3/4 in.) nylon rope.	100 kW	Wick	3
15.2 m Coil Large Rope	15.2 m (50 ft) coil of 1.9 cm (3/4 in.) nylon rope. Uncoiled.	1 MW	Wick	3
Uncoiled Chain	3.0 m (10 ft) of 2.5 cm (1 in.) plastic chain. Uncoiled	100 kW	Flame	3
7.6 m Coil Chain	7.6 m (25 ft) coil of 2.5 cm (1 in.) plastic chain	100 kW	Flame	3
15.2 m Coil Chain	15.2 m (50 ft) coil of 2.5 cm (1 in.) plastic chain	100 kW + 1 MW	Flame	2+3
Single Cone	30 cm (12 in.) plastic safety cone. Also represents other small plastic objects such as slippery floor caution signs, foreign materials exclusion plugs, etc.	100 kW	Flame	3
Four Cones	Stack of four 30 cm (12 in.) plastic safety cones	100 kW	Flame	3
Plastic Chair	White plastic, stackable patio chair. This item should bound many small upholstered office chairs.	1 MW	Flame	3
Plastic Stanchion	Plastic chain stanchion	1 MW	Flame	3
First Aid Kit	Plastic 25-person first aid kit	100 kW	Flame	3
Lift Slings	Loose pile of four 1.5 m (5 ft) long nylon lift slings	100 kW	Wick	3
Single PPE	Single set of disposable overalls, gloves, booties, and respirator. This package would also be bounding for other single items of clothing such as pants, shirts, sweatshirts.	100 kW	Wick	3

Table 3-2
Test Item Descriptions (continued)

Test Item	Description	Hood Size	Ignition Method	# Tests
Stack PPE	Four sets of disposable overalls, gloves, booties, and respirator	1 MW	Wick	2
Metal Chair	Metal folding chair with plastic-covered foam seat and back cushions	100 kW	Flame	5
Vacuum Closed	Plastic case wet/dry vacuum with closed lid filled with 280 g of paper, sweeping compound, and pine shavings.	1 MW	Wick	2
Vacuum Open	Plastic case wet/dry vacuum with lid removed filled with 280 g of paper, sweeping compound, and pine shavings.	1 MW	Wick	2
Laptop + Cart	102 cm x 66 cm (40 in. x 26 in.) two-shelf plastic cart with 36 cm (14 in.) laptop computer, 3-ring binder with paper, and printer/fax machine. This package replicates the worst event observed in the FEDB.	1 MW + 3 MW	Flame	1+2
Water Hose	15.2 m (50 ft) coil of 1.6 cm (5/8 in.) black rubber water hose	1 MW	Flame	3
Wood Block Flame	0.6 m (2 ft) length of nominal 8 in. x 8 in. wood. Representative of wood used for cribbing.	100 kW	Flame	5
Wood Block Panel	0.6 m (2 ft) length of nominal 8 in. x 8 in. wood.	100 kW	Panel	3
Pallet Flame	Wood shipping pallet	1 MW	Flame	2
Pallet Panel	Wood shipping pallet	1 MW	Panel	3
Plank Flame	Nominal 2 in. x 10 in. x 8 ft. pine board. This is representative of planks used for scaffolding.	1 MW	Panel	3
Plank Panel	Nominal 2 in. x 10 in. x 8 ft. pine board	1 MW	Panel	3
Alcohol Bottle	250 mL plastic wash bottle, 50 % full of methanol.	1 MW	Flame	3
Oil Bottle	250 mL plastic wash bottle, 50 % full of linseed oil. Linseed oil is a nontoxic surrogate for lube oils or other high-flashpoint lubricants.	1 MW	Flame	3

4
EXPERIMENTAL SETUP AND METHOD

4.1 Test Facility Experimental Setup

4.1.1 100 kW Calorimeter

The 100 kW calorimeter is a test apparatus located in the Baltimore, MD, fire testing laboratory of Jensen Hughes. The apparatus is an insert that can be placed under a 1 MW calorimeter located in the laboratory.

The 100 kW calorimeter (see Figure 4-1) incorporates an exhaust hood measuring 1.2 m by 1.2 m (48 in. by 48 in.) with skirts located 1.3 m (59 in.) above floor level. The top of the hood transitions to a circular cross section duct, with internal diameter (D) of 20 cm (8 in.). An orifice plate located over 10 duct diameters from the hood is used to generate a differential pressure between measurement points P_1 and P_2. Thermocouples (TCs) downstream of the orifice plate, T_1/T_2, are used to determine the flow temperature and density using the ideal gas law. Combined pressure drop and density can be used to compute the volume flow and mass flow in the duct. Two gas sampling locations are located in the duct. The upstream location, S_1, was used during testing. A sampling pump is used to extract a small flow of gas, approximately 1 L/min. This gas flow is filtered to remove soot and dried to remove water vapor. The conditioned gas is then split and fed into three gas analyzers measuring oxygen (O_2), carbon dioxide (CO_2), and carbon monoxide (CO) gas concentrations. Gas concentrations, along with the flow rate, are used to determine the heat release rate (HRR), as discussed in Section 5.1. The duct also contains a 5 mW, 670 nm, red laser downstream of the orifice plate. The laser is directed at an amplified Si photodiode that outputs a voltage signal proportional to the light intensity. The decrease in voltage signal from ambient conditions is used to measure the soot density in the duct, as discussed in Section 5.2.

Test samples were placed on a 226.8 kg (500 lb) capacity load cell. The load cell was used to measure the mass loss rates of test samples as they burn. To prevent thermal damage to the load cell, a piece of cement board was placed on top of furring strips placed on top of the load cell. The cement board was replaced as needed because of cracking or accumulation of residue from test samples. The top of the cement board was 20 cm (8 in.) above the floor.

Plume temperature measurements were made above the test sample. Measurements were made using a two-level grid of TCs. Each grid contained nine 24-gauge, type K TCs. The center TC of each grid was centered over the load cell. The lower grid had a 15 cm (6 in.) spacing between TCs, and the upper grid has a 23 cm (9 in.) spacing. The grids are independently moveable with the maximum height of the upper grid being the bottom of the hood skirt.

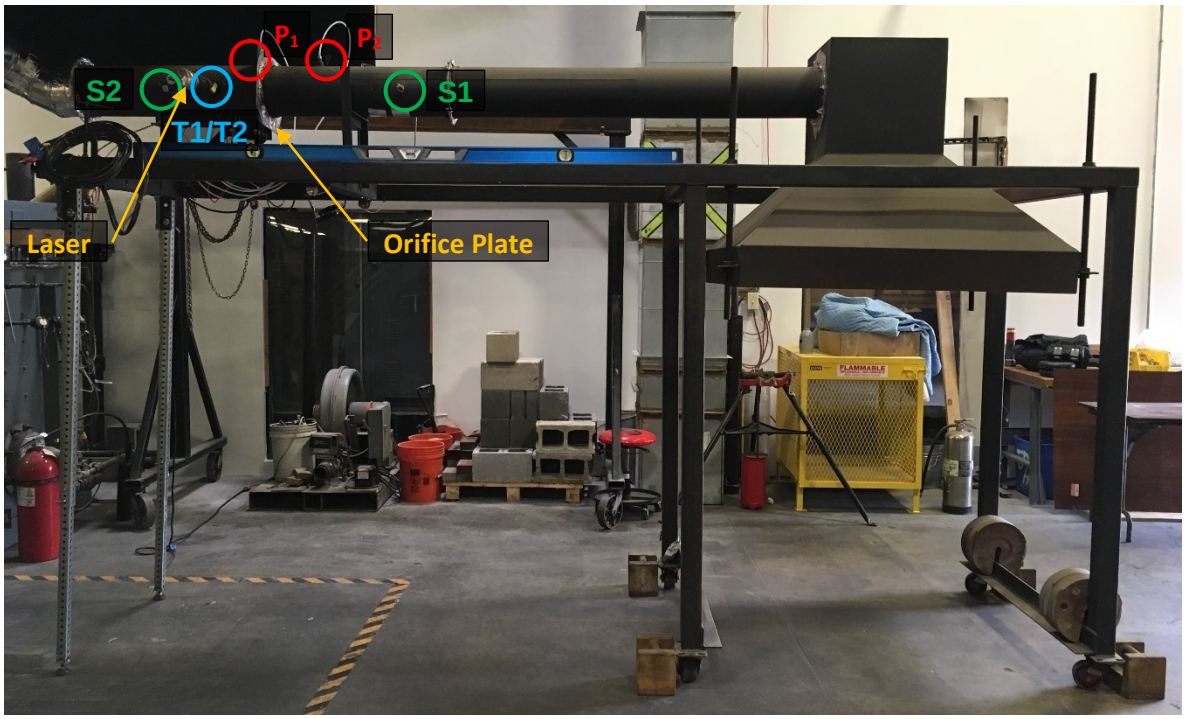


Figure 4-1
100 kW Calorimeter Located at the Jensen Hughes Baltimore Test Facility

Two heat flux gauges were centered behind the load cell. The gauges are 25 kW/m^2, water-cooled, Schmidt-Boelter heat flux gauges. The gauges were attached to a ring stand. The height of each gauge on the ring stand can be independently set, and the ring stand can be moved to change the distance of the gauges from the test sample.

Flame height was measured visually. A piece of wall board was placed behind the load cell at the edge of the hood. The board was marked with elevation lines. Peak flame height was determined from the test video and then corrected for the camera view angle as discussed in Section 5.3.

Figure 4-2 and Figure 4-3 show the layout of the additional instrumentation mentioned above.

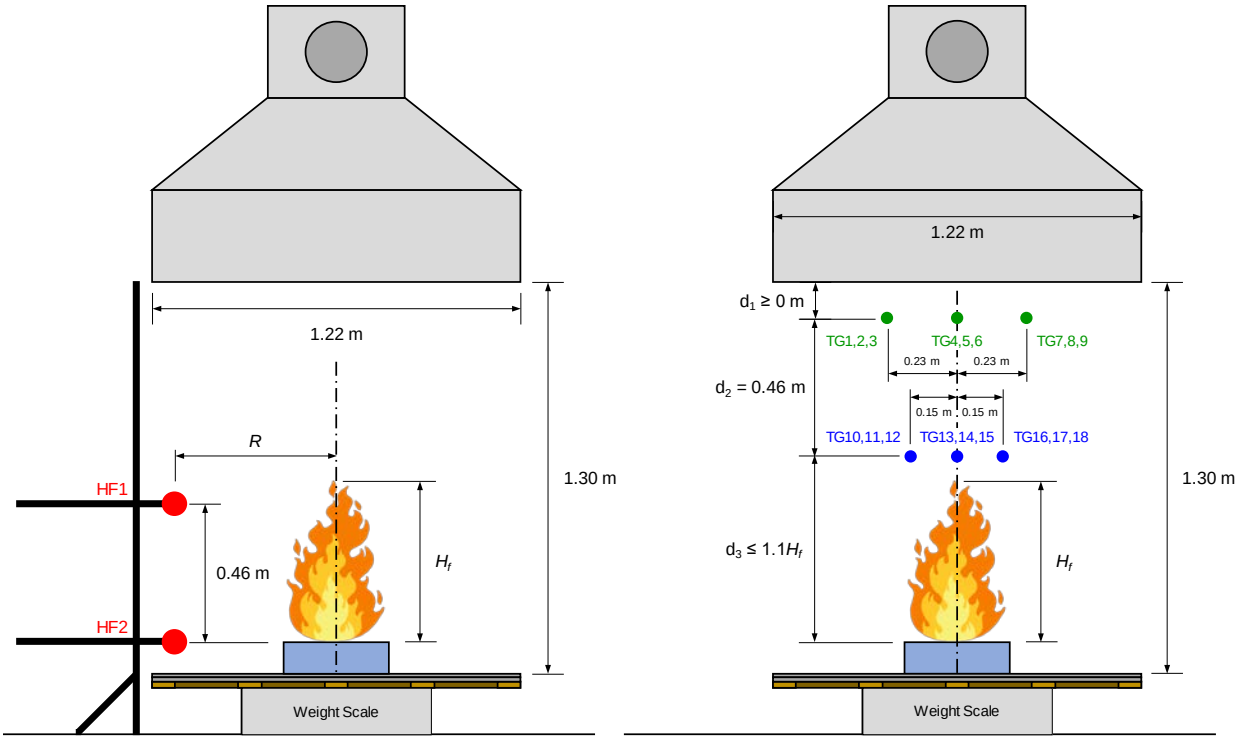


Figure 4-2
Elevation View Schematic of Heat Flux (Left) and Temperature (Right) Instrumentation for the 100 kW Calorimeter

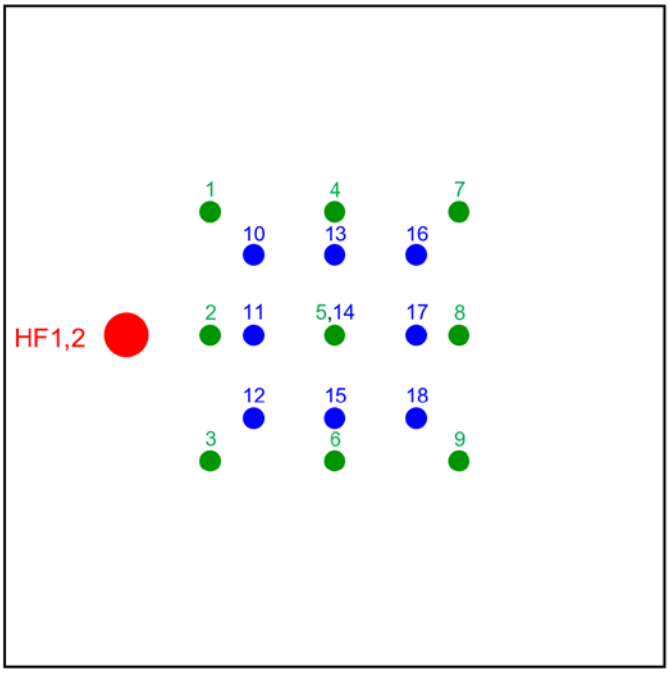


Figure 4-3
Plan View Schematic of Heat Flux and Temperature Instrumentation for the 100 kW Calorimeter

4.1.2 National Fire Research Laboratory 1 and 3 MW Calorimeters

The 1 MW and 3 MW calorimeters are located in the National Fire Research Laboratory (NFRL) at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. The 1 MW calorimeter is a 3 m by 3 m (10 ft by 10 ft) hood, and the lower edge is approximately 1.5 m (5 ft) above the floor. The 3 MW calorimeter is a 6 m by 6 m (20 ft by 20 ft) hood, and the lower edge is approximately 4.6 m (15 ft) above the floor. This calorimeter was not originally planned for use; however, the HRR of the first test of the laptop + cart fuel package was large enough that there were concerns about the accuracy of the 1 MW calorimeter HRR measurements for this test.

The exhaust ducts for the hoods contained similar instrumentation, as discussed for the 100 kW calorimeter. Gas concentration measurements were made for CO, CO_2 and O_2. Smoke obscuration was measured using a laser; however, the laser in the 3 MW calorimeter was nonoperational during testing. Flow measurements in the 1 MW and 3 MW calorimeters were made using an array of velocity probes instead of an orifice plate. Space limitations in the building did not allow for a sufficiently long length of duct to obtain a fully developed flow profile. Instead, a flow straightener was used to flatten the flow profile, and a series of commissioning tests with flow mapping in the duct, along with computational fluid dynamics modeling of the exhaust, was used to correlate the duct flow measurements with the total duct flow.

The load cell used for these calorimeters had a 150 kg (330.7 lb) maximum capacity. Cement board and a steel pan (when needed) were placed on the load cell to hold the samples.

Like the 100 kW calorimeter, two TC grids were placed above the sample platform. Each grid had nine, 30-gauge, type K TCs. The lower grid had a spacing of 23 cm (8 in.) and the upper grid has a spacing of 30 cm (12 in.). The grid heights could be adjusted independently.

Heat flux was measured using a pair of plate thermometers and a pair of 25 kW/m^2, water-cooled, Schmidt-Boelter heat flux gauges. The gauges were attached to a ring stand. The height of each pair of a plate thermometer and heat flux gauge on the ring stand can be independently set, and the ring stand can be moved to change the distance of the gauges from the test sample. A plate thermometer is a thin metal plate backed by a piece of mineral wool insulation. A TC is attached to the backside of the plate. The plate thermometer measures a quantity known as the adiabatic surface temperature. Heat flux can be extracted from this measurement using an inverse heat transfer method [10].

All tests were recorded using a digital video camera. A piece of wall board demarcated with a scale was attached to the skirt of the 1 MW calorimeter to allow an estimation of the flame height. No height scale was attached to the 3 MW calorimeter. Instead, the height of the TC racks was used to estimate the flame height during the handful of tests that used the 3 MW calorimeter.

4.1.3 Data Uncertainty

The estimated uncertainties for the various key measurements and derived quantities are temperature—0.4 %, CO concentration—1 %, soot density—15 %, heat flux—3 %, HRR—11 %, mass—5 g 1 MW / 3 MW or 10 g 100 kW, CO yield–2 to 10 %, exhaust duct flow—1.6 %, soot yield—15 to 18 %, heat of combustion—10 to 14 %, and flame height—5%.

Temperature and heat flux uncertainties represent the intrinsic uncertainty of the measurement device. The HRR uncertainty is taken from NIST SP 1007, *The NIST 3 Megawatt Quantitative Heat Release Rate Facility*, issued 2003 [11]. The soot density uncertainty is primarily caused by the uncertainty in the assumed mass extinction coefficient [12]. The uncertainty in the yields

and heat of combustion results from uncertainty in the species or HRR, the duct flow, and the mass loss. For small mass losses, the scale resolution becomes a significant contributor to the overall error. The upper end of the error range would be representative of small mass losses (about 100 grams (g)), and the lower end of the range is the limit for large mass losses (about 1,000 g or more). Flame height errors primarily result from the likelihood that the highest flame height was not fully captured on video and the uncertainty in the location of the peak flame with respect to the camera.

For usage in the FDT^S comparisons, the total experimental uncertainty in plume temperature is 7 %, heat flux is 11 %, and flame length is 7 %. The additional uncertainty over the measured experimental data accounts for the added uncertainty from the primary input to the FDT^s, which is the HRR. For example, the plume temperature is a function of the HRR to the two-thirds power; therefore, an 11 % heat release error translates to a 7 % plume temperature error.

The published uncertainties of the FDT^S correlations for temperature [13] and heat flux, based on the Fleury test only [14], are respectively 33 % and 28 %. These correlations are the basis for the ZOI determination. Propagating the error into the correlations gives estimated errors in ZOI distances of 20 % and 16 %.

4.2 Testing Procedures

4.2.1 Test Protocol

Tests were conducted in general accordance with American Society for Testing and Materials (ASTM) E2067-15, *Standard Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests* [15]. The protocol is summarized below.

The following checks were performed at the start of each test day:

- Gas analyzers were zeroed and spanned.
- Instrumentation was checked for normal ambient readings.
- Facility ventilation systems were aligned for testing.
- Fire suppression systems were readied for use (water hose and extinguisher).

The test protocol was as follows:

- Before each new test item:
  - A safety briefing was given to address any safety concerns specific to that test item.
  - TC grids and heat flux gauge positions were changed. TC grids were placed with the lower grid at the expected flame height and the upper grid generally placed 46 cm (18 in.) above the lower grid. Heat flux gauges were placed with the bottom gauge at the top of the sample and the upper gauge 46 cm (18 in.) above. Gauge heights were adjusted as needed to avoid shadowing from the TC grids. The gauge distances were set to obtain, if possible, a peak heat flux in the range of 6 to 11 kW/m^2 based on an estimated peak HRR. The minimum gauge distance for the 100 kW calorimeters was approximately 23 cm (9 in.) and for the 1 MW and 3 MW was 61 cm (24 in.).
- The hood flow rate was set based upon the expected rate of heat release for the test sample.
- The test sample and ignition method were prepared.

- Video collection was started.
- The test sample was placed on the load cell. If melting of the sample was expected, the test platform was covered with foil or a pan was placed on top of the load cell.
- A preignition background was collected.
- The sample was ignited, and the ignition time was logged.
- Data collection continued until no visible flame occurred or an extended period of time had passed since starting the ignition method with no sustained ignition of the sample (at least 10 minutes).
- Following flameout or unsuccessful ignition, posttest data were collected to obtain a posttest background used to tell if significant drift in background gas concentrations had occurred over the test.
- Test sample remains were removed from the sample platform.
- If needed, the sample platform and pan (if used) were allowed to cool before starting the next test.

4.2.2 Data Processing

4.2.2.1 100 kW Calorimeter

Four data files were created for each test. The files all begin with the test ID, which consists of the date of the test and the test number for that day (I-CAL-YEAR-MONTH-DAY-TEST#). The four files are as follows:

1. testID.csv—This file contains the raw data for all instruments except for the load cell.
2. testID-serial.csv—This file contains the raw data for the load cell.
3. testID-commentary.txt—This file contains any written commentary logged by the test engineer.
4. testID-events.csv—This file contains the time for key events during the test. Examples include starting video recording, ignition of sample, and flameout.

Test data were processed using a set of MATLAB scripts. The MATLAB scripts compute the HRR, apply a 5-second sliding window of time-averaging, shift the data in time to set the ignition time as 0 s, compute the yields of CO and soot, compute the heat of combustion, determine the maximum temperature for each TC grid, and write a summary Microsoft Excel file containing key processed data. The Excel file was then edited by hand to populate a summary page containing the test-specific details, such as the sample and instrumentation locations, as well as to select test photos or video frame grabs for key points in the test. The processed data portion of each Excel file was exported as a comma separated value (csv) file. The resulting csv files are attached to this report electronically.

4.2.2.2 National Fire Research Laboratory 1 and 3 MW Calorimeters

Two data acquisition (DAQ) systems named BONCHI and KEROSENE were used for the NFRL calorimeters. The BONCHI system recorded the data from the calorimeter instrumentation and the load cell. The KEROSENE system recorded the data from the TC grids, heat flux gauges, and plate thermometers. Immediately posttest, the two DAQ systems process the test data and created five files per test. The files each start with a test ID consisting of the date, the DAQ system name, and the test name (test number for the test series and the sample name). The following files were created:

1. testID-raw.csv—This file contains the raw voltage data collected by the DAQ system. For TCs, the units are temperature. For other devices, the units are volts (V) and, in a few cases, ohms.
2. testID-scaled.csv—This file contains the data processed into scaled units. For example, raw voltage for a gas analyzer is converted to volume fraction. The file also contains derived outputs such as the HRR and mass flow. The HRR is adjusted for the delay caused by the transport time from the duct to the gas analyzers.
3. testID-output.xls—This Excel file contains a descriptive listing of all the DAQ channels being recorded, a summary of the test setup, and a list of key events such as ignition and flameout.
4. testID-startup.log—This is a text file containing a log of system events during the DAQ system startup.
5. testID-stdev.csv—This file contains the standard deviation of voltage over the 1-second sampling period for each measurement.

After the initial data processing occurred on each DAQ system, the KEROSENE system extracted key data from both systems and saved the data to a csv file also called testID-scaled.csv. These files are attached to the report electronically. This was followed by the creation of a pdf file containing a quick look report with an HRR plot, summary details of the test, a list of test events, and integrated species production and consumption and energy release.

5
DATA ANALYSIS METHODS

This section describes the methods used to postprocess the test data.

5.1 Heat Release Rate

The heat release rate (HRR) is computed using oxygen consumption calorimetry. In brief, this method uses a hood to capture the products of combustion from a fire. These are extracted from the hood using an instrumented duct. The duct measures the flow rate and concentrations of combustion products. The oxygen deficit from ambient (oxygen consumption) plus the concentrations of carbon dioxide (CO_2) and carbon monoxide (CO) are used to compute the HRR. The theoretical HRR of the burner, Q, is computed using Equations 5-1 and 5-2 (adapted from Parker [16] and Janssens [17]).

$$Q = EAC\sqrt{\frac{\Delta P_e}{T_e}}X_{O_2}^{\circ}\left(\frac{\phi - B(1-\phi)\,X_{CO}/X_{O_2}}{(1-\phi)+\alpha\phi}\right) \quad \textbf{(5-1)}$$

$$\phi = \frac{X_{O_2}^{\circ}\left(1 - X_{CO_2} - X_{CO}\right) - X_{O_2}\left(1 - X_{CO_2}^{\circ}\right)}{X_{O_2}^{\circ}\left(1 - X_{O_2} - X_{CO_2} - X_{CO}\right)} \quad \textbf{(5-2)}$$

where X is a species mole fraction where ° indicates an ambient value, T_e is the duct temperature (K), ΔP_e is the differential pressure (Pa) across the orifice plate in the duct, E is the energy released per unit mass of oxygen (kJ/kg), A is duct area (m^2), C is the calibration parameter for the mass flow rate, α is the molar expansion factor from fuel and air to products, and B is a term quantifying the reduction in energy released from the formation of incomplete products of combustion (e.g., CO).

The following are the major sources of error in oxygen consumption calorimetry:

- The intrinsic error of the measurement devices in the exhaust duct.
- Combustion products do not all immediately enter the exhaust duct. Some of the combustion products mix with gases present under the hood and have a delayed entry into the duct. This means the hood does result in some time-averaging of the HRR. If data collection continues for a brief period following the end of the fire, then the hood will measure the total energy production of the fire; however, very short peaks will experience time-averaging.
- Escape of smoke from the hood will result in measuring a lower than actual HRR. This can occur if smoke production exceeds the hood exhaust capacity or the test sample is geometrically large compared to the hood size, such that the hood is incapable of capturing all the smoke. In this test program, this source of error was mitigated by the initial selection of test facility for each test package based on its expected HRR. Physically large packages or packages where the HRR could potentially exceed 100 kW were tested in the 1 MW calorimeter. If needed, test packages were retested using the 3 MW calorimeter.

- Using the generic value of 13,100 kJ of heat release per kg of O_2 consumed, typical transient-type fuels would be expected to be within 10 % of this value [18].

5.2 CO Yield, Soot Yield, and Heat of Combustion

The CO yield, or the mass of CO produced as a fraction of the mass of fuel burned, is determined by dividing the total mass of CO transported in the exhaust duct by the mass of fuel burned during the test. The mass of fuel burned is determined from the difference in the fuel mass before and after the test. The mass of CO produced is determined from the concentration measurements in the duct and the duct mass flowrate. The duct measures the mole fraction of CO, which can be converted to a mass fraction using the assumed molecular weight discussed in Section 5.1. Multiplying the mass fraction by the duct mass flow rate gives the mass flow rate of CO. Integrating this over the burning duration gives the total CO production.

The soot yield is determined in a similar manner to the CO yield. Multiplying the soot density in the gas by the duct mass flow rate and integrating over time gives the total soot production. The soot density is computed using a laser extinction measurement. A laser is passed through the duct onto a photometer that outputs a voltage proportional to the initial incident light intensity, I_0 (W/m²). The decrease in voltage from its pretest value indicates the fraction of laser light unattenuated by the smoke. By assuming an extinction coefficient, κ =8700±1100 m²/kg [12], the soot density, ρ_s (kg/m³), is computed as shown in Equation 5-3:

$$I = I_0 e^{-\rho_s \kappa L} \quad \textbf{(5-3)}$$

Where I is the light intensity at the measured location (W/m²) and L is the pathlength (the width of the exhaust duct at the laser location). Note that, in both facilities, the laser and photodiodes are mounted in short lengths of tube attached to the exhaust duct. A small inflow is provided to keep smoke from entering the tubes and ensure that the pathlength is the duct diameter; however, some smoke ingress into the tubes is likely, which adds uncertainty to the effective path length. This uncertainty is assumed to be 5 % of the duct diameter.

The heat of combustion is determined by integrating the measured HRR over the burning duration and dividing by the total mass loss.

These parameters all require a measurement of the mass loss during the test. The test mass loss was taken as the change in mass measured by the hood load cell during the test. The 100 kW hood load cell had an approximately 20 g (0.04 lb) resolution. The load cell for the 1 MW hood was transferred to the 3 MW, and that load cell had an approximately 10 g (0.02 lb) resolution. In some cases, pre- and post-test mass measurements were available for small samples. In general, for tests with low mass loss rates or tests with no flaming ignition, no computation of soot yield, CO yield, or heat of combustion was performed. Additionally, as there was no functioning laser in the 3 MW hood, the soot yield was not computed for the tests using that hood.

5.3 Flame Height

Flame height is determined from video collected during each test. The video camera records the fire with a vertical scale visible in the background. Each test video was watched to determine the peak flame height seen on the scale. Since the flame height is generally not equal with the height of the lens, the observed flame height needs to be corrected for the perspective view. The flame height as seen on the video is the linear projection onto the vertical scale of the line from the video camera lens to the tip of the flame. The actual flame height location can then be

determined by scaling the observed flame height with the ratio of the distance of the camera to flame tip and the distance of the camera to the vertical scale. The actual flame tip location relative to the load cell platform is not well known; however, for adjusting the perspective of the camera, it is assumed as the center of the load cell platform.

5.4 Fire Froude Number (Q^*)

A fire Froude number, Q^* [4], is computed for each test item using the peak HRR and the fire diameter at the peak. The fire Froude number is a measure of the intensity of the fire source. Very low Q^* fires are associated with smoldering like conditions and very high Q^* fires would be associated with momentum-driven fire sources like a petrochemical flare. For the same peak HRR, a lower Q^* will increase the radial distance, where radiation is a potential hazard, and a higher Q^* will increase the height above the fire, where the plume is a potential hazard. For the hot gas layer, a lower Q^* will result in a deeper, cooler layer, and a higher Q^* will result in a shallower, hotter layer.

$$Q^* = \frac{Q}{\rho_\infty T_\infty c_{p,\infty}\sqrt{gD}} \quad \textbf{(5-4)}$$

where ρ_∞ is the ambient density (1.18 kg/m^3 for a standard atmosphere with 40 % humidity at 1 atmosphere and 298.15 K), T_∞ is the ambient temperature (298.15 K), $c_{p,\infty}$ is the ambient specific heat at constant pressure (1.02 kJ/(kg K) for a standard atmosphere with 40 % humidity), g is the acceleration of gravity (9.81 m/s^2), and D is the fire diameter in meters.

5.5 Comparison of Fire Dynamics Tools with Testing

Section 5.6 discusses the method used to determine the ZOI for each test. This approach makes use of the FDT^S [5]. The validity of the ZOI calculation is dependent upon the validity of applying the FDT^S to the HRR data collected during the test. Since the testing measured the incident heat flux and the plume temperature, the peak flux, temperature, or flame height computed with the FDT^S can be compared against the values measured during the test. Since the type-K thermocouples (TCs) used in testing have an upper measurement limit of 1,000 °C the FDT^S for the plume temperature was also limited to 1,000 °C.

The FDT^S correlation for flame height, L_f in meters, is the Heskestad correlation shown in Equation 5-5 as a function of the fire size, $\dot{Q}$ (kW) and the effective fire diameter, D (m):

$$L_f = 0.235Q^{2/5} - 1.02D \quad \textbf{(5-5)}$$

The FDT^S correlation for plume temperature, T_p in Kelvin, at a distance z in meters above the base of the fire is shown in Equation 5-6, where χ_r is the radiant fraction of the fire.

$$T_p = T_\infty + 9.1\left(\frac{T_\infty}{{\rho_\infty}^2 {c_{p,\infty}}^2 g}\right)^{1/3}\left((1-\chi_r)Q\right)^{2/3}(z-z_0)^{-5/3} \quad \textbf{(5-6)}$$
$$z_0 = 0.083Q^{2/5} - 1.02D$$

The FDT^S correlation for radiant heat flux, in kW/m^2, is the solid flame model for a target located above the base of the fire. The ZOI is the maximum distance at which a target can be affected by a fire. For the solid flame model, the maximum heat flux is obtained for a target that is oriented vertically at an elevation equal to one-half of the flame height above the base of the fire. At that height, the resulting FDT^S correlation is shown in Equation 5-7, where E is the emissive power in kW/m^2 and R is the distance of the target in meters from the edge of the fire.

$$\dot{q}'' = EF$$

$$F = 2\left(\frac{1}{\pi S}\tan^{-1}\left(\frac{h}{\sqrt{S^2-1}}\right) - \frac{h}{\pi S}\tan^{-1}\left(\sqrt{\frac{S-1}{S+1}}\right) + \frac{1}{\pi S\sqrt{A^2-1}}\tan^{-1}\left(\sqrt{\frac{(A+1)(S-1)}{(A-1)(S+1)}}\right)\right) \quad \textbf{(5-7)}$$

$$h = \frac{L_f}{D}, \qquad S = \frac{D+2R}{D}, \qquad A = \frac{h^2+S^2+1}{2S}, \qquad B = \frac{1+S^2}{2S}$$

The FDT^S calculation for heat flux used the modified emissive power calculation documented in [14]. The FDT^S calculation as published in Reference 5 uses the Shokri-Beyler [19, 20] correlation, which was developed using very large hydrocarbon fires. As discussed in [14], this correlation is overly conservative when fire diameters drop below diameters on the order of 1 m (3 ft). Only a few test items had diameters on the order of 1 m (3 ft) or more. The modified correlation, shown in Equation 5-8, selects either the Shokri-Beyler correlation or a radiant-fraction-based emissive power, depending on the net energy radiated:

$$E = Min\left(58\times10^{-0.083D}, \frac{\chi_r Q}{\pi L_f D}\right) \quad \textbf{(5-8)}$$

The fire diameter at the peak HRR was, in some cases, the size of the object (when it is fully involved) and, in other cases, was estimated from test video and photos. The height used for the heat flux calculation was 50 % of the flame height at the peak fire size and diameter as computed by the FDT^S correlation for flame height. Section 4.1.3 discusses the estimated uncertainties of the FDT^s.

The convective and radiant heat release fractions are not known a priori; however, for generic combustibles, the FDT^S guidance [5] is to assume a 30 % radiant fraction (and thus a 70 % convective fraction).

As noted previously, the fire diameter at the peak HRR was either the effective diameter of the test item, for items that become fully involved, or determined by examination of the test video. The fire diameter at other fire sizes is determined by assuming that the fire has the same burning rate throughout the test. For example, if a test item had a maximum HRR of 8 kW with a diameter of 16 cm (6.3 in.), then when the item was at 2 kW, the diameter would be assumed to be 8 cm (3.1 in.), since one-quarter the fire size implies one-quarter of the fire area or one-half the fire diameter.

The distance of the heat flux gauge is determined in a similar manner. Each fuel package was placed at the centerline of the hood. The fire at its maximum HRR is assumed to be centered at the centerline of the hood. This establishes the distance of the gauge from the edge of the fire at its peak HRR. That distance from the edge is kept constant for evaluating other HRRs. That is, the fire is assumed to have started at the distance from the edge given by the peak HRR and then grows inward towards the centerline of the hood. This is a conservative assumption since, in many cases, the item was not ignited at a location closest to the gauge. This is illustrated in Figure 5-1.

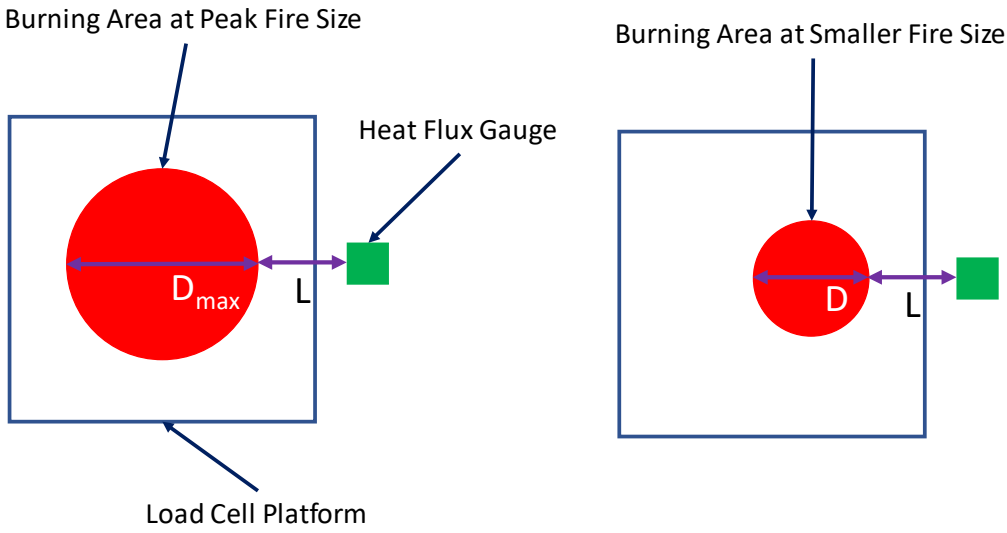


Figure 5-1
Illustration of Heat Flux Gauge Distance from Fire for FDT^S Calculation

A Fortran program was written to evaluate each test. The program was provided a list of all test datafiles along with a unique name for the test, the start and end of the fire in the test data, the laboratory that collected the data (data file formats differed depending on the laboratory), the fire diameter, the vertical locations of the TC grids, and horizontal location of the flux gauges. The program then reads in the test data and, for each time point during the test, computes the plume temperature and radiant flux at the measurement locations. The program outputs a table of the maximum test values compared against the maximum FDT^S computed values as well as files containing time-dependent summaries of the computations.

5.6 Assessing the Zone of Influence

The process described for assessing the FDT^S performance was also applied to determining the ZOI for each test. This ZOI was determined for sensitive electronics not enclosed in a cabinet per Frequently Asked Question (FAQ) 13-0004 [21], thermoplastic (TP) cables, Kerite Fire Retardant (FR) cables, thermoset (TS) cables, and bulk tray ignition.

In a typical FPRA, the ZOI for an ignition source is established using its 98th percentile peak HRR and then applying the FDT^S calculations for plume temperature and heat flux to establish the maximum distance to reach the threshold values for damage. For plume temperature, these values are 65 °C (149 °F) for exposed sensitive electronics [1], 205 °C (401 °F) for TP cable [1], 247 °C (477 °F) for Kerite FR cable [22], 330 °C (626 °F) for TS cable [1], and 500 °C (932 °F) for bulk tray ignition [23].

At the threshold values, the time to damage is not instantaneous. For example, if the exposure is by a fire plume, then tray ignition requires 1 minute of exposure to flame temperature [23] and TP cable damage requires 30 minutes [1] to a minimum temperature of 205 °C (401 °F). For all tests with a significant HRR, the peak HRR only occurred for a brief period. Using only the peak HRR, therefore, would result in a ZOI with poor realism, as targets would spend little time being exposed to the most severe conditions. Instead, a heat soak process [14], previously reviewed by the NRC [24,25,26], was applied, which accounts for time varying exposures. Sections 5.6.1 through 5.6.4 discuss how the heat soak method was applied to sensitive electronics, TP and TS cables, Kerite FR cables, and bulk cable tray ignition.

Briefly, the heat soak method uses the concept of a damage integral. It assumes that exposure to an elevated temperature or heat flux continuously causes damage at a rate that is a function of the exposure. Given sufficient exposure, the accumulation of damage (the integration of the time-dependent damage rate based on exposure) will result in a failure.

Since the heat soak method accounts for the shape of the time-dependent HRR curve, it is possible that a fire with a lower peak HRR will have a larger ZOI than a fire with a larger peak HRR. For example, the Appendix H tables in NUREG/CR-6850 state that it takes a minimum of 1 minute to damage a cable at high exposure temperatures. Consider two fires, (1) a fire that burns at 100 kW for 5 s followed by 20 kW for 125 s and (2) a fire that burns at 50 kW for 60 s. Both of these fires have a total energy release (TER) of 3 MJ. The peak of the first fire is very short compared to the minimum time to damage of 1 minute; therefore, it is the 20 kW that primarily defines the ZOI. This means that the second fire, which spends 1 minute at 50 kW, will have a larger ZOI.

A Fortran program was written to process each test to determine the ZOI. The program took as input a list of tests and their data files, fire diameters, start and end time of the fire, and the test laboratory. For each test, the program read in the HRR data. The ZOI was determined from that data in a two-step process:

1. In the first step, the maximum fire size during the test was used to determine the maximum possible radius and height where damage could occur. This was done by assuming a constant fire at the maximum fire size and locating the height where the plume temperature would no longer cause damage and the radius where the radiation would no longer cause damage. This was performed using the respective values for sensitive electronics of 65 °C (149 °F) and 3 kW/m^2. A search process began at a height and radius of 5 cm (2 in.) and evaluated the plume temperature and heat flux. The distances were increased by 5 cm (2 in.) until the threshold values were no longer reached. The radius and height determined by the search set an upper bound on the ZOI for the test.
2. In the second step, the time-dependent HRR was used to determine the ZOIs for each test. The program begins with the radius and height from the first step and determines whether damage occurs (sensitive electronics damage, TP cable damage, Kerite FR cable damage, TS cable damage, and cable tray ignition) using the heat soak method. The height and radius are decreased in 5 cm (2 in.) increments until no category of damage occurs. The results for each type of damage for temperature and radiation are tabulated in an output file. If no damage occurs for one or more categories, the respective ZOIs are set to 5 cm (2 in.) (i.e., a ZOI floor is set at 5 cm (2 in.).

5.6.1 Sensitive Electronics Zone of Influence

Few data are available on the failure of sensitive electronics caused by heat. NUREG/CR-6850 provides threshold values of 65 °C (149 °F) or 3 kW/m^2 [1]. FAQ 13-0004 [21] allows one to treat sensitive electronics as TS cables if they are contained in an enclosure and neither in direct contact with the face of the enclosure that sees the fire nor immersed in a hot gas layer. Neither of these references provides any insights on the time to damage for sensitive electronics that are directly exposed to heat. For sensitive electronics directly exposed, it was assumed that a minimum of 1 minute must be spent at exposures at or above the threshold exposure for damage to occur. This is consistent with the treatment of TS and TP cables, where the time to damage is always at least 1 minute. That is, at temperatures at or above the threshold values, the rate of damage was defined as 1/min. Below the threshold values, that rate was increased inversely in proportion to the exposure. For example, at an exposure of 1.5 kW/m^2, the rate was set to 2/min. For a plume temperature exposure, the temperature is first

converted to an equivalent heat flux. Note that the heat soak method only predicts damage if both the integral of the damage rate is greater than one and the exposure at that time is over the threshold (i.e., spending hours at just slightly above a typical room temperature of 25 °C (77 °F) will not cause damage).

Note that for sensitive electronics in a cabinet that meet the conditions in FAQ 13-0004, the TS ZOI values would apply.

5.6.2 Thermoplastic and Thermoset Cable Zone of Influence

For TP and TS cables, the heat soak method uses the data in Tables H-5 through H-8 of NUREG/CR-6850 [1] to account for the time-dependent exposure seen by a target. For exposures above the maximum row in each table, the damage time is kept at 1 minute. For exposures below the minimum row in each table, the damage time is scaled as discussed in Section 5.6.1.

5.6.3 Kerite Fire Retardant (FR) Cable Zone of Influence

The series of tests in NUREG/CR-7102, *Kerite Analysis in Thermal Environment of FIRE (KATE-Fire): Test Results—Final Report*, issued December 2011 [22], exposed a selection of 11 Kerite FR cables to a continuously increasing temperature ramp in a penlight furnace. This was a similar setup to that used to gather the data reflected in Appendix H of NUREG/CR-6850. The times to failure in Appendix H were determined from tests exposing a range of TP and TS cables to constant temperatures. The results of testing were assessed to pick reasonable lower bounds to the data for each type of plastic and were compiled in Tables H-5 through H-8. The tests discussed in NUREG/CR-7102 did not use constant temperature exposures; they used a continuously increasing temperature ramp. However, if an adequate thermal model could be created for a Kerite FR cable using thermally induced electrical failure (THIEF) [27], then virtual experiments could be performed to determine the time to damage as a function of a constant exposure temperature.

The THIEF model takes as input a cable outer diameter, a cable mass per unit length (MPUL), the distance of the conductor from the outside of the cable, and a failure temperature. Typically, the conductor distance is just given as the jacket thickness since the insulation thickness is often small in comparison. The simulations in this section used the combined jacket and insulation thickness to avoid any additional bias in the results. The THIEF model treats the cable as a homogenous mass rather than layers of plastic and conductor. It predicts time to damage by solving a one-dimensional cylindrical heat transfer equation until the temperature at the minimum conductor depth exceeds the specified failure criterion. With this framework, shorter times to failure would occur with a lower MPUL, a thinner jacket/insulation thickness, or both. These characteristics mean less mass to heat and a shorter distance over which heating can occur. Conducting virtual experiments with THIEF using the cable described in NUREG/CR-7102 that would have the fastest heating time should yield a bounding set of failure time data for constant temperature exposure boundary conditions.

NUREG/CR-7102 has cable dimensions, wire gauge and strand counts, and jacket and insulation thicknesses. It does not, however, have cable mass data, which are needed to compute the MPUL. Instead, the cable mass was inferred from the cables used to validate THIEF. The cable dimension and mass data from NUREG/CR-7102 for the cables used to validate THIEF were used to compute the effective density of the nonconductor materials in a typical cable. This was done by taking each cable type and subtracting the copper mass from the reported cable mass and dividing by the nonconductor volume. The resulting nonconductor density was averaged over all the cables used for THIEF. This resulted in a nonconductor

density of 967 kg/m^3. Using this value with the density of copper of 9,000 kg/m^3, enabled the computation of the MPUL for the Kerite FR cables in NUREG/CR-7102. Cable A had the lowest mass per unit length of 0.38 kg/m versus 0.49 kg/m for the next lowest. It also has a below-average jacket and insulation thickness of 2.8 mm. Combined, these parameters suggest Cable A is the bounding cable in NUREG/CR-7102. Three penlight tests used Cable A. All three tests were modeled using THIEF. The penlight time-dependent conditions were nearly identical during the three tests; therefore, the cable temperature responses were nearly identical. Figure 5-2 shows THIEF predictions for the first of the three tests, K14. The other two tests have a nearly identical THIEF performance. THIEF slightly overpredicts the time to reach 247 °C (477 °F). The test reached the failure temperature at 608 s and the THIEF prediction was 649 s or an error of 7 %. These results give good confidence that the THIEF model is a reasonable representation of the cable response up until the failure temperature of 247 °C (477 °F).

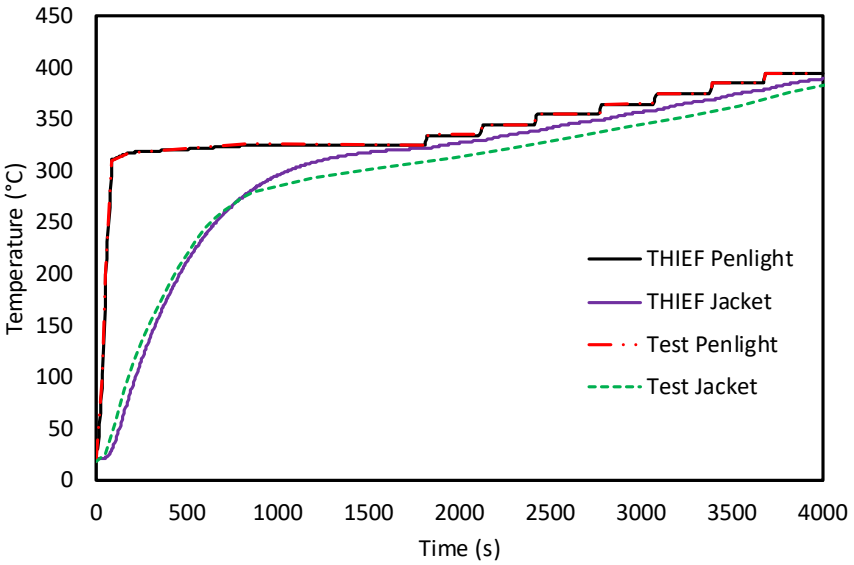


Figure 5-2
THIEF Predictions vs. Data for Kerite FR Cable A Penlight Test K14

THIEF was then run for a series of increasing, constant temperature exposures. Table 5-1 shows the results. One of the observations during the Kerite FR test was that cables began to ignite at or above cable surface temperatures of 420 °C (788 °F). Once ignition took place, the flame exposure caused a sharp increase in the rate at which the cable temperature rose. Therefore, at exposure temperatures over 420 °C (788 °F), the THIEF predictions cannot be relied upon, as ignition is a possibility. As a result, THIEF simulations were not made over that temperature. This also implies that the 5 minute time at 420 °C (788 °F) may not be applicable, as cable ignition would result in rapid cable heating. To account for this, the 420 °C (788 °F) exposure temperature was set to a failure time of 1 minute, which is consistent with the minimum time to failure for TP and TS cables in Appendix H of NUREG/CR-6850. This adjustment was propagated to lower temperatures by applying a ramp of adjustment times. A linear ramp was defined that had no adjustment at the minimum temperature of 250 °C (482 °F) and 4 minutes of adjustment at 420 °C (788 °F). Table 5-2 shows the results of this process, as well as the times for TP and TS cable based on temperature. Since the threshold failure temperature for Kerite FR of 247 °C (477 °F) is between the threshold failure temperature of 205 °C (401 °F) for TP cable and 330 °C (626 °F) for TS cable, it is expected that the Kerite FR damage time for a given exposure would also lie between the times for TP and TS cables.

As seen in Table 5-2, this is the case, and this observation serves as a qualitative validation of the approach. The Kerite FR lies between TP and TS cables but closer to TP cables. This is the expected result, since the failure temperature of Kerite FR is closer to that of TP cables than TS cables.

Table 5-1
THIEF Predictions of Kerite FR Time to Damage for Constant Temperature Exposures

Temperature (°C)	Time to Damage (min)
250	32
260	22
270	18
280	15
290	13
300	12
320	10
340	8
365	7
390	6
420	5

Table 5-2
Damage Time Table for Kerite FR Cables

Temperature Range (°C)	Time to Failure (min)		
	TP	Kerite FR	TS
T < 247	≥ 15	N/A	N/A
247 ≤ T < 250	15	32	N/A
250 ≤ T < 260	15	21	N/A
260 ≤ T < 270	10	17	N/A
270 ≤ T < 280	8–10	13	N/A
280 ≤ T < 290	8	11	N/A
290 ≤ T < 300	7	10	N/A
300 ≤ T < 320	5–6	8	N/A
320 ≤ T < 340	4–5	5	24–N/A
340 ≤ T < 365	2–4	4	10–20
365 ≤ T < 390	1–2	3	8–10
390 ≤ T < 420	1	2	5–7
420 ≤ T	1	1	≤ 5

Table 5-3 shows the damage time in terms of heat flux. These heat fluxes were determined by using the temperature setting of the penlight apparatus, along with the reported emissivity of 0.81 for the penlight apparatus and the assumption of a heat transfer coefficient of 18 W/(m^2·K) This heat transfer coefficient was determined by comparing the heat flux ranges to the temperature ranges in Appendix H of NUREG/CR-6850 and solving for the coefficient needed to obtain the correct heat flux from the temperature.

Table 5-3
Heat Flux Damage Time Table for Kerite FR Cables

Heat Flux Range (kW/m^2)	Kerite FR Time to Damage (min)
$q'' < 7.8$	N/A
$7.8 \leq q'' < 7.9$	32
$7.9 \leq q'' < 8.3$	21
$8.3 \leq q'' < 8.8$	17
$8.8 \leq q'' < 9.3$	13
$9.3 \leq q'' < 9.8$	11
$9.8 \leq q'' < 10.7$	10
$10.7 \leq q'' < 11.9$	8
$11.9 \leq q'' < 13.4$	5
$13.4 \leq q'' < 15.1$	4
$15.1 \leq \dot{q}'' < 17.3$	3
$17.3 \leq q'' < 19.8$	2
$19.8 \leq q''$	1

5.6.4 Bulk Cable Tray Ignition Zone of Influence

For cable tray ignition, the guidance in FAQ 16-0011 of 1 minute at 500 °C (932 °F) or 25 kW/m^2 [23] is used. Below the threshold value, the damage rate is scaled as discussed in Section 5.6.1.

5.6.5 Wall and Corner Zone of Influence

The ZOI for a fire against a wall and in a corner follows the recommended approach in Reference 14. For walls, there is no change to the ZOI from that of a fire in the open.

Research has shown that the presence of a wall does not substantially affect the flame length or plume temperatures above the fire. For the horizontal ZOI, the flame length is the quantity that primarily drives the radiative flux at distance; since the wall flame length is unchanged, the radiative output does not differ significantly. For the vertical ZOI, both the flame length and plume temperatures drive the hazard to a target located vertically above the fire. Since these do not differ significantly, there is no change to the vertical ZOI.

For a fire in a corner, research shows that the flame length is increased. This increase is reasonably characterized by assuming a fire in the open with four times the HRR and twice the diameter (four times the area). When determining the vertical ZOI for a fire in a corner, the HRR and fire diameter are increased by the applicable factors when computing the plume temperature. No change is made for computing the horizontal ZOI. With an increased flame height, the fire releases the same energy over a longer distance above the fire base. Since the only correction to the plume temperature is a correction to the plume entrainment, this implies that the radiative output of the fire has not significantly changed. If it had, then an additional correction beyond the entrainment correction would be required. Since the same radiative output is being emitted over a longer distance above the fire base, the radiative output at a distance will be slightly less than for an open fire. The open fire ZOI will bound that for a fire in a corner.

5.7 Fire Growth and Decay

The HRR data for each test were visually examined to identify the time to peak, the length of time the peak HRR is realized, and the decay time. Power law fits were then applied to the data to determine the rate of fire growth and the rate of fire decay. Tests where the HRR was limited to that of the ignition source or the peak HRR was below 2 kW were not assessed.

The fire growth rate was determined by fitting a power law ($f(x) = a\,x^b$) equation to the time versus HRR during the growth time. Since the noise in the HRR data signal can result in negative HRR when the actual HRR is near zero, the start time for the fit was shifted as necessary to avoid negative values. In tests with very long growth periods or with secondary peaks, the start time was shifted to reflect the growth rate of the primary peak.

The decay time used a power law fit applied to the dataset with a shifted time and HRR value. The time was shifted to put the start of the decay period at 0 s. The HRR value was shifted to be the peak HRR minus the current HRR.

This process is illustrated using test 09_06_001 Metal Trash Full. Figure 5-3 plots the HRR data and the visually determined end of the growth time and start of the decay time. This part of the process is subjective, as a test might have more than one peak, and there may not be a clear plateau. Figure 5-4 shows the process of fitting power laws to the growth and decay period. Lastly, Figure 5-5 shows the resulting HRR curve. Equation 5-9 shows the equation plotted in Figure 5-5, where q_{peak} is the peak HRR in kW; n_1 and n_2 are the growth and decay exponents from the fits shown in Figure 5-4; and t_p, t_g, and t_d are the growth, plateau, and decay exponents in seconds. Note that in Equation 5-9, the power law fit in Figure 5-4 is forced to go to zero at the end of the test, whereas the actual power law only asymptotes to zero at infinity.

$$q(t) = \begin{cases} q_{peak}\left(\frac{t}{t_g}\right)^{n_1} & t \le t_p \\ q_{peak} & t_g < t \le t_g + t_p \\ q_{peak}\left(1 - \left(\frac{t - t_g - t_p}{t_d}\right)^{n_2}\right) & t_g + t_p < t \le t_g + t_p + t_d \end{cases} \quad \textbf{(5-9)}$$

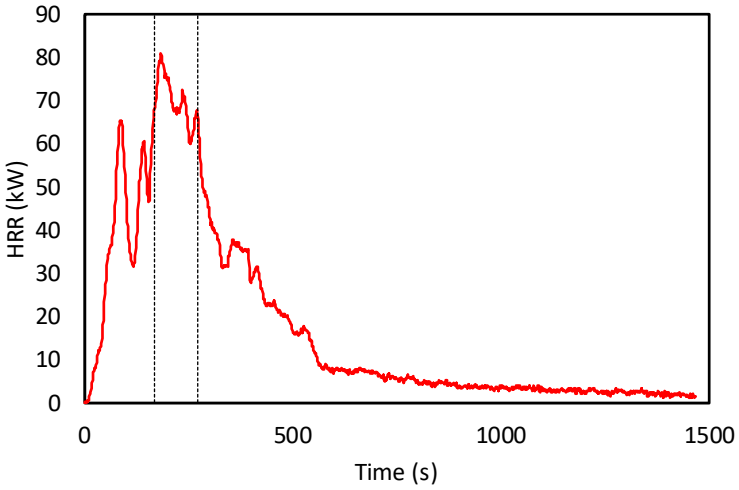


Figure 5-3
Defining Start (t_g) and Stop ($t_g + t_p$) of HRR Plateau (Dashed Vertical Lines) for Test 09_06_001

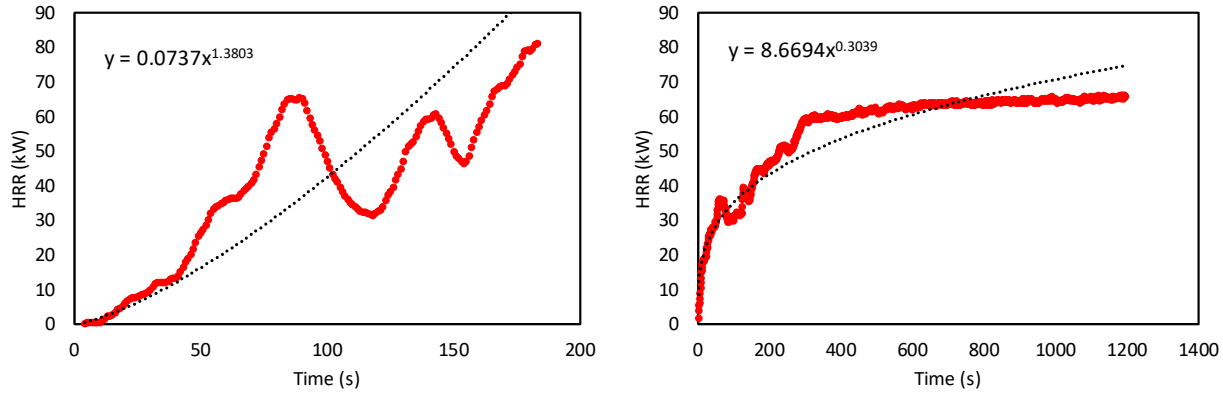


Figure 5-4
Power Law Fits to Growth and Decay for Test 09_06_001

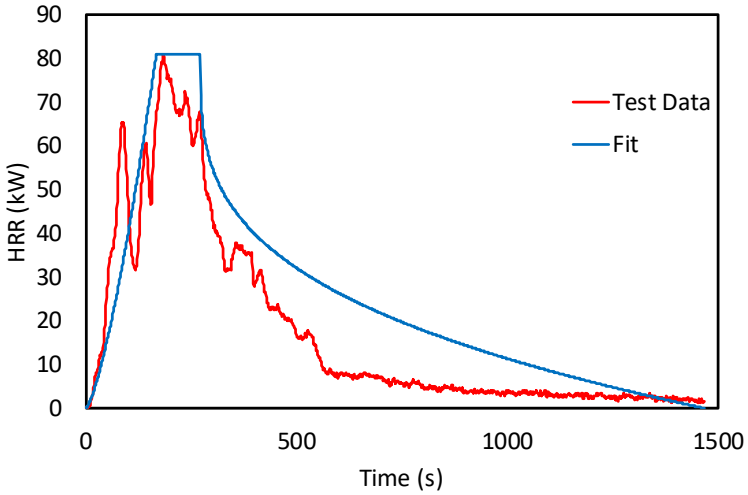


Figure 5-5
Final HRR Equation for Test 09_06_001 Plotted with Test Data

5.8 Fire Elevation

Fire elevation represents the height of the base of the fire above the floor. For a target located above a fire, a nonzero elevation reduces the distance of the target to the fire. Video and test observations were used to assign an elevation to each test. The elevation was based upon how the fuel package was burning at the peak HRR. If the fuel package was very thin or the peak burning rate occurred after the fuel package melted into a pool, an elevation of 0 m was assigned. An example of this would be the fuel packages involving plastic trash cans. For fuel packages where the peak HRR occurred when burning was limited to a small region of the fuel package, the fire elevation was set to the height of that region. An example of this would be the metal chair test, where burning was limited to the height of the burning cushion. For fuel packages where the peak HRR occurred when there was substantial involvement of the entire fuel package and the fuel package had not melted into a pool, then the fire elevation was defined as the mid-height of the fuel package. An example of this would be the cardboard box fuel packages, where the peak HRR occurred when the fire had spread to the entire surface of the box with the box mostly intact.

6
SUMMARY OF TESTING RESULTS

This section discusses the results of testing, including calorimeter calibration, laboratory inter-comparison, and test measurements and derived quantities related to FPRAs. Appendix F contains a one-page summary sheet for each test. Each summary contains test-specific setup details; a summary of key test data; plots of HRR, plume temperature, and heat flux; and photos of the test.

6.1 Validation of Calorimeter Calibration

Each test laboratory ran two types of tests to demonstrate that the calorimeter was properly calibrated.

The first test uses a flow-controlled sand burner. This is a square burner fed by either natural gas (1 and 3 MW hoods) or propane (100 kW hood). The burner flow rate is computer controlled. Since the fuels are known and well characterized, the exact heat of combustion and production of products are known. This removes the uncertainties in the input parameters to the calorimetry equation. A test with the sand burner consists of setting the flow rate to various fire sizes that span the range of the calorimeter.

The second test is a liquid pool fire. A known quantity of a single compound liquid fuel is placed in a pan and ignited. As with the first test, since the fuel is known, its combustion properties are well characterized. The time integral of the measured HRR should correspond to the energy content of the initial mass of liquid.

6.1.1 100 kW Calorimeter

Figure 6-1 shows the results of the sand burner validation test for the 100 kW calorimeter. The sand burner test used propane as the fuel. Table 6-1 shows the measurement errors for the test. Errors are +2 % to +5 % at smaller fire sizes (40 kW or less) and -3 % to -5 % at larger fire sizes (50 kW or more) with an overall root means square (RMS) error magnitude of 3.3 %.

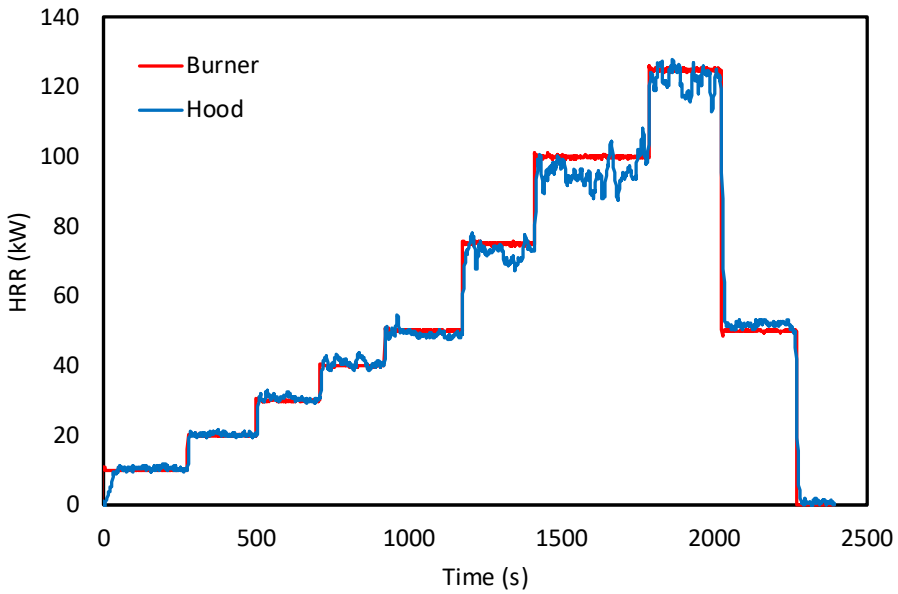


Figure 6-1
100 kW Calorimeter Sand Burner Calibration Test

Table 6-1
100 kW Calorimeter Sand Burner Calibration Results

Burner (kW)	Calorimeter (kW)	Error (%)
10.0	10.6	5.6
20.0	20.3	1.3
30.0	30.5	1.6
40.0	40.7	1.9
50.0	49.0	-2.0
75.0	72.5	-3.3
100.0	95.2	-4.9
125.0	122.2	-2.2
50.0	51.9	3.7

Two pool fire calibration tests were performed. Each test used 500 g (1.1 lb) of either heptane or methanol in a 23 cm x 23 cm (9 in. x 9 in.) pan. Figure 6-2 shows the results. The error in total energy release (TER) for the two tests was -6.8 % for heptane and -5.1 % for methanol.

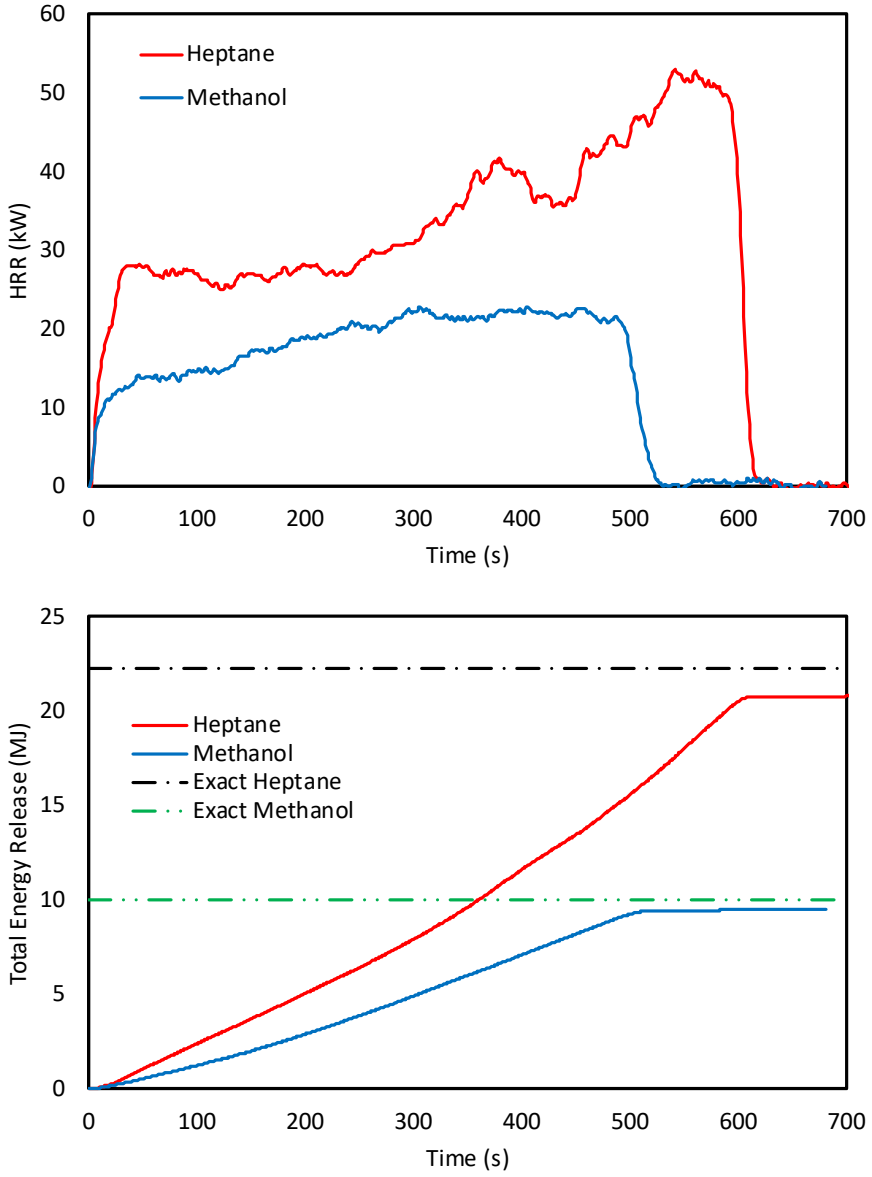


Figure 6-2
100 kW Calorimeter Pool Fire Calibration Results. Top—HRR, Bottom—TER

6.1.2 National Fire Research Laboratory 1 and 3 MW Calorimeters

Figure 6-3 shows the results of the sand burner test for the 1 MW calorimeter. Note that this plot does not correct for the transport delay of combustion products to the gas analyzers; hence, the slight time shift for the measured HRR. The sand burner test used natural gas as the fuel. Table 6-2 shows the HRR based on mass flow and the measured HRR. The average error, after accounting for transport delay, is -1.2 % for larger fire sizes (greater than 100 kW) and +2 % for smaller fire sizes (less than 100 kW) with an overall RMS error of 2.1 %.

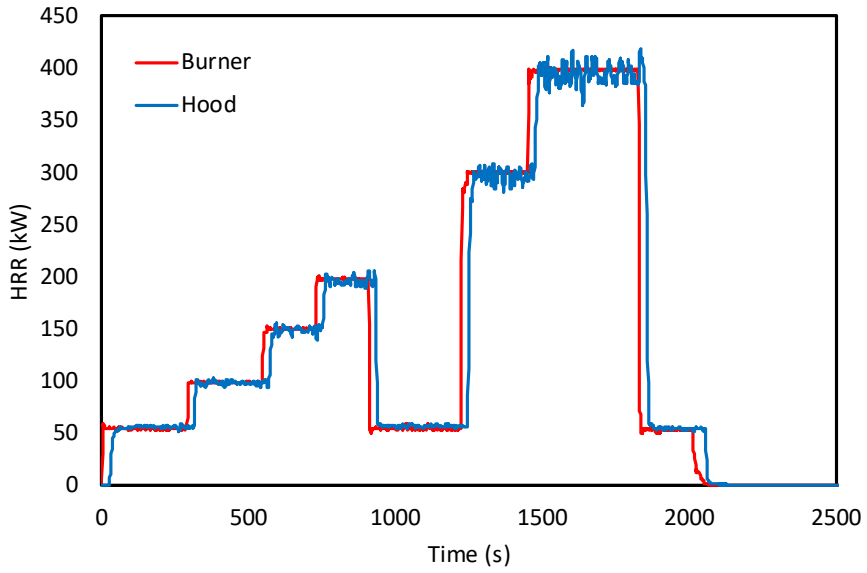


Figure 6-3
NFRL 1 MW Calorimeter Sand Burner Calibration Test

Table 6-2
NFRL 1 MW Calorimeter Sand Burner Calibration Results

Burner (kW)	Calorimeter (kW)	Error (%)
54.4	56.2	3.2
98.8	98.2	-0.6
150.3	148.8	-1.0
54.6	56.9	4.1
197.8	195.3	-1.3
300.2	295.6	-1.5
398.6	394.1	-1.1
53.9	54.5	1.1

Two pool fire calibration tests were performed for the 1 MW calorimeter. Each test used 500 mL (0.5 qt) of heptane in a 30 cm (12 in.) diameter pan. Figure 6-4 shows the results. The two tests had errors of -1.9 % and -3.0 %.

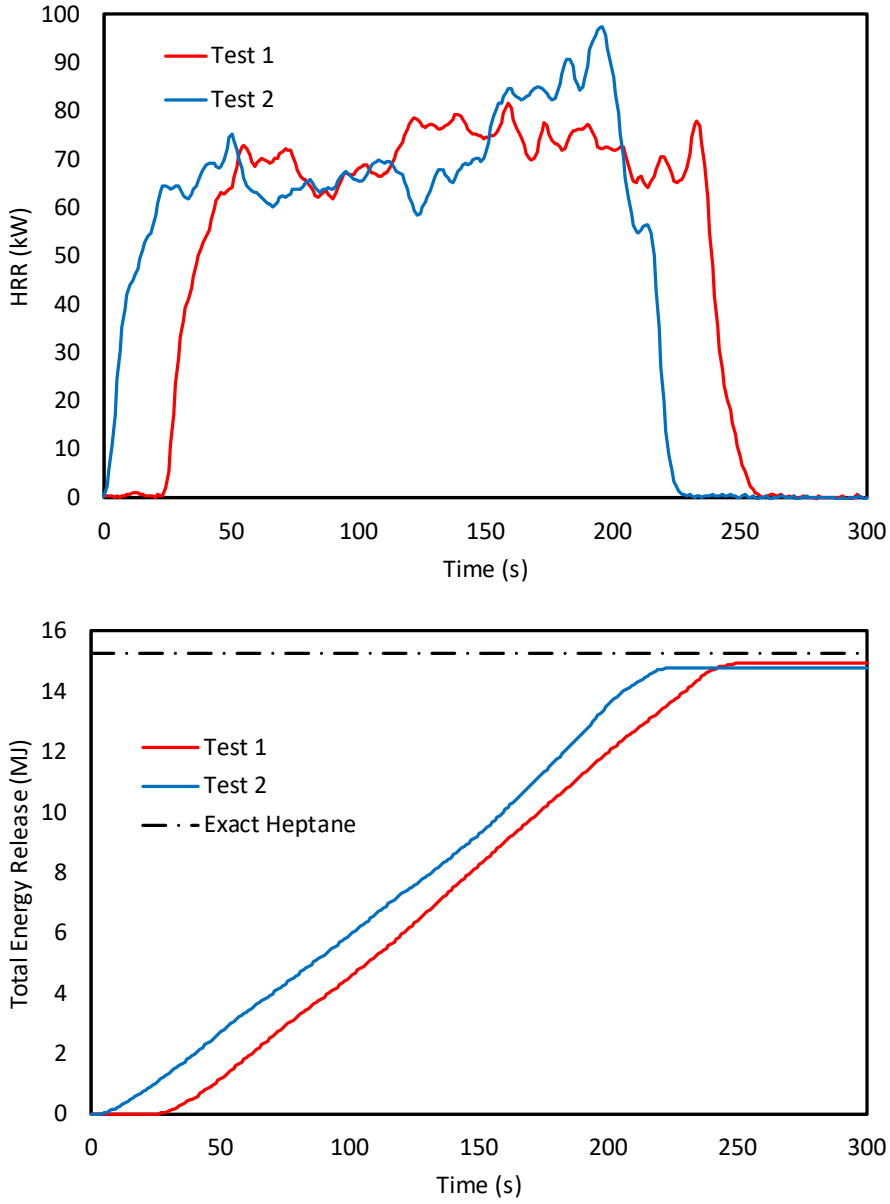


Figure 6-4
NFRL 1 MW Calorimeter Pool Fire Calibration Results. Top—HRR, Bottom—TER

Figure 6-5 shows the results of the sand burner test for the 3 MW calorimeter. The sand burner test used natural gas as the fuel. The results show that there is an approximately 20 s total delay from the time the fire changes size under the calorimeter until the data acquisition system shows a response. This delay time represents the combined transport time of the fire plume to the calorimeter exhaust, the calorimeter exhaust duct to the sampling location, and the sampling location to the gas analyzers. Table 6-3 shows the HRR based on mass flow and the measured HRR. Errors range from -4 to 4 % with an overall RMS error of 3.2 %.

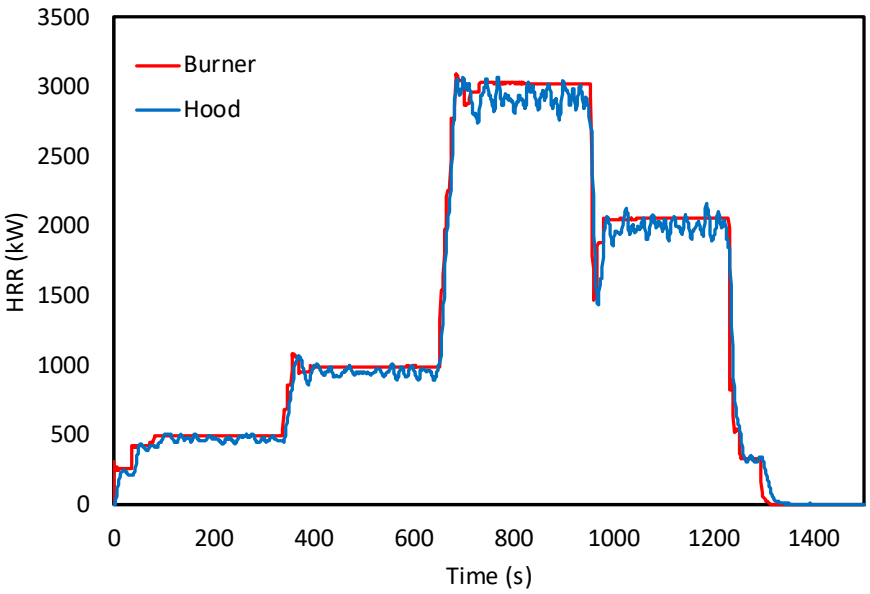


Figure 6-5
NFRL 3 MW Calorimeter Sand Burner Calibration Test

Table 6-3
NFRL 3 MW Calorimeter Sand Burner Calibration Results

Burner (kW)	Calorimeter (kW)	Error (%)
260	269	3.6
492	474	-3.6
990	952	-3.8
3028	2923	-3.5
2055	1999	-2.7
330	326	-1.1

A pool fire test was not performed for the 3 MW calorimeter.

6.2 Repeatability

Each test laboratory tested the Medium Box Empty and the Five Rags w/Heptane test items. The NFRL repeated the Large Box Empty test item using both the 1-MW and 3-MW calorimeters. The boxes and rags were procured as a single purchase to ensure identical materials were used. Figure 6-6 shows the results of testing by each laboratory for the box tests, and Figure 6-7 shows the results for the heptane rags tests.

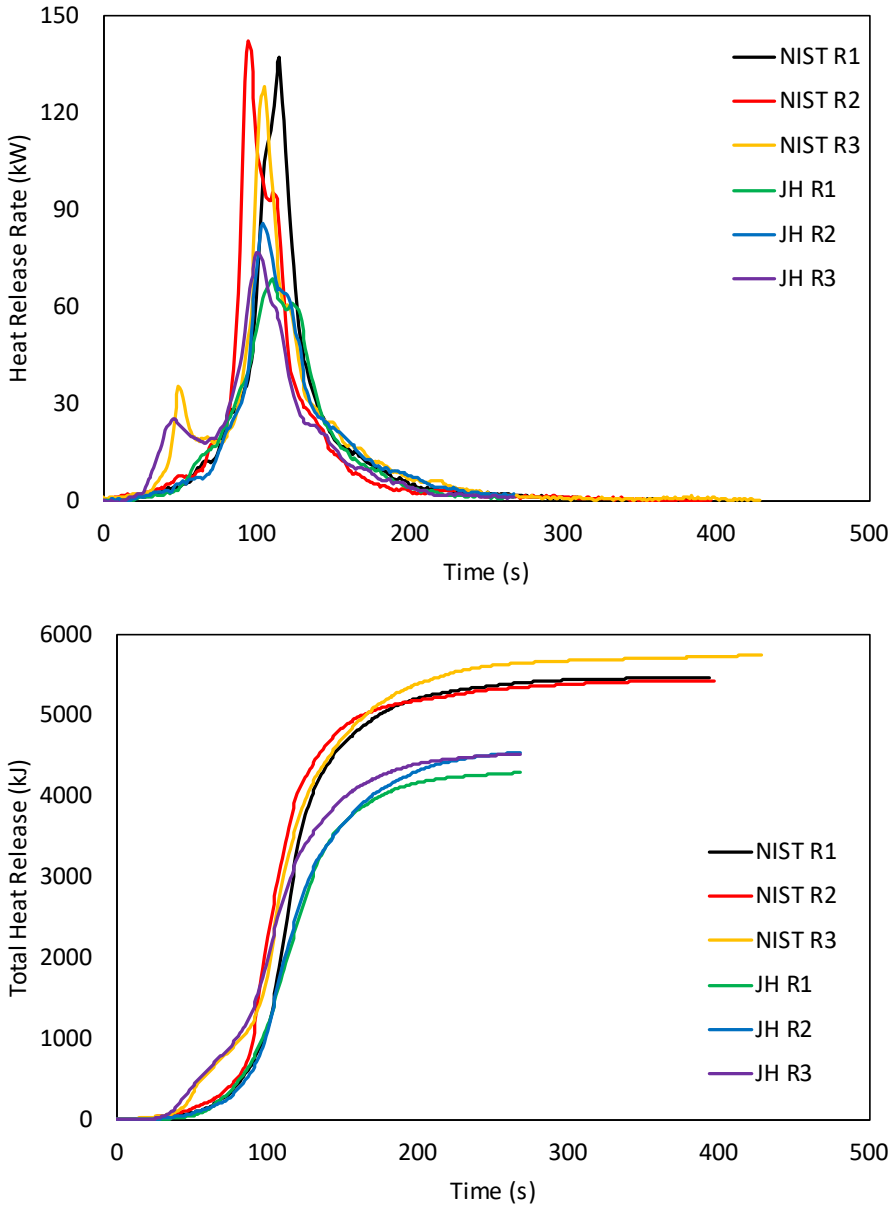


Figure 6-6
Intralaboratory Results for the Medium Box Empty Tests. Top—HRR, Bottom—TER

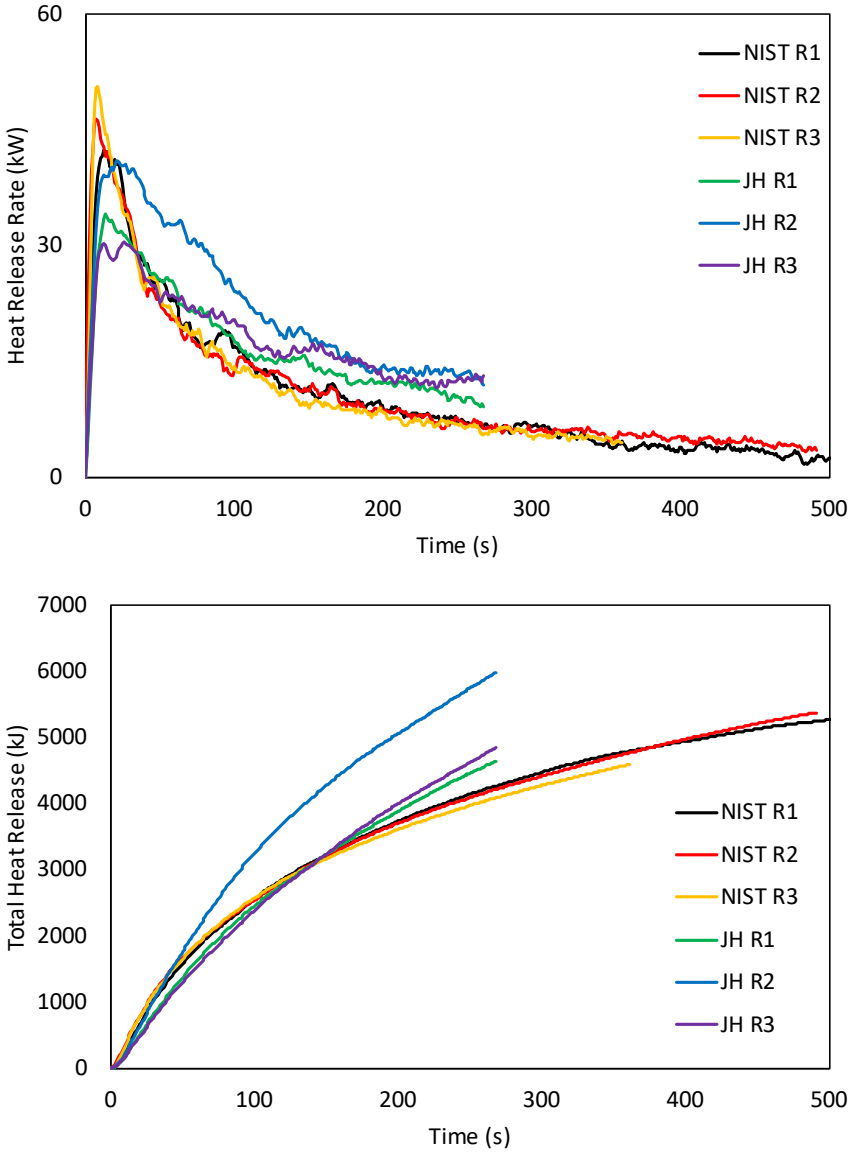


Figure 6-7
Intralaboratory Results for the Five Rags w/Heptane Tests. Top—HRR, Bottom—TER

At first glance, the peak HRR for the medium box tests are noticeably different, as is the TER. The burning rate of cardboard is susceptible to the relative humidity, which affects the total water adsorption in the cardboard. The 1 MW calorimeter is in a partially conditioned space under the low exhaust rates used during these tests. The 100 kW calorimeter is not a conditioned space and more moisture would be expected in the boxes. Normalizing the TER by the mass consumed results in an effective heat of combustion of 14.4 MJ/kg for the 1 MW calorimeter and 11.6 MJ/kg for the 100 kW calorimeter. The mass consumed would include the effect of any additional moisture in the boxes. More moisture would lead to a lower effective heat of combustion, which is the case for the medium box tested using the 100 kW calorimeter. The heptane rags show differences in peak HRR and the TER. However, the peak burning rate of the rags is a function of the initially exposed area. Figure 6-8 shows photos from each test laboratory. The separation of the vertical steel angle in the 1 MW calorimeter photo is 76 cm (30 in.) compared to the 61 cm (24 in.) wide board in the 100 kW calorimeter photo. The pile

of rags for 1 MW calorimeter tests is approximately 10–15 % larger in diameter, which would mean approximately 20–30 % higher peak HRR, which is observed in the data. The rags would not be subject to the same water adsorption issues as the boxes. The effective heat of combustion for the heptane rags was 24.2 MJ/kg for the 1 MW calorimeter and 25.2 MJ/kg for the 100 kW calorimeter. This is a negligible difference of 4 %. The results indicate that the laboratory-to-laboratory test results are comparable.

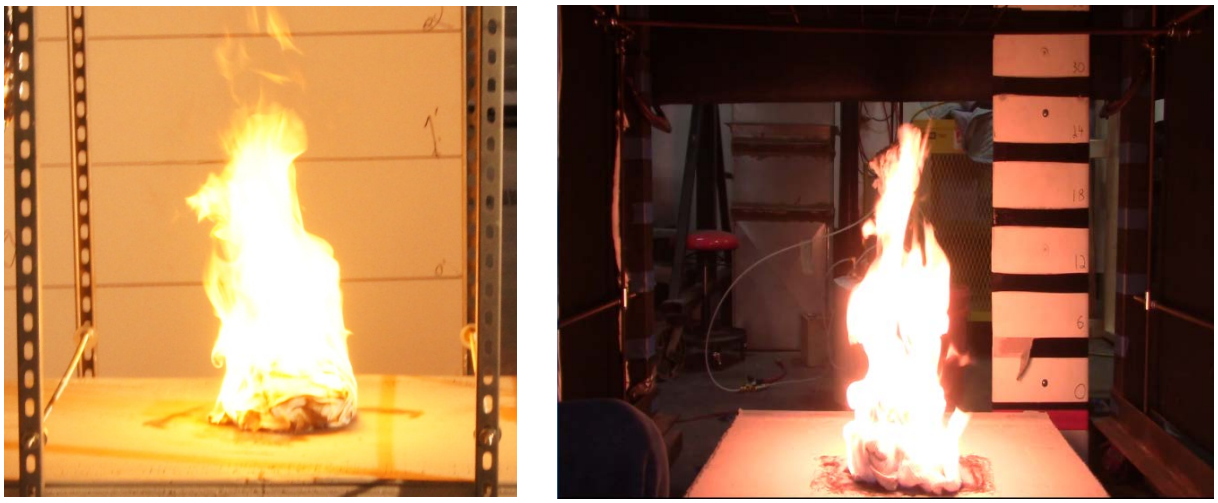


Figure 6-8
Photos of the Intralaboratory Heptane Rag Tests. Left—1 MW, Right—100 kW

During testing of the Laptop + Cart fuel package under the 1 MW calorimeter, there was a concern that the fire size was too large for that calorimeter. Further testing of that fuel package was done under the 3 MW calorimeter. To assess repeatability, the Large Empty Box test item was repeated using the 3 MW calorimeter. Figure 6-9 shows the results of the repeat test. Tests R1 to R3 were under the 1 MW calorimeter and test R4 was under the 3 MW calorimeter. The peak HRR for R4 lies within the range of peak HRRs seen in R1 to R3. All tests have a TER within 2 % of each other.

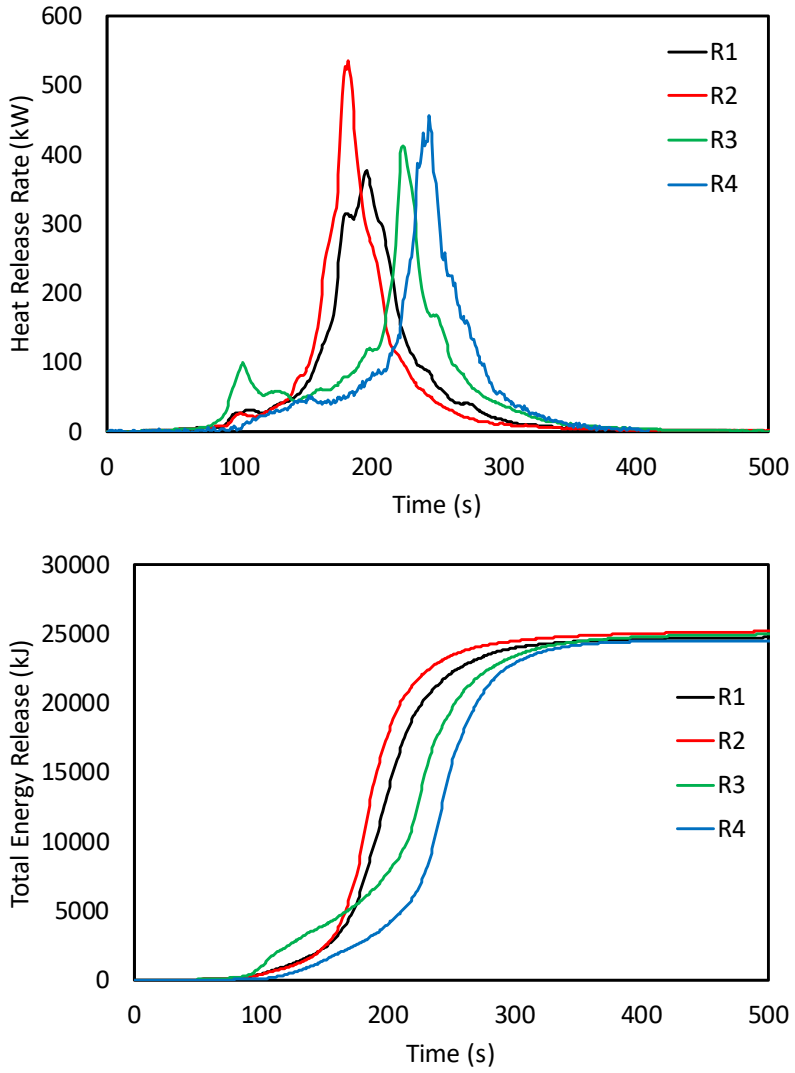


Figure 6-9
Large Empty Box Test. Top—HRR, Bottom—TER

6.3 Heat Release Rate and Burning Characteristics of Fuel Packages

Table B-1 in Appendix B presents the data plotted in this section. Figure 6-10 plots the peak HRR for each test sorted from smallest to largest. Figure 6-11 shows the same data in histogram format. Eighteen tests (6 %) have HRRs over the current 98th percentile value of 317 kW (dotted red line in Figure 6-10), 139 tests (48 %) were under 10 kW and 247 tests (85 %) were under 100 kW. However, it should be noted that this distribution is not weighed by the likelihood of the material participating in a transient fire. Simply picking the 98th percentile of all items tested without accounting for likelihood would likely not represent actual plant experience.

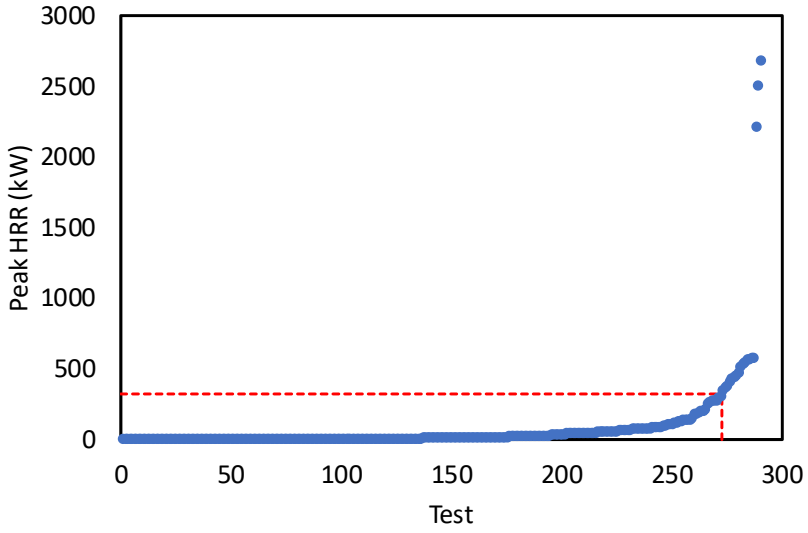


Figure 6-10
Plot of Peak HRR for Each Test. Dotted Line Is 317 kW

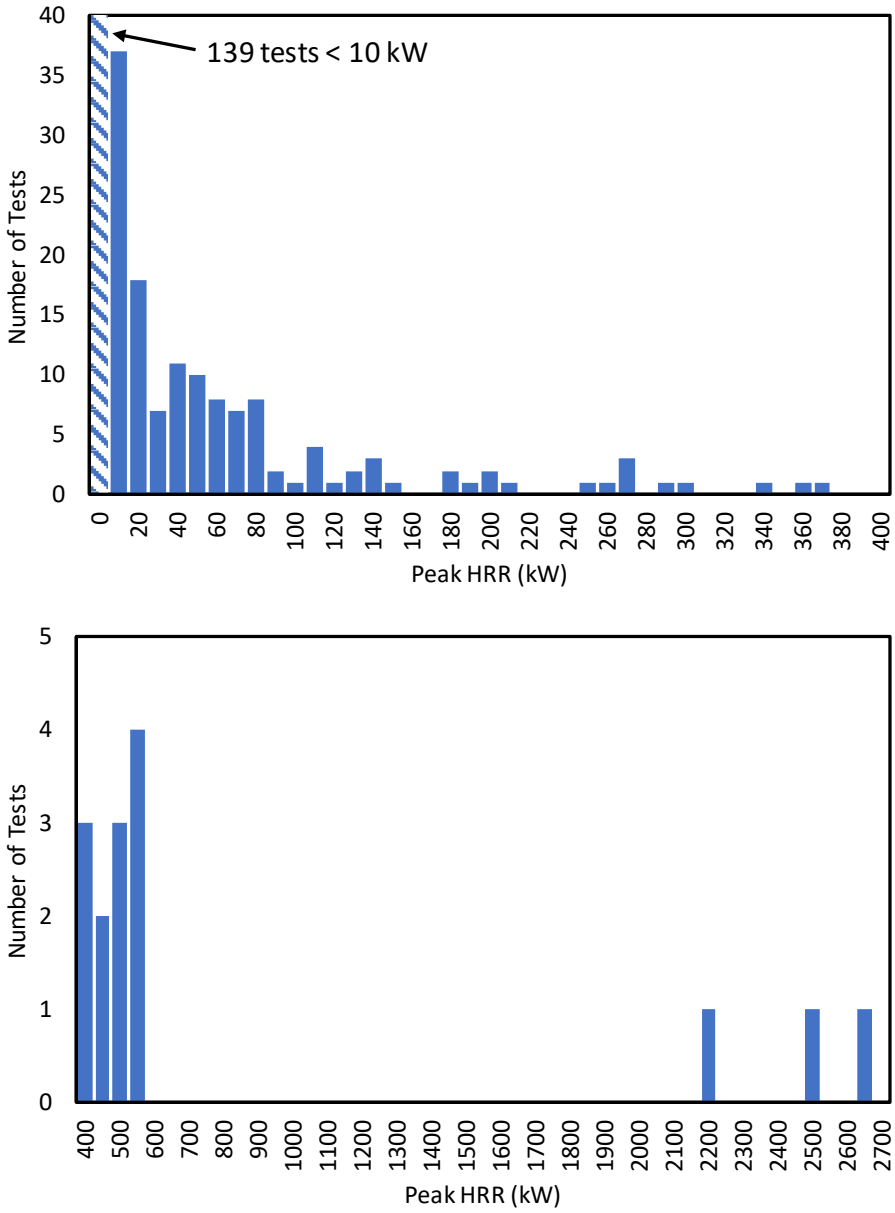


Figure 6-11
Histogram Plot of Peak HRR for Each Test. Top—Peak HRR < 400 kW, Bottom—Peak HRR > 400 kW

Figure 6-12 shows the TER for each test. Figure 6-13 shows the same data in histogram format. If a test had an energy release less than 1 MJ, that typically meant the heat release was primarily caused by the ignition source (i.e., the HRR of the lighter, wick, or small continuous flame). Below 25 MJ of energy release (approximately 80 % of the tests), the hazards from hot gas layer formation would be unlikely for very small compartments. Above 25 MJ of energy release, the potential for a hot gas layer would depend upon the volume of the compartment.

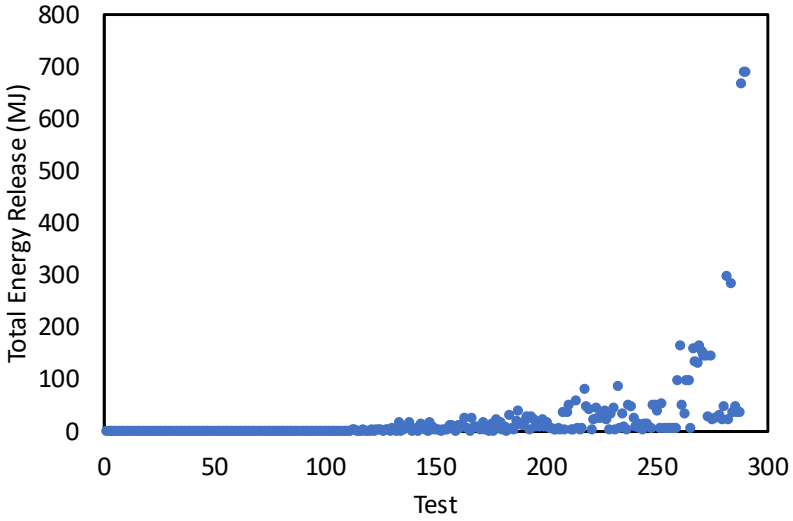


Figure 6-12
Plot of the TER for Each Test

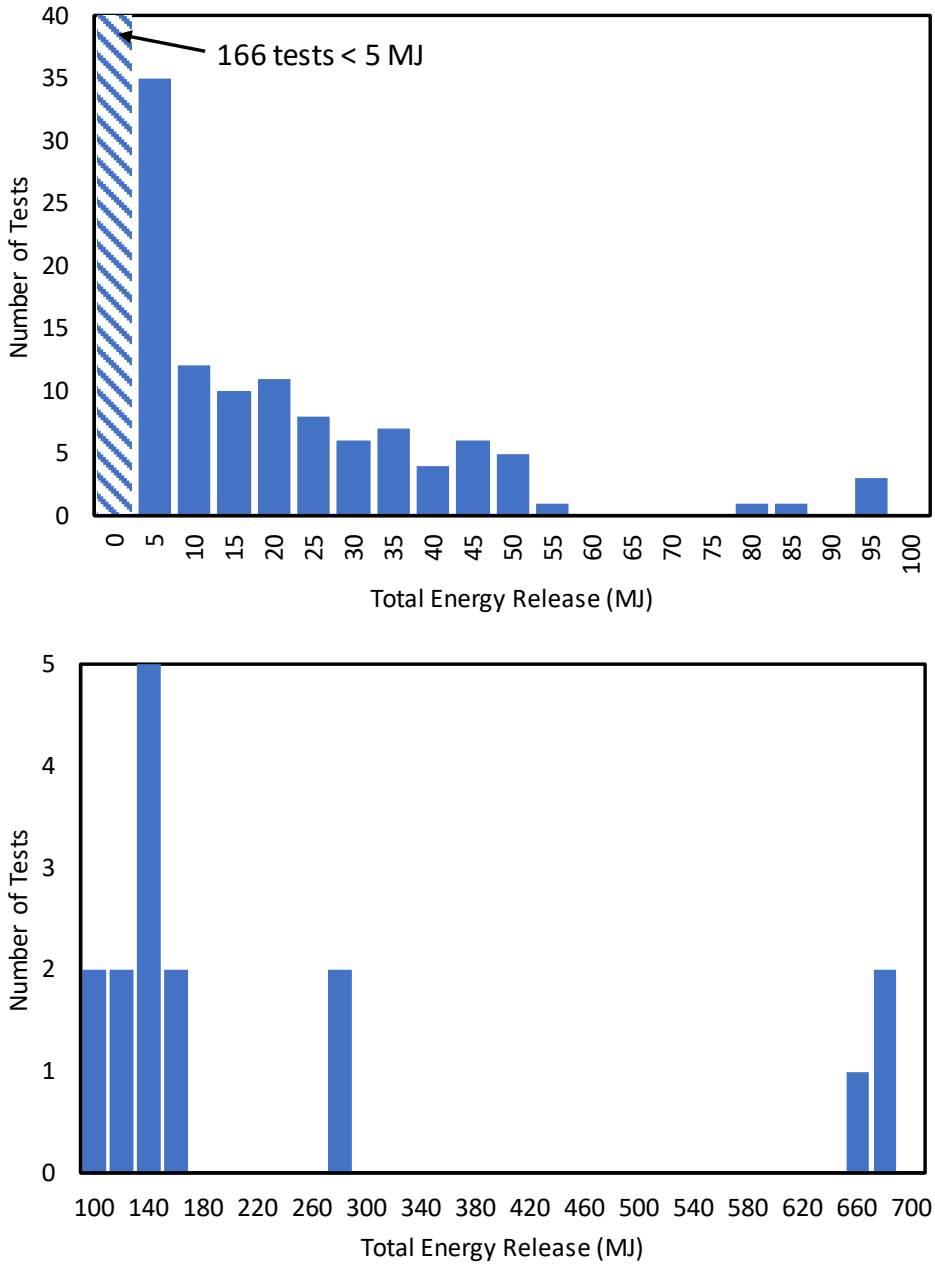


Figure 6-13
Histogram Plot of the TER for Each Test. Top—TER < 100 MJ, Bottom—TER > 100 MJ

Figure 6-14 plots the TER against the peak HRR. There is a clear correlation between the TER and the peak HRR. This is an expected result since a 1 kW fire would have to last for an hour to equal a few seconds of burning at 1 MW.

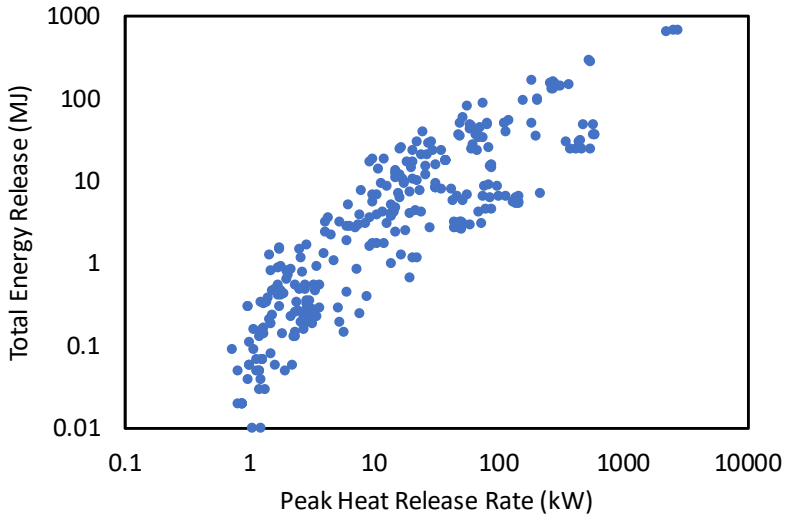


Figure 6-14
TER vs. Peak HRR

Figure 6-15 plots the fire Froude number, Q^*, as a function of the peak HRR. The points are colored based on the type of fuel burning. The plot is limited to Q^* values of 5. Many of the very low HRR, under 2 kW, tests have Q^* values larger than 5, primarily because of the ignition source. For example, the continuous flame ignition source is a jet flame, which results in very high Q^* values. Banding can be seen in the plot that is related to the type of fuel. The cluster of points near Q^* of 0.5 and HRR of 500 kW are the open vacuum tests and the draped canvas tarp tests.

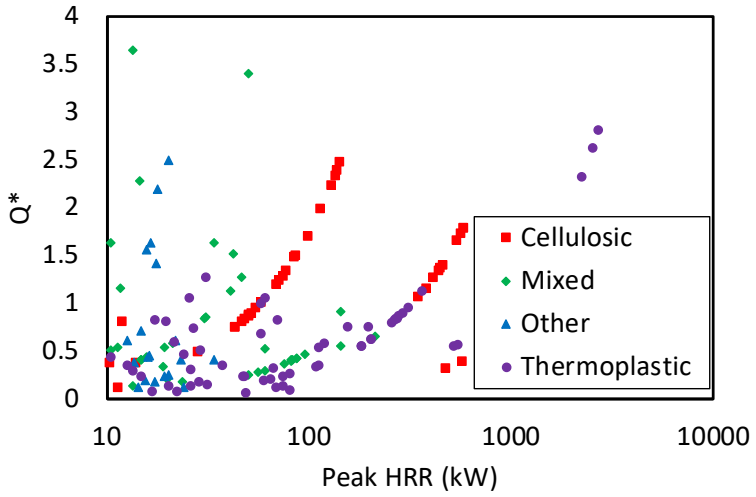


Figure 6-15
Plot of the Fire Froude Number, Q^*, vs. the Peak HRR for Each Test. Q^* Axis Limited to 4.

Figure 6-16 plots the flame height as a function of the peak HRR. The dashed line is the Heskestad flame height as a function of HRR assuming Q*=0.8 (approximately the median value for the tests). Given the combined uncertainty in the measured flame height and the measured peak HRR, the test data are well represented by the Heskestad correlation. Section 6.4 discusses this further.

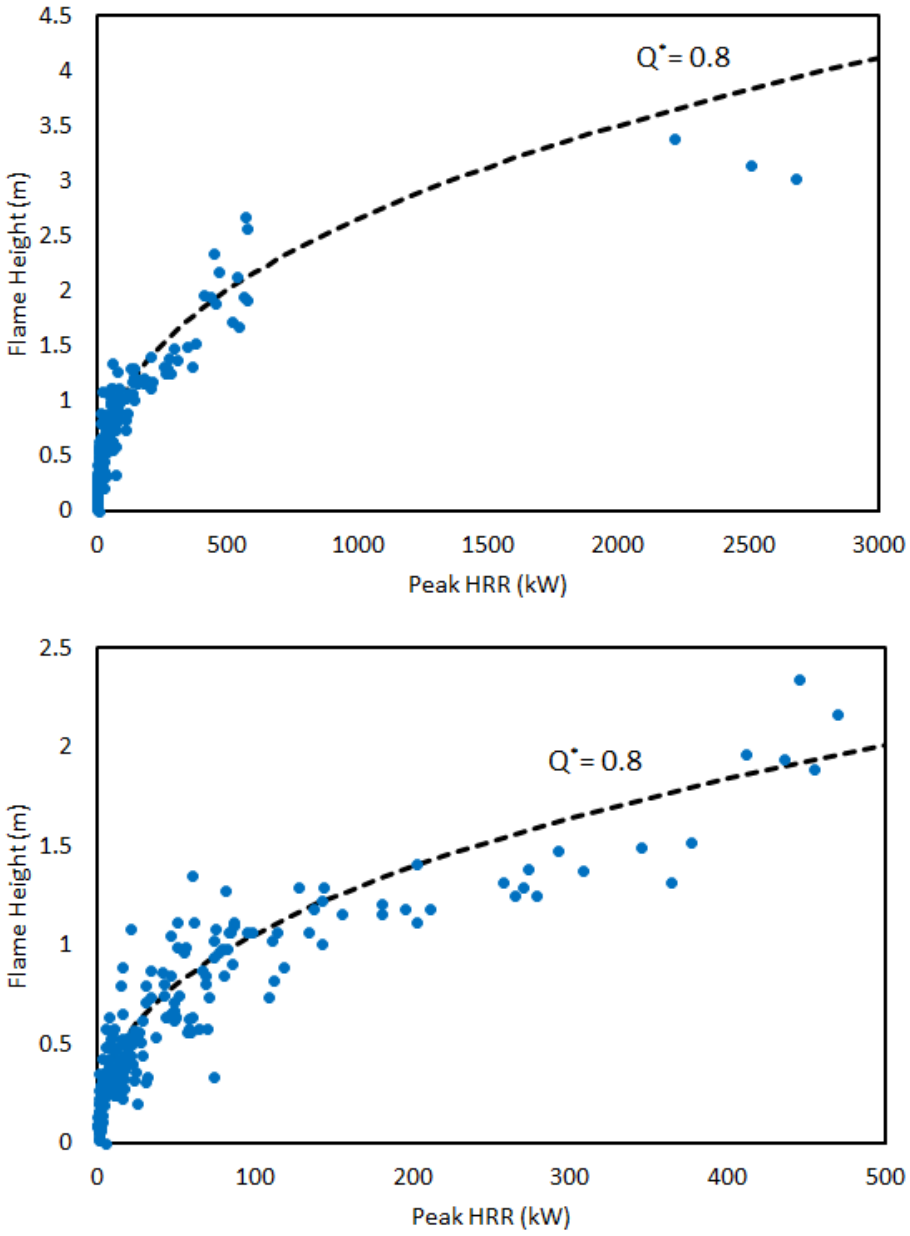


Figure 6-16
Plot of the Flame Height vs. the Peak HRR for Each Test. Top—All Data, Bottom—Remove Laptop + Cart Tests

Figure 6-17 plots the heat of combustion for each test colored by the type of fuel. Cellulosic materials have heats of combustion generally in the range of 10 to 20 MJ/kg. Thermoplastic (TP) materials have heats of combustion generally in the range of 30 to 50 MJ/kg. Mixed fuels and other types of materials range from 10 to 40 MJ/kg, depending on the specific types and quantities of materials present.

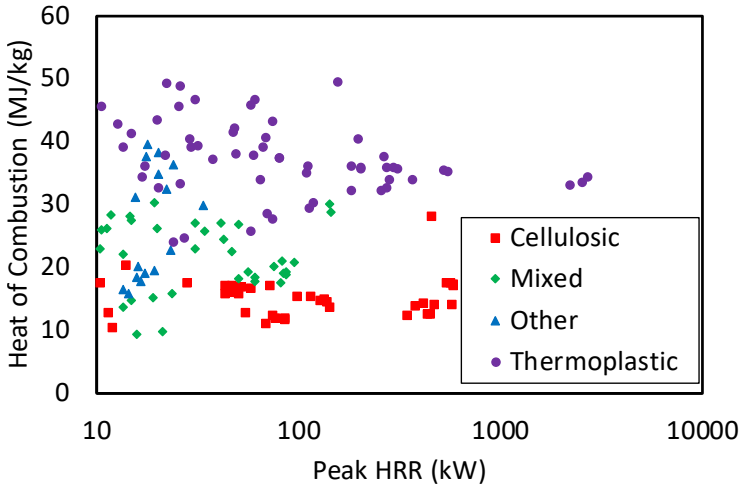


Figure 6-17
Plot of the Heat of Combustion vs. the Peak HRR for Each Test Colored by Fuel Type

Figure 6-18 and Figure 6-19, respectively, plot the soot yields and CO yields for each test colored by fuel type. Soot is a personnel and equipment hazard (deposition on electronics). CO is a personnel hazard. In both cases, small fires generally pose little risk of harm for these quantities. The "other" and TP fuel materials had higher soot yields than the wood and mixed materials. Generally, fires of well-ventilated wood products have very low soot yields [18]. Above 100 kW, soot yields were 6 % or less. Clear trends of CO yield as a function of fuel type are not readily seen. In general, higher CO yields are seen for smaller fire sizes. In many cases, this likely results from smoldering behavior occurring in some or all of the fuel package during testing. The two outlier points with yields near 20 % are one of the Plastic Tarp Folded tests and one of the Metal Trash Full Lid tests. The higher yields are because of localized low-oxygen burning resulting from the specific path of fire spread into the test items during the test.

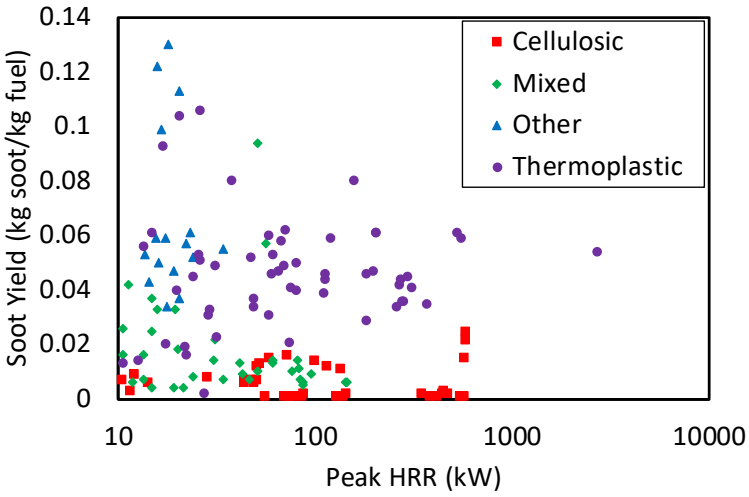


Figure 6-18
Plot of the Soot Yield vs. the Peak HRR for Each Test Colored by Fuel Type

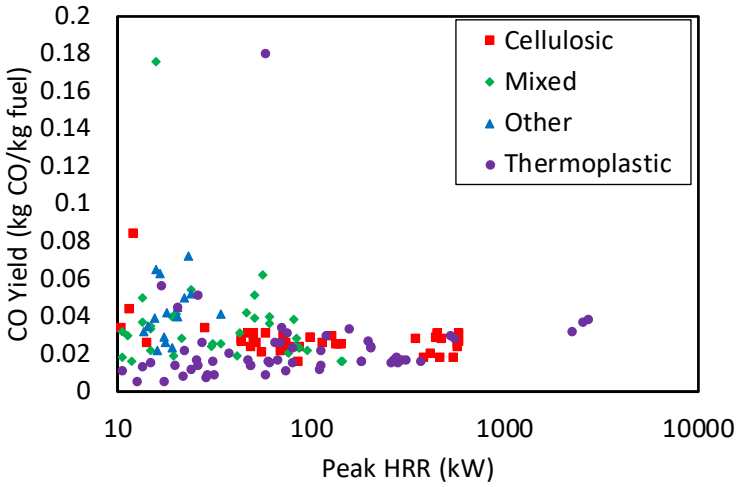


Figure 6-19
Plot of the CO Yield vs. the Peak HRR for Each Test Colored by Fuel Type

Figure 6-20 plots the fire elevation for each test and a plot of the fire elevation as a function of the peak HRR. Over two-thirds of the tests have a fire elevation of zero. Fires with a nonzero elevation are distributed throughout the range of peak HRRs measured during the testing. There is no correlation between the size of the fire and its elevation.

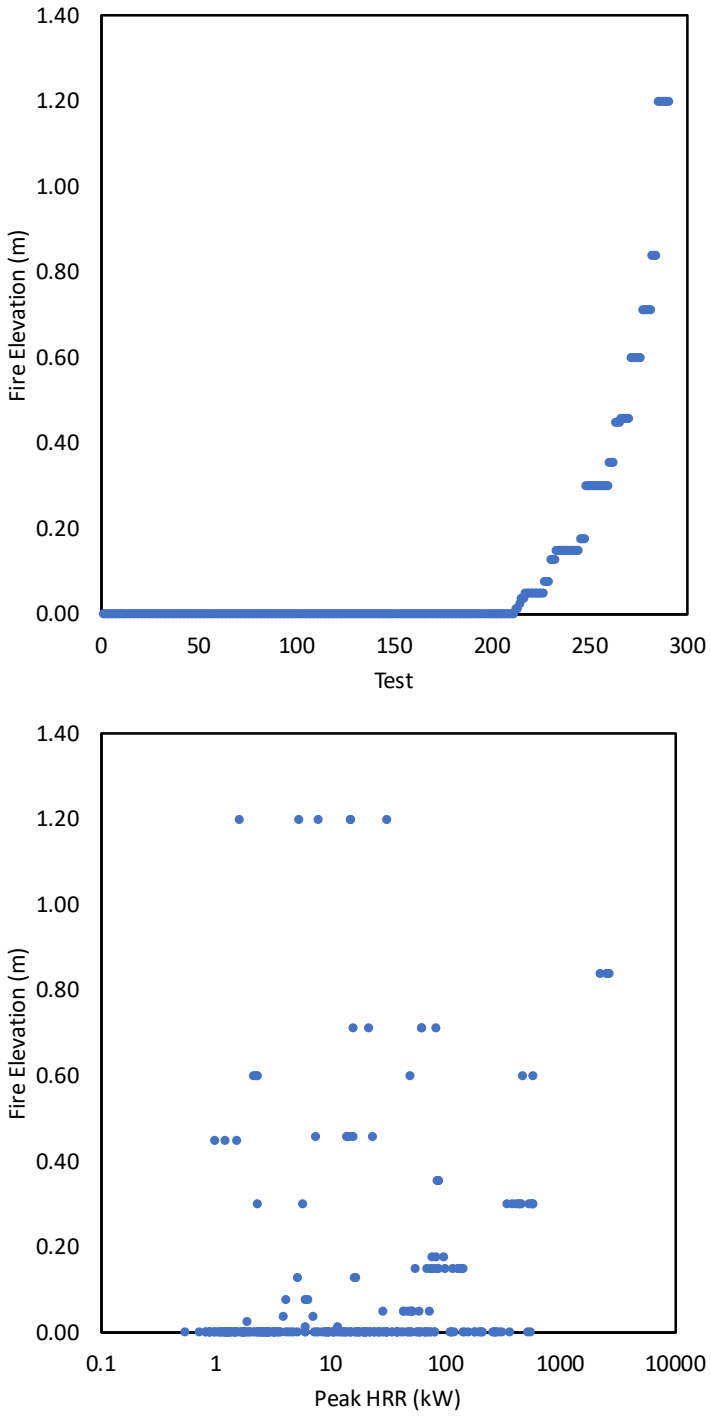


Figure 6-20
Plot of the Fire Elevation for Each Test (Top) and the Fire Elevation as a Function of Peak HRR (Bottom)

6.4 Fire Dynamics Tools Comparison

Table C-1 in Appendix C presents the data plotted in this section. Figure 6-21 shows plots of the measured and FDT^S predicted plume temperatures. Note that Type-K TCs have a maximum temperature reading of 1000 °C (1832 °F). The FDT^S computation was also limited to a maximum temperature of 1000 °C (1832 °F). There is large positive bias for both grids. Since on average the FDT^S are overpredicting the plume temperature, the overall ZOI assessment in Section 6.5 is expected to be conservative. This can be seen in Figure 6-22, which plots the time to damage computed using the heat soak method discussed in Ref. 14. In the figure, if no damage occurred, a time of 10,000 s was assigned. Of the 290 tests, 89 had a time to damage based on the FDT^S plume temperature, with 37 of those also having a time to damage based on the measured temperature. Note that this does not mean that a ZOI does not exist for that fuel package, only that the exposure at the TC grids was insufficient to result in damage. In three cases, the experimental data had a time to damage but the FDT^S did not. These were all metal trash can tests, where the FDT^S were computed using the base of the can but the initial heat release was high in the can. Overall, the FDT^S are conservatively biased compared to the experimental results.

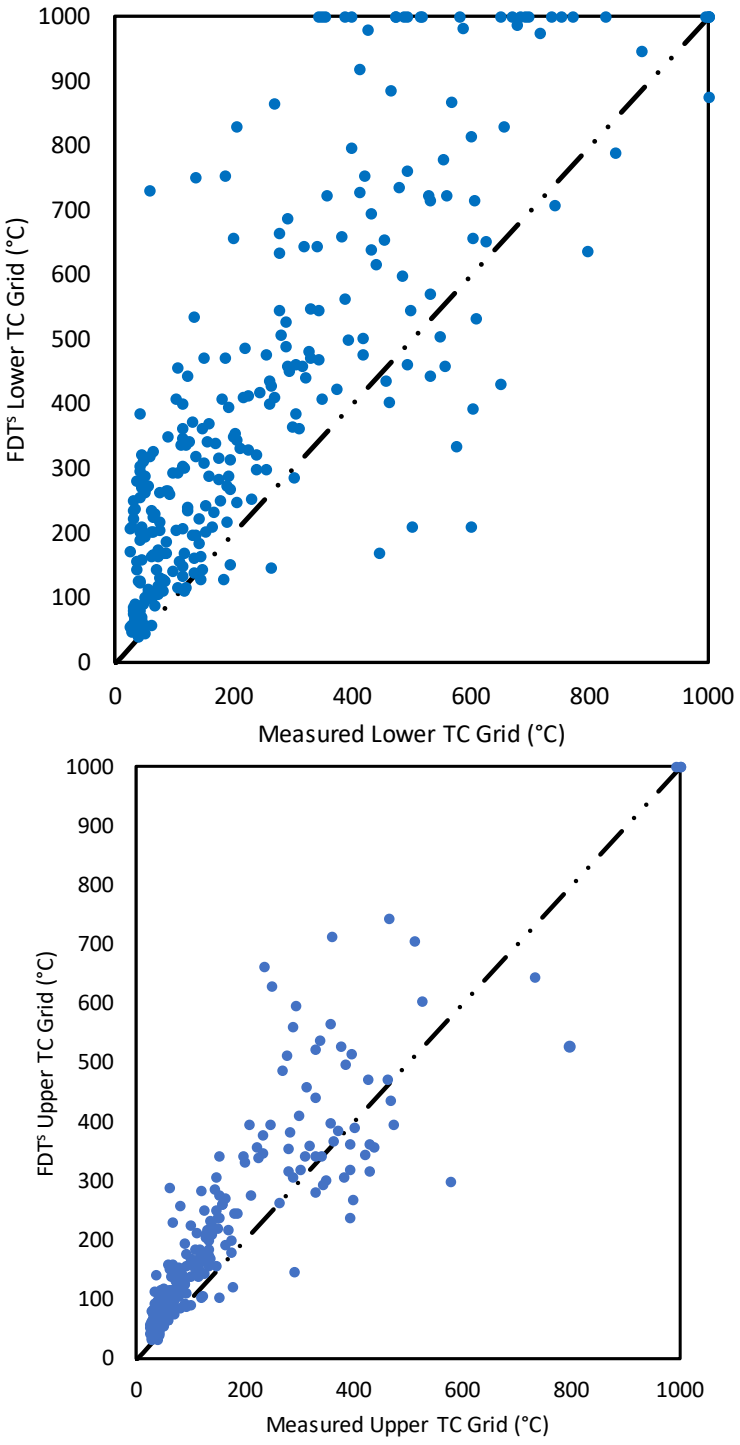


Figure 6-21
Plot of Measured (Heat Soak Time to Damage Derived from the Experimental Data) vs. FDT^S-Predicted Plume Temperature for the Lower (Top) and Upper (Bottom) TC Grids

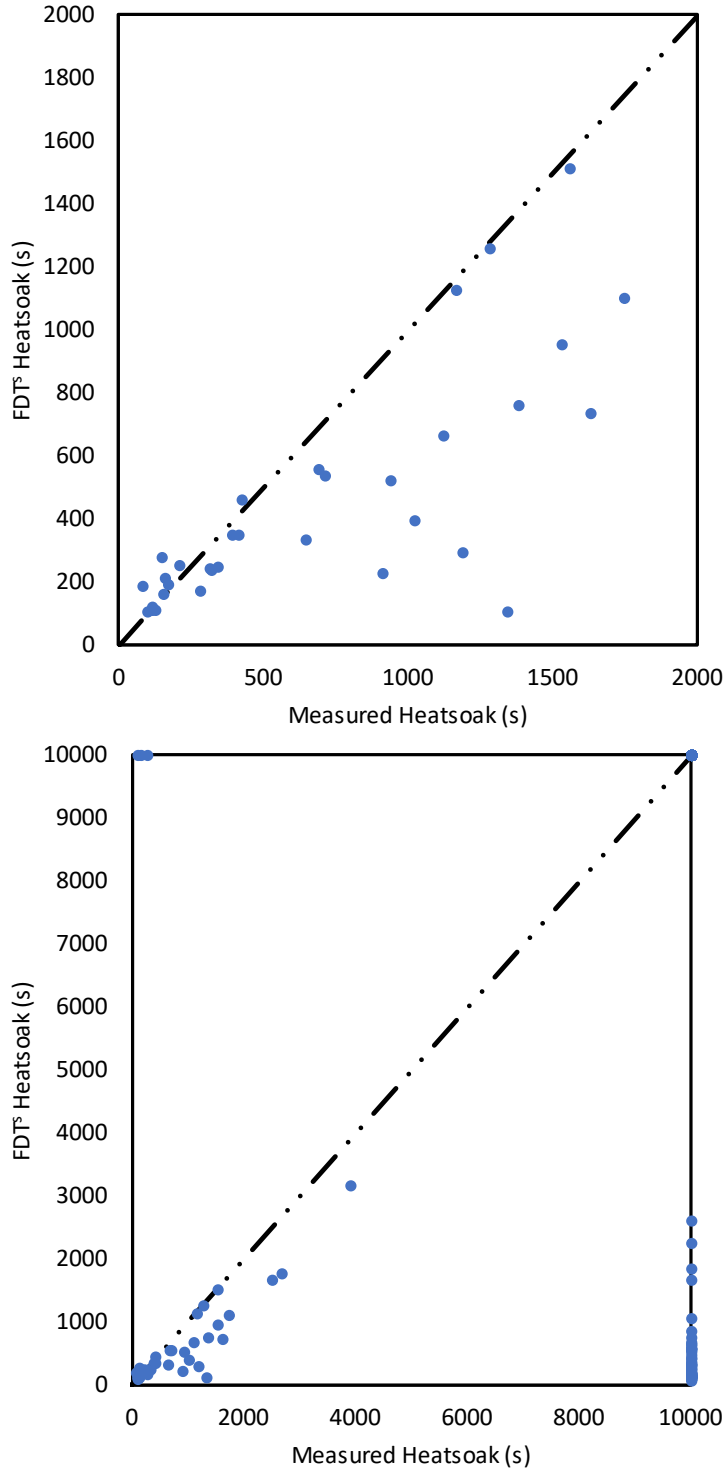


Figure 6-22
Plot of Measured (Heat Soak Time to Damage Derived from the Experimental Data) vs. FDT^S-Predicted Time to Damage for the Lower TC Grid Using the Heat Soak Method. Top—Damage Time < 2000, Bottom—All Data

Figure 6-23 shows plots of the measured and FDT^S predicted heat fluxes. While there is significant scatter, on average the FDT^S are greatly overpredicting the minimum measured value, which is expected (since the FDT^S was computed using the midpoint of the flame) and underpredicting the maximum measured value by approximately 15 %. The notable exception is the data circled in the right-hand plot. These tests are the Laptop + Cart tests. In these tests, plastic dripping from the top shelf onto the bottom shelf resulted in a flashover condition developing in the pseudo-compartment between the two shelves. This event was very rapid and caused fireball-like behavior, which resulted in flames jetting out from under the top shelf, as shown in Figure 6-24. For these tests, the diameter of the fire base does not adequately represent the heat flux conditions during the peak of the fire. The FDT^S are biased low for characterizing the maximum flux; however, from Reference 14, the heat soak method is biased high, which will compensate for the flux. Unlike the plume temperature assessment, only a few tests have a time to damage using both the FDT^S and the measured data. There are 28 tests with a time to damage using the FDT^S, and 17 tests also have a time to damage using the measured heat flux. As seen in Figure 6-25, the FDT^S times are conservatively biased compared to the experimental times. This indicates that the horizontal ZOI values in Section 6.5 should be conservative.

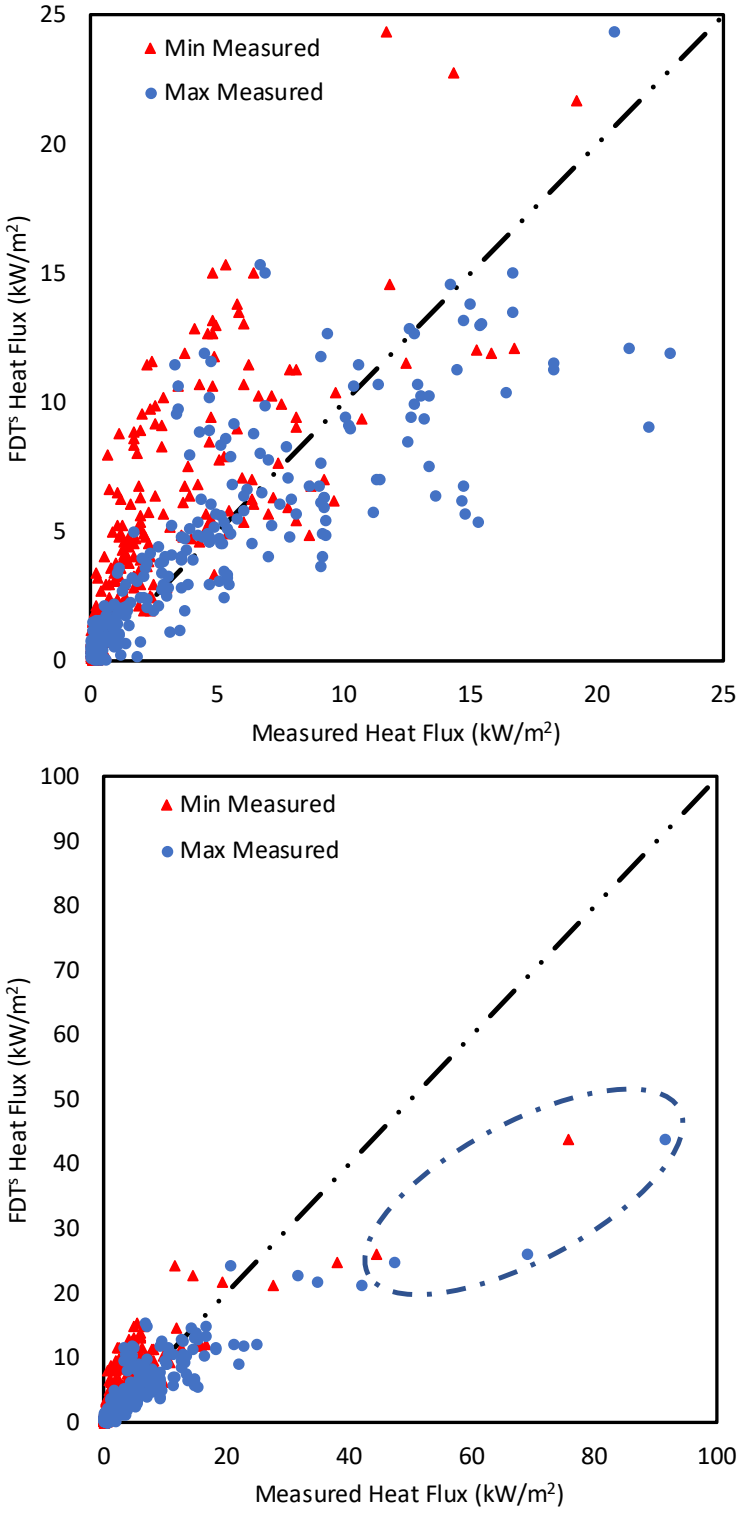


Figure 6-23
Plot of Measured vs. FDTˢ-Predicted Heat Fluxes. Inside Dashed Oval Are Laptop + Cart Tests. Top Heat Flux < 25 kW/m², Bottom—All Data

Figure 6-24
Peak of Laptop + Cart Test

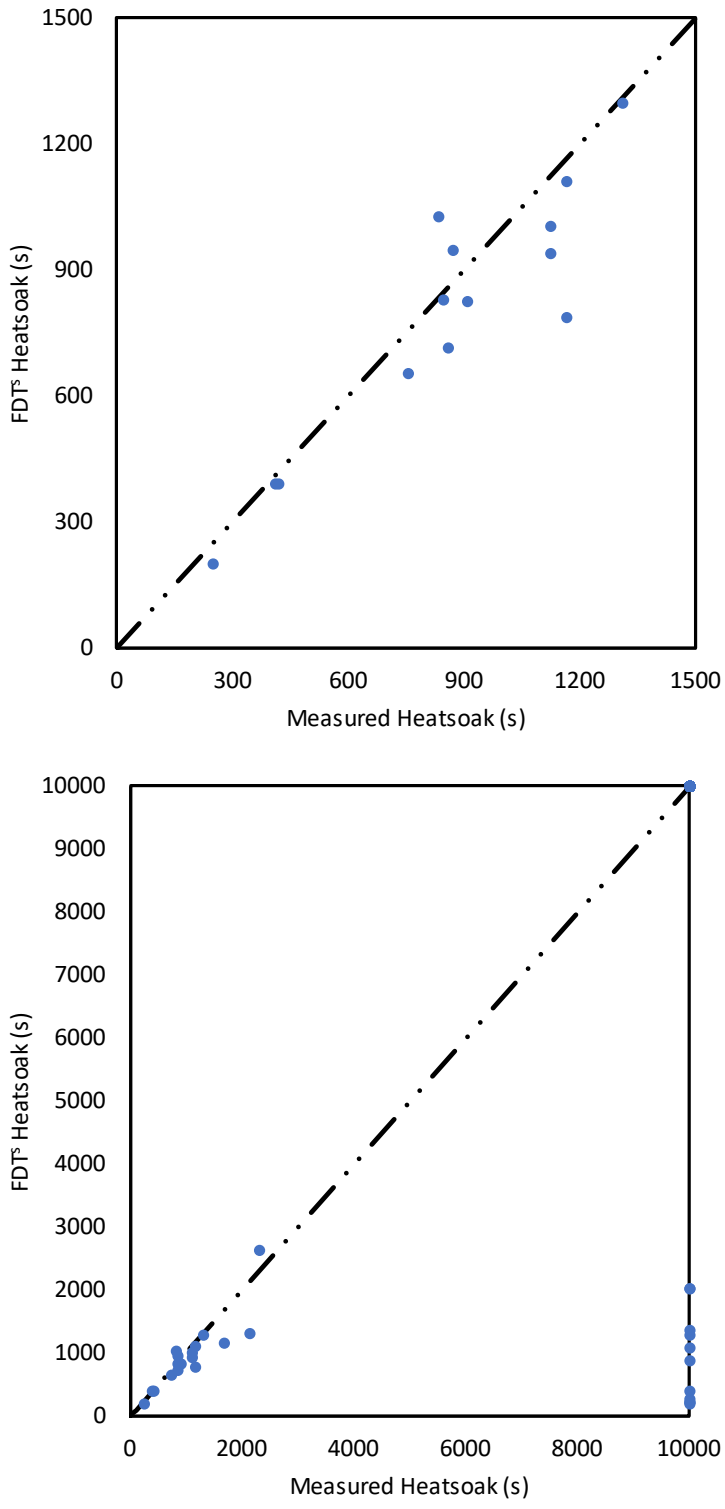


Figure 6-25
Plot of Measured (Heat Soak Time to Damage Derived from the Experimental Data) vs. FDTˢ-Predicted Time to Damage for the Maximum Heat Flux Gauge Using the Heat Soak Method. Top—Damage Time < 1500 s, Bottom—All Data

Figure 6-26 plots the measured vs. FDT^S predicted flame length. FDT^S results show a slight positive bias. However, in general, there is a good match between the FDT^S correlation and the measured flame height.

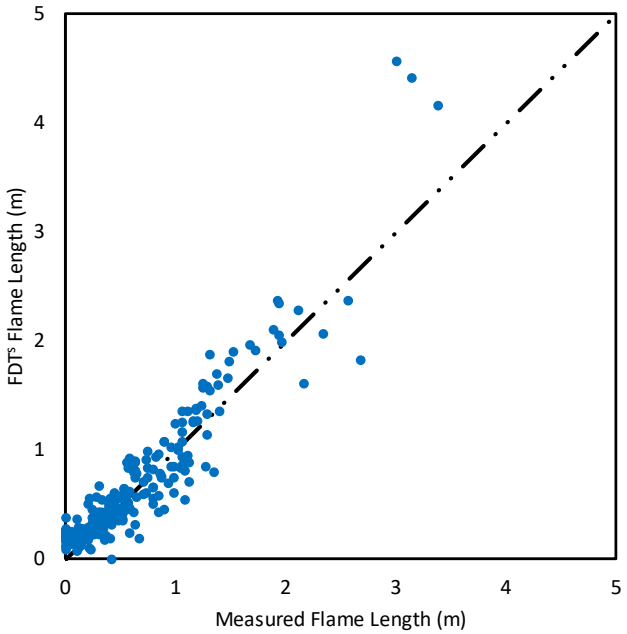


Figure 6-26
Plot of Measured vs. FDT^s-Predicted Flame Length

6.5 Zone of Influence of Test Items

Table D-1 through Table D-3 in Appendix D present the data plotted in this section. For each test, the ZOIs for the five target categories (sensitive electronics, TP cables, Kerite cables, TS cables, and tray ignition) are plotted in Figure 6-27 and Figure 6-28. As discussed in Section 5.5, the ZOI search algorithm uses a 5 cm (2 in.) increment; therefore, the minimum value a ZOI can have is 5 cm (2 in.). Table 6-4 shows the ZOIs for the peak HRRs that span 3 orders of magnitude. Note that, even though the ~500 kW test had a peak heat release almost 200 kW over the current 317 kW fire, accounting for the time dependence of the fire means the ZOI for cable damage for ~500 kW test was below that of a sustained 317 kW fire. Sensitive electronics are an exception; however, the heat soak approach for sensitive electronics is a bounding estimate because of the lack of failure data.

For tray ignition, only the laptop and cart fuel package had a horizontal ZOI over 5 cm (2 in.). Tray ignition requires a heat flux of 25 kW/m^2 for 1 minute. A fire needs to be approximately 150 kW to have an effective emissive power of 25 kW/m^2. Only 11 % of the fuel packages had a peak HRR over 150 kW. However, that emissive power is reduced by the view factor to obtain a target heat flux and, at a target distance of 5 cm (2 in.), the fire size needs to be approximately 300 kW, which was 6 % of the fuel packages. Then, the peak must last long enough to cause ignition. Combining these factors left only the laptop and cart as having a ZOI over 5 cm (2 in.).

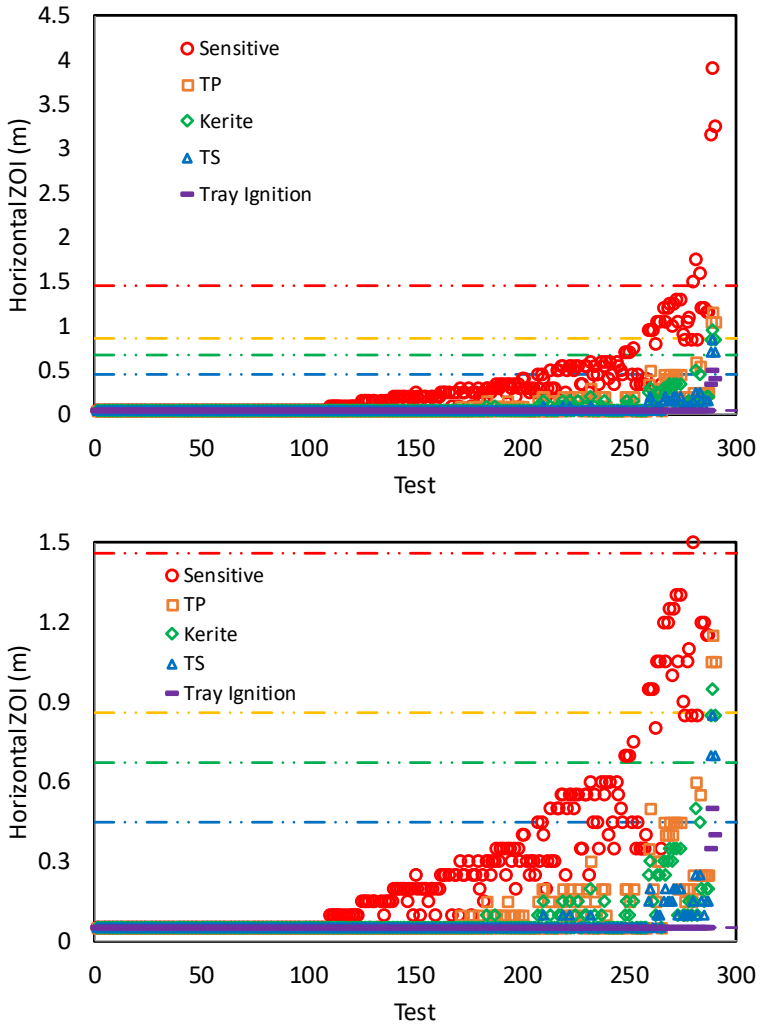


Figure 6-27
Plot of Horizontal ZOIs for Each Test Using the Heat Soak Method. Dots—Test Data, Dash-Dot Lines—Current 317 kW ZOI. Top—All Data, Bottom—Zoom to 317 kW Sensitive ZOI

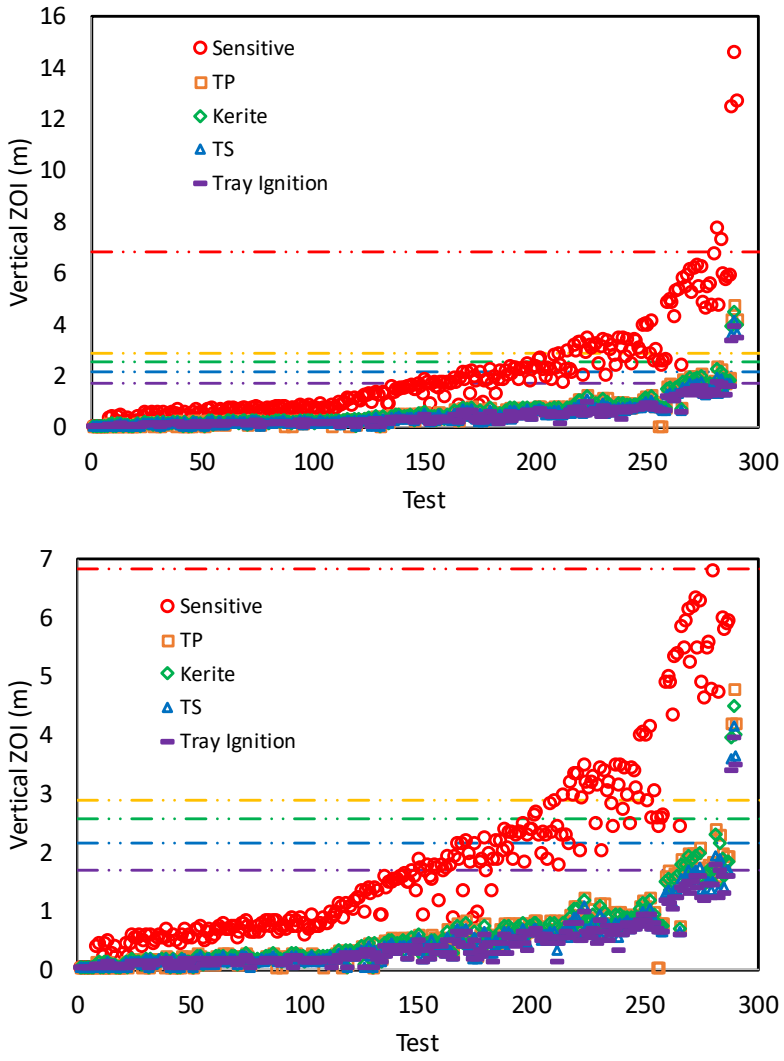


Figure 6-28
Plot of Vertical ZOIs for Each Test Using the Heat Soak Method. Dots—Test Data, Dash-Dot Lines—Current 317 kW ZOI. Top—All Data, Bottom—Zoom to 317 kW Sensitive ZOI

Table 6-4
Vertical and Horizontal ZOIs over Three Decades of Fire Size with Comparison to ZOIs Based on Current Guidance

Peak HRR (kW)	Horizontal ZOI* (m)					Vertical ZOI (m)				
	Sens	TP	Kerite	TS	Tray	Sens	TP	Kerite	TS	Tray
5.1	0.05	0.05	0.05	0.05	0.05	0.90	0.25	0.25	0.20	0.20
49.9	0.20	0.05	0.05	0.05	0.05	1.80	0.60	0.55	0.50	0.45
520	1.75	0.60	0.50	0.25	0.05	7.85	2.40	2.30	1.95	1.80
Current 317	1.46	0.86	0.67	0.45	0.05	6.82	2.89	2.57	2.17	1.17

*Shaded values are the minimum ZOI allowed by the method of computing the ZOI discussed in Section 5.6.

Figure 6-29 plots the ZOIs for each test, assuming the fire was in a corner. As discussed in Section 5.5, the ZOI search algorithm uses a 5 cm (2 in.) increment; therefore, the minimum value a ZOI can have is 5 cm (2 in.). Table 6-5 shows ZOIs for peak HRRs that span 3 orders of magnitude. Note that, even though the ~500 kW test had a peak heat release almost 200 kW over the current 317 kW fire, accounting for the time dependence of the fire means the ZOI for cable damage for ~500 kW test was equal to or below that of a sustained 317 kW fire. Sensitive electronics are an exception; however, the heat soak approach for sensitive electronics is a bounding estimate because of the lack of failure data.

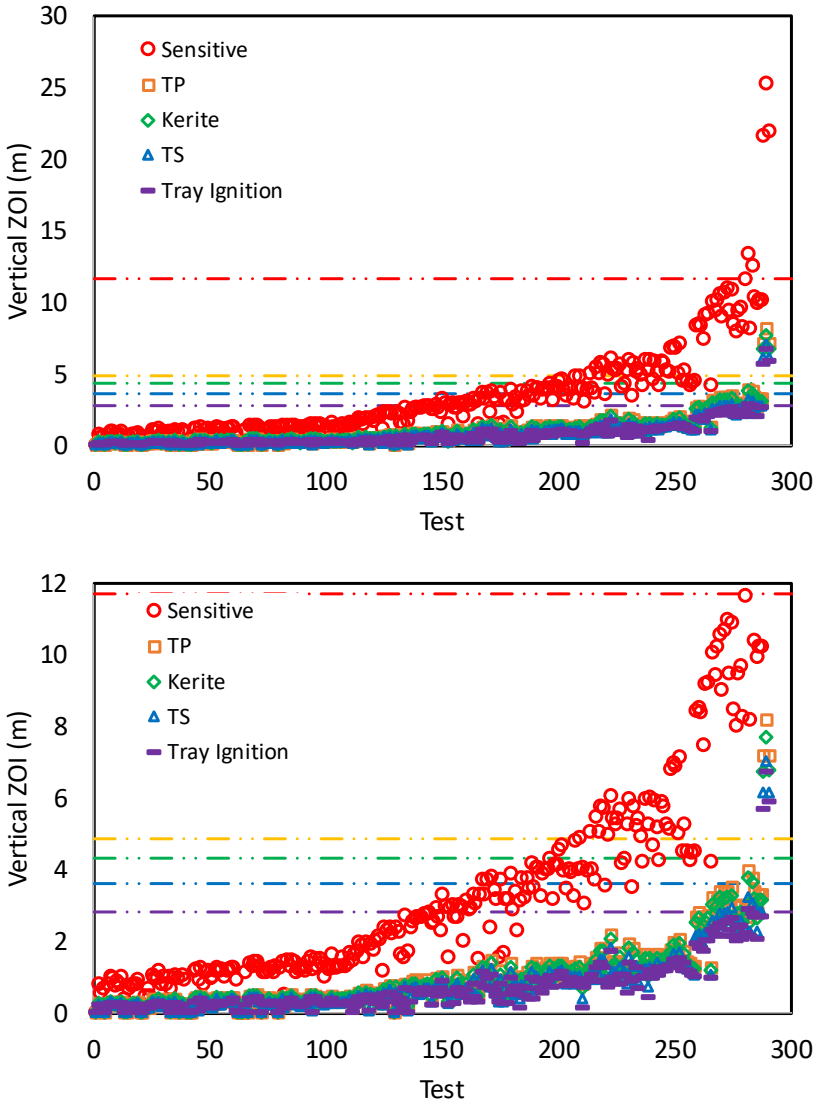


Figure 6-29
Plot of Vertical ZOIs for Each Test Using the Heat Soak Method for a Fire in a Corner. Dots—Test Data, Dash-Dot Lines—Current 317 kW ZOI. Top—All Data, Bottom—Zoom to 317 kW Sensitive ZOI

Table 6-5
Vertical in a Corner ZOIs over Three Decades of Fire Size with Comparison to ZOIs Based on Current Guidance

Peak HRR (kW)	Vertical in a Corner ZOI (m)				
	Sens	**TP**	**Kerite**	**TS**	**Tray**
5.1	1.60	0.45	0.40	0.40	0.35
49.9	4.00	1.20	1.10	1.00	0.95
520	13.40	4.00	3.80	3.25	2.90
Current 317	11.71	4.87	4.32	3.61	2.82

6.6 Fire Growth and Decay

Figure 6-30 shows the fire growth time, fire growth exponent, peak heat release plateau time, decay time, and decay exponent. Table E-1 in Appendix E provides the data for each test. Growth times range from 6 to 4,100 s. Growth exponents range from 0.2 to 254. The time at peak HRR ranges from 1 to 1,000 s. The decay time ranges from 3 to 5,200 s. The decay exponent ranges from 0.04 to 0.93. No clear trend is readily visible as a function of the peak HRR for all parameters except the growth exponent, which shows a trend between the exponent and the fire size.

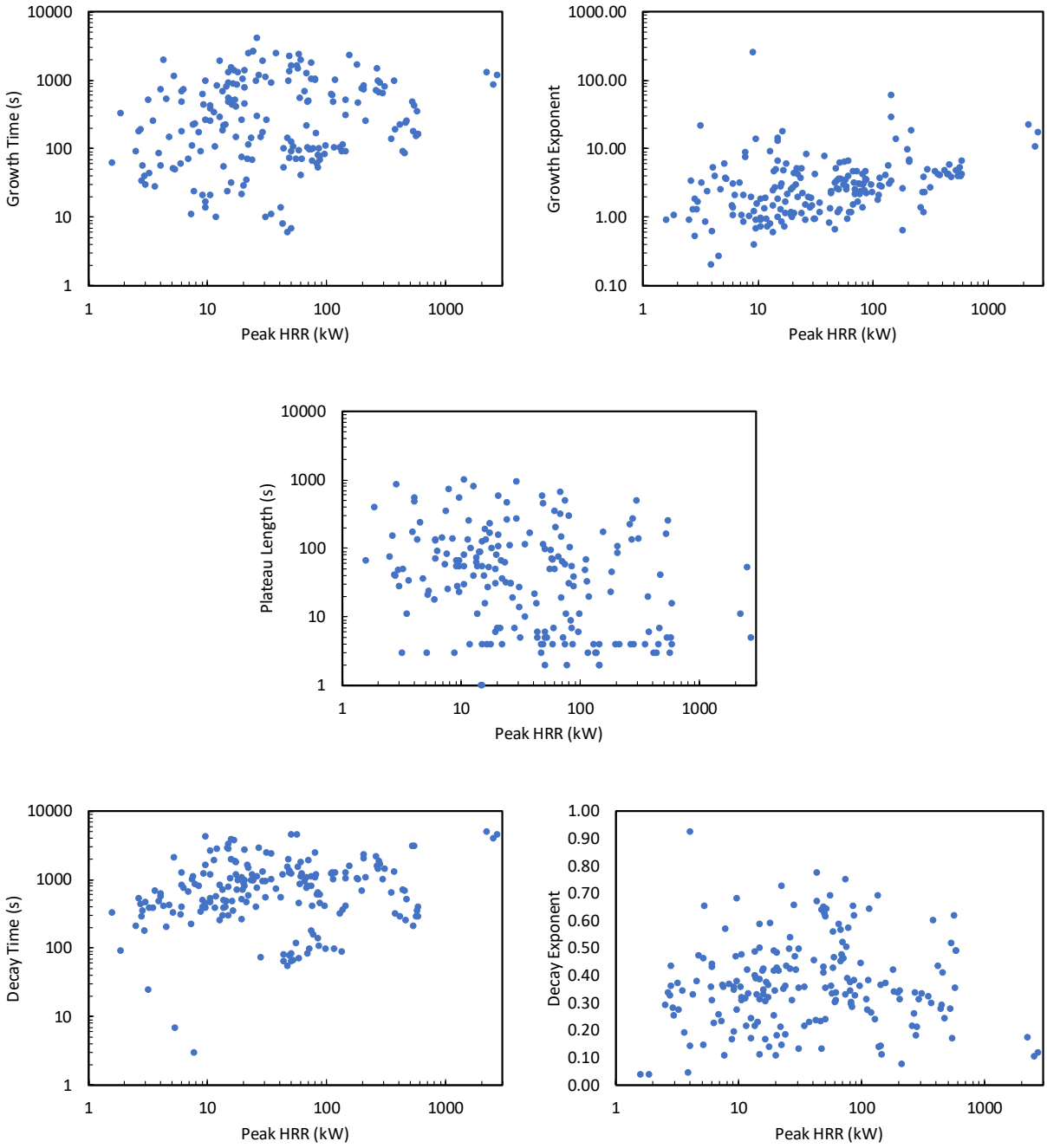


Figure 6-30
Plot of Fire Growth (Top), Plateau (Middle), and Decay (Bottom) Parameters

6.7 Variability in Test Item Heat Release Rate

Figure 6-31 below plots the average peak HRR for each test item versus the relative standard deviation of the peak HRR for all tests of that item. The overall average relative deviation over all test items is 30 % of the average peak HRR. Over 50 kW, the average relative deviation decreases with fire size. These items all have either rapid flame spread over the item, such as the cardboard boxes, or result in a liquid pool with sufficient heat feedback to ignite the entire pool, such as the test items involving plastic trash cans. The one exception with a notably large deviation is the draped plastic tarp, where in one test, the melt progression of the plastic resulted in a much larger liquid pool than the other tests. At smaller fire sizes, some items have a very large variability in the test-to-test peak HRR. These include items such as the 15.2 m (50 ft) coil of plastic chain, where all five tests resulted in the chain slowly melting and burning away from the ignition source but only two of the five tests had the resulting pool ignite. This group also includes the water hose and coils of large rope. For these items, the ignition location affected the ability of the ignition source to involve the entire test item. In the second phase of developing probabilistic risk assessment guidance, these results suggest that the upper end of probabilistic distributions (i.e., the 98th percentile fire) should not have a large degree of uncertainty caused by the testing protocol and number of repeat tests. The increased variability in the lower HRRs suggests there will be some added uncertainty to the lower end of probabilistic distributions; however, small fires are not typically large contributors to risk.

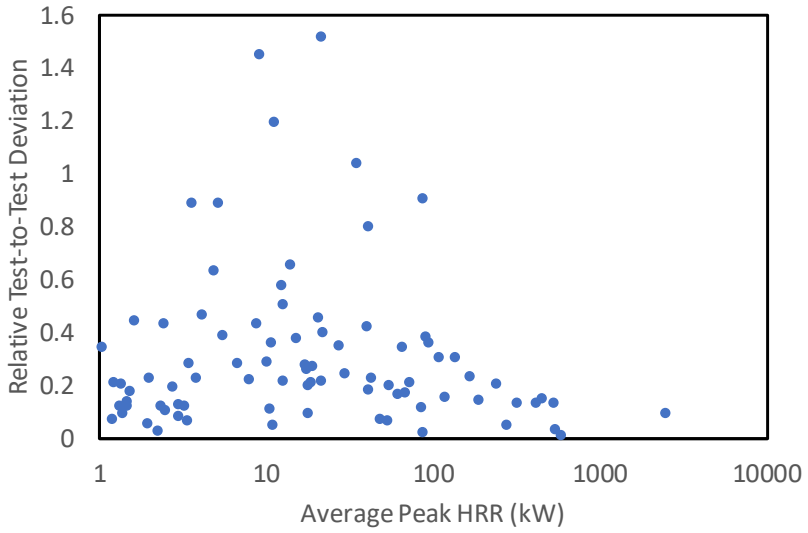


Figure 6-31
Plot of Average Peak HRR for a Test Item vs. the Relative Standard Deviation of the Peak HRR

7
REFERENCES

1. *EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 2: Detailed Methodology*. Electric Power Research Institute, Palo Alto, CA, and U.S. Nuclear Regulatory Commission, Washington, DC, September 2005. EPRI 1011989 and NUREG/CR-6850.
2. *Fire Probabilistic Risk Assessment Methods Enhancements,* U.S. Nuclear Regulatory Commission, Washington, DC, and Electric Power Research Institute, Palo Alto, CA, September 2010. NUREG/CR-6850, Supplement 1, and EPRI 1019259.
3. *The Updated Fire Events Database: Description of Content and Fire Event Classification Guidance*, Electric Power Research Institute, Palo Alto, CA, 2013. EPRI 1025284.
4. *Nuclear Power Plant Fire Modeling Analysis Guidelines (NPP FIRE MAG)*, U.S. Nuclear Regulatory Commission, Washington, DC, and Electric Power Research Institute, Palo Alto, CA. November 2012. NUREG-1934 and EPRI 1023259.
5. *Fire Dynamics Tools (FDT^S) Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program,* U.S. Nuclear Regulatory Commission, Washington, DC, July 2013. NUREG-1805, Supplement 1.
6. *Nuclear Power Plant Fire Ignition Frequency and Non-Suppression Probability Estimation Using the Updated Fire Events Database*, Electric Power Research Institute, Palo Alto, CA, and U.S. Nuclear Regulatory Commission, Washington, DC, January 2015. NUREG-2169 and EPRI 3002002936.
7. Babrauskas, V., Chapter 26, "Heat Release Rates," *SFPE Handbook of Fire Protection Engineering, 5th Edition*, Society of Fire Protection Engineers (SFPE), Bethesda, MD, 2016.
8. Koshal, D., *Manufacturing Engineer's Reference Book,* Butterworth-Heinemann Ltd., Oxford, United Kingdom, 2003.
9. Babrauskas, V., *Ignition Handbook*, Fire Science Publishers, Issaquah, WI, 2003.
10. McGrattan, K., Selepak, M., and Hnetkovsky, E., *The Influence of Walls, Corners, and Enclosures on Fire Plumes,* National Institute of Standards and Technology, Gaithersburg, MD, 2018. Technical Note 1984.
11. Bryant, R., Grove, B., Guthrie, W., and Maranghides, A., *The NIST 3 Megawatt Quantitative Heat Release Rate Facility*, National Institute of Standards and Technology, Gaithersburg, MD, 2003. NIST SP 1007.
12. Mulholland, G. and Croarkin, C. (2000), "Specific Extinction Coefficient of Flame Generated Smokes," *Fire and Materials*, 24: PP 227–230.
13. *Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications, Supplement 1*, Electric Power Research Institute, Palo Alto, CA, and U.S. Nuclear Regulatory Commission, Washington, DC, November 2016. NUREG-1824, Supplement 1, and EPRI 3002002182
14. *Refining and Characterizing Heat Release Rates from Electrical Enclosures During Fire (RACHELLE-FIRE), Volume 2: Fire Modeling Guidance for Electrical Cabinets, Electric Motors,*

Indoor Dry Transformers, and the Main Control Board, U.S. Nuclear Regulatory Commission, Washington, D.C., and Electric Power Research Institute, Palo Alto, CA, expected publication 2019. NUREG-2178 Vol. 2, and EPRI 3002016052.

15. *Standard Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests*, American Society for Testing and Materials (ASTM) E2067-15, ASTM International, West Conshohocken, PA, 2015.
16. Parker, J., "Calculations of the heat release rate by oxygen consumption for various applications," National Institute of Standards and Technology (formerly the National Bureau of Standards), Washington, DC, 1982. NBSIR 81-2427-1.
17. Janssens, M. (1991), "Measuring rate of heat release by oxygen consumption," *Fire Technology*, 27(3): pp 234–249.
18. Kann, M., Tewarson, A., and Chaos, M., Chapter 36, "Combustion Characteristics of Materials and Generation of Fire Products," *SFPE Handbook of Fire Protection Engineering, 5th Edition*, Society of Fire Protection Engineers, Bethesda, MD, 2016
19. Beyler, C., Chapter 66, "Fire Hazard Calculations for Large Open Hydrocarbon Fires," *SFPE Handbook of Fire Protection Engineering, 5th Edition*, Society of Fire Protection Engineers, Bethesda, MD, 2016.
20. Shokri, S. and Beyler, C., "Radiation from Large Pool Fires," J. Fire Prot. Engr., 1(4): pp 141-150, 1989.
21. FAQ 13-0004, "Clarifications on Treatment of Sensitive Electronics," Rev. A. Available through the NRC's Agencywide Documents Access and Management System (ADAMS): https://www.nrc.gov/docs/ML1312/ML13126A388.pdf.
22. *Kerite Analysis in Thermal Environment of FIRE (KATE-Fire): Test Results—Final Report*, U.S. Nuclear Regulatory Commission, Washington, DC, December 2011. NUREG/CR-7102.
23. FAQ 16-0011, "Cable Tray Ignition." Available through the NRC's ADAMS: https://www.nrc.gov/docs/ML1807/ML18074A021.pdf.
24. Prairie Island NFPA 805 LAR, PRA RAI 21.01, February 2017. Available through the NRC's ADAMS: https://www.nrc.gov/docs/ML1703/ML17038A513.pdf.
25. Prairie Island Response to NFPA 805 LAR, PRA RAI 21.01, March 2017. Available through the NRC's ADAMS: https://www.nrc.gov/docs/ML1706/ML17065A339.pdf.
26. *Prairie Island Nuclear Generating Plant, Units 1 and 2—Issuance of Amendments Re: Transition to NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants" CAC Nos. ME9734 and ME9735*, August 8, 2017. Available through the NRC's ADAMS: https://www.nrc.gov/docs/ML1716/ML17163A027.pdf.
27. *Thermally-Induced Electrical Failure (THIEF) Model*, Volume 3, U.S. Nuclear Regulatory Commission, Washington, DC, April 2008. NUREG/CR-6931.

APPENDIX A
FIRE EVENTS DATABASE SUMMARY

Table A-1 summarizes transient events from the Fire Events Database (FEDB). The summary provides the fire ID number, date, location, plant mode, means of ignition, a brief description of the fuel package, and the challenging classification of the fire. *The Updated Fire Events Database: Description of Content and Fire Event Classification Guidance*, issued by the Electric Power Research Institute in 2013, includes detailed explanations of plant mode and challenging classification. Except for the fuel package description, these data are a direct extraction from the FEDB. No attempts were made to reclassify the severity of events. The fuel package description summarizes the event description in the FEDB, which often contains a lengthier discussion beyond just the fuel involved.

Table A-1
Summary of FEDB Transient Events

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
6	7/13/1999	PO	Auxiliary Building (Pressurized-Water Reactor (PWR))	Hot Work	Heating, ventilation, and air conditioning (HVAC) filter	PC
22	12/3/1990	RF	Drywell (Boiling-Water Reactor (BWR))	Overheated Wire	Bundle of temporary cables wrapped in plastic run through airlock. 100+ cables and hoses run along the top of fire-resistant scaffolding. Airlock length ~13 ft	C
23	12/19/1990	PO	Turbine Building	Hot Surface	Lagging + Extension cord	PC
25	1/11/1991	PO	Turbine Building	Hot Work	Roof insulation	U-NC/PC
26	2/14/1991	RF	Containment (PWR)	Overheated Wire	Plastic tarp	C
37	11/15/1991	HS	Other	Arc Flash	Magnesium outrigger for crane	NC
42	7/3/1992	PO	Other	Unknown	Diesel air compressor	PC
55	10/13/1993	RF	Auxiliary Building (PWR)	Hot Work	Insulation	C
57	11/2/1993	PO	Turbine Building	Overheated Wire	Temporary power cable to lighting transformer. Transformer not impacted.	NC
72	4/14/1995	RF	Auxiliary Building (PWR)	Hot Work	Cork expansion joint in wall	C
75	8/22/1995	RF	Auxiliary Building (PWR)	Hot Work	2 x 4 (wood)	PC
78	1/24/1996	RF	Auxiliary Building (PWR)	Hot Work	Coating inside service water pipe	C
80	2/29/1996	CD	Turbine Building	Hot Work	Oil soaked insulation	PC
81	3/25/1996	PO	Radwaste Building	Lighting	Insulation and charcoal absorber	PC
96	10/28/1987	RF	Other	Hot Work	Paper filter cartridge	PC
101	9/3/2000	RF	Containment (PWR)	Hot Work	Non-fire-retardant (FR) tarp	U-PC/C

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
105	11/10/2000	PO	Radwaste Building	Hot Work	Debris	PC
109	4/24/2001	RF	Containment (PWR)	Electrical	Debris	U-PC/C
120	4/7/2003	RF	Containment (PWR)	Hot Work	Herculite	PC
125	1/6/2004	PO	Reactor Building (BWR)	Lighting	PVC hose wrapped in plastic, lift slings	C
129	11/6/2004	RF	Turbine Building	Unknown	Waterbox coating	PC
132	3/4/2005	RF	Turbine Building	Hot Work	Bucket of debris	U-NC/PC
133	5/4/2005	RF	Containment (PWR)	Overheated Wire	Temporary floor covering	PC
163	10/12/2009	RF	Turbine Building	Heating Blanket	Plastic tarp horizontal	PC
176	12/12/2009	PO	Other	Hot Work	Trash bag, broom, tool bag, vacuum, dust pan	PC
178	3/26/2010	RF	Turbine Building	Heating Blanket	Tape	NC
188	8/24/1999	PO	Circulating Water Pump house/Intake Structure	Lightning	Broom handles	PC
200	2/6/1990	CD	Other	Hot Work	Composite board	PC
204	4/9/1990	PO	Radwaste Building	Heater	Plastic debris	NC
208	8/8/1990	PO	Turbine Building	Overheated Wire	Cable insulation	PC
210	10/16/1990	RF	Containment (PWR)	Overheated Wire	Cable insulation	U-NC/PC
212	12/5/1990	PO	Auxiliary Building (PWR)	Hot Work	Welding blank with oil residue	NC
222	2/1/1992	PO	Circulating Water Pump house/Intake Structure	Overheated Wire	Heat trace and lagging	NC
225	3/23/1992	RF	Containment (PWR)	Hot Work	Plastic lead shielding blanket sleeves	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
231	10/22/1992	PO	Turbine Building	Hot Work	High-efficiency particulate air (HEPA) filter	PC
236	1/6/1993	PO	Control building	Overheated Wire	Power cord	U-NC/PC
237	3/19/1993	RF	Containment (PWR)	Hot Work	HVAC filter	PC
238	4/1/1993	PO	Auxiliary Building (PWR)	Overheated Wire	Portable heater	PC
239	7/14/1993	PO	Turbine Building	Hot Work	Insulation	PC
240	7/19/1993	RF	Containment (PWR)	Hot Work	HVAC filter	U-PC/C
241	11/3/1993	RF	Drywell (BWR)	Hot Work	Vinyl-coated blanket	PC
243	12/1/1993	RF	Drywell (BWR)	Hot Work	Trash	PC
244	12/7/1993	RF	Turbine Building	Overheated Wire	Vacuum cleaner	U-PC/C
246	1/12/1994	UN	Auxiliary Building (PWR)	Lighting	String on wood reel	C
248	3/5/1994	RF	Turbine Building	Hot Work	Rags and plastic sheeting	U-PC/C
252	3/18/1995	RF	Auxiliary Building (PWR)	Overheated Wire	Cable insulation	U-NC/PC
258	11/3/1997	RF	Turbine Building	Hot Work	Oil lines	C
259	12/26/1997	PO	Control building	Lighting	Cable insulation	PC
263	4/25/1999	RF	Containment (PWR)	Hot Work	Oil soaked insulation	NC
265	9/23/2006	RF	Circulating Water Pump house/Intake Structure	Hot Work	Foam insulation	NC
266	11/9/2006	PO	Turbine Building	Unknown	Vacuum cleaner (internal)	PC
267	6/2/2000	PO	Other	Hot Work	Oxy-acetylene hose	U-NC/PC
268	4/7/2000	PO	Turbine Building	Hot Work	Fire blanket	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
269	12/12/2000	PO	Other	Hot Work	Unknown	PC
270	11/18/2005	RF	Containment (PWR)	Hot Work	Cloth	PC
271	10/5/2007	CD	Turbine Building	Hot Work	Tape	NC
275	10/14/2003	RF	Containment (PWR)	Hot Work	Tape	PC
276	11/2/2003	RF	Containment (PWR)	Hot Work	Welding blanket	NC
277	11/2/2003	RF	Containment (PWR)	Hot Work	Welding blanket	NC
280	11/19/2005	RF		Hot Work	Tape	NC
283	11/20/2005	RF	Containment (PWR)	Hot Work	Piece of paper	NC
284	11/29/2005	RF		Hot Work	Tape	NC
289	5/28/2007	RF	Other	Hot Work	Grease on crane motor base	NC
292	10/8/2007	RF	Containment (PWR)	Hot Work	Welding blanket	NC
293	10/14/2007	RF	Turbine Building	Hot Work	Plywood decking	NC
294	10/13/2007	RF	Containment (PWR)	Hot Work	Oxy-acetylene hose	NC
295	10/22/2007	RF	Containment (PWR)	Hot Work	Bags of insulation	NC
296	10/30/2007	RF	Containment (PWR)	Hot Work	Orex cloth	NC
297	11/30/2007	UN		Hot Work	Masslinn	NC
298	12/16/2007	RF	Turbine Building	Hot Work	Debris	NC
300	3/16/2009	PO	Auxiliary Building (PWR)	Hot Work	Plastic bag and small amount of cardboard	NC
308	10/14/2005	RF	Turbine Building	Hot Work	Trash bags with silica insulation	PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
310	11/18/2005	RF	Containment (PWR)	Hot Work	Superheat blanket	NC
311	12/1/2005	RF	Containment (PWR)	Hot Work	Cardboard core of rolled fire blanket	NC
312	10/29/2008	RF	Containment (PWR)	Hot Work	Herculite	NC
313	11/9/2008	RF	Turbine Building	Arc	Plastic in feedwater heater	NC
316	8/17/2000	PO	Other	Hot Work	Trash	NC
317	9/27/2003			Hot Work	Tape	NC
318	10/5/2000	PO	Containment (PWR)	Hot Work	Roller on work platform	NC
319	10/5/2000	PO		Hot Work	Cotton cloth	NC
322	3/8/2001	PO		Hot Work	Single personal protective equipment (PPE)	NC
324	1/12/2005	PO	Turbine Building	Hot Surface	Danger flagging	NC
326	3/25/2005	PO	Containment (PWR)	Hot Work	Unknown	NC
328	9/24/2006	RF		Hot Work	Paint/crud	NC
329	9/25/2006	RF	Containment (PWR)	Hot Work	Plastic bag at stepoff pad	NC
330	9/27/2006	RF	Containment (PWR)	Hot Work	Oily buildup on chain	NC
342	11/4/2006	RF		Hot Work	Canvas bag	NC
343	11/4/2006	RF		Hot Work	Plastic radiation bag	NC
344	10/26/2006	RF	Containment (PWR)	Hot Work	Bag of rags	NC
349	4/5/2007	RF	Containment (PWR)	Overheated Wire	Power spider	NC
350	7/11/2002	RF	Turbine Building	Hot surface	Bottle with linseed oil	PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
351	9/26/2002	RF	Containment (PWR)	Hot Work	Bag of rags	NC
352	2/28/2003	RF	Containment (PWR)	Hot Work	Piece of paper	NC
353	1/21/2005	CD	Containment (PWR)	Hot Work	Can of touch-it-up cleaner	NC
357	1/10/2007	PO	Other	Hot Work	HVAC filter	NC
361	2/4/2002	PO		Heater	Mineral oil bath	NC
364	10/3/2003	RF		Overheated Wire	Power cord	NC
367	10/12/2006	RF	Containment (PWR)	Hot Work	Single PPE	NC
368	10/24/2006	RF	Containment (PWR)	Hot Work	Plastic	NC
392	10/30/2002	PO	Turbine Building	Hot Work	PPE hamper	NC
406	6/12/2001	PO	Other	Unknown	Trash can	NC
407	12/1/2001	PO	Other	Hot Work	Welder PCs and plastic bucket	NC
416	10/11/2000	RF	Turbine Building	Hot Work	Fire blanket	NC
418	10/8/2000	CD		Hot surface	Power cord	NC
419	4/5/2005	PO		Unknown	Trash can	NC
422	3/7/2003	PO	Other	Overheated Wire	480 V outlet	PC
429	3/12/2007	PO		Hot Work	Full face mask	NC
430	10/10/2007	RF	Containment (PWR)	Hot Work	Tape	NC
436	11/21/2000	UN		Hot Work	Rubber rake, area burned ~1' x 2'	NC
440	1/2/2003	PO	Other	Hot Work	Brush	U-NC/PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
446	10/5/2004	RF	Other	Smoking	Trash can	PC
448	11/17/2004	RF		Hot surface	Filter paper in a laboratory oven	NC
449	12/8/2004	UN	Radwaste Building	Lighting	Towel	NC
451	12/13/2004	RF	Other	Hot Work	Bird feathers	NC
455	6/6/2005	PO		Smoking	Matches in a worker pocket	NC
457	2/17/2006	RF	Other	Smoking	Trash can	NC
459	5/10/2006	RF	Other	Smoking	Trash can	PC
461	10/12/2006	UN		Hot Work	Clothing	NC
462	10/18/2006	UN	Turbine Building	Hot Work	Clothing	NC
463	11/1/2006	RF	Other	Hot Work	Single rag	NC
465	1/31/2007	UN	Other	Hot Work	Bag of hard hats	NC
467	2/13/2007	UN	Other	Hot Work	Tape attached to scaffolding	NC
468	2/20/2007	UN	Containment (PWR)	Hot Work	Spray can in canvas tool bag	PC
470	6/29/2007	UN	Other	Smoking	Paper cups in metal pail	NC
472	7/17/2007	UN	Other	Hot Work	Single rag	NC
476	12/6/2007	RF		Hot Work	Hardhat	NC
479	3/17/2000	UN	Containment (PWR)	Lighting	Power cord	NC
480	4/7/2000	PO	Other	Lighting	Wood	U-NC/PC
481	6/29/2000	UN	Radwaste Building	Heater	Herculite	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
484	11/8/2001	UN	Other	Hot Work	Plastic pallet	NC
485	9/14/2001	PO	Radwaste Building	Short	Trash bag	NC
499	12/17/2000	PO	Other	Hot Work	Dryer lint	NC
502	11/18/2003	PO	Other	Overheated Wire	Power cord	NC
504	10/9/2002	RF		Unknown	Unknown	U-NC/PC
515	10/5/2005	RF	Auxiliary Building (PWR)	Unknown	Air compressor	U-NC/PC
524	10/11/2006	RF		Hot Work	Grifflon (FR trap)	NC
537	10/13/2000	RF		Hot Work	Tape	NC
538	10/20/2000	RF	Other	Heater	Toaster oven	NC
544	12/13/2001	PO		Overheated Wire	Motor-generator set crane resistor bank	NC
555	7/27/2005	PO	Turbine Building	Hot Work	Vinyl tarp	NC
563	10/18/2006	RF	Drywell (BWR)	Hot Work	Clothing	NC
565	4/25/2007	PO	Other	Overheated Wire	Birds nest	NC
579	3/23/2004	PO	Other	Smoking	Ashtray	NC
581	4/17/2002	PO	Other	Smoking	Metal trash can	NC
584	10/8/2001	PO	Other	Hot Work	Blanket	NC
592	6/11/2009	RF		Unknown	Tarp	U-NC/PC
593	10/16/2008	CD	Turbine Building	Hot Work	Glove	NC
594	1/28/2000	PO	Containment (PWR)	Hot Work	Trash bag	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
595	2/13/2000	CD		Hot Work	Wood board	U-NC/PC
596	6/13/2000	CD	Other	Hot Work	Herculite	NC
597	7/22/2000	CD	Containment (PWR)	Hot Work	Tape	NC
598	10/12/2000	CD		Hot Work	Oily rag	U-NC/PC
599	1/0/1900	UN		Hot Work	PPE holder	NC
601	10/28/2004	PO	Other	Hot Work	Clothing	NC
602	9/29/2006	RF	Turbine Building	Hot Work	Tape and blanket	PC
609	1/0/1900	UN	Other	Hot Work	Tape	NC
10278	4/4/2001	RF	Turbine Building	Hot Work	Lagging backing paper and yellow safety netting	NC
10285	4/7/2004	PO	Other	Hot Work	Metal bucket of rags	NC
10286	5/10/2004	RF	Turbine Building	Hot Work	Wood and cardboard boxes	PC
10287	5/19/2004	RF	Turbine Building	Hot Work	Torch ignited gym bag	U-NC/PC
10288	5/22/2004	RF	Turbine Building	Hot Work	Wood board and plywood	NC
10289	5/28/2004	RF	Turbine Building	Hot Work	Welding cloth	NC
10290	6/3/2004	RF	Turbine Building	Hot Work	Rope	NC
10291.1	9/18/2004	PO	Control building	Hot Work	Roof cement	C
10291.2	9/18/2004	PO	Control building	Hot Work	Roof cement	C
10293	8/16/2005	PO	Other	Hot Work	Plywood	NC
10294	10/9/2005	RF	Turbine Building	Hot Work	Fire blanket	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
10295	10/18/2005	RF	Containment (PWR)	Hot Work	Paint	NC
10309	4/18/2006	RF	Turbine Building	Hot Work	Canvas tool bag	NC
10313	4/3/2009	RF	Turbine Building	Hot Work	Oil soaked board	U-NC/PC
10317	9/23/2004	PO	Containment (PWR)	Hot Work	Tape	NC
10318	10/16/2004	RF	Containment (PWR)	Hot Work	Oxy-acetylene hose	NC
10320	5/25/2005	PO	Other	Hot Work	Clothing	NC
10321	6/1/2005	PO	Containment (PWR)	Hot Work	Tape	NC
10330	9/23/2008	RF	Turbine Building	Hot Work	Fire blanket	NC
10334	3/30/2000	RF	Containment (PWR)	Unknown	Underwater vacuum control panel	C
10349	9/24/2007	RF	Containment (PWR)	Hot Work	Herculite	NC
10412	2/17/2009	PO	Reactor Building (BWR)	Hot Work	Oxy-acetylene hose	NC
10428	6/1/2000	PO		Short	Welding machine electronics	NC
10492	9/30/2008	RF	Turbine Building	Short	480 volt power cord flash	U-NC/PC
10503	6/19/2010	PO	Other	Hot Work	Debris	NC
10504	3/15/2000	CD	Turbine Building	Hot Work	Tape	NC
10507	3/14/2001	CD	Turbine Building	Hot Work	Mop head	NC
10516	11/20/2001	RF	Containment (PWR)	Hot Work	Electrical cable	PC
10519	9/25/2002	RF	Turbine Building	Hot Work	Foam cushion	NC
10530	3/15/2006	CD	Turbine Building	Hot Work	Tape and Herculite	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
10536	12/12/2002	RF	Drywell (BWR)	Hot Work	Face shield	NC
10542	7/9/2003	RF	Reactor Building (BWR)	Hot Work	Dust mop	NC
10543	9/3/2003	RF	Turbine Building	Hot Work	Unknown	NC
10546	3/15/2004	RF	Other	Hot Work	Tape	NC
10549	10/8/2003	RF	Turbine Building	Hot Work	Single rag	NC
10550	9/3/2003	RF	Turbine Building	Hot Work	Blanket	NC
10551	7/14/2003	RF	Reactor Building (BWR)	Hot Work	Single rag	NC
10552	7/8/2003	RF	Reactor Building (BWR)	Hot Work	Dust mop	NC
10553	4/17/2000	PO	Turbine Building	Hot Work	Cloth	NC
10554	5/3/2004	RF	Other	Smoking	Trash can	NC
10555	5/5/2004	RF	Turbine Building	Short	Preheat cables	U-NC/PC
10556	5/11/2004	RF	Reactor Building (BWR)	Hot Work	Oxy-acetylene hose	NC
10557	1/13/2005	RF	Drywell (BWR)	Hot Work	Tape	NC
10560	3/29/2005	RF	Turbine Building	Hot Work	Paper	NC
10561	4/4/2005	RF	Turbine Building	Hot Work	Unknown	NC
10562	5/23/2005	CD	Other	Hot Work	Tape	NC
10566	9/15/2005	RF	Reactor Building (BWR)	Hot Work	Cloth	NC
10567	12/19/2005	RF	Drywell (BWR)	Hot Work	Goggles	NC
10568	1/12/2006	RF	Reactor Building (BWR)	Hot Work	Herculite	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
10573	7/5/2006	RF	Turbine Building	Hot Work	Shoe cover	NC
10574	7/17/2006	RF	Turbine Building	Hot Work	Rag or cloth stuffed in pipe	NC
10579	4/4/2008	RF	Turbine Building	Hot Work	Herculite	U-NC/PC
10581	11/19/2008	PO	Other	Smoking	Trash can	NC
10582	12/9/2005	RF	Reactor Building (BWR)	Hot Work	Trash bag	U-NC/PC
10588	11/21/2000	PO	Turbine Building	Hot Work	Graphite valve packing	NC
10601	2/16/2005	RF	Reactor Building (BWR)	Hot Work	Floor wipe	NC
10618	2/15/2000	PO	Other	Hot Surface	Material in dryer	C
10628	12/30/2005	PO	Diesel Generator Building	Unknown	Air conditioning unit	PC
10631	11/28/2001	RF	Containment (PWR)	Heaters	Tarp	NC
10660	11/6/2009	RF	Turbine Building	Hot Work	Unknown	NC
10668	4/22/2001	RF	Turbine Building	Hot Work	Oxy-acetylene hose	NC
10672	6/26/2001	PO	Other	Hot Work	Oily rag	NC
10677	4/4/2003	RF	Drywell (BWR)	Hot Work	Single rag	NC
10681	11/12/2004	PO	Other	Hot Work	Bucket of glue	NC
10684	4/6/2005	PO	Turbine Building	Hot Work	FME cover	NC
10685	4/11/2005	RF	Other	Hot Work	Metal bucket with debris	NC
10687	5/4/2005	PO		Hot Work	Clothing	NC
10695	7/27/2007	PO	Circulating Water Pump House/Intake Structure	Heater	Debris in bug zapper	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
10705	12/3/2003	CD	Turbine Building	Hot Work	Debris	NC
10727	2/5/2009	RF	Other	Hot Work	Oxy-acetylene hose	NC
10729	4/3/2009	CD	Turbine Building	Hot Work	Oily rag	U-NC/PC
10732	4/22/2002	RF	Containment (PWR)	Hot Work	Clothing and dosimeter	NC
10738	8/22/2001	PO	Auxiliary Building (PWR)	Unknown	String	NC
10744	8/17/2001	PO	Other	Smoking	Trash can	NC
20266	2/19/1990	RF	Drywell (BWR)	Hot Work	Plastic	U-NC/PC
20277	11/16/1990	RF	Reactor Building (BWR)	Overheated Wire	Power cord	U-NC/PC
20285	10/25/1991	CD	Turbine Building	Hot Work	Plastic bottle	NC
20289	3/16/1992	UN	Auxiliary Building (PWR)	Unknown	Cloth	U-NC/PC
20290	4/26/1992	PO		Smoking	Trash can	NC
20293	9/1/1992	PO	Turbine Building	Hot Work	Paper	U-NC/PC
20294	10/5/1992	PO	Other	Hot Work	Paper	U-NC/PC
20296	10/23/1992	RF	Reactor Building (BWR)	Hot Work	Plastic	U-NC/PC
20297	11/17/1992	RF	Reactor Building (BWR)	Lighting	Power cord	U-NC/PC
20299	3/9/1993	RF		Overheated Wire	Welding machine electronics	NC
20300	3/10/1993	RF	Turbine Building	Hot Surface	Wire ignited by oven	U-NC/PC
20301	4/13/1993	PO	Turbine Building	Lighting	Plastic	U-NC/PC
20303	10/14/1993	RF	Diesel Generator Building	Lighting	Oily rags	PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
20304	11/2/1993	CD	Reactor Building (BWR)	Heater	Combustible liquid	PC
20306	12/30/1993	RF	Drywell (BWR)	Overheated Wire	Power cord	U-NC/PC
20307	1/25/1994	PO	Auxiliary Building (PWR)	Hot Work	Insulation	NC
20308	3/9/1994	RF	Turbine Building	Hot Work	Welding blanket	U-NC/PC
20309	3/11/1994	RF	Turbine Building	Hot Work	Unknown	NC
20310	3/26/1994	RF	Reactor Building (BWR)	Hot Work	Paper	U-NC/PC
20311	4/4/1994	RF	Containment (PWR)	Hot Work	Plastic	U-NC/PC
20313	9/29/1994	UN	Other	Hot Surface	Debris	U-NC/PC
20315	2/20/1995	RF	Turbine Building	Hot Work	Cleaning solvent	NC
20316	2/24/1995	PO	Turbine Building	Hot Work	Cloth	U-NC/PC
20317	4/10/1995	RF	Reactor Building (BWR)	Hot Work	Paper	U-NC/PC
20318	8/9/1995	PO	Other	Smoking	Trash can	NC
20326	10/12/1998	RF	Turbine Building	Unknown	Trash can	U-NC/PC
20331	11/4/1999	RF	Turbine Building	Hot Work	Padding material	NC
20332	12/14/1999	RF	Containment (PWR)	Overheated Wire	Blower	NC
20333	1/12/1990	CD	Containment (PWR)	Short	Power cord	NC
20335	4/13/1990	RF	Turbine Building	Hot Work	Plastic	NC
20336	2/14/1991	PO	Other	Unknown	Trash	U-NC/PC
20337	4/21/1991	PO	Turbine Building	Hot Work	Welding slag ignited welding blankets. Very little ash produced.	U-NC/PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
20340	12/1/1992	CD	Reactor Building (BWR)	Hot Work	Paper	U-NC/PC
20341	3/31/1993	RF		Heater	Floor paint	U-NC/PC
20342	4/30/1993	RF	Reactor Building (BWR)	Hot Work	Tape	U-NC/PC
20343	8/13/1993	RF	Reactor Building (BWR)	Hot Work	Trash	NC
20345	3/28/1994	RF	Turbine Building	Hot Work	Debris	NC
20347	4/15/1994	RF	Turbine Building	Hot Work	Tape	NC
20348	4/16/1994	RF	Drywell (BWR)	Overheated Wire	Power cord	U-NC/PC
20349	4/23/1994	RF	Turbine Building	Hot Work	Tape/paper	U-NC/PC
20354	10/8/1994	PO	Containment (PWR)	Short	Electrical cables	C
20361	1/7/1997	PO	Other	Overheated Wire	480 V power cord	U-NC/PC
20373	3/16/1999	RF	Turbine Building	Electrical Failure	Fire type not specified	PC
20375	3/29/1999	RF	Turbine Building	Hot Work	Plastic sheet	NC
20376	7/29/1999	PO	Other	Self-heating	Oily rags and paper in dumpster	NC
20381	10/17/2000	RF	Reactor Building (BWR)	Overheated Wire	Welding machine electronics	U-NC/PC
30267	3/13/2010	RF	Turbine Building	Hot Work	Plastic contamination barrier	NC
30270	3/16/2003	RF	Turbine Building	Hot Work	Tape	PC
30277	12/3/2007	PO	Turbine Building	Self-heating	Oily rags in drum	PC
30278	10/15/2000	RF	Turbine Building	Hot Work	Single rag	NC
30288	4/14/2000	RF	Containment (PWR)	Lighting	PPE hood	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30290	1/20/2001	PO	Turbine Building	Hot Surface	Rags	NC
30294	11/7/2001	PO	Other	Hot Work	Rag	NC
30295	3/15/2002	PO		Hot Work	Clothing	NC
30298	4/13/2006	PO	Turbine Building	Self-heating	Epoxy resin in plastic bucket	NC
30300	5/13/2006	RF	Containment (PWR)	Lighting	Rag	NC
30308	4/3/2001	PO		Short	Power cord	NC
30314	12/19/2001	PO	Auxiliary Building (PWR)	Overheated Wire	Heated 55-gallon drum of grease	U-PC/C
30317	4/18/2005	RF	Containment (PWR)	Hot Work	Plastic bag on scissor stand	PC
30319	7/18/2005	PO	Turbine Building	Hot Work	Single rag	NC
30320	5/8/2008	RF	Turbine Building	Hot Work	Wood	NC
30321	11/21/2008	PO		Hot Work	Clothing	NC
30322	10/27/2006	RF		Heater	Kidney loop oil heater	PC
30325	11/6/2007	RF		Lighting	Several buckets of blasting sponge material	NC
30326	5/1/2008	RF		Hot Work	Tape	NC
30330	4/30/2000	RF	Turbine Building	Heater	Kidney loop oil heater	PC
30333	7/31/2003	PO		Overheated Material	Paint thinner during cleaning of spray gun	U-PC/C
30346	10/22/2003	CD	Turbine Building	Hot Work	Single rag	NC
30347	3/27/2009	RF		Hot Work	Grifflon (FR trap)	NC
30350	7/26/2004	PO	Turbine Building	Smoking	Trash can	PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30351	5/14/2005	CD	Turbine Building	Self-heating	Trash bag with oily rags	NC
30354	2/8/2005	PO	Other	Overheated Wire	4,160 to 480 V switch possible trash nearby	C
30357	6/20/2007	CD	Control building	Hot Work	Tape and Herculite	U-NC/PC
30359	1/10/2008	PO	Other	Self-heating	Oily rags in open barrel	NC
30360	4/21/2008	RF	Other	Hot Work	Tape	NC
30361	4/11/2001	RF	Turbine Building	Heater	Cardboard boxes	PC
30363	5/5/2003	RF	Containment (PWR)	Overheated Wire	Power cord	PC
30364	5/26/2003	RF	Other	Hot Work	Filter material	NC
30365	9/8/2003	PO		Hot Surface	Rag	NC
30366	12/2/2003	PO		Hot Work	Oxy-acetylene hose	NC
30367	3/30/2004	RF		Heater	Lanyard	NC
30369	10/29/2005	RF	Containment (PWR)	Hot Work	Fire blanket	NC
30370	10/31/2005	RF	Containment (PWR)	Hot Work	Temporary HVAC duct	PC
30371	11/8/2005	RF		Hot Work	Clothing	NC
30372	11/18/2005	RF	Containment (PWR)	Hot Work	Air line	NC
30373	11/20/2005	RF	Containment (PWR)	Hot Work	Bag	NC
30374	11/30/2005	RF	Auxiliary Building (PWR)	Heater	Portable heater	PC
30375	5/9/2007	RF		Hot Work	Single rag	NC
30376	10/14/2007	RF		Hot Work	Lead blanket	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30377	11/3/2007	RF		Hot Work	Bag	NC
30378	11/6/2007	RF		Hot Work	Cloth	NC
30379	11/16/2007	RF		Heater	Tape	NC
30384	10/18/2000	RF		Hot Work	5-gallon plastic bucket	NC
30388	4/6/2002	RF		Short	Trash	PC
30390	5/7/2008	RF	Containment (PWR)	Overheated Wire	Welding machine electronics	PC
30392	3/20/2000	PO	Other	Overheated Wire	Welding lead	U-NC/PC
30393	3/24/2000	PO	Other	Overheated Wire	Power cord	U-NC/PC
30394	2/2/2003	PO	Reactor Building (BWR)	Heater	Space heater	PC
30395	3/21/2004	RF	Turbine Building	Hot Work	Unknown	U-PC/C
30397	4/4/2009	RF	Turbine Building	Hot Work	PPE	NC
30402	4/29/2008	RF	Turbine Building	Overheated Wire	Welding machine electronics	NC
30403	9/24/2009	RF	Turbine Building	Hot Work	FME cover	NC
30407	4/30/2002	RF	Containment (PWR)	Hot Work	Electrical cable	PC
30408	3/19/2001	PO	Turbine Building	Unknown	Valve label	PC
30411	3/28/2000	RF	Turbine Building	Hot Work	Oxy-acetylene hose	NC
30412	4/25/2002	RF	Containment (PWR)	Heater	Electrical cable	PC
30413	4/25/2002	RF	Containment (PWR)	Hot Work	Mop	NC
30414	3/28/2002	RF	Containment (PWR)	Hot Work	Oxy-acetylene hose	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30416	4/29/2002	RF	Turbine Building	Hot Work	Paper in tote bag	NC
30417	3/20/2002	RF	Containment (PWR)	Hot Work	Tape	NC
30418	2/19/2002	RF	Other	Short	Hold down on forklift battery	U-NC/PC
30419	10/4/2001	PO	Other	Hot Surface	Dust bag on belt sander	NC
30420	3/18/2002	RF	Containment (PWR)	Hot Work	PPE	NC
30421	3/5/2002	RF	Turbine Building	Heater	Welding rod oven on with manual inside	U-NC/PC
30424	4/11/2001	RF	Containment (PWR)	Overheated Wire	Power cords	PC
30426	10/31/2002	PO	Other	Hot Work	Chair	NC
30435	8/16/2007	PO	Diesel Generator Building	Hot Surface	Bird's nest	NC
30436	9/30/2000	RF	Containment (PWR)	Hot Work	Gasket on hand-held grinder	NC
30437	10/6/2000	CD		Overheated Wire	Temporary transformer	PC
30438	5/15/2007	PO	Auxiliary Building (PWR)	Hot Work	Oxy-acetylene hose	NC
30441	9/5/2001	PO	Circulating Water Pump House/Intake Structure	Unknown	Debris in screen house auger	NC
30444	3/13/2002	RF	Turbine Building	Hot Work	Herculite	NC
30457	10/24/2006	RF	Turbine Building	Hot Work	Oxy-acetylene hose	U-NC/PC
30459	3/9/2003	PO		Hot Surface	Chart paper box and spill kit box	PC
30465	9/24/2008	RF	Turbine Building	Hot Work	FME bag	PC
30473	9/20/2001	RF		Hot Work	Rags	NC
30479	9/24/2005	RF		Hot Work	Cloth insulating material	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30482	10/5/2005	RF		Hot Work	Smoking slag, no other combustibles	NC
30483	10/9/2005	RF	Turbine Building	Hot Work	Rag	NC
30489	10/5/2007	RF	Turbine Building	Hot Work	Rags	NC
30500	5/29/2002	PO	Reactor Building (BWR)	Hot Work	Rubber piece	NC
30508	3/26/2009	RF	Turbine Building	Overheated Wire	Welding machine electronics	PC
30510	1/17/2008	RF	Turbine Building	Hot Work	Canvas bucket	NC
30511	1/23/2008	RF	Turbine Building	Hot Work	Fire blanket	NC
30512	2/15/2006	RF	Turbine Building	Overheated Wire	Power cord	PC
30521	9/11/2000	UN	Turbine Building	Hot Work	Paper	NC
30525	3/7/2001	PO		Overheated Wire	Power cord	NC
30526	6/12/2001	RF	Turbine Building	Hot Work	Failed regulator on acetylene bottle	NC
30528	2/24/2002	RF	Turbine Building	Hot Work	Floor protective covering	NC
30529	3/8/2002	RF	Containment (PWR)	Hot Work	PPE	NC
30534	3/4/2004	PO	Turbine Building	Hot Surface	Rag	NC
30535	4/16/2004	RF	Containment (PWR)	Hot Work	Rag	NC
30539	2/3/2005	PO	Other	Short or overheated wire	Power cord	NC
30540	5/2/2005	RF	Other	Lighting	Plastic sheet	NC
30542	7/28/2005	PO	Other	Smoking	Box with cigarettes and trash	NC
30549	9/5/2006	PO	Other	Short	Plastic bag of used batteries	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30550	10/5/2006	PO	Other	Electrical Failure	Pallet jack coil	NC
30551	10/20/2006	RF	Turbine Building	Hot Work	Tape	NC
30556	4/4/2008	RF	Other	Hot Work	Rubber debris	U-NC/PC
30561	4/3/2008	RF	Containment (PWR)	Hot Work	Two pieces of cardboard	NC
30562	3/17/2008	PO		Heater	Bake off of residual manufacturing oils on new heat gun	NC
30566	9/11/2000	PO	Other	Lighting	Sweatshirt	PC
30570	3/28/2001	PO		Smoking	Debris	NC
30573	6/6/2004	PO	Other	Hot Work	Small plant pot	NC
30585	5/3/2001	PO		Smoking	Trash can	NC
30589	10/11/2009	RF	Turbine Building	Short	Accumulated dust	NC
30590	12/22/2009	PO		Hot Work	Wooden hammer handle	NC
30595	10/10/2008	PO	Other	Hot Work	Oil soaked insulation	NC
30599	3/23/2001	PO		Hot Work	Rag	NC
30601	9/14/2001	PO	Radwaste Building	Heater	Dust and grime on heater coil	NC
30602	5/19/2004	PO	Other	Hot Surface	Bird's nest	NC
30609	4/17/2001	RF	Containment (PWR)	Hot Work	Single rag	NC
30693	2/3/2004	PO	Other	Hot Surface	Bird's nest	PC
30695	9/21/2006	CD	Turbine Building	Hot Work	Oxy-acetylene hose	NC
30697	9/29/2006	RF	Containment (PWR)	Hot Work	Tape	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
30704	10/17/2007	PO		Electrical Failure	Forklift battery under charge	NC
30706	6/28/2000	PO	Other	Short	Trash can	NC
30716	9/2/2002	PO		Overheated Wire	Power cord	NC
30720	7/2/2003	PO		Hot surface	Diesel fuel	NC
30727	10/30/2000	PO	Other	Smoking	Trash can	PC
30728	12/21/2000	RF		Hot Work	PPE	NC
30729	12/22/2000	RF		Hot Work	Tape	NC
30730	3/5/2001	RF	Containment (PWR)	Hot Work	Clothing	U-NC/PC
30731	3/19/2001	CD	Containment (PWR)	Hot Work	Rags and tool bag	PC
30739	3/29/2001	PO		Hot Work	Single rag	NC
30740	2/6/2004	PO		Hot Work	Cardboard box of rags	PC
30743	4/27/2004	RF		Hot Work	Single rag	NC
30745	10/10/2004	PO		Hot Work	FME cover	NC
30746	10/28/2004	RF		Hot Work	Plastic bag	NC
30752	4/3/2007	PO	Turbine Building	Unknown	Oil bucket	PC
30753	5/16/2007	RF	Other	Hot Work	Single rag	NC
30756	11/23/2008	RF		Hot Work	Oily rag	U-NC/PC
30757	8/24/2009	PO	Other	Smoking	Box of cigarettes	U-NC/PC
40730	10/27/2000	PO	Auxiliary Building (PWR)	Self-heating	Mop head in laundry bag	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
40732	3/8/2001	RF	Turbine Building	Hot Work	Safety harness	NC
40734	3/19/2001	RF	Turbine Building	Hot Work	Clothing	NC
40736	4/15/2001	RF	Turbine Building	Short	Rope	NC
40739	7/23/2002	PO	Auxiliary Building (PWR)	Overheated Wire	Power cord	NC
40746	8/15/2006	PO	Turbine Building	Unknown	Debris pile (2–3 gallons volume)	PC
40748	11/28/2007	PO	Auxiliary Building (PWR)	Hot Work	Trash can	NC
40749	6/13/2008	PO	Turbine Building	Hot Work	Furniture in tool room	C
50358	6/1/2000	PO	Other	Hot Work	Acetylene bottle	C
50361	4/11/2001	CD	Containment (PWR)	Overheated Wire	Power cord	PC
50365	3/4/2002	PO	Turbine Building	Hot Work	FR treated wood	NC
50367	3/14/2002	RF	Turbine Building	Hot Work	Oily rags	NC
50370	10/23/2002	RF	Other	Short	Power cord	NC
50376	3/24/2005	RF	Turbine Building	Hot Work	Floor mat	NC
50387	3/29/2008	RF	Turbine Building	Heater	Single rag	NC
50390	10/1/2008	RF	Containment (PWR)	Short	Tape	NC
50391	7/2/2009	PO	Other	Unknown	Debris	NC
50393	10/17/2000	PO		Hot Work	Single rag	U-NC/PC
50395	4/16/2001	RF		Hot Work	Paint chips in metal bucket	NC
50403	11/8/2003	RF	Containment (PWR)	Hot Work	Fire blanket	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50409	10/5/2006	RF	Containment (PWR)	Unknown	Unknown	U-NC/PC
50410	9/29/2005	PO		Hot Work	Roll of debris netting	NC
50423	2/28/2000	RF	Containment (PWR)	Hot Work	PPE	NC
50424	3/15/2000	RF	Containment (PWR)	Hot Work	Tape	NC
50425	3/16/2000	RF	Containment (PWR)	Hot Work	HEPA hose	PC
50428	9/20/2000	PO	Other	Self-heating	Oily rags	NC
50444	4/27/2005	PO		Overheated Wire	Outlet	NC
50448	10/11/2005	PO	Turbine Building	Roofing	Wood under roofing	PC
50449	2/21/2006	RF	Containment (PWR)	Hot Work	Tape and plastic	U-NC/PC
50450	2/28/2006	RF	Containment (PWR)	Hot Work	Absorbent sock	NC
50452	8/18/2006	PO	Other	Hot Work	Foam insulation	U-NC/PC
50460	4/16/2008	CD	Turbine Building	Hot Work	Insulation fabric	NC
50461	4/24/2008	PO	Other	Smoking	Cigarette	NC
50463	4/11/2000	RF	Containment (PWR)	Hot Work	Lead blanket	NC
50474	8/29/2000	PO	Other	Smoking	Trash can	NC
50477	3/18/2000	RF	Turbine Building	Hot Work	Alcohol in plastic bottle	PC
50478	3/19/2000	RF		Hot Work	PPE	NC
50479	3/22/2000	RF	Other	Hot Surface	Dryer	PC
50488	5/27/2009	PO		Hot Work	Foam insulation	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50494	2/5/2009	PO	Other	Hot Surface	HVAC filter	C
50502	10/16/2002	RF	Turbine Building	Overheated Wire	Power cord	NC
50503	6/14/2001	PO	Other	Lighting	Mayflies	NC
50504	5/20/2002	RF	Auxiliary Building (PWR)	Heater	Strip heater	PC
50507	11/15/2005	RF		Hot Work	Fire blanket	NC
50508	11/26/2005	RF		Hot Work	Paper	NC
50510	4/19/2000	PO	Other	Smoking	2.5 bucket 1/3 full of butts	NC
50511	5/15/2004	RF	Turbine Building	Hot Work	Rope	NC
50515	11/30/2001	CD	Containment (PWR)	Hot Work	Face shield	U-NC/PC
50516	10/5/2001	RF	Containment (PWR)	Hot Work	Bolt bag	NC
50517	10/8/2001	RF	Containment (PWR)	Hot Work	Tape	NC
50518	11/18/2001	RF	Containment (PWR)	Hot Work	Power cord	U-NC/PC
50519	10/19/2009	PO	Turbine Building	Overheated Wire	Load bank used for testing charger	NC
50520	12/7/2001	RF	Containment (PWR)	Hot Work	FME scaffolding fence	NC
50521	2/1/2007	PO	Other	Short	Power cord	NC
50527	6/23/2004	PO	Other	Smoking	Trash can	NC
50535	1/8/2002	RF	Containment (PWR)	Hot Work	Single rag	NC
50539	5/22/2002	RF	Containment (PWR)	Hot Work	Piece of cardboard	NC
50540	5/25/2002	RF		Short	Load bank	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50543	3/27/2001	RF	Containment (PWR)	Unknown	Unknown	PC
50547	4/4/2006	PO	Reactor Building (BWR)	Hot Work	Tape	NC
50548	6/9/2006	PO		Hot Work	Foam cushion	NC
50552	3/23/2009	RF	Circulating Water Pump house/Intake Structure	Hot Work	Fire blanket	NC
50564	1/15/2007	CD	Turbine Building	Hot Work	Scotch Brite pad	NC
50574	9/16/2004	RF	Reactor Building (BWR)	Hot Work	Debris	NC
50575	9/14/2007	CD	Other	Short	3 V battery in flashlight	NC
50576	9/17/2004	PO	Reactor Building (BWR)	Hot Surface	Aerosol generator leak ignited aerosol hose	NC
50585	10/8/2009	PO	Turbine Building	Smoking	Smoking cigarette butt container	NC
50605	10/4/2009	RF	Turbine Building	Hot Work	Plastic bag	NC
50608	5/28/1997	RF	Reactor Building (BWR)	Short	Power cord	NE
50610	5/30/2005	RF	Reactor Building (BWR)	Overhead wire	Power cord	NE
50612	10/21/2002	PO	Other	Short	Power cord	NC
50613	7/3/2003	RF	Turbine Building	Hot Work	Debris	NE
50614	3/9/2004	RF		Hot Work	Oxy-acetylene hose	NE
50615	3/11/2004	RF		Hot Work	Plastic bag	NE
50616	3/21/2004	RF		Hot Work	Fire blanket	NE
50617	3/29/2005	PO		Hot Work	Debris	NE
50623	12/15/2000	PO	Other	Overheated wi0	Power cord	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50625	1/8/2001	PO		Hot Work	Tarp	NC
50633	11/12/2000	UN	Turbine Building	Hot Work	Absorbent pad	NC
50652	3/18/2004	RF	Drywell (BWR)	Hot Work	Lift sling	NC
50653	10/4/2005	RF	Reactor Building (BWR)	Hot Work	PPE	NC
50658	4/24/2004	RF	Turbine Building	Hot Work	Herculite	NC
50660	9/24/2000	PO		Hot surface	Box of Kaydrys	NC
50661	4/25/2001	PO	Main Transformer or Switch Yard	Short	Birds nest and orange ball on power line	NE
50673	4/5/2002	RF	Turbine Building	Overheated Wire	Absorbent pads over FR plywood	NE
50676	11/29/2005	PO	Service Water Pump House	Hot Work	Fire blanket	NC
50677	9/24/2002	PO		Self-heating	Absorbent pad	NC
50679	10/4/2002	RF	Containment (PWR)	Overheated Wire	Power cord	NC
50686	4/4/2007	RF	Containment (PWR)	Hot Work	Knee pad and power cord	U-NC/PC
50689	10/17/2005	RF	Containment (PWR)	Hot Work	Oxy-acetylene hose	NE
50700	5/13/2000	RF	Other	Hot Work	Unknown	NC
50726	10/14/2003	RF	Containment (PWR)	Hot Work	Tape	NC
50733	4/23/2004	RF	Turbine Building	Hot Work	Strap and blanket	U-NC/PC
50735	4/9/2007	RF	Containment (PWR)	Hot Work	Power cable	NC
50746	5/6/2001	CD	Turbine Building	Hot Work	Tape	NC
50747	2/9/2007	RF	Turbine Building	Hot Work	Clothing	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50748	9/22/2000	PO	Other	Short	Power strip	NC
50749	10/28/2008	PO	Other	Unknown	Plastic cart with laptop, wires, papers, batteries, and other miscellaneous materials	C
50760	11/8/2006	RF	Turbine Building	Hot Work	FME bladder	NC
50761	1/25/2008	PO	Other	Short	Power cord	NC
50770	1/30/2003	PO	Turbine Building	Unknown	Trash can	NC
50771	5/6/2003	PO	Other	Hot Surface	Respirator facepiece dryer	PC
50778	10/11/2004	PO		Hot Work	Tape	NC
50795	7/12/2009	PO	Turbine Building	Lighting	Ballast	NC
50796	11/4/2009	RF	Auxiliary Building (PWR)	Unknown	Floor scrubber	PC
50797	11/8/2009	RF		Hot Work	Fire blanket	NC
50799	12/12/2009	RF	Containment (PWR)	Hot Work	Oil cloth	NC
50808	3/21/2006	RF	Reactor Building (BWR)	Short	Masslinn mop	NC
50809	11/9/2000	RF	Reactor Building (BWR)	Overheated Wire	Power cord	PC
50810	6/25/2000	PO	Reactor Building (BWR)	Hot Work	Plastic bag	NC
50821	10/30/2008	RF	Turbine Building	Hot Work	Trash and wood	PC
50825	10/1/2009	PO	Other	Lighting	Plastic cover on light	PC
50828	10/2/2003	RF	Turbine Building	Hot Work	Oily rags	NC
50833	9/23/2008	RF	Turbine Building	Lighting	Plastic cover on light	PC
50834	9/24/2008	RF	Turbine Building	Hot Work	FME bag	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50838	11/19/2001	RF		Hot Work	Plastic sheet	NE
50839	11/26/2001	RF	Reactor Building (BWR)	Hot Work	Rag	NE
50840	11/28/2001	RF	Reactor Building (BWR)	Hot Work	Rags	NE
50841	11/29/2001	RF	Reactor Building (BWR)	Hot Work	Rag	NE
50842	8/23/2002	PO	Reactor Building (BWR)	Hot Work	Fire blanket	NE
50843	3/22/2003	RF	Circulating Water Pump house/Intake Structure	Hot Surface	Plywood	NE
50846	1/24/2005	RF		Hot Work	Canvas cover for FME bladder	NE
50850	4/1/2005	CD	Circulating Water Pump house/Intake Structure	Hot Work	HEPA filter	NE
50853	11/28/2005	PO		Hot Work	Tape	NE
50854	9/18/2006	PO	Other	Hot Surface	Pan fan in control room kitchen	NE
50855	4/26/2008	RF	Turbine Building	Hot Work	Dust and pipe insulation	NE
50856	1/31/2008	PO	Other	Short	Power cord	NE
50862	2/9/2006	RF	Turbine Building	Overheated Wire	Power cord	NC
50863	9/30/2008	PO	Other	Hot Work	Boot	NC
50865	1/31/2000	RF	Other	Hot Work	Acetylene gas trapped in hose bag	NC
50870	1/8/2002	PO	Other	Hot Work	Clothing	NC
50872	3/31/2002	CD	Drywell (BWR)	Hot Work	Unknown	NC
50875	11/10/2002	RF	Turbine Building	Hot Work	Oil residue in 55 gallon drum	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50878	11/12/2002	RF	Reactor Building (BWR)	Hot Work	Rag	PC
50879	11/15/2002	RF	Turbine Building	Hot Work	Fire blanket	NC
50880	11/15/2002	RF	Drywell (BWR)	Hot Work	Bucket of rags	NC
50883	4/18/2003	CD	Turbine Building	Hot Work	Rag	NC
50884	2/23/2004	PO	Turbine Building	Hot Work	Rag	U-NC/PC
50886	2/27/2004	RF	Turbine Building	Hot Work	Scotch Brite pad	NC
50887	3/7/2004	RF	Turbine Building	Hot Work	Welding blanket	NC
50890	4/3/2005	RF	Other	Hot Work	Oxy-acetylene hose	NC
50891	4/8/2005	RF	Drywell (BWR)	Hot Work	Rubber glove and cotton liner	NC
50892	4/12/2005	RF	Drywell (BWR)	Hot Work	Rubber shoe cover	NC
50895.1	5/13/2007	RF	Turbine Building	Hot Work	Unknown	C
50895.2	5/13/2007	RF	Turbine Building	Hot Work	Unknown	C
50896	5/13/2007	RF	Drywell (BWR)	Hot Work	Tie wrap	U-NC/PC
50900	5/1/2009	RF	Drywell (BWR)	Hot Work	HVAC duct	NC
50901	8/28/2009	PO	Turbine Building	Hot Work	Fire blanket	NC
50920	9/29/2010		Drywell (BWR)	Hot Work	Power cord	NC
50924	1/16/2011		Turbine Building	Self-heating	Oily rags in trash can	NC
50928	3/23/2011		Control building	Short	Battery in DASH-10 recorder	PC
50930	3/29/2011	RF	Reactor Building (BWR)	Unknown	Battery in man lift	PC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
50940	10/11/2011		Turbine Building	Hot Work	Fire blanket	NC
50941	10/31/2011		Turbine Building	Overheated Wire	Power cord	NC
50960	12/4/2010		Other	Hot Work	Tape	NC
50962	1/5/2010		Containment (PWR)	Hot Work	Power cord	NC
50985	3/26/2012		Turbine Building	Hot Work	Pipe insulation	PC
50992	11/17/2010		Service Water Pump House	Self-heating	Oil rags in trash can	PC
50998	4/17/2012	RF	Turbine Building	Hot Work	FME blanket	NC
51005	4/30/2010		Turbine Building	Hot Work	Welding machine electronics	PC
51024	3/13/2010	RF	Turbine Building	Hot Work	Visqueen contamination barrier	NC
51031	6/19/2010		Other	Hot Work	Dust and spider webs	NC
51036	11/2/2011		Turbine Building	Hot Work	Foam sealant	NC
51047	2/2/2011		Other	Short	Power cord	NC
51048	3/24/2010		Reactor Building (BWR)	Electrical Failure	Small skid-mounted pump	PC
51049	3/30/2011			Hot Work	PPE	NC
51050	3/31/2010	RF	Turbine Building	Hot Work	Rags	NC
51051	4/6/2011		Turbine Building	Hot Work	Rags	U-NC/PC
51059	10/31/2012	RF	Containment (PWR)	Hot Work	Canvas bags	NC
51064	10/24/2010	RF	Turbine Building	Hot Work	Rags and PPE	NC
51065	10/28/2010	RF	Turbine Building	Hot Work	Tape	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
51066	10/28/2010	RF	Turbine Building	Hot Work	Tape	NC
51069	9/17/2010		Turbine Building, Other	Roofing	Roofing sealant	NC
51070	10/12/2011	RF	Turbine Building	Hot Work	Tape	NC
51071	10/21/2011	RF	Turbine Building	Hot Work	FME plug	NC
51073	9/20/2012		Turbine Building	Hot Work	Tape	NC
51074	10/20/2011		Turbine Building	Hot Work	Tape	NC
51075	11/11/2011		Turbine Building	Hot Work	TIG wire	NC
51076	10/22/2011		Turbine Building	Hot Work	Fire blanket	NC
51081	12/14/2010		Turbine Building	Hot Work	Cardboard box	PC
51082	4/4/2011	RF	Turbine Building	Short	Welding lead	U-NC/PC
51083	4/18/2011	RF	Other	Hot Work	Nylon retainer	NC
51091	10/20/2010	RF	Containment (PWR)	Lighting	Drop light	NC
51096	4/28/2011		Turbine Building	Hot Work	Cork mastic	NC
51097	5/17/2011		Turbine Building	Hot Work	FR plastic	NC
51099	5/22/2011	RF	Turbine Building	Hot Work	Knee pad	NC
51100	5/6/2011		Turbine Building	Hot Work	Hose	NC
51101	6/1/2011	RF	Turbine Building	Hot Work	Tape	NC
51102	6/10/2011	RF	Turbine Building	Hot Work	Masslinn mop	NC
51103	6/3/2011	RF	Turbine Building	Hot Work	FME plug	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
51104	6/8/2011		Turbine Building	Hot Work	Tarp	NC
51105	7/21/2011	RF	Turbine Building	Hot Work	Unknown	NC
51106	8/13/2011	RF	Turbine Building	Hot Work	Tape	NC
51107	8/4/2011	RF	Turbine Building	Hot Work	Tape	NC
51108	8/8/2011	RF	Turbine Building	Hot Work	Tape	NC
51109	10/15/2010		Turbine Building	Hot Work	Green board	U-NC/PC
51111	11/2/2010	RF	Turbine Building	Hot Work	Unknown	U-NC/PC
51114	11/8/2011		Other	Hot Work	Birds nest	NC
51115	11/3/2012		Turbine Building	Hot Work	Mop	NC
51117	3/11/2013	RF	Containment (PWR)	Lighting	Submersible Light	PC
51120	1/27/2012		Turbine Building	Overheated Wire	Welding machine electronics	NC
51130	3/16/2010	RF	Turbine Building	Hot Work	Visqueen barrier	NC
51136	1/19/2011	PO	Other	Short	Power cord	PC
51138	5/16/2011		Turbine Building	Hot Work	Tape	NC
51142	4/6/2010		Turbine Building	Hot Work	Dust	NC
51143	3/27/2010		Turbine Building	Hot Work	Fire blanket	NC
51147	3/27/2013	RF	Turbine Building	Hot Work	HVAC filter	NC
51148	9/13/2011		Office Building	Roofing	Wood fiber insulation	NC
51149	1/31/2010		Reactor Building (BWR)	Hot Work	Tape	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
51153	1/28/2010		Turbine Building	Hot Work	Paper	PC
51157	9/20/2010		Other	Smoking	Cigarette	U-NC/PC
51158	10/4/2012		Turbine Building	Hot Work	Debris	PC
51161	9/20/2010		Turbine Building	Overheated Wire	Power cord	NC
51164.1	9/19/2011	RF	Turbine Building	Hot Work	Canvas bag	U-NC/PC
51164.2	9/19/2011	RF	Turbine Building	Hot Work	Temporary HVAC duct	U-NC/PC
51164.3	9/19/2011	RF	Turbine Building	Hot Work	Power cord	U-NC/PC
51164.3	9/19/2011	RF	Turbine Building	Hot Work	Unknown	U-NC/PC
51168	12/3/2012	RF	Turbine Building	Hot Work	FME cover and pearl weave	U-NC/PC
51171	7/13/2012		Auxiliary Building (PWR)	Overheated Wire	480 V power cord	PC
51173	4/4/2013		Turbine Building	Hot Work	Fire blanket	NC
51183	8/1/2012			Hot Work	Slag	NC
51189	9/25/2010		Diesel Generator Building	Hot Work	Drip bag	NC
51202	4/27/2013		Other	Hot Work	Paper filter	NC
51211	7/31/2013		Reactor Building (BWR)	Hot Work	Paper and scrap materials caught up in the web of an I-beam	NC
51214	9/29/2013		Turbine Building	Hot Work	FME plug	NC
51220	3/26/2010	RF	Turbine Building	Hot Work	Construction debris in I-beam gap	U-NC/PC
51222	10/12/2011	PO	Turbine Building	Overheated Wire	Power cord	C
51223	4/21/2011		Turbine Building	Hot Work	Ladder	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
51224	7/8/2011		Turbine Building	Hot Work	Fire blanket	NC
51230	3/2/2014		Other	Short	Power cord	NC
51231	4/7/2014		Other	Hot Surface	Cotton rag	U-NC/PC
51237	5/6/2015		Turbine Building	Hot Work	Unknown	NE
51240	5/19/2015		Containment (PWR)	Hot Work	Unknown	NE
51245	12/30/2010		Other	Smoking	Trash can	NC
51246	1/12/2011	RF	Containment (PWR)	Hot Work	Unknown	NC
51247	1/26/2015		Turbine Building	Overheated Wire	Power outlet	NE
51255	10/30/2011		Control building	Hot Work	HEPA filter	NC
51260	3/18/2015		Turbine Building	Unknown	Chiller electrical panel	NE
51261	3/5/2015		Containment (PWR)	Overheated Wire	Underwater light	NE
51264	3/4/2015		Turbine Building	Hot Surface	Clothing	NE
51265	8/24/2012	RF	Containment (PWR)	Overheated Wire	Power spider	PC
51266	3/19/2015		Turbine Building	Hot Work	FME plug	NE
51267	3/5/2015		Other	Hot Work	Temporary HVAC duct	NE
51269	3/12/2015		Auxiliary Building (PWR)	Hot Work	Paper towel	NE
51273	4/2/2013	PO	Main Transformer or Switch Yard	Short	Transformer arc flash	U-NC/PC
51275	4/29/2013	RF	Containment (PWR)	Hot Surface	Lead blanket	NC
51284	3/17/2014		Other	Smoking	30 gallon drum with trash	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
51286	9/24/2013	RF	Turbine Building	Hot Work	FME plug	NC
51292	9/4/2013		Other	Hot Work	Glue on prefab metal module	NC
51293	11/6/2013		Turbine Building	Hot Work	Oily debris	PC
51310	4/17/2014		Turbine Building	Overheated Wire	Power cord	PC
51311	4/17/2014		Reactor Building (BWR)	Hot Work	Rag	NC
51312	11/17/2012		Control building	Overheated Wire	Power outlet	NC
51318	4/3/2014	RF	Main Transformer or Switch Yard	Short	480 V power cord	PC
51322	6/19/2014		Diesel Generator Building	Short	Power cord	U-NC/PC
51323	6/9/2014		Radwaste Building	Short	Power outlet	NC
51326	6/28/2014		Turbine Building	Hot Work	Rag	NC
51335	9/15/2014		Other	Overheated Wire	Power cord	PC
51336	10/14/2014	CD	Containment (PWR)	Hot Work	Tape	NC
51342	9/29/2014		Containment (PWR)	Overheated Wire	480 V power cord	NC
51350	12/1/2014		Other	Hot Surface	Wood	NC
51357	3/25/2011	UN	Other	Unknown	Power outlet	NC
51358	5/21/2011		Other	Overheated wire	Alternator on diesel generator	NC
51362	12/30/2014		Office Building	Short	Power cord	NC
51366	4/21/2010	RF	Containment (PWR)	Overheated Wire	Power cord	PC
51371	5/12/2010	RF	Containment (PWR)	Hot Work	Welding lead	NC

Table A-1
Summary of FEDB Transient Events (continued)

Fire ID	Date	Plant Mode[1]	Location	Ignition Method	Fuel Package	Class[2]
51374	3/1/2014	RF	Reactor Building (BWR)	Electrical Arcing or Sparks	Temporary power rack	U-NC/PC
51384	4/14/2015		Auxiliary Building (PWR)	Short	Test leads	NE
51387	5/6/2015		Turbine Building	Hot Work	Welding blanket	NE

[1]UN = unknown, RF = thermal power 0 % T_{avg} < 140 °F, CD = thermal power 0 % T_{avg} < 200 °F, HD = thermal power 0 % T_{avg} < 350 °F, HS = thermal power 0 % T_{avg} ≥ 350 °F, SU = thermal power < 5 % T_{avg} ≥ 350 °F, PO = thermal power > 5 % T_{avg} ≥ 350 °F

[2]NC= Non challenging, PC= Potentially Challenging, C = Challenging, U-NC/PC = Undetermined Nonchallenging/Potentially Challenging, U-PC/C = Undetermined Potentially Challenging/Challenging, NE = Not Evaluated

APPENDIX B
SUMMARY OF TEST RESULTS

Table B-1 summarizes key test results, including the peak heat release rate (HRR), the total energy release (TER), the peak flame height (L_f) and the diameter at which it occurs, the heat of combustion (ΔH_C), the soot yield, the carbon monoxide (CO) yield, the fire Froude number ($Q^{*)}$, and the fire elevation (Z). Values of N/A indicate test samples for which the mass loss was too low to evaluate the heat of combustion or yields.

Table B-1
Summary of HRR Testing

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
Test001	Medium Box Empty	137	5.45	0.30	1.18	14.5	0.001	0.025	2.4	0.15
Test002	Medium Box Empty	142	5.40	0.30	1.23	13.7	0.002	0.025	2.5	0.15
Test004	Medium Box Empty	128	5.71	0.30	1.29	14.7	0.001	0.030	2.2	0.15
Test003	Five Rags w/Heptane	42.3	5.78	0.23	0.80	24.4	0.009	0.031	1.5	0.00
Test005	Five Rags w/Heptane	46.4	6.70	0.25	1.05	22.4	0.007	0.042	1.3	0.00
Test006	Five Rags w/Heptane	50.6	5.79	0.18	1.11	26.9	0.010	0.039	3.4	0.00
Test007	Large Box Empty	377	24.45	0.61	1.52	13.8	0.001	0.018	1.2	0.30
Test010	Large Box Empty	536	24.67	0.61	2.12	17.5	0.001	0.018	1.7	0.30
Test014	Large Box Empty	412	24.80	0.61	1.96	14.2	0.001	0.020	1.3	0.30
Test0104	Large Box Empty	455	24.40	0.61	1.89	28.2	N/A	0.018	1.4	0.30
Test008	Large Box w/Peanuts	563	36.70	0.61	1.94	17.5	0.015	0.025	1.7	0.30
Test011	Large Box w/Peanuts	579	36.34	0.61	2.57	17.4	0.022	0.027	1.8	0.30
Test015	Large Box w/Peanuts	579	36.78	0.61	1.92	17.2	0.025	0.031	1.8	0.30
Test009	Large Box w/Paper	436	29.95	0.61	1.94	12.5	0.002	0.029	1.3	0.30
Test012	Large Box w/Paper	446	31.07	0.61	2.34	12.6	0.003	0.031	1.4	0.30
Test016	Large Box w/Paper	346	30.28	0.61	1.49	12.4	0.002	0.028	1.1	0.30
Test017	Plastic Tarp Draped	7.2	3.60	0.51	0.42	44.8	0.007	0.109	0.0	0.00
Test018	Plastic Tarp Draped	74.3	33.56	0.76	0.33	43.2	0.041	0.031	0.1	0.00
Test019	Plastic Tarp Draped	195	34.93	0.56	1.18	40.5	0.047	0.027	0.7	0.00
Test020	Plastic Tarp Draped	68.9	34.73	0.76	0.80	40.7	0.049	0.026	0.1	0.00
Test021	Welding Blanket Draped	2.2	0.13	0.05	0.21	N/A	N/A	N/A	3.4	0.60
Test022	Welding Blanket Draped	2.1	0.23	0.05	0.22	N/A	N/A	N/A	3.3	0.60

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_c (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
Test023	Welding Blanket Draped	2.3	0.15	0.10	0.22	N/A	N/A	N/A	0.6	0.60
Test024	Mop + Bucket	64.6	36.48	0.61	0.58	34.0	0.047	0.026	0.2	0.00
Test025	Mop + Bucket	113	40.00	0.61	0.82	29.5	0.046	0.022	0.3	0.00
Test027	Blower Duct	8.7	0.40	0.13	0.33	10.4	0.083	0.083	1.4	0.00
Test028	Blower Duct	5.9	0.45	0.13	0.35	12.1	0.075	0.086	0.9	0.00
Test029	Blower Duct	5.1	0.29	0.13	0.35	7.5	0.042	0.044	0.8	0.00
Test030	Water Hose	24.1	40.52	0.51	0.35	36.2	0.052	0.052	0.1	0.00
Test082	Water Hose	1.2	0.35	0.01	0.12	N/A	N/A	N/A	59.5	0.00
Test083	Water Hose	1.7	0.82	0.01	0.22	N/A	N/A	N/A	82.2	0.00
Test031	15.2 m Coil 120 V Cord	1.0	0.14	0.01	0.05	N/A	N/A	N/A	47.7	0.00
Test032	15.2 m Coil 120 V Cord	0.7	0.06	0.03	0.13	N/A	N/A	N/A	6.1	0.00
Test033	15.2 m Coil 120 V Cord	0.9	0.00	0.01	0.06	N/A	N/A	N/A	43.3	0.00
Test034	7.6 m Coil 250 V Cord	0.8	0.05	0.01	0.10	N/A	N/A	N/A	39.4	0.00
Test035	7.6 m Coil 250 V Cord	1.2	0.14	0.01	0.12	N/A	N/A	N/A	59.0	0.00
Test036	7.6 m Coil 250 V Cord	1.0	0.04	0.01	0.20	N/A	N/A	N/A	46.7	0.00
Test037	Scissor Stand Quarter	17.2	9.50	0.20	0.38	36.1	0.020	0.005	0.8	0.00
Test040	Scissor Stand Quarter	12.6	8.90	0.25	0.33	42.8	0.014	0.005	0.3	0.00
Test043	Scissor Stand Quarter	21.7	10.47	0.25	0.44	37.9	0.019	0.008	0.6	0.00
Test038	Scissor Stand Half	29.1	23.59	0.30	0.44	39.1	0.033	0.009	0.5	0.00
Test041	Scissor Stand Half	31.4	23.66	0.51	0.33	39.4	0.023	0.009	0.2	0.00
Test044	Scissor Stand Half	59.6	24.31	0.61	0.56	37.9	0.046	0.016	0.2	0.00
Test039	Scissor Stand Full	109	50.57	0.61	0.73	35.1	0.039	0.012	0.3	0.00
Test042	Scissor Stand Full	111	49.94	0.51	1.02	36.0	0.044	0.014	0.5	0.00
Test045	Scissor Stand Full	181	50.52	0.61	1.16	36.1	0.046	0.016	0.6	0.00
Test047	Vacuum Closed	1.3	0.05	0.03	0.00	N/A	N/A	N/A	11.0	0.00
Test048	Vacuum Closed	0.8	0.06	0.03	0.00	N/A	N/A	N/A	6.7	0.00
Test046	Vacuum Open	545	285.1	0.94	1.67	35.2	0.059	0.028	0.6	0.00

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
Test049	Vacuum Open	520	298.7	0.94	1.72	35.4	0.061	0.030	0.5	0.00
Test050	FR Plastic Tarp Draped	80.3	48.60	0.91	0.85	37.4	0.050	0.023	0.1	0.00
Test051	FR Plastic Tarp Draped	48.7	50.97	0.91	0.67	38.1	0.034	0.014	0.1	0.60
Test052	FR Plastic Tarp Folded	79.8	51.31	0.60	0.98	37.4	0.040	0.015	0.3	0.00
Test053	Canvas Tarp Draped	470	48.27	1.12	2.16	14.1	0.002	0.028	0.3	0.60
Test054	Canvas Tarp Draped	570	49.03	1.12	2.68	14.0	0.001	0.024	0.4	0.60
Test055	Canvas Tarp Folded	12	18.48	0.18	0.24	10.5	0.009	0.084	0.8	0.00
Test056	Alcohol Bottle	211	7.19	0.61	1.18	N/A	N/A	N/A	0.7	0.00
Test060	Alcohol Bottle	144	5.70	0.56	1.29	28.7	0.006	0.016	0.6	0.00
Test061	Alcohol Bottle	143	6.56	0.46	1.00	30.1	0.006	0.016	0.9	0.00
Test062	Oil Bottle	1.7	0.93	0.08	0.06	N/A	N/A	N/A	1.0	0.00
Test063	Oil Bottle	1.7	0.91	0.09	0.02	N/A	N/A	N/A	0.6	0.00
Test065	Oil Bottle	2.5	1.48	0.09	0.06	N/A	N/A	N/A	0.9	0.00
Test064	Rags w/Oil	11.3	9.50	0.20	0.47	26.2	0.042	0.030	0.5	0.00
Test066	Rags w/Oil	10.5	6.93	0.20	0.35	22.9	0.026	0.032	0.5	0.00
Test057	Plastic Trash Quarter	292	144.5	0.61	1.47	35.9	0.045	0.017	0.9	0.00
Test067	Plastic Trash Quarter	270	132.2	0.61	1.29	35.8	0.044	0.016	0.8	0.00
Test070	Plastic Trash Quarter	265	135.2	0.61	1.25	37.6	0.042	0.017	0.8	0.00
Test058	Plastic Trash Half	279	155.2	0.61	1.25	33.9	0.036	0.015	0.9	0.00
Test068	Plastic Trash Half	364	147.0	0.61	1.31	34.0	0.035	0.016	1.1	0.00
Test071	Plastic Trash Half	308	147.0	0.61	1.37	35.6	0.041	0.017	1.0	0.00
Test059	Plastic Trash Full	181	166.0	0.61	1.20	32.1	0.029	0.016	0.6	0.00
Test069	Plastic Trash Full	273	164.3	0.61	1.38	32.6	0.036	0.018	0.8	0.00
Test072	Plastic Trash Full	257	158.8	0.61	1.31	32.1	0.034	0.015	0.8	0.00
Test073	Plastic Stanchion	66.8	40.60	0.51	0.87	39.2	0.058	0.017	0.3	0.00
Test074	Plastic Stanchion	47.1	36.41	0.51	0.85	41.4	0.052	0.017	0.2	0.00
Test075	Plastic Stanchion	48.3	36.23	0.51	0.71	42.2	0.037	0.014	0.2	0.00
Test076	15.2 m Coil Chain	1.8	0.42	0.01	0.15	N/A	N/A	N/A	86.6	0.00
Test077	15.2 m Coil Chain	28.6	29.87	0.46	0.62	40.5	0.031	0.007	0.2	0.00
Test078	15.2 m Coil Chain	22.1	30.74	0.61	0.40	49.3	0.016	0.022	0.1	0.00
Test079	15.2 m Coil Large Rope	73.8	88.67	0.61	0.94	27.6	0.021	0.011	0.2	0.00

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
Test080	15.2 m Coil Large Rope	2.9	0.23	0.05	0.42	N/A	N/A	N/A	4.4	0.00
Test081	15.2 m Coil Large Rope	27	28.61	0.25	0.56	24.7	0.002	0.026	0.7	0.00
Test084	Plastic Chair	203	98.01	0.61	1.40	35.8	0.061	0.024	0.6	0.00
Test085	Plastic Chair	155	97.67	0.51	1.16	49.5	0.080	0.033	0.8	0.00
Test086	Plastic Chair	203	99.71	0.61	1.11	35.6	0.061	0.023	0.6	0.00
Test087	Plank Flame	2.0	0.64	0.01	0.12	N/A	N/A	N/A	95.9	0.00
Test088	Plank Flame	2.0	0.73	0.03	0.00	N/A	N/A	N/A	17.3	0.00
Test089	Plank Flame	1.8	0.48	0.01	0.26	N/A	N/A	N/A	87.6	0.00
Test093	Pallet Flame	2.1	0.87	0.01	0.24	N/A	N/A	N/A	104.3	0.00
Test094	Pallet Flame	2.5	1.21	0.05	0.22	N/A	N/A	N/A	3.9	0.00
Test095	Pallet Panel	1.0	0.31	0.01	0.00	N/A	N/A	N/A	85.8	0.00
Test096	Pallet Panel	0.2	0.00	0.01	0.00	N/A	N/A	N/A	21.5	0.00
Test097	Pallet Panel	1.4	0.82	0.01	0.00	N/A	N/A	N/A	128.8	0.00
Test098	Plank Panel	0.7	0.09	0.01	0.00	N/A	N/A	N/A	59.0	0.00
Test099	Plank Panel	1.1	0.30	0.01	0.00	N/A	N/A	N/A	95.7	0.00
Test100	Plank Panel	0.7	0.09	0.01	0.00	N/A	N/A	N/A	63.5	0.00
Test101	Stack PPE	69.7	44.56	0.36	0.58	28.6	0.062	0.034	0.8	0.00
Test103	Stack PPE	118	54.90	0.51	0.89	30.2	0.059	0.030	0.6	0.00
Test102	Laptop + Cart	2683	691.6	0.94	3.01	34.3	0.054	0.038	2.8	0.84
Test0105	Laptop + Cart	2510	690.8	0.94	3.14	33.4	N/A	0.037	2.6	0.84
Test0106	Laptop + Cart	2214	669.3	0.94	3.38	33.0	N/A	0.032	2.3	0.84
07_10_001	Single Rag	3.5	0.92	0.14	0.23	20.2	0.014	0.019	0.4	0.00
07_10_002	Single Rag	4.7	1.10	0.15	0.34	24.2	0.014	0.025	0.5	0.00
07_10_003	Single Rag	2.6	0.80	0.11	0.22	17.7	0.019	0.030	0.5	0.00
07_23_002	Single Rag	2.7	0.55	0.18	0.20	24.2	0.006	0.048	0.2	0.00
07_16_001	5 Rags	7.5	3.97	0.24	0.26	19.4	0.011	0.061	0.2	0.00
07_16_002	5 Rags	8.3	3.05	0.30	0.28	14.9	0.008	0.038	0.1	0.00
07_16_003	5 Rags	14.0	4.14	0.25	0.44	20.3	0.006	0.026	0.4	0.00
07_23_003	5 Rags	10.4	3.91	0.23	0.34	17.5	0.007	0.034	0.4	0.00
07_16_004	Single Rag w/Heptane	9.6	1.80	0.13	0.54	26.5	0.015	0.015	1.5	0.00

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
07_16_005	Single Rag w/Heptane	10.5	1.76	0.13	0.58	25.9	0.016	0.018	1.6	0.00
07_16_006	Single Rag w/Heptane	9.1	1.62	0.10	0.56	23.8	0.015	0.018	2.5	0.00
07_23_001	Single Rag w/Heptane	11.8	1.75	0.15	0.40	28.4	0.006	0.016	1.2	0.00
07_17_001	Bag of Rags	4.0	3.27	0.23	0.19	24.0	0.018	0.080	0.1	0.08
07_17_002	Bag of Rags	6.0	2.86	0.23	0.25	12.6	0.005	0.052	0.2	0.08
07_17_003	Bag of Rags	2.2	2.87	0.23	0.23	15.8	0.006	0.044	0.1	0.08
07_17_004	5 Rags w/Heptane	34.0	8.15	0.20	0.87	25.7	0.007	0.025	1.6	0.00
07_17_005	5 Rags w/Heptane	41.0	7.96	0.25	0.86	27.0	0.013	0.019	1.1	0.00
07_17_006	5 Rags w/Heptane	30.5	8.58	0.25	0.79	27.0	0.014	0.024	0.8	0.00
07_18_001	Cardstock Wall	0.5	0.00	0.03	0.00	N/A	N/A	N/A	4.6	0.00
07_18_001	Cardstock Wall	0.5	0.00	0.03	0.00	N/A	N/A	N/A	4.6	0.00
07_18_001	Cardstock Wall	0.5	0.00	0.03	0.00	N/A	N/A	N/A	4.6	0.00
07_18_002	Cardstock Air	5.3	0.20	0.22	0.58	N/A	N/A	N/A	0.2	1.20
07_18_003	Cardstock Air	7.7	0.25	0.22	0.63	N/A	N/A	N/A	0.3	1.20
07_18_004	Cardstock Air	1.6	0.06	0.11	0.35	N/A	N/A	N/A	0.4	1.20
07_18_005	Small Binder Closed	1.8	0.43	0.10	0.08	N/A	N/A	N/A	0.5	0.03
07_18_006	Small Binder Open	11.4	4.35	0.38	0.30	12.8	0.003	0.044	0.1	0.01
07_18_007	Small Binder Open	6.0	1.88	0.15	0.26	10.4	0.003	0.050	0.7	0.01
07_18_008	Pad of Paper	1.5	0.08	0.08	0.08	N/A	N/A	N/A	0.8	0.00
07_18_009	Pad of Paper	1.8	0.14	0.17	0.06	N/A	N/A	N/A	0.1	0.00
07_18_010	Pad of Paper	1.3	0.07	0.08	0.06	N/A	N/A	N/A	0.7	0.00
07_18_011	Large Binder Closed	0.1	0.00	0.03	0.00	N/A	N/A	N/A	1.1	0.00
07_18_011	Large Binder Closed	0.1	0.00	0.03	0.00	N/A	N/A	N/A	1.1	0.00
07_18_011	Large Binder Closed	0.1	0.00	0.03	0.00	N/A	N/A	N/A	1.1	0.00
07_18_012	Large Binder Open	6.9	2.79	0.13	0.25	13.7	0.004	0.065	0.9	0.04
07_18_013	Large Binder Open	3.9	1.33	0.13	0.25	14.7	0.011	0.085	0.5	0.04
07_23_004	Duct Tape Wall	0.3	0.05	0.03	0.00	N/A	N/A	N/A	2.3	0.00
07_23_005	Short Duct Tape Air	0.5	0.00	0.03	0.00	N/A	N/A	N/A	4.7	0.00
07_23_006	Short Duct Tape Air	0.8	0.03	0.01	0.01	N/A	N/A	N/A	40.8	0.00
07_24_001	Bucket w/Debris	7.2	0.85	0.13	0.49	37.3	0.019	0.075	1.1	0.00
07_24_002	Bucket w/Debris	9.5	18.80	0.11	0.47	39.4	0.008	0.055	1.9	0.00

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
07_24_003	Bucket w/Debris	14.7	13.37	0.13	0.80	28.1	0.004	0.035	2.3	0.00
07_31_001	Empty Bucket	10.5	14.40	0.22	0.24	45.5	0.013	0.011	0.4	0.00
07_31_002	Empty Bucket	30.8	15.90	0.22	0.71	46.6	0.049	0.016	1.3	0.00
07_31_003	Empty Bucket	19.8	14.80	0.22	0.51	43.5	0.040	0.014	0.8	0.00
07_31_004	Empty Bucket	25.6	15.50	0.22	0.53	45.6	0.053	0.017	1.1	0.00
08_01_001	Debris Pile	23.7	4.31	0.43	0.32	15.8	0.008	0.054	0.2	0.00
08_01_002	Debris Pile	13.4	4.03	0.10	0.40	13.7	0.007	0.050	3.6	0.00
08_01_003	Debris Pile	19.1	4.10	0.30	0.48	15.1	0.004	0.040	0.3	0.00
08_01_004	Single Cone	6.0	5.16	0.21	0.30	16.3	0.123	0.061	0.3	0.00
08_01_005	Single Cone	9.5	6.82	0.13	0.56	18.8	0.112	0.067	1.5	0.00
08_01_006	Single Cone	7.8	7.83	0.18	0.38	23.0	0.103	0.067	0.5	0.00
08_02_001	Uncoiled 120 V Cord	1.0	0.01	0.01	0.10	N/A	N/A	N/A	51.2	0.00
08_02_002	3 m Coil 120 V Cord	1.2	0.14	0.01	0.10	N/A	N/A	N/A	60.5	0.00
08_03_001	3 m Coil 120 V Cord	1.5	0.48	0.05	0.10	N/A	N/A	N/A	2.3	0.00
08_03_002	3 m Coil 120 V Cord	1.2	0.04	0.05	0.15	N/A	N/A	N/A	1.9	0.00
08_03_003	7.6 m Coil 120 V Cord	1.6	0.50	0.15	0.10	N/A	N/A	N/A	0.2	0.00
08_03_004	7.6 m Coil 120 V Cord	1.4	0.34	0.08	0.15	N/A	N/A	N/A	0.8	0.00
08_03_005	7.6 m Coil 120 V Cord	1.0	0.16	0.03	0.15	N/A	N/A	N/A	9.0	0.00
08_06_001	Medium Box Empty	68.4	4.29	0.30	0.84	11.1	0.001	0.022	1.2	0.15
08_06_002	Medium Box Empty	85.7	4.56	0.30	0.90	11.8	0.002	0.024	1.5	0.15
08_06_003	Medium Box Empty	76.9	4.60	0.30	0.96	11.9	0.001	0.024	1.3	0.15
08_06_004	Medium Box w/Paper	54.6	6.96	0.30	0.96	12.8	0.001	0.021	1.0	0.15
08_06_005	Medium Box w/Paper	73.9	6.73	0.30	1.02	12.4	0.001	0.026	1.3	0.15
08_06_006	Medium Box w/Paper	84.8	6.48	0.30	1.06	11.9	0.001	0.016	1.5	0.15
08_06_007	Medium Box w/Peanuts	134	6.42	0.30	1.06	14.9	0.011	0.025	2.3	0.15
08_06_008	Medium Box w/Peanuts	114	6.64	0.30	1.06	15.4	0.012	0.026	2.0	0.15
08_06_009	Medium Box w/Peanuts	98.0	6.58	0.30	1.06	15.3	0.014	0.029	1.7	0.15
08_07_001	Small Box Empty	28.0	2.79	0.30	0.51	17.6	0.008	0.034	0.5	0.05
08_07_002	Small Box Empty	49.9	2.67	0.30	0.63	16.8	0.007	0.031	0.9	0.05
08_07_003	Small Box Empty	42.9	2.71	0.30	0.74	17.1	0.006	0.028	0.7	0.05

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
08_07_004	Small Box Empty	46.5	2.72	0.30	0.65	17.2	0.007	0.031	0.8	0.05
08_07_005	Small Box w/Paper	48.3	3.26	0.30	0.62	16.0	0.006	0.024	0.8	0.05
08_07_006	Small Box w/Paper	43.2	3.21	0.30	0.63	15.7	0.007	0.027	0.8	0.05
08_07_007	Small Box w/Paper	50.2	3.22	0.30	0.63	15.8	0.012	0.029	0.9	0.05
08_07_008	Small Box w/Peanuts	51.6	3.05	0.30	0.74	16.8	0.013	0.026	0.9	0.05
08_07_009	Small Box w/Peanuts	57.9	3.03	0.30	0.63	16.7	0.015	0.031	1.0	0.05
08_07_010	Small Box w/Peanuts	71.4	3.12	0.30	0.74	17.2	0.016	0.030	1.2	0.05
08_08_001 a	Metal Chair	14.3	4.27	0.41	0.27	15.7	0.043	0.035	0.1	0.46
08_08_001 b	Metal Chair	15.5	7.05	0.36	0.41	31.1	0.059	0.039	0.2	0.46
08_08_002 a	Metal Chair	13.6	3.71	0.25	0.43	16.4	0.053	0.032	0.4	0.46
08_08_002 b	Metal Chair	7.4	2.98	0.10	0.39	26.3	0.094	0.044	2.0	0.46
08_08_003	Metal Chair	23.2	7.70	0.30	0.57	22.6	0.061	0.072	0.4	0.46
08_08_004	First Aid Kit	30.8	9.38	0.25	0.30	23.0	0.022	0.025	0.8	1.20
08_09_001	First Aid Kit	14.8	11.18	0.25	0.30	27.4	0.037	0.033	0.4	1.20
08_09_002	First Aid Kit	14.8	12.70	0.25	0.30	14.8	0.025	0.022	0.4	1.20
08_09_003	15.2 m Coil Chain	1.7	1.51	0.08	0.05	33.2	0.017	0.019	1.0	0.00
08_13_002	15.2 m Coil Chain	1.1	0.16	0.01	0.09	N/A	N/A	N/A	53.1	0.00
08_14_002	4 Cones	15.8	25.06	0.15	0.22	18.4	0.122	0.065	1.6	0.13
08_15_001	4 Cones	5.2	3.19	0.10	0.48	15.6	0.101	0.056	1.4	0.13
08_15_002	4 Cones	16.5	26.04	0.15	0.65	17.7	0.099	0.063	1.6	0.13
08_15_003	HVAC Filter	19.3	0.69	0.25	0.44	30.3	0.033	0.019	0.5	0.00
08_15_004	HVAC Filter	20.0	1.18	0.38	0.42	26.1	0.018	0.041	0.2	0.00
08_15_005	HVAC Filter	13.5	1.00	0.38	0.31	22.0	0.016	0.037	0.1	0.00
08_16_001	Uncoiled Small Rope	3.0	0.36	0.10	0.26	N/A	N/A	N/A	0.8	0.00
08_16_002	Uncoiled Small Rope	2.9	0.23	0.10	0.26	N/A	N/A	N/A	0.8	0.00
08_16_003	Uncoiled Small Rope	3.6	0.56	0.10	0.27	N/A	N/A	N/A	1.0	0.00
08_16_004	7.6 m Coil Small Rope	2.8	1.73	0.28	0.11	N/A	N/A	N/A	0.1	0.00
08_20_001	7.6 m Coil Small Rope	4.0	2.43	0.30	0.22	N/A	0.025	0.013	0.1	0.00
08_20_002	7.6 m Coil Small Rope	4.5	2.25	0.13	0.24	N/A	0.037	0.012	0.7	0.00

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
08_20_003	15.2 m Coil Small Rope	9.5	5.63	0.30	0.29	44.3	0.055	0.014	0.2	0.00
08_20_004	15.2 m Coil Small Rope	13.4	5.31	0.28	0.33	39.0	0.056	0.013	0.3	0.00
08_20_005	15.2 m Coil Small Rope	14.8	4.77	0.32	0.42	41.3	0.061	0.015	0.2	0.00
08_21_001	Uncoiled Large Rope	3.2	0.26	0.10	0.31	31.0	0.027	0.005	0.9	0.00
08_21_002	Uncoiled Large Rope	2.8	0.28	0.10	0.20	41.9	0.019	0.000	0.8	0.00
08_21_003	Uncoiled Large Rope	2.7	0.50	0.10	0.20	36.8	0.016	0.000	0.7	0.00
08_21_005	7.6 m Coil Large Rope	2.4	0.27	0.10	0.24	N/A	N/A	N/A	0.6	0.00
08_21_006	7.6 m Coil Large Rope	57.8	42.55	0.36	0.57	25.7	0.031	0.009	0.7	0.00
08_21_007	7.6 m Coil Large Rope	2.7	0.16	0.10	0.27	N/A	N/A	N/A	0.7	0.00
08_22_001	Duct Tape Roll	20.3	17.39	0.14	0.53	38.2	0.113	0.040	2.5	0.00
08_22_002	Duct Tape Roll	3.4	0.23	0.05	0.31	N/A	N/A	N/A	5.3	0.00
08_22_003	Duct Tape Roll	17.9	17.05	0.14	0.44	39.6	0.130	0.042	2.2	0.00
08_22_005	Single Oil Pad	3.2	0.28	0.10	0.26	N/A	N/A	N/A	0.9	0.00
08_22_006	Single Oil Pad	3.6	0.29	0.10	0.20	N/A	N/A	N/A	1.0	0.00
08_22_007	Single Oil Pad	3.2	0.26	0.10	0.26	N/A	N/A	N/A	0.9	0.00
08_23_001	4 Oil Pads	2.4	0.34	0.10	0.26	N/A	N/A	N/A	0.6	0.00
08_23_002	4 Oil Pads	2.3	0.26	0.10	0.20	N/A	N/A	N/A	0.6	0.00
08_23_003	4 Oil Pads	2.8	0.19	0.10	0.20	N/A	N/A	N/A	0.8	0.00
08_23_004	Single Oil Pad w/Oil	2.3	0.13	0.10	0.26	N/A	N/A	N/A	0.6	0.00
08_23_005	Single Oil Pad w/Oil	2.5	0.20	0.10	0.26	N/A	N/A	N/A	0.7	0.00
08_23_006	Single Oil Pad w/Oil	3.3	0.47	0.10	0.26	N/A	N/A	N/A	0.9	0.00
08_23_007	4 Oil Pads w/Oil	3.2	0.23	0.10	0.26	N/A	N/A	N/A	0.9	0.00
08_23_008	4 Oil Pads w/Oil	2.7	0.23	0.10	0.26	N/A	N/A	N/A	0.7	0.00
08_24_001	Lift Slings	17.3	10.03	0.38	0.32	19.1	0.059	0.029	0.2	0.00
08_24_002	Lift Slings	19.2	7.33	0.36	0.43	19.5	0.047	0.023	0.2	0.00
08_24_003	Lift Slings	15.9	6.47	0.25	0.51	20.1	0.050	0.022	0.4	0.00
08_24_004	Uncoiled Chain	1.3	0.17	0.01	0.10	N/A	N/A	N/A	62.5	0.00
08_24_005	Uncoiled Chain	1.1	0.07	0.01	0.10	N/A	N/A	N/A	55.6	0.00
08_24_006	Uncoiled Chain	1.1	0.05	0.01	0.08	N/A	N/A	N/A	54.6	0.00
08_27_001	7.6 m Coil Tubing	1.4	0.21	0.08	0.15	N/A	N/A	N/A	0.8	0.00

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
08_27_002	7.6 m Coil Tubing	1.2	0.01	0.15	0.12	N/A	N/A	N/A	0.1	0.00
08_27_003	7.6 m Coil Tubing	1.5	0.19	0.15	0.14	N/A	N/A	N/A	0.1	0.00
08_27_004	15.2 m Coil Tubing	1.4	0.38	0.10	0.14	N/A	N/A	N/A	0.4	0.00
08_27_005	15.2 m Coil Tubing	1.7	0.42	0.13	0.10	N/A	N/A	N/A	0.3	0.00
08_28_001	15.2 m Coil Tubing	1.3	0.34	0.01	0.02	N/A	N/A	N/A	64.0	0.00
08_28_002	Uncoiled Tubing	0.8	0.02	0.01	0.08	N/A	N/A	N/A	39.4	0.00
08_28_003	Uncoiled Tubing	0.6	0.03	0.01	0.08	N/A	N/A	N/A	27.1	0.00
08_28_004	Uncoiled Tubing	0.9	0.02	0.03	0.06	N/A	N/A	N/A	7.6	0.00
08_28_005	Welding Blanket Folded	0.6	0.00	0.01	0.09	N/A	N/A	N/A	27.5	0.00
08_28_005	Welding Blanket Folded	0.6	0.00	0.01	0.09	N/A	N/A	N/A	27.5	0.00
08_28_005	Welding Blanket Folded	0.6	0.00	0.01	0.09	N/A	N/A	N/A	27.5	0.00
08_28_006	Long Duct Tape Air	1.2	0.13	0.03	0.08	N/A	N/A	N/A	10.3	0.45
08_28_007	Long Duct Tape Air	1.0	0.11	0.03	0.05	N/A	N/A	N/A	8.4	0.45
08_28_008	Long Duct Tape Air	1.5	0.24	0.03	0.12	N/A	N/A	N/A	13.0	0.45
08_29_001	Plastic Tarp Folded	2.9	0.36	0.10	0.31	N/A	N/A	N/A	0.8	0.00
08_29_002	Plastic Tarp Folded	60.2	46.60	0.30	0.63	46.6	0.053	0.015	1.0	0.00
08_29_003	Plastic Tarp Folded	57.4	48.60	0.30	0.56	45.7	0.060	0.180	1.0	0.00
08_29_004	Power Spider	1.3	0.56	0.01	0.20	N/A	N/A	N/A	63.5	0.30
08_30_001	Power Spider	5.7	0.15	0.10	0.00	N/A	N/A	N/A	1.6	0.30
08_30_002	Canvas Tarp Folded	2.8	0.33	0.10	0.29	19.4	0.011	0.015	0.8	0.00
08_30_003	Canvas Tarp Folded	3.2	0.56	0.10	0.14	23.5	0.010	0.041	0.9	0.00
08_30_004	Canvas Tarp Folded	2.5	0.50	0.10	0.29	11.6	0.004	0.020	0.7	0.00
08_30_005	Oxy-acetylene Hose	3.2	0.19	0.01	0.10	N/A	N/A	N/A	155.0	0.00
09_04_001	Oxy-acetylene Hose	1.7	0.55	0.01	0.13	N/A	N/A	N/A	81.7	0.00
09_04_002	Single PPE	16.8	10.82	0.51	0.37	34.3	0.093	0.056	0.1	0.00
09_04_003	Single PPE	25.9	11.96	0.51	0.52	33.2	0.106	0.051	0.1	0.00
09_04_004	Single PPE	20.3	10.63	0.46	0.41	32.7	0.104	0.045	0.1	0.00
09_05_001	Metal Trash Quarter	95.3	8.94	0.51	1.06	20.8	0.009	0.022	0.5	0.18
09_05_002	Metal Trash Quarter	82.1	8.99	0.51	0.98	20.9	0.011	0.024	0.4	0.18
09_05_003	Metal Trash Quarter	75.5	8.73	0.51	1.08	20.2	0.010	0.020	0.4	0.18
09_05_004	Metal Trash Half	86.9	15.67	0.51	1.10	19.2	0.006	0.023	0.4	0.36

Table B-1
Summary of HRR Testing (continued)

Test ID	Item	Max HRR (kW)	TER (MJ)	Max D (m)	L_f (m)	ΔH_C (kJ/kg)	Soot Yield (kg/kg)	CO Yield (kg/kg)	Q^*	Z (m)
09_05_005	Metal Trash Half	83.4	15.14	0.51	1.06	19.1	0.007	0.028	0.4	0.36
09_05_006	Metal Trash Half	86.5	14.90	0.51	1.12	18.8	0.005	0.023	0.4	0.36
09_05_007	Metal Trash Full	61.0	27.52	0.51	1.12	18.4	0.013	0.040	0.3	0.71
09_06_001	Metal Trash Full	81.1	25.40	0.51	1.27	17.5	0.014	0.038	0.4	0.71
09_06_002	Metal Trash Full	60.9	25.67	0.41	1.35	17.7	0.014	0.036	0.5	0.71
09_06_003	Metal Trash Full Lid	15.7	11.96	0.25	0.89	9.3	0.033	0.176	0.4	0.71
09_06_004	Metal Trash Full Lid	21.2	4.40	0.25	1.08	9.7	0.004	0.028	0.6	0.71
09_07_001	7.6 m Coil Chain	26.1	21.20	0.36	0.20	48.9	0.051	0.014	0.3	0.00
09_07_002	7.6 m Coil Chain	23.9	21.28	0.29	0.54	23.9	0.045	0.012	0.5	0.00
09_10_001	7.6 m Coil Chain	37.2	18.20	0.39	0.54	37.2	0.080	0.020	0.3	0.00
09_10_002	Wood Block Flame	0.9	0.00	0.03	0.00	N/A	N/A	N/A	7.8	0.00
09_10_002	Wood Block Flame	0.9	0.00	0.03	0.00	N/A	N/A	N/A	7.8	0.00
09_10_002	Wood Block Flame	0.9	0.00	0.03	0.00	N/A	N/A	N/A	7.8	0.00
09_10_002	Wood Block Flame	0.9	0.00	0.03	0.00	N/A	N/A	N/A	7.8	0.00
09_10_002	Wood Block Flame	0.9	0.00	0.03	0.00	N/A	N/A	N/A	7.8	0.00
09_10_004	Laptop	17.6	2.54	0.17	0.28	37.7	0.034	0.026	1.4	0.00
09_11_001	Laptop	14.8	2.41	0.20	0.39	N/A	N/A	N/A	0.7	0.00
09_11_002	Laptop	4.2	3.58	0.09	0.24	N/A	N/A	N/A	1.6	0.00
09_10_003	Wood Block Panel	1.7	1.58	0.03	0.00	N/A	N/A	N/A	14.3	0.00
09_11_003	Wood Block Panel	1.3	0.33	0.03	0.00	N/A	N/A	N/A	11.2	0.00
09_11_004	Wood Block Panel	1.4	1.27	0.03	0.00	N/A	N/A	N/A	12.4	0.00
09_12_001	Tablet	12.6	3.06	0.20	0.49	N/A	N/A	N/A	0.6	0.00
09_12_002	Tablet	16.3	1.28	0.25	0.52	N/A	N/A	N/A	0.4	0.00
09_12_003	Tablet	22.0	1.17	0.25	0.50	32.4	0.057	0.050	0.6	0.00
09_12_004	Tablet + Plastic Case	33.9	23.65	0.36	0.73	29.8	0.055	0.041	0.4	0.00
09_12_005	Tablet + Plastic Case	20.3	23.65	0.36	0.52	34.8	0.037	0.045	0.2	0.00
09_12_006	Tablet + Metal Case	9.1	17.10	0.20	0.52	N/A	N/A	N/A	0.4	0.00
09_19_001	Tool Bag	55.7	81.70	0.51	0.99	19.3	0.057	0.062	0.3	0.00
09_19_002	Tool Bag	50.5	59.23	0.51	0.99	118.1	0.094	0.051	0.2	0.00

APPENDIX C
SUMMARY OF FDT^S COMPUTATIONS VERSUS TEST DATA

Table C-1 summarizes the Fire Dynamics Tools (FDT^s)-predicted temperature, heat flux, and flame height compared against test data. The predictions are based on the peak heat release rate (HRR), and the test data represent the maximum value seen during the test. The experimental plume temperature data represent the highest temperature measured by each thermocouple (TC) grid, where low and high indicates the grid elevation over the fire. The high grid was typically 46 cm (18 in.) above the low grid. Note that type-K TCs have a maximum temperature reading of 1000 °C, and the FDT^s calculations for plume temperature were limited to a maximum temperature of 1000 °C. For the 100 kW hood, two water-cooled heat flux gauges were placed at the same distance from the test item and separated vertically by 46 cm (18 in.) unless this interfered with the TC grid locations, in which case the heights of the gauges were adjusted. The 1 MW and 3 MW hoods used a similar setup for the heat flux gauges with the addition of two plate thermometers located immediately adjacent to the heat flux gauges where the temperature was converted to heat flux following the method in Ref. 10. In the table value for heat flux, Exp. Min is the minimum value measures over all heat flux measurements and Exp. Max is the maximum heat flux over all heat flux measurements. Depending on the test item, the maximum measurement could occur at either the lower or the upper measurement location.

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
Test001	Medium Box Empty	554	780	283	383	6.4	7.5	6.1	1.18	1.37
Test002	Medium Box Empty	599	815	355	397	6.4	8.0	6.3	1.23	1.40
Test004	Medium Box Empty	557	723	319	360	5.5	6.0	5.8	1.29	1.33
Test003	Five Rags w/Heptane	191	288	115	162	2.5	2.9	3.0	0.80	0.82
Test005	Five Rags w/Heptane	238	298	117	168	1.7	2.1	3.3	1.05	0.83

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		**High TC Grid**		**Exp. Min**	**Exp. Max**	**FDT^s**	**Exp.**	**FDT^s**
		Exp.	**FDT^s**	**Exp.**	**FDT^s**					
Test006	Five Rags w/Heptane	303	286	147	156	2.3	3.0	2.5	1.11	0.95
Test007	Large Box Empty	305	461	280	317	8.1	12.7	9.5	1.52	1.90
Test010	Large Box Empty	602	658	468	437	12.5	18.3	11.6	2.12	2.28
Test014	Large Box Empty	418	502	339	343	7.5	12.8	10.0	1.96	1.99
Test0104	Large Box Empty	626	651	310	342	9.6	14.7	6.2	1.89	2.10
Test008	Large Box w/Peanuts	432	695	312	458	15.8	22.9	11.9	1.94	2.34
Test011	Large Box w/Peanuts	607	715	462	470	15.2	25.0	12.1	2.57	2.37
Test015	Large Box w/Peanuts	532	716	425	471	16.7	21.3	12.1	1.92	2.37
Test009	Large Box w/Paper	610	532	392	361	7.1	13.1	10.3	1.94	2.05
Test012	Large Box w/Paper	498	544	363	368	9.7	16.4	10.4	2.34	2.07
Test016	Large Box w/Paper	374	424	344	295	5.8	10.3	9.0	1.49	1.81
Test017	Plastic Tarp Draped	48	46	42	41	0.3	1.0	0.6	0.42	0.00
Test018	Plastic Tarp Draped	119	115	101	91	1.7	4.3	8.9	0.33	0.54
Test019	Plastic Tarp Draped	193	268	165	193	4.8	10.4	10.6	1.18	1.37
Test020	Plastic Tarp Draped	116	110	92	88	1.7	5.4	8.6	0.80	0.50
Test021	Welding Blanket Draped	50	59	39	43	0.2	0.3	0.2	0.21	0.27
Test022	Welding Blanket Draped	37	58	36	43	0.1	0.3	0.2	0.22	0.27
Test023	Welding Blanket Draped	62	57	42	42	0.2	0.3	0.2	0.22	0.22
Test024	Mop + Bucket	206	247	134	157	2.5	6.0	6.4	0.58	0.62
Test025	Mop + Bucket	260	400	153	239	4.7	12.5	8.5	0.82	0.93

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
Test027	Blower Duct	81	110	54	70	0.5	1.9	0.7	0.33	0.43
Test028	Blower Duct	66	88	49	59	0.2	0.3	0.5	0.35	0.35
Test029	Blower Duct	39	81	50	55	0.2	0.4	0.4	0.35	0.32
Test030	Water Hose	177	252	87	134	1.3	2.8	2.8	0.35	0.32
Test082	Water Hose	48	90	36	48	0.1	0.2	0.1	0.12	0.24
Test083	Water Hose	55	109	38	54	0.1	0.2	0.1	0.22	0.28
Test031	15.2-m Coil 120-V Cord	31	80	28	45	0.1	0.2	0.1	0.05	0.22
Test032	15.2-m Coil 120-V Cord	33	66	28	40	0.1	0.4	0.1	0.13	0.18
Test033	15.2-m Coil 120-V Cord	30	76	27	43	0.1	0.2	0.1	0.06	0.21
Test034	7.6-m Coil 250 V Cord	32	68	27	41	0.1	0.2	0.1	0.10	0.20
Test035	7.6 m Coil 250 V Cord	33	89	29	48	0.1	0.2	0.1	0.12	0.24
Test036	7.6 m Coil 250 V Cord	38	79	29	44	0.1	0.1	0.1	0.20	0.22
Test037	Scissor Stand Quarter	61	99	51	72	0.5	1.0	1.4	0.38	0.53
Test040	Scissor Stand Quarter	72	118	46	77	0.6	1.0	1.1	0.33	0.39
Test043	Scissor Stand Quarter	115	170	72	104	0.4	1.2	1.8	0.44	0.54
Test038	Scissor Stand Half	82	125	66	89	0.8	2.0	2.4	0.44	0.59
Test041	Scissor Stand Half	132	161	77	106	0.9	2.8	3.4	0.33	0.41
Test044	Scissor Stand Half	166	232	117	148	1.5	4.8	6.1	0.56	0.58
Test039	Scissor Stand Full	152	244	130	167	1.7	5.1	8.4	0.73	0.91
Test042	Scissor Stand Full	290	458	156	261	3.9	13.3	7.5	1.02	1.03

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		**High TC Grid**		**Exp. Min**	**Exp. Max**	**FDT^s**	**Exp.**	**FDT^s**
		Exp.	**FDT^s**	**Exp.**	**FDT^s**					
Test045	Scissor Stand Full	433	638	220	356	6.0	12.9	10.7	1.16	1.26
Test047	Vacuum Closed	26	56	26	41	0.1	0.1	0.2	0.00	0.23
Test048	Vacuum Closed	28	59	27	43	0.1	0.1	0.2	0.00	0.19
Test046	Vacuum Open	772	1000	466	743	19.2	34.9	21.7	1.67	1.96
Test049	Vacuum Open	826	1000	511	705	27.6	42.0	21.3	1.72	1.91
Test050	FR Plastic Tarp Draped	601	210	124	144	4.6	9.4	12.7	0.85	0.43
Test051	FR Plastic Tarp Draped	263	146	121	105	2.4	4.8	11.6	0.67	0.18
Test052	FR Plastic Tarp Folded	253	298	134	184	6.4	11.3	7.1	0.98	0.74
Test053	Canvas Tarp Draped	1000	875	796	528	14.4	31.7	22.8	2.16	1.61
Test054	Canvas Tarp Draped	996	1000	732	644	11.7	20.7	24.3	2.68	1.83
Test055	Canvas Tarp Folded	83	126	56	79	0.3	0.8	1.0	0.24	0.45
Test056	Alcohol Bottle	419	754	299	411	6.3	10.6	11.5	1.18	1.38
Test060	Alcohol Bottle	276	546	286	308	2.8	10.2	9.1	1.29	1.14
Test061	Alcohol Bottle	317	643	197	342	2.8	7.7	8.3	1.00	1.24
Test062	Oil Bottle	37	52	31	40	0.2	0.3	0.2	0.06	0.22
Test063	Oil Bottle	37	51	31	39	0.1	0.2	0.1	0.02	0.20
Test065	Oil Bottle	39	59	33	44	0.1	0.3	0.2	0.06	0.25
Test064	Rags w/Oil	105	117	70	75	0.3	1.1	1.0	0.47	0.41
Test066	Rags w/Oil	71	111	51	73	0.3	1.0	0.9	0.35	0.39
Test057	Plastic Trash Quarter	579	1000	358	564	5.8	16.7	13.5	1.47	1.66
Test067	Plastic Trash Quarter	487	1000	330	521	4.9	15.4	13.0	1.29	1.58
Test070	Plastic Trash Quarter	425	980	277	511	4.1	12.6	12.8	1.25	1.57

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
Test058	Plastic Trash Half	517	1000	337	539	4.8	14.7	13.2	1.25	1.61
Test068	Plastic Trash Half	514	1000	359	712	6.4	16.6	15.0	1.31	1.87
Test071	Plastic Trash Half	492	1000	294	596	5.8	15.0	13.8	1.37	1.70
Test059	Plastic Trash Full	796	637	437	356	4.3	11.3	10.7	1.20	1.26
Test069	Plastic Trash Full	690	1000	375	527	6.0	15.4	13.0	1.38	1.59
Test072	Plastic Trash Full	887	947	385	497	4.8	12.8	12.7	1.31	1.54
Test073	Plastic Stanchion	159	290	118	176	2.0	5.1	5.6	0.87	0.74
Test074	Plastic Stanchion	188	218	114	138	1.5	5.2	4.5	0.85	0.58
Test075	Plastic Stanchion	141	222	99	140	1.3	4.7	4.6	0.71	0.59
Test076	15.2 m Coil Chain	55	112	38	55	0.1	0.2	0.1	0.15	0.28
Test077	15.2 m Coil Chain	239	321	113	160	0.6	3.8	2.9	0.62	0.43
Test078	15.2 m Coil Chain	129	198	85	115	1.0	1.8	3.1	0.40	0.19
Test079	15.2 m Coil Large Rope	531	571	211	276	4.2	5.6	6.9	0.94	0.69
Test080	15.2 m Coil Large Rope	98	140	56	66	0.1	0.2	0.2	0.42	0.31
Test081	15.2 m Coil Large Rope	393	500	174	200	0.7	1.4	2.2	0.56	0.62
Test084	Plastic Chair	529	722	247	396	8.1	14.4	11.3	1.40	1.35
Test085	Plastic Chair	341	643	233	348	8.1	22.1	9.1	1.16	1.25
Test086	Plastic Chair	358	723	208	396	7.8	18.3	11.3	1.11	1.35
Test087	Plank Flame	36	58	33	42	0.2	0.4	0.2	0.12	0.29
Test088	Plank Flame	30	57	30	42	0.1	0.3	0.2	0.00	0.28
Test089	Plank Flame	30	56	31	41	0.1	0.2	0.1	0.26	0.28
Test093	Pallet Flame	38	126	41	60	0.2	1.8	0.2	0.24	0.30
Test094	Pallet Flame	80	128	52	62	0.2	0.3	0.2	0.22	0.29

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
Test095	Pallet Panel	42	80	40	45	0.1	0.5	0.1	0.00	0.22
Test096	Pallet Panel	49	45	40	32	0.1	0.6	0.0	0.00	0.12
Test097	Pallet Panel	49	100	45	51	0.2	0.4	0.1	0.00	0.26
Test098	Plank Panel	33	66	34	40	0.2	0.3	0.1	0.00	0.19
Test099	Plank Panel	30	84	31	46	0.1	0.1	0.1	0.00	0.23
Test100	Plank Panel	34	69	35	41	0.3	0.4	0.1	0.00	0.19
Test101	Stack PPE	349	1000	233	377	3.6	4.2	4.9	0.58	0.92
Test103	Stack PPE	355	1000	269	487	5.1	7.0	7.8	0.89	1.07
Test102	Laptop + Cart	1000	1000	994	1000	75.6	91.6	43.9	3.01	4.57
Test0105	Laptop + Cart	1000	1000	1000	1000	44.4	69.0	26.1	3.14	4.42
Test0106	Laptop + Cart	1000	1000	1000	1000	38.1	47.3	24.8	3.38	4.16
07_10_001	Single Rag	204	344	63	96	0.4	1.3	2.1	0.23	0.24
07_10_002	Single Rag	264	429	62	113	0.4	1.3	2.7	0.34	0.28
07_10_003	Single Rag	151	309	49	86	0.2	1.0	1.6	0.22	0.23
07_23_002	Single Rag	86	265	43	82	0.6	0.7	2.0	0.20	0.17
07_16_001	5 Rags	220	487	76	137	1.1	3.6	4.8	0.26	0.28
07_16_002	5 Rags	181	409	72	132	1.1	6.7	6.5	0.28	0.24
07_16_003	5 Rags	464	885	127	209	0.8	6.2	6.6	0.44	0.42
07_23_003	5 Rags	413	729	90	176	1.9	4.2	5.4	0.34	0.37
07_16_004	Single Rag w/Heptane	224	330	87	125	1.3	2.0	4.0	0.54	0.45
07_16_005	Single Rag w/Heptane	201	355	76	132	1.4	2.3	4.2	0.58	0.47
07_16_006	Single Rag w/Heptane	155	342	75	125	1.2	2.2	3.6	0.56	0.47
07_23_001	Single Rag w/Heptane	147	362	63	138	1.8	3.7	4.7	0.40	0.47
07_17_001	Bag of Rags	75	264	46	117	0.3	1.7	3.2	0.19	0.18
07_17_002	Bag of Rags	131	373	61	152	0.5	2.9	4.1	0.25	0.25
07_17_003	Bag of Rags	72	165	40	82	0.2	0.5	2.1	0.23	0.09

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
07_17_004	Five Rags w/Heptane	294	450	134	201	2.3	2.9	3.9	0.87	0.76
07_17_005	Five Rags w/Heptane	418	477	170	217	5.3	5.5	7.9	0.86	0.78
07_17_006	Five Rags w/Heptane	308	362	129	173	4.8	10.1	9.5	0.79	0.66
07_18_001	Cardstock Wall	35	46	33	35	0.0	0.0	0.3	0.00	0.16
07_18_001	Cardstock Wall	33	68	33	44	0.0	0.0	0.7	0.00	0.24
07_18_001	Cardstock Wall	33	55	33	39	0.0	0.0	0.5	0.00	0.20
07_18_002	Cardstock Air	72	105	58	64	0.8	1.1	3.6	0.58	0.24
07_18_003	Cardstock Air	115	133	65	77	1.5	2.6	4.4	0.63	0.31
07_18_004	Cardstock Air	45	65	36	44	0.3	0.6	1.0	0.35	0.17
07_18_005	Small Binder Closed	37	280	32	75	0.1	0.2	1.1	0.08	0.20
07_18_006	Small Binder Open	215	411	82	145	2.5	6.9	9.9	0.30	0.23
07_18_007	Small Binder Open	199	658	69	141	1.0	5.1	3.1	0.26	0.33
07_18_008	Pad of Paper	45	270	34	70	0.3	0.5	0.9	0.08	0.20
07_18_009	Pad of Paper	41	201	35	68	0.3	1.5	1.4	0.06	0.13
07_18_010	Pad of Paper	33	237	31	65	0.0	0.1	0.8	0.06	0.18
07_18_011	Large Binder Closed	44	71	32	34	0.2	0.2	0.1	0.00	0.08
07_18_011	Large Binder Closed	44	322	34	69	0.1	0.1	0.6	0.00	0.23
07_18_011	Large Binder Closed	51	288	31	65	0.4	0.9	0.6	0.00	0.22
07_18_012	Large Binder Open	204	829	66	158	1.1	3.1	3.3	0.25	0.37
07_18_013	Large Binder Open	106	457	52	109	0.9	0.9	2.2	0.25	0.27
07_23_004	Duct Tape Wall	39	39	29	31	0.0	0.0	0.2	0.00	0.11

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		**High TC Grid**		**Exp. Min**	**Exp. Max**	**FDT^s**	**Exp.**	**FDT^s**
		Exp.	**FDT^s**	**Exp.**	**FDT^s**					
07_23_005	Short Duct Tape Air	29	48	28	35	0.0	0.0	0.3	0.00	0.16
07_23_006	Short Duct Tape Air	29	57	28	39	0.1	0.1	0.4	0.01	0.21
07_24_001	Bucket w/Debris	107	157	56	83	0.3	0.4	1.4	0.49	0.39
07_24_002	Bucket w/Debris	136	198	69	98	1.5	2.2	3.8	0.47	0.46
07_24_003	Bucket w/Debris	268	410	76	155	2.0	3.9	5.1	0.80	0.56
07_31_001	Empty Bucket	121	240	73	110	1.1	3.2	5.2	0.24	0.38
07_31_002	Empty Bucket	388	1000	147	305	3.9	13.6	6.4	0.71	0.71
07_31_003	Empty Bucket	289	687	111	212	2.1	9.1	5.0	0.51	0.55
07_31_004	Empty Bucket	412	919	158	261	2.3	11.2	5.8	0.53	0.64
08_01_001	Debris Pile	348	408	132	175	2.0	4.7	8.9	0.32	0.39
08_01_002	Debris Pile	185	753	90	194	1.2	4.6	4.9	0.40	0.56
08_01_003	Debris Pile	327	482	127	179	2.5	5.6	9.2	0.48	0.45
08_01_004	Single Cone	122	235	59	96	1.0	2.7	3.8	0.30	0.27
08_01_005	Single Cone	186	471	70	145	1.3	3.6	3.9	0.56	0.45
08_01_006	Single Cone	192	315	61	116	1.7	7.0	4.0	0.38	0.35
08_02_001	Uncoiled 120-V Cord	41	257	31	63	0.1	0.3	0.5	0.10	0.23
08_02_002	3 m Coil 120 V Cord	42	295	30	68	0.1	0.1	0.6	0.10	0.24
08_03_001	3 m Coil 120 V Cord	55	274	33	71	0.0	0.1	0.8	0.10	0.22
08_03_002	3 m Coil 120 V Cord	67	230	33	64	0.1	0.1	0.7	0.15	0.20
08_03_003	7.6 m Coil 120 V Cord	72	173	34	63	0.0	0.1	1.2	0.10	0.13
08_03_004	7.6 m Coil 120 V Cord	76	218	34	65	0.0	0.1	0.8	0.15	0.19
08_03_005	7.6 m Coil 120 V Cord	61	235	33	62	0.0	0.1	0.6	0.15	0.21

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
08_06_001	Medium Box Empty	493	760	300	319	8.7	14.7	6.8	0.84	0.96
08_06_002	Medium Box Empty	677	986	402	390	7.2	9.2	6.3	0.90	1.08
08_06_003	Medium Box Empty	566	868	281	353	7.8	9.2	5.9	0.96	1.02
08_06_004	Medium Box w/Paper	483	598	263	264	3.7	4.7	4.8	0.96	0.85
08_06_005	Medium Box w/Paper	655	830	330	341	6.0	7.8	7.1	1.02	1.00
08_06_006	Medium Box w/Paper	717	974	371	386	7.4	9.1	7.7	1.06	1.08
08_06_007	Medium Box w/Peanuts	751	1000	527	605	9.2	11.4	7.0	1.06	1.36
08_06_008	Medium Box w/Peanuts	735	1000	396	514	8.1	9.3	5.4	1.06	1.25
08_06_009	Medium Box w/Peanuts	668	1000	329	442	8.6	9.3	4.9	1.06	1.16
08_07_001	Small Box Empty	176	317	96	158	2.0	4.0	3.9	0.51	0.58
08_07_002	Small Box Empty	343	545	181	245	10.7	13.2	9.4	0.63	0.81
08_07_003	Small Box Empty	342	469	130	217	4.6	5.4	5.1	0.74	0.75
08_07_004	Small Box Empty	278	508	134	231	4.7	5.3	5.4	0.65	0.78
08_07_005	Small Box w/Paper	287	527	150	238	4.7	5.8	5.5	0.62	0.80
08_07_006	Small Box w/Paper	330	472	135	218	3.1	4.9	5.2	0.63	0.75
08_07_007	Small Box w/Paper	331	548	184	246	4.5	4.9	5.7	0.63	0.81
08_07_008	Small Box w/Peanuts	386	564	148	252	4.3	4.7	4.6	0.74	0.83
08_07_009	Small Box w/Peanuts	277	635	151	277	5.4	5.6	5.0	0.63	0.88
08_07_010	Small Box w/Peanuts	397	798	199	331	7.0	8.1	5.7	0.74	0.98

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		**High TC Grid**		**Exp. Min**	**Exp. Max**	**FDT^s**	**Exp.**	**FDT^s**
		Exp.	**FDT^s**	**Exp.**	**FDT^s**					
08_08_001 a	Metal Chair	144	127	89	93	0.7	1.4	3.0	0.27	0.27
08_08_001 b	Metal Chair	146	144	152	102	3.0	3.0	2.8	0.41	0.34
08_08_002 a	Metal Chair	193	152	120	104	1.9	2.7	2.1	0.43	0.41
08_08_002 b	Metal Chair	183	128	81	86	0.6	0.8	1.0	0.39	0.42
08_08_003	Metal Chair	64	167	74	139	2.4	2.5	1.9	0.57	0.52
08_08_004	First Aid Kit	304	386	175	180	3.7	9.0	6.8	0.30	0.67
08_09_001	First Aid Kit	164	209	93	110	2.3	6.4	4.6	0.30	0.43
08_09_002	First Aid Kit	115	208	78	110	1.7	5.2	4.6	0.30	0.43
08_09_003	15.2 m Coil Chain	40	73	35	46	0.0	0.1	0.4	0.05	0.21
08_13_002	15.2 m Coil Chain	35	64	31	42	0.0	0.0	0.1	0.09	0.23
08_14_002	Four Cones	188	272	85	129	1.3	2.2	2.1	0.22	0.55
08_15_001	Four Cones	75	132	46	71	0.5	1.1	1.0	0.48	0.35
08_15_002	Four Cones	175	282	86	132	1.7	3.6	2.9	0.65	0.57
08_15_003	HVAC Filter	344	1000	79	257	2.0	9.2	6.3	0.44	0.51
08_15_004	HVAC Filter	452	654	140	209	1.1	6.5	8.8	0.42	0.39
08_15_005	HVAC Filter	320	440	91	156	0.7	3.9	8.0	0.31	0.28
08_16_001	Uncoiled Small Rope	158	370	62	94	0.1	0.8	1.6	0.26	0.26
08_16_002	Uncoiled Small Rope	114	362	56	92	0.3	0.9	1.6	0.26	0.26
08_16_003	Uncoiled Small Rope	122	444	63	105	0.1	1.2	1.9	0.27	0.29
08_16_004	7.6-m Coil Small Rope	86	168	59	71	0.2	1.0	3.4	0.11	0.07
08_20_001	7.6-m Coil Small Rope	152	202	58	82	0.9	1.7	5.0	0.22	0.10

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
08_20_002	7.6m Coil Small Rope	150	472	63	115	1.1	2.3	2.4	0.24	0.30
08_20_003	15.2 m Coil Small Rope	242	418	74	138	1.9	8.7	6.8	0.29	0.27
08_20_004	15.2 m Coil Small Rope	382	659	107	185	1.3	7.2	5.3	0.33	0.38
08_20_005	15.2 m Coil Small Rope	439	616	116	185	3.7	9.1	6.2	0.42	0.37
08_21_001	Uncoiled Large Rope	192	396	49	98	0.4	1.4	1.7	0.31	0.27
08_21_002	Uncoiled Large Rope	89	350	44	91	0.2	0.7	1.6	0.20	0.25
08_21_003	Uncoiled Large Rope	123	343	49	89	0.2	0.9	1.5	0.20	0.25
08_21_005	7.6 m Coil Large Rope	112	305	50	83	0.1	0.2	1.4	0.24	0.23
08_21_006	7.6 m Coil Large Rope	650	1000	287	561	11.8	14.2	14.6	0.57	0.83
08_21_007	7.6 m Coil Large Rope	169	339	49	89	0.1	0.1	1.5	0.27	0.25
08_22_001	Duct Tape Roll	398	1000	124	250	2.4	5.2	2.5	0.53	0.64
08_22_002	Duct Tape Roll	91	260	53	87	0.2	0.4	0.7	0.31	0.33
08_22_003	Duct Tape Roll	269	866	99	226	2.0	5.5	3.0	0.44	0.60
08_22_005	Single Oil Pad	64	202	45	78	0.2	0.7	1.4	0.26	0.27
08_22_006	Single Oil Pad	31	222	31	83	0.1	0.2	1.6	0.20	0.29
08_22_007	Single Oil Pad	74	205	44	79	0.2	0.4	1.5	0.26	0.27
08_23_001	Four Oil Pads	116	302	50	82	0.1	0.7	1.4	0.26	0.23
08_23_002	Four Oil Pads	97	293	55	81	0.1	0.2	1.3	0.20	0.22
08_23_003	Four Oil Pads	114	348	45	90	0.1	0.3	1.6	0.20	0.25
08_23_004	Single Oil Pad w/Oil	105	295	39	81	0.2	0.5	1.3	0.26	0.22
08_23_005	Single Oil Pad w/Oil	136	319	46	85	0.2	0.4	1.4	0.26	0.24

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
08_23_006	Single Oil Pad w/Oil	103	408	40	100	0.5	0.6	1.8	0.26	0.28
08_23_007	Four Oil Pads w/Oil	114	400	39	99	0.4	1.0	1.8	0.26	0.27
08_23_008	Four Oil Pads w/Oil	112	338	46	89	0.1	0.4	1.5	0.26	0.25
08_24_001	Lift Slings	199	350	77	149	1.6	5.4	3.2	0.32	0.35
08_24_002	Lift Slings	224	414	109	167	1.3	3.2	4.1	0.43	0.40
08_24_003	Lift Slings	256	477	99	170	1.3	4.7	3.0	0.51	0.45
08_24_004	Uncoiled Chain	42	304	33	92	0.2	0.2	0.6	0.10	0.25
08_24_005	Uncoiled Chain	46	275	33	87	0.1	0.2	0.6	0.10	0.23
08_24_006	Uncoiled Chain	53	270	33	85	0.1	0.1	0.6	0.08	0.23
08_27_001	7.6m Coil Tubing	41	124	32	55	0.1	0.1	0.2	0.15	0.19
08_27_002	7.6 m Coil Tubing	71	144	35	56	0.3	0.4	0.9	0.12	0.10
08_27_003	7.6 m Coil Tubing	61	165	37	61	0.6	3.1	1.1	0.14	0.12
08_27_004	15.2 m Coil Tubing	49	194	33	63	0.3	0.5	0.9	0.14	0.16
08_27_005	15.2 m Coil Tubing	62	203	35	67	0.2	0.3	1.1	0.10	0.16
08_28_001	15.2 m Coil Tubing	46	311	32	70	0.1	0.1	0.7	0.02	0.25
08_28_002	Uncoiled Tubing	44	209	31	56	0.1	0.2	0.4	0.08	0.20
08_28_003	Uncoiled Tubing	36	157	30	49	0.1	0.1	0.3	0.08	0.17
08_28_004	Uncoiled Tubing	46	206	32	57	0.1	0.3	0.5	0.06	0.20
08_28_005	Welding Blanket Folded	45	160	32	49	0.1	0.1	0.3	0.09	0.17
08_28_005	Welding Blanket Folded	42	126	33	44	0.0	0.0	0.2	0.09	0.15
08_28_005	Welding Blanket Folded	41	189	31	53	0.0	0.0	0.4	0.09	0.19

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		High TC Grid		Exp. Min	Exp. Max	FDT^s	Exp.	FDT^s
		Exp.	FDT^s	Exp.	FDT^s					
08_28_006	Long Duct Tape Air	49	262	39	65	0.1	0.1	0.6	0.08	0.23
08_28_007	Long Duct Tape Air	63	224	34	60	0.0	0.1	0.5	0.05	0.21
08_28_008	Long Duct Tape Air	59	320	39	73	0.1	0.1	0.8	0.12	0.25
08_29_001	Plastic Tarp Folded	87	186	49	74	0.1	0.2	0.4	0.31	0.25
08_29_002	Plastic Tarp Folded	684	1000	235	662	6.6	13.4	10.3	0.63	0.90
08_29_003	Plastic Tarp Folded	698	1000	248	630	4.9	5.4	3.3	0.56	0.88
08_29_004	Power Spider	36	144	37	70	0.0	0.0	0.2	0.20	0.25
08_30_001	Power Spider	65	327	36	141	0.0	0.0	0.8	0.00	0.37
08_30_002	Canvas Tarp Folded	140	183	60	90	0.1	0.3	0.4	0.29	0.25
08_30_003	Canvas Tarp Folded	101	204	53	98	0.0	0.1	0.5	0.14	0.27
08_30_004	Canvas Tarp Folded	83	170	60	85	0.0	0.1	0.4	0.29	0.24
08_30_005	Oxy-Acetylene Hose	57	732	34	115	0.9	3.5	1.2	0.10	0.36
09_04_001	Oxy-Acetylene Hose	41	384	28	79	0.1	0.4	0.8	0.13	0.27
09_04_002	Single PPE	229	253	87	125	1.3	3.8	4.3	0.37	0.21
09_04_003	Single PPE	298	365	136	168	1.8	6.7	8.1	0.52	0.35
09_04_004	Single PPE	210	333	107	151	1.2	4.3	6.3	0.41	0.32
09_05_001	Metal Trash Quarter	548	505	421	345	2.9	4.7	10.2	1.06	0.94
09_05_002	Metal Trash Quarter	456	437	350	302	2.0	3.4	9.5	0.98	0.85
09_05_003	Metal Trash Quarter	463	404	329	282	2.2	3.3	11.5	1.08	0.81
09_05_004	Metal Trash Half	493	462	394	318	2.4	3.4	9.8	1.10	0.88

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		**High TC Grid**		**Exp. Min**	**Exp. Max**	**FDT^s**	**Exp.**	**FDT^s**
		Exp.	**FDT^s**	**Exp.**	**FDT^s**					
09_05_005	Metal Trash Half	531	444	383	307	3.7	4.5	11.9	1.06	0.86
09_05_006	Metal Trash Half	557	460	429	317	5.3	6.7	15.4	1.12	0.88
09_05_007	Metal Trash Full	575	333	392	237	3.5	3.5	10.6	1.12	0.70
09_06_001	Metal Trash Full	651	432	579	299	4.8	6.9	15.0	1.27	0.85
09_06_002	Metal Trash Full	602	394	397	269	4.9	9.1	11.8	1.35	0.80
09_06_003	Metal Trash Full Lid	446	168	177	120	1.1	1.5	2.0	0.89	0.45
09_06_004	Metal Trash Full Lid	500	210	290	147	1.4	2.1	2.5	1.08	0.54
09_07_001	7.6 m Coil Chain	586	981	162	270	2.4	9.2	4.1	0.20	0.50
09_07_002	7.6 m Coil Chain	474	1000	119	284	1.9	5.3	3.4	0.54	0.54
09_10_001	7.6 m Coil Chain	472	1000	153	341	6.0	15.3	5.4	0.54	0.60
09_10_002	Wood Block Flame	29	211	31	58	0.0	0.0	0.5	0.00	0.20
09_10_002	Wood Block Flame	26	172	25	52	0.0	0.0	0.4	0.00	0.18
09_10_002	Wood Block Flame	26	208	26	58	0.0	0.0	0.5	0.00	0.20
09_10_002	Wood Block Flame	32	236	28	62	0.0	0.0	0.6	0.00	0.21
09_10_002	Wood Block Flame	30	250	28	64	0.0	0.0	0.6	0.00	0.22
09_10_004	Laptop	135	751	62	289	1.3	1.6	2.3	0.28	0.57
09_11_001	Laptop	134	535	67	231	0.7	1.1	2.1	0.39	0.48
09_11_002	Laptop	89	265	49	118	0.1	0.3	0.6	0.24	0.33
09_10_003	Wood Block Panel	144	164	52	77	0.6	1.2	0.2	0.00	0.26
09_11_003	Wood Block Panel	133	138	54	68	0.3	1.4	0.7	0.00	0.23
09_11_004	Wood Block Panel	112	149	53	72	0.0	0.6	0.7	0.00	0.25
09_12_001	Tablet	317	458	128	204	2.2	9.1	3.7	0.49	0.44

Table C-1
Comparison of FDT^s to Measured Temperature and Heat Flux (continued)

Test ID	Item	Plume Temperature (°C)				Heat Flux (kW/m^2)			Flame Length (m)	
		Low TC Grid		**High TC Grid**		**Exp. Min**	**Exp. Max**	**FDT^s**	**Exp.**	**FDT^s**
		Exp.	**FDT^s**	**Exp.**	**FDT^s**					
09_12_002	Tablet	288	490	138	225	1.5	7.8	4.8	0.52	0.46
09_12_003	Tablet	278	664	144	287	2.9	14.8	5.7	0.50	0.55
09_12_004	Tablet + Plastic Case	478	736	224	338	2.2	4.4	4.8	0.73	0.60
09_12_005	Tablet + Plastic Case	261	436	151	221	2.1	3.7	1.9	0.52	0.42
09_12_006	Tablet + Metal Case	118	337	58	159	0.5	0.9	1.4	0.52	0.36
09_19_001	Tool Bag	845	789	474	396	3.6	3.6	4.1	0.8	0.66
09_19_002	Tool Bag	742	709	430	362	4.0	5.1	4.7	0.99	0.61

APPENDIX D
SUMMARY OF COMPUTED ZONES OF INFLUENCE

Table D-1 through D-3 summarize the zone of influence (ZOI) computed based upon the measured heat release rate (HRR). Table D-1 contains the horizontal (radiation) ZOI, Table D-2 contains the vertical (plume temperature) ZOI, and Table D-3 contains the vertical ZOI for a fire in a corner. The ZOI was computed using the method discussed in Section 5.6 of the main report. This method searched for the ZOI using 5 cm increments; therefore, the minimum ZOI is 0.05 m. Cells where this occur are shaded in the tables. ZOIs were evaluated for damage to exposed sensitive electronics (Sens), damage to thermoplastic cable (TP), damage to Kerite FR cable (K), damage to thermoset cable (TS), and sustained ignition of a cable tray (Tray).

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
Test001	Medium Box Empty	137	0.35	0.05	0.05	0.05	0.05
Test002	Medium Box Empty	142	0.35	0.05	0.05	0.05	0.05
Test004	Medium Box Empty	128	0.35	0.05	0.05	0.05	0.05
Test003	Five Rags w/Heptane	42.3	0.30	0.05	0.05	0.05	0.05
Test005	Five Rags w/Heptane	46.4	0.30	0.05	0.05	0.05	0.05
Test006	Five Rags w/Heptane	50.6	0.30	0.05	0.05	0.05	0.05
Test007	Large Box Empty	377	0.90	0.20	0.10	0.10	0.05
Test010	Large Box Empty	536	0.85	0.20	0.10	0.10	0.05
Test014	Large Box Empty	412	0.85	0.15	0.10	0.10	0.05
Test0104	Large Box Empty	455	0.85	0.15	0.10	0.10	0.05
Test008	Large Box w/Peanuts	563	1.20	0.25	0.20	0.15	0.05
Test011	Large Box w/Peanuts	579	1.15	0.25	0.20	0.15	0.05
Test015	Large Box w/Peanuts	579	1.15	0.25	0.20	0.15	0.05
Test009	Large Box w/Paper	436	1.05	0.20	0.10	0.10	0.05
Test012	Large Box w/Paper	446	1.10	0.20	0.15	0.10	0.05
Test016	Large Box w/Paper	346	1.05	0.20	0.10	0.10	0.05
Test017	Plastic Tarp Draped	7.2	0.05	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
Test018	Plastic Tarp Draped	74.3	0.55	0.15	0.10	0.05	0.05
Test019	Plastic Tarp Draped	195	0.80	0.15	0.10	0.05	0.05
Test020	Plastic Tarp Draped	68.9	0.55	0.15	0.10	0.05	0.05
Test021	Welding Blanket Draped	2.2	0.05	0.05	0.05	0.05	0.05
Test022	Welding Blanket Draped	2.1	0.05	0.05	0.05	0.05	0.05
Test023	Welding Blanket Draped	2.3	0.05	0.05	0.05	0.05	0.05
Test024	Mop + Bucket	64.6	0.55	0.15	0.10	0.05	0.05
Test025	Mop + Bucket	113	0.70	0.15	0.10	0.05	0.05
Test027	Blower Duct	8.7	0.05	0.05	0.05	0.05	0.05
Test028	Blower Duct	5.9	0.10	0.05	0.05	0.05	0.05
Test029	Blower Duct	5.1	0.05	0.05	0.05	0.05	0.05
Test030	Water Hose	24.1	0.30	0.10	0.10	0.05	0.05
Test082	Water Hose	1.2	0.05	0.05	0.05	0.05	0.05
Test083	Water Hose	1.7	0.05	0.05	0.05	0.05	0.05
Test031	15.2 m Coil 120 V Cord	1.0	0.05	0.05	0.05	0.05	0.05
Test032	15.2 m Coil 120 V Cord	0.7	0.05	0.05	0.05	0.05	0.05
Test033	15.2 m Coil 120 V Cord	0.9	0.05	0.05	0.05	0.05	0.05
Test034	7.6 m Coil 250 V Cord	0.8	0.05	0.05	0.05	0.05	0.05
Test035	7.6 m Coil 250 V Cord	1.2	0.05	0.05	0.05	0.05	0.05
Test036	7.6 m Coil 250 V Cord	1.0	0.05	0.05	0.05	0.05	0.05
Test037	Scissor Stand Quarter	17.2	0.25	0.05	0.05	0.05	0.05
Test040	Scissor Stand Quarter	12.6	0.20	0.05	0.05	0.05	0.05
Test043	Scissor Stand Quarter	21.7	0.25	0.05	0.05	0.05	0.05
Test038	Scissor Stand Half	29.1	0.35	0.10	0.05	0.05	0.05
Test041	Scissor Stand Half	31.4	0.35	0.10	0.05	0.05	0.05
Test044	Scissor Stand Half	59.6	0.50	0.10	0.05	0.05	0.05
Test039	Scissor Stand Full	109	0.70	0.20	0.10	0.05	0.05
Test042	Scissor Stand Full	111	0.70	0.20	0.15	0.05	0.05
Test045	Scissor Stand Full	181	0.95	0.20	0.15	0.05	0.05
Test047	Vacuum Closed	1.3	0.05	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
Test048	Vacuum Closed	0.8	0.05	0.05	0.05	0.05	0.05
Test046	Vacuum Open	545	1.60	0.55	0.45	0.25	0.05
Test049	Vacuum Open	520	1.75	0.60	0.50	0.25	0.05
Test050	FR Plastic Tarp Draped	80.3	0.55	0.20	0.15	0.05	0.05
Test051	FR Plastic Tarp Draped	48.7	0.40	0.20	0.15	0.10	0.05
Test052	FR Plastic Tarp Folded	79.8	0.60	0.20	0.10	0.05	0.05
Test053	Canvas Tarp Draped	470	1.50	0.25	0.15	0.15	0.05
Test054	Canvas Tarp Draped	570	1.20	0.25	0.15	0.10	0.05
Test055	Canvas Tarp Folded	12	0.20	0.05	0.05	0.05	0.05
Test056	Alcohol Bottle	211	0.35	0.05	0.05	0.05	0.05
Test060	Alcohol Bottle	144	0.40	0.05	0.05	0.05	0.05
Test061	Alcohol Bottle	143	0.35	0.05	0.05	0.05	0.05
Test062	Oil Bottle	1.7	0.05	0.05	0.05	0.05	0.05
Test063	Oil Bottle	1.7	0.05	0.05	0.05	0.05	0.05
Test065	Oil Bottle	2.5	0.05	0.05	0.05	0.05	0.05
Test064	Rags w/Oil	11.3	0.20	0.05	0.05	0.05	0.05
Test066	Rags w/Oil	10.5	0.20	0.05	0.05	0.05	0.05
Test057	Plastic Trash Quarter	292	1.25	0.45	0.35	0.20	0.05
Test067	Plastic Trash Quarter	270	1.20	0.40	0.30	0.15	0.05
Test070	Plastic Trash Quarter	265	1.05	0.40	0.25	0.20	0.05
Test058	Plastic Trash Half	279	1.00	0.40	0.30	0.15	0.05
Test068	Plastic Trash Half	364	1.30	0.45	0.35	0.20	0.05
Test071	Plastic Trash Half	308	1.30	0.45	0.35	0.20	0.05
Test059	Plastic Trash Full	181	0.95	0.50	0.30	0.20	0.05
Test069	Plastic Trash Full	273	1.25	0.45	0.35	0.15	0.05
Test072	Plastic Trash Full	257	1.20	0.45	0.30	0.15	0.05
Test073	Plastic Stanchion	66.8	0.55	0.20	0.15	0.05	0.05
Test074	Plastic Stanchion	47.1	0.45	0.15	0.10	0.05	0.05
Test075	Plastic Stanchion	48.3	0.45	0.20	0.10	0.05	0.05
Test076	15.2 m Coil Chain	1.8	0.05	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
Test077	15.2 m Coil Chain	28.6	0.35	0.15	0.05	0.05	0.05
Test078	15.2 m Coil Chain	22.1	0.30	0.15	0.10	0.05	0.05
Test079	15.2 m Coil Large Rope	73.8	0.60	0.30	0.20	0.10	0.05
Test080	15.2 m Coil Large Rope	2.9	0.05	0.05	0.05	0.05	0.05
Test081	15.2 m Coil Large Rope	27	0.35	0.10	0.05	0.05	0.05
Test084	Plastic Chair	203	1.05	0.30	0.25	0.10	0.05
Test085	Plastic Chair	155	0.95	0.35	0.25	0.15	0.05
Test086	Plastic Chair	203	1.05	0.30	0.25	0.10	0.05
Test087	Plank Flame	2.0	0.05	0.05	0.05	0.05	0.05
Test088	Plank Flame	2.0	0.05	0.05	0.05	0.05	0.05
Test089	Plank Flame	1.8	0.05	0.05	0.05	0.05	0.05
Test093	Pallet Flame	2.1	0.05	0.05	0.05	0.05	0.05
Test094	Pallet Flame	2.5	0.05	0.05	0.05	0.05	0.05
Test095	Pallet Panel	1.0	0.05	0.05	0.05	0.05	0.05
Test096	Pallet Panel	0.2	0.05	0.05	0.05	0.05	0.05
Test097	Pallet Panel	1.4	0.05	0.05	0.05	0.05	0.05
Test098	Plank Panel	0.7	0.05	0.05	0.05	0.05	0.05
Test099	Plank Panel	1.1	0.05	0.05	0.05	0.05	0.05
Test100	Plank Panel	0.7	0.05	0.05	0.05	0.05	0.05
Test101	Stack PPE	69.7	0.55	0.20	0.10	0.05	0.05
Test103	Stack PPE	118	0.75	0.20	0.15	0.05	0.05
Test102	Laptop + Cart	2683	3.25	1.05	0.85	0.70	0.40
Test0105	Laptop + Cart	2510	3.90	1.15	0.95	0.85	0.50
Test0106	Laptop + Cart	2214	3.15	1.05	0.85	0.70	0.35
07_10_001	Single Rag	3.5	0.05	0.05	0.05	0.05	0.05
07_10_002	Single Rag	4.7	0.10	0.05	0.05	0.05	0.05
07_10_003	Single Rag	2.6	0.05	0.05	0.05	0.05	0.05
07_23_002	Single Rag	2.7	0.05	0.05	0.05	0.05	0.05
07_16_001	Five Rags	7.5	0.15	0.05	0.05	0.05	0.05
07_16_002	Five Rags	8.3	0.15	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
07_16_003	Five Rags	14.0	0.20	0.05	0.05	0.05	0.05
07_23_003	Five Rags	10.4	0.20	0.05	0.05	0.05	0.05
07_16_004	Single Rag w/Heptane	9.6	0.15	0.05	0.05	0.05	0.05
07_16_005	Single Rag w/Heptane	10.5	0.20	0.05	0.05	0.05	0.05
07_16_006	Single Rag w/Heptane	9.1	0.15	0.05	0.05	0.05	0.05
07_23_001	Single Rag w/Heptane	11.8	0.15	0.05	0.05	0.05	0.05
07_17_001	Bag of Rags	4.0	0.10	0.05	0.05	0.05	0.05
07_17_002	Bag of Rags	6.0	0.10	0.05	0.05	0.05	0.05
07_17_003	Bag of Rags	2.2	0.05	0.05	0.05	0.05	0.05
07_17_004	Five Rags w/Heptane	34.0	0.30	0.05	0.05	0.05	0.05
07_17_005	Five Rags w/Heptane	41.0	0.40	0.05	0.05	0.05	0.05
07_17_006	Five Rags w/Heptane	30.5	0.30	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_002	Cardstock Air	5.3	0.05	0.05	0.05	0.05	0.05
07_18_003	Cardstock Air	7.7	0.05	0.05	0.05	0.05	0.05
07_18_004	Cardstock Air	1.6	0.05	0.05	0.05	0.05	0.05
07_18_005	Small Binder Closed	1.8	0.05	0.05	0.05	0.05	0.05
07_18_006	Small Binder Open	11.4	0.20	0.05	0.05	0.05	0.05
07_18_007	Small Binder Open	6.0	0.10	0.05	0.05	0.05	0.05
07_18_008	Pad of Paper	1.5	0.05	0.05	0.05	0.05	0.05
07_18_009	Pad of Paper	1.8	0.05	0.05	0.05	0.05	0.05
07_18_010	Pad of Paper	1.3	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_012	Large Binder Open	6.9	0.15	0.05	0.05	0.05	0.05
07_18_013	Large Binder Open	3.9	0.10	0.05	0.05	0.05	0.05
07_23_004	Duct Tape Wall	0.3	0.05	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
07_23_005	Short Duct Tape Air	0.5	0.05	0.05	0.05	0.05	0.05
07_23_006	Short Duct Tape Air	0.8	0.05	0.05	0.05	0.05	0.05
07_24_001	Bucket w/Debris	7.2	0.15	0.05	0.05	0.05	0.05
07_24_002	Bucket w/Debris	9.5	0.15	0.05	0.05	0.05	0.05
07_24_003	Bucket w/Debris	14.7	0.15	0.05	0.05	0.05	0.05
07_31_001	Empty Bucket	10.5	0.20	0.05	0.05	0.05	0.05
07_31_002	Empty Bucket	30.8	0.35	0.10	0.05	0.05	0.05
07_31_003	Empty Bucket	19.8	0.30	0.05	0.05	0.05	0.05
07_31_004	Empty Bucket	25.6	0.35	0.10	0.05	0.05	0.05
08_01_001	Debris Pile	23.7	0.25	0.05	0.05	0.05	0.05
08_01_002	Debris Pile	13.4	0.25	0.05	0.05	0.05	0.05
08_01_003	Debris Pile	19.1	0.25	0.05	0.05	0.05	0.05
08_01_004	Single Cone	6.0	0.10	0.05	0.05	0.05	0.05
08_01_005	Single Cone	9.5	0.15	0.05	0.05	0.05	0.05
08_01_006	Single Cone	7.8	0.15	0.05	0.05	0.05	0.05
08_02_001	Uncoiled 120 V Cord	1.0	0.05	0.05	0.05	0.05	0.05
08_02_002	3 m Coil 120 V Cord	1.2	0.05	0.05	0.05	0.05	0.05
08_03_001	3 m Coil 120 V Cord	1.5	0.05	0.05	0.05	0.05	0.05
08_03_002	3 m Coil 120 V Cord	1.2	0.05	0.05	0.05	0.05	0.05
08_03_003	7.6 m Coil 120 V Cord	1.6	0.05	0.05	0.05	0.05	0.05
08_03_004	7.6 m Coil 120 V Cord	1.4	0.05	0.05	0.05	0.05	0.05
08_03_005	7.6 m Coil 120 V Cord	1.0	0.05	0.05	0.05	0.05	0.05
08_06_001	Medium Box Empty	68.4	0.35	0.05	0.05	0.05	0.05
08_06_002	Medium Box Empty	85.7	0.35	0.05	0.05	0.05	0.05
08_06_003	Medium Box Empty	76.9	0.35	0.05	0.05	0.05	0.05
08_06_004	Medium Box w/Paper	54.6	0.50	0.05	0.05	0.05	0.05
08_06_005	Medium Box w/Paper	73.9	0.45	0.05	0.05	0.05	0.05
08_06_006	Medium Box w/Paper	84.8	0.45	0.05	0.05	0.05	0.05
08_06_007	Medium Box w/Peanuts	134	0.45	0.05	0.05	0.05	0.05
08_06_008	Medium Box w/Peanuts	114	0.45	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
08_06_009	Medium Box w/Peanuts	98.0	0.45	0.05	0.05	0.05	0.05
08_07_001	Small Box Empty	28.0	0.25	0.05	0.05	0.05	0.05
08_07_002	Small Box Empty	49.9	0.20	0.05	0.05	0.05	0.05
08_07_003	Small Box Empty	42.9	0.25	0.05	0.05	0.05	0.05
08_07_004	Small Box Empty	46.5	0.25	0.05	0.05	0.05	0.05
08_07_005	Small Box w/Paper	48.3	0.30	0.05	0.05	0.05	0.05
08_07_006	Small Box w/Paper	43.2	0.30	0.05	0.05	0.05	0.05
08_07_007	Small Box w/Paper	50.2	0.30	0.05	0.05	0.05	0.05
08_07_008	Small Box w/Peanuts	51.6	0.30	0.05	0.05	0.05	0.05
08_07_009	Small Box w/Peanuts	57.9	0.25	0.05	0.05	0.05	0.05
08_07_010	Small Box w/Peanuts	71.4	0.25	0.05	0.05	0.05	0.05
08_08_001a	Metal Chair	14.3	0.20	0.05	0.05	0.05	0.05
08_08_001b	Metal Chair	15.5	0.20	0.05	0.05	0.05	0.05
08_08_002a	Metal Chair	13.6	0.20	0.05	0.05	0.05	0.05
08_08_002b	Metal Chair	7.4	0.15	0.05	0.05	0.05	0.05
08_08_003	Metal Chair	23.2	0.30	0.05	0.05	0.05	0.05
08_08_004	First Aid Kit	30.8	0.20	0.05	0.05	0.05	0.05
08_09_001	First Aid Kit	14.8	0.20	0.05	0.05	0.05	0.05
08_09_002	First Aid Kit	14.8	0.20	0.05	0.05	0.05	0.05
08_09_003	15.2 m Coil Chain	1.7	0.05	0.05	0.05	0.05	0.05
08_13_002	15.2 m Coil Chain	1.1	0.05	0.05	0.05	0.05	0.05
08_14_002	Four Cones	15.8	0.25	0.05	0.05	0.05	0.05
08_15_001	Four Cones	5.2	0.10	0.05	0.05	0.05	0.05
08_15_002	Four Cones	16.5	0.25	0.05	0.05	0.05	0.05
08_15_003	HVAC Filter	19.3	0.05	0.05	0.05	0.05	0.05
08_15_004	HVAC Filter	20.0	0.10	0.05	0.05	0.05	0.05
08_15_005	HVAC Filter	13.5	0.10	0.05	0.05	0.05	0.05
08_16_001	Uncoiled Small Rope	3.0	0.05	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
08_16_002	Uncoiled Small Rope	2.9	0.05	0.05	0.05	0.05	0.05
08_16_003	Uncoiled Small Rope	3.6	0.05	0.05	0.05	0.05	0.05
08_16_004	7.6 m Coil Small Rope	2.8	0.05	0.05	0.05	0.05	0.05
08_20_001	7.6 m Coil Small Rope	4.0	0.10	0.05	0.05	0.05	0.05
08_20_002	7.6 m Coil Small Rope	4.5	0.10	0.05	0.05	0.05	0.05
08_20_003	15.2 m Coil Small Rope	9.5	0.15	0.05	0.05	0.05	0.05
08_20_004	15.2 m Coil Small Rope	13.4	0.20	0.05	0.05	0.05	0.05
08_20_005	15.2 m Coil Small Rope	14.8	0.20	0.05	0.05	0.05	0.05
08_21_001	Uncoiled Large Rope	3.2	0.05	0.05	0.05	0.05	0.05
08_21_002	Uncoiled Large Rope	2.8	0.05	0.05	0.05	0.05	0.05
08_21_003	Uncoiled Large Rope	2.7	0.05	0.05	0.05	0.05	0.05
08_21_005	7.6 m Coil Large Rope	2.4	0.05	0.05	0.05	0.05	0.05
08_21_006	7.6 m Coil Large Rope	57.8	0.55	0.20	0.15	0.10	0.05
08_21_007	7.6 m Coil Large Rope	2.7	0.05	0.05	0.05	0.05	0.05
08_22_001	Duct Tape Roll	20.3	0.30	0.10	0.05	0.05	0.05
08_22_002	Duct Tape Roll	3.4	0.05	0.05	0.05	0.05	0.05
08_22_003	Duct Tape Roll	17.9	0.30	0.10	0.05	0.05	0.05
08_22_005	Single Oil Pad	3.2	0.05	0.05	0.05	0.05	0.05
08_22_006	Single Oil Pad	3.6	0.05	0.05	0.05	0.05	0.05
08_22_007	Single Oil Pad	3.2	0.05	0.05	0.05	0.05	0.05
08_23_001	Four Oil Pads	2.4	0.05	0.05	0.05	0.05	0.05
08_23_002	Four Oil Pads	2.3	0.05	0.05	0.05	0.05	0.05
08_23_003	Four Oil Pads	2.8	0.05	0.05	0.05	0.05	0.05
08_23_004	Single Oil Pad w/Oil	2.3	0.05	0.05	0.05	0.05	0.05
08_23_005	Single Oil Pad w/Oil	2.5	0.05	0.05	0.05	0.05	0.05
08_23_006	Single Oil Pad w/Oil	3.3	0.05	0.05	0.05	0.05	0.05
08_23_007	Four Oil Pads w/Oil	3.2	0.05	0.05	0.05	0.05	0.05
08_23_008	Four Oil Pads w/Oil	2.7	0.05	0.05	0.05	0.05	0.05
08_24_001	Lift Slings	17.3	0.25	0.05	0.05	0.05	0.05
08_24_002	Lift Slings	19.2	0.25	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
08_24_003	Lift Slings	15.9	0.25	0.05	0.05	0.05	0.05
08_24_004	Uncoiled Chain	1.3	0.05	0.05	0.05	0.05	0.05
08_24_005	Uncoiled Chain	1.1	0.05	0.05	0.05	0.05	0.05
08_24_006	Uncoiled Chain	1.1	0.05	0.05	0.05	0.05	0.05
08_27_001	7.6 m Coil Tubing	1.4	0.05	0.05	0.05	0.05	0.05
08_27_002	7.6 m Coil Tubing	1.2	0.05	0.05	0.05	0.05	0.05
08_27_003	7.6 m Coil Tubing	1.5	0.05	0.05	0.05	0.05	0.05
08_27_004	15.2 m Coil Tubing	1.4	0.05	0.05	0.05	0.05	0.05
08_27_005	15.2 m Coil Tubing	1.7	0.05	0.05	0.05	0.05	0.05
08_28_001	15.2 m Coil Tubing	1.3	0.05	0.05	0.05	0.05	0.05
08_28_002	Uncoiled Tubing	0.8	0.05	0.05	0.05	0.05	0.05
08_28_003	Uncoiled Tubing	0.6	0.05	0.05	0.05	0.05	0.05
08_28_004	Uncoiled Tubing	0.9	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.05	0.05	0.05	0.05	0.05
08_28_006	Long Duct Tape Air	1.2	0.05	0.05	0.05	0.05	0.05
08_28_007	Long Duct Tape Air	1.0	0.05	0.05	0.05	0.05	0.05
08_28_008	Long Duct Tape Air	1.5	0.05	0.05	0.05	0.05	0.05
08_29_001	Plastic Tarp Folded	2.9	0.05	0.05	0.05	0.05	0.05
08_29_002	Plastic Tarp Folded	60.2	0.55	0.20	0.15	0.10	0.05
08_29_003	Plastic Tarp Folded	57.4	0.55	0.15	0.10	0.05	0.05
08_29_004	Power Spider	1.3	0.05	0.05	0.05	0.05	0.05
08_30_001	Power Spider	5.7	0.10	0.05	0.05	0.05	0.05
08_30_002	Canvas Tarp Folded	2.8	0.05	0.05	0.05	0.05	0.05
08_30_003	Canvas Tarp Folded	3.2	0.05	0.05	0.05	0.05	0.05
08_30_004	Canvas Tarp Folded	2.5	0.05	0.05	0.05	0.05	0.05
08_30_005	Oxy-Acetylene Hose	3.2	0.05	0.05	0.05	0.05	0.05
09_04_001	Oxy-Acetylene Hose	1.7	0.05	0.05	0.05	0.05	0.05
09_04_002	Single PPE	16.8	0.10	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
09_04_003	Single PPE	25.9	0.30	0.05	0.05	0.05	0.05
09_04_004	Single PPE	20.3	0.25	0.05	0.05	0.05	0.05
09_05_001	Metal Trash Quarter	95.3	0.50	0.05	0.05	0.05	0.05
09_05_002	Metal Trash Quarter	82.1	0.40	0.05	0.05	0.05	0.05
09_05_003	Metal Trash Quarter	75.5	0.45	0.05	0.05	0.05	0.05
09_05_004	Metal Trash Half	86.9	0.55	0.05	0.05	0.05	0.05
09_05_005	Metal Trash Half	83.4	0.60	0.05	0.05	0.05	0.05
09_05_006	Metal Trash Half	86.5	0.60	0.05	0.05	0.05	0.05
09_05_007	Metal Trash Full	61.0	0.50	0.10	0.05	0.05	0.05
09_06_001	Metal Trash Full	81.1	0.60	0.10	0.05	0.05	0.05
09_06_002	Metal Trash Full	60.9	0.55	0.10	0.05	0.05	0.05
09_06_003	Metal Trash Full Lid	15.7	0.25	0.05	0.05	0.05	0.05
09_06_004	Metal Trash Full Lid	21.2	0.20	0.05	0.05	0.05	0.05
09_07_001	7.6 m Coil Chain	26.1	0.35	0.10	0.05	0.05	0.05
09_07_002	7.6 m Coil Chain	23.9	0.30	0.10	0.05	0.05	0.05
09_10_001	7.6 m Coil Chain	37.2	0.40	0.10	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.05	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.05	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.05	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.05	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.05	0.05	0.05	0.05	0.05
09_10_004	Laptop	17.6	0.10	0.05	0.05	0.05	0.05
09_11_001	Laptop	14.8	0.10	0.05	0.05	0.05	0.05
09_11_002	Laptop	4.2	0.10	0.05	0.05	0.05	0.05
09_10_003	Wood Block Panel	1.7	0.05	0.05	0.05	0.05	0.05
09_11_003	Wood Block Panel	1.3	0.05	0.05	0.05	0.05	0.05
09_11_004	Wood Block Panel	1.4	0.05	0.05	0.05	0.05	0.05
09_12_001	Tablet	12.6	0.10	0.05	0.05	0.05	0.05
09_12_002	Tablet	16.3	0.05	0.05	0.05	0.05	0.05
09_12_003	Tablet	22.0	0.15	0.05	0.05	0.05	0.05

Table D-1
Horizontal (Radiation) ZOI Using Fire Dynamics Tools (FDT^S) and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Horizontal ZOI (m)				
			Sens	TP	K	TS	Tray
09_12_004	Tablet + Plastic Case	33.9	0.35	0.10	0.05	0.05	0.05
09_12_005	Tablet + Plastic Case	20.3	0.25	0.10	0.05	0.05	0.05
09_12_006	Tablet + Metal Case	9.1	0.05	0.05	0.05	0.05	0.05
09_19_001	Tool Bag	55.7	0.50	0.15	0.10	0.05	0.05
09_19_002	Tool Bag	50.5	0.50	0.15	0.10	0.05	0.05

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
Test001	Medium Box Empty	137	2.60	0.05	0.80	0.75	0.70
Test002	Medium Box Empty	142	2.45	0.05	0.75	0.70	0.65
Test004	Medium Box Empty	128	2.60	0.85	0.85	0.75	0.70
Test003	Five Rags w/Heptane	42.3	2.30	0.75	0.70	0.65	0.60
Test005	Five Rags w/Heptane	46.4	2.30	0.70	0.70	0.60	0.60
Test006	Five Rags w/Heptane	50.6	2.30	0.80	0.75	0.65	0.65
Test007	Large Box Empty	377	4.90	1.60	1.50	1.35	1.25
Test010	Large Box Empty	536	4.75	1.60	1.50	1.35	1.25
Test014	Large Box Empty	412	4.65	1.50	1.45	1.30	1.20
Test0104	Large Box Empty	455	4.80	1.60	1.50	1.35	1.25
Test008	Large Box w/Peanuts	563	6.00	2.00	1.90	1.70	1.60
Test011	Large Box w/Peanuts	579	5.90	1.95	1.85	1.70	1.60
Test015	Large Box w/Peanuts	579	5.95	1.95	1.85	1.70	1.60
Test009	Large Box w/Paper	436	5.50	1.75	1.65	1.50	1.45
Test012	Large Box w/Paper	446	5.60	1.80	1.70	1.50	1.45
Test016	Large Box w/Paper	346	5.50	1.75	1.60	1.45	1.40
Test017	Plastic Tarp Draped	7.2	1.00	0.15	0.10	0.05	0.05
Test018	Plastic Tarp Draped	74.3	3.20	0.80	0.75	0.60	0.50
Test019	Plastic Tarp Draped	195	4.35	1.40	1.30	1.15	1.05
Test020	Plastic Tarp Draped	68.9	3.15	0.75	0.70	0.55	0.45
Test021	Welding Blanket Draped	2.2	0.65	0.20	0.20	0.15	0.15
Test022	Welding Blanket Draped	2.1	0.75	0.25	0.20	0.20	0.20
Test023	Welding Blanket Draped	2.3	0.65	0.20	0.15	0.15	0.15
Test024	Mop + Bucket	64.6	3.20	0.90	0.85	0.70	0.55
Test025	Mop + Bucket	113	4.00	1.10	1.05	0.90	0.85
Test027	Blower Duct	8.7	0.95	0.30	0.30	0.25	0.25
Test028	Blower Duct	5.9	1.05	0.30	0.30	0.25	0.25
Test029	Blower Duct	5.1	0.90	0.25	0.25	0.20	0.20
Test030	Water Hose	24.1	2.05	0.65	0.55	0.45	0.30
Test082	Water Hose	1.2	0.70	0.25	0.20	0.20	0.20
Test083	Water Hose	1.7	0.80	0.30	0.25	0.25	0.20

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
Test031	15.2 m Coil 120 V Cord	1.0	0.55	0.20	0.15	0.15	0.15
Test032	15.2 m Coil 120 V Cord	0.7	0.45	0.05	0.15	0.10	0.10
Test033	15.2 m Coil 120 V Cord	0.9	0.30	0.10	0.10	0.10	0.05
Test034	7.6 m Coil 250 V Cord	0.8	0.40	0.05	0.10	0.10	0.10
Test035	7.6 m Coil 250 V Cord	1.2	0.55	0.20	0.20	0.15	0.15
Test036	7.6 m Coil 250 V Cord	1.0	0.45	0.15	0.15	0.15	0.10
Test037	Scissor Stand Quarter	17.2	1.90	0.60	0.60	0.50	0.45
Test040	Scissor Stand Quarter	12.6	1.60	0.50	0.45	0.40	0.30
Test043	Scissor Stand Quarter	21.7	2.00	0.60	0.60	0.50	0.45
Test038	Scissor Stand Half	29.1	2.35	0.80	0.75	0.60	0.55
Test041	Scissor Stand Half	31.4	2.30	0.65	0.60	0.45	0.35
Test044	Scissor Stand Half	59.6	2.95	0.75	0.70	0.60	0.50
Test039	Scissor Stand Full	109	4.00	1.10	1.05	0.90	0.85
Test042	Scissor Stand Full	111	4.05	1.20	1.15	1.00	0.95
Test045	Scissor Stand Full	181	4.90	1.45	1.35	1.20	1.15
Test047	Vacuum Closed	1.3	0.05	0.05	0.05	0.05	0.05
Test048	Vacuum Closed	0.8	0.05	0.05	0.05	0.05	0.05
Test046	Vacuum Open	545	7.35	2.30	2.15	1.90	1.70
Test049	Vacuum Open	520	7.80	2.40	2.30	1.95	1.80
Test050	FR Plastic Tarp Draped	80.3	3.15	0.75	0.70	0.55	0.35
Test051	FR Plastic Tarp Draped	48.7	2.45	0.60	0.50	0.35	0.15
Test052	FR Plastic Tarp Folded	79.8	3.50	1.00	0.95	0.80	0.70
Test053	Canvas Tarp Draped	470	6.80	1.85	1.70	1.50	1.45
Test054	Canvas Tarp Draped	570	5.80	1.70	1.60	1.40	1.30
Test055	Canvas Tarp Folded	12	1.70	0.55	0.55	0.45	0.40
Test056	Alcohol Bottle	211	2.45	0.75	0.70	0.65	0.60
Test060	Alcohol Bottle	144	2.65	0.80	0.75	0.65	0.65
Test061	Alcohol Bottle	143	2.60	0.80	0.75	0.65	0.65
Test062	Oil Bottle	1.7	0.70	0.25	0.20	0.20	0.15
Test063	Oil Bottle	1.7	0.70	0.20	0.20	0.15	0.15

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
Test065	Oil Bottle	2.5	0.85	0.25	0.25	0.20	0.20
Test064	Rags w/Oil	11.3	1.65	0.50	0.45	0.40	0.35
Test066	Rags w/Oil	10.5	1.55	0.45	0.45	0.35	0.35
Test057	Plastic Trash Quarter	292	6.20	2.00	1.90	1.65	1.50
Test067	Plastic Trash Quarter	270	5.95	1.85	1.80	1.55	1.45
Test070	Plastic Trash Quarter	265	5.50	1.80	1.65	1.50	1.35
Test058	Plastic Trash Half	279	5.25	1.90	1.70	1.50	1.30
Test068	Plastic Trash Half	364	6.30	2.10	2.00	1.75	1.60
Test071	Plastic Trash Half	308	6.35	2.00	1.95	1.70	1.60
Test059	Plastic Trash Full	181	5.00	1.70	1.55	1.35	1.15
Test069	Plastic Trash Full	273	6.15	2.00	1.95	1.70	1.50
Test072	Plastic Trash Full	257	5.85	1.90	1.80	1.55	1.40
Test073	Plastic Stanchion	66.8	3.30	1.05	0.95	0.80	0.70
Test074	Plastic Stanchion	47.1	2.85	0.85	0.80	0.65	0.55
Test075	Plastic Stanchion	48.3	2.90	0.85	0.80	0.65	0.55
Test076	15.2 m Coil Chain	1.8	0.75	0.25	0.25	0.20	0.20
Test077	15.2 m Coil Chain	28.6	2.30	0.70	0.65	0.50	0.40
Test078	15.2 m Coil Chain	22.1	1.90	0.50	0.45	0.30	0.15
Test079	15.2 m Coil Large Rope	73.8	3.40	1.15	1.00	0.85	0.65
Test080	15.2 m Coil Large Rope	2.9	0.75	0.25	0.25	0.20	0.20
Test081	15.2 m Coil Large Rope	27	2.35	0.80	0.70	0.60	0.55
Test084	Plastic Chair	203	5.35	1.65	1.55	1.35	1.25
Test085	Plastic Chair	155	4.90	1.60	1.50	1.30	1.20
Test086	Plastic Chair	203	5.40	1.65	1.60	1.35	1.25
Test087	Plank Flame	2.0	0.80	0.25	0.25	0.25	0.20
Test088	Plank Flame	2.0	0.80	0.25	0.25	0.25	0.20
Test089	Plank Flame	1.8	0.75	0.25	0.25	0.20	0.20
Test093	Pallet Flame	2.1	0.85	0.30	0.30	0.25	0.25
Test094	Pallet Flame	2.5	0.85	0.30	0.30	0.25	0.20
Test095	Pallet Panel	1.0	0.60	0.20	0.20	0.15	0.15
Test096	Pallet Panel	0.2	0.05	0.05	0.05	0.05	0.05

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
Test097	Pallet Panel	1.4	0.75	0.25	0.25	0.25	0.20
Test098	Plank Panel	0.7	0.45	0.15	0.15	0.10	0.10
Test099	Plank Panel	1.1	0.60	0.20	0.20	0.20	0.15
Test100	Plank Panel	0.7	0.50	0.15	0.15	0.15	0.15
Test101	Stack PPE	69.7	3.45	1.15	1.10	0.95	0.85
Test103	Stack PPE	118	4.15	1.25	1.20	1.05	0.95
Test102	Laptop + Cart	2683	12.70	4.20	4.00	3.65	3.50
Test0105	Laptop + Cart	2510	14.60	4.80	4.50	4.15	3.95
Test0106	Laptop + Cart	2214	12.50	4.20	3.95	3.60	3.40
07_10_001	Single Rag	3.5	0.90	0.05	0.25	0.20	0.20
07_10_002	Single Rag	4.7	1.10	0.05	0.30	0.25	0.25
07_10_003	Single Rag	2.6	0.85	0.05	0.25	0.20	0.20
07_23_002	Single Rag	2.7	0.75	0.05	0.15	0.15	0.10
07_16_001	Five Rags	7.5	1.30	0.35	0.35	0.25	0.25
07_16_002	Five Rags	8.3	1.35	0.30	0.30	0.25	0.20
07_16_003	Five Rags	14.0	1.80	0.50	0.45	0.40	0.35
07_23_003	Five Rags	10.4	1.55	0.45	0.40	0.35	0.30
07_16_004	Single Rag w/Heptane	9.6	1.55	0.50	0.45	0.40	0.40
07_16_005	Single Rag w/Heptane	10.5	1.60	0.50	0.45	0.40	0.40
07_16_006	Single Rag w/Heptane	9.1	1.60	0.50	0.45	0.40	0.40
07_23_001	Single Rag w/Heptane	11.8	1.50	0.45	0.45	0.40	0.35
07_17_001	Bag of Rags	4.0	0.95	0.25	0.25	0.20	0.15
07_17_002	Bag of Rags	6.0	1.20	0.30	0.30	0.25	0.20
07_17_003	Bag of Rags	2.2	1.20	0.30	0.30	0.25	0.20
07_17_004	Five Rags w/Heptane	34.0	2.40	0.75	0.75	0.65	0.60
07_17_005	Five Rags w/Heptane	41.0	2.70	0.85	0.80	0.70	0.70
07_17_006	Five Rags w/Heptane	30.5	2.35	0.70	0.70	0.60	0.55
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_002	Cardstock Air	5.3	0.30	0.10	0.05	0.05	0.05

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
07_18_003	Cardstock Air	7.7	0.05	0.05	0.05	0.05	0.05
07_18_004	Cardstock Air	1.6	0.55	0.15	0.15	0.10	0.10
07_18_005	Small Binder Closed	1.8	0.65	0.20	0.20	0.15	0.15
07_18_006	Small Binder Open	11.4	1.50	0.30	0.30	0.25	0.20
07_18_007	Small Binder Open	6.0	1.25	0.35	0.35	0.30	0.30
07_18_008	Pad of Paper	1.5	0.50	0.15	0.15	0.10	0.10
07_18_009	Pad of Paper	1.8	0.55	0.10	0.10	0.10	0.10
07_18_010	Pad of Paper	1.3	0.50	0.15	0.10	0.10	0.10
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_012	Large Binder Open	6.9	1.35	0.40	0.40	0.35	0.30
07_18_013	Large Binder Open	3.9	1.00	0.25	0.25	0.25	0.20
07_23_004	Duct Tape Wall	0.3	0.05	0.05	0.05	0.05	0.05
07_23_005	Short Duct Tape Air	0.5	0.05	0.05	0.05	0.05	0.05
07_23_006	Short Duct Tape Air	0.8	0.25	0.10	0.05	0.05	0.05
07_24_001	Bucket w/Debris	7.2	1.35	0.40	0.35	0.35	0.35
07_24_002	Bucket w/Debris	9.5	1.50	0.55	0.50	0.45	0.40
07_24_003	Bucket w/Debris	14.7	1.55	0.60	0.50	0.50	0.40
07_31_001	Empty Bucket	10.5	1.60	0.55	0.50	0.40	0.35
07_31_002	Empty Bucket	30.8	2.50	0.80	0.80	0.70	0.65
07_31_003	Empty Bucket	19.8	2.15	0.70	0.65	0.55	0.50
07_31_004	Empty Bucket	25.6	2.40	0.80	0.75	0.65	0.60
08_01_001	Debris Pile	23.7	1.90	0.45	0.40	0.35	0.30
08_01_002	Debris Pile	13.4	1.90	0.60	0.60	0.55	0.50
08_01_003	Debris Pile	19.1	2.00	0.50	0.45	0.40	0.40
08_01_004	Single Cone	6.0	1.25	0.35	0.35	0.30	0.25
08_01_005	Single Cone	9.5	1.50	0.50	0.50	0.40	0.35
08_01_006	Single Cone	7.8	1.40	0.45	0.45	0.35	0.30
08_02_001	Uncoiled 120 V Cord	1.0	0.50	0.15	0.15	0.15	0.15
08_02_002	3 m Coil 120 V Cord	1.2	0.60	0.20	0.20	0.20	0.15

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
08_03_001	3 m Coil 120 V Cord	1.5	0.70	0.20	0.20	0.20	0.15
08_03_002	3 m Coil 120 V Cord	1.2	0.55	0.05	0.15	0.15	0.15
08_03_003	7.6 m Coil 120 V Cord	1.6	0.60	0.10	0.15	0.10	0.10
08_03_004	7.6 m Coil 120 V Cord	1.4	0.60	0.20	0.15	0.15	0.15
08_03_005	7.6 m Coil 120 V Cord	1.0	0.60	0.20	0.15	0.15	0.15
08_06_001	Medium Box Empty	68.4	2.50	0.80	0.75	0.70	0.65
08_06_002	Medium Box Empty	85.7	2.50	0.80	0.75	0.70	0.65
08_06_003	Medium Box Empty	76.9	2.45	0.80	0.75	0.65	0.65
08_06_004	Medium Box w/Paper	54.6	3.20	0.95	0.90	0.80	0.80
08_06_005	Medium Box w/Paper	73.9	3.05	0.95	0.90	0.80	0.75
08_06_006	Medium Box w/Paper	84.8	3.00	0.95	0.90	0.85	0.80
08_06_007	Medium Box w/Peanuts	134	3.05	1.00	0.95	0.85	0.80
08_06_008	Medium Box w/Peanuts	114	2.90	1.00	0.95	0.85	0.75
08_06_009	Medium Box w/Peanuts	98.0	2.95	0.95	0.90	0.80	0.80
08_07_001	Small Box Empty	28.0	1.90	0.60	0.55	0.50	0.45
08_07_002	Small Box Empty	49.9	1.80	0.60	0.55	0.50	0.45
08_07_003	Small Box Empty	42.9	2.00	0.60	0.60	0.50	0.50
08_07_004	Small Box Empty	46.5	1.90	0.60	0.55	0.50	0.45
08_07_005	Small Box w/Paper	48.3	2.35	0.70	0.65	0.60	0.55
08_07_006	Small Box w/Paper	43.2	2.35	0.70	0.65	0.60	0.55
08_07_007	Small Box w/Paper	50.2	2.30	0.70	0.65	0.60	0.55
08_07_008	Small Box w/Peanuts	51.6	2.15	0.65	0.65	0.55	0.55
08_07_009	Small Box w/Peanuts	57.9	2.05	0.65	0.65	0.55	0.50
08_07_010	Small Box w/Peanuts	71.4	2.05	0.65	0.60	0.55	0.50
08_08_001a	Metal Chair	14.3	1.60	0.35	0.30	0.25	0.20
08_08_001b	Metal Chair	15.5	1.70	0.45	0.40	0.35	0.30
08_08_002a	Metal Chair	13.6	1.70	0.45	0.45	0.40	0.35
08_08_002b	Metal Chair	7.4	1.40	0.45	0.45	0.40	0.35
08_08_003	Metal Chair	23.2	2.20	0.60	0.55	0.50	0.45
08_08_004	First Aid Kit	30.8	1.85	0.60	0.55	0.50	0.45
08_09_001	First Aid Kit	14.8	1.80	0.55	0.50	0.45	0.40

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
08_09_002	First Aid Kit	14.8	1.80	0.55	0.50	0.40	0.40
08_09_003	15.2 m Coil Chain	1.7	0.70	0.30	0.15	0.15	0.15
08_13_002	15.2 m Coil Chain	1.1	0.60	0.20	0.20	0.20	0.15
08_14_002	Four Cones	15.8	1.95	0.70	0.65	0.55	0.50
08_15_001	Four Cones	5.2	1.15	0.35	0.35	0.30	0.30
08_15_002	Four Cones	16.5	1.95	0.65	0.65	0.55	0.50
08_15_003	HVAC Filter	19.3	0.90	0.25	0.25	0.20	0.20
08_15_004	HVAC Filter	20.0	1.00	0.25	0.25	0.20	0.20
08_15_005	HVAC Filter	13.5	0.95	0.25	0.25	0.20	0.15
08_16_001	Uncoiled Small Rope	3.0	0.80	0.25	0.25	0.20	0.20
08_16_002	Uncoiled Small Rope	2.9	0.90	0.25	0.25	0.20	0.20
08_16_003	Uncoiled Small Rope	3.6	0.80	0.25	0.25	0.20	0.20
08_16_004	7.6 m Coil Small Rope	2.8	0.75	0.15	0.15	0.10	0.05
08_20_001	7.6 m Coil Small Rope	4.0	0.90	0.20	0.15	0.10	0.05
08_20_002	7.6 m Coil Small Rope	4.5	1.15	0.35	0.35	0.30	0.25
08_20_003	15.2 m Coil Small Rope	9.5	1.40	0.40	0.35	0.30	0.25
08_20_004	15.2 m Coil Small Rope	13.4	1.75	0.45	0.45	0.35	0.35
08_20_005	15.2 m Coil Small Rope	14.8	1.75	0.45	0.40	0.35	0.30
08_21_001	Uncoiled Large Rope	3.2	0.70	0.20	0.20	0.20	0.15
08_21_002	Uncoiled Large Rope	2.8	0.85	0.25	0.20	0.20	0.20
08_21_003	Uncoiled Large Rope	2.7	0.75	0.25	0.20	0.20	0.15
08_21_005	7.6 m Coil Large Rope	2.4	0.75	0.20	0.20	0.15	0.15
08_21_006	7.6 m Coil Large Rope	57.8	3.35	1.10	1.05	0.90	0.80
08_21_007	7.6 m Coil Large Rope	2.7	0.70	0.20	0.20	0.15	0.15
08_22_001	Duct Tape Roll	20.3	2.25	0.80	0.75	0.65	0.60
08_22_002	Duct Tape Roll	3.4	0.80	0.20	0.20	0.15	0.15
08_22_003	Duct Tape Roll	17.9	2.20	0.85	0.80	0.70	0.65
08_22_005	Single Oil Pad	3.2	0.75	0.20	0.20	0.15	0.15
08_22_006	Single Oil Pad	3.6	0.80	0.25	0.20	0.20	0.20
08_22_007	Single Oil Pad	3.2	0.75	0.20	0.20	0.20	0.15
08_23_001	Four Oil Pads	2.4	0.80	0.20	0.20	0.20	0.15

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
08_23_002	Four Oil Pads	2.3	0.75	0.20	0.20	0.15	0.15
08_23_003	Four Oil Pads	2.8	0.70	0.20	0.20	0.15	0.15
08_23_004	Single Oil Pad w/Oil	2.3	0.65	0.20	0.15	0.15	0.15
08_23_005	Single Oil Pad w/Oil	2.5	0.75	0.20	0.20	0.20	0.15
08_23_006	Single Oil Pad w/Oil	3.3	0.75	0.25	0.25	0.20	0.20
08_23_007	Four Oil Pads w/Oil	3.2	0.75	0.20	0.20	0.15	0.15
08_23_008	Four Oil Pads w/Oil	2.7	0.65	0.20	0.20	0.15	0.15
08_24_001	Lift Slings	17.3	2.15	0.75	0.70	0.65	0.60
08_24_002	Lift Slings	19.2	1.85	0.50	0.45	0.35	0.30
08_24_003	Lift Slings	15.9	1.80	0.45	0.45	0.35	0.30
08_24_004	Uncoiled Chain	1.3	0.45	0.05	0.05	0.05	0.05
08_24_005	Uncoiled Chain	1.1	0.55	0.20	0.15	0.15	0.15
08_24_006	Uncoiled Chain	1.1	0.50	0.15	0.15	0.15	0.15
08_27_001	7.6 m Coil Tubing	1.4	0.70	0.25	0.20	0.20	0.20
08_27_002	7.6 m Coil Tubing	1.2	0.50	0.15	0.15	0.10	0.10
08_27_003	7.6 m Coil Tubing	1.5	0.55	0.10	0.10	0.10	0.10
08_27_004	15.2 m Coil Tubing	1.4	0.55	0.10	0.10	0.10	0.05
08_27_005	15.2 m Coil Tubing	1.7	0.70	0.20	0.20	0.15	0.15
08_28_001	15.2 m Coil Tubing	1.3	0.55	0.15	0.15	0.10	0.10
08_28_002	Uncoiled Tubing	0.8	0.30	0.10	0.10	0.10	0.10
08_28_003	Uncoiled Tubing	0.6	0.05	0.05	0.05	0.05	0.05
08_28_004	Uncoiled Tubing	0.9	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.40	0.15	0.10	0.05	0.10
08_28_005	Welding Blanket Folded	0.6	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.25	0.05	0.05	0.05	0.05
08_28_006	Long Duct Tape Air	1.2	0.60	0.20	0.15	0.20	0.15
08_28_007	Long Duct Tape Air	1.0	0.55	0.20	0.15	0.15	0.15
08_28_008	Long Duct Tape Air	1.5	0.65	0.20	0.20	0.20	0.20
08_29_001	Plastic Tarp Folded	2.9	0.85	0.30	0.30	0.25	0.25
08_29_002	Plastic Tarp Folded	60.2	3.50	1.25	1.20	1.10	1.00
08_29_003	Plastic Tarp Folded	57.4	3.35	1.10	1.05	0.90	0.80

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
08_29_004	Power Spider	1.3	0.70	0.25	0.15	0.20	0.20
08_30_001	Power Spider	5.7	1.10	0.35	0.35	0.30	0.25
08_30_002	Canvas Tarp Folded	2.8	0.90	0.30	0.30	0.25	0.25
08_30_003	Canvas Tarp Folded	3.2	0.95	0.30	0.25	0.25	0.20
08_30_004	Canvas Tarp Folded	2.5	0.85	0.25	0.25	0.20	0.20
08_30_005	Oxy-Acetylene Hose	3.2	0.60	0.20	0.15	0.15	0.15
09_04_001	Oxy-Acetylene Hose	1.7	0.75	0.25	0.25	0.20	0.20
09_04_002	Single PPE	16.8	2.15	0.80	0.75	0.70	0.65
09_04_003	Single PPE	25.9	2.10	0.50	0.45	0.35	0.30
09_04_004	Single PPE	20.3	1.90	0.40	0.40	0.30	0.25
09_05_001	Metal Trash Quarter	95.3	3.10	0.90	0.85	0.75	0.70
09_05_002	Metal Trash Quarter	82.1	2.75	0.80	0.75	0.65	0.60
09_05_003	Metal Trash Quarter	75.5	2.85	0.80	0.75	0.70	0.60
09_05_004	Metal Trash Half	86.9	3.40	0.95	0.90	0.80	0.75
09_05_005	Metal Trash Half	83.4	3.45	0.95	0.90	0.80	0.75
09_05_006	Metal Trash Half	86.5	3.45	0.95	0.90	0.80	0.75
09_05_007	Metal Trash Full	61.0	3.10	0.90	0.85	0.70	0.60
09_06_001	Metal Trash Full	81.1	3.50	1.00	0.95	0.80	0.75
09_06_002	Metal Trash Full	60.9	3.20	0.90	0.85	0.70	0.65
09_06_003	Metal Trash Full Lid	15.7	1.75	0.40	0.35	0.30	0.25
09_06_004	Metal Trash Full Lid	21.2	1.70	0.55	0.50	0.45	0.40
09_07_001	7.6 m Coil Chain	26.1	2.35	0.80	0.75	0.65	0.55
09_07_002	7.6 m Coil Chain	23.9	2.20	0.70	0.65	0.55	0.45
09_10_001	7.6 m Coil Chain	37.2	2.65	0.85	0.80	0.70	0.65
09_10_002	Wood Block Flame	0.9	0.25	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.10	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.45	0.15	0.15	0.15	0.10
09_10_002	Wood Block Flame	0.9	0.40	0.05	0.10	0.10	0.10
09_10_002	Wood Block Flame	0.9	0.45	0.10	0.10	0.10	0.10
09_10_004	Laptop	17.6	1.35	0.50	0.45	0.45	0.40
09_11_001	Laptop	14.8	1.20	0.40	0.35	0.35	0.30

Table D-2
Vertical (Plume Temperature) ZOI Using FDT^S and the Heat Soak Method (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI (m)				
			Sens	TP	K	TS	Tray
09_11_002	Laptop	4.2	1.00	0.30	0.25	0.20	0.15
09_10_003	Wood Block Panel	1.7	0.70	0.25	0.25	0.20	0.15
09_11_003	Wood Block Panel	1.3	0.60	0.25	0.20	0.20	0.15
09_11_004	Wood Block Panel	1.4	0.70	0.30	0.25	0.20	0.20
09_12_001	Tablet	12.6	1.35	0.50	0.50	0.45	0.40
09_12_002	Tablet	16.3	0.90	0.30	0.30	0.25	0.20
09_12_003	Tablet	22.0	1.35	0.40	0.35	0.30	0.30
09_12_004	Tablet + Plastic Case	33.9	2.40	0.80	0.75	0.65	0.60
09_12_005	Tablet + Plastic Case	20.3	1.85	0.60	0.55	0.45	0.35
09_12_006	Tablet + Metal Case	9.1	0.95	0.20	0.15	0.15	0.15
09_19_001	Tool Bag	55.7	3.00	0.85	0.80	0.70	0.60
09_19_002	Tool Bag	50.5	3.00	0.85	0.80	0.65	0.55

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	TP	K	TS	Tray
Test001	Medium Box Empty	137	4.55	1.45	1.40	1.25	1.20
Test002	Medium Box Empty	142	4.30	1.40	1.35	1.20	1.15
Test004	Medium Box Empty	128	4.55	1.50	1.40	1.30	1.20
Test003	Five Rags w/Heptane	42.3	4.00	1.30	1.20	1.10	1.00
Test005	Five Rags w/Heptane	46.4	3.95	1.25	1.15	1.05	1.00
Test006	Five Rags w/Heptane	50.6	4.05	1.35	1.30	1.15	1.10
Test007	Large Box Empty	377	8.45	2.65	2.50	2.25	2.10
Test010	Large Box Empty	536	8.20	2.70	2.55	2.30	2.15
Test014	Large Box Empty	412	8.05	2.55	2.40	2.15	2.05
Test0104	Large Box Empty	455	8.25	2.65	2.50	2.25	2.10
Test008	Large Box w/Peanuts	563	10.35	3.40	3.20	2.85	2.70
Test011	Large Box w/Peanuts	579	10.25	3.35	3.15	2.85	2.65
Test015	Large Box w/Peanuts	579	10.25	3.35	3.15	2.85	2.65
Test009	Large Box w/Paper	436	9.45	3.00	2.80	2.55	2.40

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
Test012	Large Box w/Paper	446	9.70	3.05	2.85	2.55	2.45
Test016	Large Box w/Paper	346	9.50	2.90	2.75	2.45	2.35
Test017	Plastic Tarp Draped	7.2	1.65	0.15	0.15	0.05	0.05
Test018	Plastic Tarp Draped	74.3	5.45	1.25	1.15	0.90	0.65
Test019	Plastic Tarp Draped	195	7.50	2.30	2.15	1.90	1.75
Test020	Plastic Tarp Draped	68.9	5.30	1.20	1.05	0.85	0.60
Test021	Welding Blanket Draped	2.2	1.15	0.35	0.35	0.30	0.30
Test022	Welding Blanket Draped	2.1	1.35	0.45	0.40	0.35	0.35
Test023	Welding Blanket Draped	2.3	1.15	0.30	0.30	0.25	0.25
Test024	Mop + Bucket	64.6	5.45	1.40	1.30	1.05	0.85
Test025	Mop + Bucket	113	6.85	1.80	1.70	1.45	1.35
Test027	Blower Duct	8.7	1.65	0.50	0.50	0.45	0.40
Test028	Blower Duct	5.9	1.80	0.55	0.50	0.45	0.40
Test029	Blower Duct	5.1	1.60	0.45	0.40	0.35	0.35
Test030	Water Hose	24.1	3.45	1.05	0.85	0.65	0.40
Test082	Water Hose	1.2	1.20	0.45	0.40	0.35	0.35
Test083	Water Hose	1.7	1.40	0.50	0.50	0.45	0.40
Test031	15.2 m Coil 120 V Cord	1.0	0.95	0.35	0.30	0.30	0.25
Test032	15.2 m Coil 120 V Cord	0.7	0.80	0.25	0.25	0.20	0.20
Test033	15.2 m Coil 120 V Cord	0.9	0.55	0.20	0.15	0.15	0.15
Test034	7.6 m Coil 250 V Cord	0.8	0.70	0.25	0.25	0.20	0.20
Test035	7.6 m Coil 250 V Cord	1.2	1.00	0.30	0.35	0.30	0.30
Test036	7.6 m Coil 250 V Cord	1.0	0.85	0.30	0.25	0.25	0.25
Test037	Scissor Stand Quarter	17.2	3.30	1.05	1.00	0.85	0.75
Test040	Scissor Stand Quarter	12.6	2.70	0.85	0.80	0.65	0.50
Test043	Scissor Stand Quarter	21.7	3.40	1.05	0.95	0.85	0.75
Test038	Scissor Stand Half	29.1	4.05	1.30	1.20	1.00	0.85
Test041	Scissor Stand Half	31.4	3.90	1.00	0.90	0.70	0.55
Test044	Scissor Stand Half	59.6	4.95	1.20	1.15	0.90	0.75
Test039	Scissor Stand Full	109	6.85	1.80	1.70	1.45	1.30

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
Test042	Scissor Stand Full	111	6.95	2.00	1.90	1.65	1.50
Test045	Scissor Stand Full	181	8.35	2.35	2.20	1.95	1.85
Test047	Vacuum Closed	1.3	0.05	0.05	0.05	0.05	0.05
Test048	Vacuum Closed	0.8	0.05	0.05	0.05	0.05	0.05
Test046	Vacuum Open	545	12.55	3.80	3.60	3.10	2.80
Test049	Vacuum Open	520	13.40	3.95	3.80	3.20	2.90
Test050	FR Plastic Tarp Draped	80.3	5.30	1.15	1.05	0.75	0.45
Test051	FR Plastic Tarp Draped	48.7	4.05	0.85	0.70	0.40	0.15
Test052	FR Plastic Tarp Folded	79.8	6.00	1.65	1.55	1.25	1.05
Test053	Canvas Tarp Draped	470	11.60	2.95	2.70	2.35	2.25
Test054	Canvas Tarp Draped	570	9.90	2.80	2.65	2.30	2.10
Test055	Canvas Tarp Folded	12	2.95	1.00	0.95	0.75	0.65
Test056	Alcohol Bottle	211	4.25	1.30	1.20	1.10	1.00
Test060	Alcohol Bottle	144	4.55	1.35	1.25	1.10	1.05
Test061	Alcohol Bottle	143	4.50	1.35	1.25	1.15	1.10
Test062	Oil Bottle	1.7	1.25	0.40	0.40	0.35	0.30
Test063	Oil Bottle	1.7	1.20	0.40	0.35	0.30	0.25
Test065	Oil Bottle	2.5	1.45	0.50	0.45	0.40	0.35
Test064	Rags w/Oil	11.3	2.85	0.85	0.80	0.65	0.60
Test066	Rags w/Oil	10.5	2.70	0.75	0.75	0.60	0.55
Test057	Plastic Trash Quarter	292	10.65	3.40	3.20	2.80	2.50
Test067	Plastic Trash Quarter	270	10.20	3.15	3.00	2.60	2.40
Test070	Plastic Trash Quarter	265	9.40	3.00	2.75	2.45	2.20
Test058	Plastic Trash Half	279	9.05	3.00	2.85	2.60	2.15
Test068	Plastic Trash Half	364	10.90	3.55	3.30	2.95	2.65
Test071	Plastic Trash Half	308	10.95	3.40	3.25	2.80	2.60
Test059	Plastic Trash Full	181	8.55	2.85	2.60	2.20	1.85
Test069	Plastic Trash Full	273	10.55	3.40	3.25	2.80	2.45
Test072	Plastic Trash Full	257	10.05	3.20	3.05	2.60	2.35
Test073	Plastic Stanchion	66.8	5.70	1.70	1.60	1.30	1.10

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
Test074	Plastic Stanchion	47.1	4.85	1.35	1.25	1.05	0.80
Test075	Plastic Stanchion	48.3	4.90	1.45	1.30	1.05	0.85
Test076	15.2 m Coil Chain	1.8	1.30	0.45	0.45	0.40	0.35
Test077	15.2 m Coil Chain	28.6	3.90	1.15	1.05	0.80	0.60
Test078	15.2 m Coil Chain	22.1	3.15	0.80	0.60	0.40	0.15
Test079	15.2 m Coil Large Rope	73.8	5.80	1.85	1.65	1.35	0.95
Test080	15.2 m Coil Large Rope	2.9	1.35	0.45	0.45	0.35	0.35
Test081	15.2 m Coil Large Rope	27	4.05	1.25	1.15	1.00	0.90
Test084	Plastic Chair	203	9.20	2.70	2.60	2.25	2.05
Test085	Plastic Chair	155	8.45	2.65	2.50	2.15	1.95
Test086	Plastic Chair	203	9.25	2.75	2.65	2.25	2.05
Test087	Plank Flame	2.0	1.35	0.50	0.50	0.45	0.40
Test088	Plank Flame	2.0	1.45	0.50	0.50	0.40	0.40
Test089	Plank Flame	1.8	1.30	0.45	0.45	0.40	0.40
Test093	Pallet Flame	2.1	1.45	0.55	0.50	0.45	0.45
Test094	Pallet Flame	2.5	1.50	0.55	0.50	0.45	0.40
Test095	Pallet Panel	1.0	1.05	0.40	0.35	0.35	0.30
Test096	Pallet Panel	0.2	0.05	0.05	0.05	0.05	0.05
Test097	Pallet Panel	1.4	1.30	0.50	0.45	0.40	0.40
Test098	Plank Panel	0.7	0.80	0.30	0.25	0.20	0.25
Test099	Plank Panel	1.1	1.05	0.40	0.35	0.35	0.30
Test100	Plank Panel	0.7	0.85	0.30	0.30	0.20	0.25
Test101	Stack PPE	69.7	5.95	1.95	1.85	1.60	1.40
Test103	Stack PPE	118	7.15	2.10	1.95	1.70	1.55
Test102	Laptop + Cart	2683	21.95	7.20	6.80	6.15	5.90
Test0105	Laptop + Cart	2510	25.25	8.15	7.65	7.00	6.70
Test0106	Laptop + Cart	2214	21.55	7.15	6.75	6.05	5.70
07_10_001	Single Rag	3.5	1.60	0.45	0.40	0.35	0.30
07_10_002	Single Rag	4.7	1.90	0.50	0.45	0.40	0.40
07_10_003	Single Rag	2.6	1.45	0.40	0.40	0.35	0.30

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
07_23_002	Single Rag	2.7	1.30	0.30	0.25	0.20	0.20
07_16_001	Five Rags	7.5	2.25	0.55	0.55	0.45	0.35
07_16_002	Five Rags	8.3	2.30	0.50	0.45	0.35	0.30
07_16_003	Five Rags	14.0	3.05	0.80	0.75	0.65	0.60
07_23_003	Five Rags	10.4	2.70	0.70	0.65	0.55	0.50
07_16_004	Single Rag w/Heptane	9.6	2.70	0.80	0.75	0.70	0.65
07_16_005	Single Rag w/Heptane	10.5	2.80	0.85	0.80	0.70	0.70
07_16_006	Single Rag w/Heptane	9.1	2.75	0.85	0.80	0.75	0.70
07_23_001	Single Rag w/Heptane	11.8	2.60	0.80	0.75	0.65	0.65
07_17_001	Bag of Rags	4.0	1.65	0.40	0.40	0.30	0.20
07_17_002	Bag of Rags	6.0	2.05	0.55	0.50	0.40	0.30
07_17_003	Bag of Rags	2.2	2.10	0.50	0.50	0.40	0.35
07_17_004	Five Rags w/Heptane	34.0	4.10	1.30	1.25	1.10	1.05
07_17_005	Five Rags w/Heptane	41.0	4.70	1.40	1.30	1.20	1.15
07_17_006	Five Rags w/Heptane	30.5	4.05	1.20	1.15	1.00	0.95
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_001	Cardstock Wall	0.5	0.05	0.05	0.05	0.05	0.05
07_18_002	Cardstock Air	5.3	0.55	0.15	0.15	0.10	0.10
07_18_003	Cardstock Air	7.7	0.05	0.05	0.05	0.05	0.05
07_18_004	Cardstock Air	1.6	1.00	0.25	0.25	0.20	0.20
07_18_005	Small Binder Closed	1.8	1.15	0.30	0.30	0.25	0.25
07_18_006	Small Binder Open	11.4	2.55	0.50	0.50	0.35	0.25
07_18_007	Small Binder Open	6.0	2.15	0.60	0.60	0.50	0.45
07_18_008	Pad of Paper	1.5	0.85	0.25	0.25	0.20	0.20
07_18_009	Pad of Paper	1.8	0.95	0.20	0.15	0.15	0.10
07_18_010	Pad of Paper	1.3	0.85	0.25	0.20	0.20	0.20
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05
07_18_011	Large Binder Closed	0.1	0.05	0.05	0.05	0.05	0.05

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
07_18_012	Large Binder Open	6.9	2.35	0.70	0.65	0.60	0.55
07_18_013	Large Binder Open	3.9	1.70	0.50	0.45	0.40	0.35
07_23_004	Duct Tape Wall	0.3	0.05	0.05	0.05	0.05	0.05
07_23_005	Short Duct Tape Air	0.5	0.05	0.05	0.05	0.05	0.05
07_23_006	Short Duct Tape Air	0.8	0.50	0.15	0.15	0.15	0.15
07_24_001	Bucket w/Debris	7.2	2.35	0.65	0.60	0.55	0.55
07_24_002	Bucket w/Debris	9.5	2.65	0.95	0.90	0.75	0.65
07_24_003	Bucket w/Debris	14.7	2.70	1.05	1.00	0.85	0.70
07_31_001	Empty Bucket	10.5	2.75	0.95	0.85	0.70	0.55
07_31_002	Empty Bucket	30.8	4.30	1.40	1.35	1.15	1.05
07_31_003	Empty Bucket	19.8	3.75	1.20	1.10	0.95	0.85
07_31_004	Empty Bucket	25.6	4.15	1.35	1.30	1.15	1.00
08_01_001	Debris Pile	23.7	3.25	0.70	0.65	0.55	0.50
08_01_002	Debris Pile	13.4	3.30	1.05	1.00	0.90	0.90
08_01_003	Debris Pile	19.1	3.45	0.85	0.75	0.65	0.65
08_01_004	Single Cone	6.0	2.10	0.60	0.55	0.45	0.35
08_01_005	Single Cone	9.5	2.55	0.90	0.85	0.70	0.65
08_01_006	Single Cone	7.8	2.40	0.80	0.75	0.60	0.50
08_02_001	Uncoiled 120 V Cord	1.0	0.90	0.30	0.30	0.25	0.25
08_02_002	3 m Coil 120 V Cord	1.2	1.05	0.35	0.35	0.30	0.30
08_03_001	3 m Coil 120 V Cord	1.5	1.20	0.40	0.35	0.35	0.30
08_03_002	3 m Coil 120 V Cord	1.2	0.95	0.30	0.30	0.25	0.25
08_03_003	7.6 m Coil 120 V Cord	1.6	1.05	0.25	0.20	0.15	0.15
08_03_004	7.6 m Coil 120 V Cord	1.4	1.10	0.30	0.30	0.25	0.25
08_03_005	7.6 m Coil 120 V Cord	1.0	1.05	0.35	0.30	0.30	0.30
08_06_001	Medium Box Empty	68.4	4.35	1.35	1.30	1.15	1.10
08_06_002	Medium Box Empty	85.7	4.30	1.35	1.30	1.15	1.10
08_06_003	Medium Box Empty	76.9	4.25	1.35	1.25	1.15	1.05
08_06_004	Medium Box w/Paper	54.6	5.45	1.60	1.50	1.35	1.30
08_06_005	Medium Box w/Paper	73.9	5.25	1.60	1.50	1.35	1.30

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
08_06_006	Medium Box w/Paper	84.8	5.20	1.65	1.55	1.40	1.30
08_06_007	Medium Box w/Peanuts	134	5.30	1.75	1.65	1.45	1.40
08_06_008	Medium Box w/Peanuts	114	5.05	1.65	1.60	1.40	1.30
08_06_009	Medium Box w/Peanuts	98.0	5.15	1.65	1.55	1.40	1.30
08_07_001	Small Box Empty	28.0	3.30	0.95	0.90	0.80	0.70
08_07_002	Small Box Empty	49.9	3.10	1.00	0.95	0.80	0.75
08_07_003	Small Box Empty	42.9	3.45	1.05	1.00	0.85	0.80
08_07_004	Small Box Empty	46.5	3.25	1.00	0.95	0.85	0.80
08_07_005	Small Box w/Paper	48.3	4.00	1.20	1.10	1.00	0.95
08_07_006	Small Box w/Paper	43.2	4.05	1.20	1.10	1.00	0.95
08_07_007	Small Box w/Paper	50.2	4.00	1.20	1.10	1.00	0.95
08_07_008	Small Box w/Peanuts	51.6	3.75	1.15	1.05	0.95	0.90
08_07_009	Small Box w/Peanuts	57.9	3.55	1.10	1.05	0.95	0.85
08_07_010	Small Box w/Peanuts	71.4	3.50	1.10	1.05	0.95	0.90
08_08_001a	Metal Chair	14.3	2.70	0.55	0.50	0.40	0.30
08_08_001b	Metal Chair	15.5	2.90	0.70	0.65	0.55	0.45
08_08_002a	Metal Chair	13.6	2.95	0.75	0.70	0.60	0.60
08_08_002b	Metal Chair	7.4	2.40	0.80	0.75	0.65	0.60
08_08_003	Metal Chair	23.2	3.80	1.00	0.95	0.80	0.75
08_08_004	First Aid Kit	30.8	3.20	1.05	0.95	0.80	0.75
08_09_001	First Aid Kit	14.8	3.10	0.90	0.85	0.70	0.60
08_09_002	First Aid Kit	14.8	3.05	0.95	0.85	0.70	0.60
08_09_003	15.2 m Coil Chain	1.7	1.20	0.40	0.30	0.25	0.25
08_13_002	15.2 m Coil Chain	1.1	1.05	0.35	0.35	0.35	0.30
08_14_002	Four Cones	15.8	3.35	1.15	1.10	0.95	0.85
08_15_001	Four Cones	5.2	2.00	0.65	0.60	0.55	0.50
08_15_002	Four Cones	16.5	3.35	1.15	1.10	0.95	0.85
08_15_003	HVAC Filter	19.3	1.60	0.45	0.40	0.35	0.35
08_15_004	HVAC Filter	20.0	1.70	0.45	0.40	0.35	0.30
08_15_005	HVAC Filter	13.5	1.60	0.40	0.35	0.30	0.25

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
08_16_001	Uncoiled Small Rope	3.0	1.40	0.40	0.40	0.35	0.30
08_16_002	Uncoiled Small Rope	2.9	1.55	0.45	0.40	0.35	0.35
08_16_003	Uncoiled Small Rope	3.6	1.40	0.45	0.40	0.35	0.30
08_16_004	7.6 m Coil Small Rope	2.8	1.25	0.20	0.20	0.10	0.05
08_20_001	7.6 m Coil Small Rope	4.0	1.50	0.30	0.25	0.15	0.05
08_20_002	7.6 m Coil Small Rope	4.5	2.00	0.60	0.60	0.50	0.45
08_20_003	15.2 m Coil Small Rope	9.5	2.40	0.60	0.55	0.45	0.35
08_20_004	15.2 m Coil Small Rope	13.4	2.95	0.75	0.75	0.60	0.55
08_20_005	15.2 m Coil Small Rope	14.8	3.00	0.70	0.70	0.55	0.50
08_21_001	Uncoiled Large Rope	3.2	1.25	0.35	0.35	0.30	0.30
08_21_002	Uncoiled Large Rope	2.8	1.45	0.40	0.40	0.35	0.30
08_21_003	Uncoiled Large Rope	2.7	1.30	0.40	0.35	0.30	0.30
08_21_005	7.6 m Coil Large Rope	2.4	1.30	0.35	0.35	0.30	0.30
08_21_006	7.6 m Coil Large Rope	57.8	5.70	1.85	1.75	1.50	1.30
08_21_007	7.6 m Coil Large Rope	2.7	1.25	0.35	0.35	0.30	0.30
08_22_001	Duct Tape Roll	20.3	3.90	1.40	1.30	1.15	1.00
08_22_002	Duct Tape Roll	3.4	1.35	0.35	0.35	0.30	0.25
08_22_003	Duct Tape Roll	17.9	3.85	1.50	1.40	1.25	1.10
08_22_005	Single Oil Pad	3.2	1.30	0.35	0.30	0.30	0.25
08_22_006	Single Oil Pad	3.6	1.35	0.40	0.40	0.35	0.30
08_22_007	Single Oil Pad	3.2	1.30	0.40	0.35	0.30	0.30
08_23_001	Four Oil Pads	2.4	1.35	0.40	0.35	0.30	0.30
08_23_002	Four Oil Pads	2.3	1.30	0.35	0.35	0.30	0.30
08_23_003	Four Oil Pads	2.8	1.20	0.35	0.35	0.30	0.25
08_23_004	Single Oil Pad w/Oil	2.3	1.15	0.35	0.30	0.25	0.25
08_23_005	Single Oil Pad w/Oil	2.5	1.35	0.35	0.35	0.30	0.30
08_23_006	Single Oil Pad w/Oil	3.3	1.35	0.40	0.40	0.35	0.30
08_23_007	Four Oil Pads w/Oil	3.2	1.30	0.35	0.35	0.30	0.30
08_23_008	Four Oil Pads w/Oil	2.7	1.15	0.35	0.35	0.25	0.25
08_24_001	Lift Slings	17.3	3.70	1.25	1.25	1.10	1.00

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
08_24_002	Lift Slings	19.2	3.20	0.75	0.75	0.60	0.50
08_24_003	Lift Slings	15.9	3.10	0.75	0.70	0.55	0.45
08_24_004	Uncoiled Chain	1.3	0.70	0.05	0.05	0.05	0.05
08_24_005	Uncoiled Chain	1.1	0.95	0.35	0.30	0.30	0.25
08_24_006	Uncoiled Chain	1.1	0.85	0.30	0.30	0.25	0.25
08_27_001	7.6 m Coil Tubing	1.4	1.20	0.40	0.35	0.35	0.35
08_27_002	7.6 m Coil Tubing	1.2	0.85	0.25	0.25	0.20	0.20
08_27_003	7.6 m Coil Tubing	1.5	0.95	0.20	0.20	0.15	0.10
08_27_004	15.2 m Coil Tubing	1.4	0.95	0.20	0.20	0.15	0.10
08_27_005	15.2 m Coil Tubing	1.7	1.20	0.30	0.30	0.25	0.25
08_28_001	15.2 m Coil Tubing	1.3	1.00	0.25	0.20	0.15	0.15
08_28_002	Uncoiled Tubing	0.8	0.60	0.20	0.20	0.15	0.15
08_28_003	Uncoiled Tubing	0.6	0.05	0.05	0.05	0.05	0.05
08_28_004	Uncoiled Tubing	0.9	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.70	0.20	0.20	0.20	0.15
08_28_005	Welding Blanket Folded	0.6	0.05	0.05	0.05	0.05	0.05
08_28_005	Welding Blanket Folded	0.6	0.50	0.15	0.15	0.15	0.15
08_28_006	Long Duct Tape Air	1.2	1.10	0.40	0.35	0.30	0.30
08_28_007	Long Duct Tape Air	1.0	1.00	0.30	0.30	0.30	0.25
08_28_008	Long Duct Tape Air	1.5	1.15	0.40	0.40	0.35	0.30
08_29_001	Plastic Tarp Folded	2.9	1.55	0.50	0.50	0.45	0.45
08_29_002	Plastic Tarp Folded	60.2	6.05	2.15	2.05	1.85	1.75
08_29_003	Plastic Tarp Folded	57.4	5.80	1.85	1.75	1.50	1.35
08_29_004	Power Spider	1.3	1.20	0.40	0.40	0.35	0.35
08_30_001	Power Spider	5.7	1.90	0.60	0.55	0.50	0.45
08_30_002	Canvas Tarp Folded	2.8	1.60	0.55	0.50	0.45	0.45
08_30_003	Canvas Tarp Folded	3.2	1.65	0.50	0.45	0.40	0.35
08_30_004	Canvas Tarp Folded	2.5	1.50	0.40	0.40	0.35	0.30
08_30_005	Oxy-Acetylene Hose	3.2	1.05	0.30	0.30	0.25	0.25
09_04_001	Oxy-Acetylene Hose	1.7	1.30	0.45	0.45	0.40	0.35

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
09_04_002	Single PPE	16.8	3.70	1.35	1.30	1.20	1.15
09_04_003	Single PPE	25.9	3.50	0.75	0.70	0.55	0.40
09_04_004	Single PPE	20.3	3.20	0.65	0.60	0.45	0.30
09_05_001	Metal Trash Quarter	95.3	5.30	1.55	1.45	1.30	1.20
09_05_002	Metal Trash Quarter	82.1	4.70	1.30	1.25	1.10	1.00
09_05_003	Metal Trash Quarter	75.5	4.90	1.35	1.25	1.10	1.00
09_05_004	Metal Trash Half	86.9	5.80	1.60	1.50	1.30	1.20
09_05_005	Metal Trash Half	83.4	5.95	1.55	1.45	1.25	1.20
09_05_006	Metal Trash Half	86.5	5.90	1.60	1.45	1.30	1.20
09_05_007	Metal Trash Full	61.0	5.25	1.45	1.35	1.15	1.00
09_06_001	Metal Trash Full	81.1	6.05	1.60	1.55	1.30	1.20
09_06_002	Metal Trash Full	60.9	5.45	1.45	1.35	1.15	1.00
09_06_003	Metal Trash Full Lid	15.7	2.95	0.65	0.55	0.45	0.35
09_06_004	Metal Trash Full Lid	21.2	2.90	0.90	0.85	0.75	0.65
09_07_001	7.6 m Coil Chain	26.1	4.05	1.40	1.25	1.05	0.90
09_07_002	7.6 m Coil Chain	23.9	3.80	1.15	1.05	0.90	0.70
09_10_001	7.6 m Coil Chain	37.2	4.60	1.40	1.35	1.15	1.05
09_10_002	Wood Block Flame	0.9	0.35	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.20	0.05	0.05	0.05	0.05
09_10_002	Wood Block Flame	0.9	0.85	0.25	0.25	0.25	0.20
09_10_002	Wood Block Flame	0.9	0.70	0.25	0.20	0.20	0.20
09_10_002	Wood Block Flame	0.9	0.80	0.25	0.25	0.20	0.20
09_10_004	Laptop	17.6	2.35	0.90	0.85	0.75	0.70
09_11_001	Laptop	14.8	2.05	0.70	0.65	0.55	0.50
09_11_002	Laptop	4.2	1.75	0.50	0.45	0.35	0.25
09_10_003	Wood Block Panel	1.7	1.25	0.45	0.40	0.35	0.25
09_11_003	Wood Block Panel	1.3	1.10	0.35	0.40	0.35	0.30
09_11_004	Wood Block Panel	1.4	1.25	0.45	0.45	0.40	0.35
09_12_001	Tablet	12.6	2.35	0.95	0.85	0.80	0.70
09_12_002	Tablet	16.3	1.55	0.55	0.50	0.45	0.35

Table D-3
Vertical (Plume Temperature) ZOI Using FDT^S and Heat Soak Method for Fires in a Corner (continued)

Test ID	Item	Peak HRR (kW)	Vertical ZOI in a Corner (m)				
			Sens	**TP**	**K**	**TS**	**Tray**
09_12_003	Tablet	22.0	2.30	0.65	0.60	0.55	0.55
09_12_004	Tablet + Plastic Case	33.9	4.15	1.35	1.25	1.10	1.00
09_12_005	Tablet + Plastic Case	20.3	3.15	0.95	0.90	0.70	0.55
09_12_006	Tablet + Metal Case	9.1	1.60	0.30	0.25	0.20	0.20
09_19_001	Tool Bag	55.7	5.1	1.45	1.3	1.1	0.9
09_19_002	Tool Bag	50.5	5.1	1.4	1.3	1.05	0.85

APPENDIX E
SUMMARY OF FIRE GROWTH PARAMETERS

Table E-1 summarizes the fire growth and decay parameters. These parameters were computed based on the procedure in Section 5.8 of the main report. The parameters are the growth time, the growth exponent, the plateau length, the decay time, and the decay exponent. ND (Not Determined) values in the table indicate the fire was too small to develop a meaningful set of parameters.

Table E-1
Fire Growth and Decay Parameters

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
Test001	Medium Box Empty	115	3.09	3	365	0.14
Test002	Medium Box Empty	93	3.44	4	418	0.37
Test004	Medium Box Empty	104	4.09	4	324	0.24
Test003	Five Rags w/Heptane	8	1.36	16	1175	0.24
Test005	Five Rags w/Heptane	6	0.67	3	1522	0.23
Test006	Five Rags w/Heptane	7	1.32	2	1234	0.24
Test007	Large Box Empty	194	4.16	6	320	0.60
Test010	Large Box Empty	183	4.89	5	211	0.52
Test014	Large Box Empty	225	4.89	3	290	0.44
Test0104	Large Box Empty	238	5.81	7	259	0.41
Test008	Large Box w/Peanuts	153	5.31	3	292	0.62
Test011	Large Box w/Peanuts	162	6.69	16	292	0.49
Test015	Large Box w/Peanuts	166	4.26	4	406	0.49
Test009	Large Box w/Paper	91	4.32	3	709	0.28
Test012	Large Box w/Paper	86	4.30	4	684	0.29
Test016	Large Box w/Paper	142	4.67	4	645	0.33
Test017	Plastic Tarp Draped	446	0.40	28	1222	0.35
Test018	Plastic Tarp Draped	1061	3.07	59	823	0.50
Test019	Plastic Tarp Draped	753	9.72	4	699	0.34
Test020	Plastic Tarp Draped	489	2.54	147	823	0.47
Test021	Welding Blanket Draped	ND	ND	ND	ND	ND

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
Test022	Welding Blanket Draped	ND	ND	ND	ND	ND
Test023	Welding Blanket Draped	ND	ND	ND	ND	ND
Test024	Mop + Bucket	695	1.20	76	939	0.59
Test025	Mop + Bucket	494	2.93	33	1021	0.38
Test027	Blower Duct	93	1.98	3	339	0.17
Test028	Blower Duct	61	1.49	18	308	0.36
Test029	Blower Duct	52	6.11	3	335	0.46
Test030	Water Hose	2653	2.24	474	990	0.44
Test082	Water Hose	ND	ND	ND	ND	ND
Test083	Water Hose	ND	ND	ND	ND	ND
Test031	15.2 m Coil 120 V Cord	ND	ND	ND	ND	ND
Test032	15.2 m Coil 120 V Cord	ND	ND	ND	ND	ND
Test033	15.2 m Coil 120 V Cord	ND	ND	ND	ND	ND
Test034	7.6 m Coil 250 V Cord	ND	ND	ND	ND	ND
Test035	7.6 m Coil 250 V Cord	ND	ND	ND	ND	ND
Test036	7.6 m Coil 250 V Cord	ND	ND	ND	ND	ND
Test037	Scissor Stand Quarter	148	1.16	170	1804	0.32
Test040	Scissor Stand Quarter	290	0.82	821	843	0.17
Test043	Scissor Stand Quarter	72	5.26	68	1632	0.21
Test038	Scissor Stand Half	176	1.49	940	960	0.42
Test041	Scissor Stand Half	219	1.52	675	1074	0.45
Test044	Scissor Stand Half	562	0.94	7	859	0.47
Test039	Scissor Stand Full	627	1.78	49	1243	0.31
Test042	Scissor Stand Full	608	2.12	69	1270	0.28
Test045	Scissor Stand Full	468	2.65	46	1004	0.34
Test047	Vacuum Closed	ND	ND	ND	ND	ND
Test048	Vacuum Closed	ND	ND	ND	ND	ND
Test046	Vacuum Open	432	4.07	257	3146	0.17
Test049	Vacuum Open	482	4.84	164	3110	0.28
Test050	FR Plastic Tarp Draped	1042	4.26	300	1073	0.35
Test051	FR Plastic Tarp Draped	1352	1.18	463	1289	0.41

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
Test052	FR Plastic Tarp Folded	1031	2.99	31	2476	0.38
Test053	Canvas Tarp Draped	255	3.89	41	516	0.25
Test054	Canvas Tarp Draped	354	4.05	5	359	0.36
Test055	Canvas Tarp Folded	852	0.75	102	2809	0.33
Test056	Alcohol Bottle	259	18.58	4	1073	0.08
Test060	Alcohol Bottle	519	28.79	2	1284	0.11
Test061	Alcohol Bottle	309	60.23	2	1058	0.14
Test062	Oil Bottle	ND	ND	ND	ND	ND
Test063	Oil Bottle	ND	ND	ND	ND	ND
Test065	Oil Bottle	ND	ND	ND	ND	ND
Test064	Rags w/Oil	348	1.34	134	1919	0.32
Test066	Rags w/Oil	387	1.84	30	2690	0.32
Test057	Plastic Trash Quarter	647	5.07	509	1025	0.31
Test067	Plastic Trash Quarter	986	3.88	136	1442	0.34
Test070	Plastic Trash Quarter	1476	2.36	4	1594	0.26
Test058	Plastic Trash Half	930	2.36	4	1675	0.22
Test068	Plastic Trash Half	998	4.29	20	1327	0.30
Test071	Plastic Trash Half	802	2.75	140	1464	0.34
Test059	Plastic Trash Full	1703	0.65	23	1059	0.42
Test069	Plastic Trash Full	664	1.21	278	1843	0.18
Test072	Plastic Trash Full	705	1.41	226	2216	0.22
Test073	Plastic Stanchion	1263	4.65	319	764	0.57
Test074	Plastic Stanchion	996	5.11	586	1961	0.13
Test075	Plastic Stanchion	2263	3.46	116	1375	0.43
Test076	15.2 m Coil Chain	ND	ND	ND	ND	ND
Test077	15.2 m Coil Chain	1916	1.94	270	1329	0.47
Test078	15.2 m Coil Chain	2511	1.96	37	1503	0.73
Test079	15.2 m Coil Large Rope	1818	1.67	497	1111	0.33
Test080	15.2 m Coil Large Rope	ND	ND	ND	ND	ND
Test081	15.2 m Coil Large Rope	1178	1.99	19	2877	0.31
Test084	Plastic Chair	741	6.41	86	2331	0.35

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
Test085	Plastic Chair	2333	13.96	173	1588	0.37
Test086	Plastic Chair	839	7.01	110	2045	0.31
Test087	Plank Flame	ND	ND	ND	ND	ND
Test088	Plank Flame	ND	ND	ND	ND	ND
Test089	Plank Flame	ND	ND	ND	ND	ND
Test093	Pallet Flame	ND	ND	ND	ND	ND
Test094	Pallet Flame	ND	ND	ND	ND	ND
Test095	Pallet Panel	ND	ND	ND	ND	ND
Test096	Pallet Panel	ND	ND	ND	ND	ND
Test097	Pallet Panel	ND	ND	ND	ND	ND
Test098	Plank Panel	ND	ND	ND	ND	ND
Test099	Plank Panel	ND	ND	ND	ND	ND
Test100	Plank Panel	ND	ND	ND	ND	ND
Test101	Stack PPE	506	2.19	65	1915	0.52
Test103	Stack PPE	1020	2.85	20	1288	0.27
Test102	Laptop + Cart	1197	17.66	5	4619	0.12
Test0105	Laptop + Cart	866	10.68	54	4064	0.10
Test0106	Laptop + Cart	1318	22.83	11	5030	0.18
07_10_001	Single Rag	261	0.87	11	384	0.35
07_10_002	Single Rag	149	2.60	37	426	0.47
07_10_003	Single Rag	179	3.42	153	543	0.34
07_23_002	Single Rag	195	1.33	42	438	0.33
07_16_001	Five Rags	229	0.87	84	1132	0.36
07_16_002	Five Rags	176	1.06	140	806	0.37
07_16_003	Five Rags	226	2.77	88	396	0.33
07_23_003	Five Rags	260	0.99	81	478	0.36
07_16_004	Single Rag w/Heptane	14	1.58	56	462	0.38
07_16_005	Single Rag w/Heptane	21	0.74	56	541	0.31
07_16_006	Single Rag w/Heptane	21	1.24	55	496	0.36
07_23_001	Single Rag w/Heptane	10	0.95	4	577	0.42
07_17_001	Bag of Rags	748	5.39	494	627	0.14

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
07_17_002	Bag of Rags	494	1.41	132	846	0.44
07_17_003	Bag of Rags	748	2.13	92	756	0.23
07_17_004	Five Rags w/Heptane	11	1.20	10	1019	0.36
07_17_005	Five Rags w/Heptane	14	0.84	22	552	0.46
07_17_006	Five Rags w/Heptane	10	0.96	27	957	0.36
07_18_001	Cardstock Wall	ND	ND	ND	ND	ND
07_18_001	Cardstock Wall	ND	ND	ND	ND	ND
07_18_001	Cardstock Wall	ND	ND	ND	ND	ND
07_18_002	Cardstock Air	51	3.70	24	7	0.66
07_18_003	Cardstock Air	24	7.65	26	3	0.11
07_18_004	Cardstock Air	62	0.92	67	328	0.04
07_18_005	Small Binder Closed	331	1.07	404	93	0.04
07_18_006	Small Binder Open	107	1.90	254	389	0.22
07_18_007	Small Binder Open	179	3.08	71	403	0.31
07_18_008	Pad of Paper	ND	ND	ND	ND	ND
07_18_009	Pad of Paper	ND	ND	ND	ND	ND
07_18_010	Pad of Paper	ND	ND	ND	ND	ND
07_18_011	Large Binder Closed	ND	ND	ND	ND	ND
07_18_011	Large Binder Closed	ND	ND	ND	ND	ND
07_18_011	Large Binder Closed	ND	ND	ND	ND	ND
07_18_012	Large Binder Open	71	3.22	146	665	0.26
07_18_013	Large Binder Open	87	0.20	173	494	0.05
07_23_004	Duct Tape Wall	ND	ND	ND	ND	ND
07_23_005	Short Duct Tape Air	ND	ND	ND	ND	ND
07_23_006	Short Duct Tape Air	ND	ND	ND	ND	ND
07_24_001	Bucket w/Debris	11	1.08	59	229	0.24
07_24_002	Bucket w/Debris	17	0.93	546	4304	0.68
07_24_003	Bucket w/Debris	24	1.02	1	2917	0.39
07_31_001	Empty Bucket	422	0.92	1011	1182	0.48
07_31_002	Empty Bucket	1102	0.94	14	553	0.50
07_31_003	Empty Bucket	1050	1.02	81	713	0.34

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
07_31_004	Empty Bucket	997	1.54	112	406	0.50
08_01_001	Debris Pile	70	1.17	32	1197	0.19
08_01_002	Debris Pile	189	0.62	73	721	0.40
08_01_003	Debris Pile	75	1.09	51	517	0.42
08_01_004	Single Cone	684	1.08	136	1254	0.43
08_01_005	Single Cone	262	13.83	23	1626	0.28
08_01_006	Single Cone	231	9.07	748	863	0.57
08_02_001	Uncoiled 120V Cord	ND	ND	ND	ND	ND
08_02_002	3 m Coil 120 V Cord	ND	ND	ND	ND	ND
08_03_001	3 m Coil 120 V Cord	ND	ND	ND	ND	ND
08_03_002	3 m Coil 120 V Cord	ND	ND	ND	ND	ND
08_03_003	7.6 m Coil 120 V Cord	ND	ND	ND	ND	ND
08_03_004	7.6 m Coil 120 V Cord	ND	ND	ND	ND	ND
08_03_005	7.6 m Coil 120 V Cord	ND	ND	ND	ND	ND
08_06_001	Medium Box Empty	106	3.19	19	83	0.48
08_06_002	Medium Box Empty	102	3.68	4	110	0.62
08_06_003	Medium Box Empty	100	2.37	2	159	0.58
08_06_004	Medium Box w/Paper	71	3.05	51	120	0.69
08_06_005	Medium Box w/Paper	98	3.11	4	178	0.75
08_06_006	Medium Box w/Paper	81	4.73	7	141	0.66
08_06_007	Medium Box w/Peanuts	92	5.73	3	89	0.69
08_06_008	Medium Box w/Peanuts	105	3.72	3	99	0.64
08_06_009	Medium Box w/Peanuts	111	2.35	11	97	0.45
08_07_001	Small Box Empty	149	1.40	7	74	0.66
08_07_002	Small Box Empty	129	3.61	6	65	0.63
08_07_003	Small Box Empty	103	2.43	5	64	0.78
08_07_004	Small Box Empty	143	3.21	4	56	0.64
08_07_005	Small Box w/Paper	74	2.62	4	78	0.65
08_07_006	Small Box w/Paper	53	2.25	6	81	0.67
08_07_007	Small Box w/Paper	93	2.54	5	83	0.62
08_07_008	Small Box w/Peanuts	109	3.67	5	68	0.64

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
08_07_009	Small Box w/Peanuts	96	2.81	4	72	0.56
08_07_010	Small Box w/Peanuts	98	4.73	5	99	0.46
08_08_001a	Metal Chair	814	5.01	88	481	0.23
08_08_001b	Metal Chair	524	1.33	40	1050	0.42
08_08_002a	Metal Chair	218	4.65	55	502	0.39
08_08_002b	Metal Chair	113	2.13	352	1014	0.37
08_08_003	Metal Chair	144	3.73	62	997	0.35
08_08_004	First Aid Kit	268	4.22	5	2520	0.13
08_09_001	First Aid Kit	482	6.80	128	3359	0.32
08_09_002	First Aid Kit	1296	13.30	1	2825	0.50
08_09_003	15.2 m Coil Chain	ND	ND	ND	ND	ND
08_13_002	15.2 m Coil Chain	ND	ND	ND	ND	ND
08_14_002	Four Cones	1540	3.06	16	3844	0.33
08_15_001	Four Cones	1169	3.79	21	2136	0.15
08_15_002	Four Cones	1406	4.81	27	3807	0.31
08_15_003	HVAC Filter	22	2.58	6	265	0.26
08_15_004	HVAC Filter	29	2.71	7	909	0.11
08_15_005	HVAC Filter	55	2.46	11	395	0.22
08_16_001	Uncoiled Small Rope	30	1.68	28	473	0.25
08_16_002	Uncoiled Small Rope	40	1.30	48	182	0.28
08_16_003	Uncoiled Small Rope	28	2.42	34	699	0.19
08_16_004	7.6 m Coil Small Rope	57	0.54	875	357	0.43
08_20_001	7.6 m Coil Small Rope	58	0.63	557	575	0.93
08_20_002	7.6 m Coil Small Rope	529	0.28	243	208	0.38
08_20_003	15.2 m Coil Small Rope	1000	0.69	67	385	0.47
08_20_004	15.2 m Coil Small Rope	691	1.49	62	301	0.49
08_20_005	15.2 m Coil Small Rope	551	1.87	55	303	0.59
08_21_001	Uncoiled Large Rope	ND	ND	ND	ND	ND
08_21_002	Uncoiled Large Rope	ND	ND	ND	ND	ND
08_21_003	Uncoiled Large Rope	ND	ND	ND	ND	ND
08_21_005	7.6 m Coil Large Rope	ND	ND	ND	ND	ND

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
08_21_006	7.6 m Coil Large Rope	2400	2.55	70	450	0.43
08_21_007	7.6 m Coil Large Rope	ND	ND	ND	ND	ND
08_22_001	Duct Tape Roll	1422	4.38	110	996	0.48
08_22_002	Duct Tape Roll	ND	ND	ND	ND	ND
08_22_003	Duct Tape Roll	1303	2.20	102	982	0.59
08_22_005	Single Oil Pad	ND	ND	ND	ND	ND
08_22_006	Single Oil Pad	ND	ND	ND	ND	ND
08_22_007	Single Oil Pad	ND	ND	ND	ND	ND
08_23_001	Four Oil Pads	ND	ND	ND	ND	ND
08_23_002	Four Oil Pads	ND	ND	ND	ND	ND
08_23_003	Four Oil Pads	ND	ND	ND	ND	ND
08_23_004	Single Oil Pad w/Oil	ND	ND	ND	ND	ND
08_23_005	Single Oil Pad w/Oil	ND	ND	ND	ND	ND
08_23_006	Single Oil Pad w/Oil	ND	ND	ND	ND	ND
08_23_007	Four Oil Pads w/Oil	ND	ND	ND	ND	ND
08_23_008	Four Oil Pads w/Oil	ND	ND	ND	ND	ND
08_24_001	Lift Slings	421	1.72	231	1195	0.37
08_24_002	Lift Slings	264	1.18	31	1073	0.49
08_24_003	Lift Slings	445	0.87	137	484	0.35
08_24_004	Uncoiled Chain	ND	ND	ND	ND	ND
08_24_005	Uncoiled Chain	ND	ND	ND	ND	ND
08_24_006	Uncoiled Chain	ND	ND	ND	ND	ND
08_27_001	7.6 m Coil Tubing	ND	ND	ND	ND	ND
08_27_002	7.6 m Coil Tubing	ND	ND	ND	ND	ND
08_27_003	7.6 m Coil Tubing	ND	ND	ND	ND	ND
08_27_004	15.2 m Coil Tubing	ND	ND	ND	ND	ND
08_27_005	15.2 m Coil Tubing	ND	ND	ND	ND	ND
08_28_001	15.2 m Coil Tubing	ND	ND	ND	ND	ND
08_28_002	Uncoiled Tubing	ND	ND	ND	ND	ND
08_28_003	Uncoiled Tubing	ND	ND	ND	ND	ND
08_28_004	Uncoiled Tubing	ND	ND	ND	ND	ND

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
08_28_005	Welding Blanket Folded	ND	ND	ND	ND	ND
08_28_005	Welding Blanket Folded	ND	ND	ND	ND	ND
08_28_005	Welding Blanket Folded	ND	ND	ND	ND	ND
08_28_006	Long Duct Tape Air	ND	ND	ND	ND	ND
08_28_007	Long Duct Tape Air	ND	ND	ND	ND	ND
08_28_008	Long Duct Tape Air	ND	ND	ND	ND	ND
08_29_001	Plastic Tarp Folded	ND	ND	ND	ND	ND
08_29_002	Plastic Tarp Folded	2021	6.60	51	1827	0.30
08_29_003	Plastic Tarp Folded	1511	3.57	72	1540	0.34
08_29_004	Power Spider	ND	ND	ND	ND	ND
08_30_001	Power Spider	ND	ND	ND	ND	ND
08_30_002	Canvas Tarp Folded	34	1.85	40	291	0.36
08_30_003	Canvas Tarp Folded	44	3.19	51	384	0.28
08_30_004	Canvas Tarp Folded	92	0.91	75	209	0.29
08_30_005	Oxy-Acetylene Hose	513	21.80	3	25	0.37
09_04_001	Oxy-Acetylene Hose	ND	ND	ND	ND	ND
09_04_002	Single PPE	518	0.73	54	1863	0.38
09_04_003	Single PPE	306	0.93	31	1126	0.42
09_04_004	Single PPE	450	1.14	160	811	0.43
09_05_001	Metal Trash Quarter	85	3.00	6	416	0.36
09_05_002	Metal Trash Quarter	60	3.10	9	607	0.30
09_05_003	Metal Trash Quarter	68	2.20	11	409	0.39
09_05_004	Metal Trash Half	69	3.56	39	608	0.33
09_05_005	Metal Trash Half	53	2.46	56	655	0.29
09_05_006	Metal Trash Half	79	2.24	28	462	0.39
09_05_007	Metal Trash Full	72	1.18	205	1243	0.34
09_06_001	Metal Trash Full	167	1.38	104	1194	0.30
09_06_002	Metal Trash Full	41	4.02	353	1118	0.31
09_06_003	Metal Trash Full Lid	32	2.86	193	1971	0.42
09_06_004	Metal Trash Full Lid	35	3.03	7	473	0.42
09_07_001	7.6 m Coil Chain	4123	8.37	31	754	0.54

Table E-1
Fire Growth and Decay Parameters (continued)

Test ID	Item	Growth Time (s)	Growth Exponent	Plateau Length (s)	Decay Time (s)	Decay Exponent
09_07_002	7.6 m Coil Chain	2643	5.18	262	978	0.36
09_10_001	7.6 m Coil Chain	2507	7.98	169	729	0.23
09_10_002	Wood Block Flame	ND	ND	ND	ND	ND
09_10_002	Wood Block Flame	ND	ND	ND	ND	ND
09_10_002	Wood Block Flame	ND	ND	ND	ND	ND
09_10_002	Wood Block Flame	ND	ND	ND	ND	ND
09_10_002	Wood Block Flame	ND	ND	ND	ND	ND
09_10_004	Laptop	862	6.15	4	709	0.14
09_11_001	Laptop	932	14.49	4	793	0.11
09_11_002	Laptop	1970	4.04	135	410	0.33
09_10_003	Wood Block Panel	ND	ND	ND	ND	ND
09_11_003	Wood Block Panel	ND	ND	ND	ND	ND
09_11_004	Wood Block Panel	ND	ND	ND	ND	ND
09_12_001	Tablet	1910	9.26	40	256	0.25
09_12_002	Tablet	894	17.89	4	356	0.17
09_12_003	Tablet	115	4.28	4	587	0.15
09_12_004	Tablet + Plastic Case	915	1.64	117	2447	0.22
09_12_005	Tablet + Plastic Case	779	1.17	599	2701	0.18
09_12_006	Tablet + Metal Case	624	254.33	68	396	0.20
09_19_001	Tool Bag	1664	6.50	94	4517	0.36
09_19_002	Tool Bag	1663	6.30	98	4514	0.36

APPENDIX F
TEST SUMMARY REPORTS

This appendix contains a one-page summary report for each test. The report provides a summary of the test setup, fuel package, and ignition method; a summary of heat release and combustion properties data (heat of combustion, total energy release, soot yield, and carbon monoxide (CO) yield); plots of heat release rate (HRR), plume temperature, and heat flux; and pictures of the test. The plume temperature plots contain two curves, one for the upper (high) thermocouple (TC) grid and one for the lower (low) thermocouple grid. The plotted temperature represents the highest measured temperature on each grid over time. The heat flux plot contains two to four curves. For the 100 kW calorimeter, the plot contains the data for the upper (high) and lower (low) heat flux (HF) gauge. For the 1 MW and 3 MW calorimeters, the plot contains four curves for the two heat flux gauges (HFG high and HFG low) and two plate thermometers (PT high and PT low). Note that Test001 through Test006 on the 1 MW calorimeter did not have heat flux gauges present.

The summary reports are in two sections. The first section contains all the tests performed using the 1 MW and 3 MW calorimeters. The second section contains all the tests performed using the 100 kW calorimeter. Each section lists the tests by fuel package in the order that the fuel package was first tested. For example, the Large Box Empty fuel package was the third fuel package tested using the 1 MW and 3 MW calorimeters; therefore, the four tests (Test007, Test010, Test014, and Test0104) are the third group of tests listed after all the Medium Empty Box and Five Rags w/Heptane tests (the first and second fuel packages tested).

F.1 1 MW + 3 MW Calorimeter Summary Results

This section contains the one-page summary reports for the tests performed using the 1 MW and 3 MW calorimeters. The U.S. Nuclear Regulatory Commission (NRC) sponsored these tests that were conducted at the National Institute of Standards and Technology (NRC/NIST).

Test ID: Test001 (NRC/NIST) **Test Item: Medium Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.18

Peak HRR (kW): 137 Burning Duration (s): 273 Ignition Method: Wick

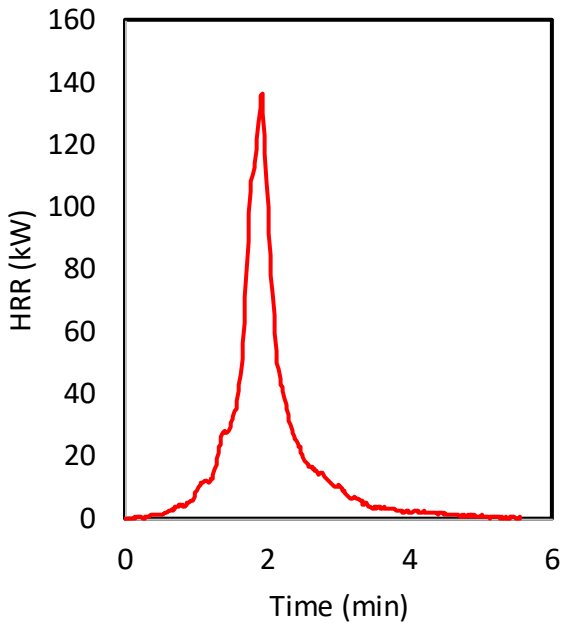
Heat of Combustion (MJ/kg): 14.5 Total Energy Release (MJ): 5.45

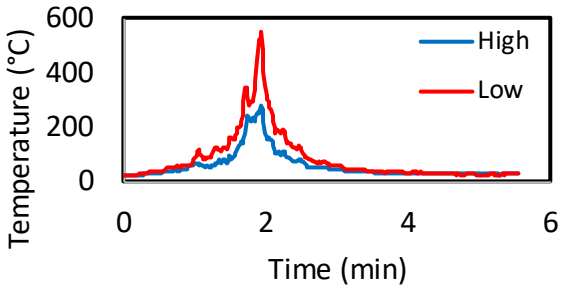
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.025

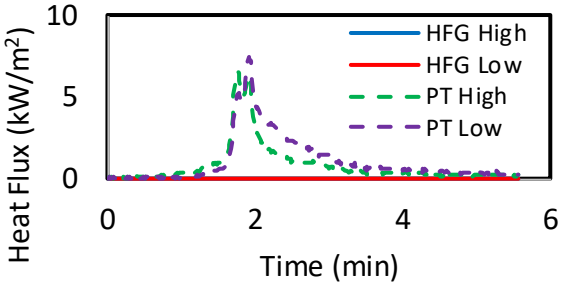
TC Grid Heights[1] (cm): 109, 155

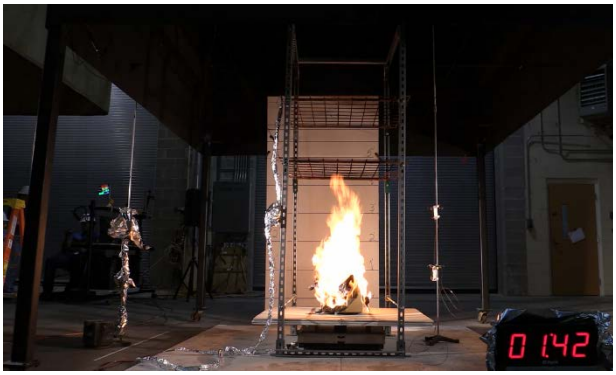
HF Gauge Heights[1] (cm): 30, 76 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform









Test ID: Test002 (NRC/NIST) **Test Item: Medium Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.22

Peak HRR (kW): 142 Burning Duration (s): 276 Ignition Method: Wick

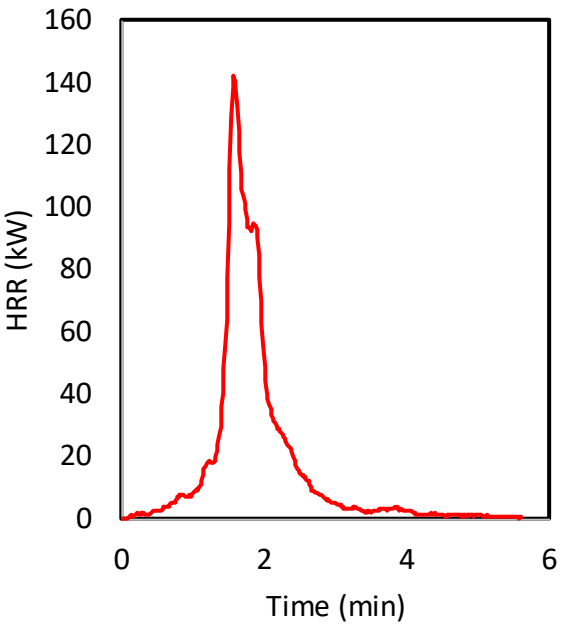
Heat of Combustion (MJ/kg): 13.7 Total Energy Release (MJ): 5.40

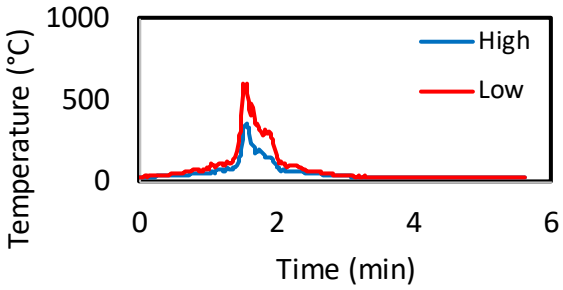
Soot Yield (kg/kg): 0.002 CO Yield (kg/kg): 0.025

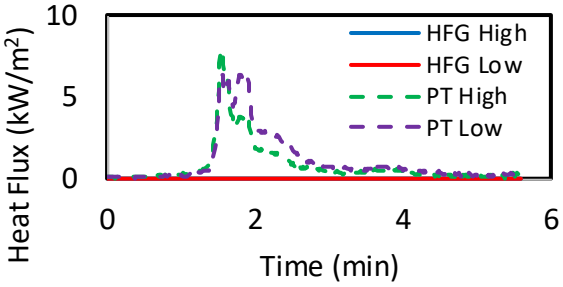
TC Grid Heights[1] (cm): 109, 155

HF Gauge Heights[1] (cm): 30, 76 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform







Test ID: Test004 (NRC/NIST) **Test Item: Medium Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.29

Peak HRR (kW): 128 Burning Duration (s): 307 Ignition Method: Wick

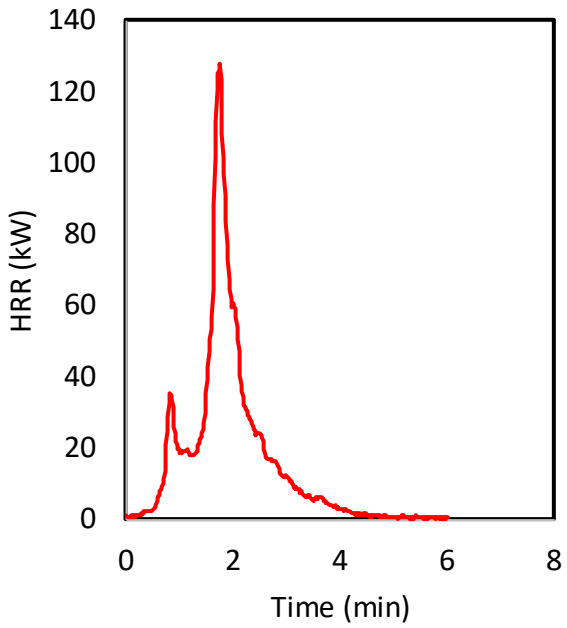
Heat of Combustion (MJ/kg): 14.7 Total Energy Release (MJ): 5.71

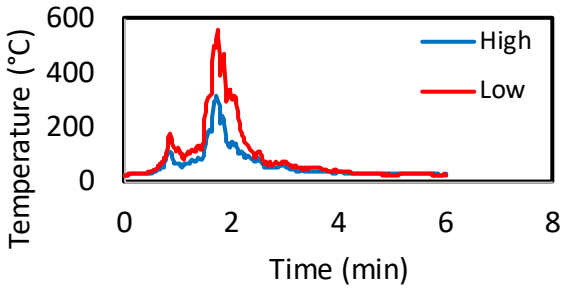
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.030

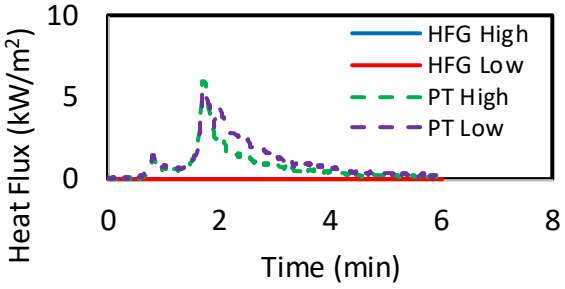
TC Grid Heights[1] (cm): 109, 155

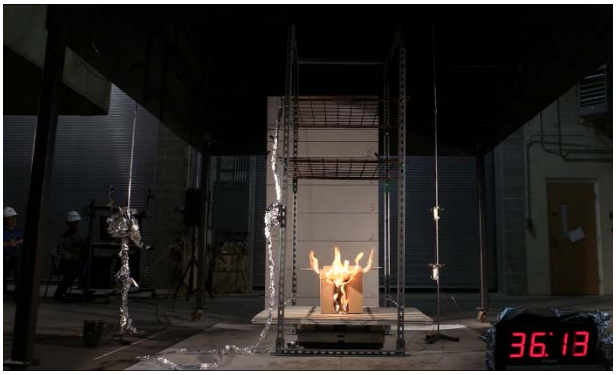
HF Gauge Heights[1] (cm): 30, 76 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform









Test ID: Test003 (NRC/NIST) **Test Item: 5 Rags w/Heptane**

Max Fire Diameter (m): 0.23 Max Flame Height (m): 0.80

Peak HRR (kW): 42.3 Burning Duration (s): 936 Ignition Method: Lighter

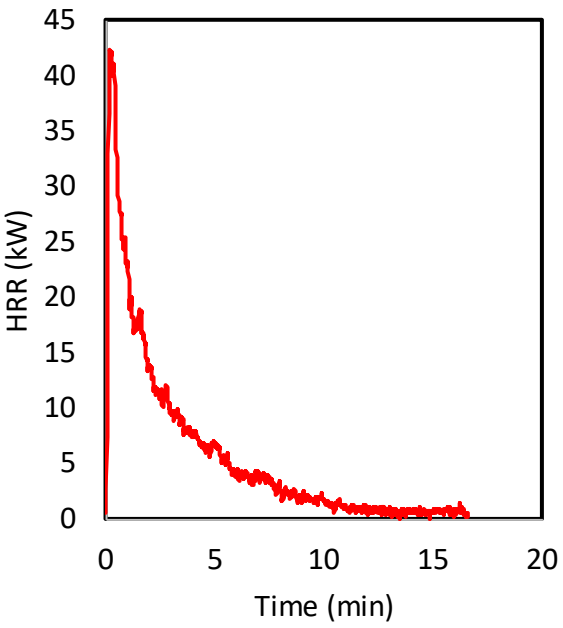
Heat of Combustion (MJ/kg): 24.4 Total Energy Release (MJ): 5.78

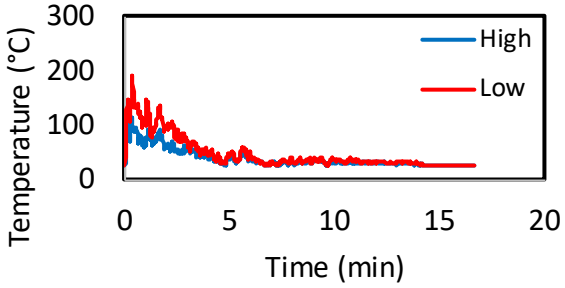
Soot Yield (kg/kg): 0.009 CO Yield (kg/kg): 0.031

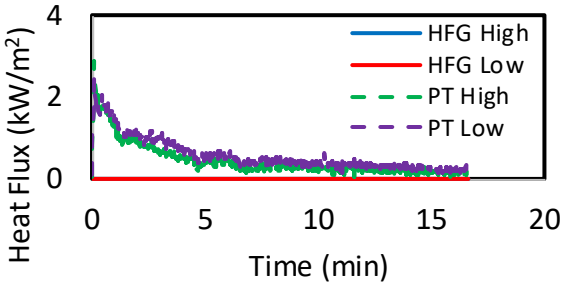
TC Grid Heights[1] (cm): 109, 155

HF Gauge Heights[1] (cm): 5,50 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test005 (NRC/NIST) **Test Item: 5 Rags w/Heptane**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 1.05

Peak HRR (kW): 46.4 Burning Duration (s): 1,386 Ignition Method: Lighter

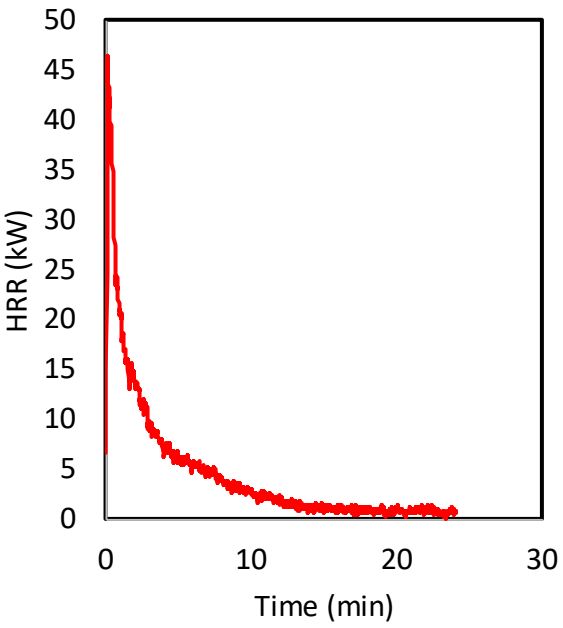
Heat of Combustion (MJ/kg): 22.4 Total Energy Release (MJ): 6.70

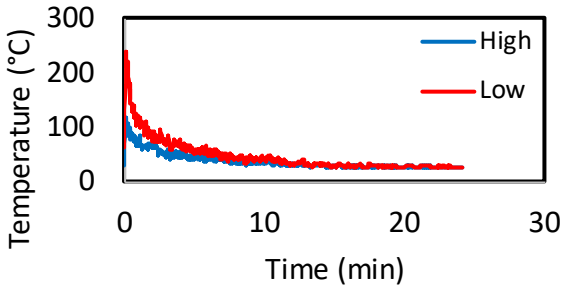
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.042

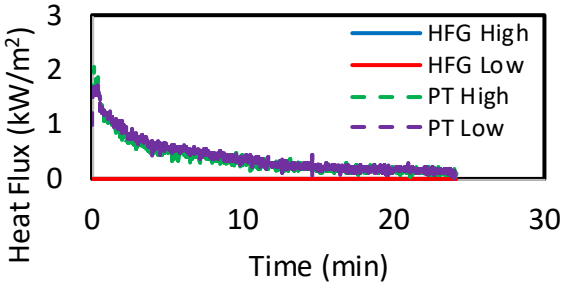
TC Grid Heights[1] (cm): 109, 155

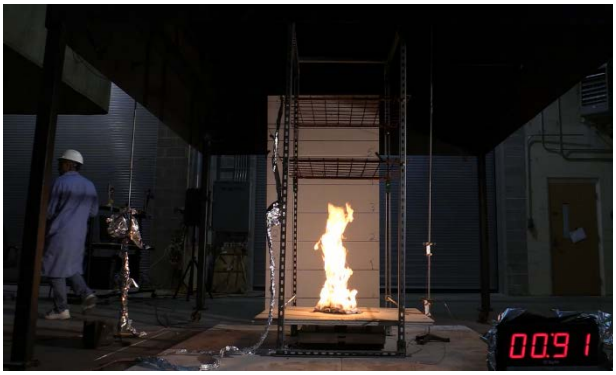
HF Gauge Heights[1] (cm): 5, 50 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test006 (NRC/NIST) **Test Item: 5 Rags w/Heptane**

Max Fire Diameter (m): 0.18 Max Flame Height (m): 1.11

Peak HRR (kW): 50.6 Burning Duration (s): 1,051 Ignition Method: Lighter

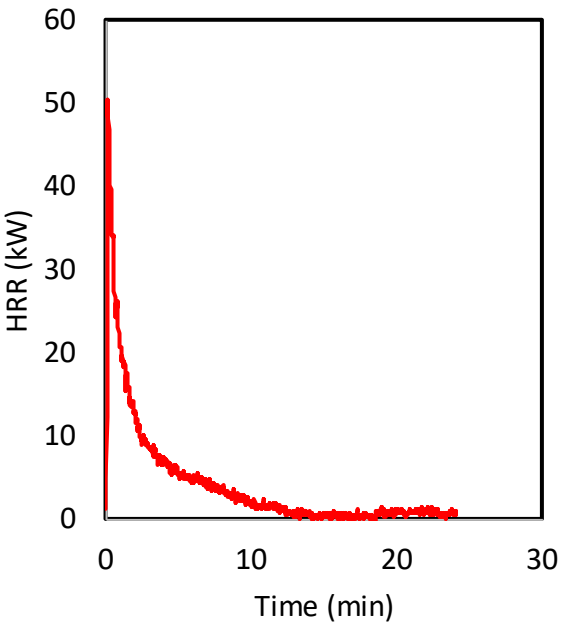
Heat of Combustion (MJ/kg): 26.9 Total Energy Release (MJ): 5.79

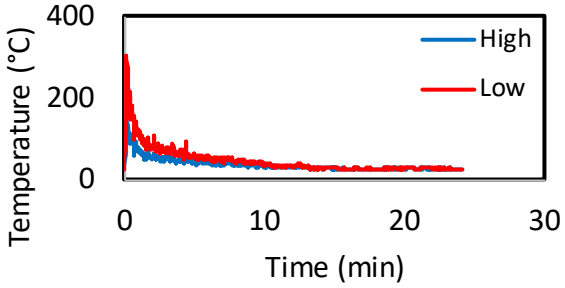
Soot Yield (kg/kg): 0.010 CO Yield (kg/kg): 0.039

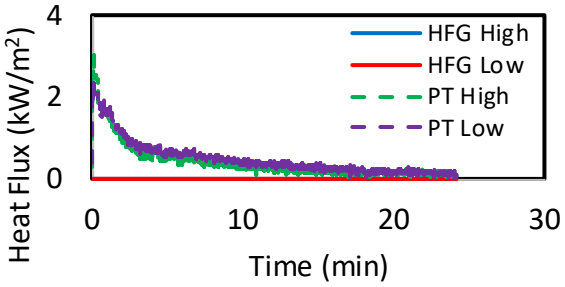
TC Grid Heights[1] (cm): 109, 155

HF Gauge Heights[1] (cm): 5, 51 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test007 (NRC/NIST) **Test Item: Large Box Empty**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.52

Peak HRR (kW): 377 Burning Duration (s): 289 Ignition Method: Wick

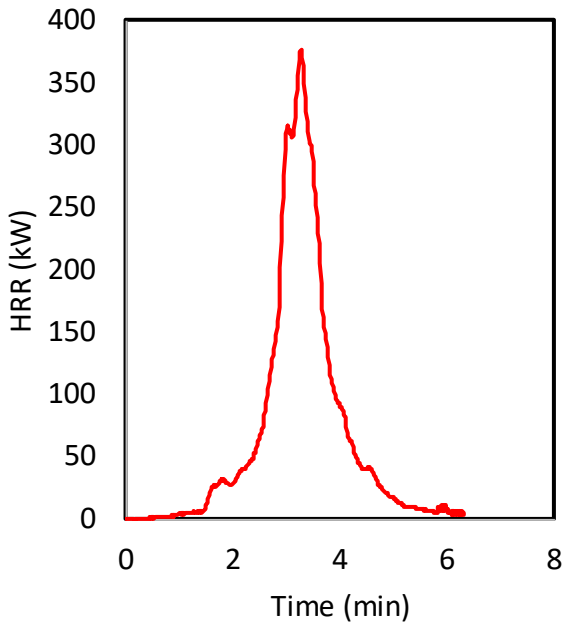
Heat of Combustion (MJ/kg): 13.8 Total Energy Release (MJ): 24.45

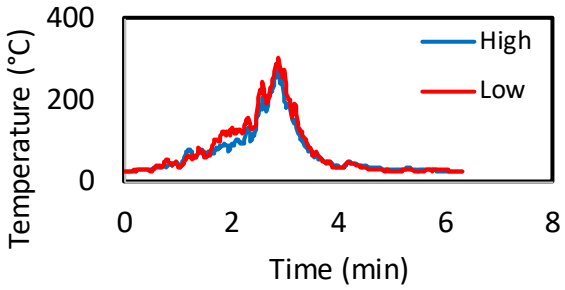
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.018

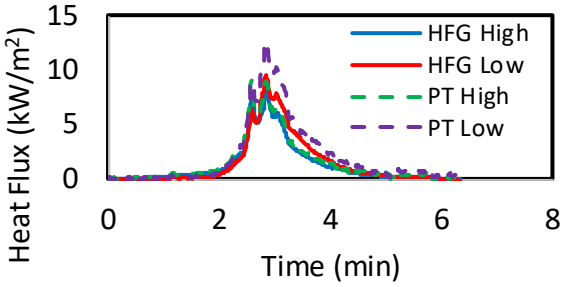
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform







Test ID: Test010 (NRC/NIST) **Test Item: Large Box Empty**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 2.12

Peak HRR (kW): 536 Burning Duration (s): 266 Ignition Method: Wick

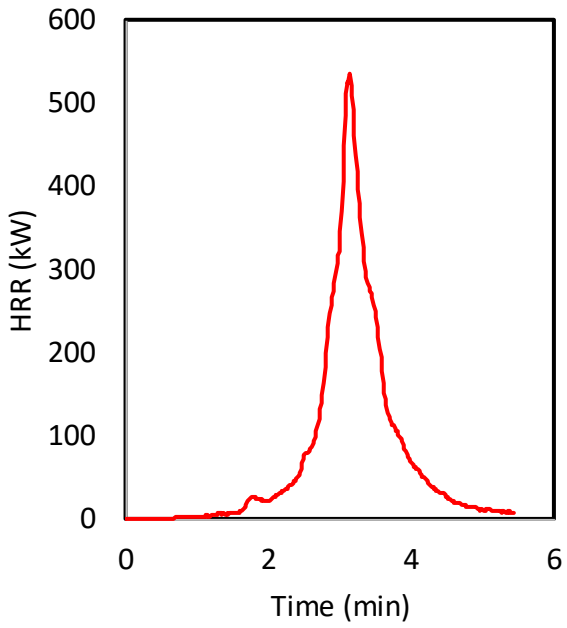
Heat of Combustion (MJ/kg): 17.5 Total Energy Release (MJ): 24.67

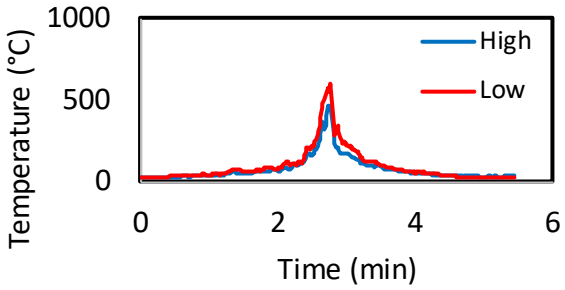
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.018

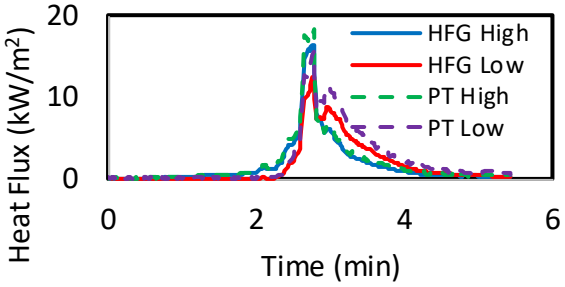
TC Grid Heights[1] (cm): 196, 241

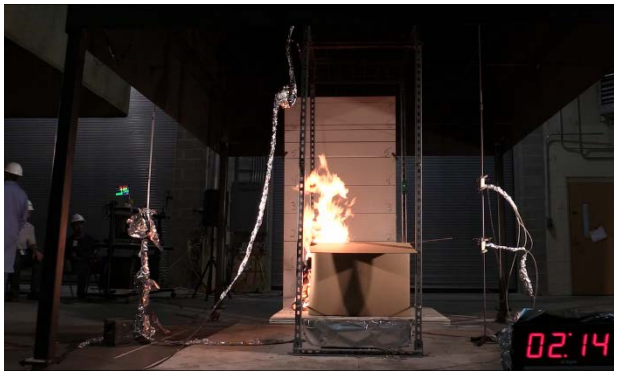
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

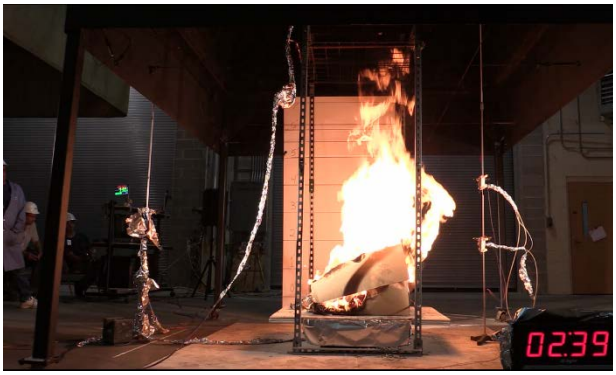
[1]From top of platform, [2]From center of platform











Test ID: Test014 (NRC/NIST) **Test Item: Large Box Empty**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.96

Peak HRR (kW): 412 Burning Duration (s): 344 Ignition Method: Wick

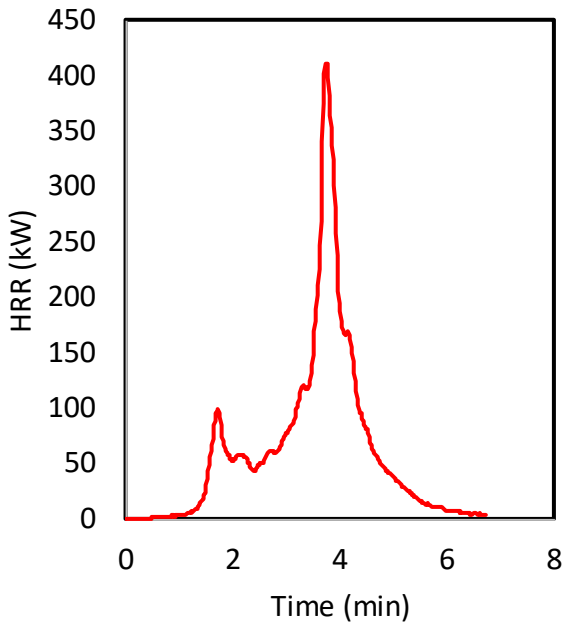
Heat of Combustion (MJ/kg): 14.2 Total Energy Release (MJ): 24.80

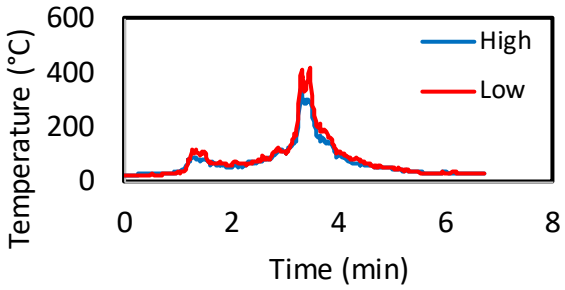
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.020

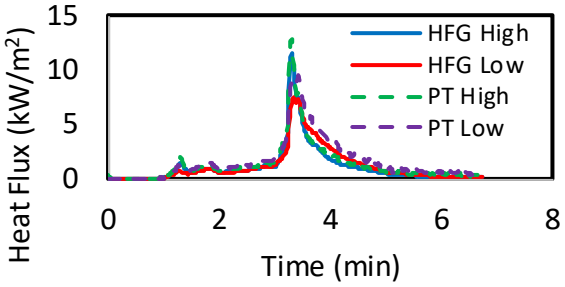
TC Grid Heights[1] (cm): 196, 241

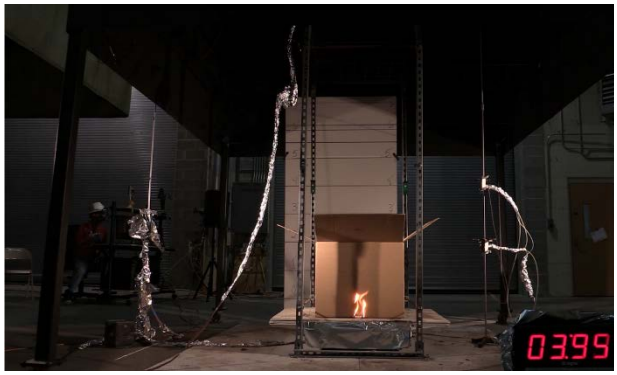
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform









Test ID: Test0104 (NRC/NIST) **Test Item: Large Box Empty**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.89

Peak HRR (kW): 455 Burning Duration (s): 319 Ignition Method: Wick

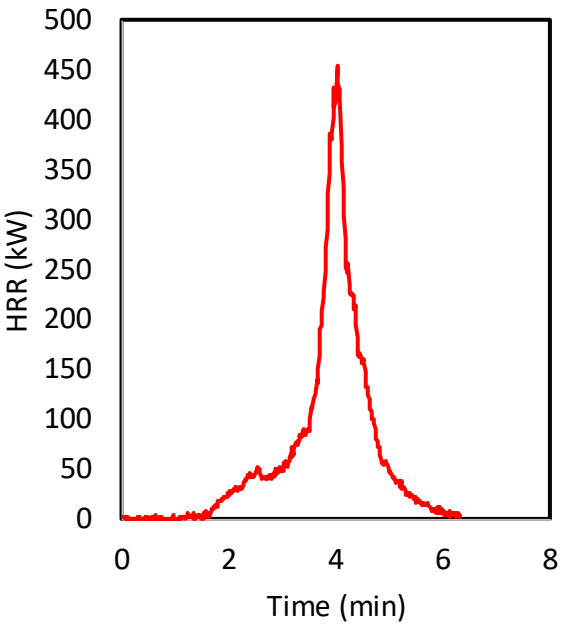
Heat of Combustion (MJ/kg): 28.2 Total Energy Release (MJ): 24.40

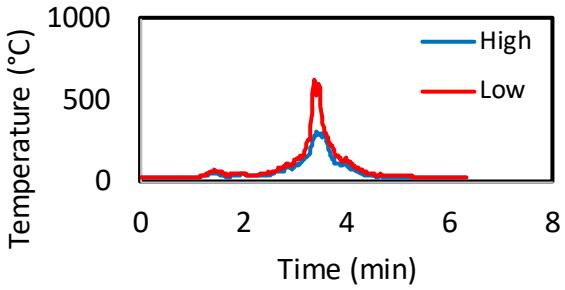
Soot Yield (kg/kg): N/A CO Yield (kg/kg): 0.018

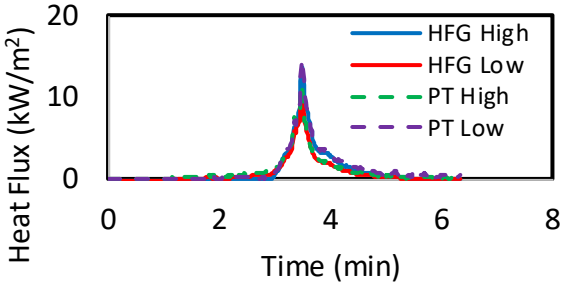
TC Grid Heights[1] (cm): 135, 180

HF Gauge Heights[1] (cm): 76, 124 HF Gauge Distance[2] (cm): 254

[1]From top of platform, [2]From center of platform







Test ID: Test008 (NRC/NIST) **Test Item: Large Box w/Peanuts**

Max Fire Diameter (m): 0.061 Max Flame Height (m): 1.94

Peak HRR (kW): 563 Burning Duration (s): 294 Ignition Method: Wick

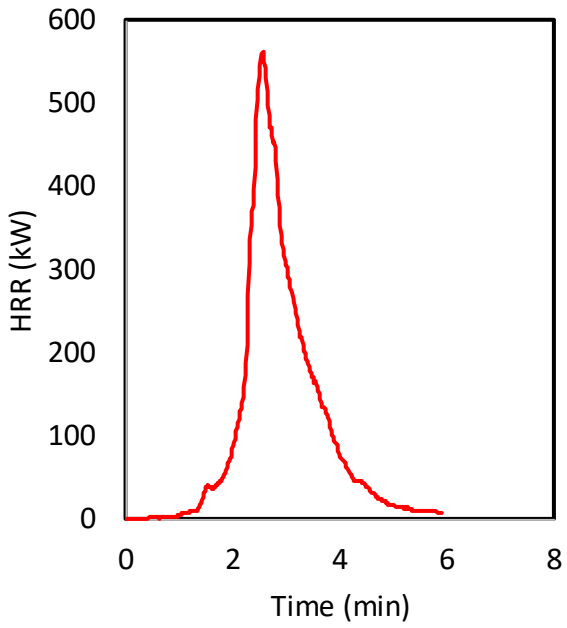
Heat of Combustion (MJ/kg): 17.5 Total Energy Release (MJ): 36.7

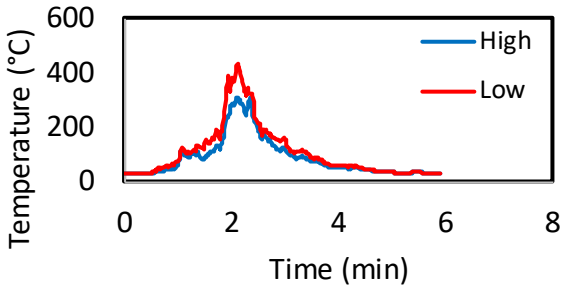
Soot Yield (kg/kg): 0.015 CO Yield (kg/kg): 0.025

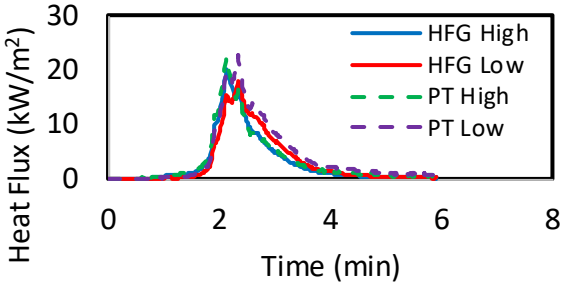
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform







Test ID: Test011 (NRC/NIST) **Test Item: Large Box w/Peanuts**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 2.57

Peak HRR (kW): 579 Burning Duration (s): 331 Ignition Method: Wick

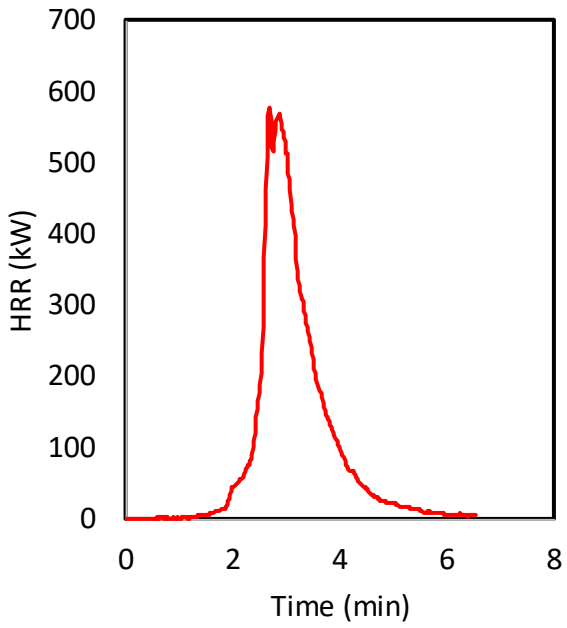
Heat of Combustion (MJ/kg): 17.4 Total Energy Release (MJ): 36.34

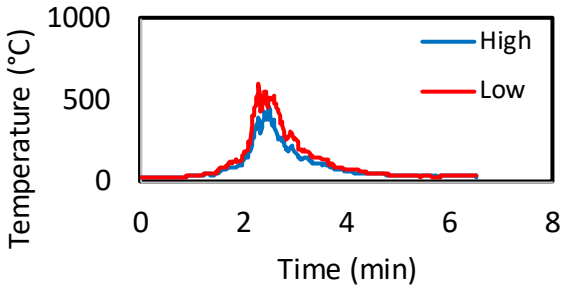
Soot Yield (kg/kg): 0.022 CO Yield (kg/kg): 0.027

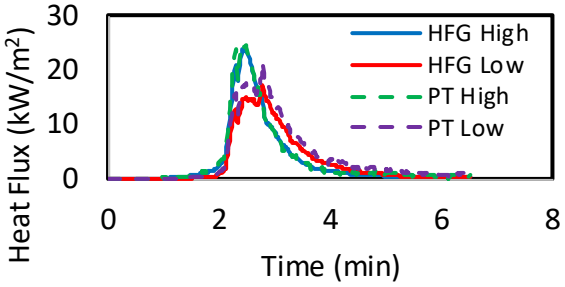
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform







Test ID: Test015 (NRC/NIST) **Test Item: Large Box w/Peanuts**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.92

Peak HRR (kW): 579 Burning Duration (s): 412 Ignition Method: Wick

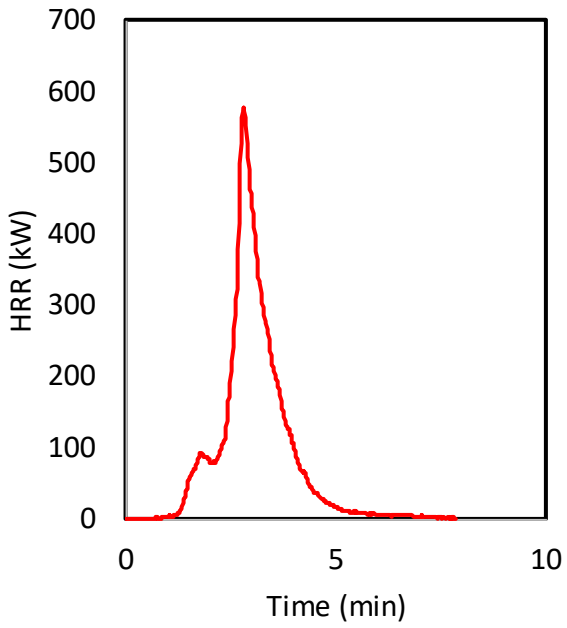
Heat of Combustion (MJ/kg): 17.2 Total Energy Release (MJ): 36.78

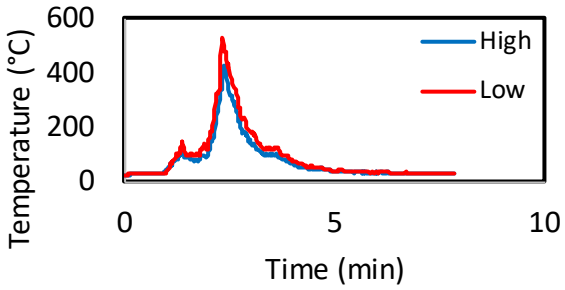
Soot Yield (kg/kg): 0.025 CO Yield (kg/kg): 0.031

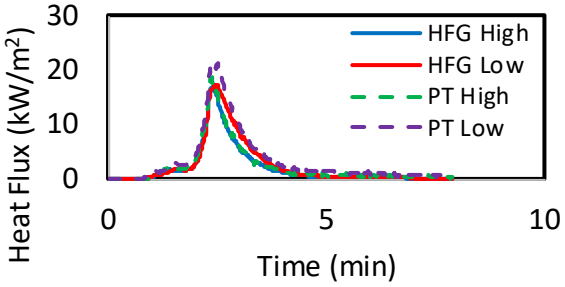
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform







Test ID: Test009 (NRC/NIST) **Test Item: Large Box w/Paper**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.94

Peak HRR (kW): 436 Burning Duration (s): 631 Ignition Method: Wick

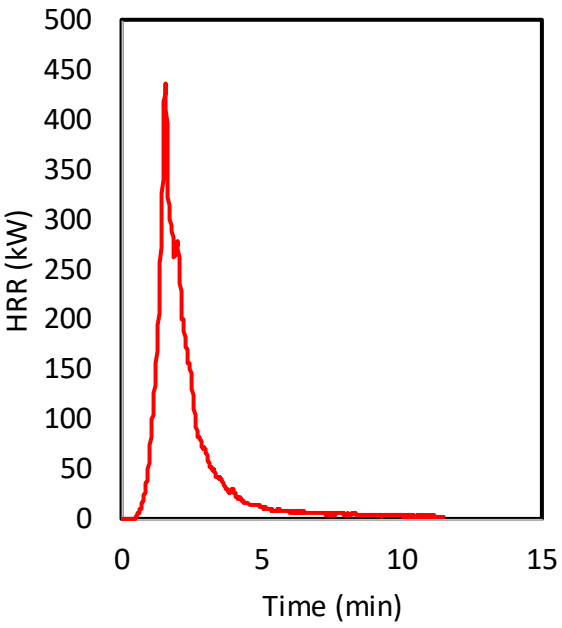
Heat of Combustion (MJ/kg): 12.5 Total Energy Release (MJ): 29.95

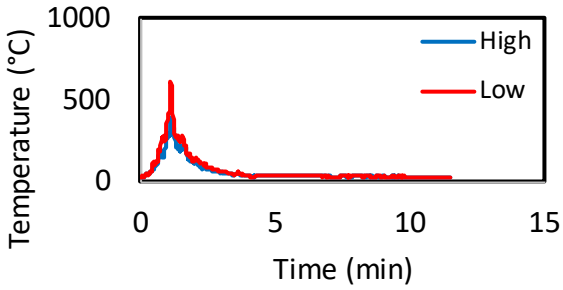
Soot Yield (kg/kg): 0.002 CO Yield (kg/kg): 0.029

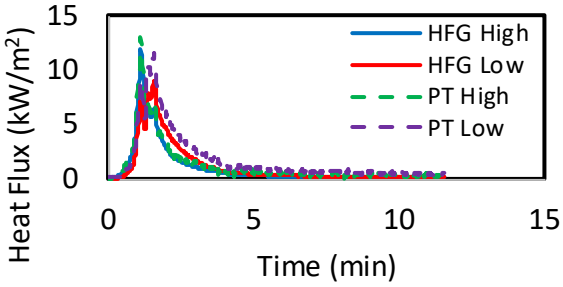
TC Grid Heights[1] (cm): 196, 241

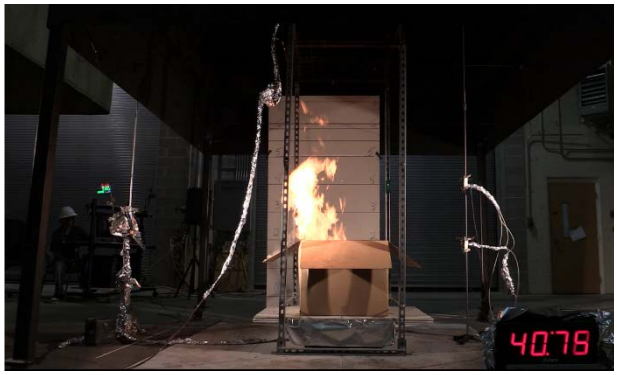
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform









Test ID: Test012 (NRC/NIST) **Test Item: Large Box w/Paper**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 2.34

Peak HRR (kW): 446 Burning Duration (s): 641 Ignition Method: Wick

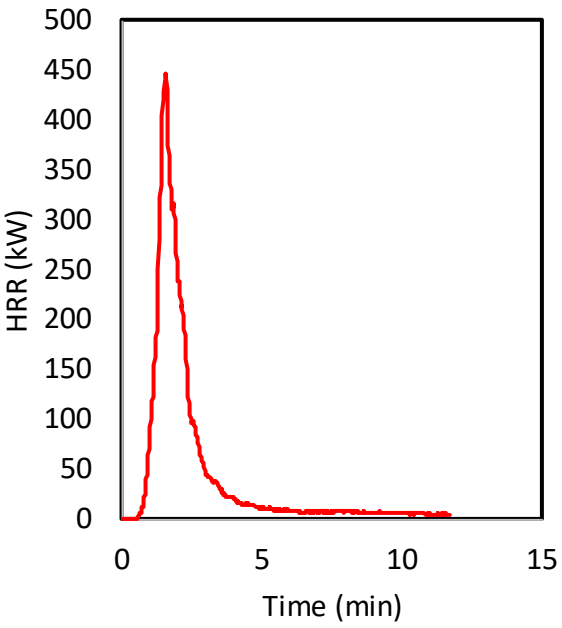
Heat of Combustion (MJ/kg): 12.6 Total Energy Release (MJ): 31.07

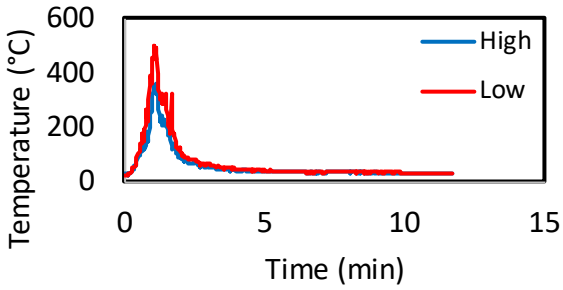
Soot Yield (kg/kg): 0.003 CO Yield (kg/kg): 0.031

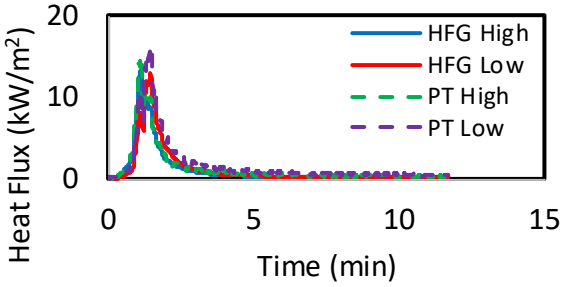
TC Grid Heights[1] (cm): 196, 241

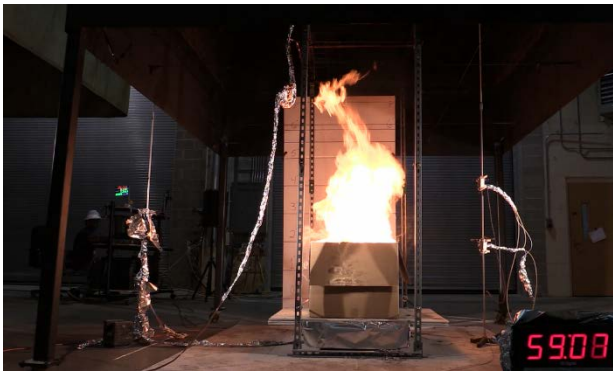
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 91

[1]From top of platform, [2]From center of platform









Test ID: Test016 (NRC/NIST) **Test Item: Large Box w/Paper**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.49

Peak HRR (kW): 346 Burning Duration (s): 643 Ignition Method: Wick

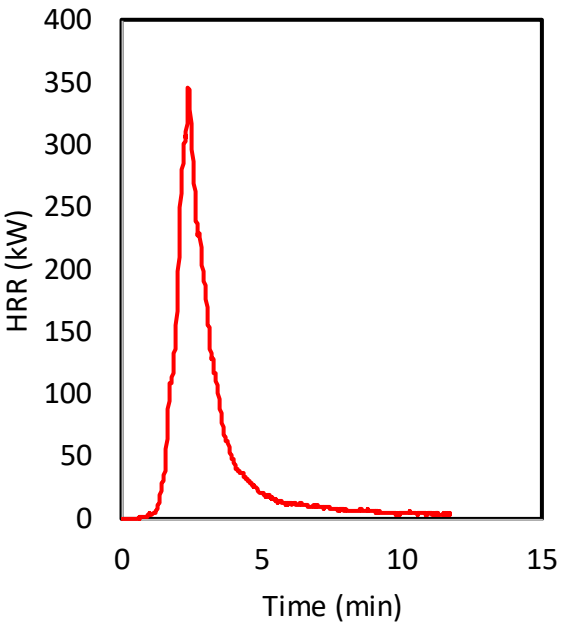
Heat of Combustion (MJ/kg): 12.4 Total Energy Release (MJ): 30.28

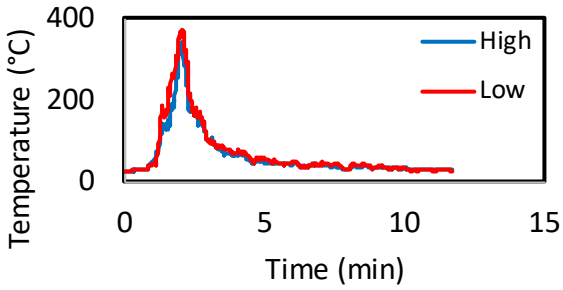
Soot Yield (kg/kg): 0.002 CO Yield (kg/kg): 0.028

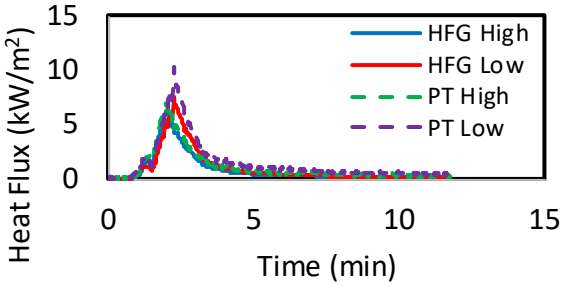
TC Grid Heights[1] (cm): 196, 241

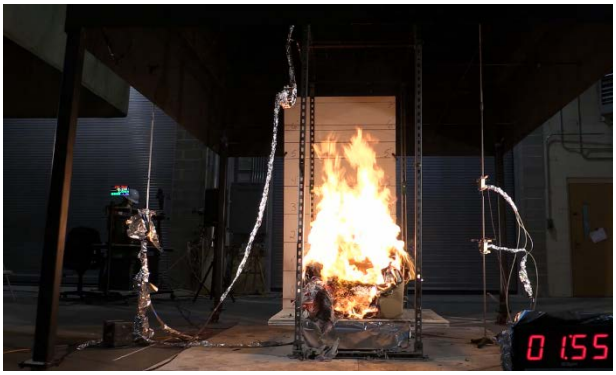
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test017 (NRC/NIST) **Test Item: Plastic Tarp Draped**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.42

Peak HRR (kW): 7.2 Burning Duration (s): 1,220 Ignition Method: Wick

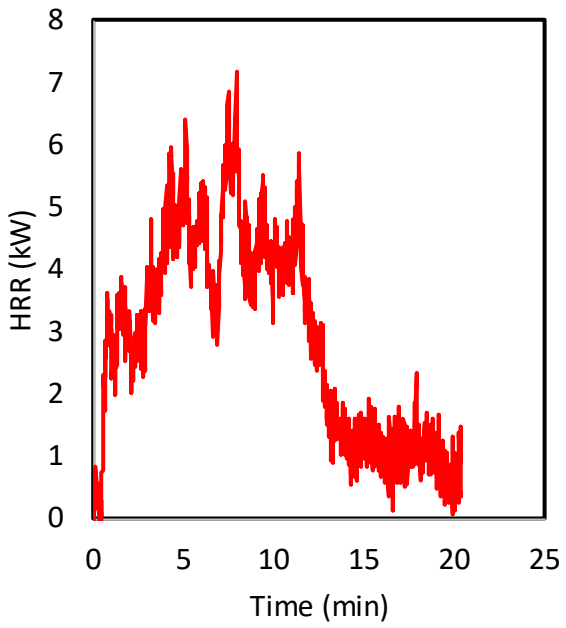
Heat of Combustion (MJ/kg): 44.8 Total Energy Release (MJ): 3.60

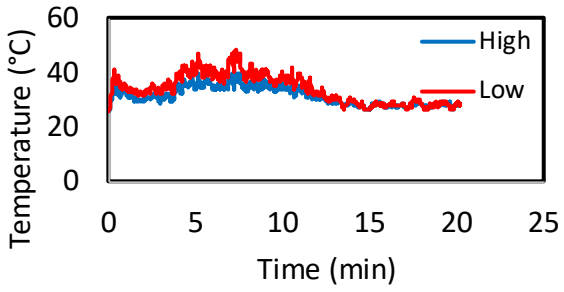
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.109

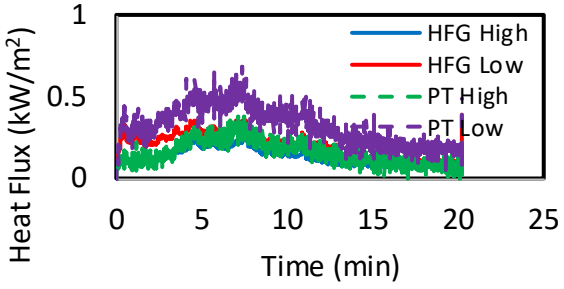
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test018 (NRC/NIST) **Test Item: Plastic Tarp Draped**

Max Fire Diameter (m): 0.76 Max Flame Height (m): 0.33

Peak HRR (kW): 74.3 Burning Duration (s): 1,662 Ignition Method: Wick

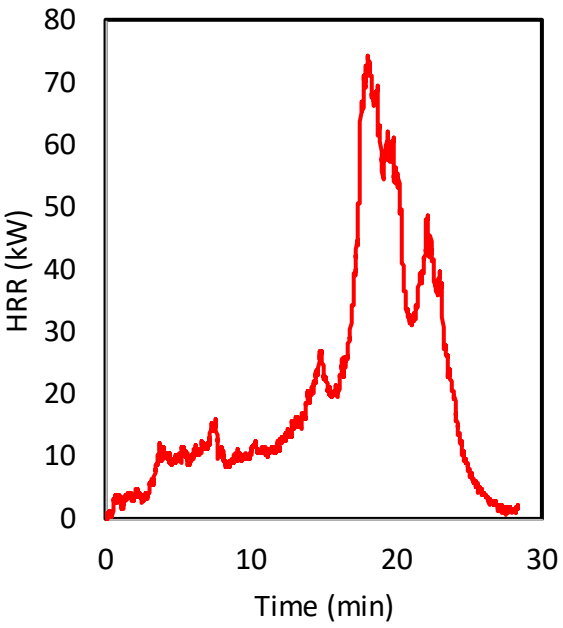
Heat of Combustion (MJ/kg): 43.2 Total Energy Release (MJ): 33.56

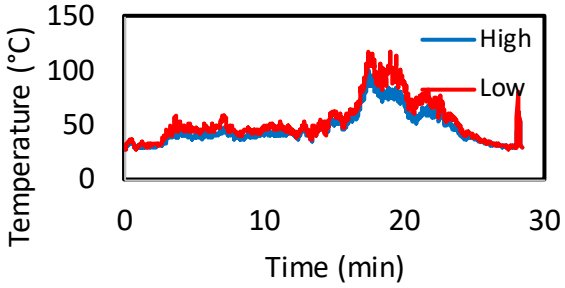
Soot Yield (kg/kg): 0.041 CO Yield (kg/kg): 0.031

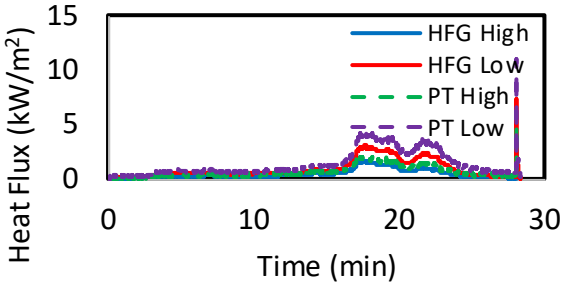
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test019 (NRC/NIST) **Test Item: Plastic Tarp Draped**

Max Fire Diameter (m): 0.56 Max Flame Height (m): 1.18

Peak HRR (kW): 195 Burning Duration (s): 1,330 Ignition Method: Wick

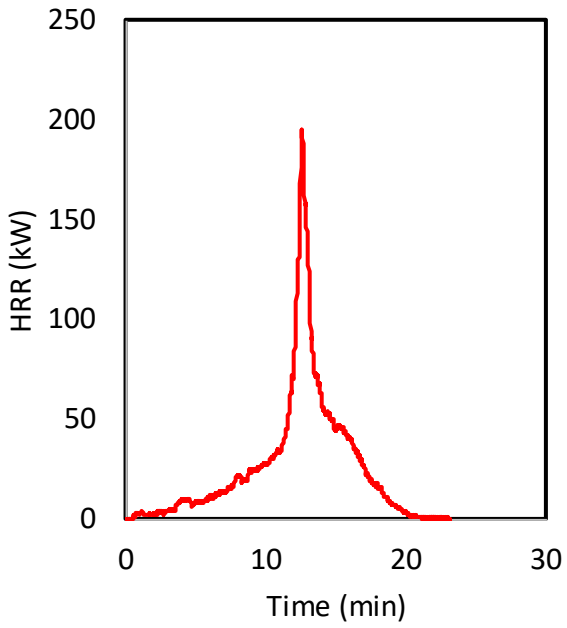
Heat of Combustion (MJ/kg): 40.5 Total Energy Release (MJ): 34.93

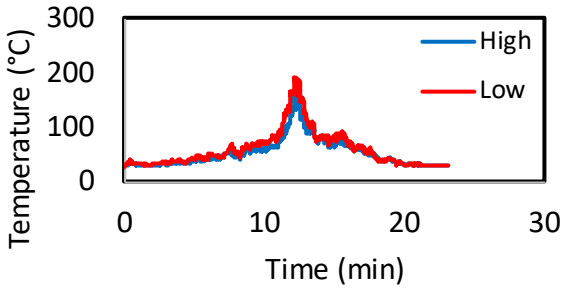
Soot Yield (kg/kg): 0.047 CO Yield (kg/kg): 0.027

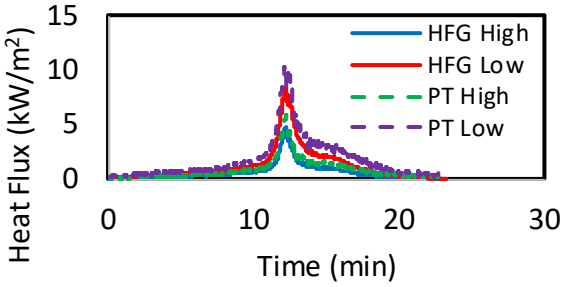
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test020 (NRC/NIST) **Test Item: Plastic Tarp Draped**

Max Fire Diameter (m): 0.76 Max Flame Height (m): 0.80

Peak HRR (kW): 68.9 Burning Duration (s): 1,316 Ignition Method: Wick

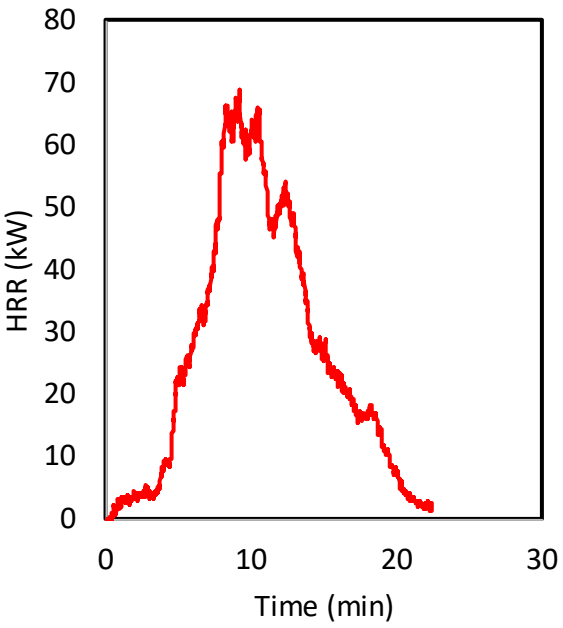
Heat of Combustion (MJ/kg): 40.7 Total Energy Release (MJ): 34.73

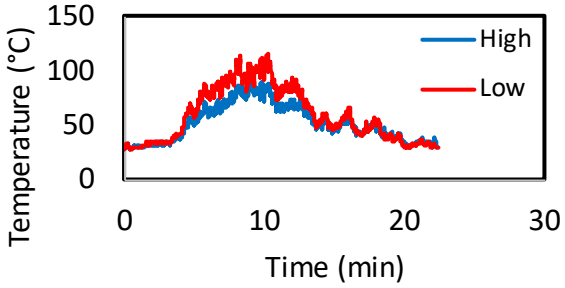
Soot Yield (kg/kg): 0.049 CO Yield (kg/kg): 0.026

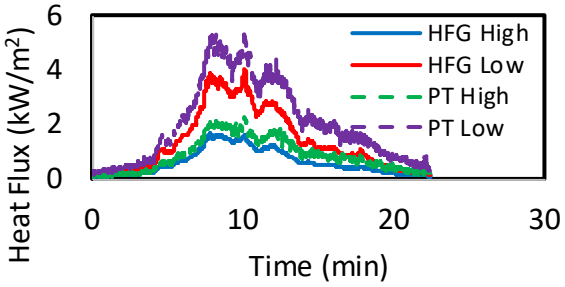
TC Grid Heights[1] (cm): 196, 241

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test021 (NRC/NIST) **Test Item: Welding Blanket Draped**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.21

Peak HRR (kW): 2.2 Burning Duration (s): 247 Ignition Method: Wick

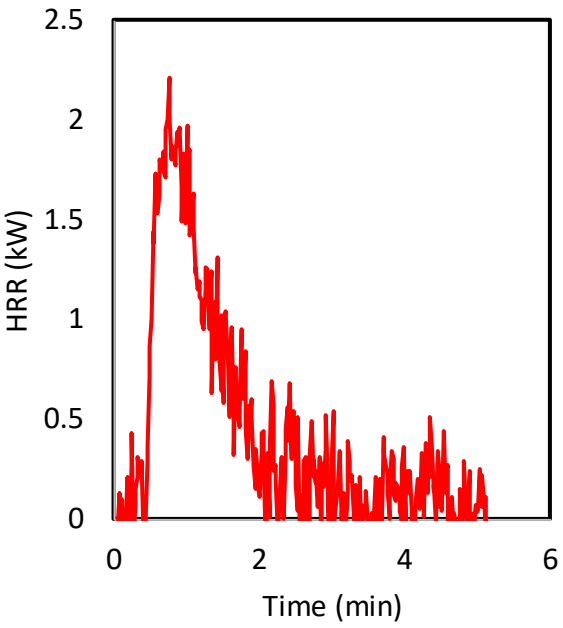
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.13

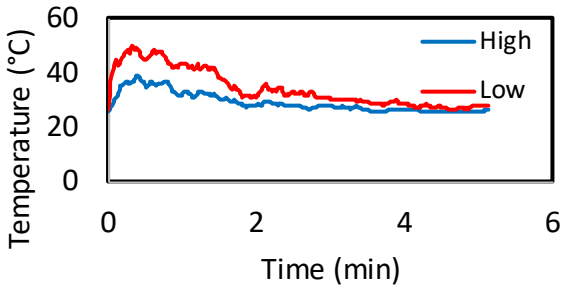
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

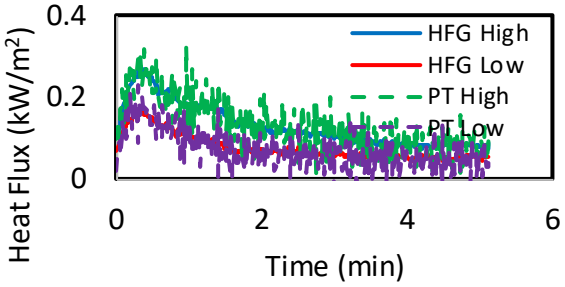
TC Grid Heights[1] (cm): 107, 152

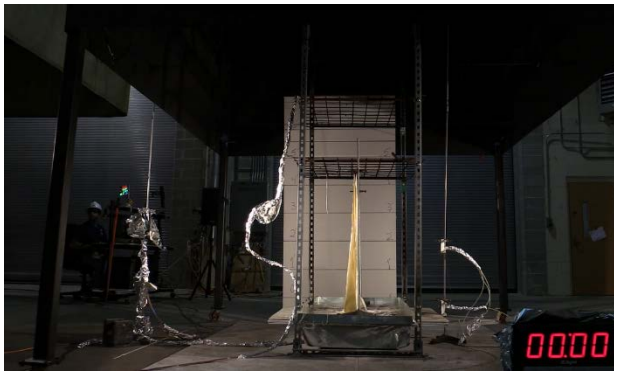
HF Gauge Heights[1] (cm): 5, 51 HF Gauge Distance[2] (cm): 61

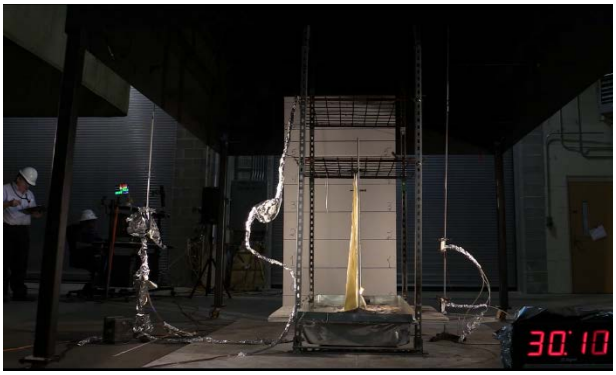
[1]From top of platform, [2]From center of platform











Test ID: Test022 (NRC/NIST) **Test Item: Welding Blanket Draped**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.22

Peak HRR (kW): 2.1 Burning Duration (s): 313 Ignition Method: Wick

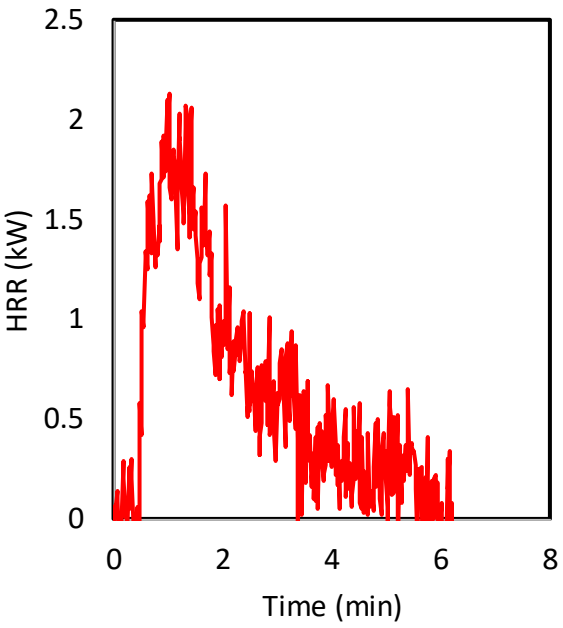
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.23

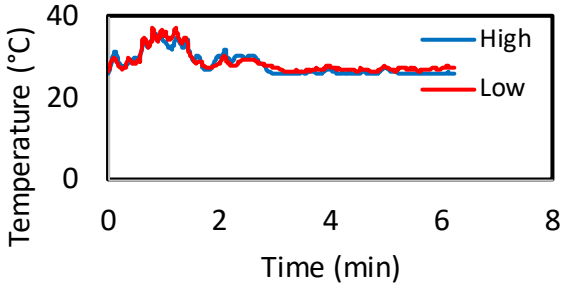
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

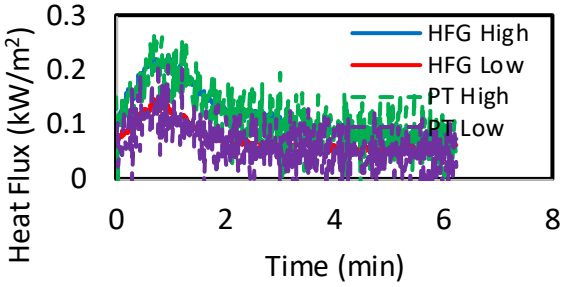
TC Grid Heights[1] (cm): 107, 152

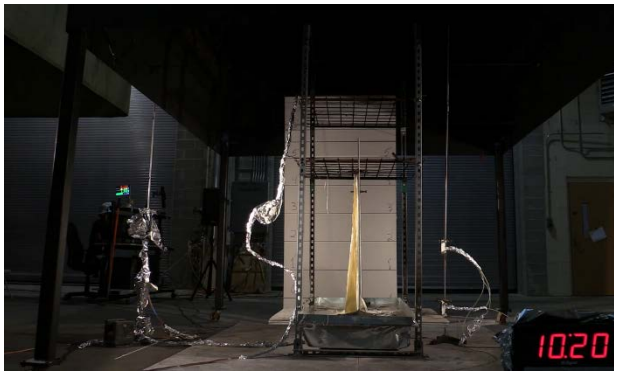
HF Gauge Heights[1] (cm): 5, 51 HF Gauge Distance[2] (cm): 61

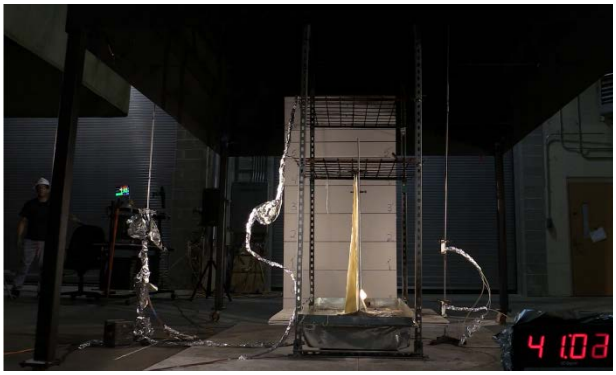
[1]From top of platform, [2]From center of platform











Test ID: Test023 (NRC/NIST) **Test Item: Welding Blanket Draped**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.22

Peak HRR (kW): 2.3 Burning Duration (s): 256 Ignition Method: Wick

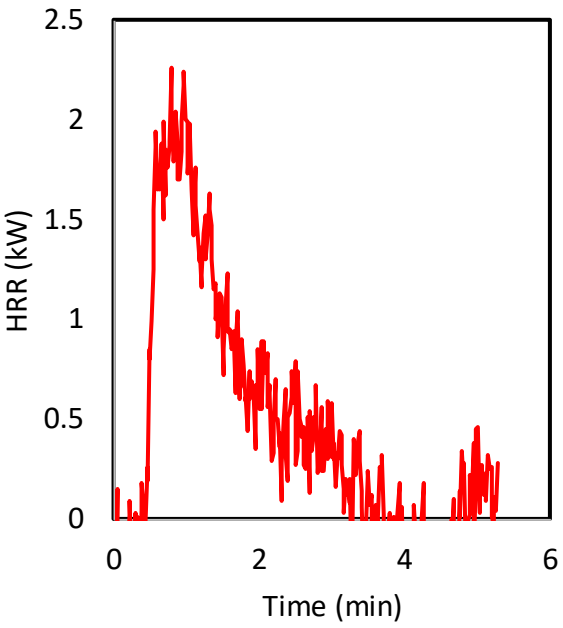
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.15

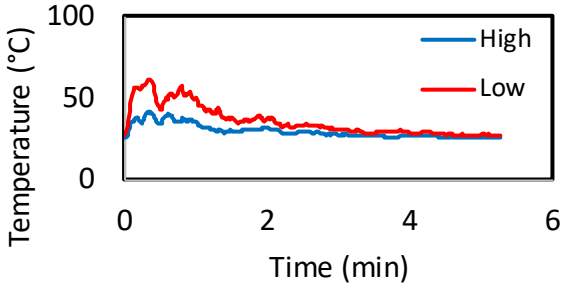
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

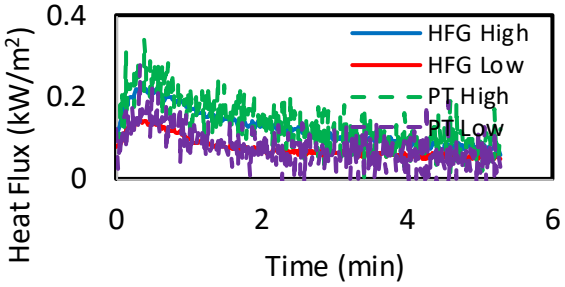
TC Grid Heights[1] (cm): 107, 152

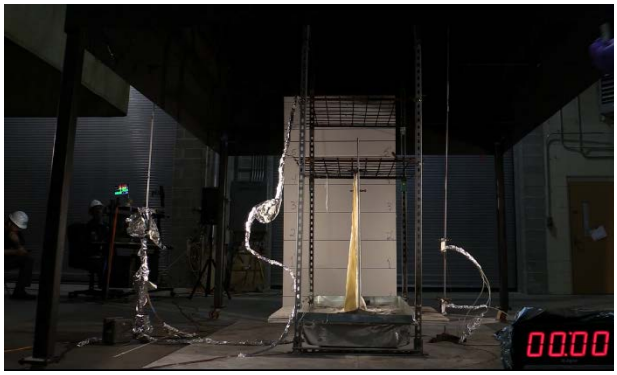
HF Gauge Heights[1] (cm): 5, 51 HF Gauge Distance[2] (cm): 61

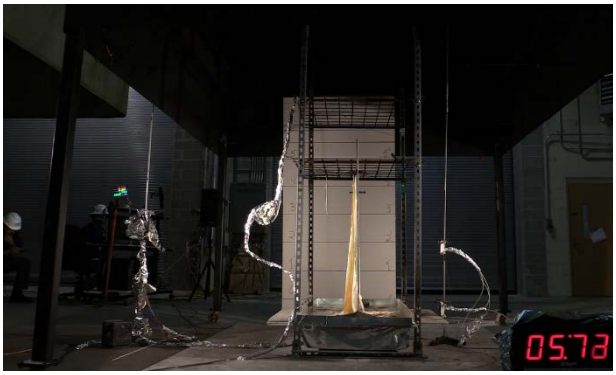
[1]From top of platform, [2]From center of platform











Test ID: Test024 (NRC/NIST) **Test Item: Mop + Bucket**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 0.58

Peak HRR (kW): 64.6 Burning Duration (s): 1,585 Ignition Method: Wick

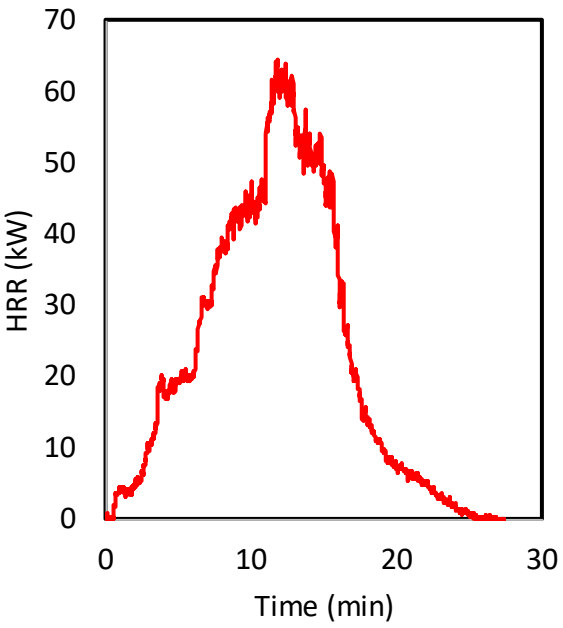
Heat of Combustion (MJ/kg): 34.0 Total Energy Release (MJ): 36.48

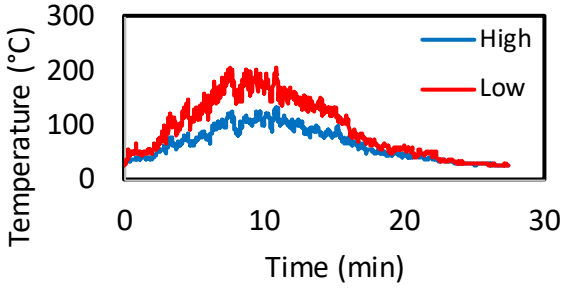
Soot Yield (kg/kg): 0.047 CO Yield (kg/kg): 0.026

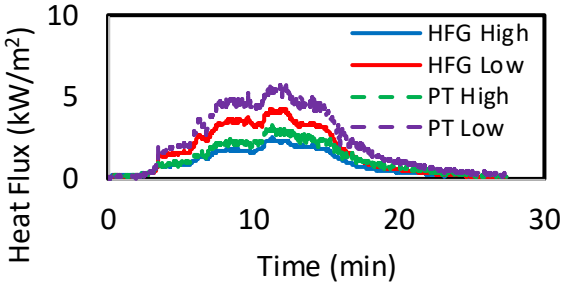
TC Grid Heights[1] (cm): 107, 152

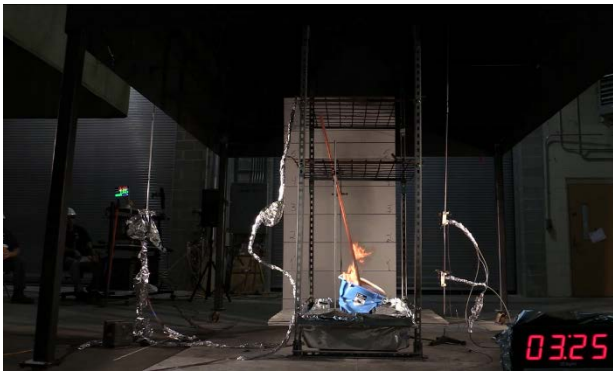
HF Gauge Heights[1] (cm): 28, 74 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test025 (NRC/NIST) **Test Item: Mop + Bucket**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 0.82

Peak HRR (kW): 113 Burning Duration (s): 1,331 Ignition Method: Wick

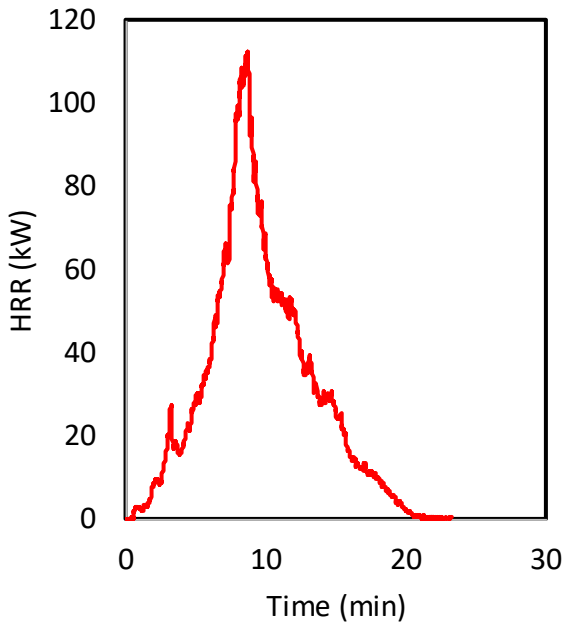
Heat of Combustion (MJ/kg): 29.5 Total Energy Release (MJ): 40.00

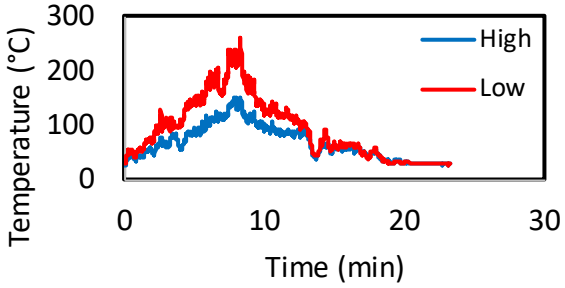
Soot Yield (kg/kg): 0.049 CO Yield (kg/kg): 0.026

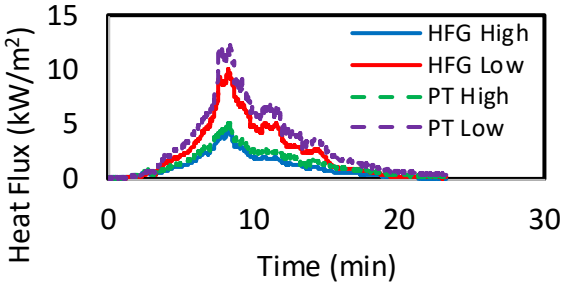
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 28, 74 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test027 (NRC/NIST) **Test Item: Blower Duct**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.33

Peak HRR (kW): 8.7 Burning Duration (s): 283 Ignition Method: Wick

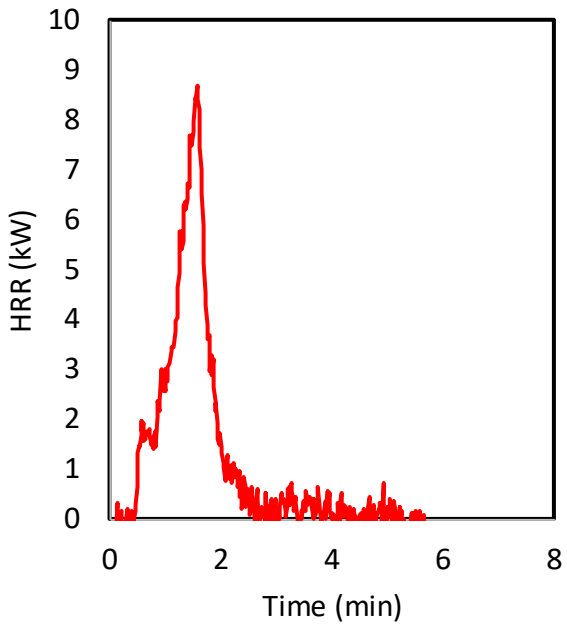
Heat of Combustion (MJ/kg): 10.4 Total Energy Release (MJ): 0.40

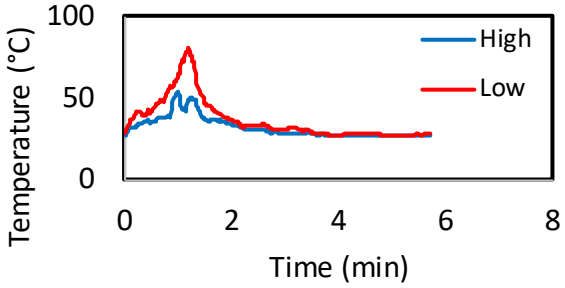
Soot Yield (kg/kg): 0.083 CO Yield (kg/kg): 0.083

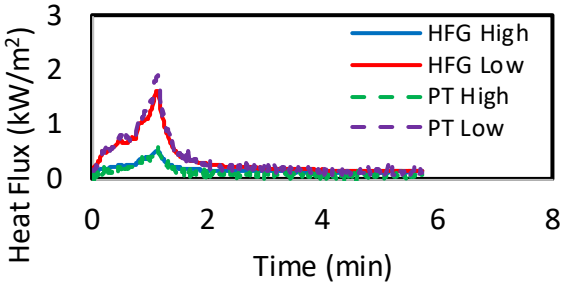
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 28, 74 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test028 (NRC/NIST) **Test Item: Blower Duct**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.35

Peak HRR (kW): 5.9 Burning Duration (s): 226 Ignition Method: Wick

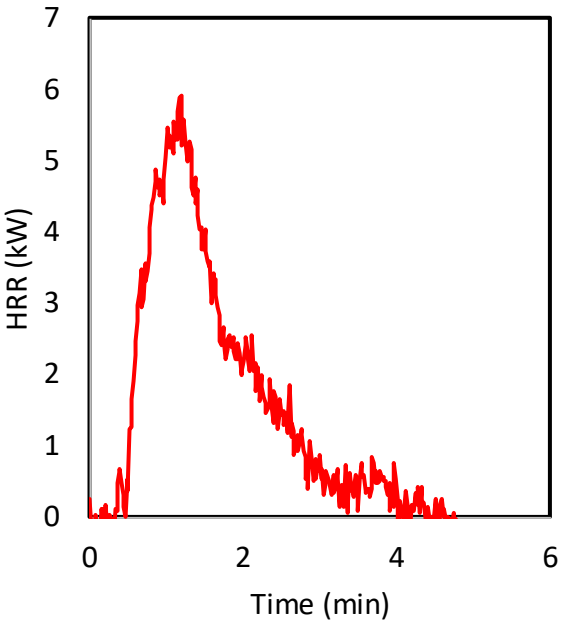
Heat of Combustion (MJ/kg): 12.1 Total Energy Release (MJ): 0.45

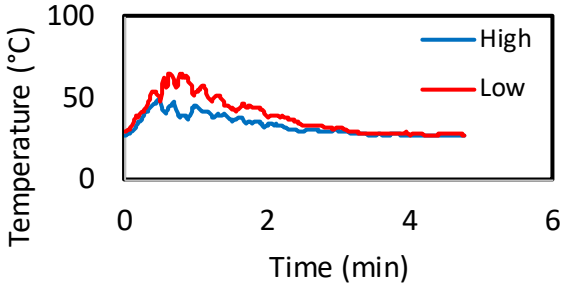
Soot Yield (kg/kg): 0.075 CO Yield (kg/kg): 0.086

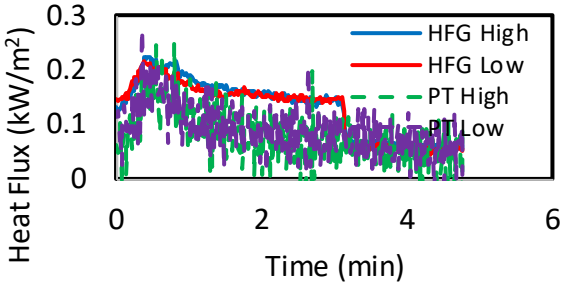
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 28, 74 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test029 (NRC/NIST) **Test Item: Blower Duct**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.35

Peak HRR (kW): 5.1 Burning Duration (s): 263 Ignition Method: Wick

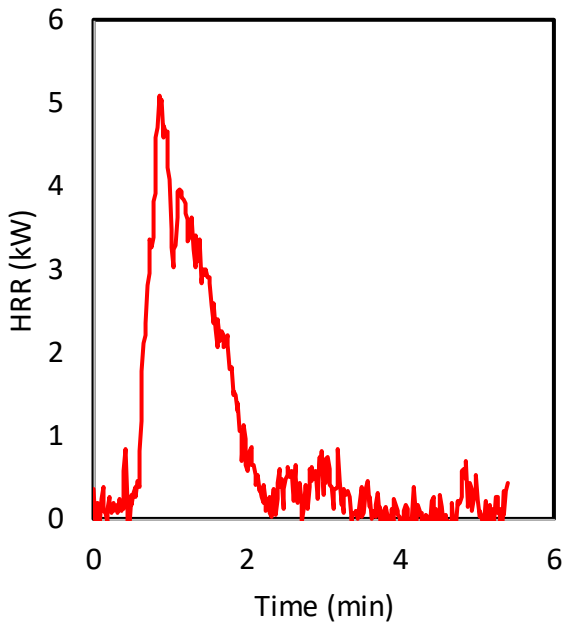
Heat of Combustion (MJ/kg): 7.5 Total Energy Release (MJ): 0.29

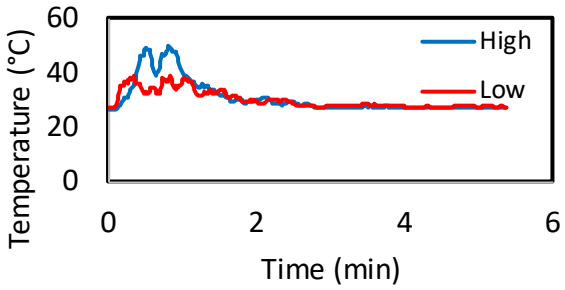
Soot Yield (kg/kg): 0.042 CO Yield (kg/kg): 0.044

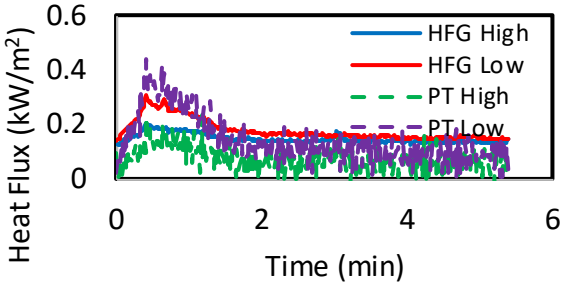
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 28, 74 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test030 (NRC/NIST) **Test Item: Water Hose**

Max Fire Diameter (m): 0.051 Max Flame Height (m): 0.35

Peak HRR (kW): 24.1 Burning Duration (s): 3,966 Ignition Method: Flame

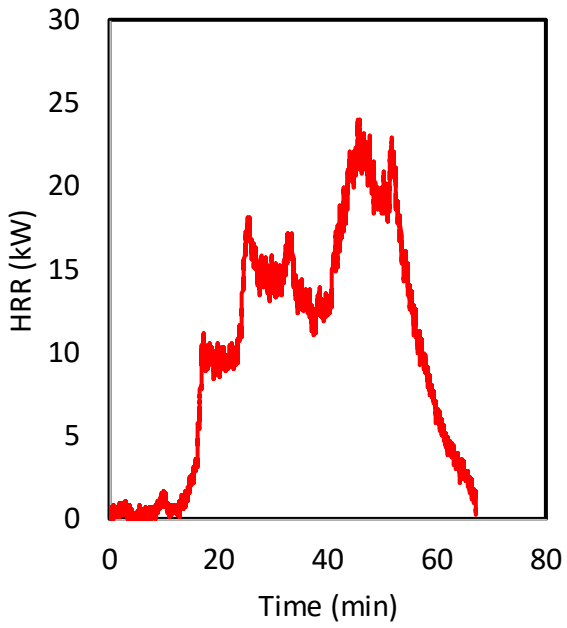
Heat of Combustion (MJ/kg): 36.2 Total Energy Release (MJ): 40.52

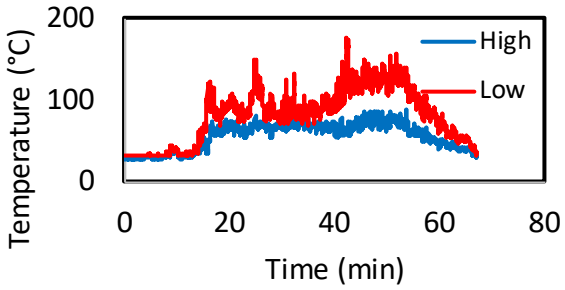
Soot Yield (kg/kg): 0.052 CO Yield (kg/kg): 0.052

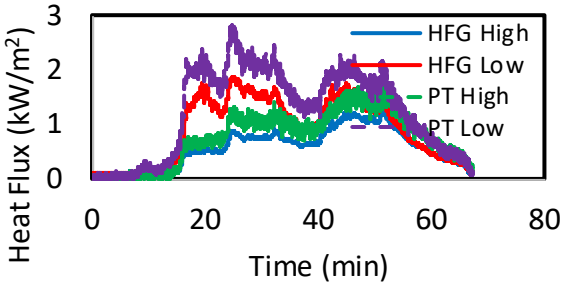
TC Grid Heights[1] (cm): 61, 107

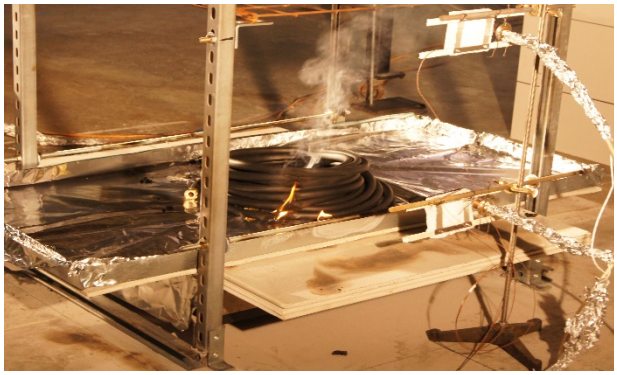
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test082 (NRC/NIST) **Test Item: Water Hose**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.12

Peak HRR (kW): 1.2 Burning Duration (s): 806 Ignition Method: Flame

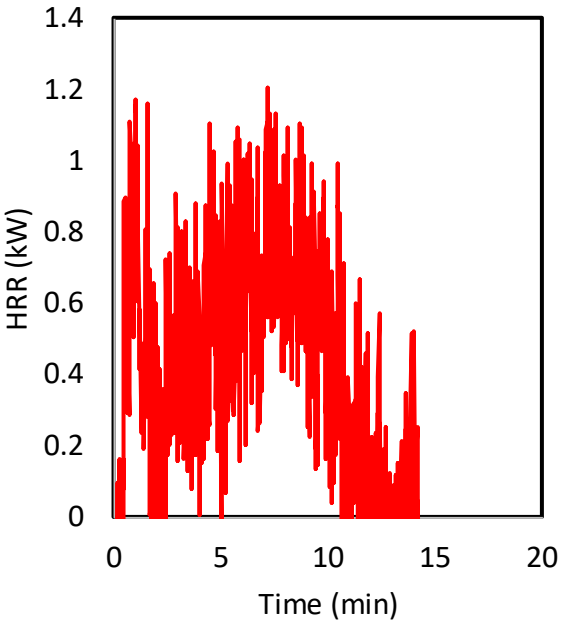
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.35

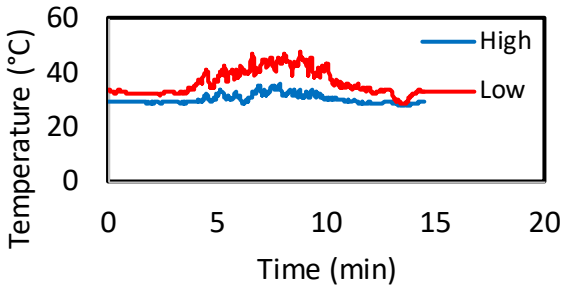
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

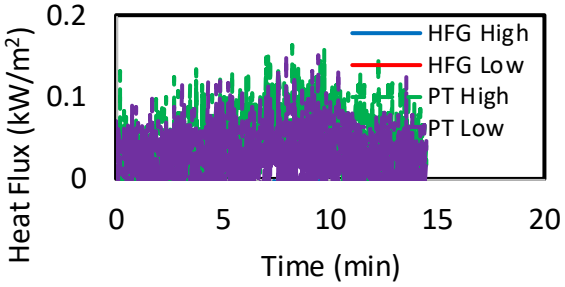
TC Grid Heights[1] (cm): 61, 107

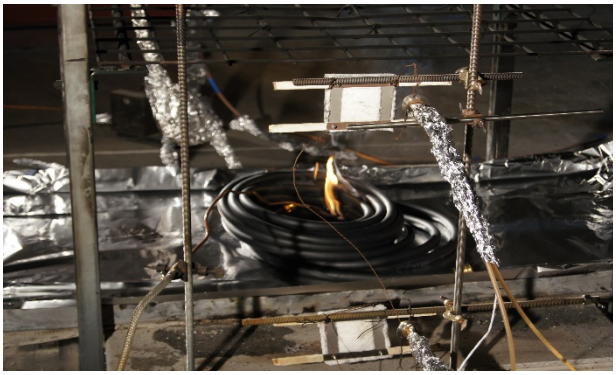
HF Gauge Heights[1] (cm): 10, 56 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test083 (NRC/NIST) **Test Item: Water Hose**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.05

Peak HRR (kW): 1.7 Burning Duration (s): 974 Ignition Method: Flame

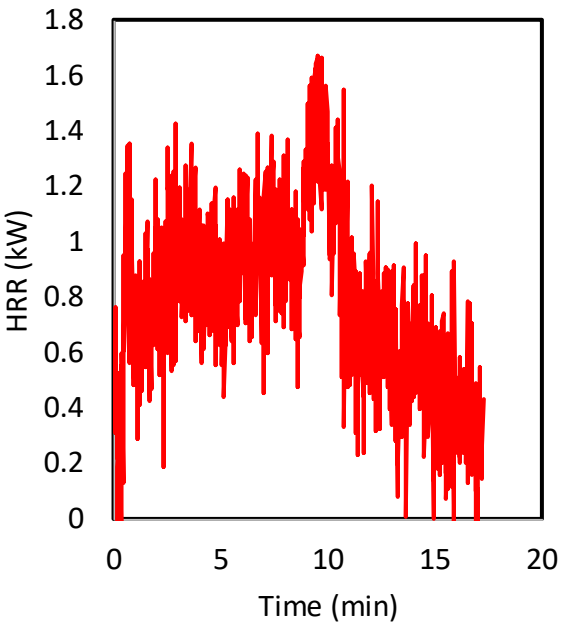
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.82

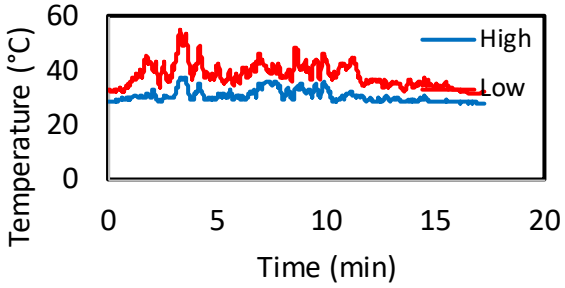
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

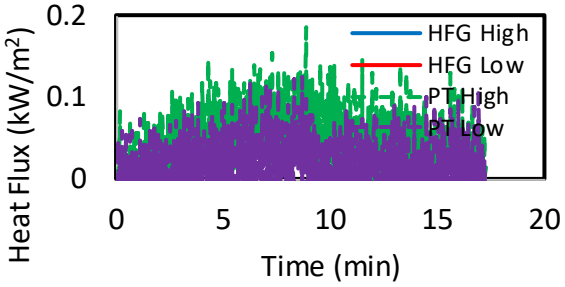
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 10, 56 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test031 (NRC/NIST) **Test Item: 15.2 m Coil 120 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.05

Peak HRR (kW): 1.0 Burning Duration (s): 607 Ignition Method: Flame

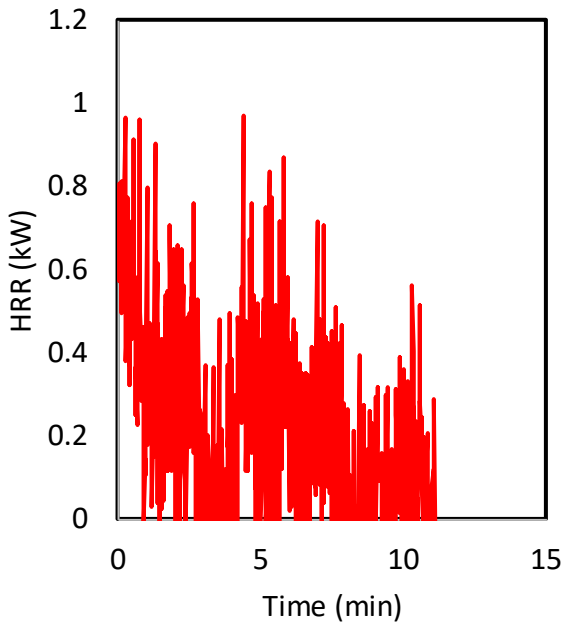
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.14

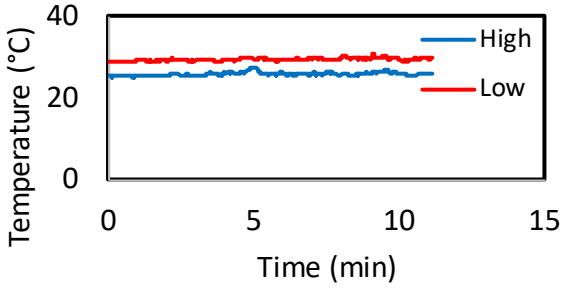
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

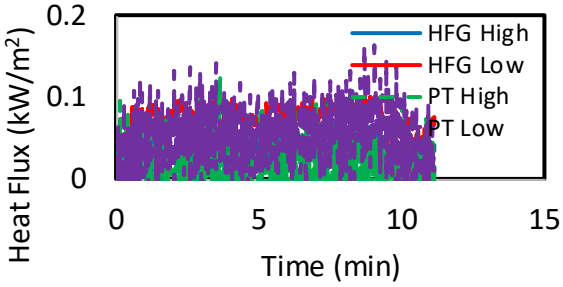
TC Grid Heights[1] (cm): 61, 107

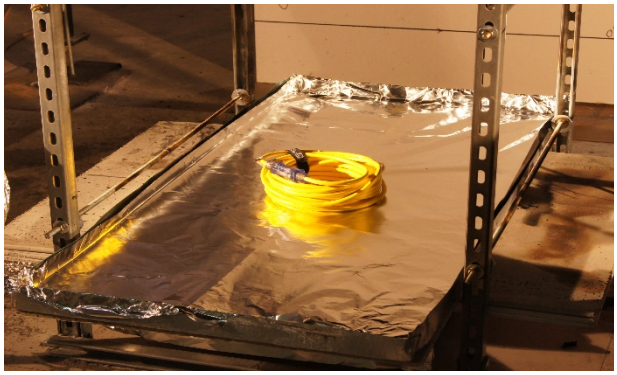
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test032 (NRC/NIST) **Test Item: 15.2 m Coil 120 V Cord**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.13

Peak HRR (kW): 0.7 Burning Duration (s): 603 Ignition Method: Flame

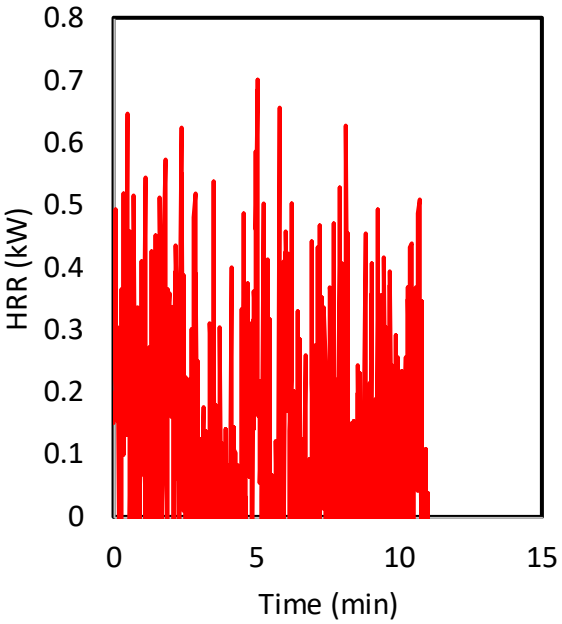
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.06

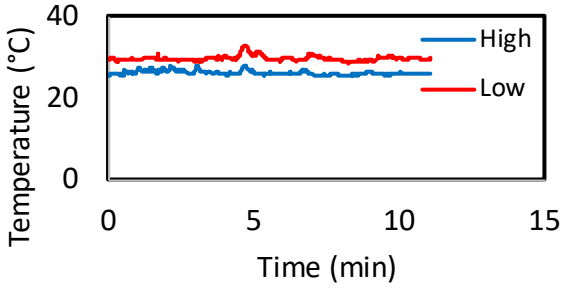
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

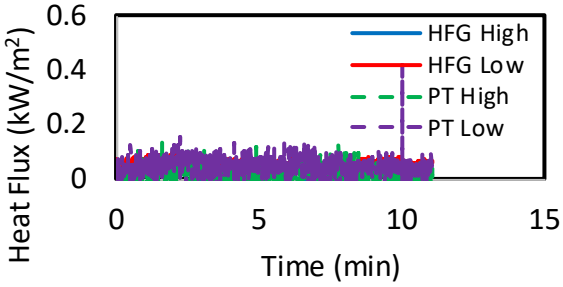
TC Grid Heights[1] (cm): 61, 107

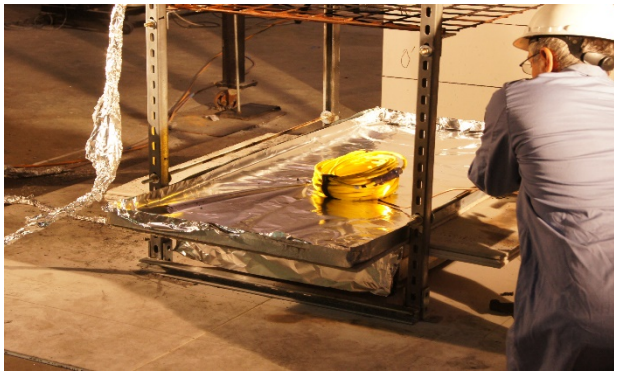
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test033 (NRC/NIST) **Test Item: 15.2 m Coil 120 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.06

Peak HRR (kW): 0.9 Burning Duration (s): 344 Ignition Method: Flame

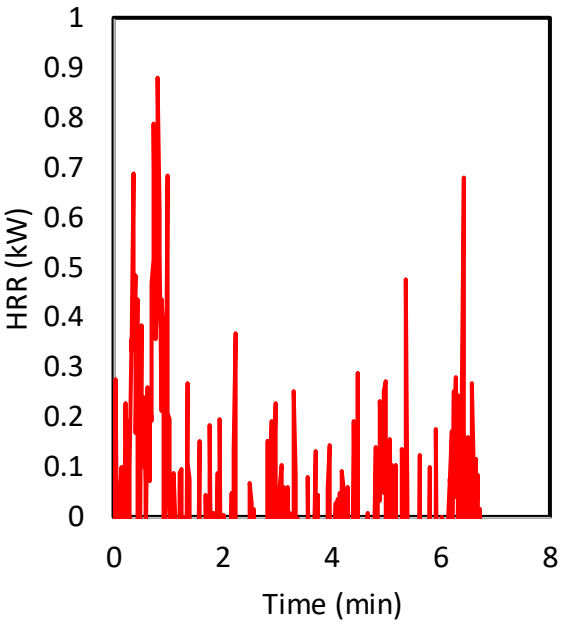
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.0

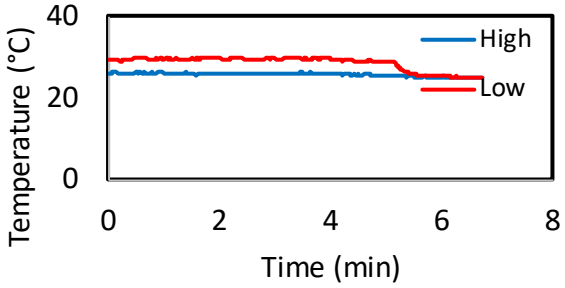
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

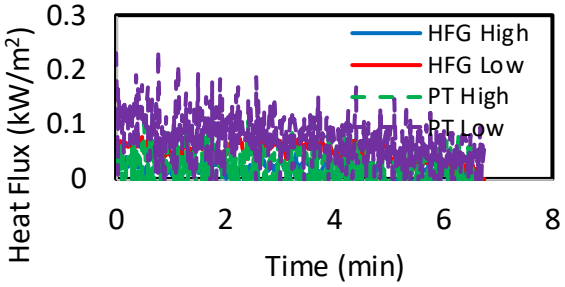
TC Grid Heights[1] (cm): 61, 107

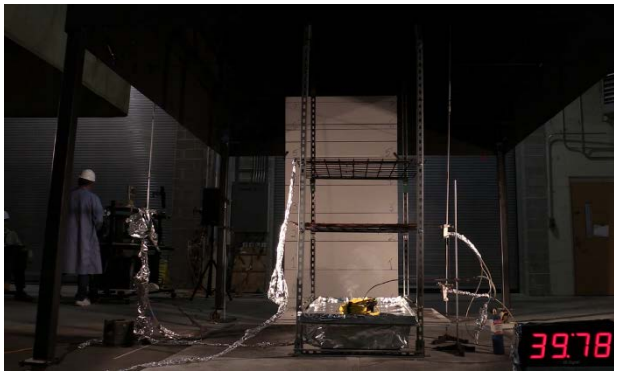
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test034 (NRC/NIST) **Test Item: 7.6 m Coil 250 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.12

Peak HRR (kW): 0.8 Burning Duration (s): 608 Ignition Method: Flame

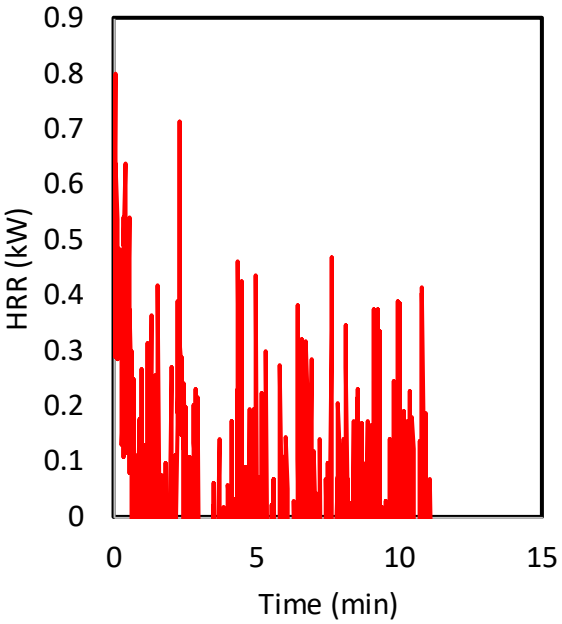
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.05

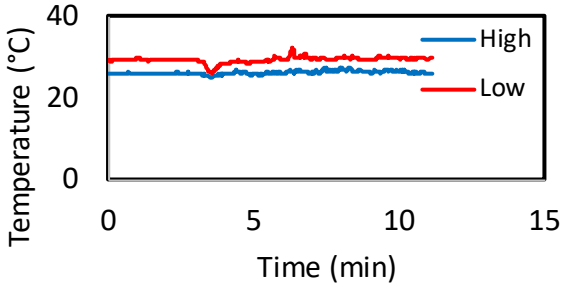
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

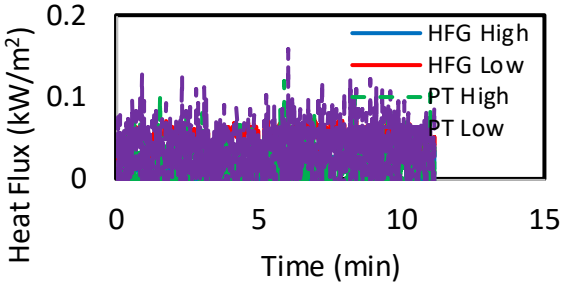
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test035 (NRC/NIST) **Test Item: 7.6 m Coil 250 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.12

Peak HRR (kW): 1.2 Burning Duration (s): 606 Ignition Method: Flame

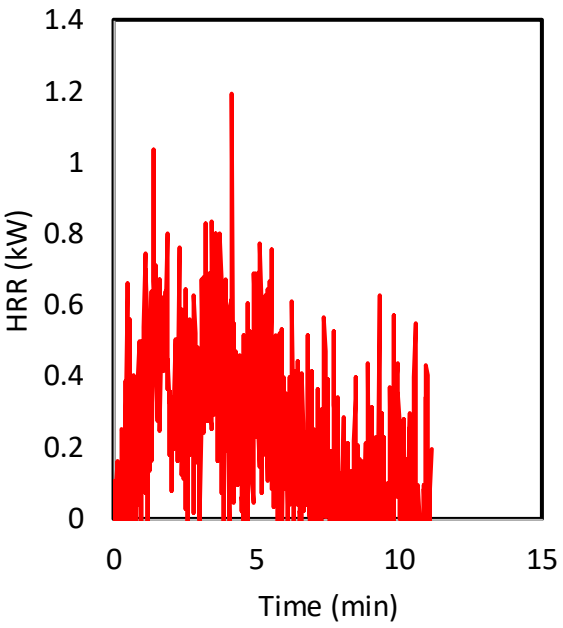
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.14

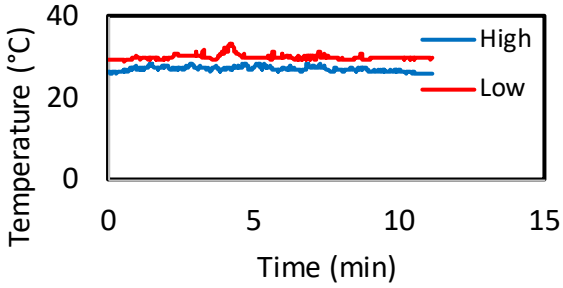
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

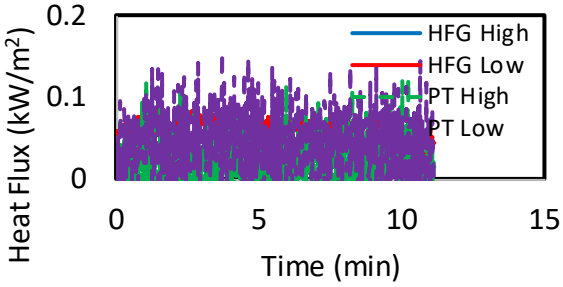
TC Grid Heights[1] (cm): 61, 107

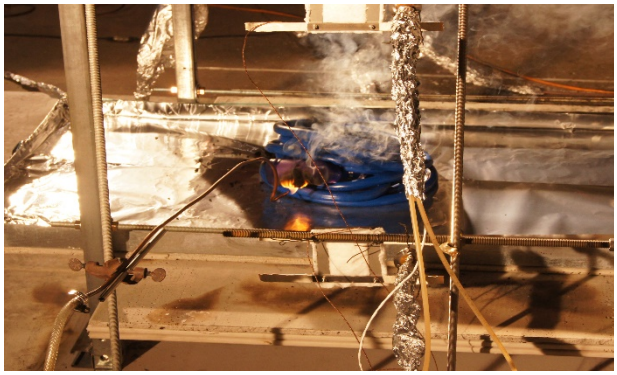
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

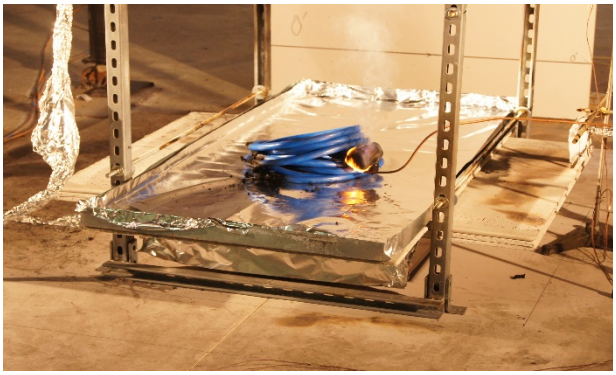
[1]From top of platform, [2]From center of platform











Test ID: Test036 (NRC/NIST) **Test Item: 7.6 m Coil 250 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.20

Peak HRR (kW): 1.0 Burning Duration (s): 625 Ignition Method: Flame

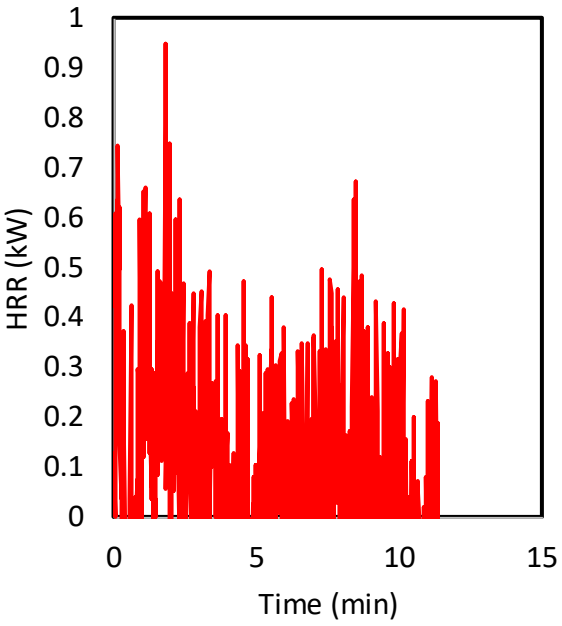
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.04

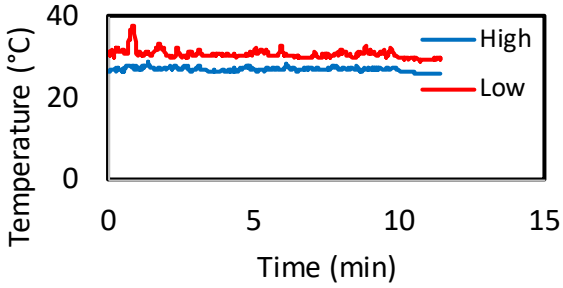
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

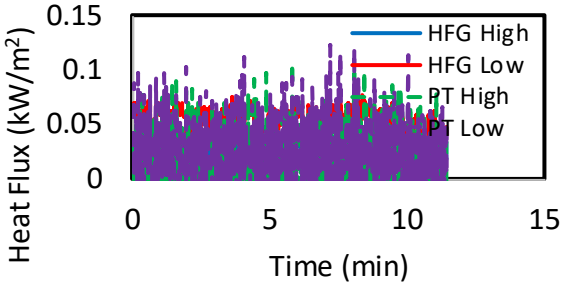
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test037 (NRC/NIST) **Test Item: Scissor Stand Quarter**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.38

Peak HRR (kW): 17.2 Burning Duration (s): 1,972 Ignition Method: Wick

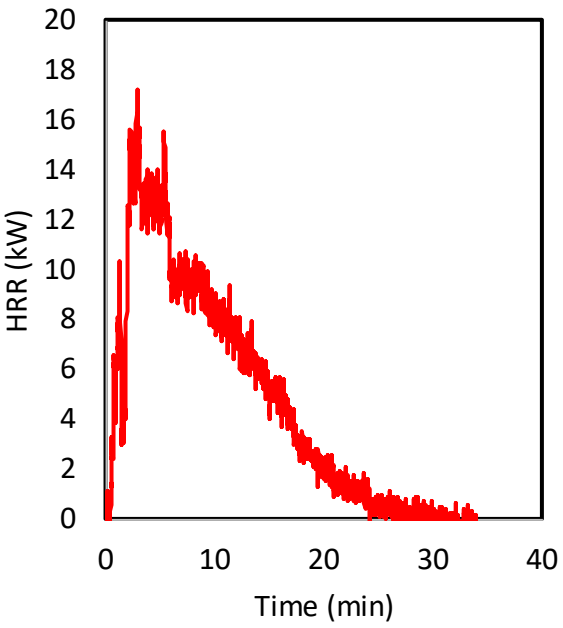
Heat of Combustion (MJ/kg): 36.1 Total Energy Release (MJ): 9.50

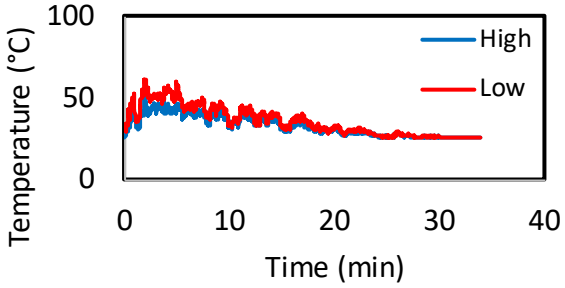
Soot Yield (kg/kg): 0.020 CO Yield (kg/kg): 0.005

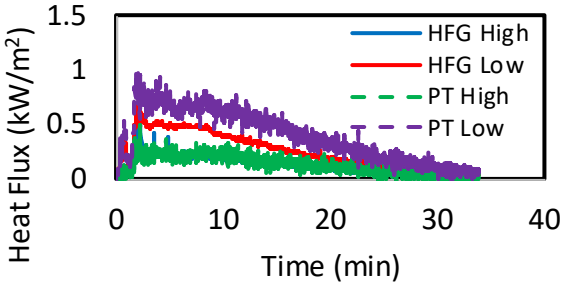
TC Grid Heights[1] (cm): 147, 193

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test040 (NRC/NIST) **Test Item: Scissor Stand Quarter**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.33

Peak HRR (kW): 12.6 Burning Duration (s): 1,790 Ignition Method: Wick

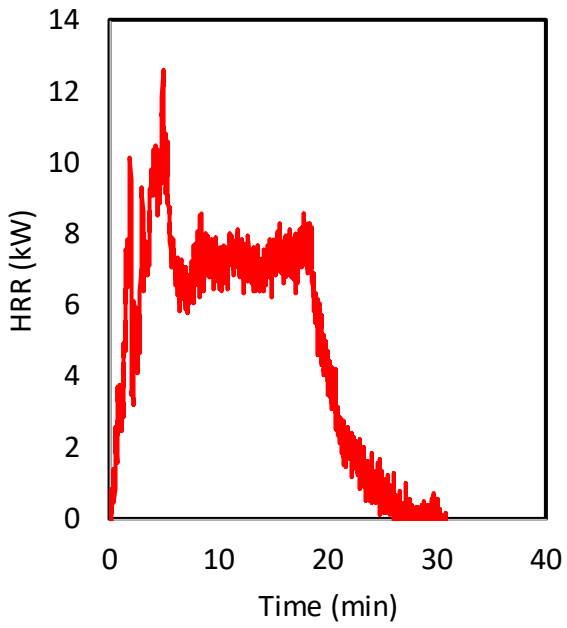
Heat of Combustion (MJ/kg): 42.8 Total Energy Release (MJ): 8.90

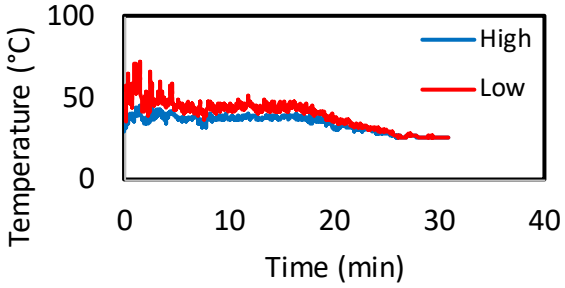
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.005

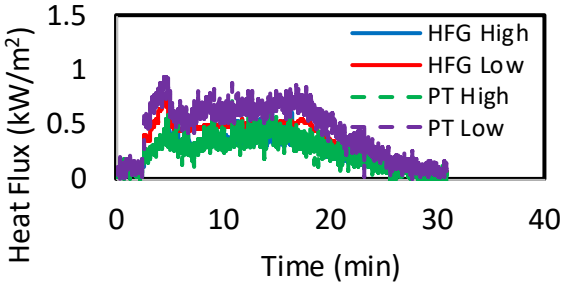
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test043 (NRC/NIST) **Test Item: Scissor Stand Quarter**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.44

Peak HRR (kW): 21.7 Burning Duration (s): 1,625 Ignition Method: Wick

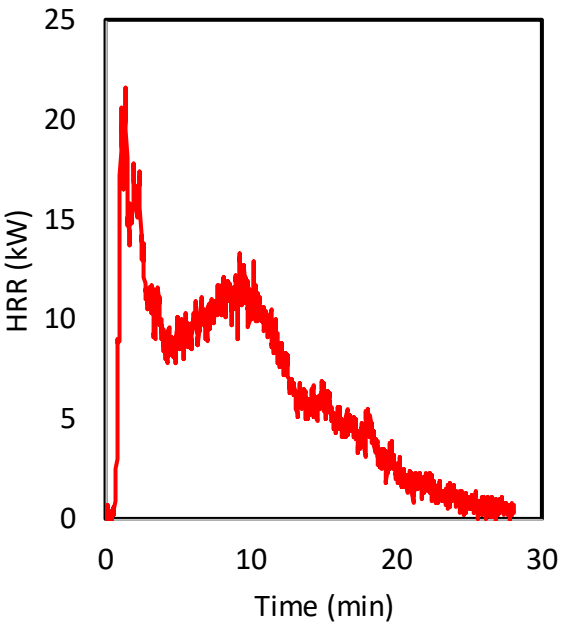
Heat of Combustion (MJ/kg): 37.9 Total Energy Release (MJ): 10.47

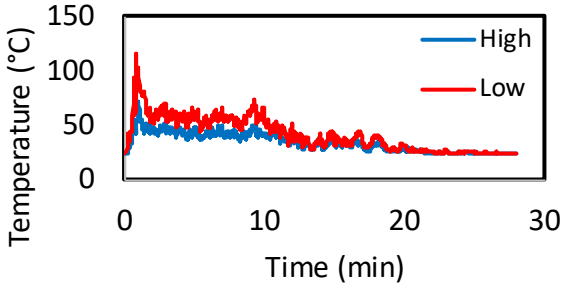
Soot Yield (kg/kg): 0.019 CO Yield (kg/kg): 0.008

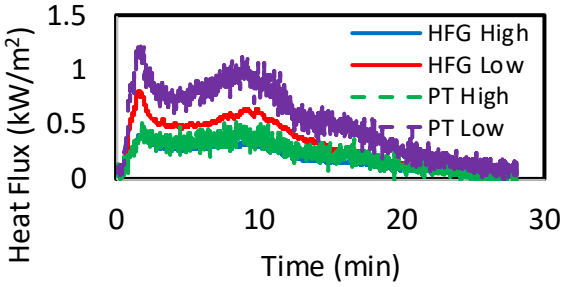
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test038 (NRC/NIST) **Test Item: Scissor Stand Half**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.44

Peak HRR (kW): 29.1 Burning Duration (s): 1,904 Ignition Method: Wick

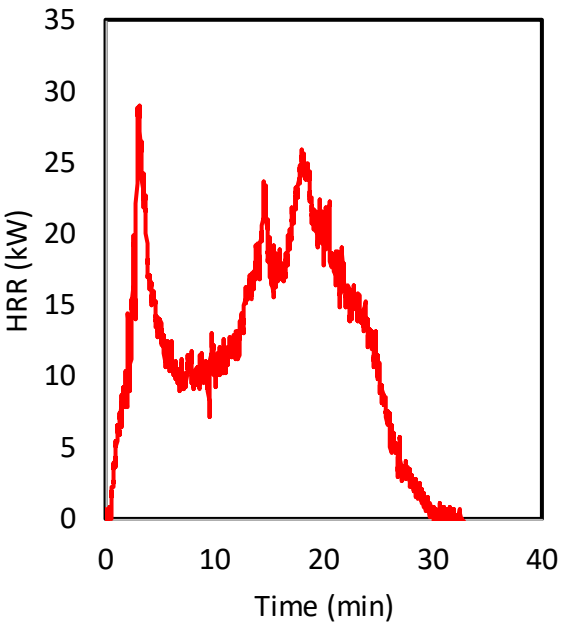
Heat of Combustion (MJ/kg): 39.1 Total Energy Release (MJ): 23.59

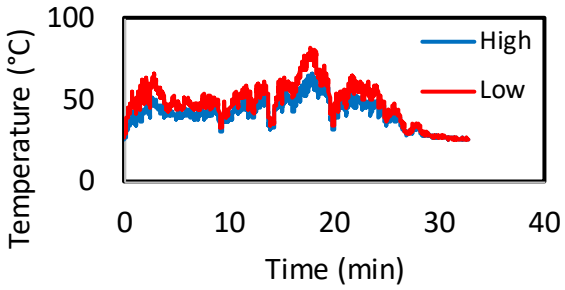
Soot Yield (kg/kg): 0.033 CO Yield (kg/kg): 0.009

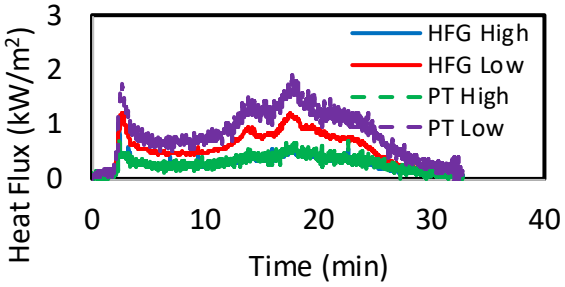
TC Grid Heights[1] (cm): 147, 193

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test041 (NRC/NIST) **Test Item: Scissor Stand Half**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.33

Peak HRR (kW): 31.4 Burning Duration (s): 1,796 Ignition Method: Wick

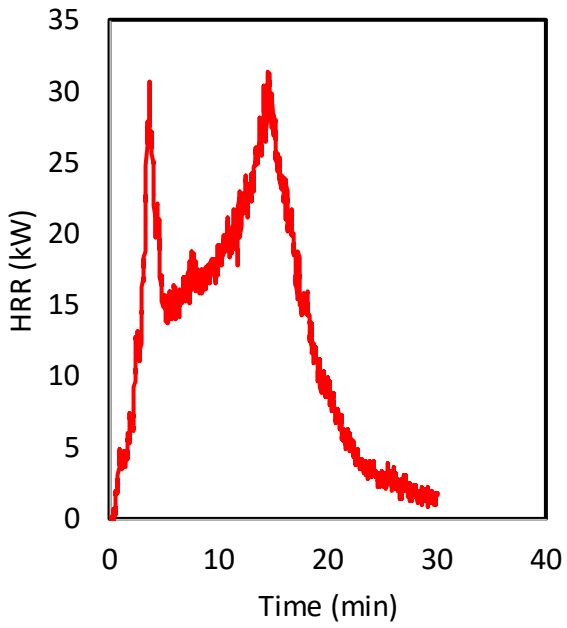
Heat of Combustion (MJ/kg): 39.4 Total Energy Release (MJ): 23.66

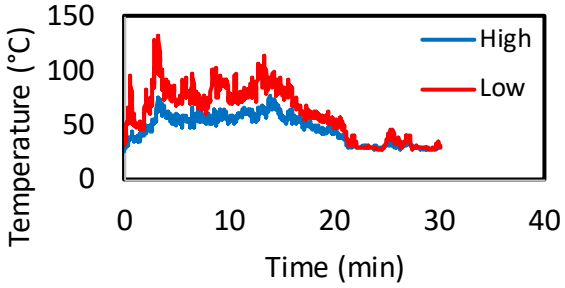
Soot Yield (kg/kg): 0.023 CO Yield (kg/kg): 0.009

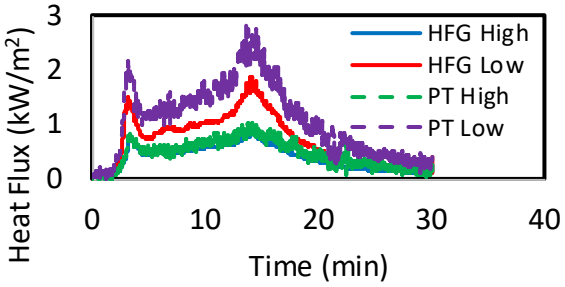
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test044 (NRC/NIST) **Test Item: Scissor Stand Half**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 0.56

Peak HRR (kW): 59.6 Burning Duration (s): 1,299 Ignition Method: Wick

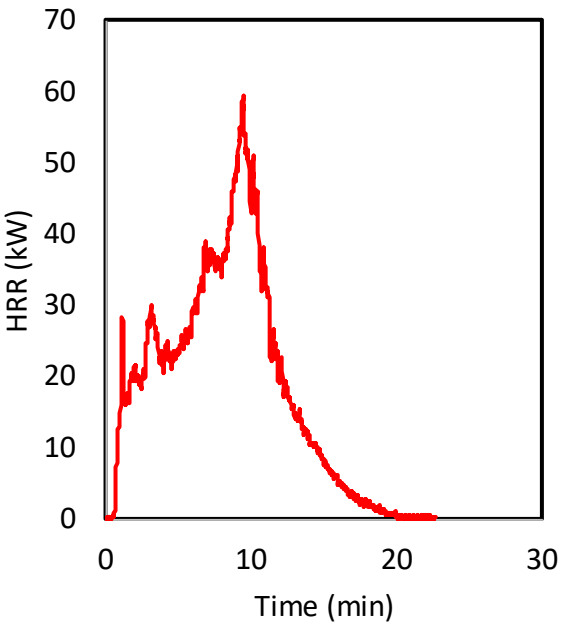
Heat of Combustion (MJ/kg): 37.9 Total Energy Release (MJ): 24.31

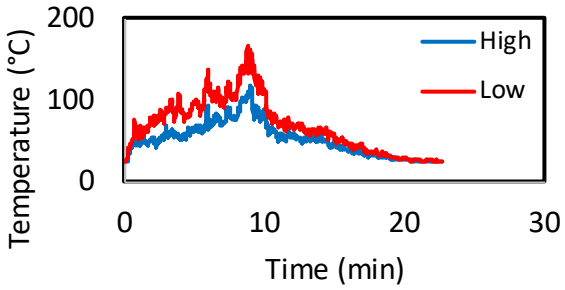
Soot Yield (kg/kg): 0.046 CO Yield (kg/kg): 0.016

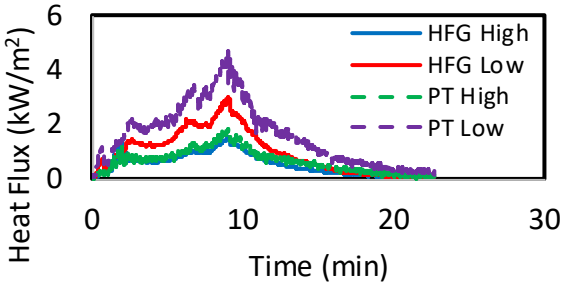
TC Grid Heights[1] (cm): 107, 152

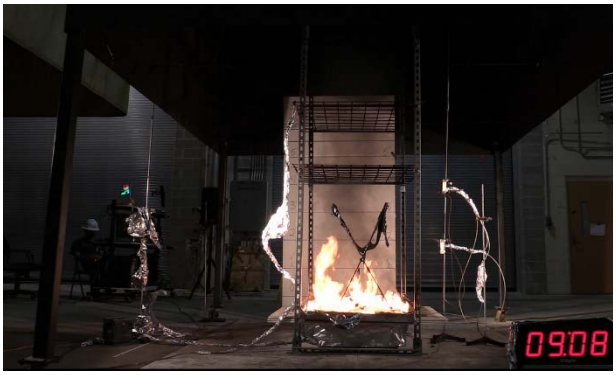
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test039 (NRC/NIST) **Test Item: Scissor Stand Full**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 0.73

Peak HRR (kW): 109 Burning Duration (s): 1,788 Ignition Method: Wick

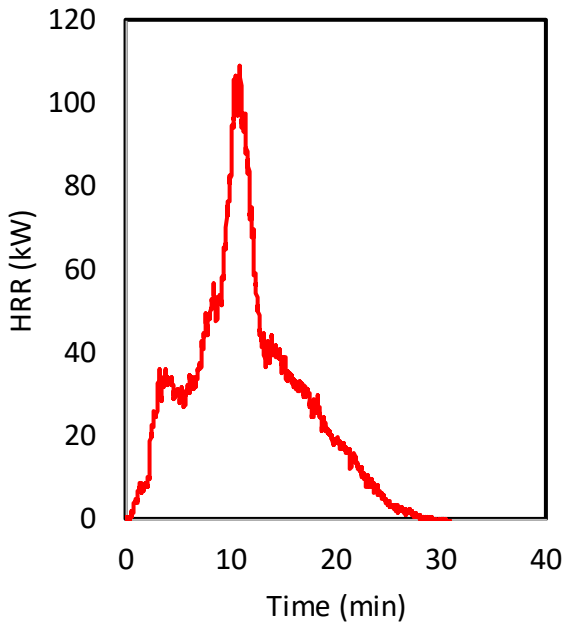
Heat of Combustion (MJ/kg): 35.1 Total Energy Release (MJ): 50.57

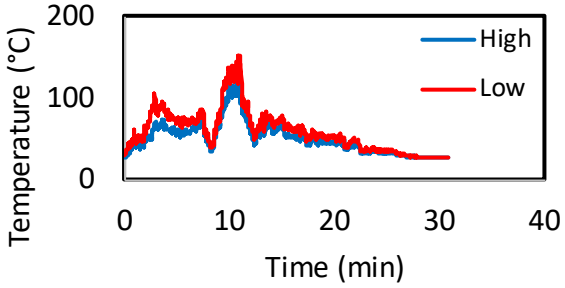
Soot Yield (kg/kg): 0.039 CO Yield (kg/kg): 0.012

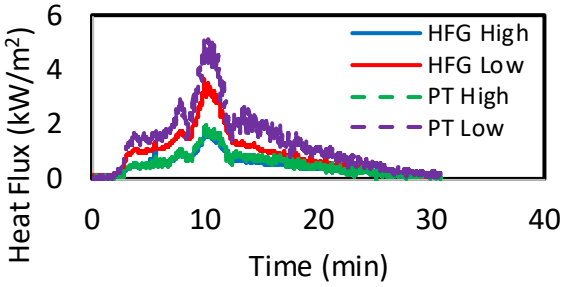
TC Grid Heights[1] (cm): 147, 193

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test042 (NRC/NIST) **Test Item: Scissor Stand Full**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.02

Peak HRR (kW): 111 Burning Duration (s): 1,753 Ignition Method: Flame

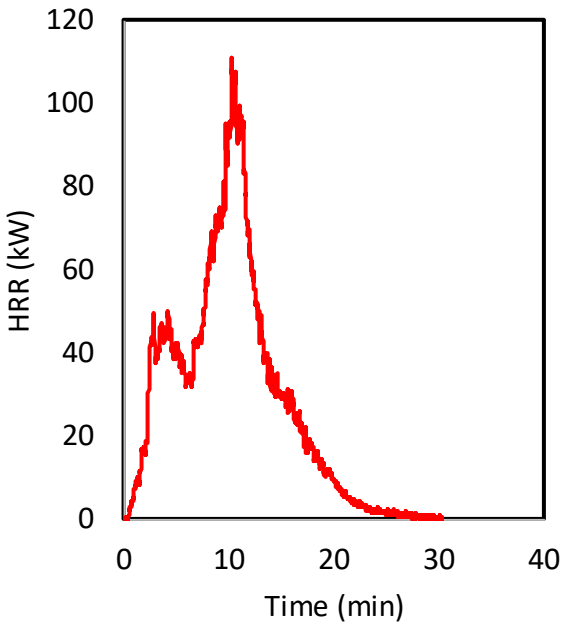
Heat of Combustion (MJ/kg): 36.0 Total Energy Release (MJ): 49.94

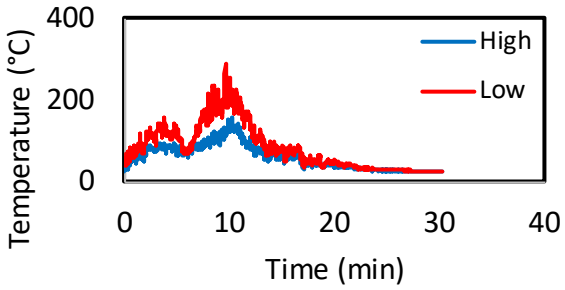
Soot Yield (kg/kg): 0.044 CO Yield (kg/kg): 0.014

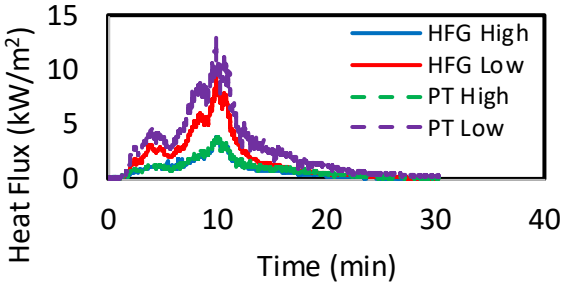
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test045 (NRC/NIST) **Test Item: Scissor Stand Full**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.16

Peak HRR (kW): 181 Burning Duration (s): 1,276 Ignition Method: Flame

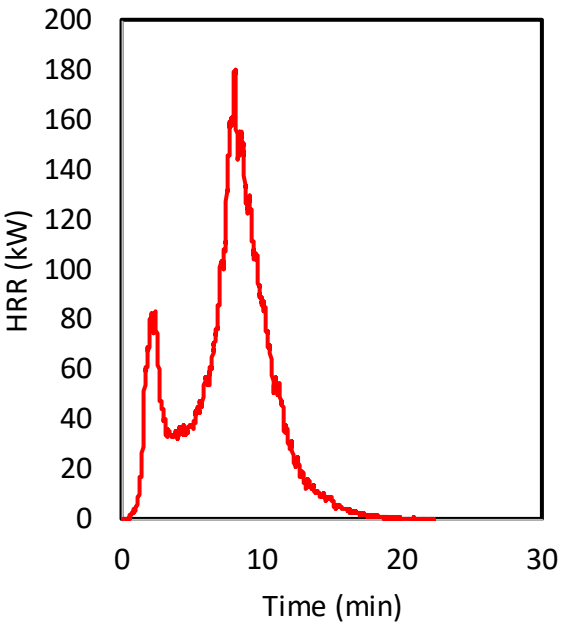
Heat of Combustion (MJ/kg): 36.1 Total Energy Release (MJ): 50.52

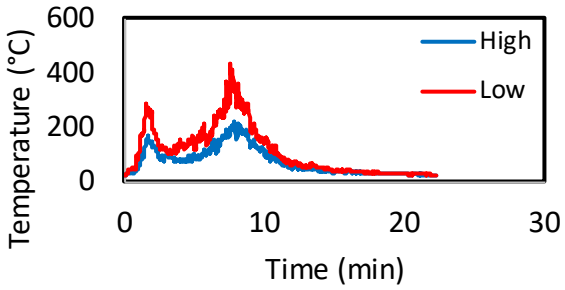
Soot Yield (kg/kg): 0.046 CO Yield (kg/kg): 0.016

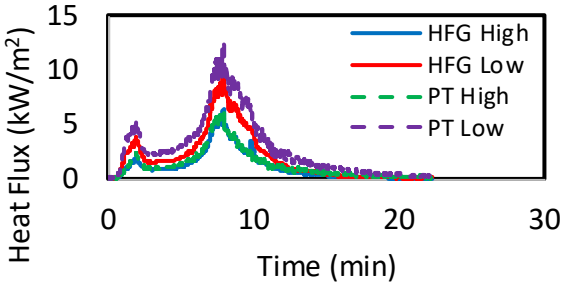
TC Grid Heights[1] (cm): 107, 152

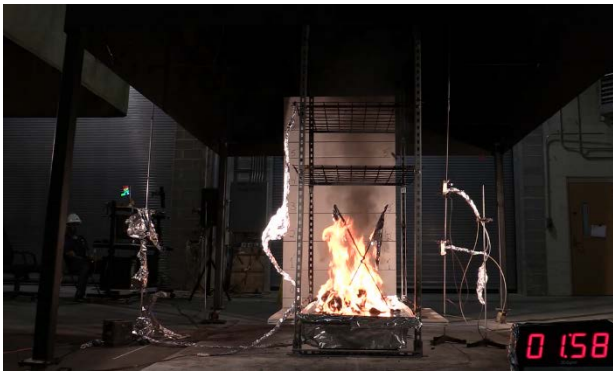
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 58

[1]From top of platform, [2]From center of platform









Test ID: Test046 (NRC/NIST) **Test Item: Vacuum Open**

Max Fire Diameter (m): 0.94 Max Flame Height (m): 1.67

Peak HRR (kW): 545 Burning Duration (s): 3,615 Ignition Method: Wick

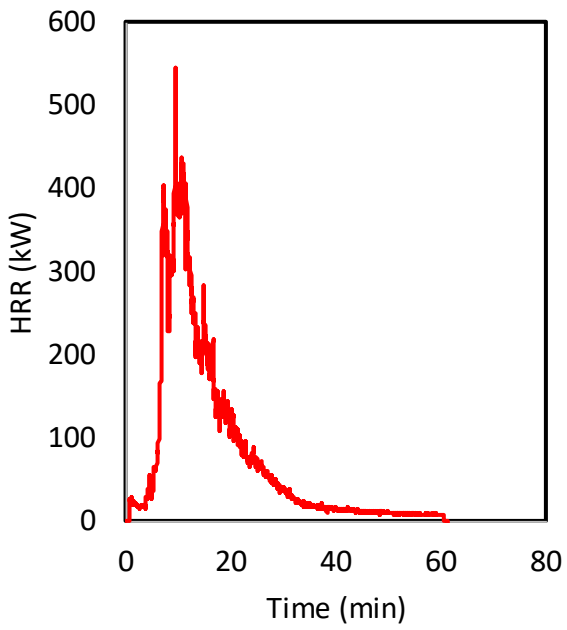
Heat of Combustion (MJ/kg): 35.2 Total Energy Release (MJ): 285.1

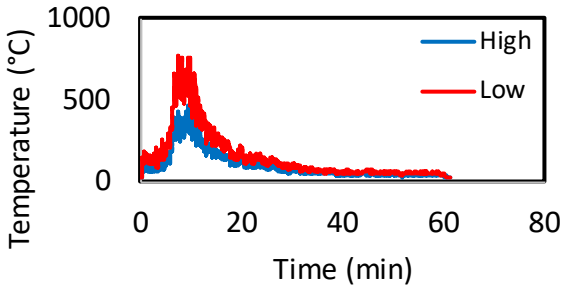
Soot Yield (kg/kg): 0.059 CO Yield (kg/kg): 0.028

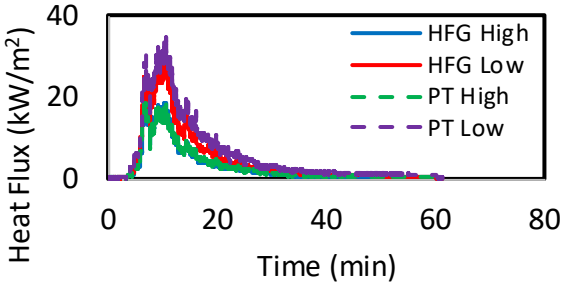
TC Grid Heights[1] (cm): 107, 152

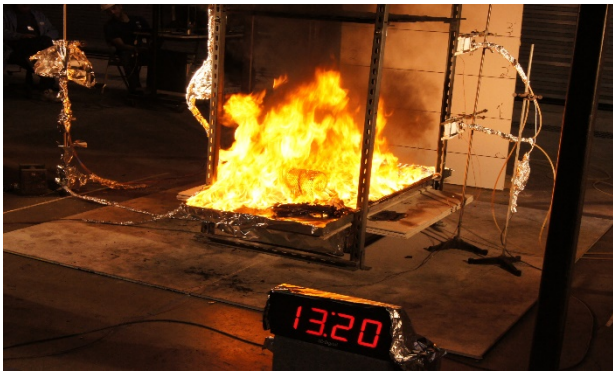
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test049 (NRC/NIST) **Test Item: Vacuum Open**

Max Fire Diameter (m): 0.94 Max Flame Height (m): 1.72

Peak HRR (kW): 520 Burning Duration (s): 3,617 Ignition Method: Wick

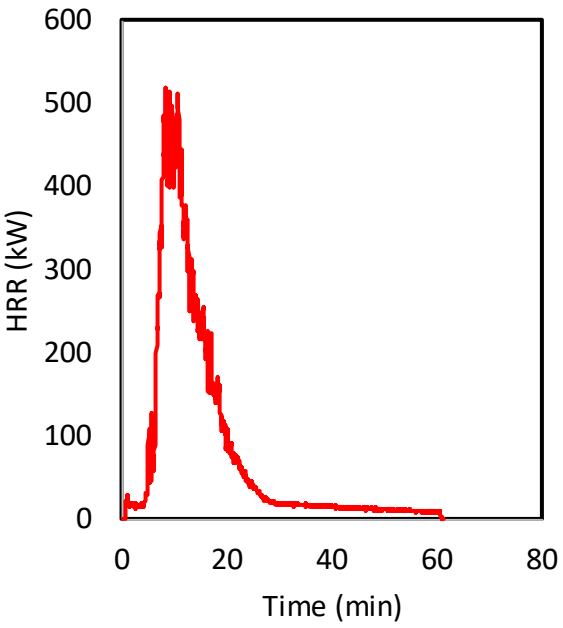
Heat of Combustion (MJ/kg): 35.4 Total Energy Release (MJ): 298.7

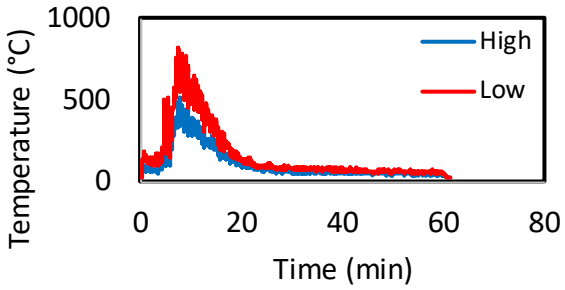
Soot Yield (kg/kg): 0.061 CO Yield (kg/kg): 0.030

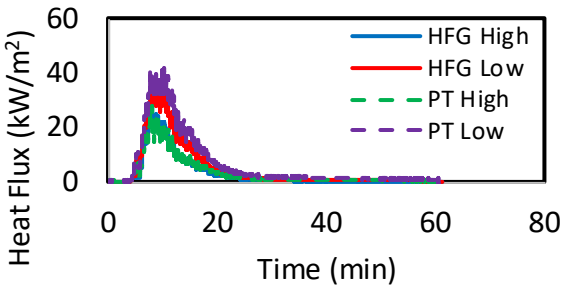
TC Grid Heights[1] (cm): 107, 152

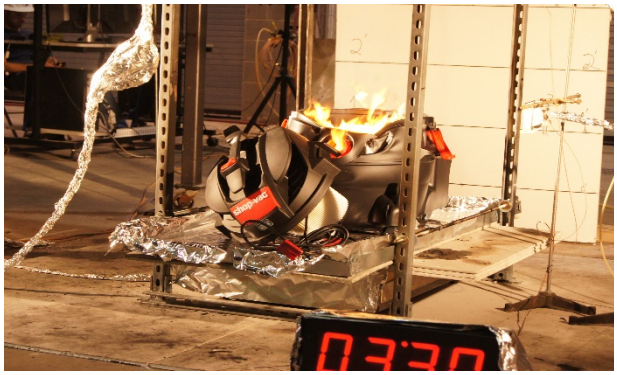
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test047 (NRC/NIST) **Test Item: Vacuum Closed**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.00

Peak HRR (kW): 1.3 Burning Duration (s): 25 Ignition Method: Wick

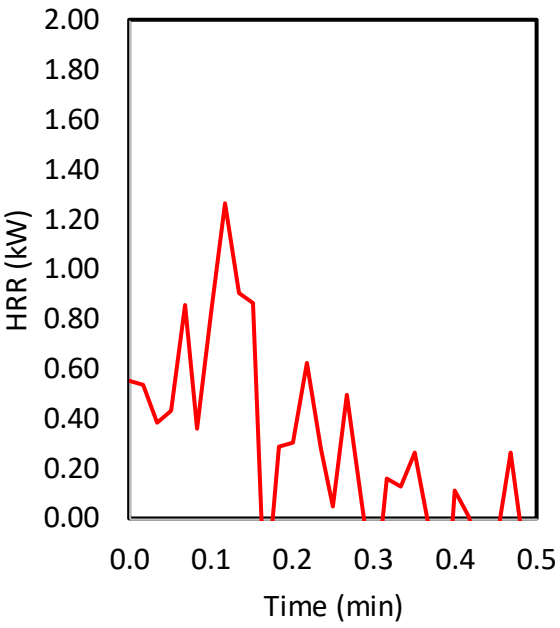
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.05

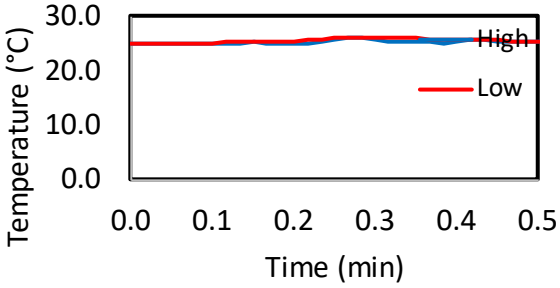
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

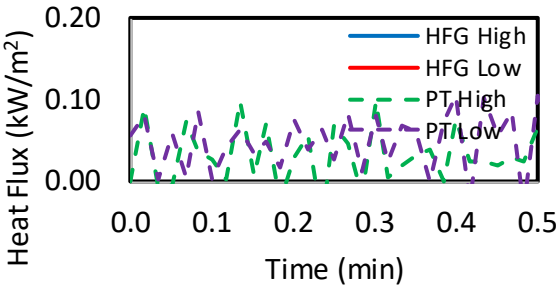
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test048 (NRC/NIST) **Test Item: Vacuum Closed**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.00

Peak HRR (kW): 0.8 Burning Duration (s): 23 Ignition Method: Wick

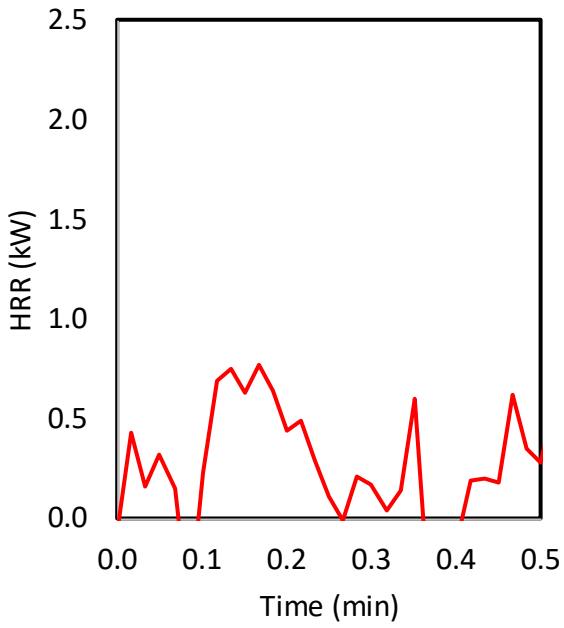
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.06

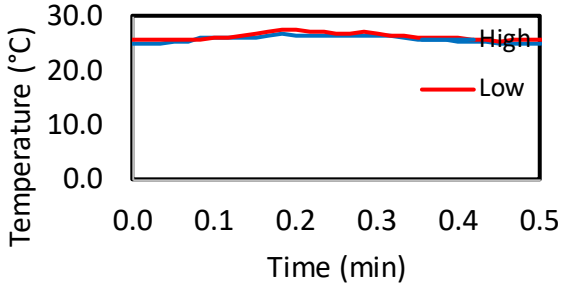
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

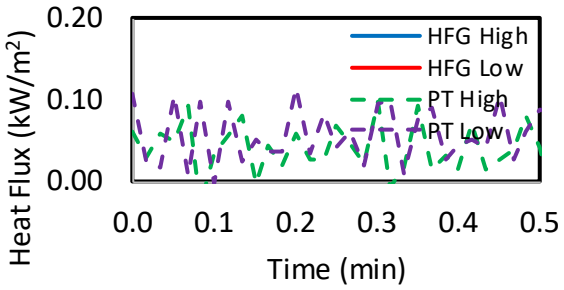
TC Grid Heights[1] (cm): 107, 152

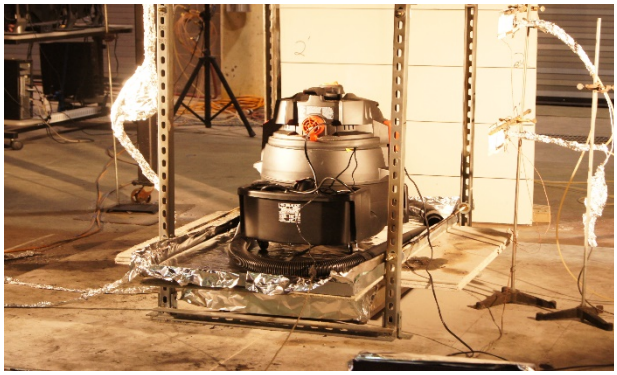
HF Gauge Heights[1] (cm): 51, 97 HF Gauge Distance[2] (cm): 61

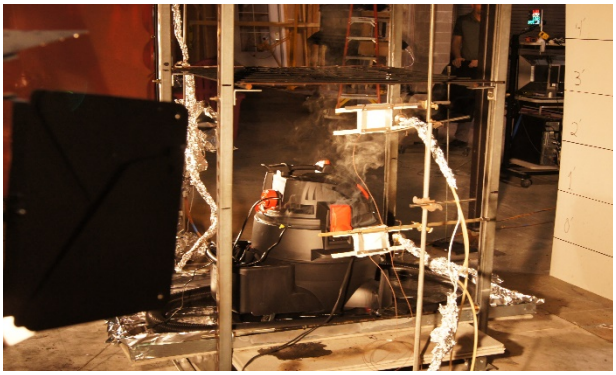
[1]From top of platform, [2]From center of platform











Test ID: Test050 (NRC/NIST) **Test Item: FR Plastic Tarp Draped**

Max Fire Diameter (m): 0.91 Max Flame Height (m): 0.85

Peak HRR (kW): 80.3 Burning Duration (s): 2,163 Ignition Method: Wick

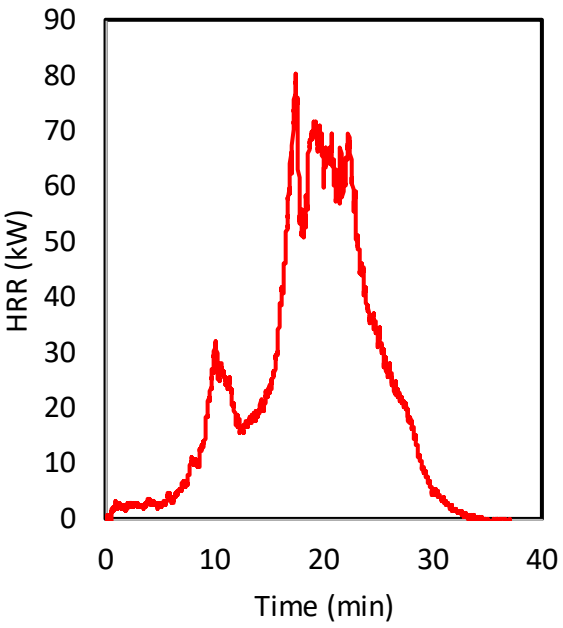
Heat of Combustion (MJ/kg): 37.4 Total Energy Release (MJ): 48.60

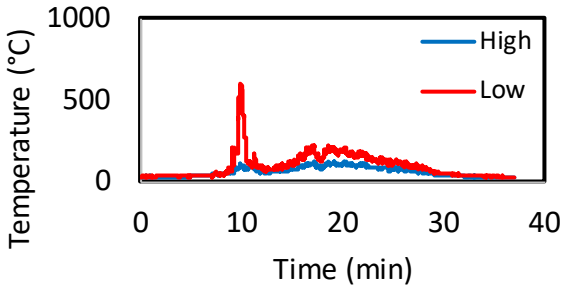
Soot Yield (kg/kg): 0.050 CO Yield (kg/kg): 0.023

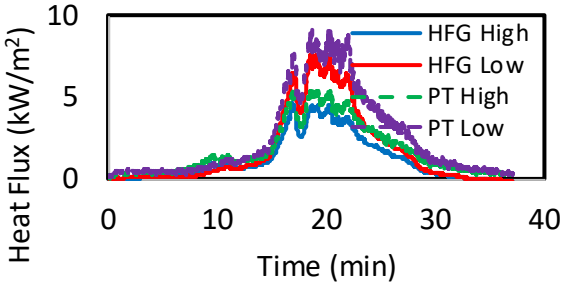
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test051 (NRC/NIST) **Test Item: FR Plastic Tarp Draped**

Max Fire Diameter (m): 0.91 Max Flame Height (m): 0.67

Peak HRR (kW): 48.7 Burning Duration (s): 2,855 Ignition Method: Wick

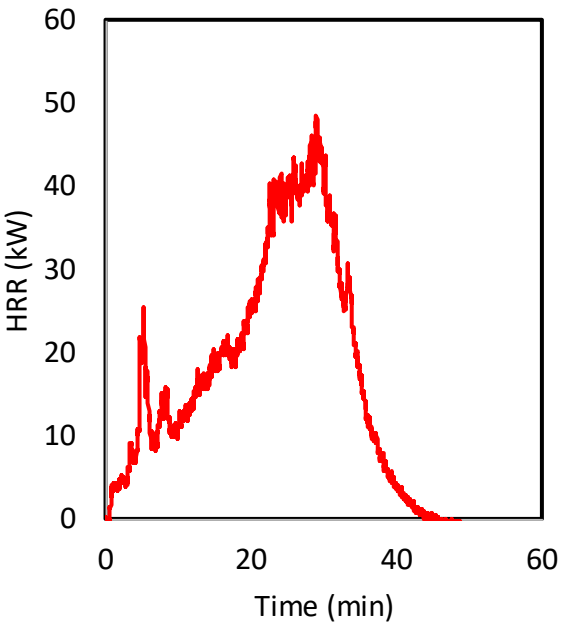
Heat of Combustion (MJ/kg): 38.1 Total Energy Release (MJ): 50.97

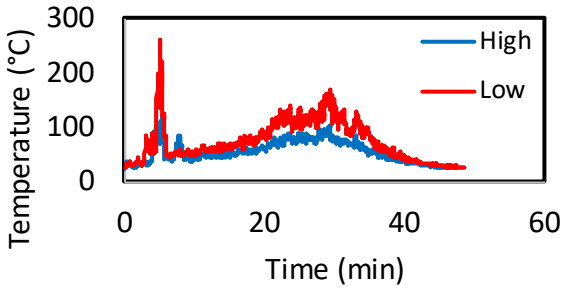
Soot Yield (kg/kg): 0.034 CO Yield (kg/kg): 0.014

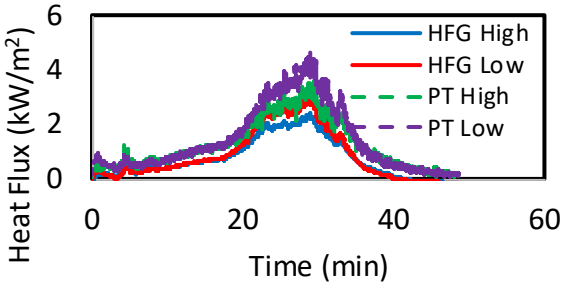
TC Grid Heights[1] (cm): 107, 152

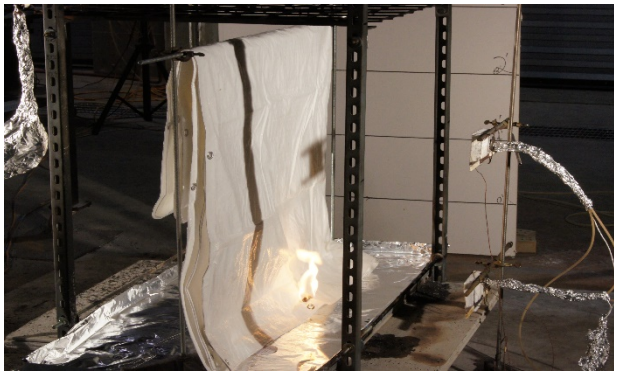
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test052 (NRC/NIST) **Test Item: FR Plastic Tarp Folded**

Max Fire Diameter (m): 0.60 Max Flame Height (m): 0.98

Peak HRR (kW): 79.8 Burning Duration (s): 3,392 Ignition Method: Wick

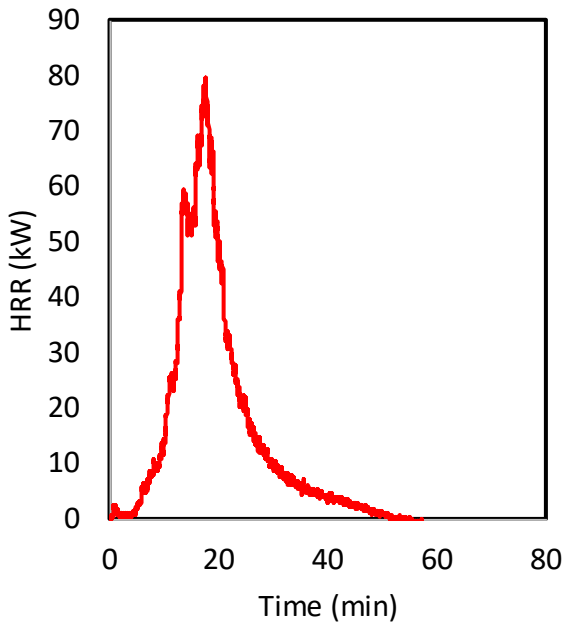
Heat of Combustion (MJ/kg): 37.4 Total Energy Release (MJ): 51.31

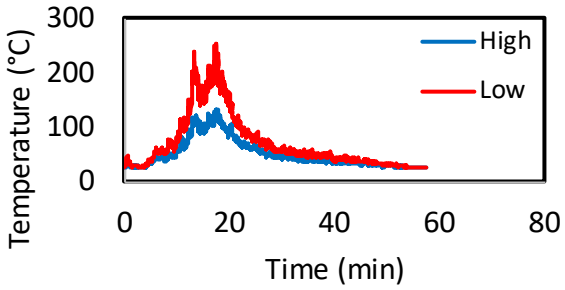
Soot Yield (kg/kg): 0.040 CO Yield (kg/kg): 0.015

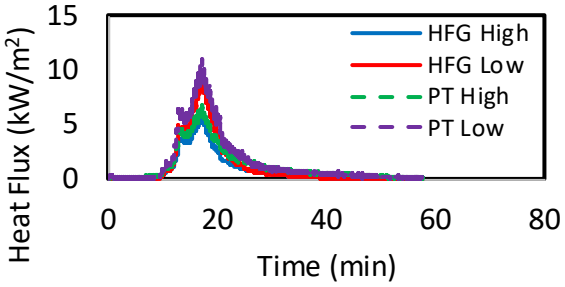
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test053 (NRC/NIST) **Test Item: Canvas Tarp Draped**

Max Fire Diameter (m): 1.12 Max Flame Height (m): 2.16

Peak HRR (kW): 470 Burning Duration (s): 581 Ignition Method: Wick

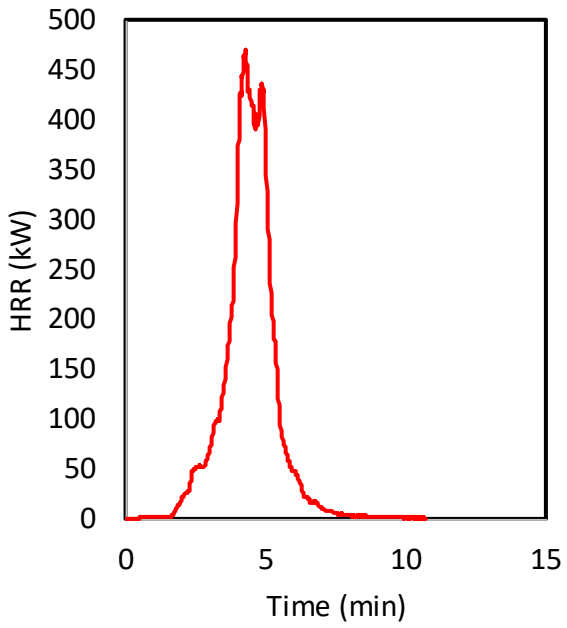
Heat of Combustion (MJ/kg): 14.1 Total Energy Release (MJ): 48.27

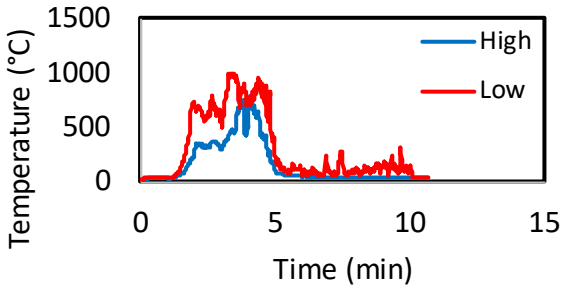
Soot Yield (kg/kg): 0.002 CO Yield (kg/kg): 0.028

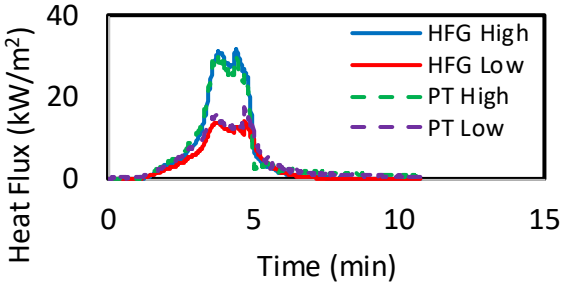
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test054 (NRC/NIST) **Test Item: Canvas Tarp Draped**

Max Fire Diameter (m): 1.12 Max Flame Height (m): 2.68

Peak HRR (kW): 570 Burning Duration (s): 517 Ignition Method: Wick

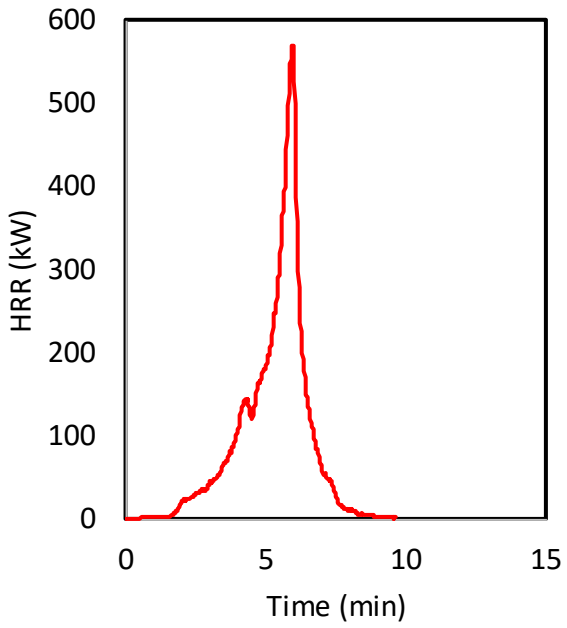
Heat of Combustion (MJ/kg): 14.0 Total Energy Release (MJ): 49.03

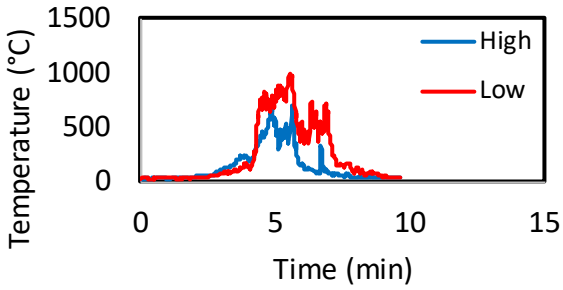
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.024

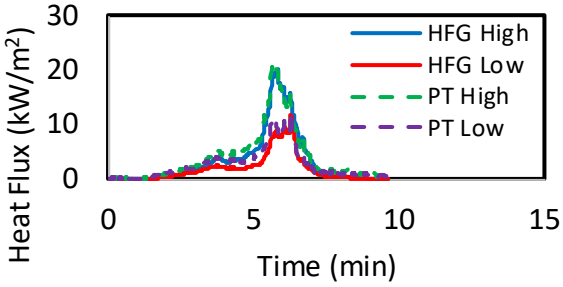
TC Grid Heights[1] (cm): 107, 152

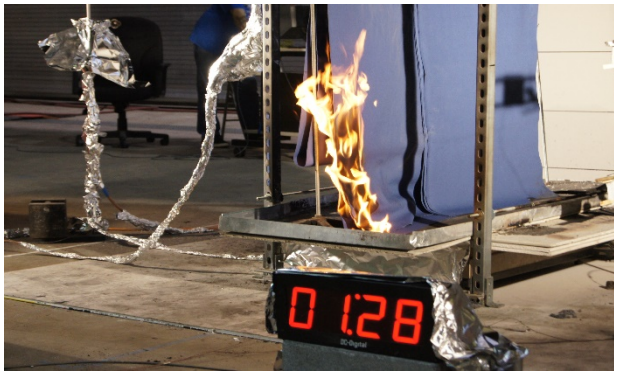
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test055 (NRC/NIST) **Test Item: Canvas Tarp Folded**

Max Fire Diameter (m): 0.17 Max Flame Height (m): 0.24

Peak HRR (kW): 12.0 Burning Duration (s): 3,585 Ignition Method: Wick

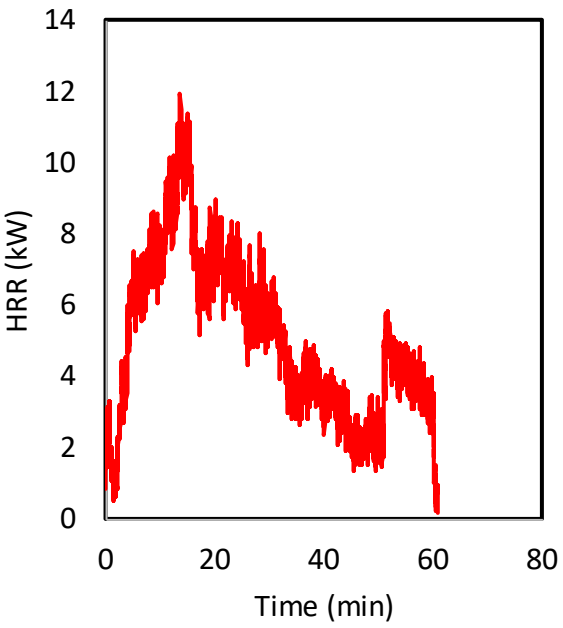
Heat of Combustion (MJ/kg): 10.5 Total Energy Release (MJ): 18.48

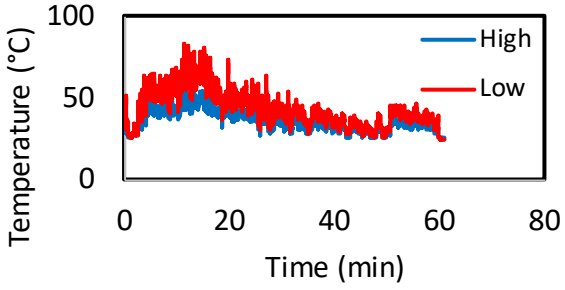
Soot Yield (kg/kg): 0.009 CO Yield (kg/kg): 0.084

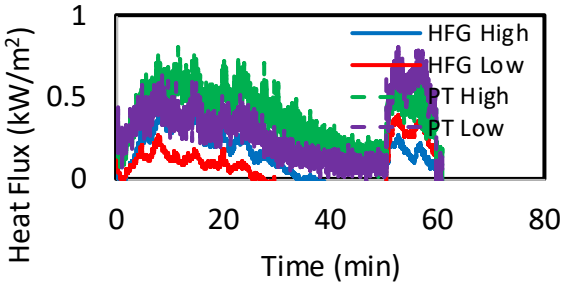
TC Grid Heights[1] (cm): 107, 152

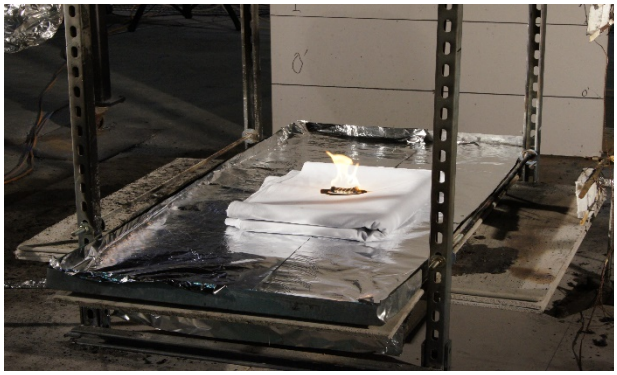
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test056 (NRC/NIST) **Test Item: Alcohol Bottle**

Max Fire Diameter (m): 0.1 Max Flame Height (m): 1.18

Peak HRR (kW): 211 Burning Duration (s): 1,235 Ignition Method: Flame

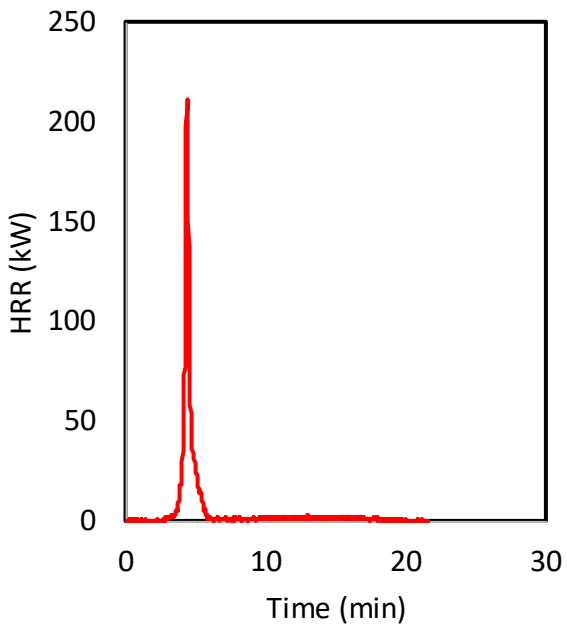
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 7.19

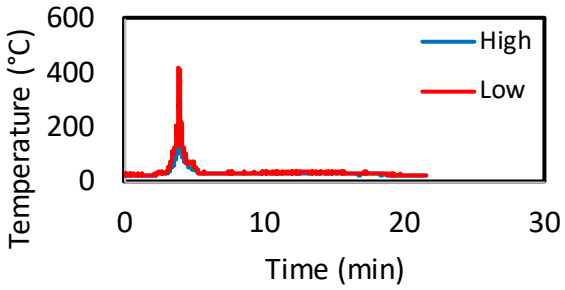
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

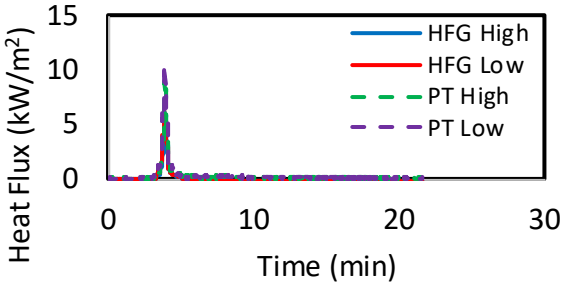
TC Grid Heights[1] (cm): 107, 152

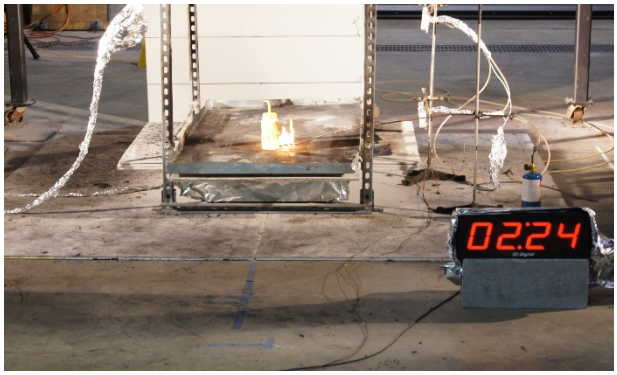
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

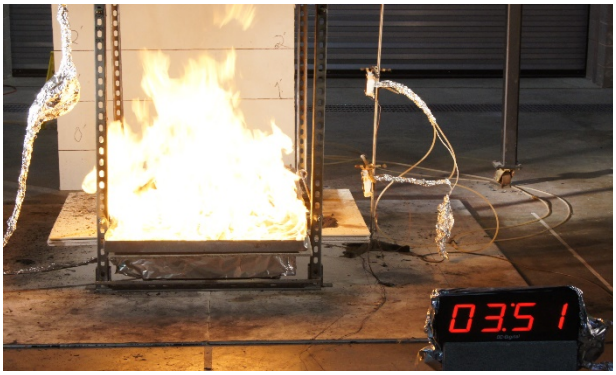
[1]From top of platform, [2]From center of platform











Test ID: Test060 (NRC/NIST) **Test Item: Alcohol Bottle**

Max Fire Diameter (m): 0.56 Max Flame Height (m): 1.29

Peak HRR (kW): 144 Burning Duration (s): 1,673 Ignition Method: Flame

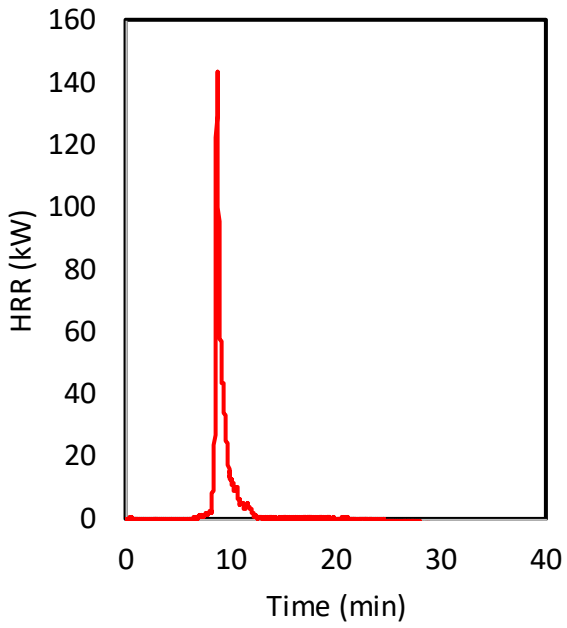
Heat of Combustion (MJ/kg): 28.7 Total Energy Release (MJ): 5.70

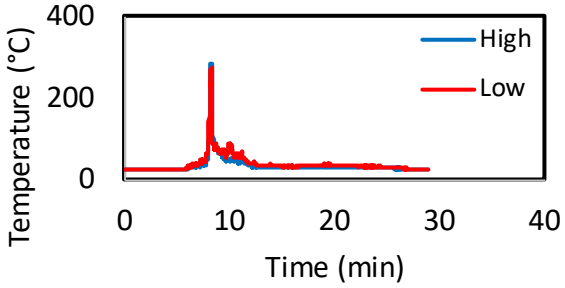
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.016

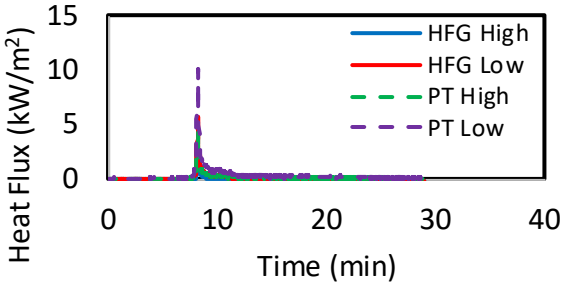
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test061 (NRC/NIST) **Test Item: Alcohol Bottle**

Max Fire Diameter (m): 0.46 Max Flame Height (m): 1.00

Peak HRR (kW): 143 Burning Duration (s): 1,199 Ignition Method: Flame

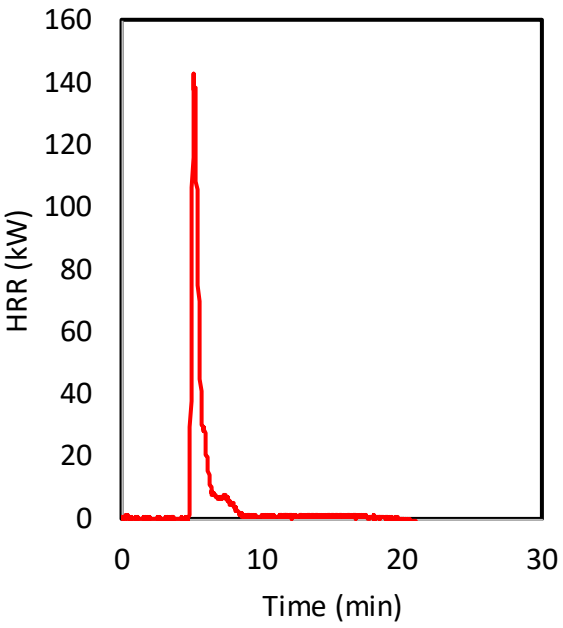
Heat of Combustion (MJ/kg): 30.1 Total Energy Release (MJ): 6.56

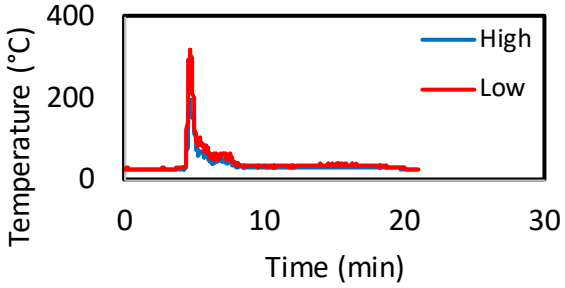
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.016

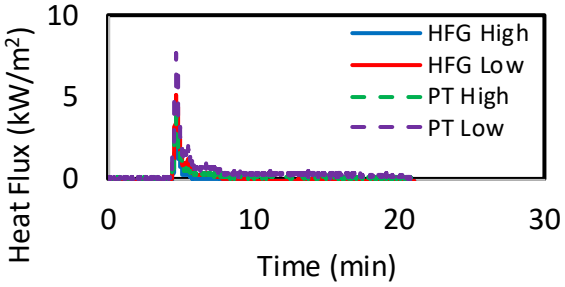
TC Grid Heights[1] (cm): 107, 152

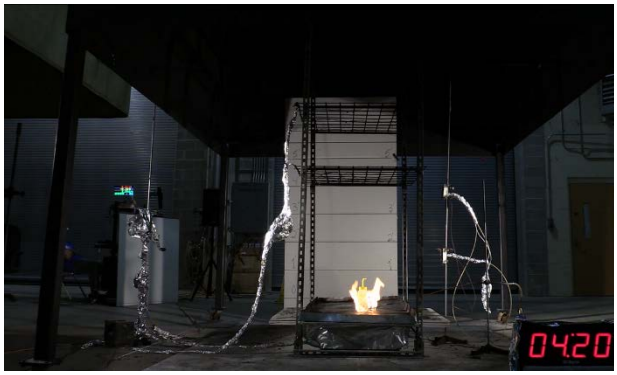
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test062 (NRC/NIST) **Test Item: Oil Bottle**

Max Fire Diameter (m): 0.08 Max Flame Height (m): 0.06

Peak HRR (kW): 1.7 Burning Duration (s): 1,497 Ignition Method: Flame

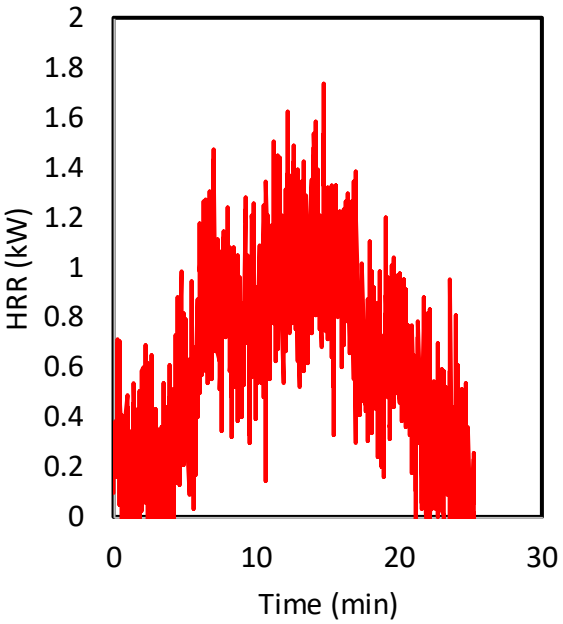
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.93

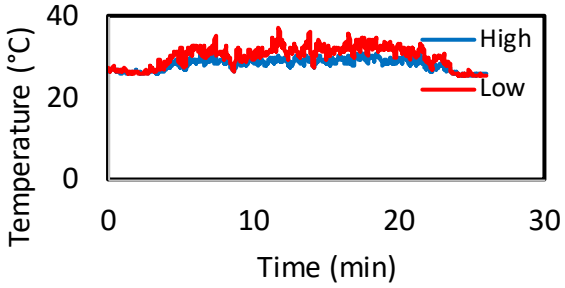
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

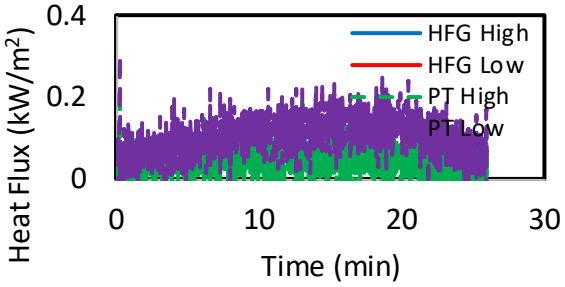
TC Grid Heights[1] (cm): 107, 152

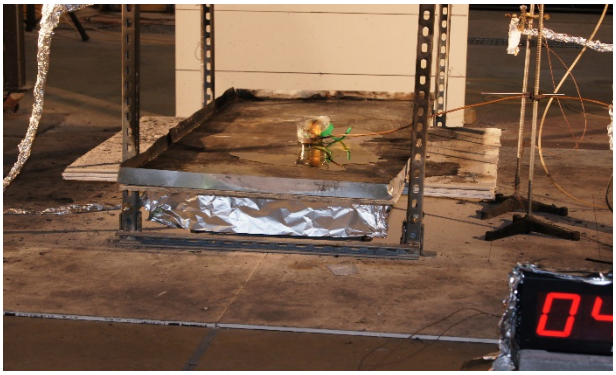
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test063 (NRC/NIST) **Test Item: Oil Bottle**

Max Fire Diameter (m): 0.09 Max Flame Height (m): 0.02

Peak HRR (kW): 1.7 Burning Duration (s): 1,714 Ignition Method: Flame

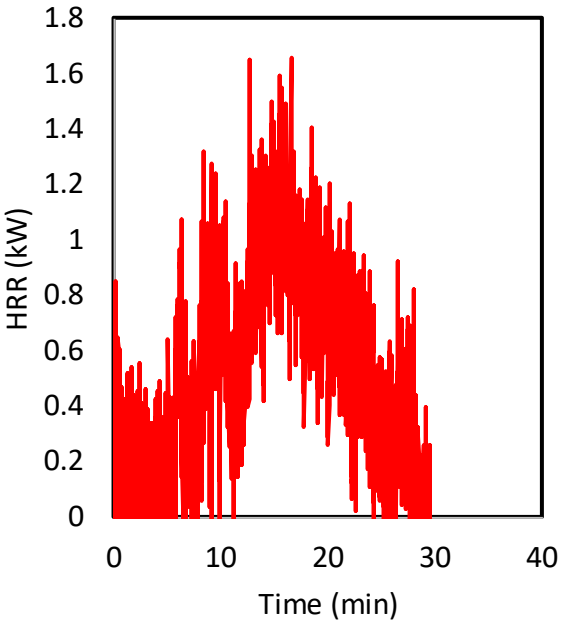
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.91

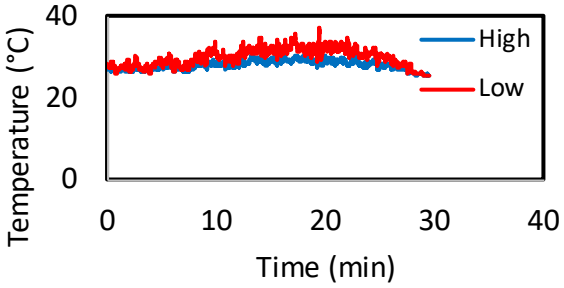
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

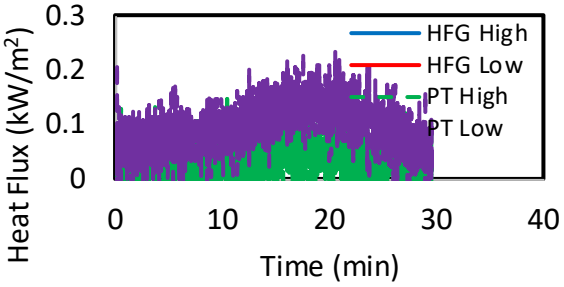
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test065 (NRC/NIST) **Test Item: Oil Bottle**

Max Fire Diameter (m): 0.09 Max Flame Height (m): 0.06

Peak HRR (kW): 2.5 Burning Duration (s): 1,516 Ignition Method: Flame

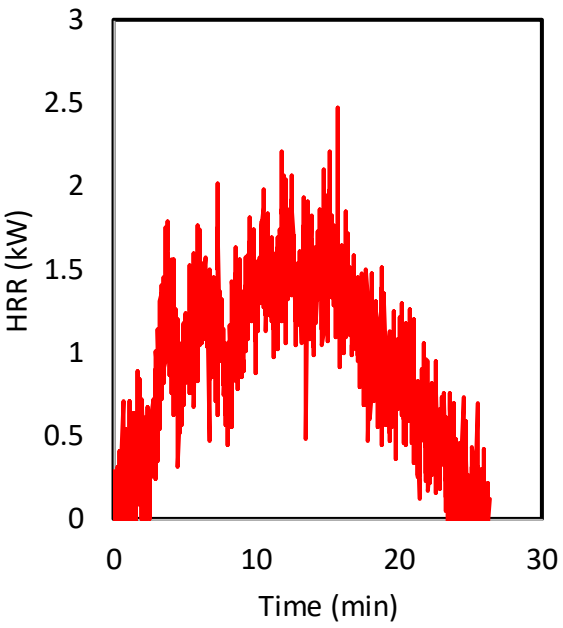
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 1.48

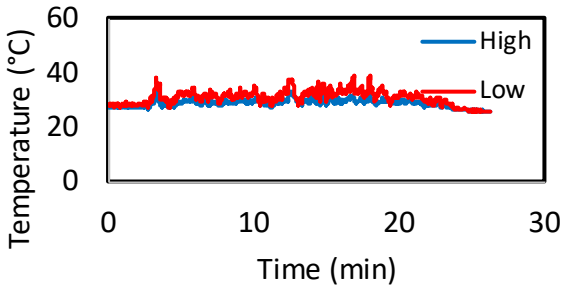
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

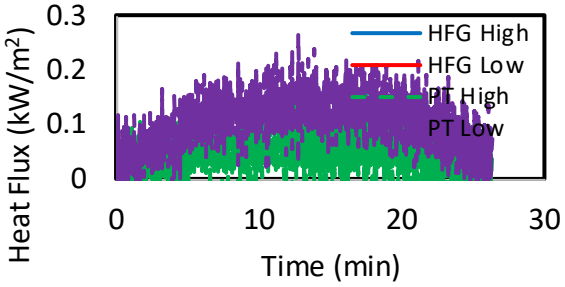
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test064 (NRC/NIST) **Test Item: Rags w/Oil**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.47

Peak HRR (kW): 11.3 Burning Duration (s): 2,230 Ignition Method: Flame

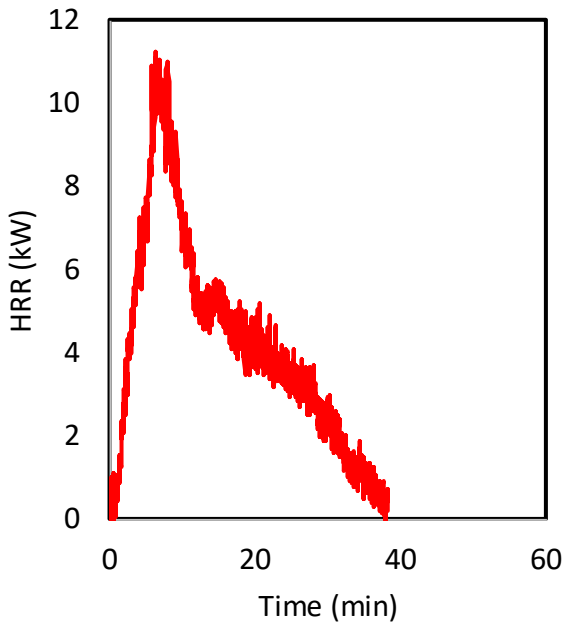
Heat of Combustion (MJ/kg): 26.2 Total Energy Release (MJ): 9.50

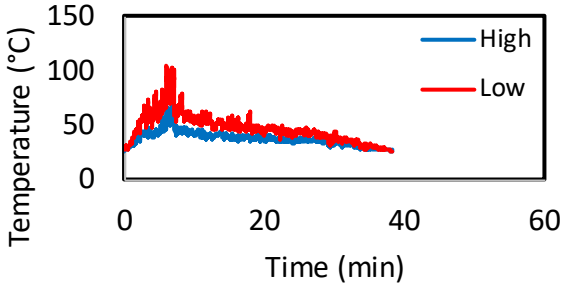
Soot Yield (kg/kg): 0.042 CO Yield (kg/kg): 0.030

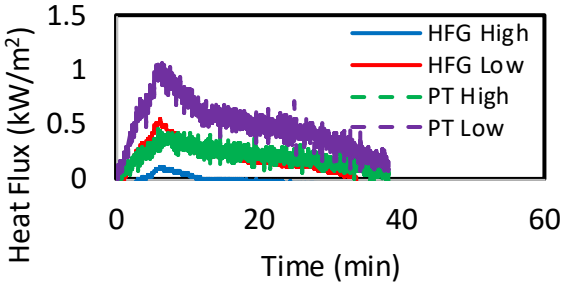
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test066 (NRC/NIST) **Test Item: Rags w/Oil**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.35

Peak HRR (kW): 10.5 Burning Duration (s): 2,978 Ignition Method: Flame

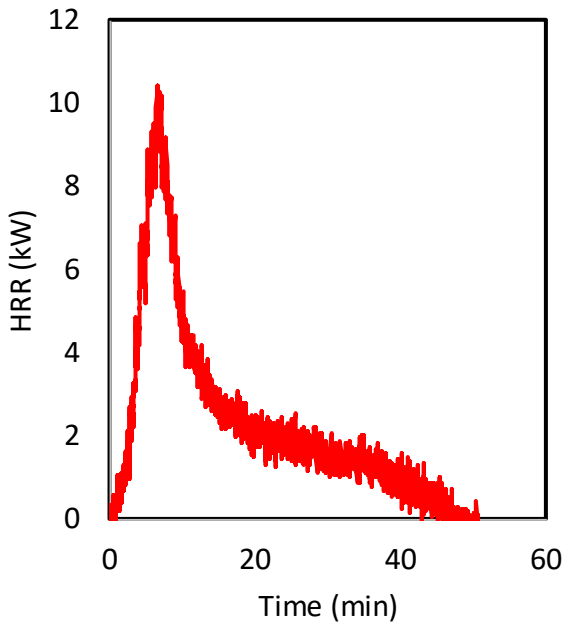
Heat of Combustion (MJ/kg): 22.9 Total Energy Release (MJ): 6.93

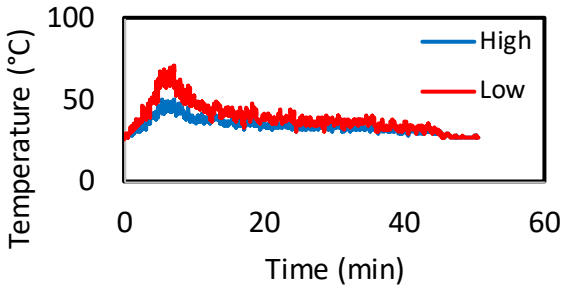
Soot Yield (kg/kg): 0.026 CO Yield (kg/kg): 0.032

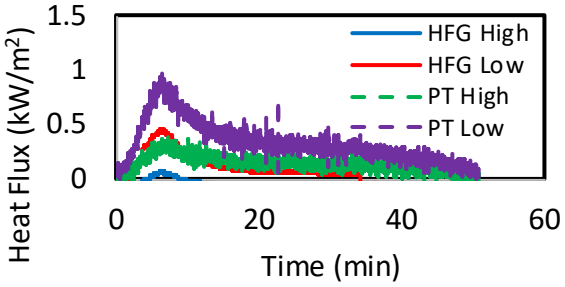
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test057 (NRC/NIST) **Test Item: Plastic Trash Quarter**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.47

Peak HRR (kW): 292 Burning Duration (s): 2,047 Ignition Method: Wick

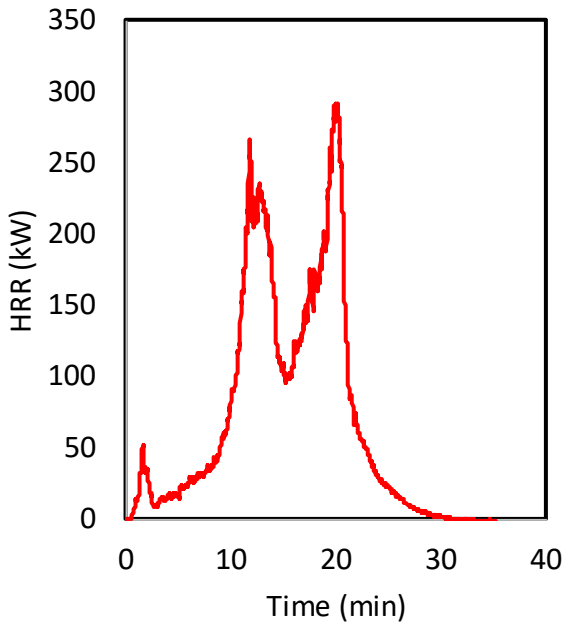
Heat of Combustion (MJ/kg): 35.9 Total Energy Release (MJ): 144.48

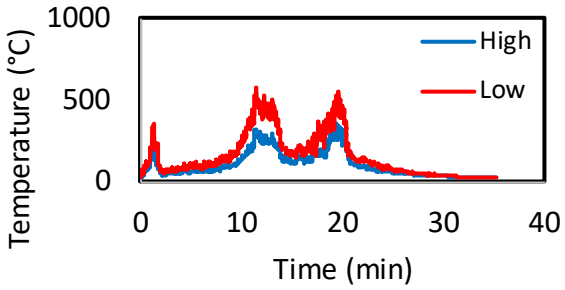
Soot Yield (kg/kg): 0.045 CO Yield (kg/kg): 0.017

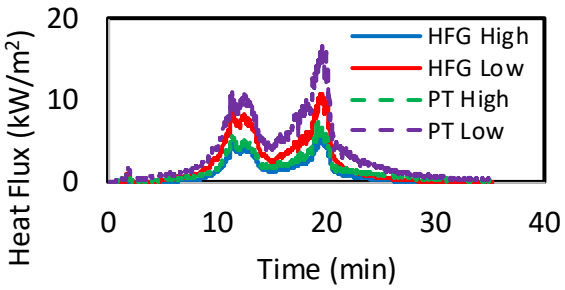
TC Grid Heights[1] (cm): 107, 152

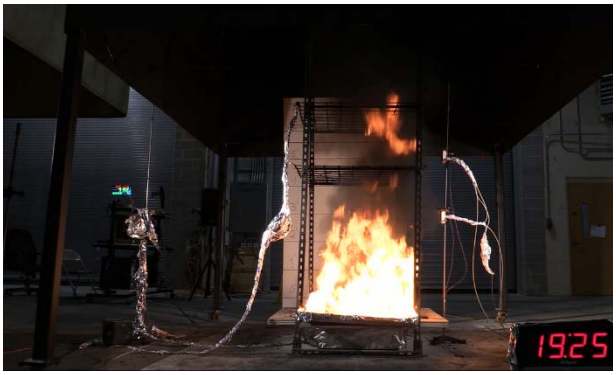
HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test067 (NRC/NIST) **Test Item: Plastic Trash Quarter**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.29

Peak HRR (kW): 270 Burning Duration (s): 2,398 Ignition Method: Wick

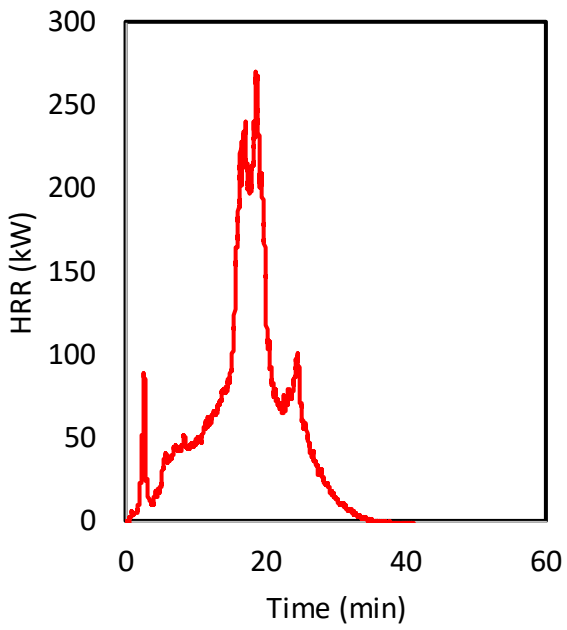
Heat of Combustion (MJ/kg): 35.8 Total Energy Release (MJ): 132.17

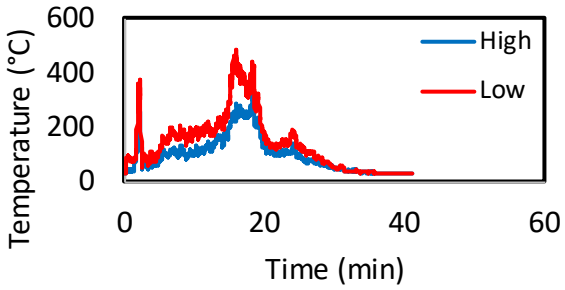
Soot Yield (kg/kg): 0.044 CO Yield (kg/kg): 0.016

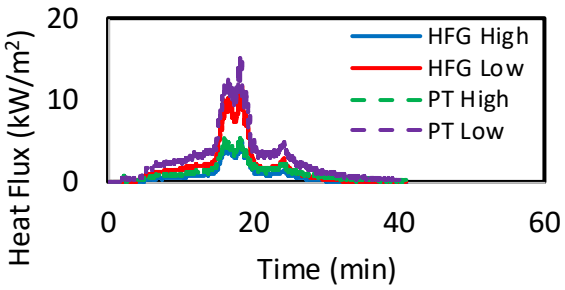
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test070 (NRC/NIST) **Test Item: Plastic Trash Quarter**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.25

Peak HRR (kW): 265 Burning Duration (s): 2,948 Ignition Method: Wick

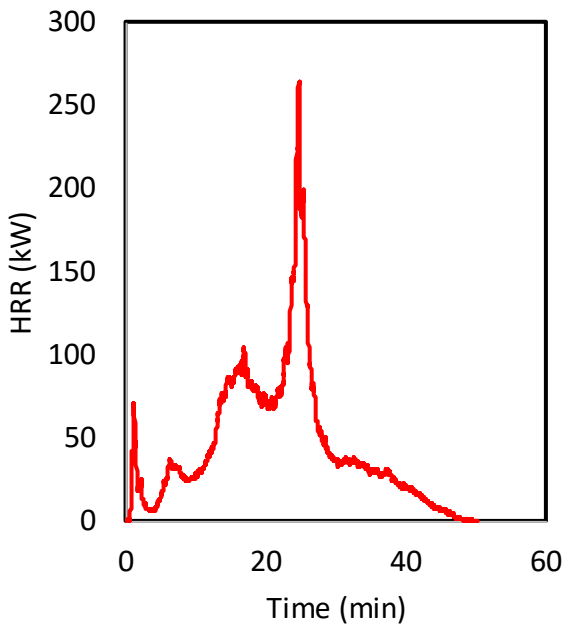
Heat of Combustion (MJ/kg): 37.6 Total Energy Release (MJ): 135.16

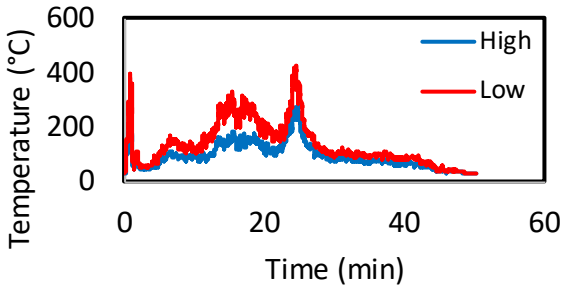
Soot Yield (kg/kg): 0.042 CO Yield (kg/kg): 0.017

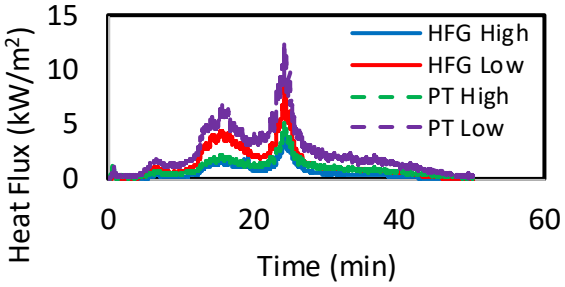
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test058 (NRC/NIST) **Test Item: Plastic Trash Half**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.25

Peak HRR (kW): 279 Burning Duration (s): 2,423 Ignition Method: Wick

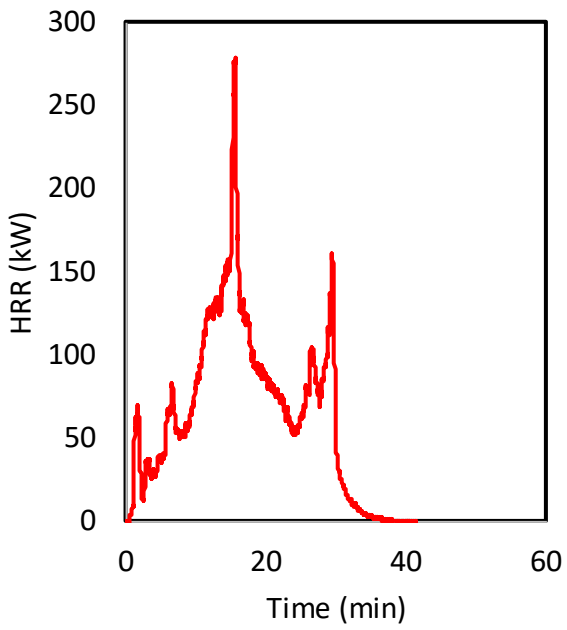
Heat of Combustion (MJ/kg): 33.9 Total Energy Release (MJ): 155.19

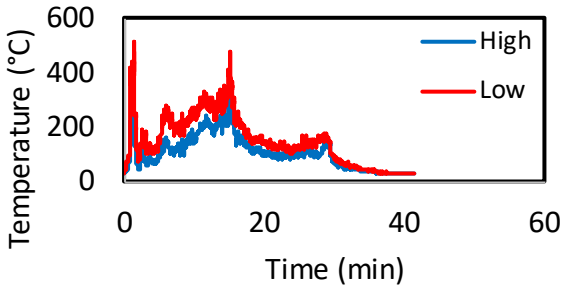
Soot Yield (kg/kg): 0.036 CO Yield (kg/kg): 0.015

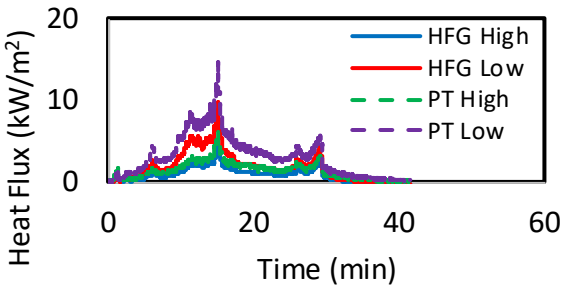
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test068 (NRC/NIST) **Test Item: Plastic Trash Half**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.31

Peak HRR (kW): 364 Burning Duration (s): 2,210 Ignition Method: Wick

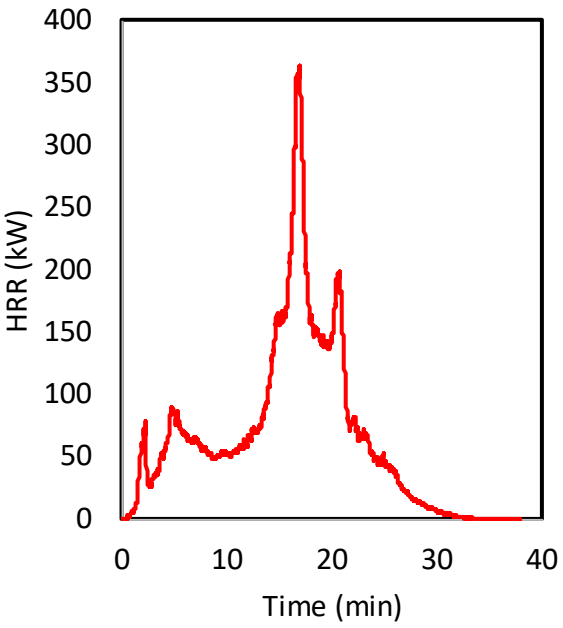
Heat of Combustion (MJ/kg): 34.0 Total Energy Release (MJ): 147.02

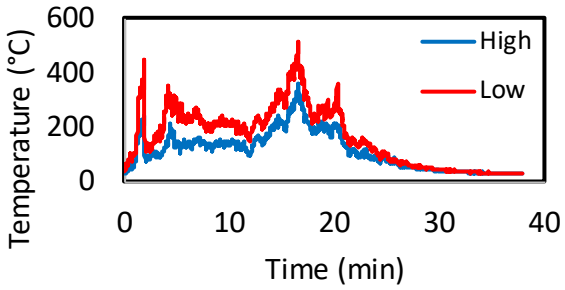
Soot Yield (kg/kg): 0.035 CO Yield (kg/kg): 0.016

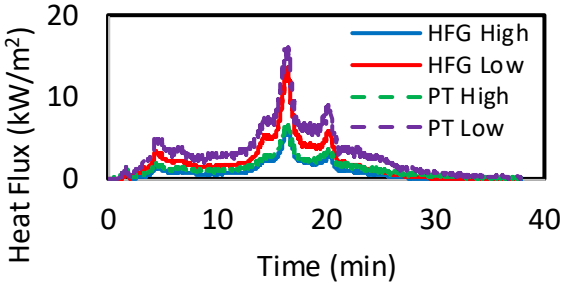
TC Grid Heights[1] (cm): 107, 152

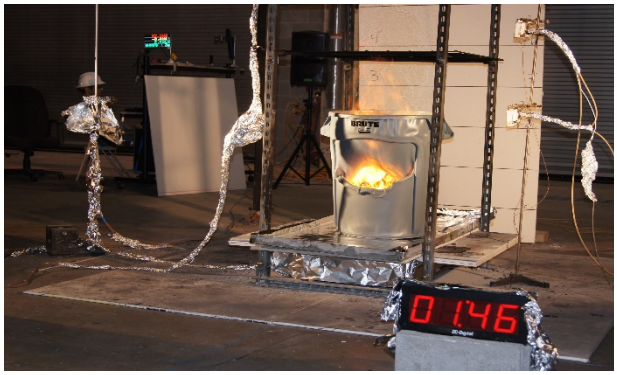
HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test071 (NRC/NIST) **Test Item: Plastic Trash Half**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.37

Peak HRR (kW): 308 Burning Duration (s): 2,127 Ignition Method: Wick

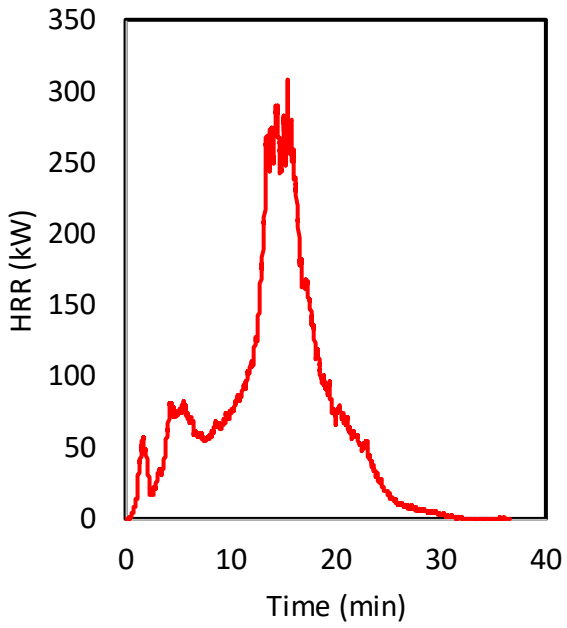
Heat of Combustion (MJ/kg): 35.6 Total Energy Release (MJ): 146.97

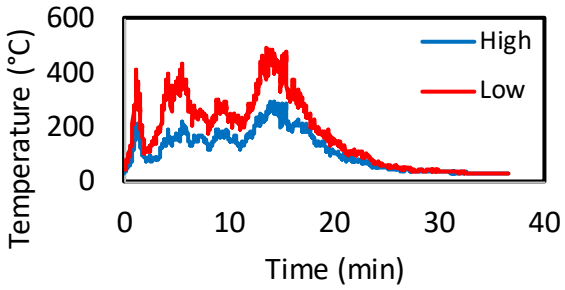
Soot Yield (kg/kg): 0.041 CO Yield (kg/kg): 0.017

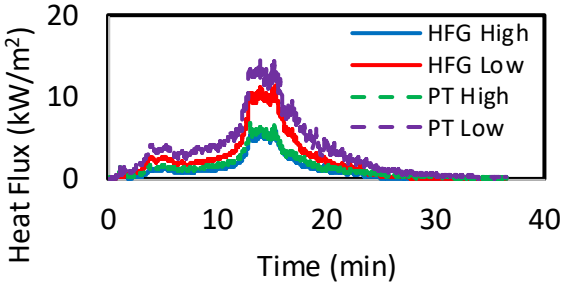
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test059 (NRC/NIST) **Test Item: Plastic Trash Full**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.20

Peak HRR (kW): 181 Burning Duration (s): 2,634 Ignition Method: Wick

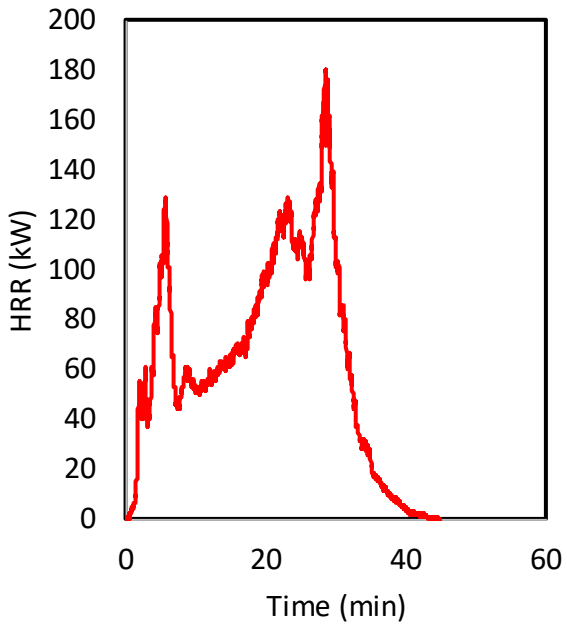
Heat of Combustion (MJ/kg): 32.1 Total Energy Release (MJ): 166.00

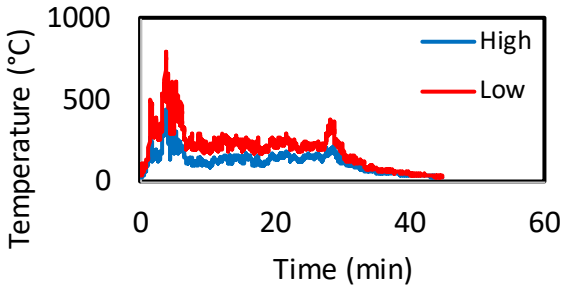
Soot Yield (kg/kg): 0.029 CO Yield (kg/kg): 0.016

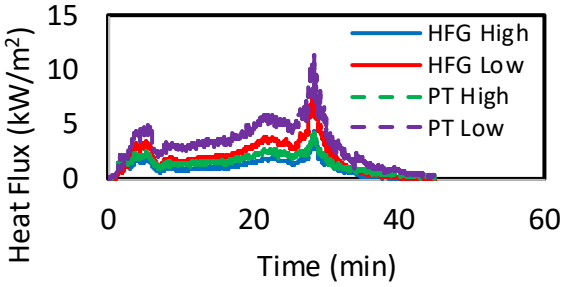
TC Grid Heights[1] (cm): 107, 152

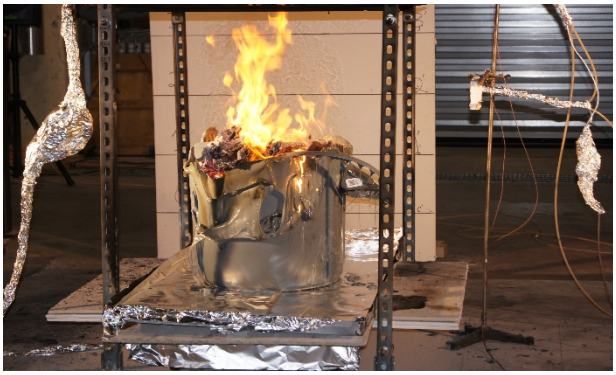
HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test069 (NRC/NIST) **Test Item: Plastic Trash Full**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.38

Peak HRR (kW): 273 Burning Duration (s): 2,621 Ignition Method: Wick

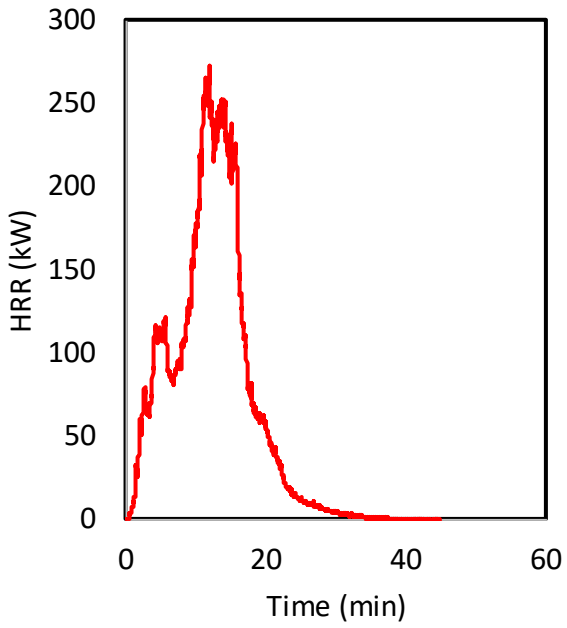
Heat of Combustion (MJ/kg): 32.6 Total Energy Release (MJ): 164.33

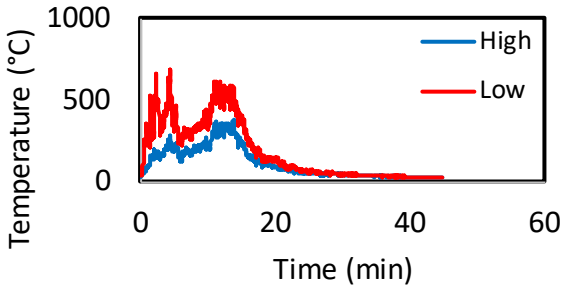
Soot Yield (kg/kg): 0.036 CO Yield (kg/kg): 0.018

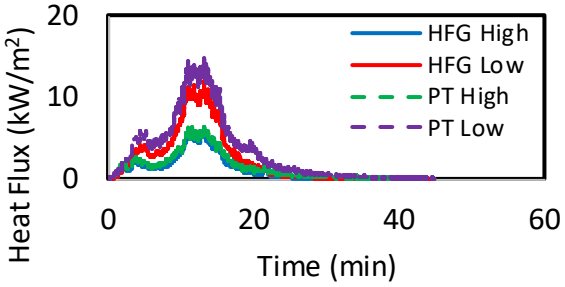
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test072 (NRC/NIST) **Test Item: Plastic Trash Full**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.31

Peak HRR (kW): 257 Burning Duration (s): 2,907 Ignition Method: Wick

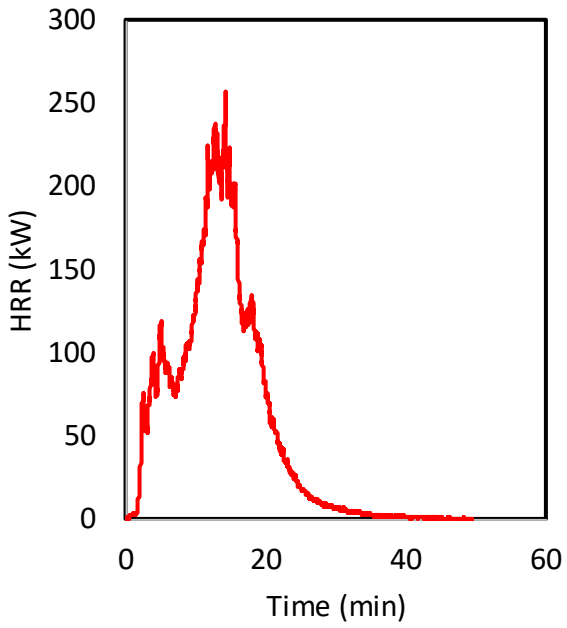
Heat of Combustion (MJ/kg): 32.1 Total Energy Release (MJ): 158.76

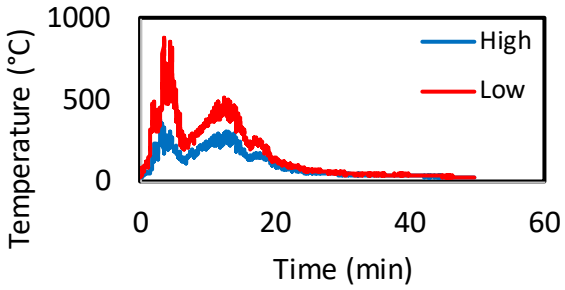
Soot Yield (kg/kg): 0.034 CO Yield (kg/kg): 0.015

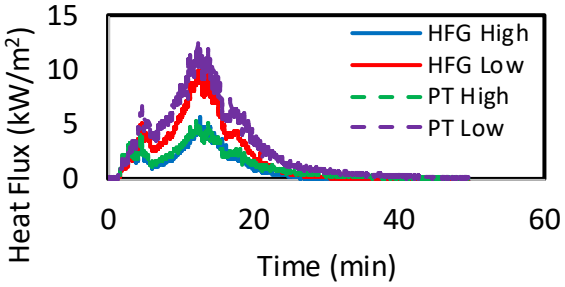
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test073 (NRC/NIST) **Test Item: Plastic Stanchion**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.87

Peak HRR (kW): 66.8 Burning Duration (s): 2,022 Ignition Method: Flame

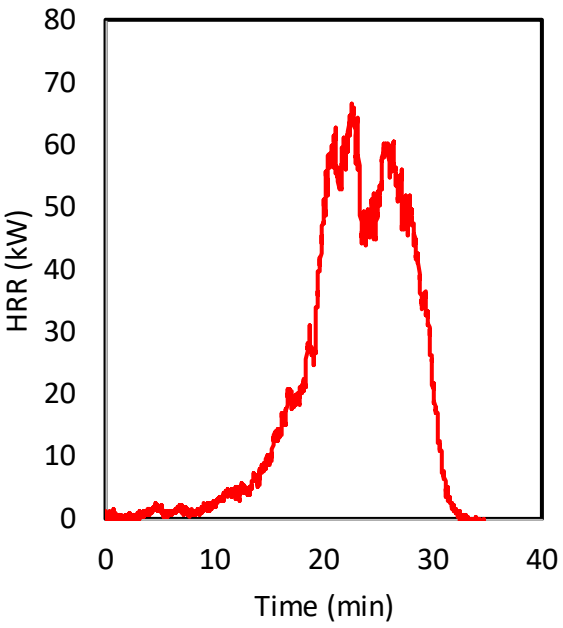
Heat of Combustion (MJ/kg): 39.2 Total Energy Release (MJ): 40.60

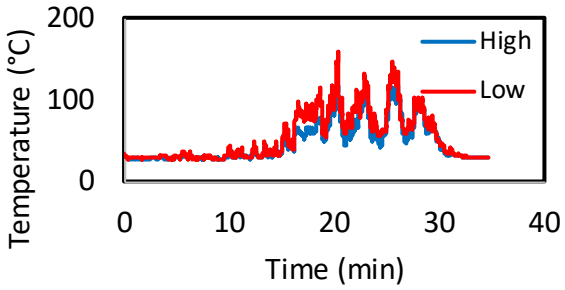
Soot Yield (kg/kg): 0.058 CO Yield (kg/kg): 0.017

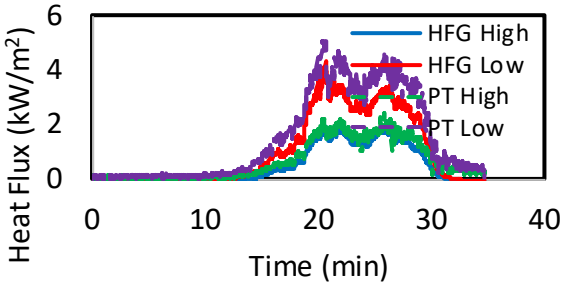
TC Grid Heights[1] (cm): 107, 152

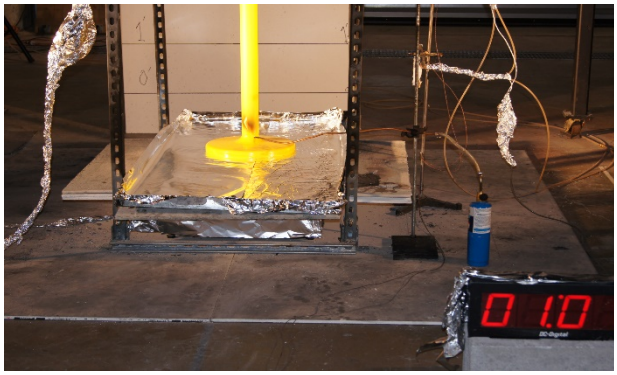
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test074 (NRC/NIST) **Test Item: Plastic Stanchion**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.85

Peak HRR (kW): 47.1 Burning Duration (s): 3,286 Ignition Method: Flame

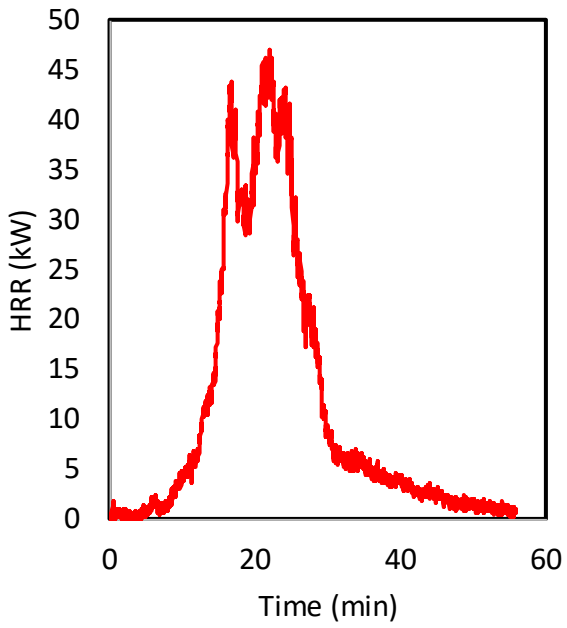
Heat of Combustion (MJ/kg): 41.4 Total Energy Release (MJ): 36.41

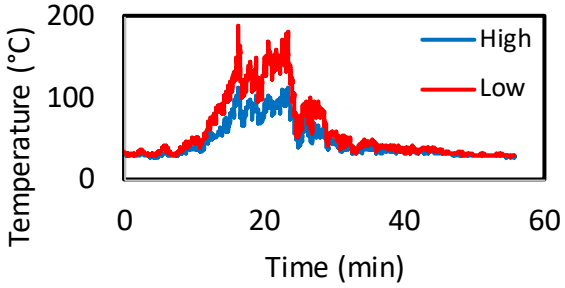
Soot Yield (kg/kg): 0.052 CO Yield (kg/kg): 0.017

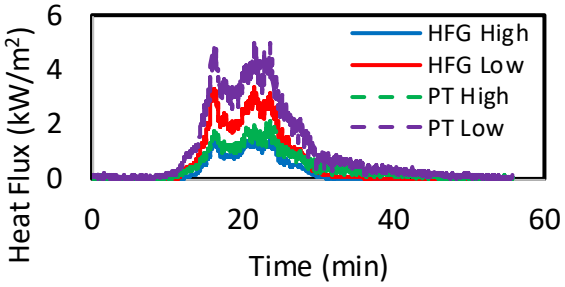
TC Grid Heights[1] (cm): 107, 152

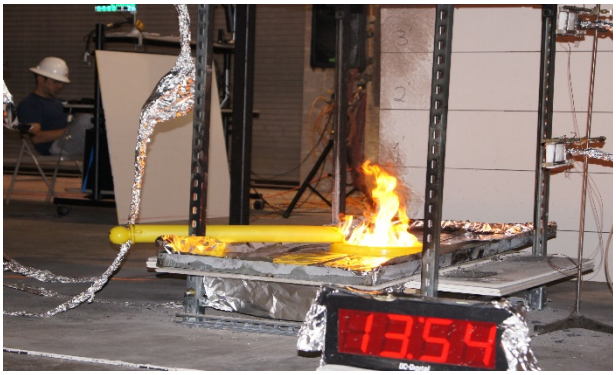
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test075 (NRC/NIST) **Test Item: Plastic Stanchion**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.71

Peak HRR (kW): 48.3 Burning Duration (s): 3,596 Ignition Method: Flame

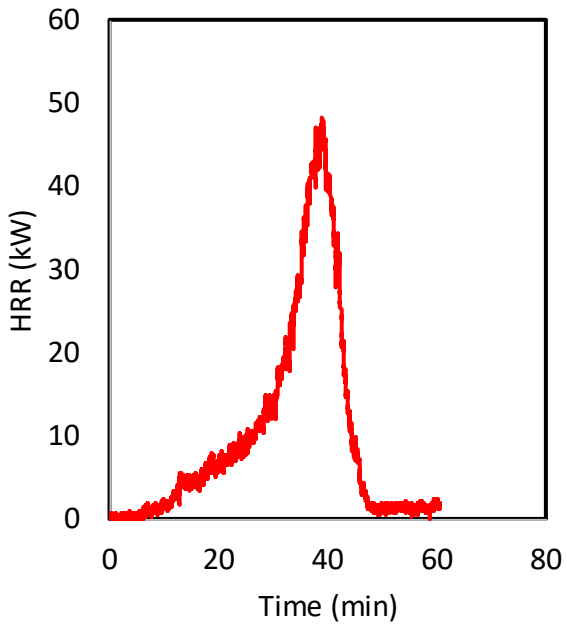
Heat of Combustion (MJ/kg): 42.2 Total Energy Release (MJ): 36.23

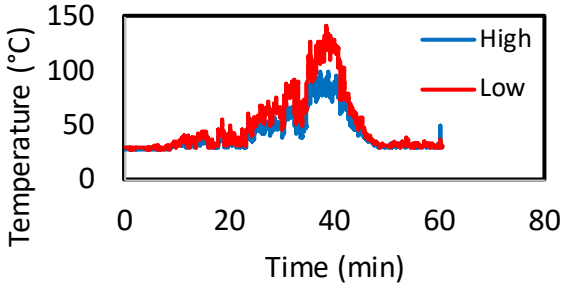
Soot Yield (kg/kg): 0.037 CO Yield (kg/kg): 0.014

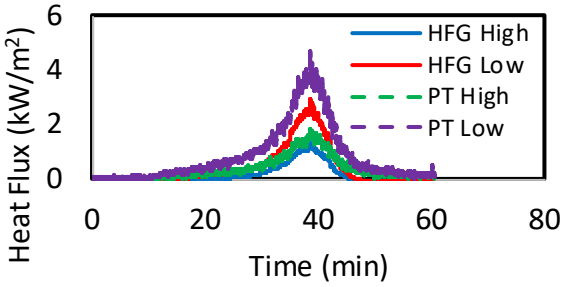
TC Grid Heights[1] (cm): 107, 152

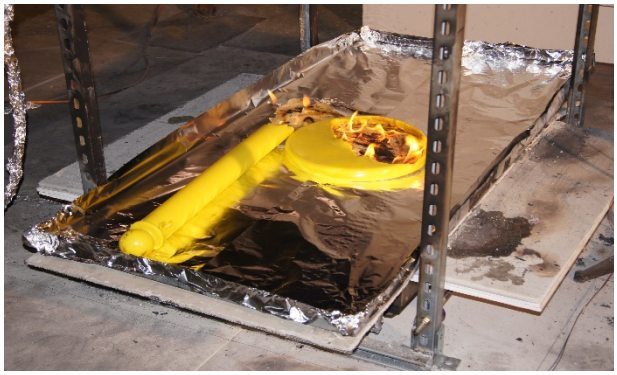
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test076 (NRC/NIST) **Test Item: 15.2 m Coil Chain**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.15

Peak HRR (kW): 1.8 Burning Duration (s): 606 Ignition Method: Flame

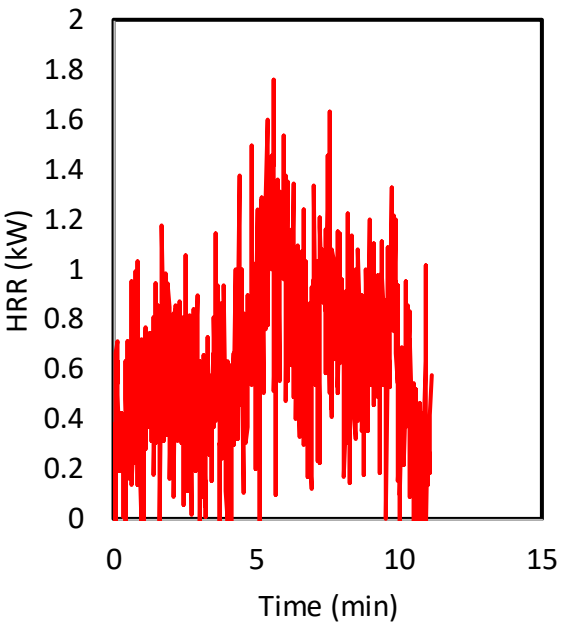
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.42

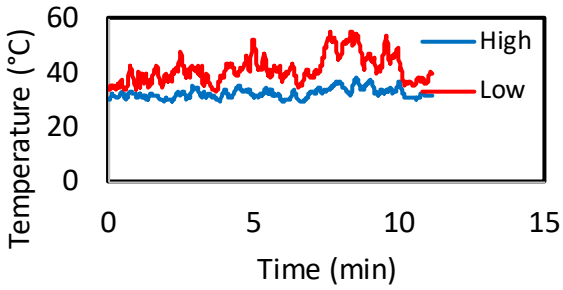
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

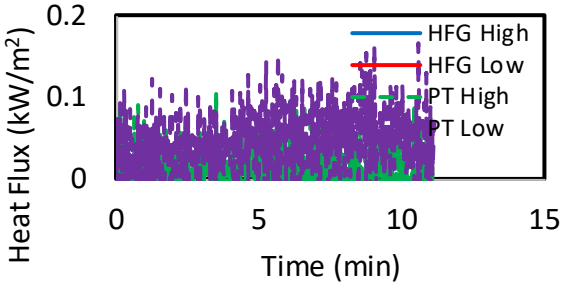
TC Grid Heights[1] (cm): 61, 107

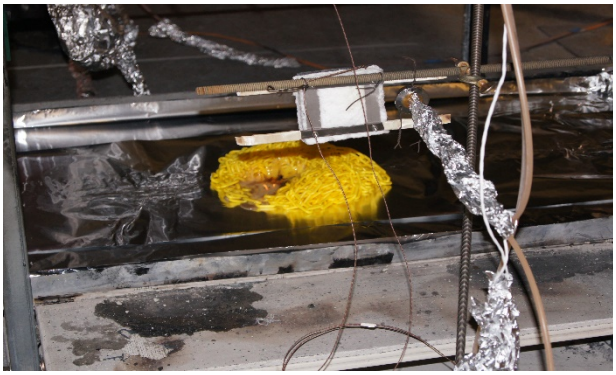
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test077 (NRC/NIST) **Test Item: 15.2 m Coil Chain**

Max Fire Diameter (m): 0.46 Max Flame Height (m): 0.62

Peak HRR (kW): 28.6 Burning Duration (s): 3,403 Ignition Method: Flame

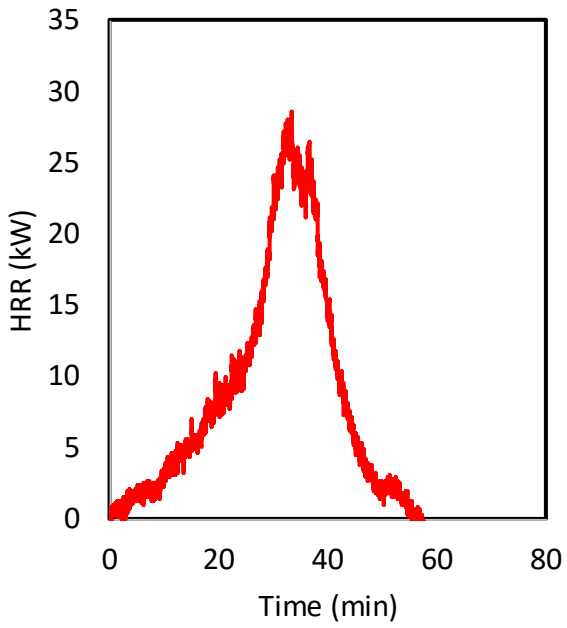
Heat of Combustion (MJ/kg): 40.5 Total Energy Release (MJ): 29.87

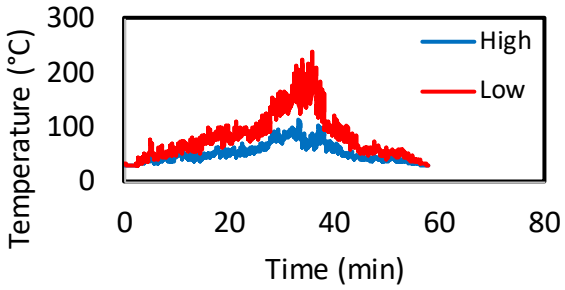
Soot Yield (kg/kg): 0.031 CO Yield (kg/kg): 0.014

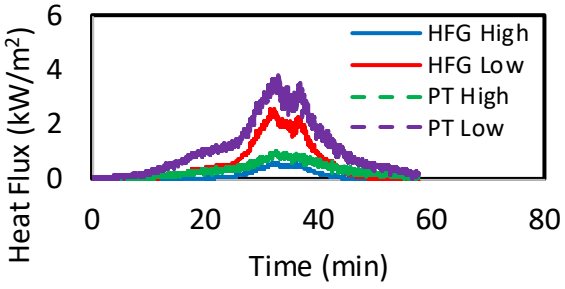
TC Grid Heights[1] (cm): 61, 107

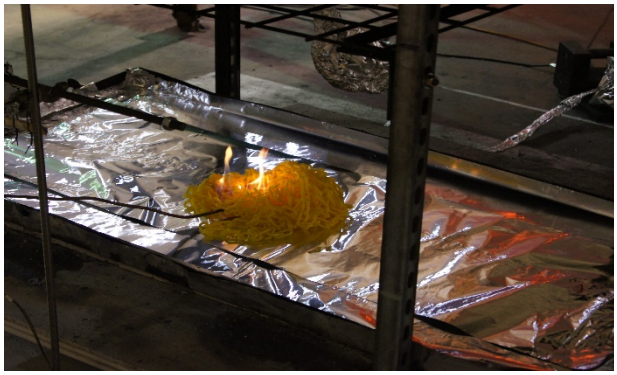
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

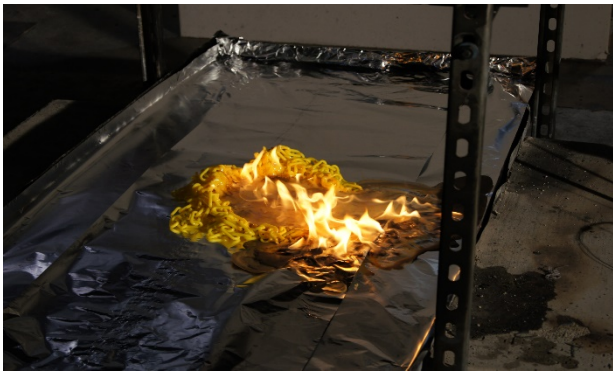
[1]From top of platform, [2]From center of platform











Test ID: Test078 (NRC/NIST) **Test Item: 15.2 m Coil Chain**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 0.40

Peak HRR (kW): 22.1 Burning Duration (s): 3,908 Ignition Method: Flame

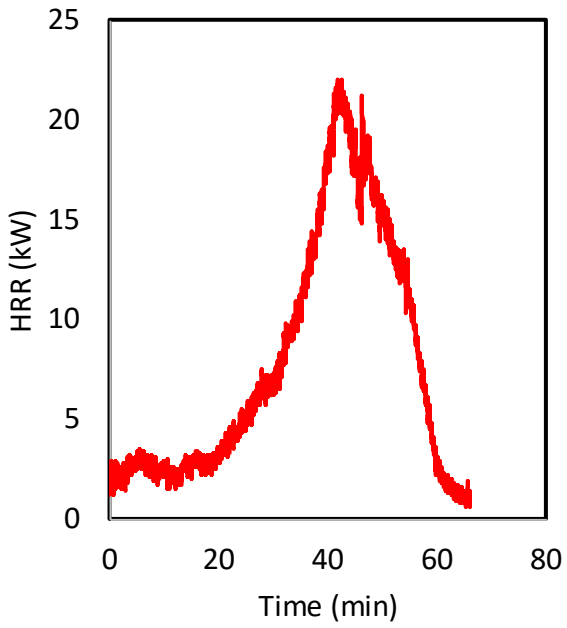
Heat of Combustion (MJ/kg): 49.3 Total Energy Release (MJ): 30.74

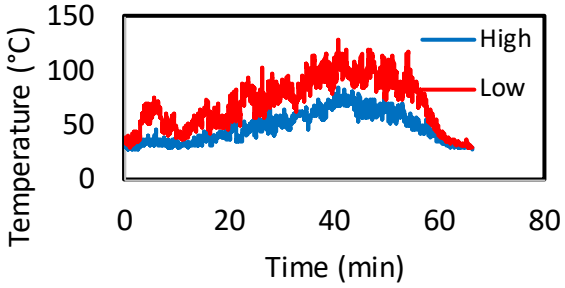
Soot Yield (kg/kg): 0.016 CO Yield (kg/kg): 0.022

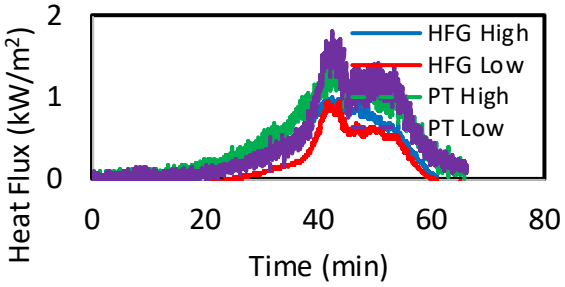
TC Grid Heights[1] (cm): 61, 107

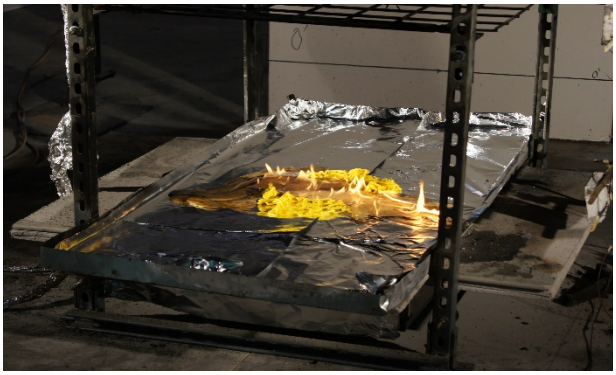
HF Gauge Heights[1] (cm): 10, 56 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test079 (NRC/NIST) **Test Item: 15.2 m Coil Large Rope**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 0.94

Peak HRR (kW): 73.8 Burning Duration (s): 3,291 Ignition Method: Wick

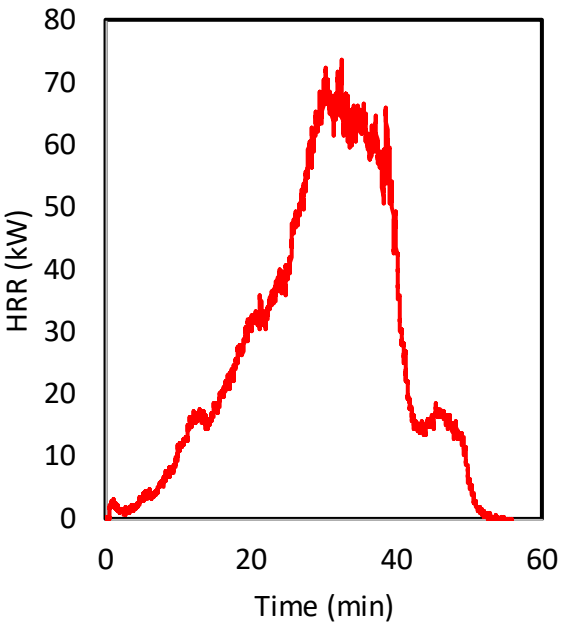
Heat of Combustion (MJ/kg): 27.6 Total Energy Release (MJ): 88.67

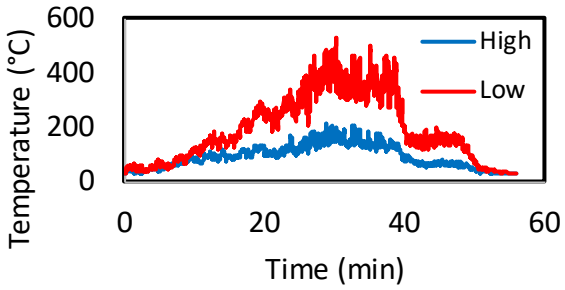
Soot Yield (kg/kg): 0.021 CO Yield (kg/kg): 0.011

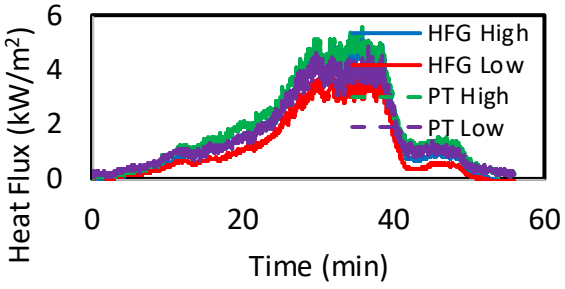
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 10, 56 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test080 (NRC/NIST) **Test Item: 15.2 m Coil Large Rope**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.42

Peak HRR (kW): 2.9 Burning Duration (s): 281 Ignition Method: Wick

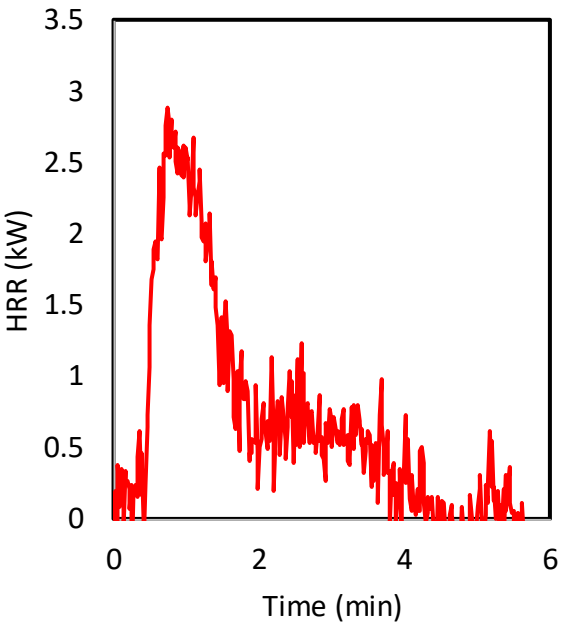
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.23

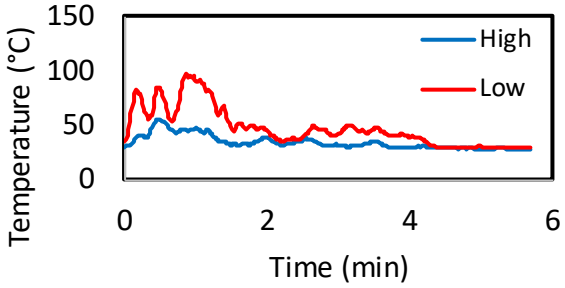
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

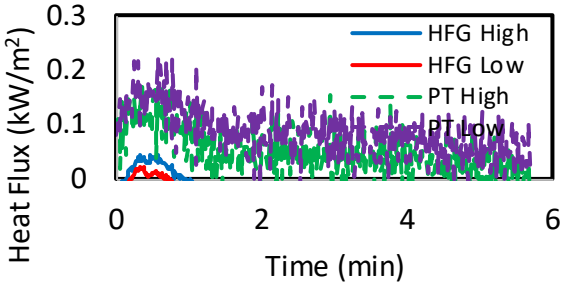
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 10, 56 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test081 (NRC/NIST) **Test Item: 15.2 m Coil Large Rope**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.56

Peak HRR (kW): 27.0 Burning Duration (s): 3,901 Ignition Method: Wick

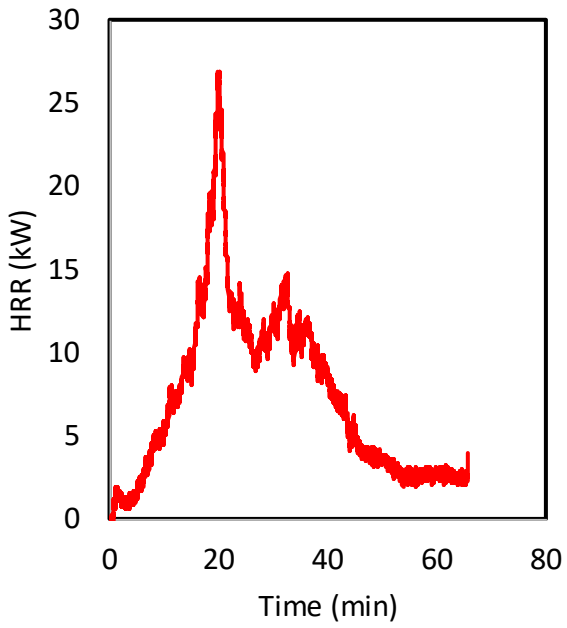
Heat of Combustion (MJ/kg): 24.7 Total Energy Release (MJ): 28.61

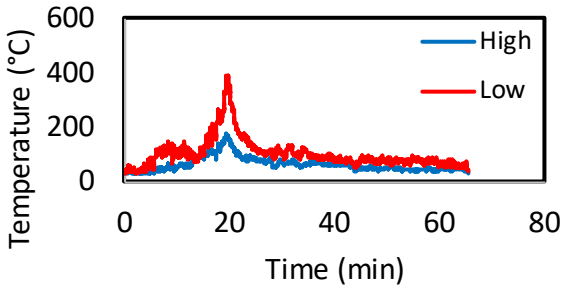
Soot Yield (kg/kg): 0.002 CO Yield (kg/kg): 0.026

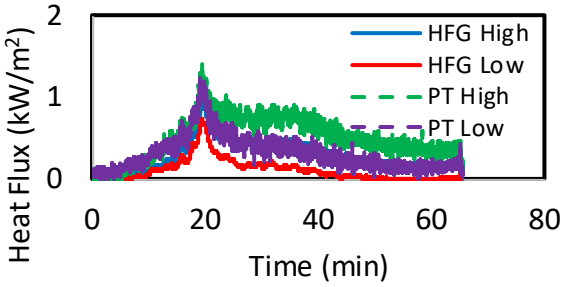
TC Grid Heights[1] (cm): 61, 107

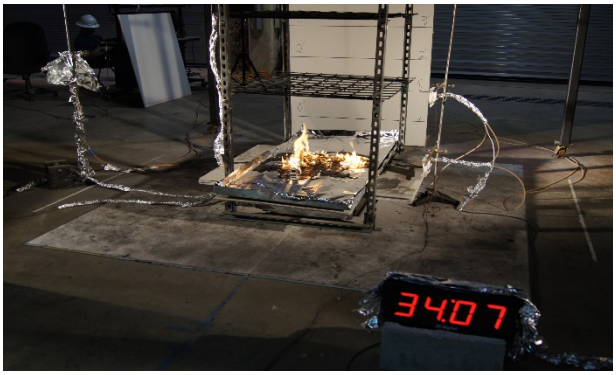
HF Gauge Heights[1] (cm): 10, 56 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test084 (NRC/NIST) **Test Item: Plastic Chair**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.40

Peak HRR (kW): 203 Burning Duration (s): 2,806 Ignition Method: Flame

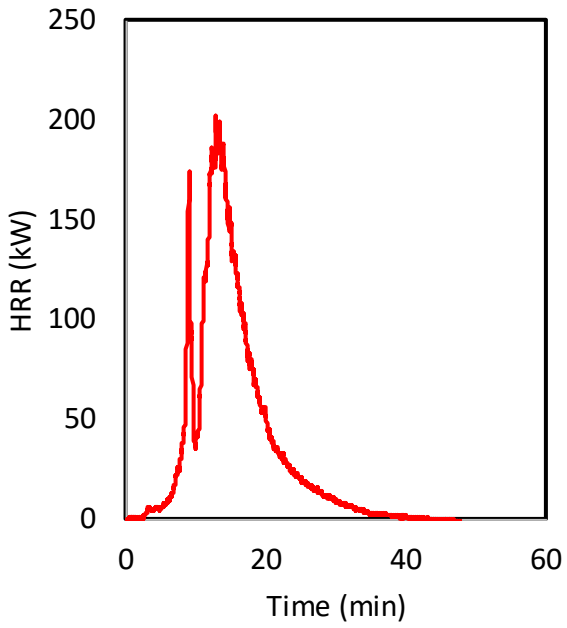
Heat of Combustion (MJ/kg): 35.8 Total Energy Release (MJ): 98.01

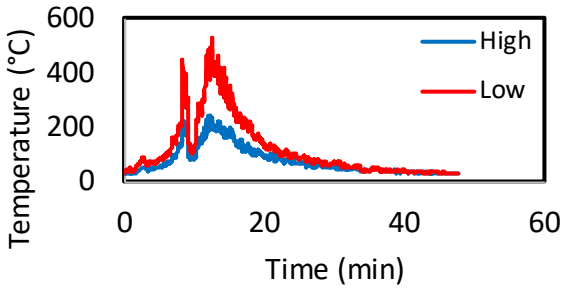
Soot Yield (kg/kg): 0.061 CO Yield (kg/kg): 0.024

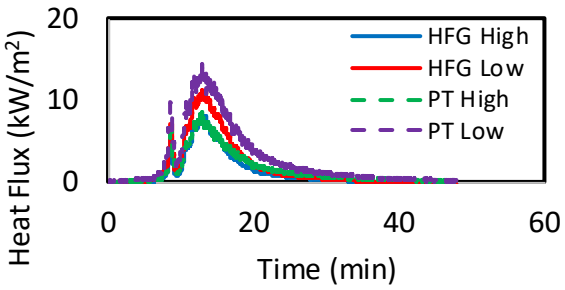
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test085 (NRC/NIST) **Test Item: Plastic Chair**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.16

Peak HRR (kW): 155 Burning Duration (s): 3,906 Ignition Method: Flame

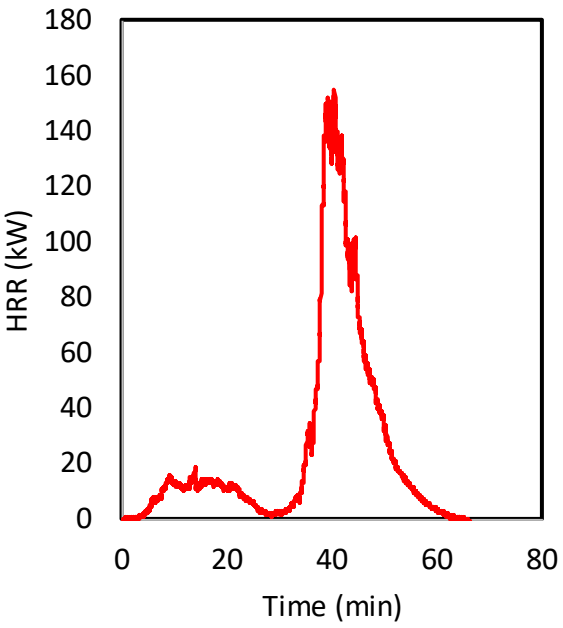
Heat of Combustion (MJ/kg): 49.5 Total Energy Release (MJ): 97.67

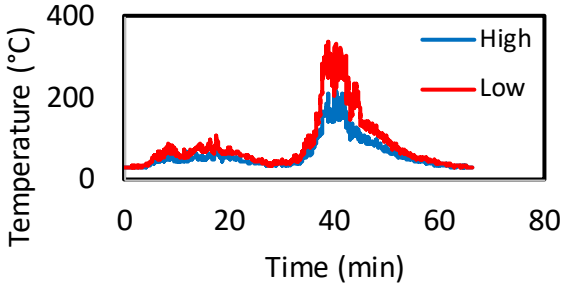
Soot Yield (kg/kg): 0.080 CO Yield (kg/kg): 0.033

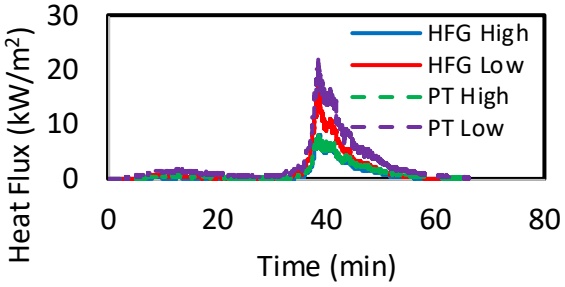
TC Grid Heights[1] (cm): 107, 152

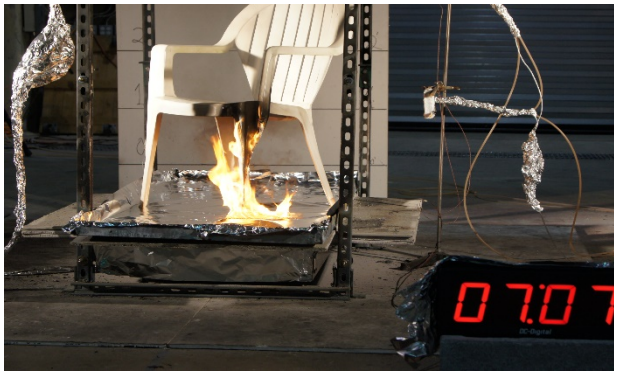
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test086 (NRC/NIST) **Test Item: Plastic Chair**

Max Fire Diameter (m): 0.61 Max Flame Height (m): 1.11

Peak HRR (kW): 203 Burning Duration (s): 2,802 Ignition Method: Flame

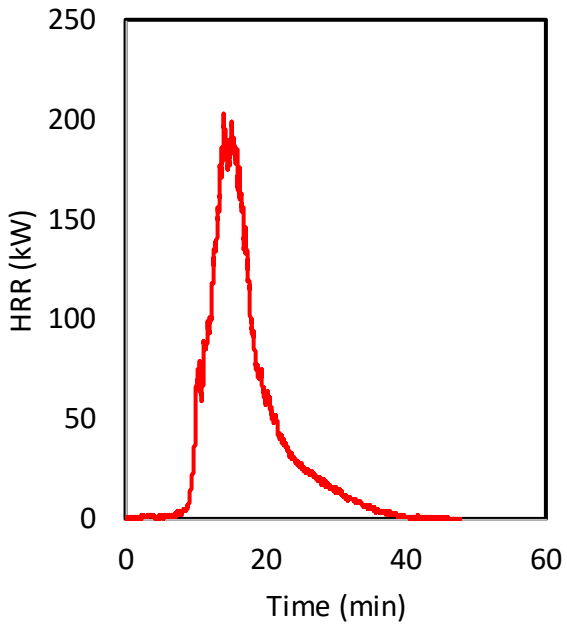
Heat of Combustion (MJ/kg): 36.8 Total Energy Release (MJ): 99.71

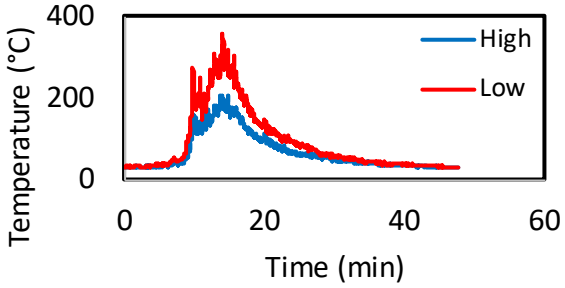
Soot Yield (kg/kg): 0.061 CO Yield (kg/kg): 0.023

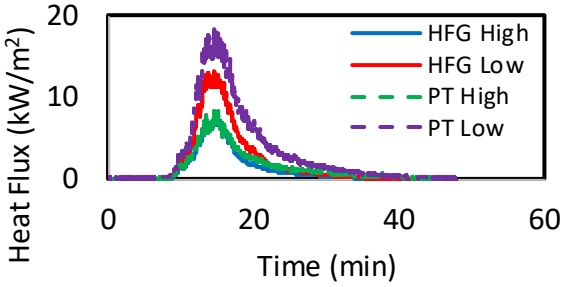
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test087 (NRC/NIST) **Test Item: Plank Flame**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.12

Peak HRR (kW): 2.0 Burning Duration (s): 922 Ignition Method: Flame

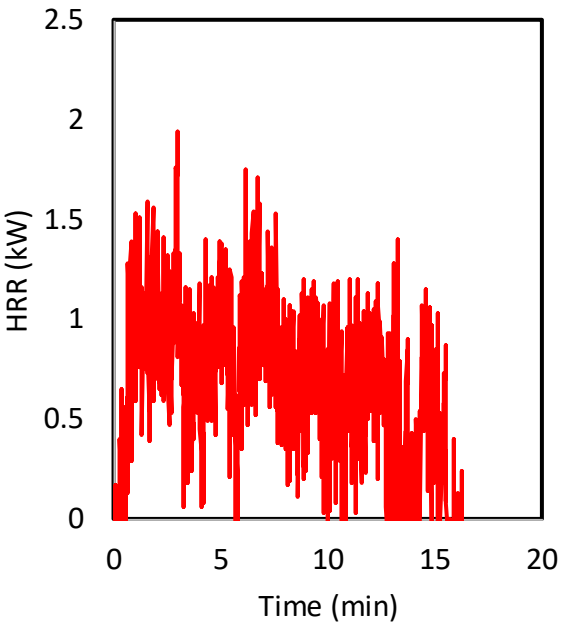
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.64

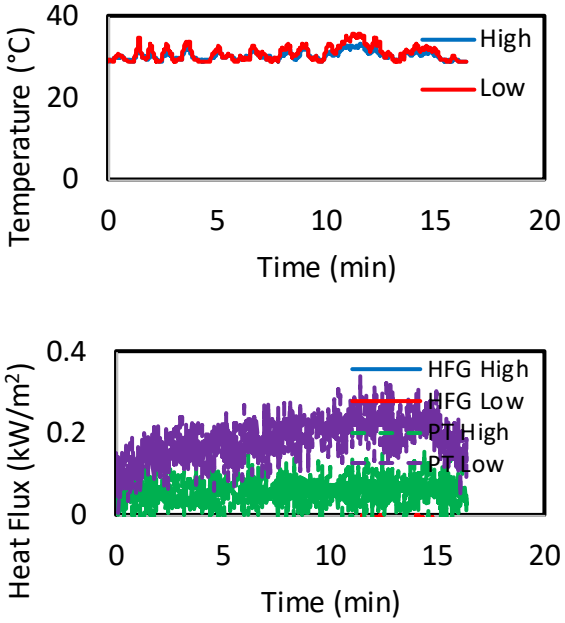
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

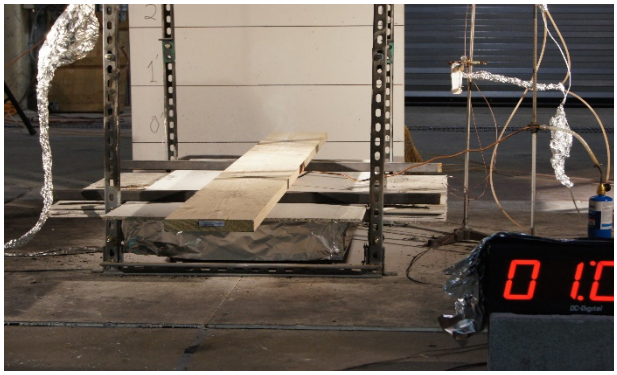
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test088 (NRC/NIST) **Test Item: Plank Flame**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.00

Peak HRR (kW): 2.0 Burning Duration (s): 907 Ignition Method: Flame

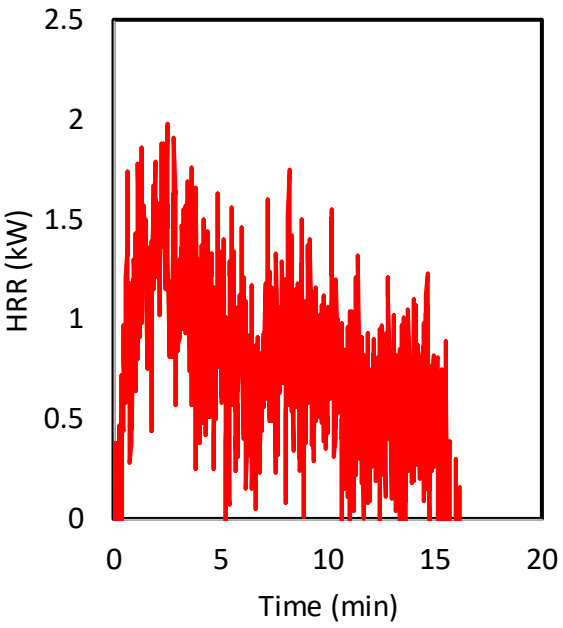
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.73

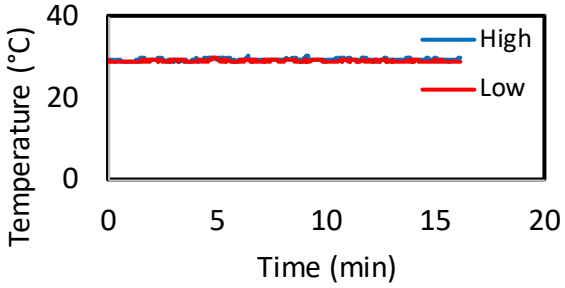
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

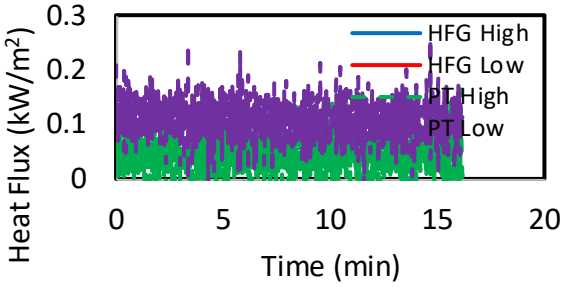
TC Grid Heights[1] (cm): 107, 152

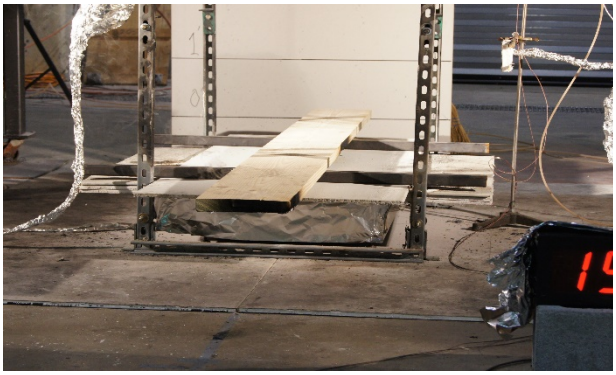
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: Test089 (NRC/NIST) **Test Item: Plank Flame**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.26

Peak HRR (kW): 1.8 Burning Duration (s): 909 Ignition Method: Flame

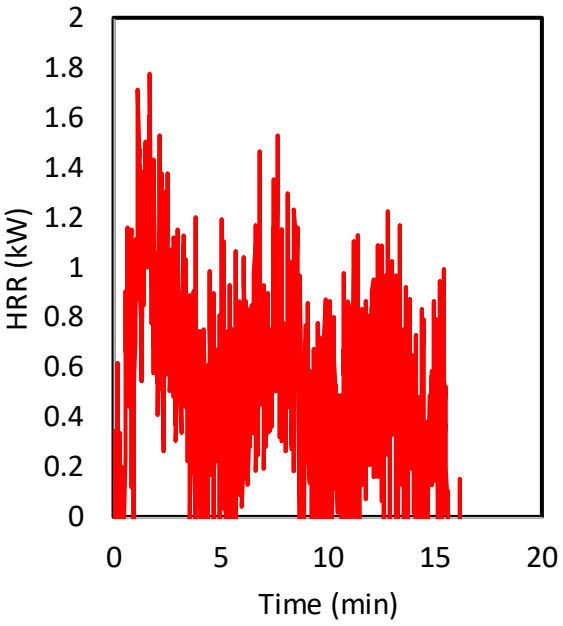
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.48

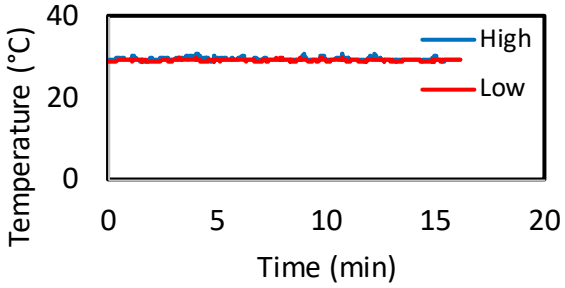
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/a

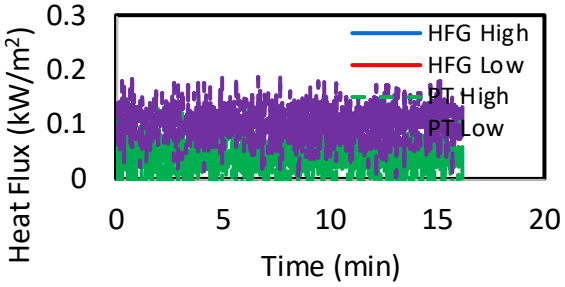
TC Grid Heights[1] (cm): 107, 152

HF Gauge Heights[1] (cm): 46, 76 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test093 (NRC/NIST) **Test Item: Pallet Flame**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.24

Peak HRR (kW): 2.1 Burning Duration (s): 912 Ignition Method: Flame

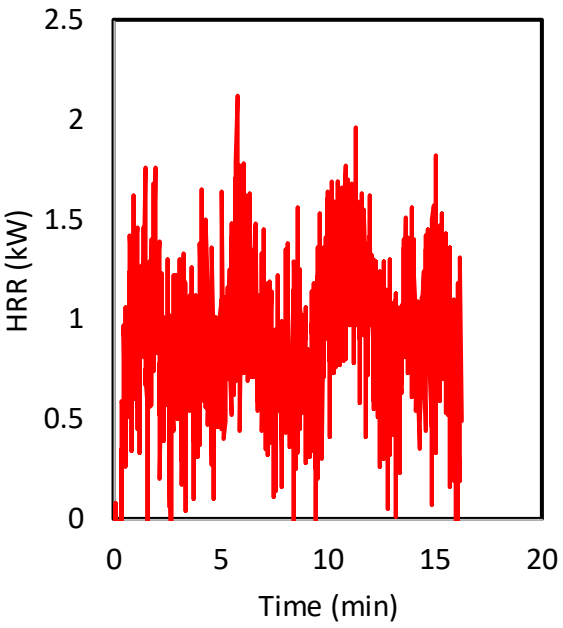
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.87

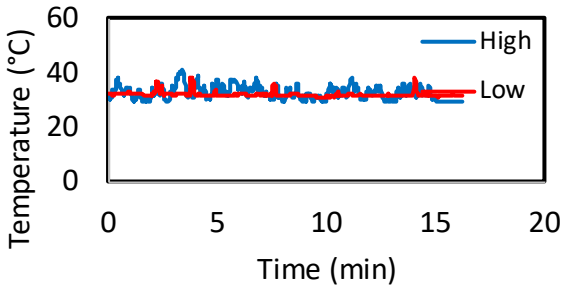
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

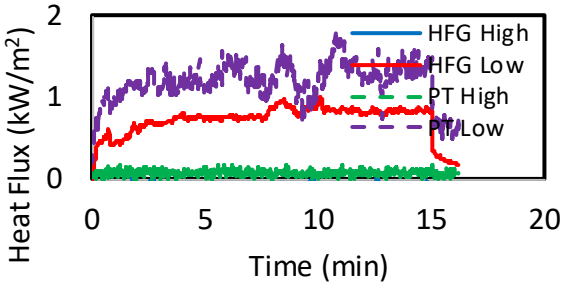
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test094 (NRC/NIST) **Test Item: Pallet Flame**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.22

Peak HRR (kW): 2.5 Burning Duration (s): 1,039 Ignition Method: Flame

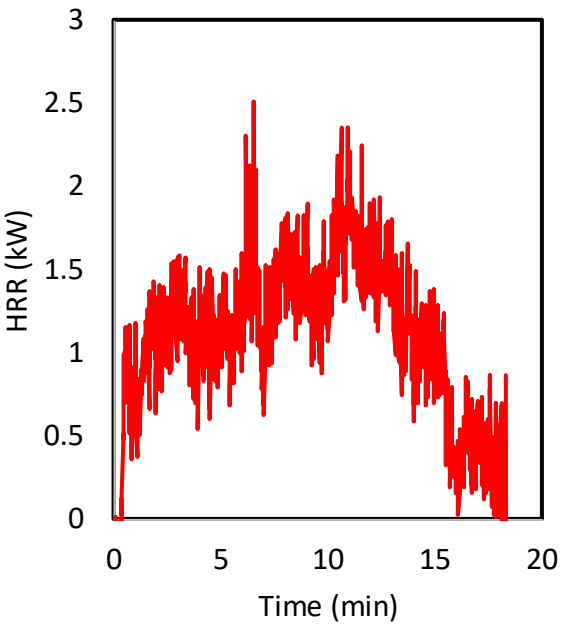
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 1.21

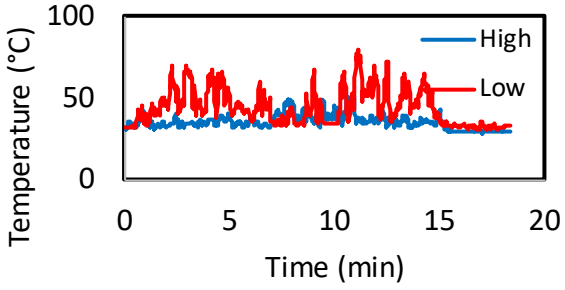
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

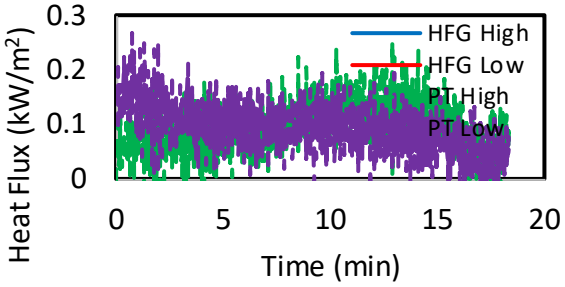
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test095 (NRC/NIST) **Test Item: Pallet Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 1.0 Burning Duration (s): 1,315 Ignition Method: Panel

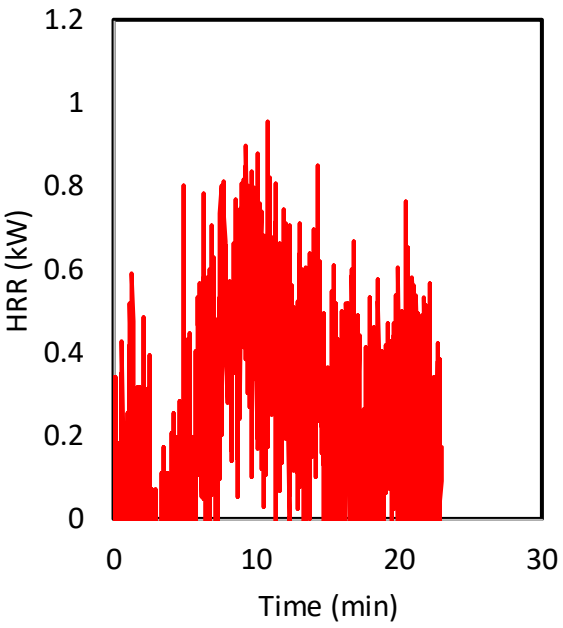
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.31

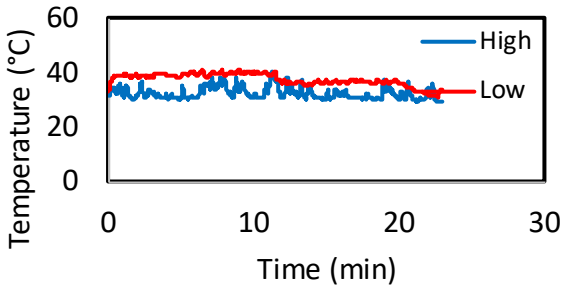
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

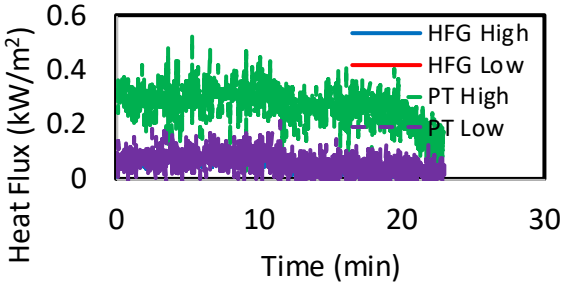
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test096 (NRC/NIST) **Test Item: Pallet Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.2 Burning Duration (s): 1,234 Ignition Method: Panel

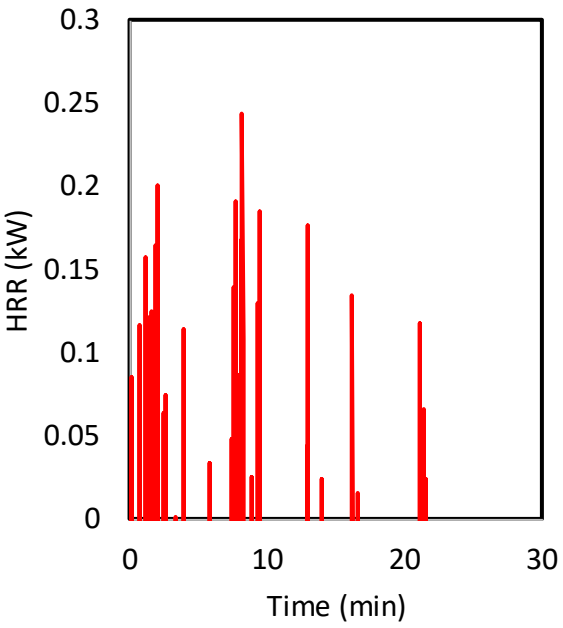
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.00

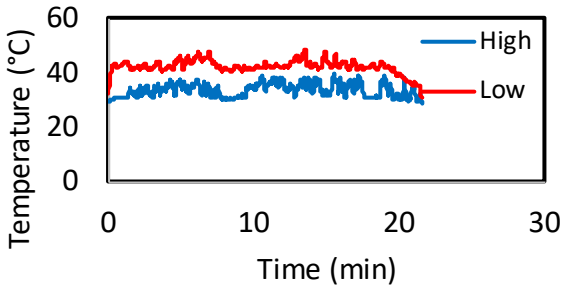
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

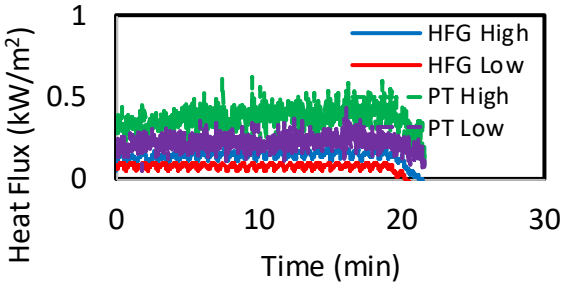
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test097 (NRC/NIST) **Test Item: Pallet Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 1.4 Burning Duration (s): 1,218 Ignition Method: Panel

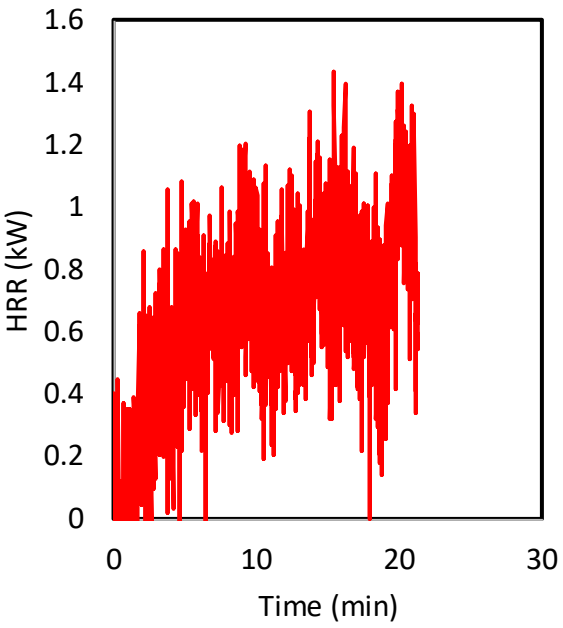
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.82

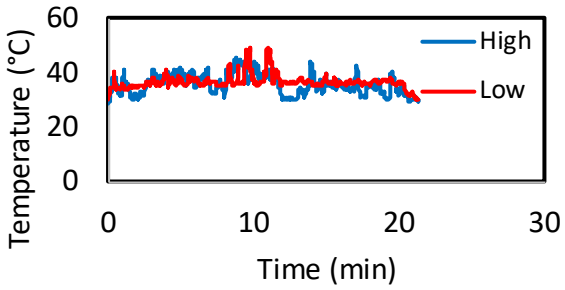
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

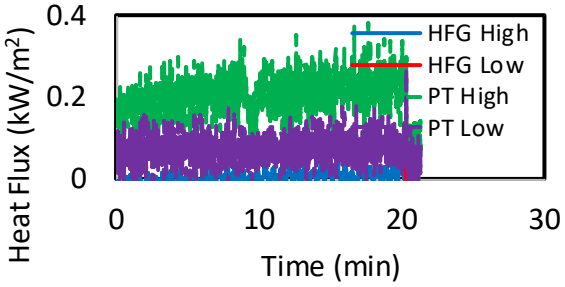
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test098 (NRC/NIST) **Test Item: Plank Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.7 Burning Duration (s): 1,237 Ignition Method: Panel

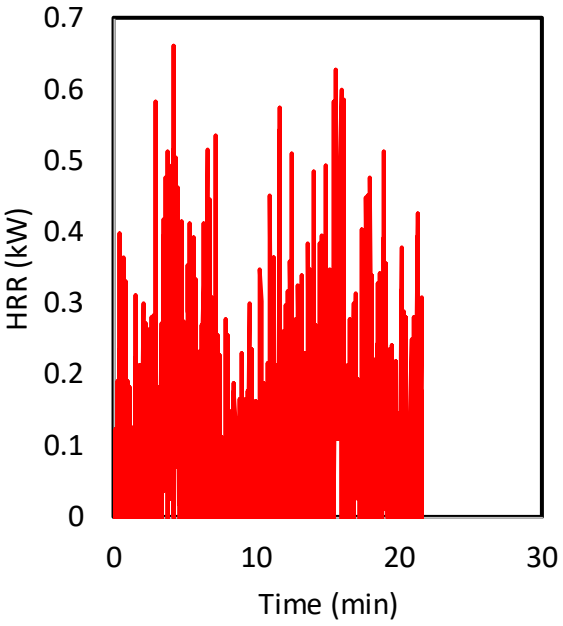
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.09

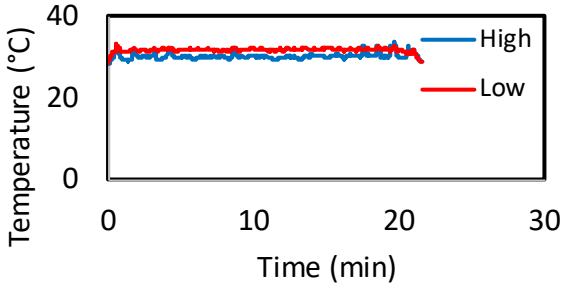
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

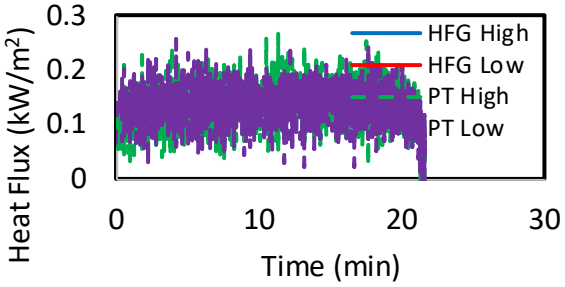
TC Grid Heights[1] (cm): 61, 107

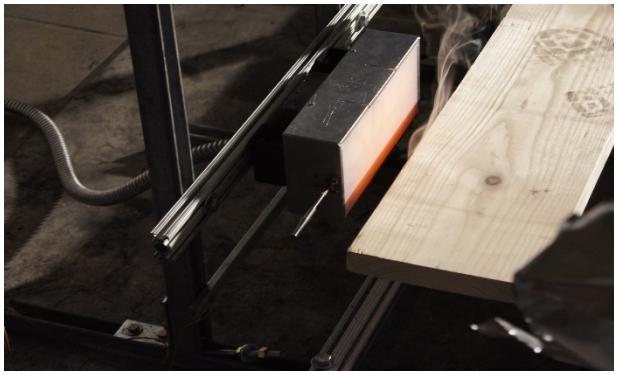
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

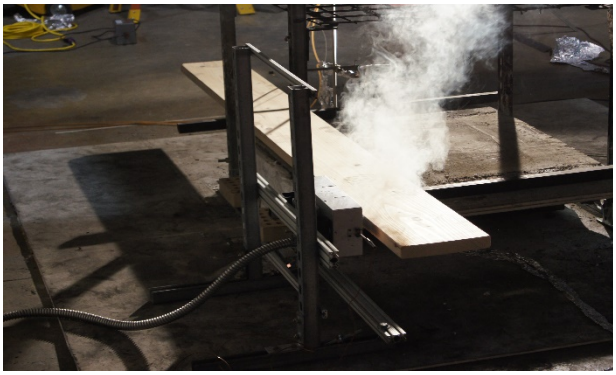
[1]From top of platform, [2]From center of platform











Test ID: Test099 (NRC/NIST) **Test Item: Plank Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 1.1 Burning Duration (s): 1,219 Ignition Method: Panel

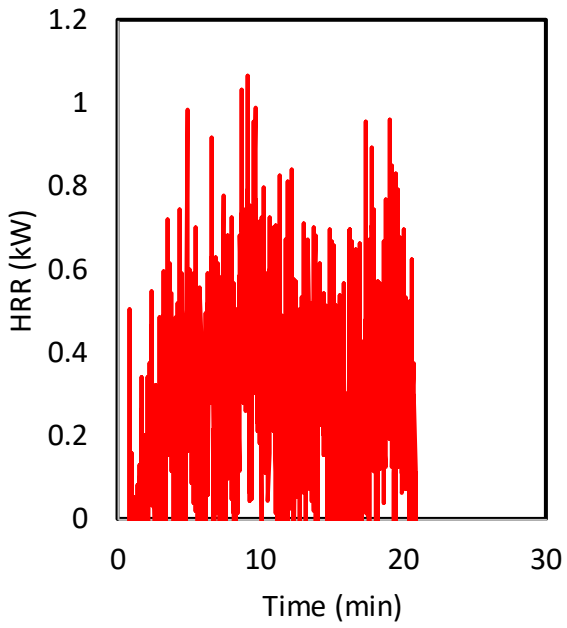
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.30

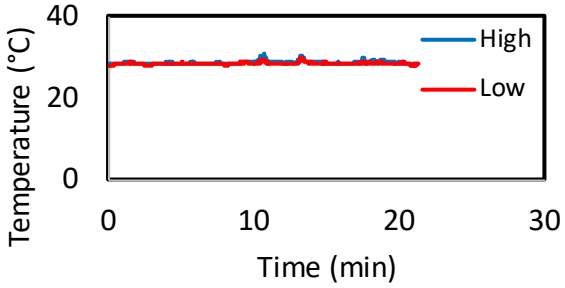
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

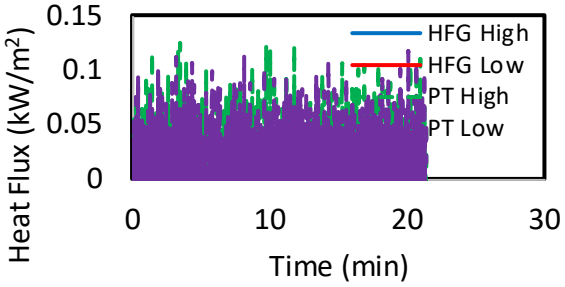
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test100 (NRC/NIST) **Test Item: Plank Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.7 Burning Duration (s): 1,219 Ignition Method: Panel

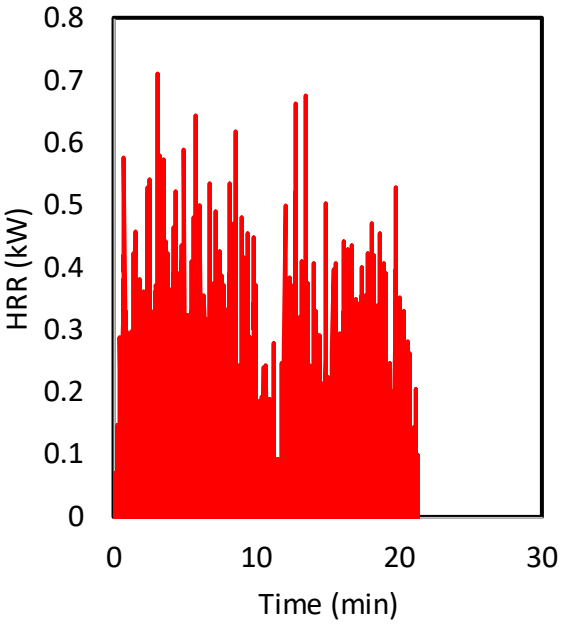
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.09

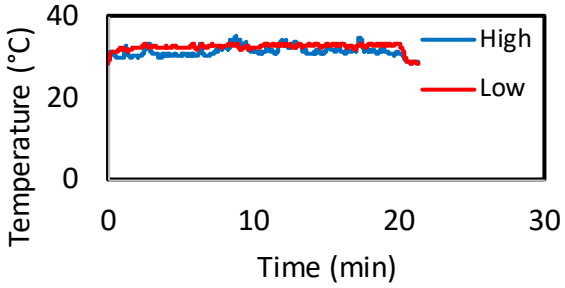
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

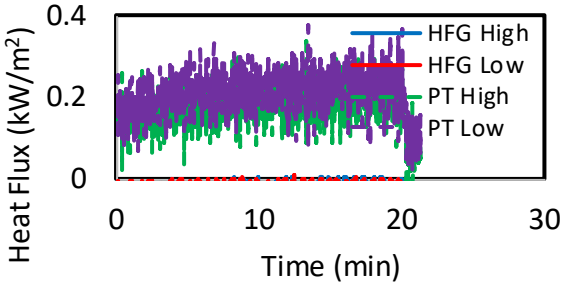
TC Grid Heights[1] (cm): 61, 107

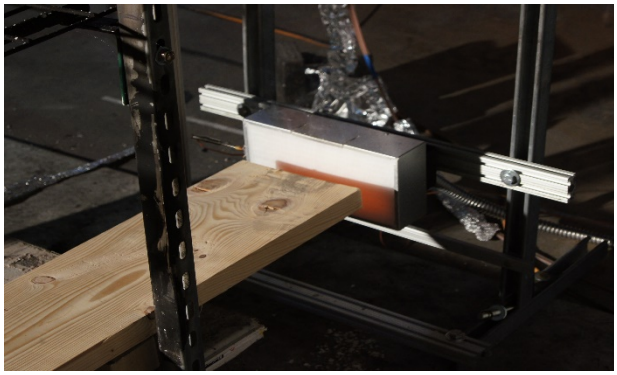
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

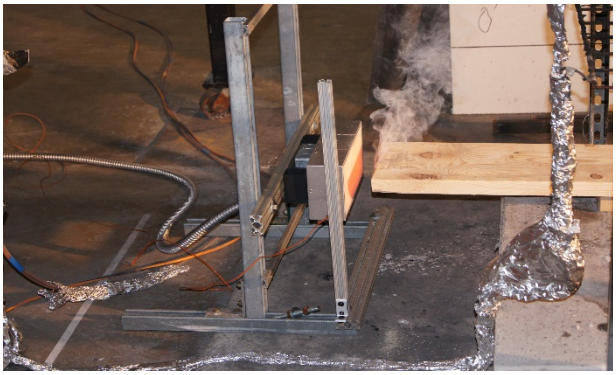
[1]From top of platform, [2]From center of platform











Test ID: Test101 (NRC/NIST) **Test Item: Stack PPE**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.58

Peak HRR (kW): 69.7 Burning Duration (s): 2,261 Ignition Method: Wick

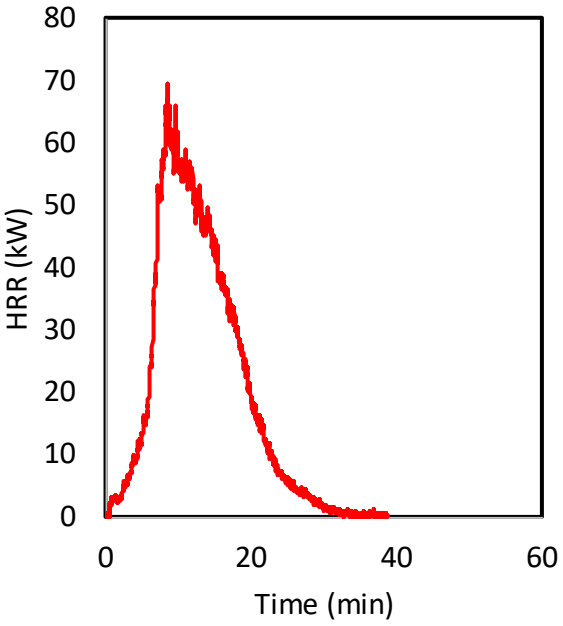
Heat of Combustion (MJ/kg): 28.6 Total Energy Release (MJ): 44.56

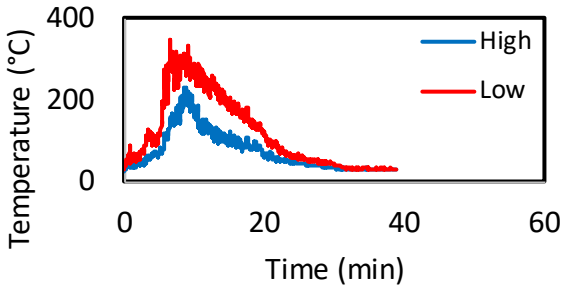
Soot Yield (kg/kg): 0.062 CO Yield (kg/kg): 0.034

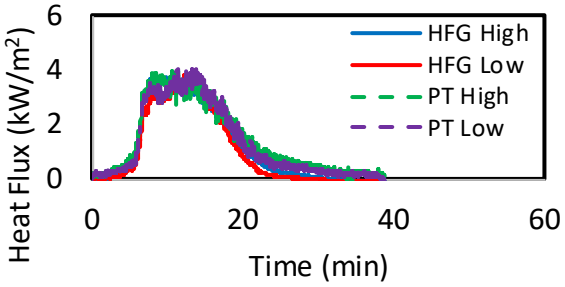
TC Grid Heights[1] (cm): 61, 107

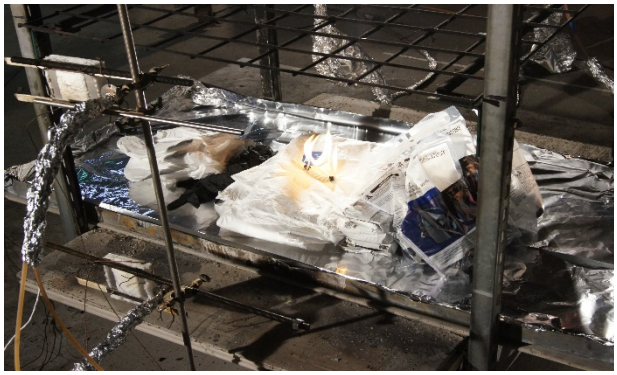
HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

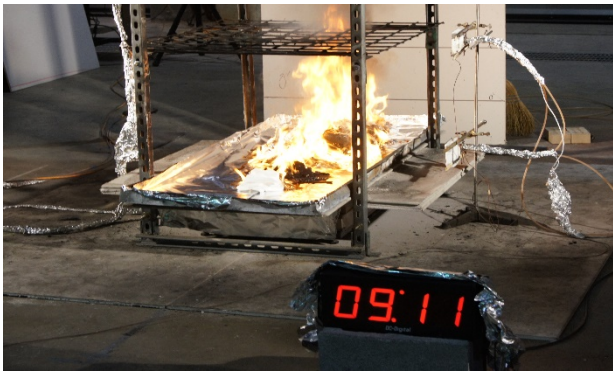
[1]From top of platform, [2]From center of platform











Test ID: Test103 (NRC/NIST) **Test Item: Stack PPE**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.89

Peak HRR (kW): 118 Burning Duration (s): 2,127 Ignition Method: Wick

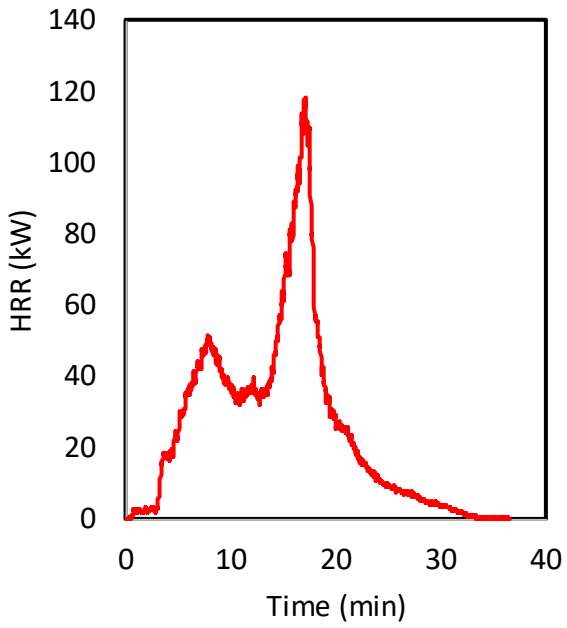
Heat of Combustion (MJ/kg): 30.2 Total Energy Release (MJ): 54.9

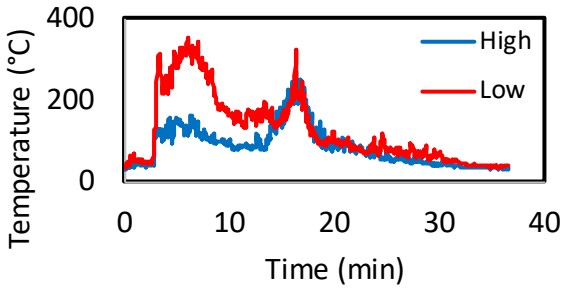
Soot Yield (kg/kg): 0.059 CO Yield (kg/kg): 0.030

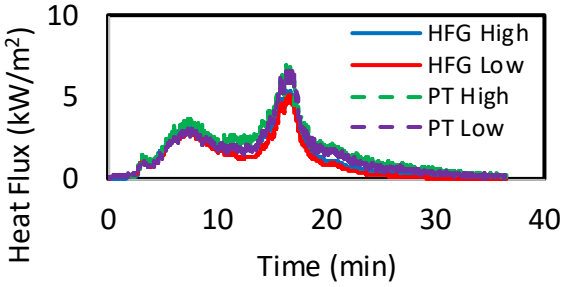
TC Grid Heights[1] (cm): 61, 107

HF Gauge Heights[1] (cm): 46, 91 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: Test102 (NRC/NIST) **Test Item: Laptop + Cart**

Max Fire Diameter (m): 0.94 Max Flame Height (m): 3.01

Peak HRR (kW): 2683 Burning Duration (s): 5,411 Ignition Method: Flame

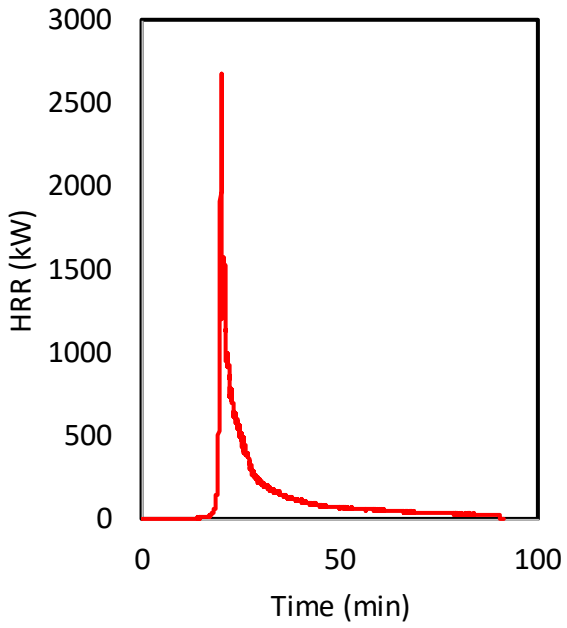
Heat of Combustion (MJ/kg): 34.3 Total Energy Release (MJ): 691.6

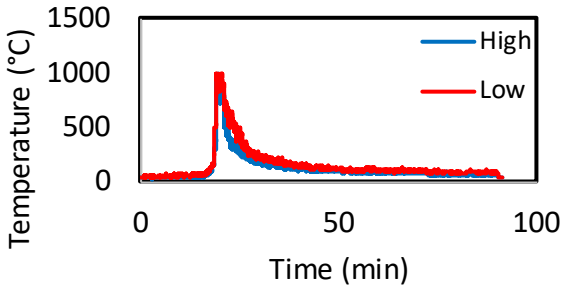
Soot Yield (kg/kg): 0.054 CO Yield (kg/kg): 0.038

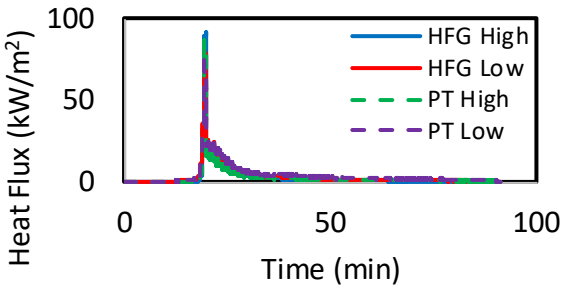
TC Grid Heights[1] (cm): 132, 178

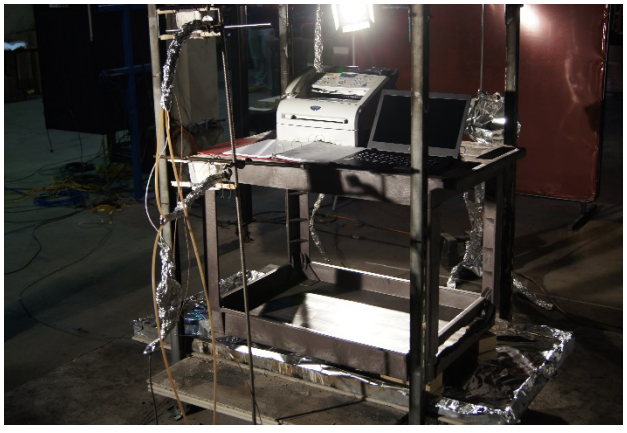
HF Gauge Heights[1] (cm): 81, 127 HF Gauge Distance[2] (cm): 61 (moved during test)

[1]From top of platform, [2]From center of platform









Test ID: Test0105 (NRC/NIST) **Test Item: Laptop + Cart**

Max Fire Diameter (m): 0.94 Max Flame Height (m): 3.14

Peak HRR (kW): 2510 Burning Duration (s): 4,519 Ignition Method: Flame

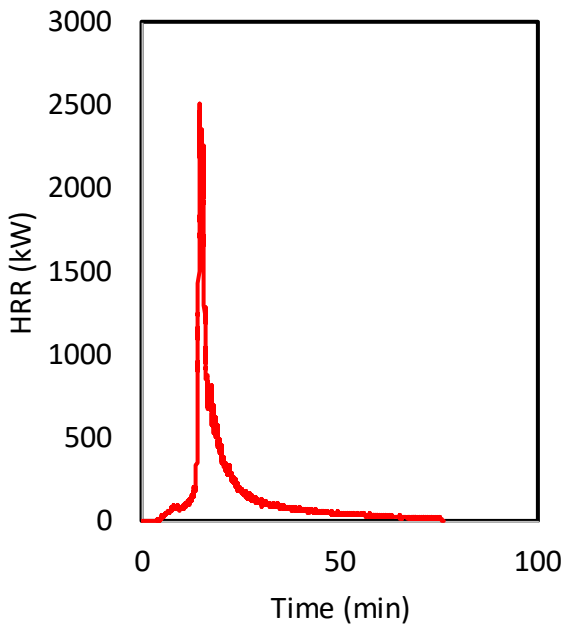
Heat of Combustion (MJ/kg): 33.4 Total Energy Release (MJ): 690.82

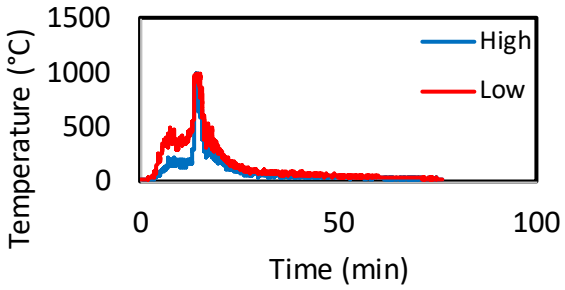
Soot Yield (kg/kg): N/A CO Yield (kg/kg): 0.037

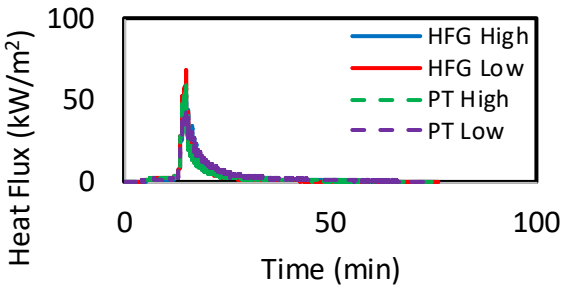
TC Grid Heights[1] (cm): 135, 180

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 102

[1]From top of platform, [2]From center of platform







Test ID: Test0106 (NRC/NIST) **Test Item: Laptop + Cart**

Max Fire Diameter (m): 0.94 Max Flame Height (m): 3.38

Peak HRR (kW): 2214 Burning Duration (s): 5,422 Ignition Method: Flame

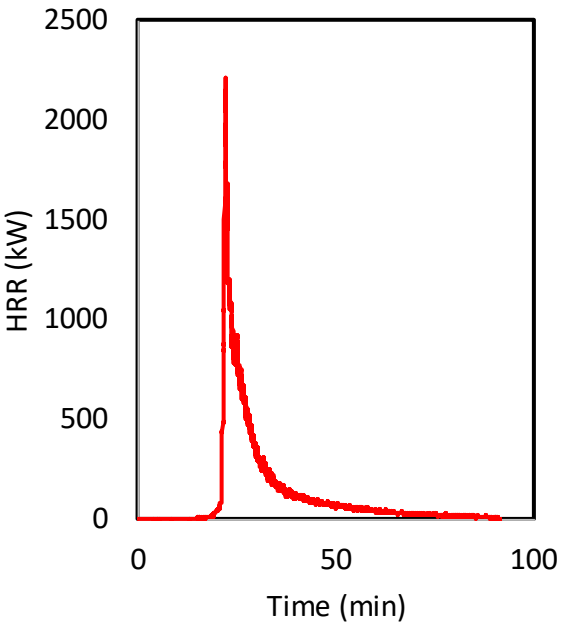
Heat of Combustion (MJ/kg): 33.0 Total Energy Release (MJ): 669.30

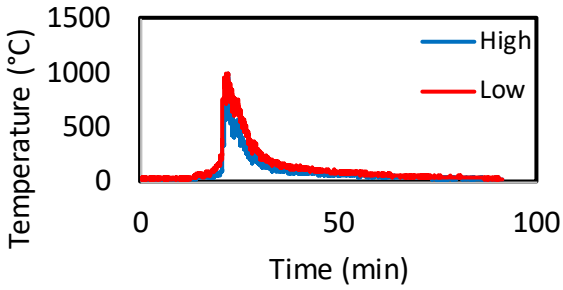
Soot Yield (kg/kg): N/A CO Yield (kg/kg): 0.032

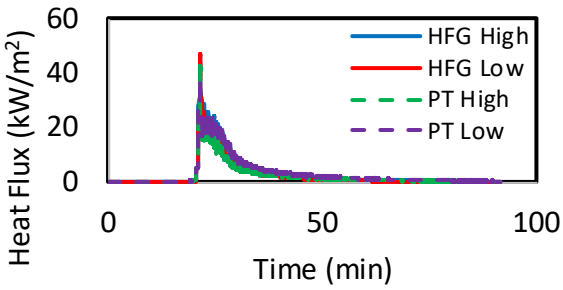
TC Grid Heights[1] (cm): 135, 180

HF Gauge Heights[1] (cm): 76, 122 HF Gauge Distance[2] (cm): 102

[1]From top of platform, [2]From center of platform







F.2 100 kW Calorimeter Summary Reports

This section contains the one-page summary reports for the tests performed using the 100 kW calorimeters. The Electric Power Research Institute (EPRI) sponsored these tests.

Test ID: 07_10_001 (EPRI) **Test Item: Single Rag**

Max Fire Diameter (m): 0.14 Max Flame Height (m): 0.23

Peak HRR (kW): 3.5 Burning Duration (s): 656 Ignition Method: Lighter

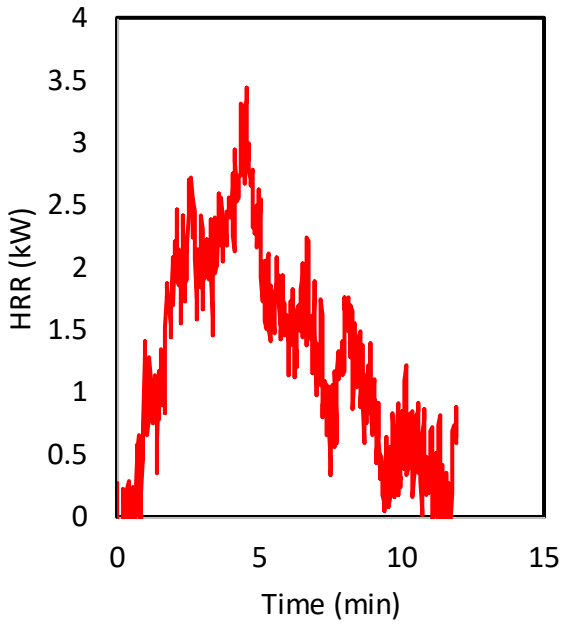
Heat of Combustion (MJ/kg): 20.2 Total Energy Release (MJ): 0.92

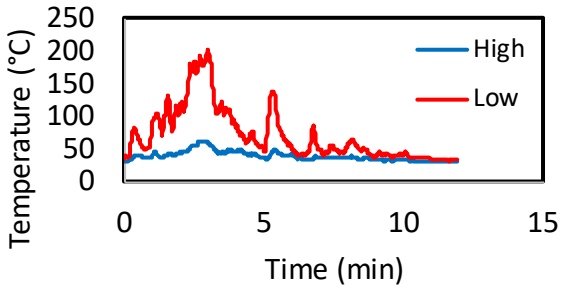
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.019

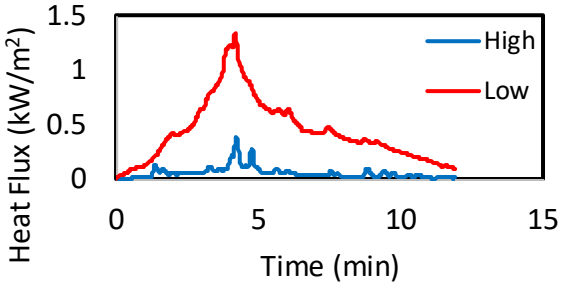
TC Grid Heights[1] (cm): 30, 76

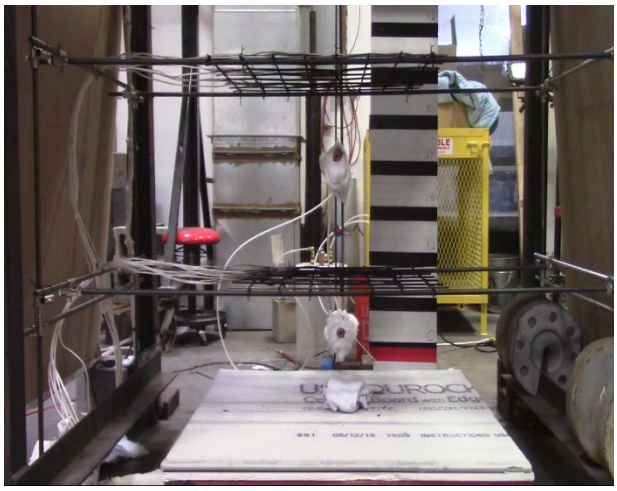
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

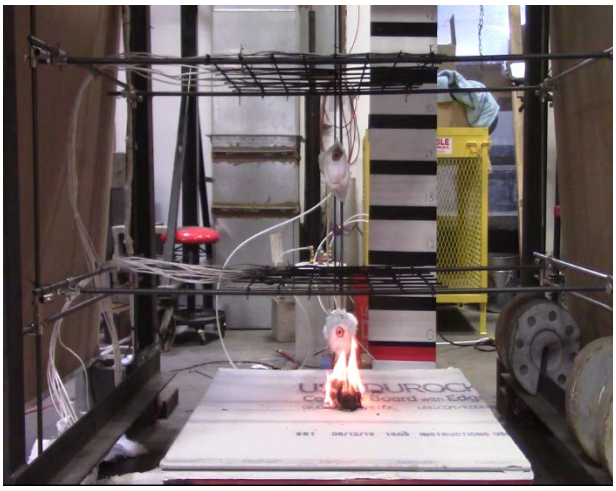
[1]From top of platform, [2]From center of platform











Test ID: 07_10_002 (EPRI) **Test Item: Single Rag**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.34

Peak HRR (kW): 4.7 Burning Duration (s): 612 Ignition Method: Lighter

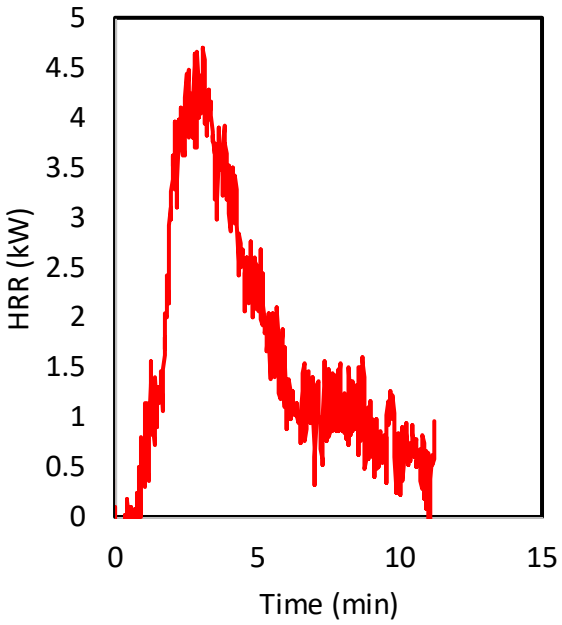
Heat of Combustion (MJ/kg): 24.2 Total Energy Release (MJ): 1.10

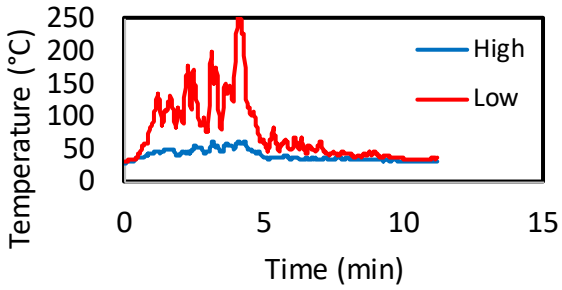
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.025

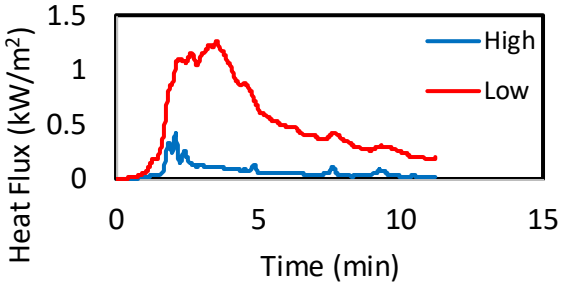
TC Grid Heights[1] (cm): 30, 76

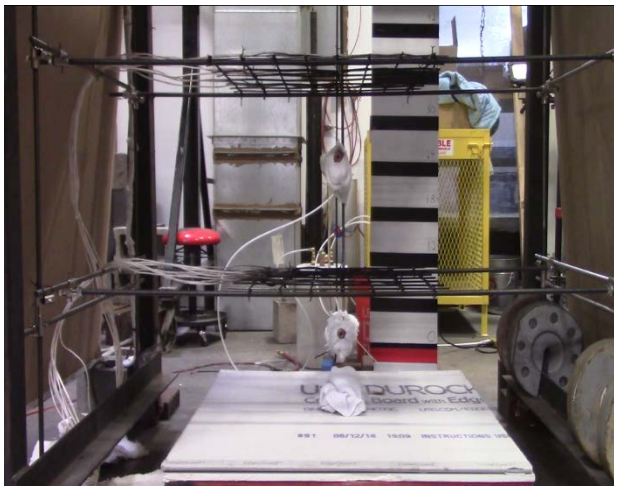
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

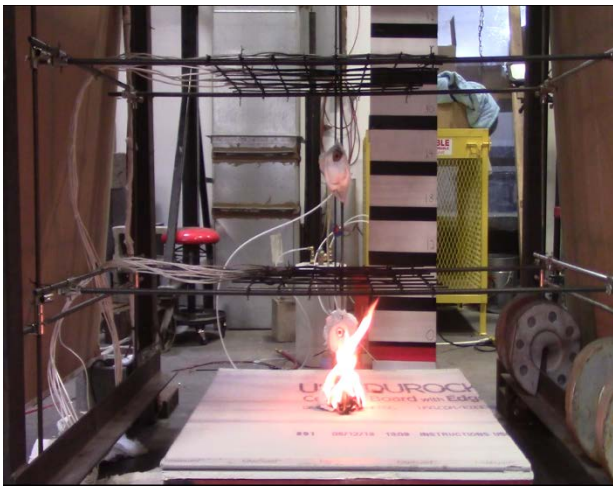
[1]From top of platform, [2]From center of platform











Test ID: 07_10_003 (EPRI) **Test Item: Single Rag**

Max Fire Diameter (m): 0.11 Max Flame Height (m): 0.22

Peak HRR (kW): 2.6 Burning Duration (s): 875 Ignition Method: Lighter

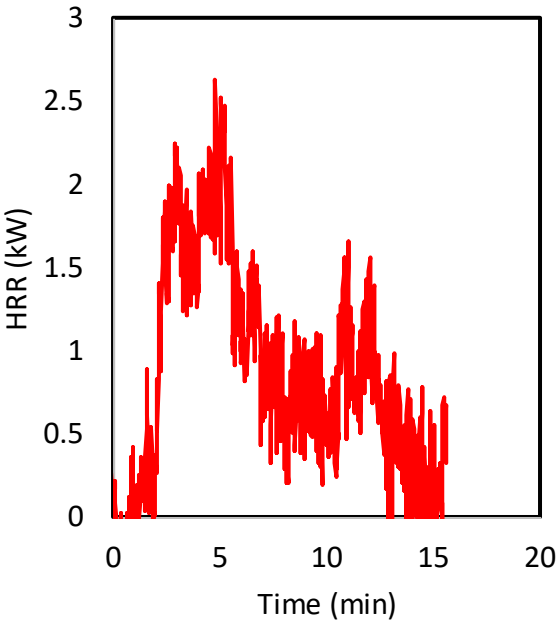
Heat of Combustion (MJ/kg): 17.7 Total Energy Release (MJ): 0.80

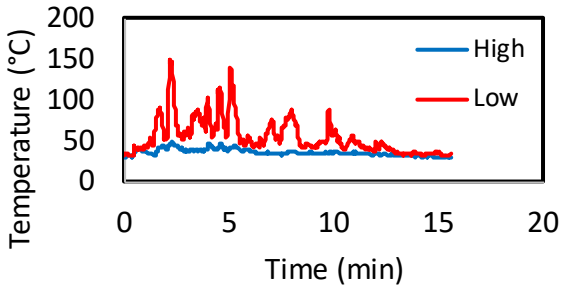
Soot Yield (kg/kg): 0.0194 CO Yield (kg/kg): 0.030

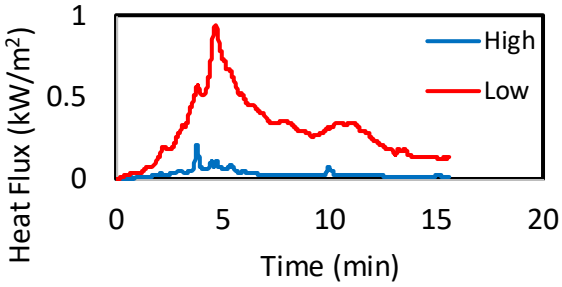
TC Grid Heights[1] (cm): 30, 76

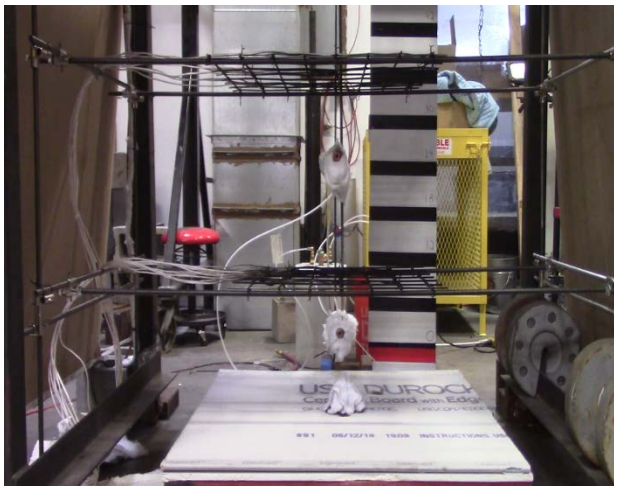
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

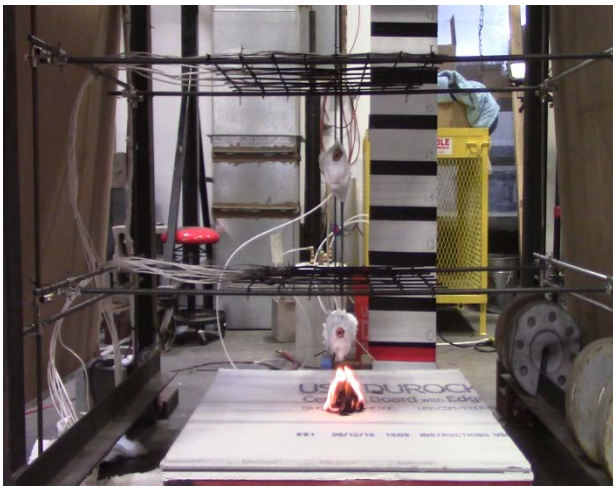
[1]From top of platform, [2]From center of platform











Test ID: 07_23_002 (EPRI) **Test Item: Single Rag**

Max Fire Diameter (m): 0.18 Max Flame Height (m): 0.20

Peak HRR (kW): 2.7 Burning Duration (s): 675 Ignition Method: Lighter

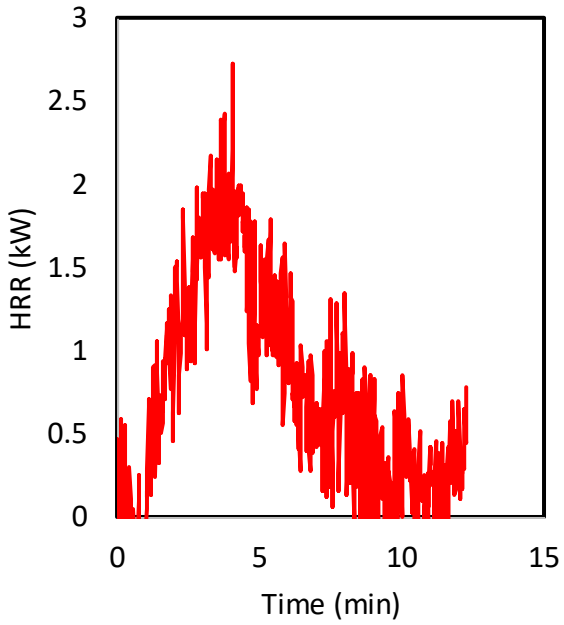
Heat of Combustion (MJ/kg): 24.2 Total Energy Release (MJ): 0.55

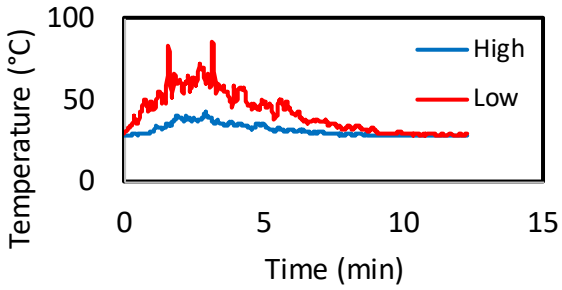
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.048

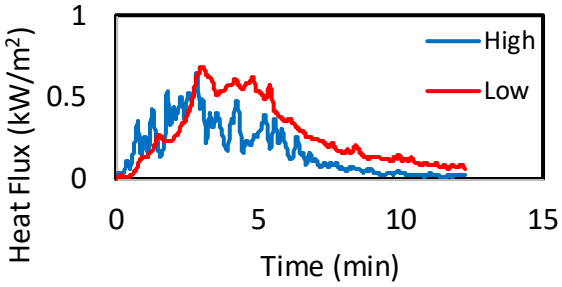
TC Grid Heights[1] (cm): 28, 74

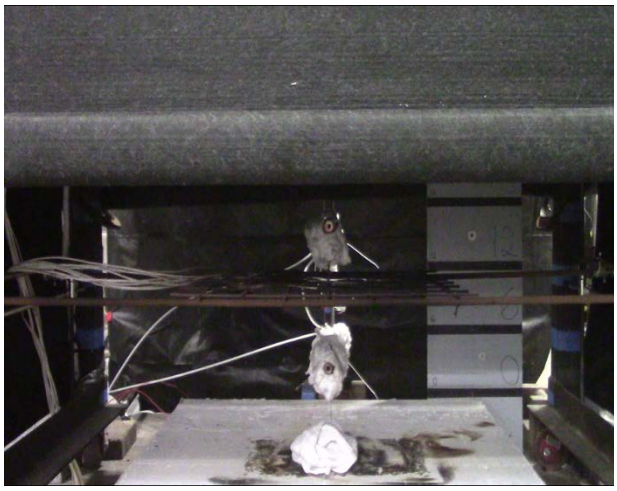
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

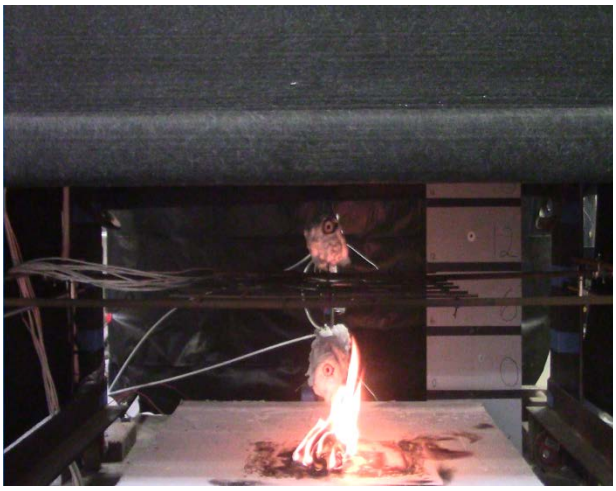
[1]From top of platform, [2]From center of platform











Test ID: 07_16_001 (EPRI) **Test Item: 5 Rags**

Max Fire Diameter (m): 0.24 Max Flame Height (m): 0.26

Peak HRR (kW): 7.5 Burning Duration (s): 1,445 Ignition Method: Lighter

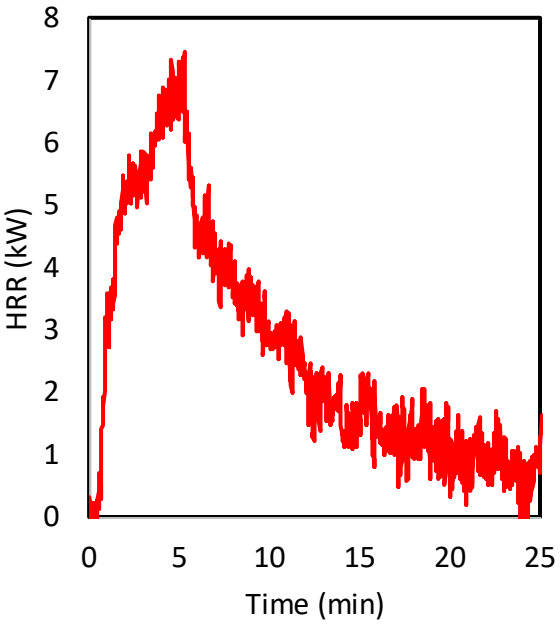
Heat of Combustion (MJ/kg): 19.4 Total Energy Release (MJ): 3.97

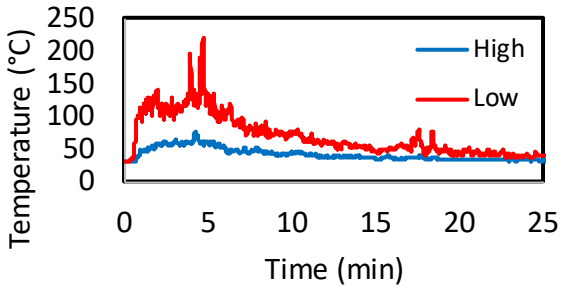
Soot Yield (kg/kg): 0.011 CO Yield (kg/kg): 0.061

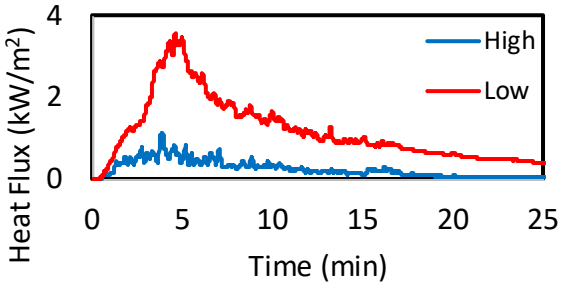
TC Grid Heights[1] (cm): 28, 74

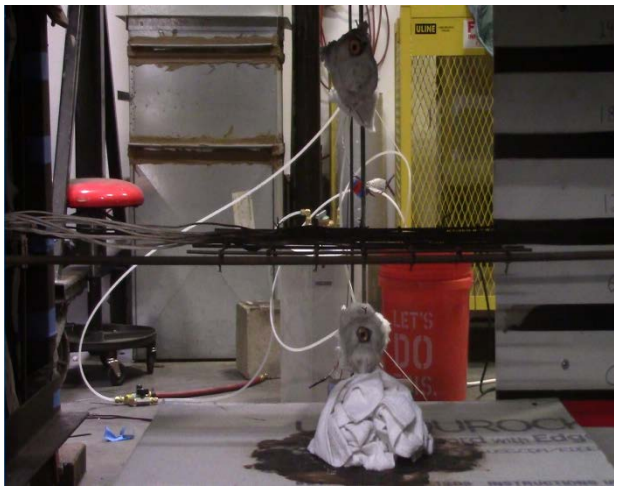
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

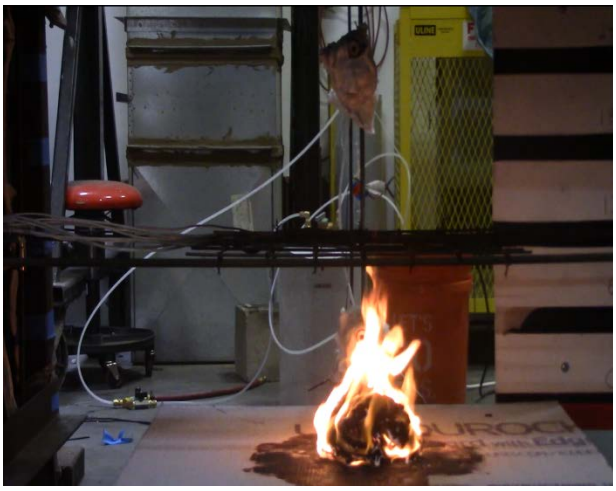
[1]From top of platform, [2]From center of platform











Test ID: 07_16_002 (EPRI) **Test Item: 5 Rags**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.20

Peak HRR (kW): 8.3 Burning Duration (s): 1,122 Ignition Method: Lighter

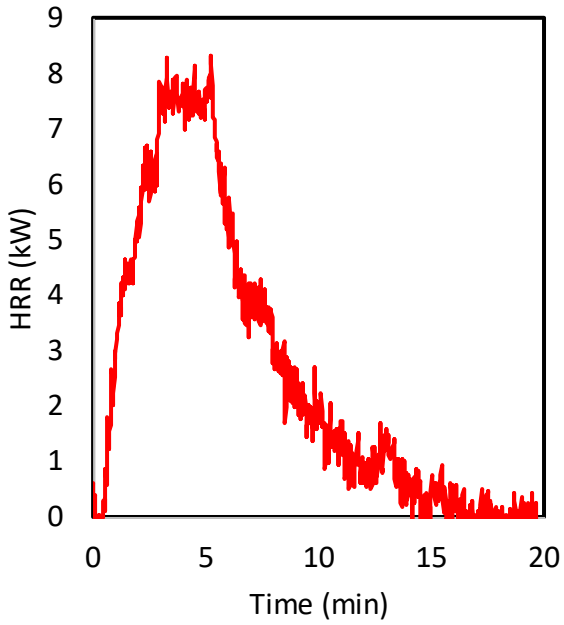
Heat of Combustion (MJ/kg): 14.9 Total Energy Release (MJ): 3.05

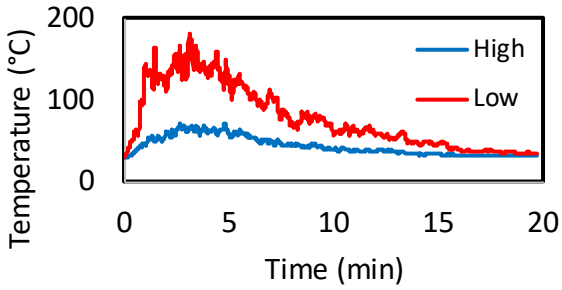
Soot Yield (kg/kg): 0.008 CO Yield (kg/kg): 0.038

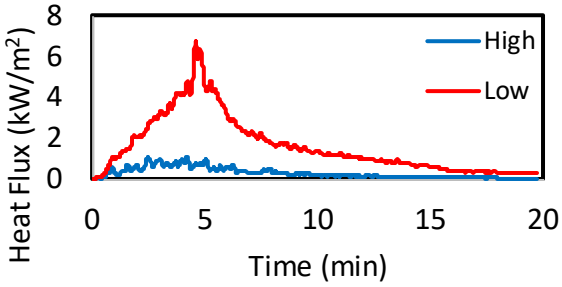
TC Grid Heights[1] (cm): 28, 74

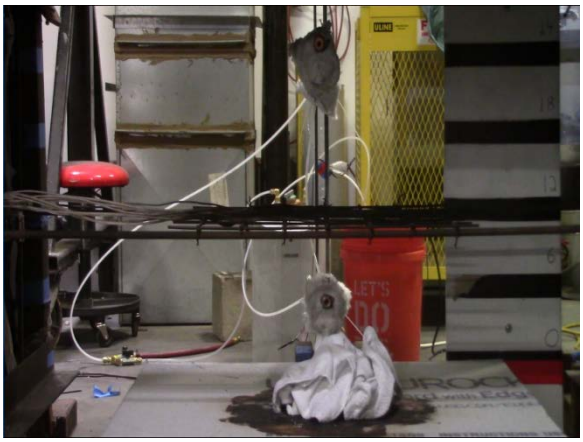
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_16_003 (EPRI) **Test Item: 5 Rags**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.44

Peak HRR (kW): 14.0 Burning Duration (s): 710 Ignition Method: Lighter

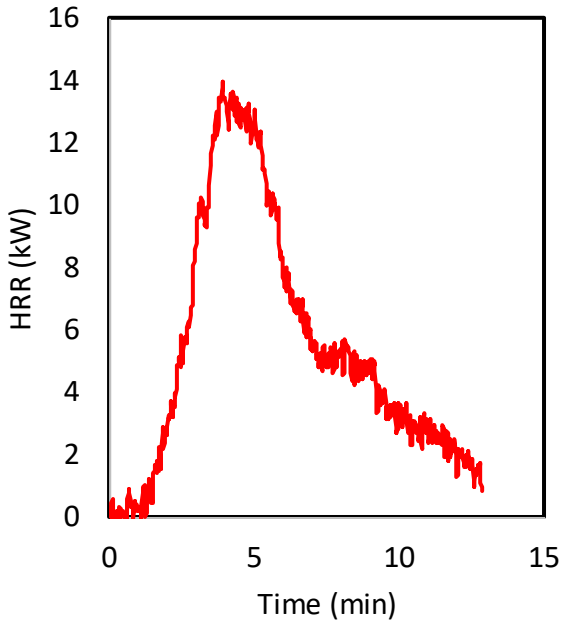
Heat of Combustion (MJ/kg): 20.3 Total Energy Release (MJ): 4.14

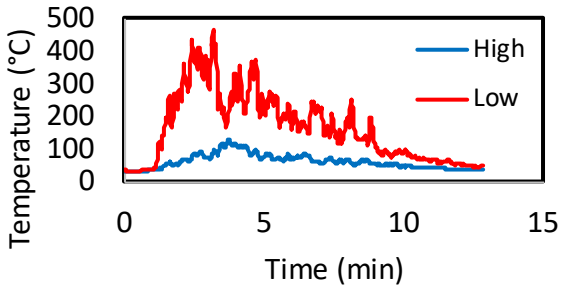
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.026

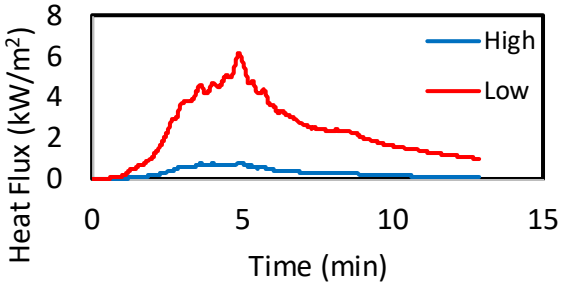
TC Grid Heights[1] (cm): 28, 74

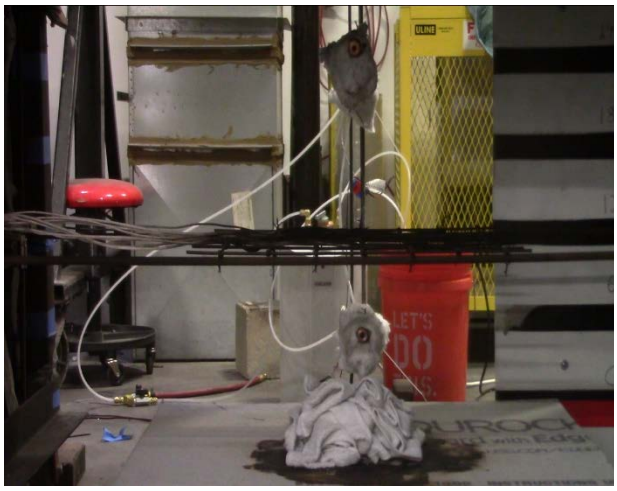
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

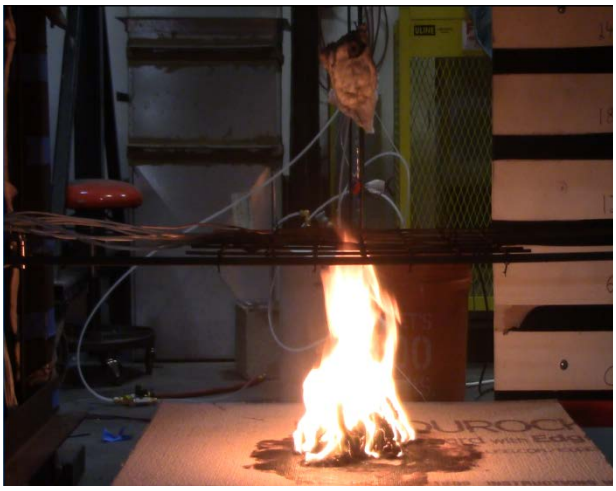
[1]From top of platform, [2]From center of platform











Test ID: 07_23_003 (EPRI) **Test Item: 5 Rags**

Max Fire Diameter (m): 0.23 Max Flame Height (m): 0.34

Peak HRR (kW): 10.4 Burning Duration (s): 819 Ignition Method: Lighter

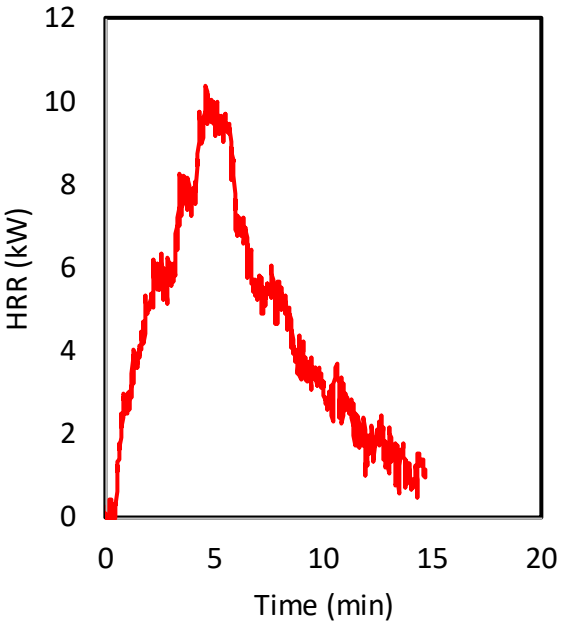
Heat of Combustion (MJ/kg): 17.5 Total Energy Release (MJ): 3.91

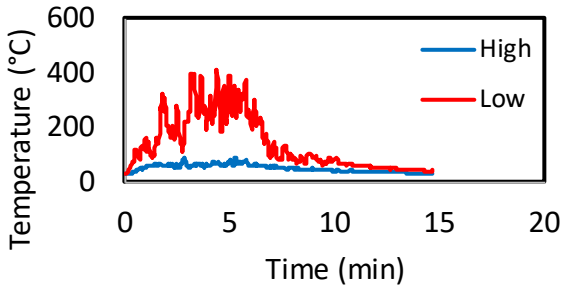
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.034

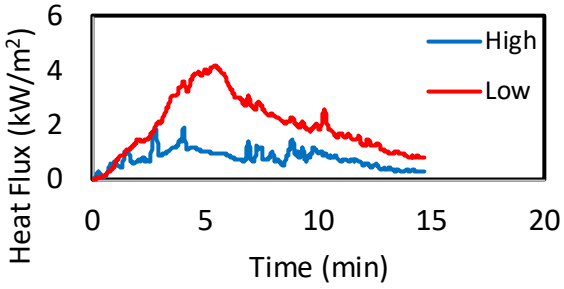
TC Grid Heights[1] (cm): 28, 74

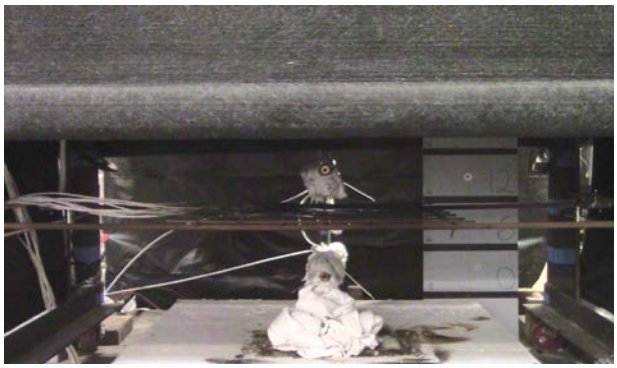
HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_16_004 (EPRI) **Test Item: Single Rag w/Heptane**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.54

Peak HRR (kW): 9.6 Burning Duration (s): 532 Ignition Method: Lighter

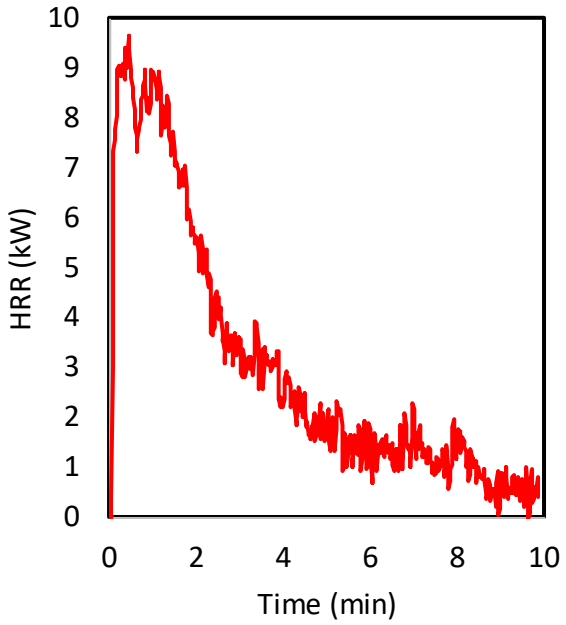
Heat of Combustion (MJ/kg): 26.5 Total Energy Release (MJ): 1.80

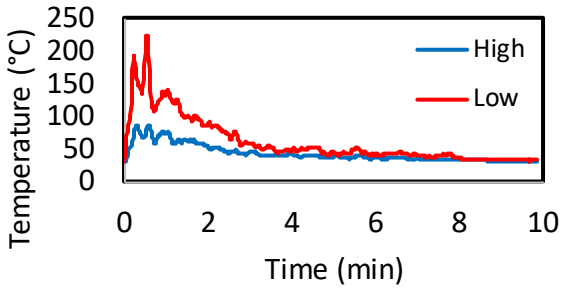
Soot Yield (kg/kg): 0.015 CO Yield (kg/kg): 0.015

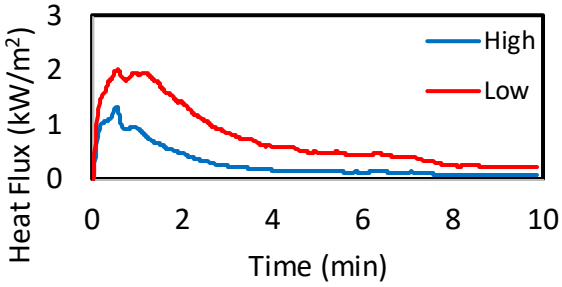
TC Grid Heights[1] (cm): 56, 102

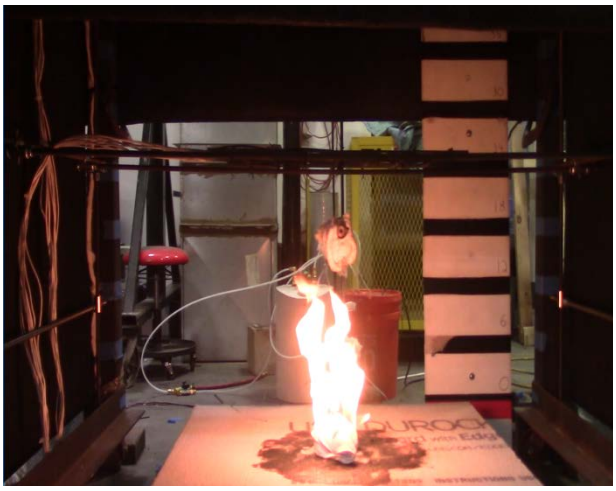
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_16_005 (EPRI) **Test Item: Single Rag w/Heptane**

Max Fire Diameter (m): 0.013 Max Flame Height (m): 0.58

Peak HRR (kW): 10.5 Burning Duration (s): 618 Ignition Method: Lighter

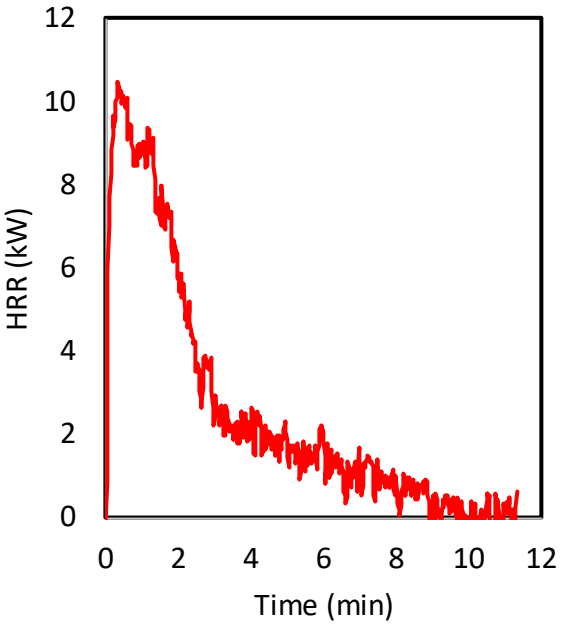
Heat of Combustion (MJ/kg): 25.9 Total Energy Release (MJ): 1.76

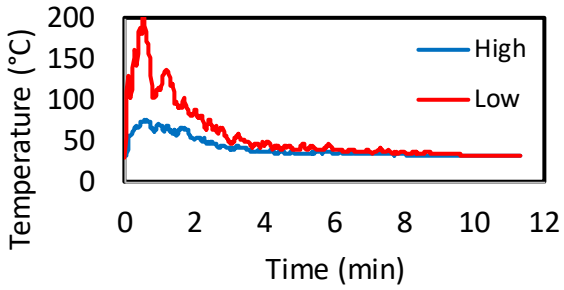
Soot Yield (kg/kg): 0.016 CO Yield (kg/kg): 0.018

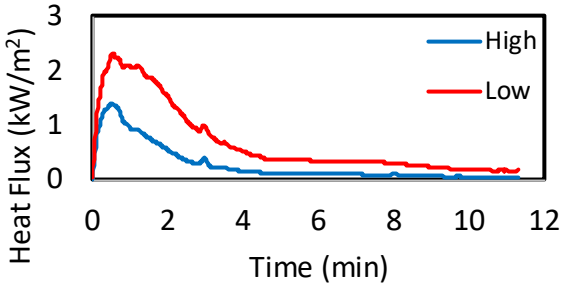
TC Grid Heights[1] (cm): 56, 102

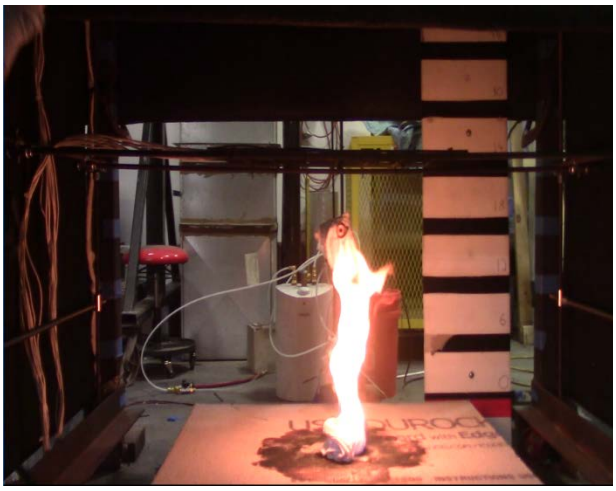
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_16_006 (EPRI) **Test Item: Single Rag w/Heptane**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.56

Peak HRR (kW): 9.1 Burning Duration (s): 572 Ignition Method: Lighter

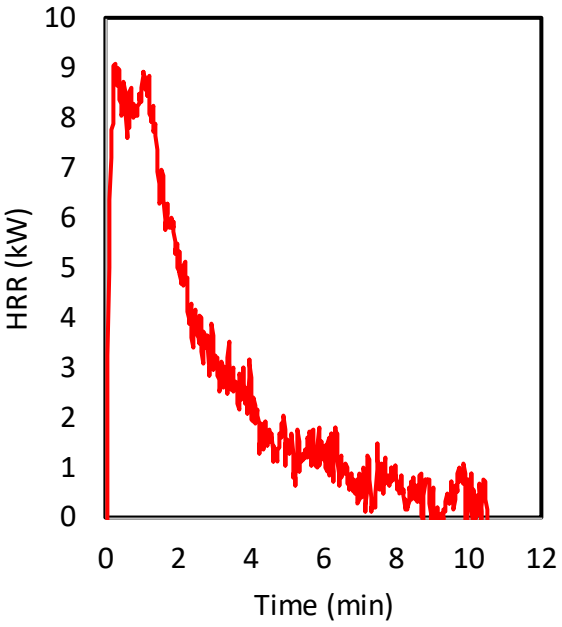
Heat of Combustion (MJ/kg): 23.8 Total Energy Release (MJ): 1.62

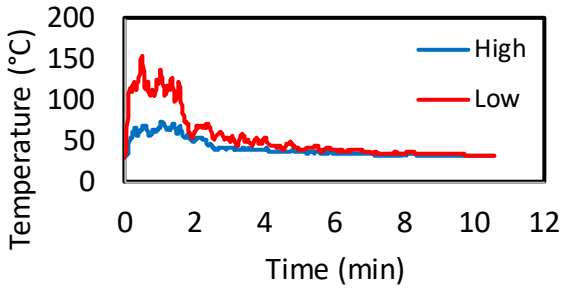
Soot Yield (kg/kg): 0.015 CO Yield (kg/kg): 0.018

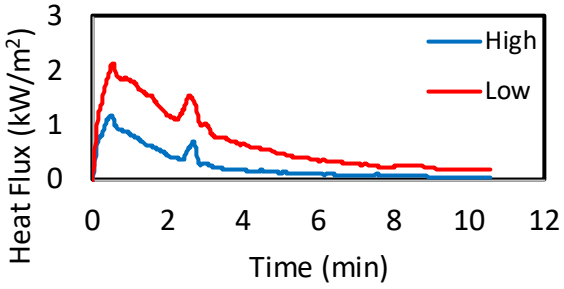
TC Grid Heights[1] (cm): 56, 102

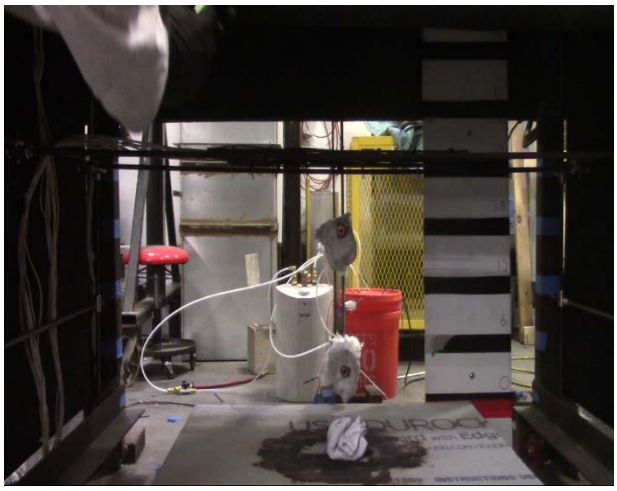
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

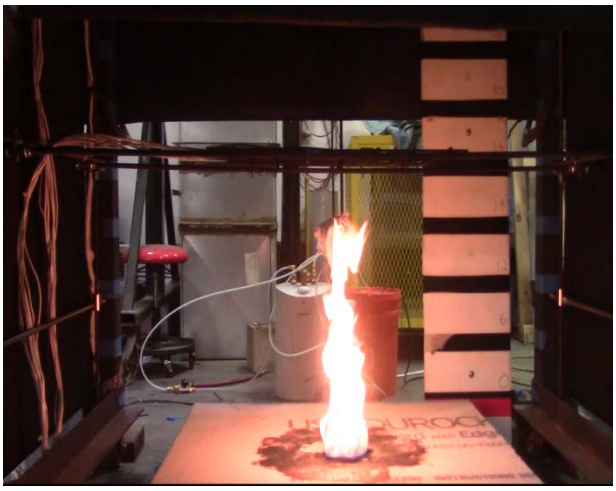
[1]From top of platform, [2]From center of platform











Test ID: 07_23_001 (EPRI) **Test Item: Single Rag w/Heptane**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.40

Peak HRR (kW): 11.8 Burning Duration (s): 591 Ignition Method: Lighter

Heat of Combustion (MJ/kg): 28.4 Total Energy Release (MJ): 1.75

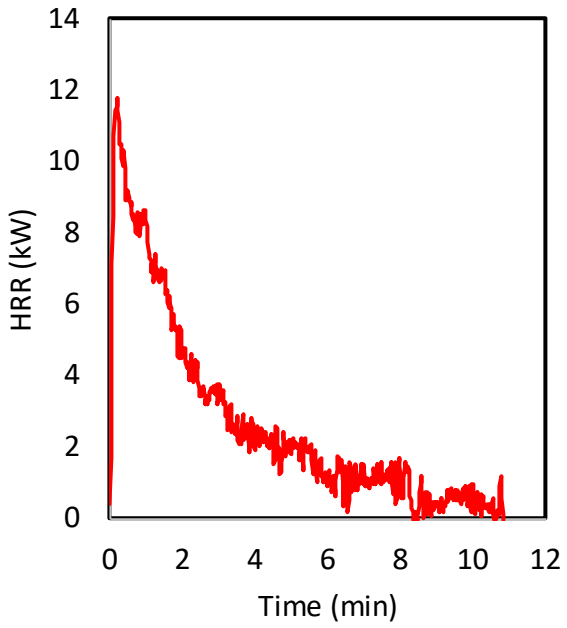
Soot Yield (kg/kg): 0.0063 CO Yield (kg/kg): 0.016

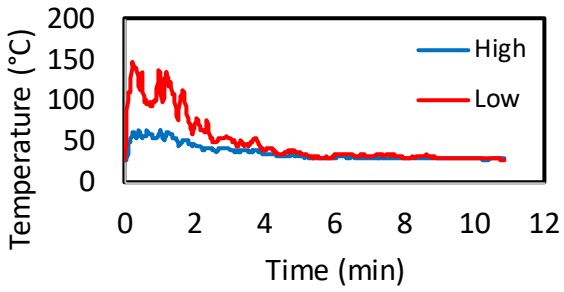
TC Grid Heights[1] (cm): 56, 102

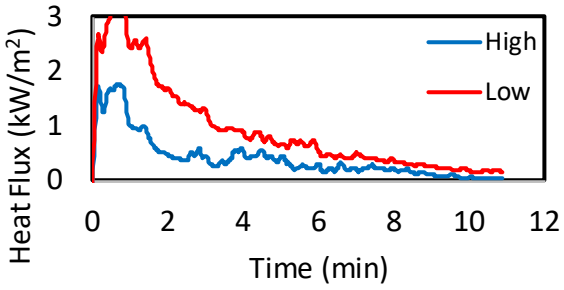
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

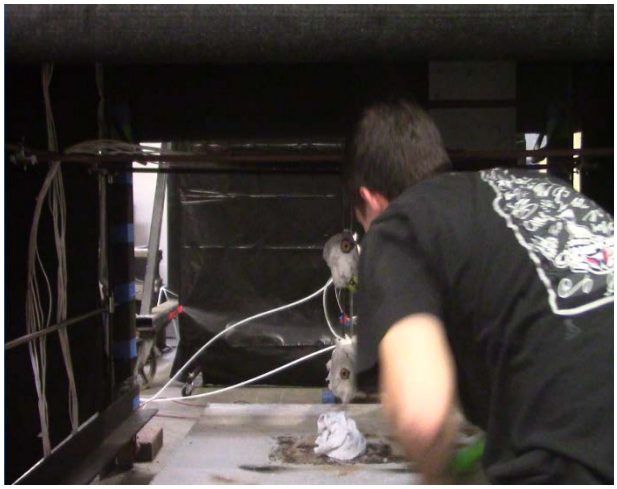
[1]From top of platform, [2]From center of platform

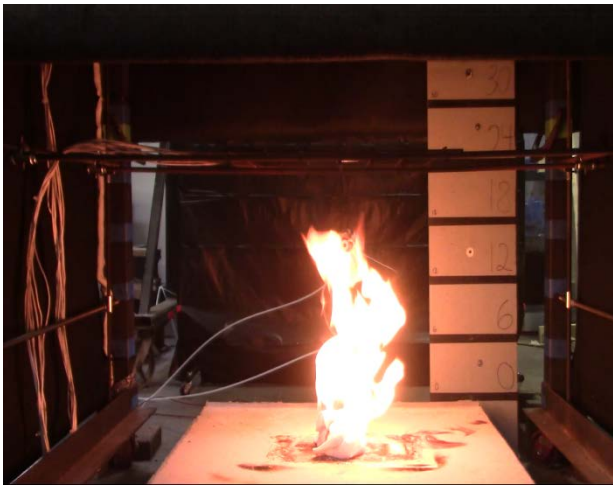
V











Test ID: 07_17_001 (EPRI) **Test Item: Bag of Rags**

Max Fire Diameter (m): 0.23 Max Flame Height (m): 0.19

Peak HRR (kW): 4.0 Burning Duration (s): 1,869 Ignition Method: Lighter

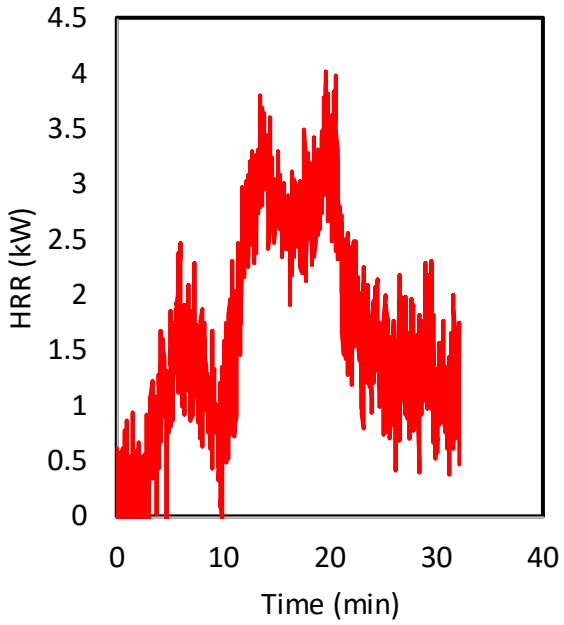
Heat of Combustion (MJ/kg): 24.0 Total Energy Release (MJ): 3.27

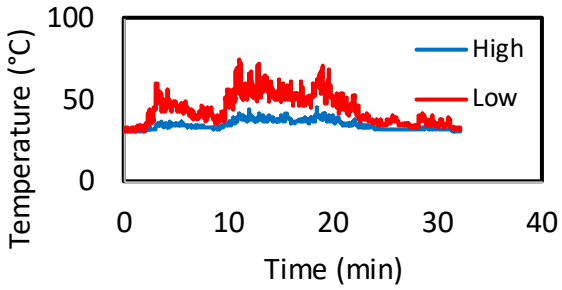
Soot Yield (kg/kg): 0.018 CO Yield (kg/kg): 0.078

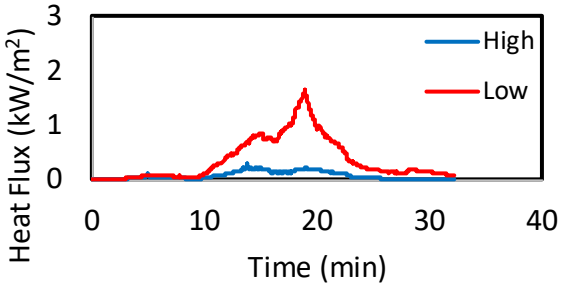
TC Grid Heights[1] (cm): 30, 61

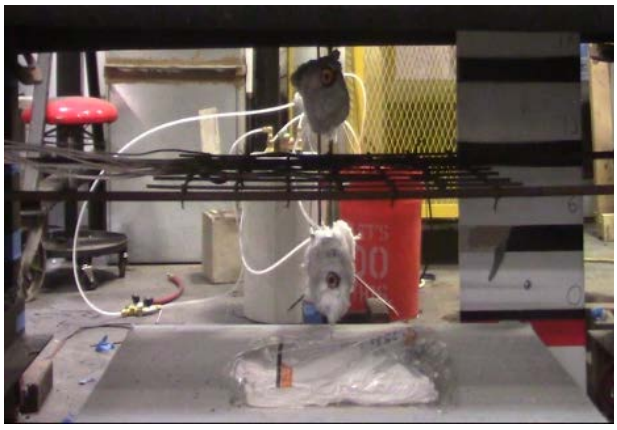
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

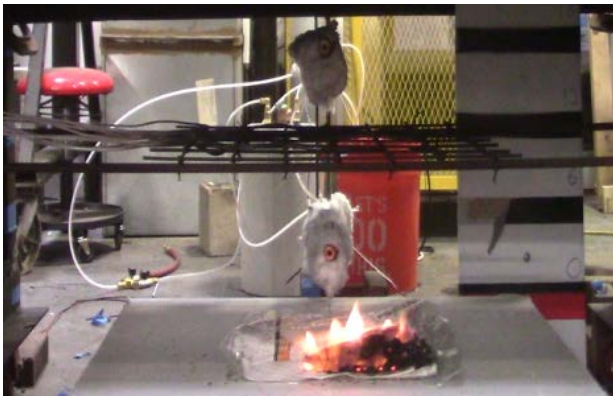
[1]From top of platform, [2]From center of platform











Test ID: 07_17_002 (EPRI) **Test Item: Bag of Rags**

Max Fire Diameter (m): 0.23 Max Flame Height (m): 0.25

Peak HRR (kW): 6.0 Burning Duration (s): 1,472 Ignition Method: Lighter

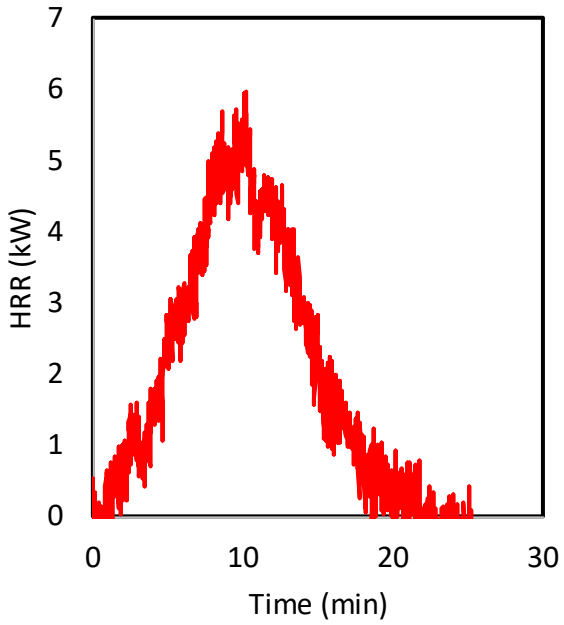
Heat of Combustion (MJ/kg): 12.6 Total Energy Release (MJ): 2.86

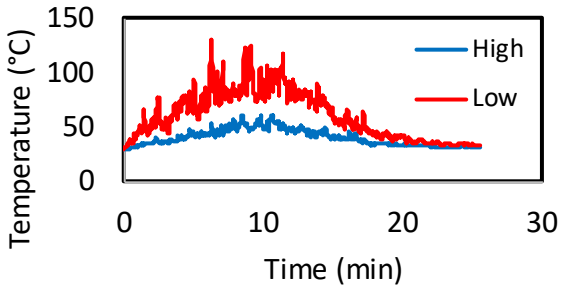
Soot Yield (kg/kg): 0.005 CO Yield (kg/kg): 0.052

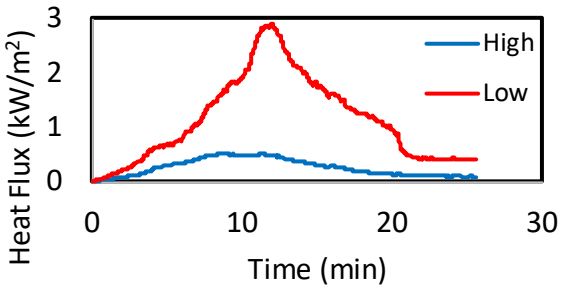
TC Grid Heights[1] (cm): 30, 61

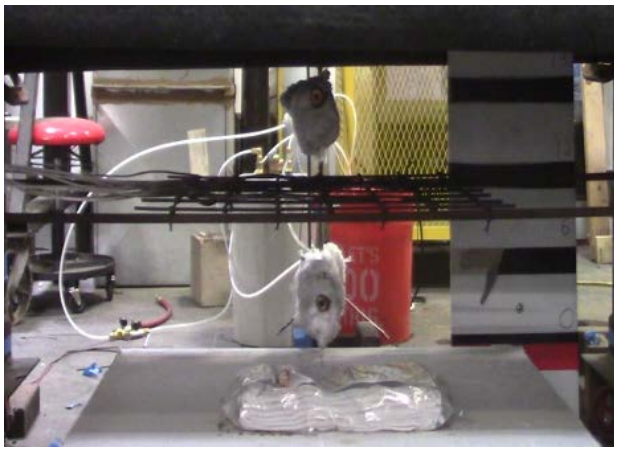
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

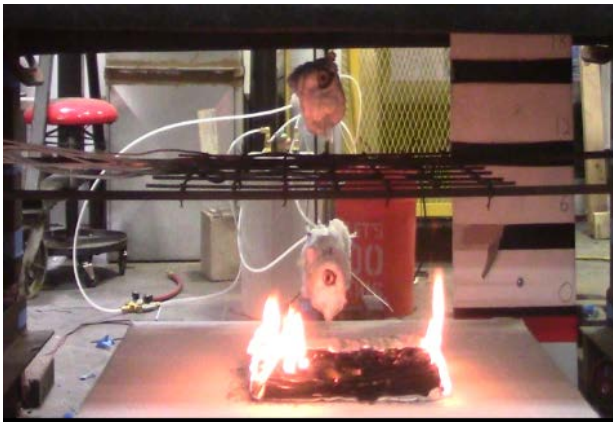
[1]From top of platform, [2]From center of platform











Test ID: 07_17_003 (EPRI) **Test Item: Bag of Rags**

Max Fire Diameter (m): 0.23 Max Flame Height (m): 0.23

Peak HRR (kW): 6.3 Burning Duration (s): 1,596 Ignition Method: Lighter

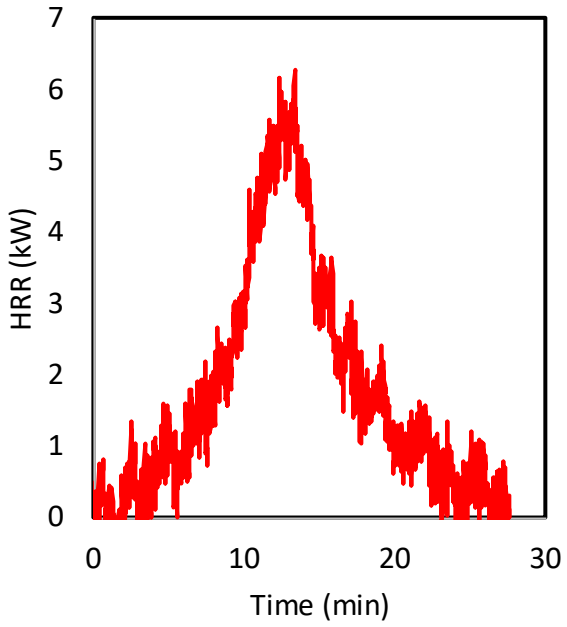
Heat of Combustion (MJ/kg): 15.8 Total Energy Release (MJ): 2.87

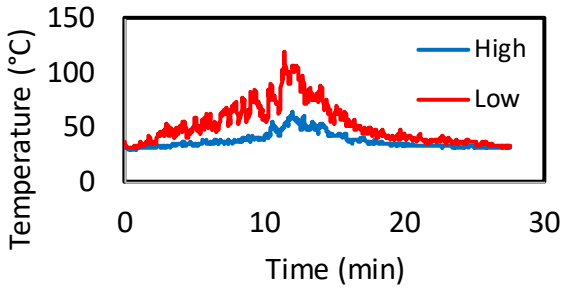
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.044

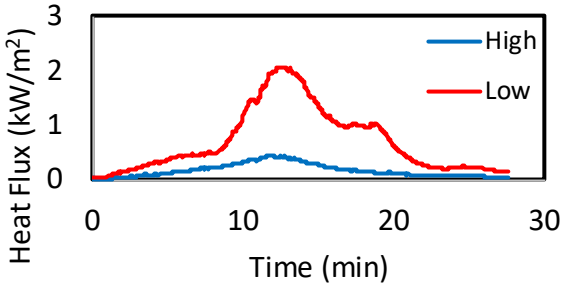
TC Grid Heights[1] (cm): 30, 61

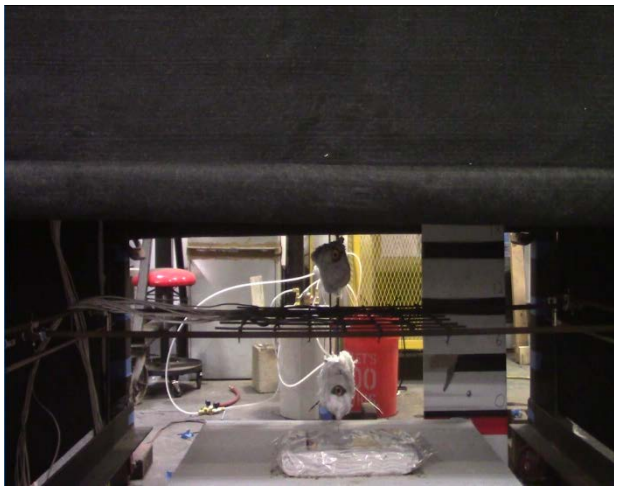
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

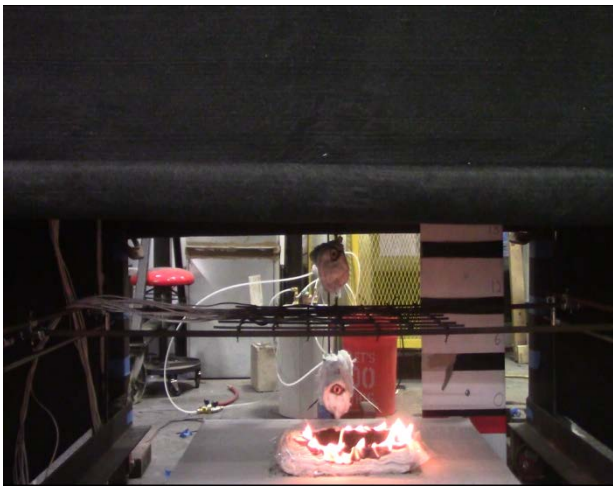
[1]From top of platform, [2]From center of platform











Test ID: 07_17_004 (EPRI) **Test Item: 5 Rags w/Heptane**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.87

Peak HRR (kW): 34.0 Burning Duration (s): 1,040 Ignition Method: Lighter

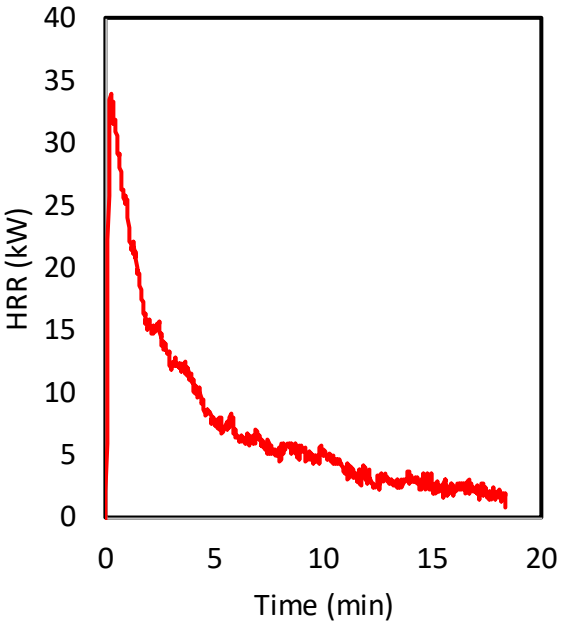
Heat of Combustion (MJ/kg): 25.7 Total Energy Release (MJ): 8.15

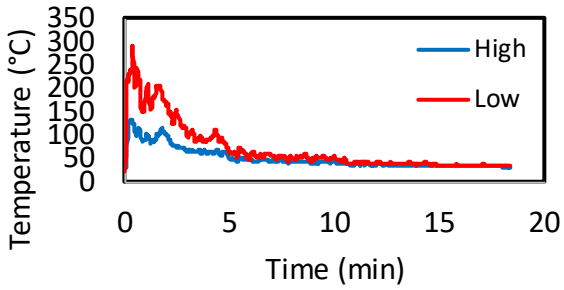
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.025

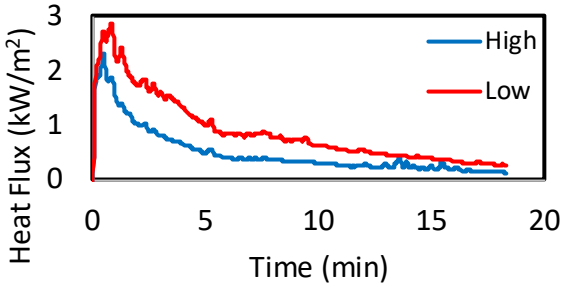
TC Grid Heights[1] (cm): 79, 124

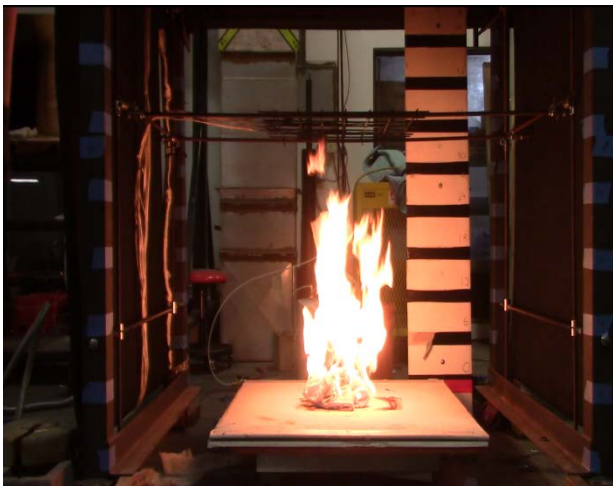
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 07_17_005 (EPRI) **Test Item: 5 Rags w/Heptane**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.86

Peak HRR (kW): 41.0 Burning Duration (s): 588 Ignition Method: Lighter

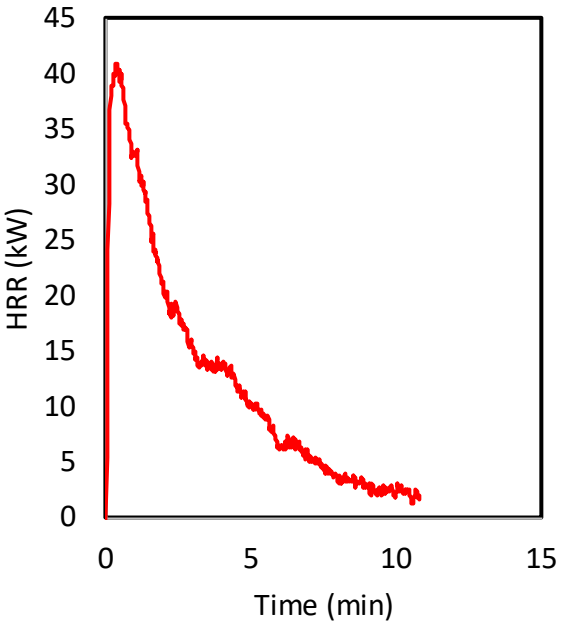
Heat of Combustion (MJ/kg): 27.0 Total Energy Release (MJ): 7.96

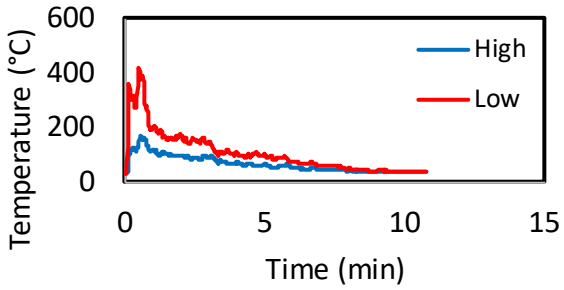
Soot Yield (kg/kg): 0.013 CO Yield (kg/kg): 0.019

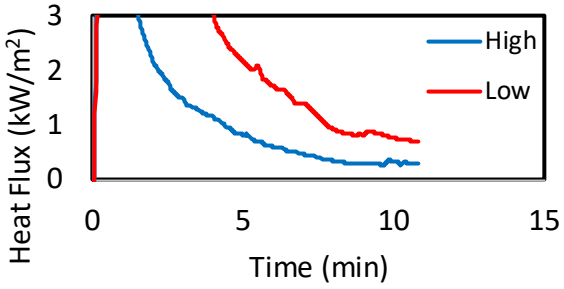
TC Grid Heights[1] (cm): 79, 124

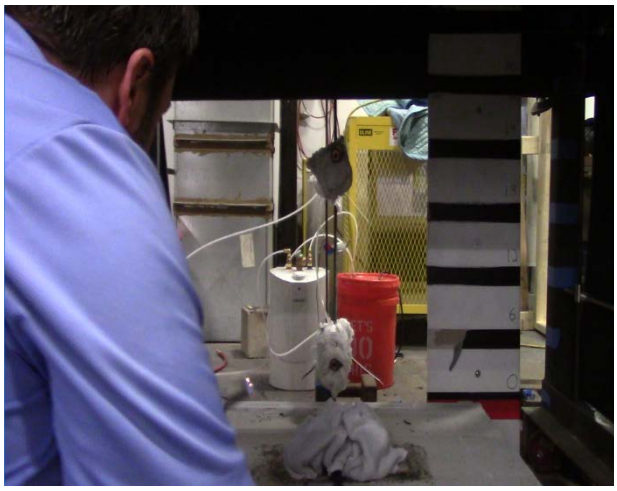
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform









Test ID: 07_17_006 (EPRI) **Test Item: 5 Rags w/Heptane**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.80

Peak HRR (kW): 30.5 Burning Duration (s): 994 Ignition Method: Lighter

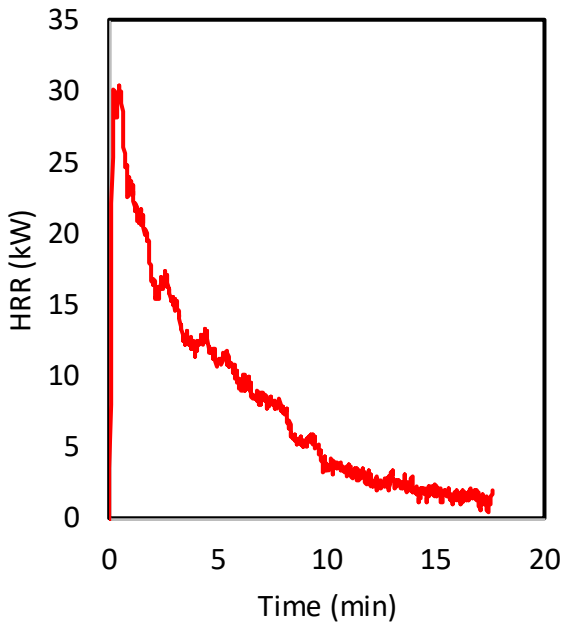
Heat of Combustion (MJ/kg): 27.0 Total Energy Release (MJ): 8.58

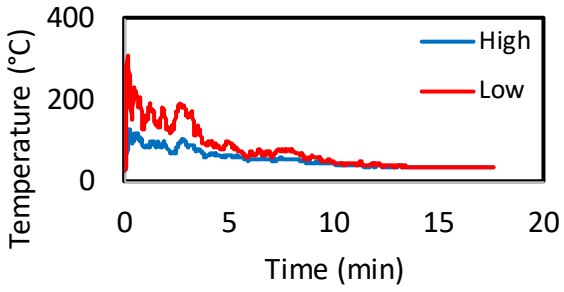
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.024

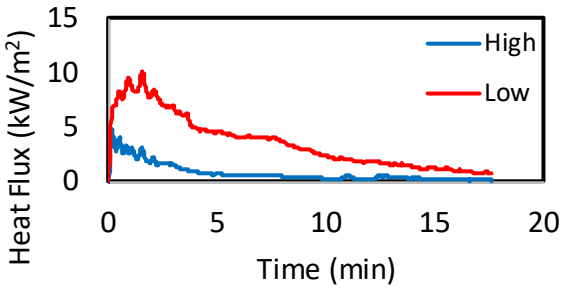
TC Grid Heights[1] (cm): 79, 124

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 07_18_001a (EPRI) **Test Item: Cardstock Wall**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.5 Burning Duration (s): 18 Ignition Method: Blowtorch

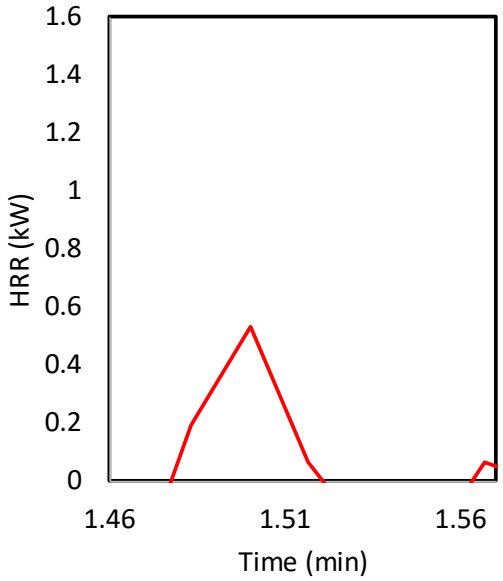
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): N/A

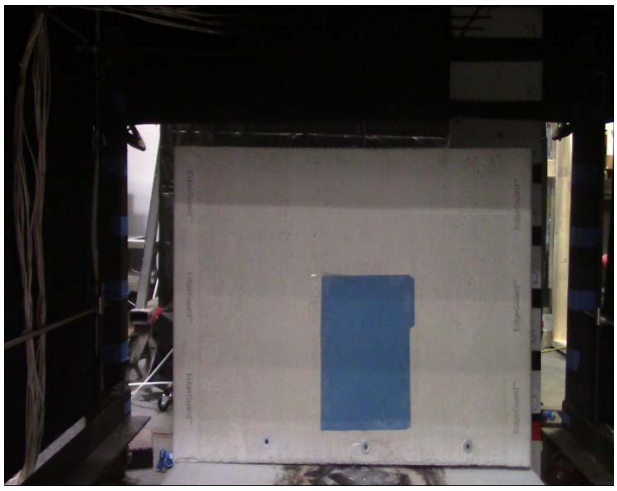
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

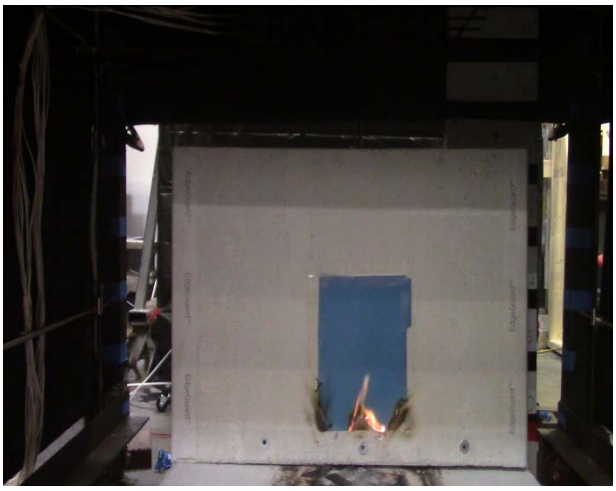
TC Grid Heights[1] (cm): N/A

HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

[1]From top of platform, [2]From center of platform







Test ID: 07_18_001b (EPRI) **Test Item: Cardstock Wall**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.7 Burning Duration (s): 33 Ignition Method: Blowtorch

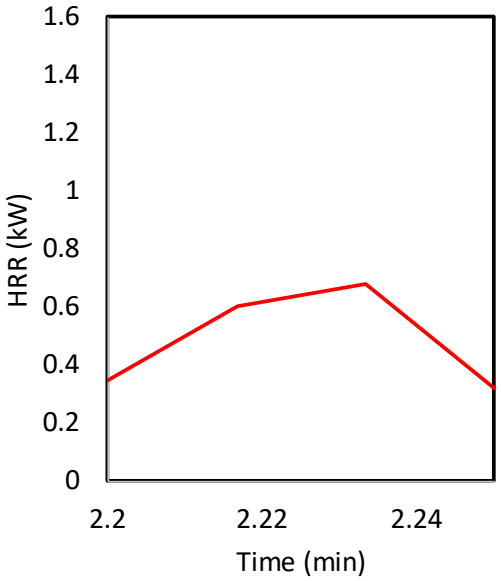
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): N/A

Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

TC Grid Heights[1] (cm): N/A

HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

[1]From top of platform, [2]From center of platform



No photos available

Test ID: 07_18_001c (EPRI) **Test Item: Cardstock Wall**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.8 Burning Duration (s): 14 Ignition Method: Blowtorch

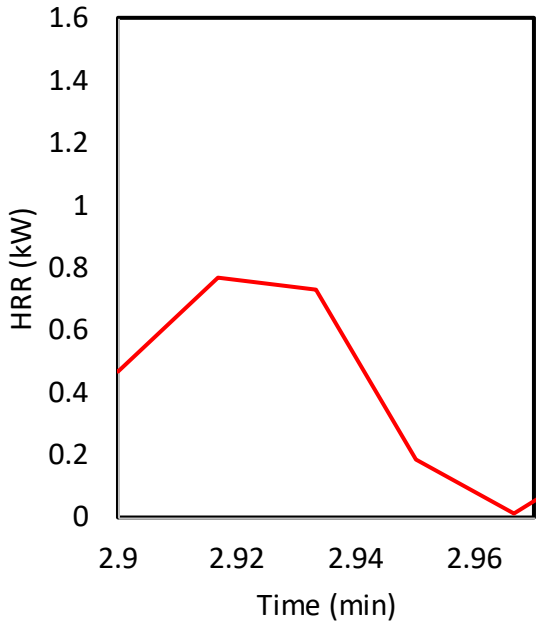
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): N/A

Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

TC Grid Heights[1] (cm): N/A

HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

[1]From top of platform, [2]From center of platform



No photos available

Test ID: 07_18_002 (EPRI) **Test Item: Cardstock Air**

Max Fire Diameter (m): 0.22 Max Flame Height (m): 0.58

Peak HRR (kW): 5.3 Burning Duration (s): 82 Ignition Method: Lighter

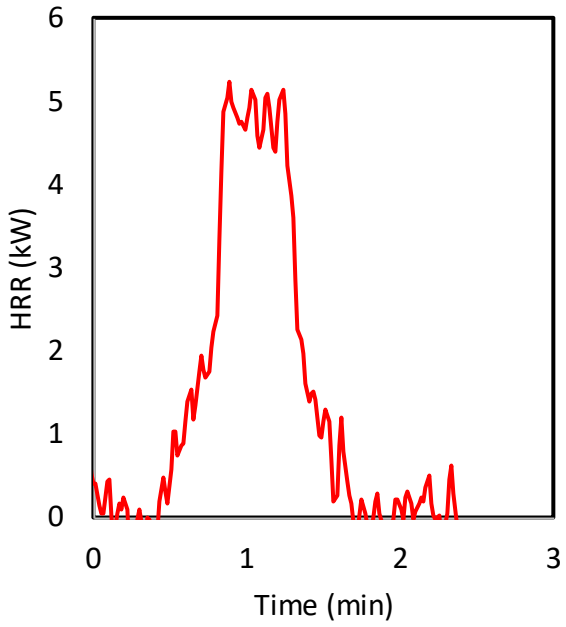
Heat of Combustion (MJ/kg): 15.6 Total Energy Release (MJ): 0.20

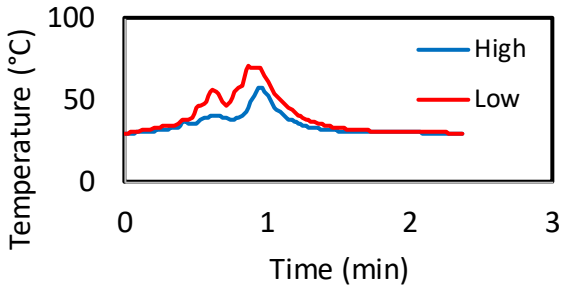
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

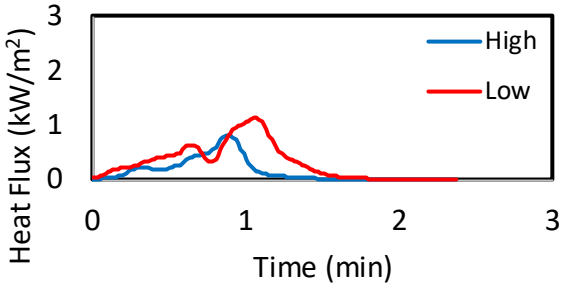
TC Grid Heights[1] (cm): 79, 124

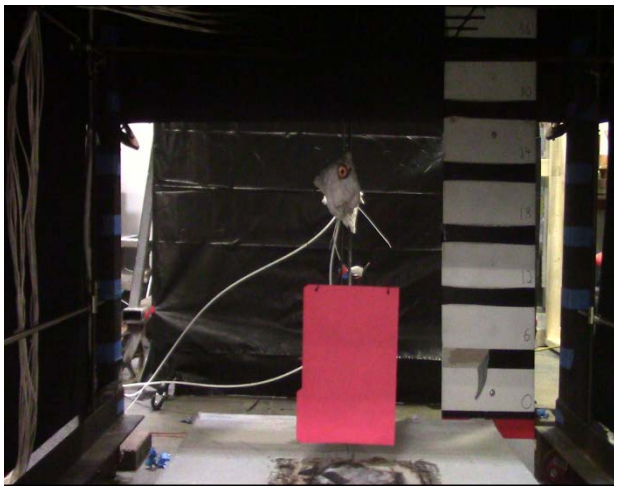
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

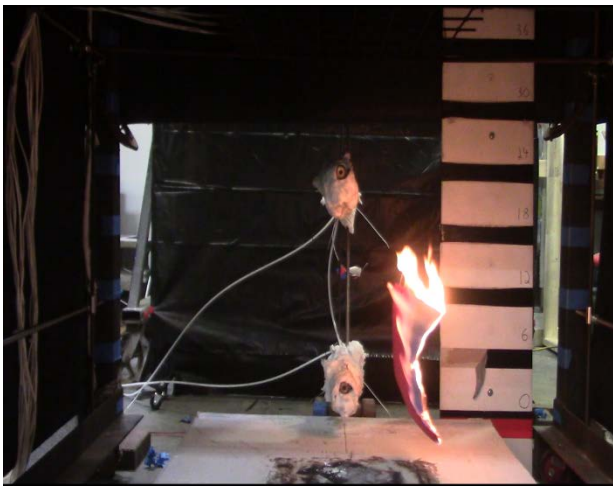
[1]From top of platform, [2]From center of platform











Test ID: 07_18_003 (EPRI) **Test Item: Cardstock Air**

Max Fire Diameter (m): 0.22 Max Flame Height (m): 0.63

Peak HRR (kW): 7.7 Burning Duration (s): 53 Ignition Method: Lighter

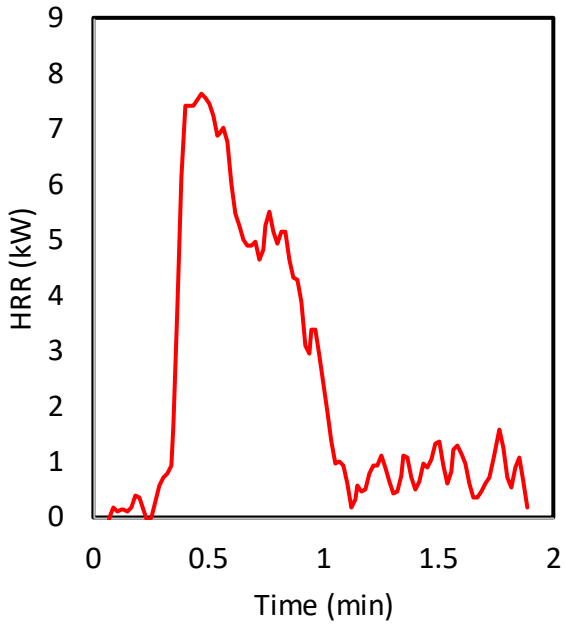
Heat of Combustion (MJ/kg): 19.5 Total Energy Release (MJ): 0.25

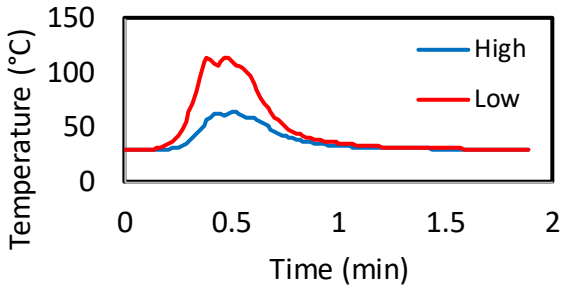
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

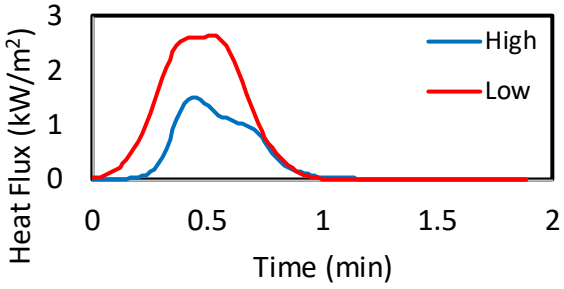
TC Grid Heights[1] (cm): 79, 124

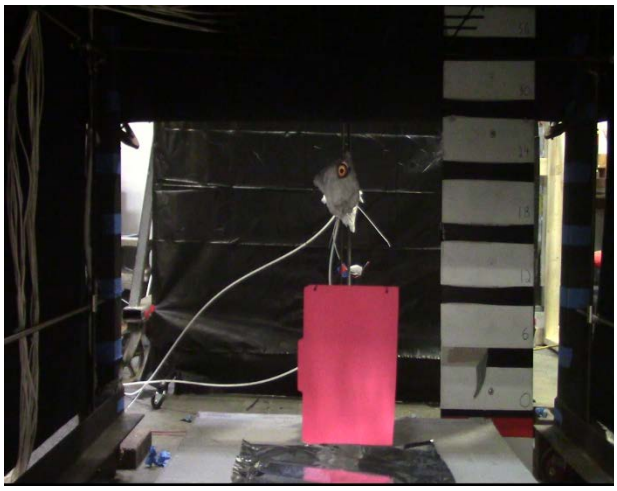
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

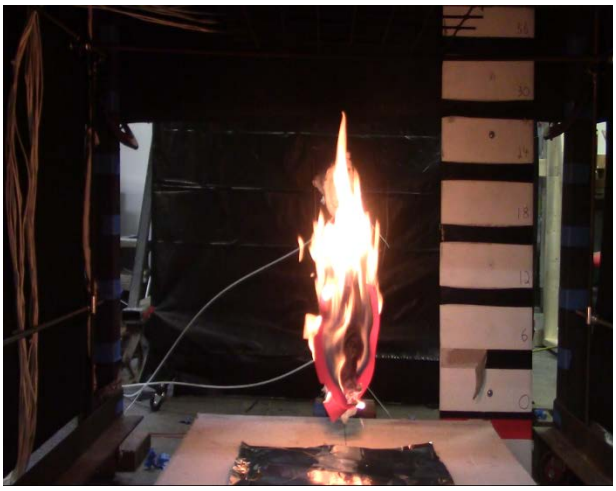
[1]From top of platform, [2]From center of platform











Test ID: 07_18_004 (EPRI) **Test Item: Cardstock Air**

Max Fire Diameter (m): 0.11 Max Flame Height (m): 0.35

Peak HRR (kW): 1.6 Burning Duration (s): 457 Ignition Method: Lighter

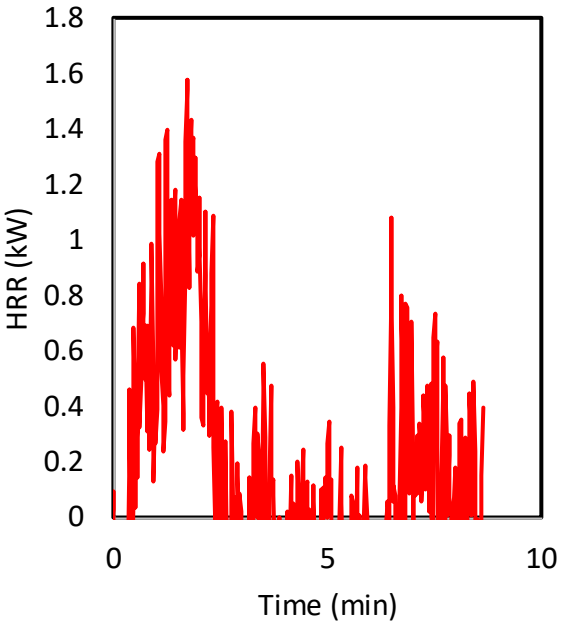
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.06

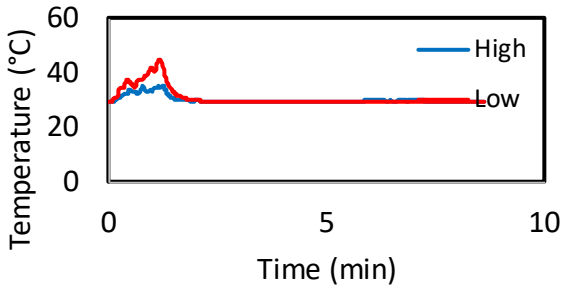
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

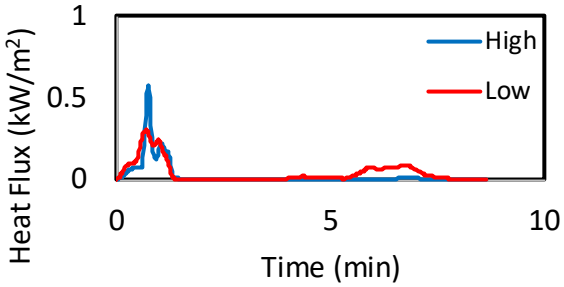
TC Grid Heights[1] (cm): 79, 124

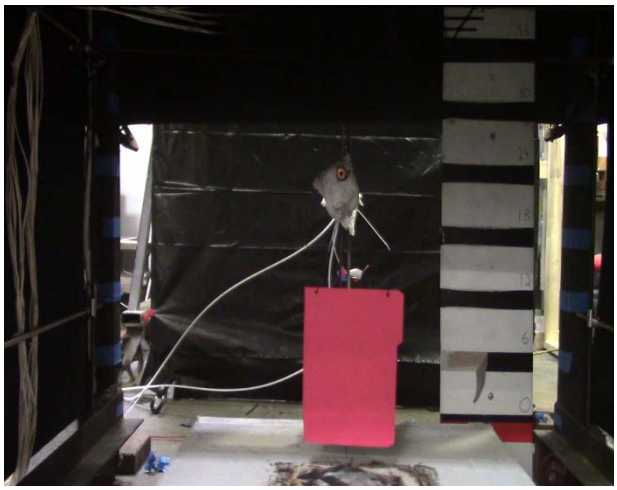
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

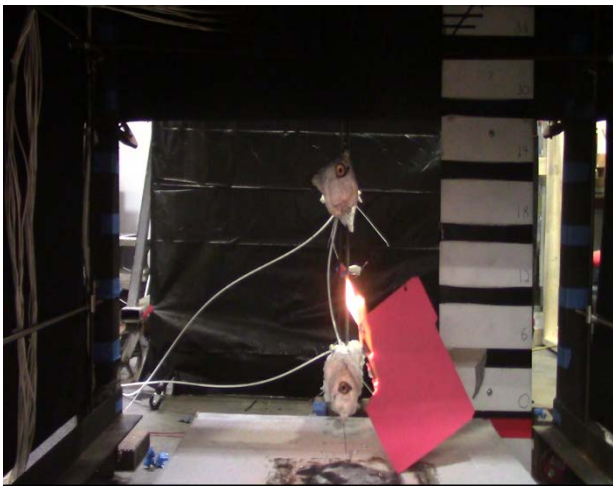
[1]From top of platform, [2]From center of platform











Test ID: 07_18_005 (EPRI) **Test Item: Small Binder Closed**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.08

Peak HRR (kW): 1.8 Burning Duration (s): 828 Ignition Method: Lighter

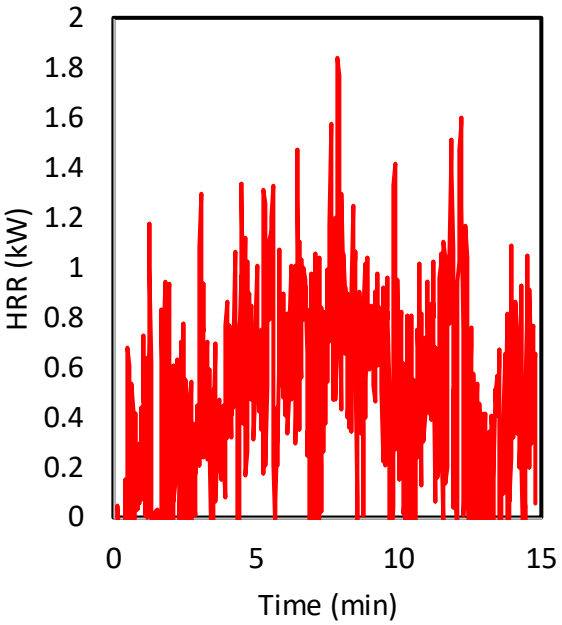
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.43

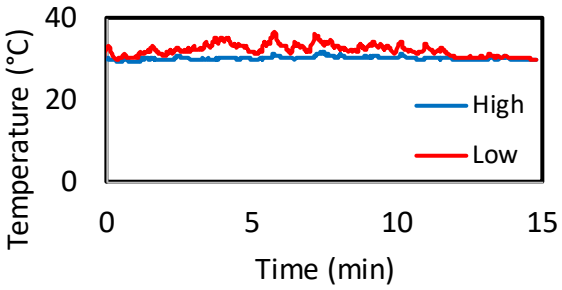
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

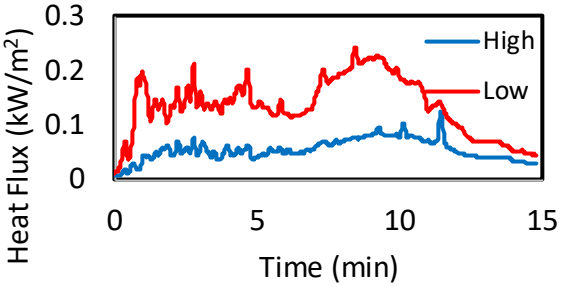
TC Grid Heights[1] (cm): 28, 74

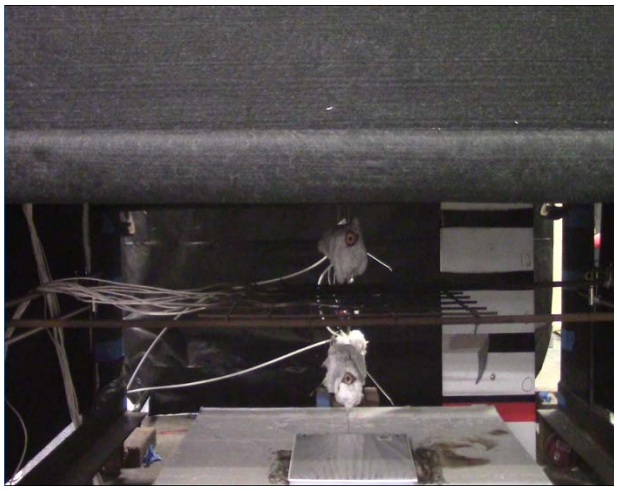
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

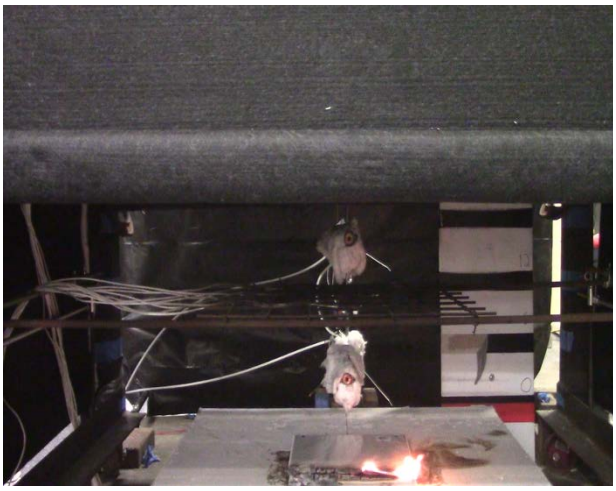
[1]From top of platform, [2]From center of platform











Test ID: 07_018_006 (EPRI) **Test Item: Small Binder Open**

Max Fire Diameter (m): 0.53 Max Flame Height (m): 0.30

Peak HRR (kW): 11.4 Burning Duration (s): 750 Ignition Method: Lighter

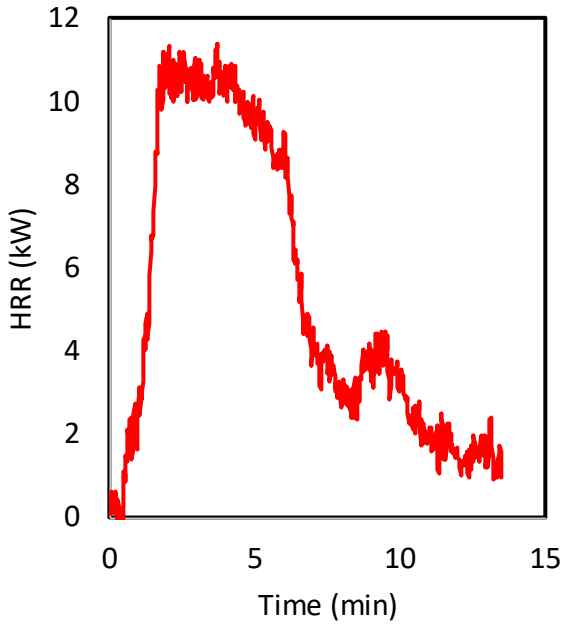
Heat of Combustion (MJ/kg): 12.8 Total Energy Release (MJ): 4.35

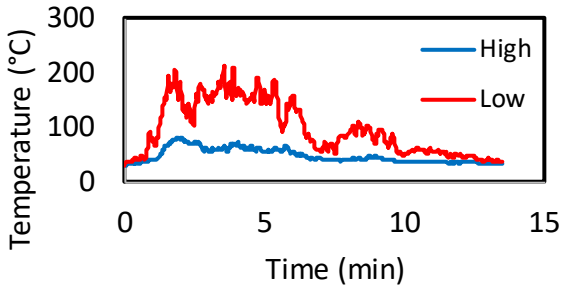
Soot Yield (kg/kg): 0.003 CO Yield (kg/kg): 0.044

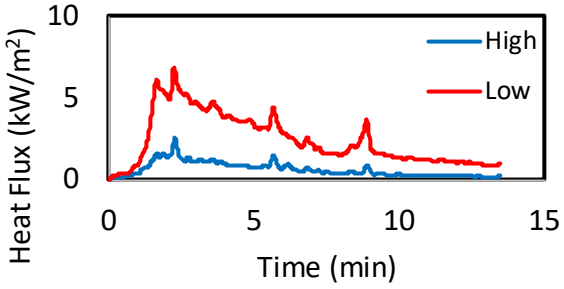
TC Grid Heights[1] (cm): 28, 74

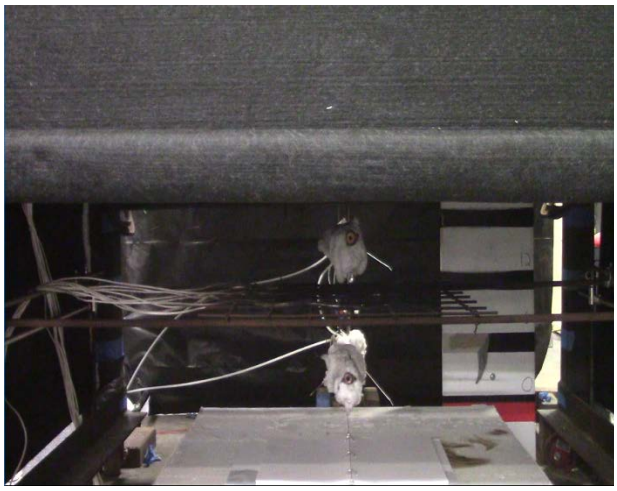
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_18_007 (EPRI) **Test Item: Small Binder Open**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.26

Peak HRR (kW): 6.0 Burning Duration (s): 653 Ignition Method: Lighter

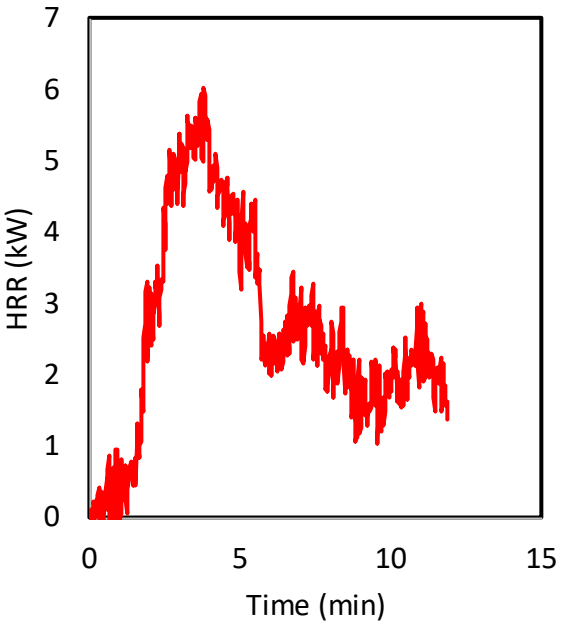
Heat of Combustion (MJ/kg): 10.4 Total Energy Release (MJ): 1.88

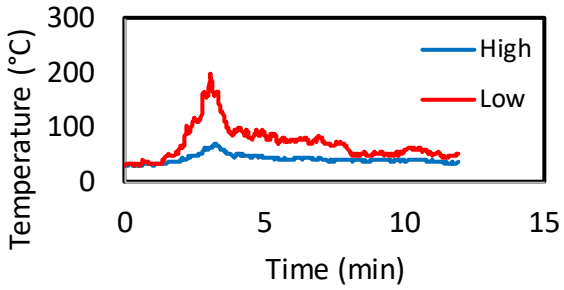
Soot Yield (kg/kg): 0.003 CO Yield (kg/kg): 0.050

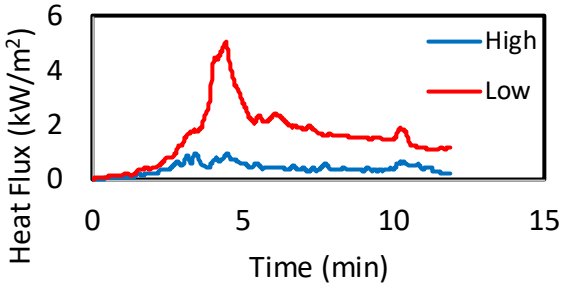
TC Grid Heights[1] (cm): 28, 74

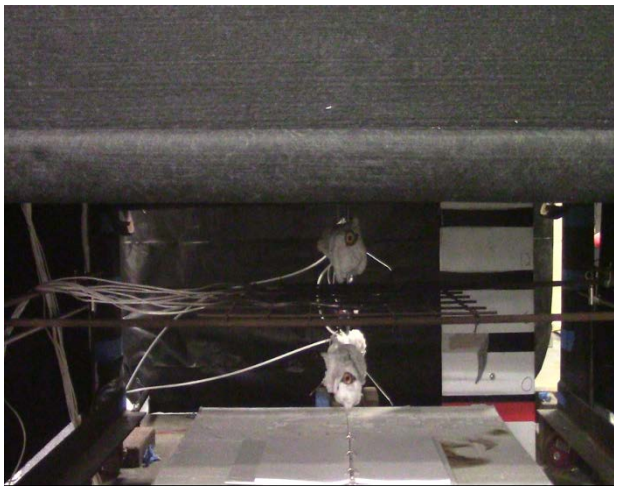
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

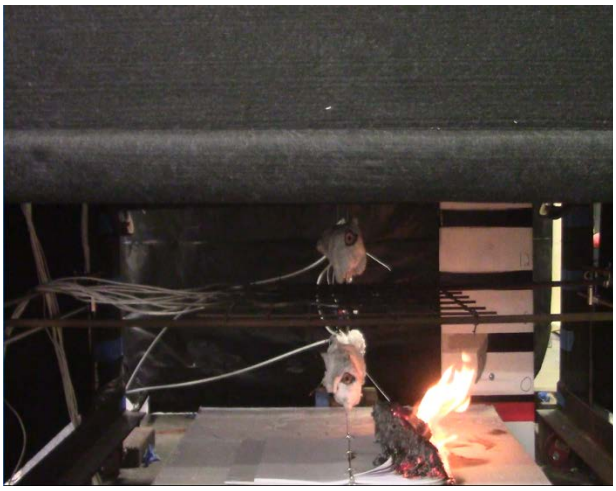
[1]From top of platform, [2]From center of platform











Test ID: 07_18_008 (EPRI) **Test Item: Pad of Paper**

Max Fire Diameter (m): 0.08 Max Flame Height (m): 0.08

Peak HRR (kW): 1.5 Burning Duration (s): 72 Ignition Method: Lighter

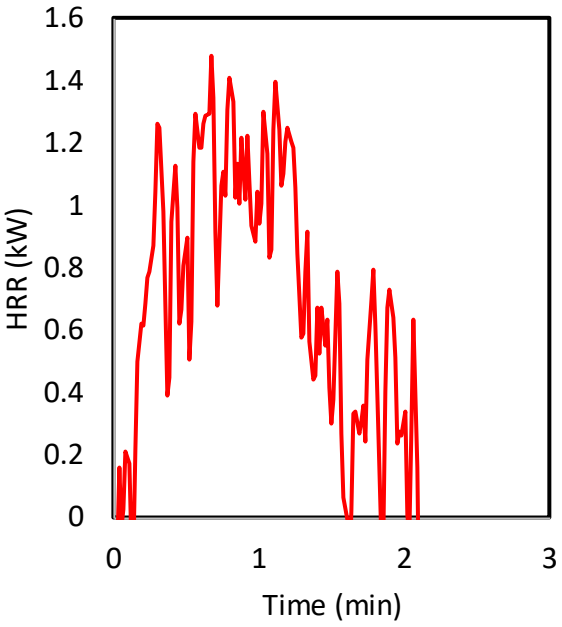
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.08

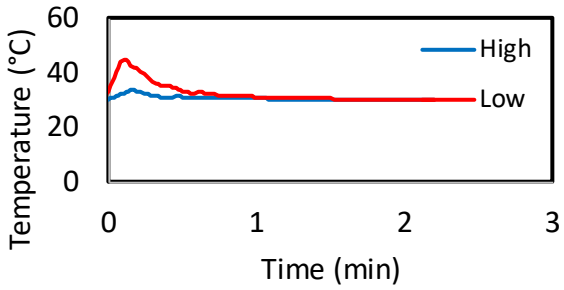
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

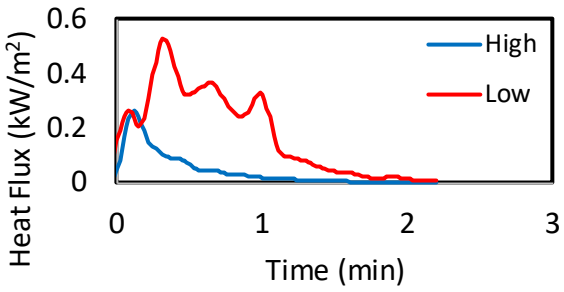
TC Grid Heights[1] (cm): 28, 74

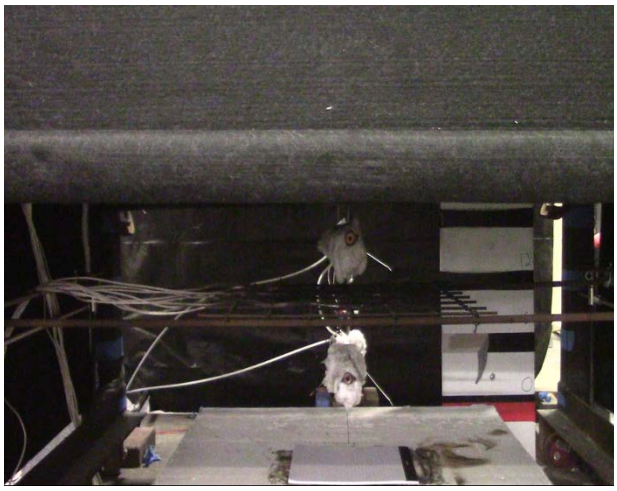
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

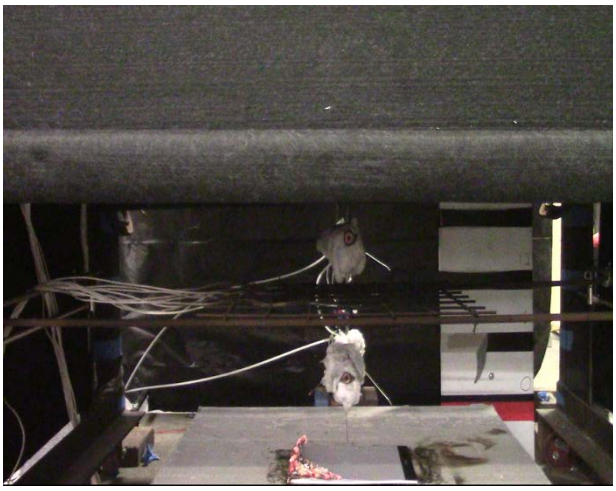
[1]From top of platform, [2]From center of platform











Test ID: 07_18_009 (EPRI) **Test Item: Pad of Paper**

Max Fire Diameter (m): 0.17 Max Flame Height (m): 0.06

Peak HRR (kW): 1.8 Burning Duration (s): 141 Ignition Method: Lighter

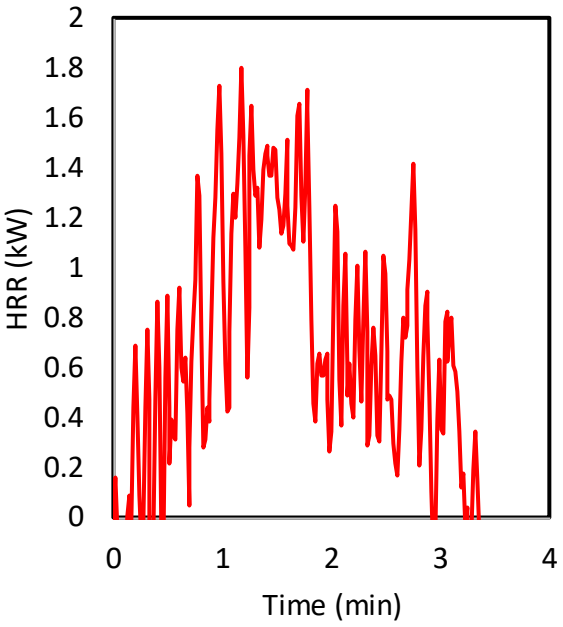
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.14

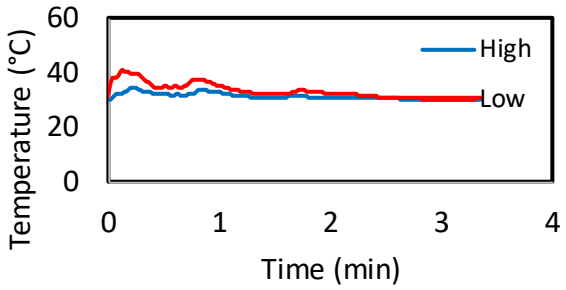
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

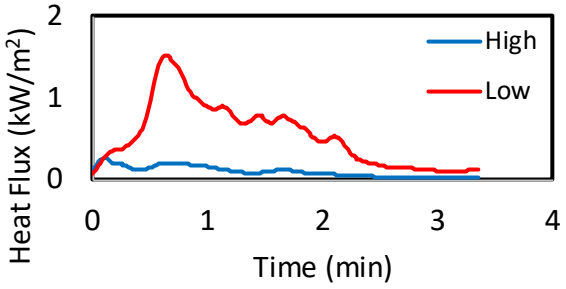
TC Grid Heights[1] (cm): 28, 74

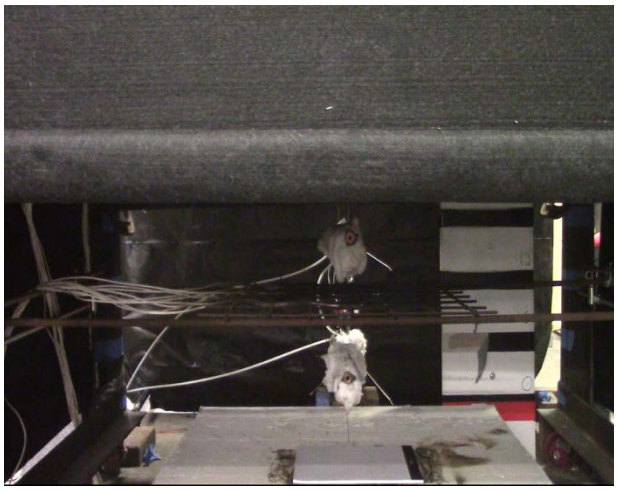
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

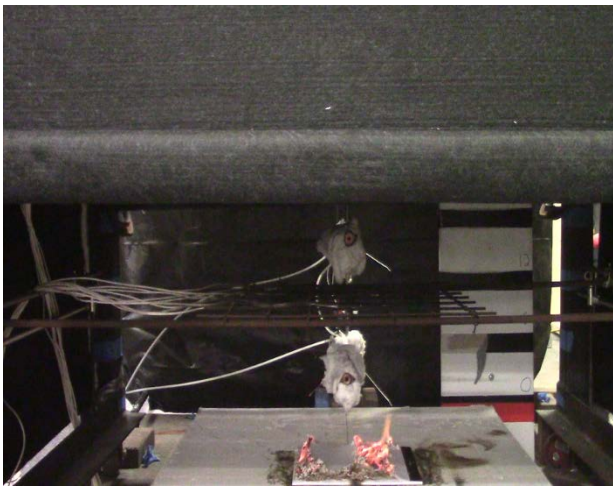
[1]From top of platform, [2]From center of platform











Test ID: 07_18_010 (EPRI) **Test Item: Pad of Paper**

Max Fire Diameter (m): 0.07 Max Flame Height (m): 0.06

Peak HRR (kW): 1.3 Burning Duration (s): 205 Ignition Method: Lighter

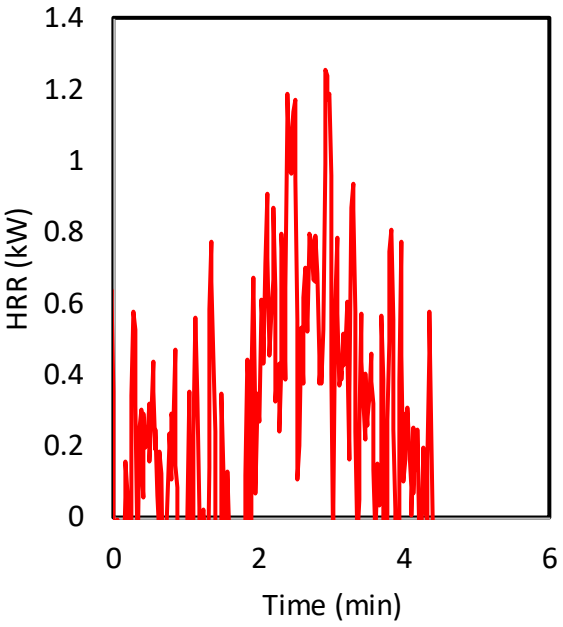
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.07

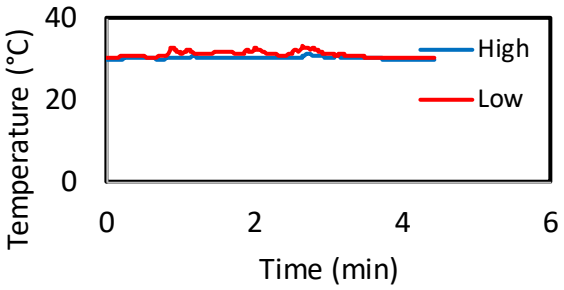
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

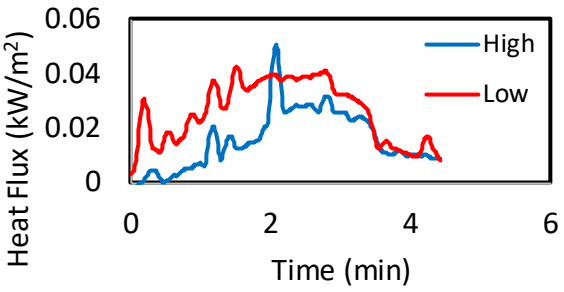
TC Grid Heights[1] (cm): 28, 74

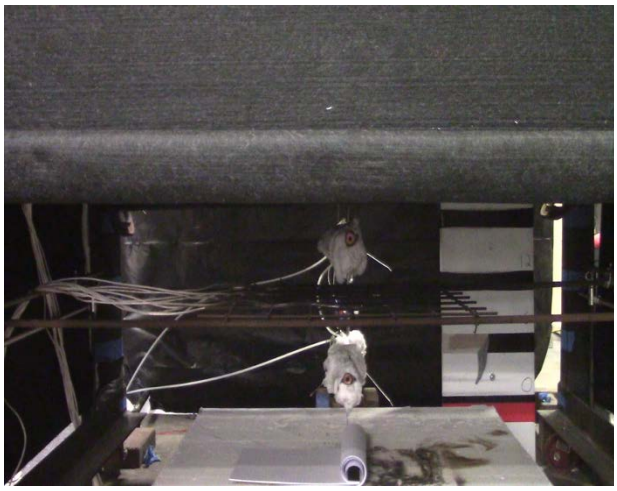
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

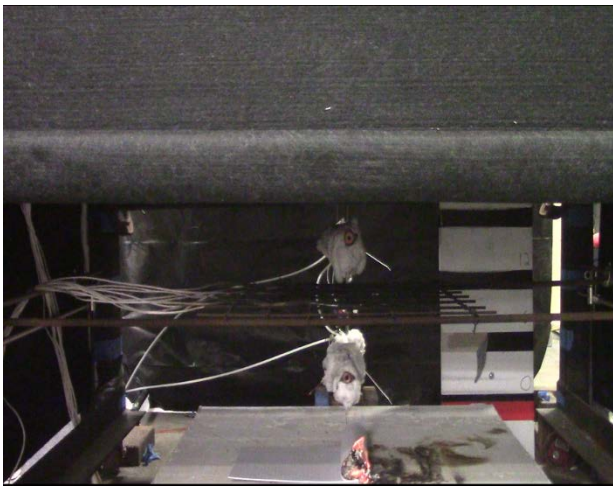
[1]From top of platform, [2]From center of platform











Test ID: 07_18_011a, b, c (EPRI) **Test Item: Large Binder Closed**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): ~1.0 Burning Duration (s): N/A Ignition Method: Lighter

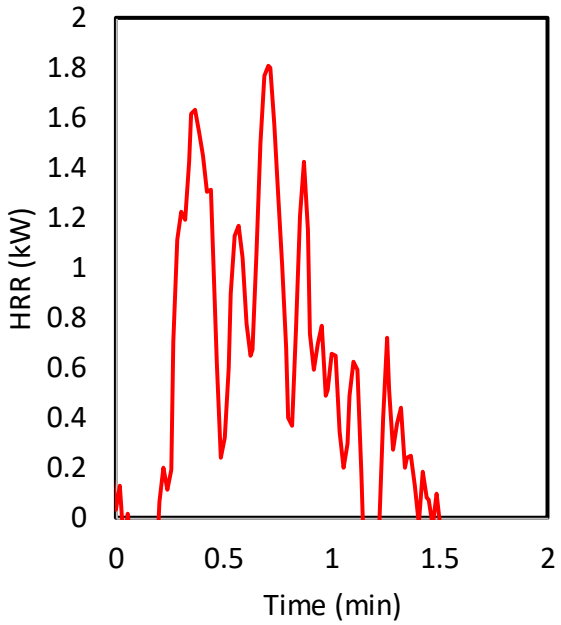
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): N/A

Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

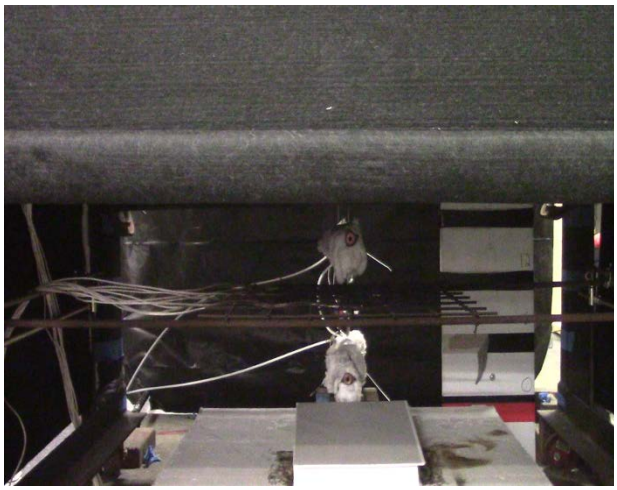
TC Grid Heights[1] (cm): 28, 74

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform



Multiple ignition attempts made with handheld torch. No sustained ignition after removing flame. HRR is torch.



Test ID: 07_18_012 (EPRI) **Test Item: Large Binder Open**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.25

Peak HRR (kW): 6.9 Burning Duration (s): 882 Ignition Method: Lighter

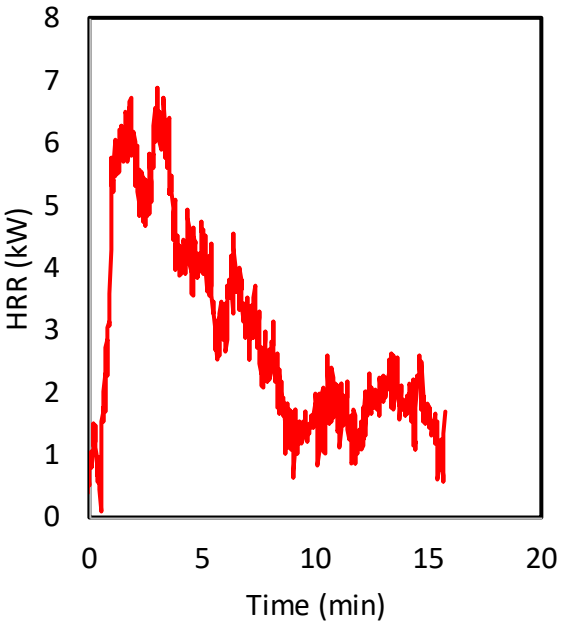
Heat of Combustion (MJ/kg): 13.7 Total Energy Release (MJ): 2.79

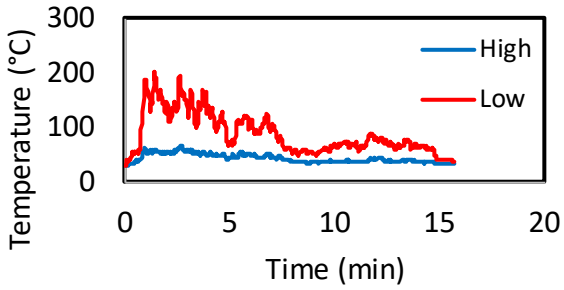
Soot Yield (kg/kg): 0.004 CO Yield (kg/kg): 0.065

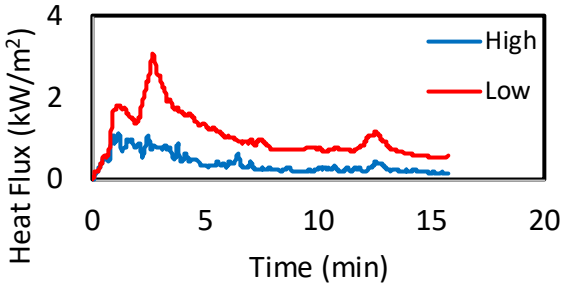
TC Grid Heights[1] (cm): 28, 74

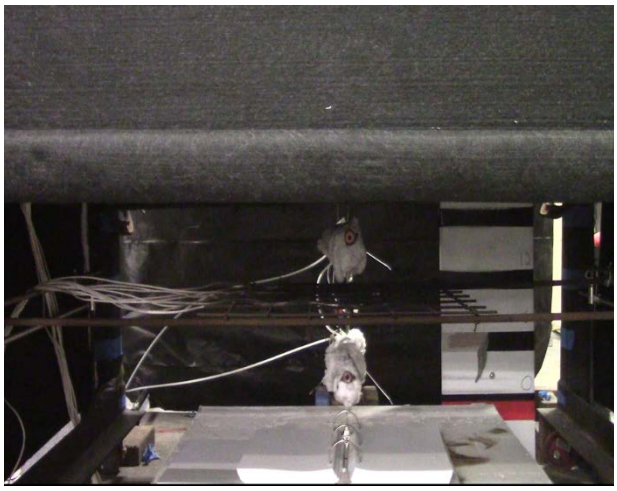
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

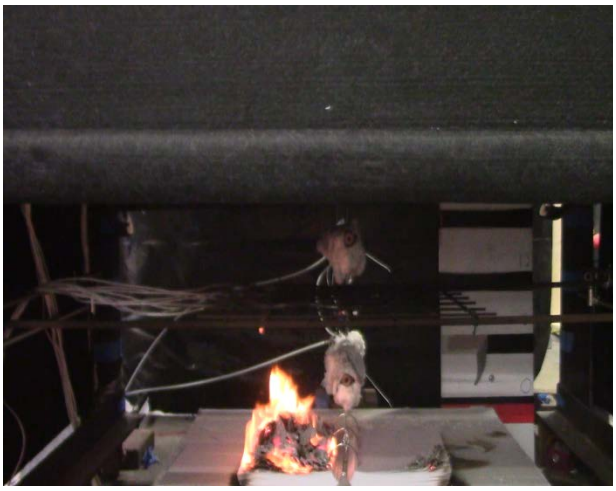
[1]From top of platform, [2]From center of platform











Test ID: 07_18_013 (EPRI) **Test Item: Large Binder Open**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.25

Peak HRR (kW): 3.9 Burning Duration (s): 754 Ignition Method: Lighter

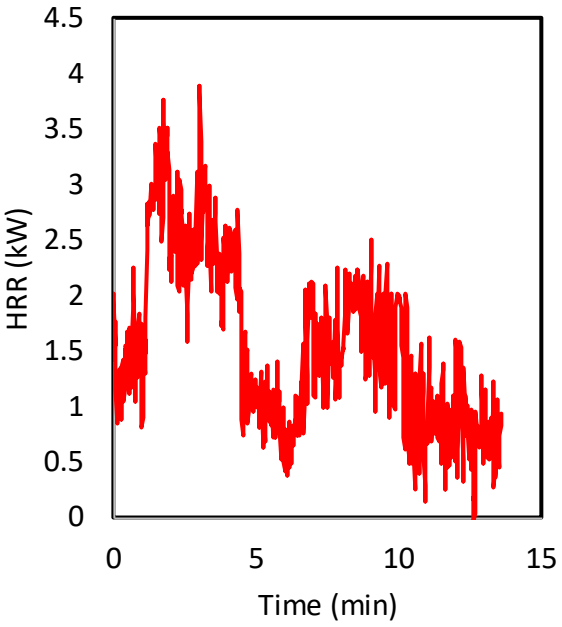
Heat of Combustion (MJ/kg): 14.7 Total Energy Release (MJ): 1.33

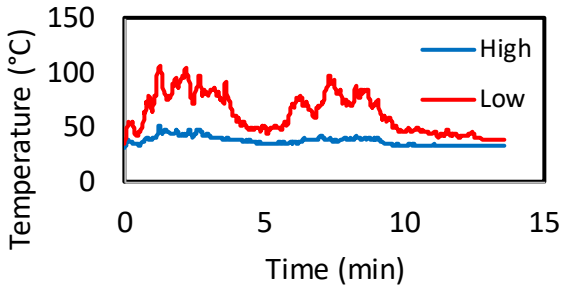
Soot Yield (kg/kg): 0.011 CO Yield (kg/kg): 0.085

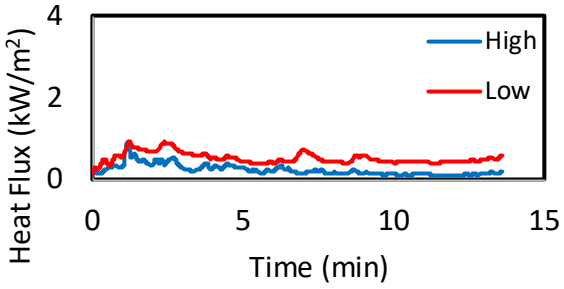
TC Grid Heights[1] (cm): 28, 74

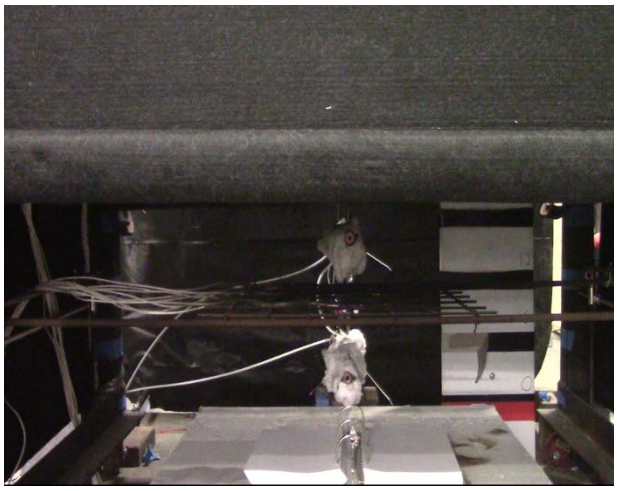
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

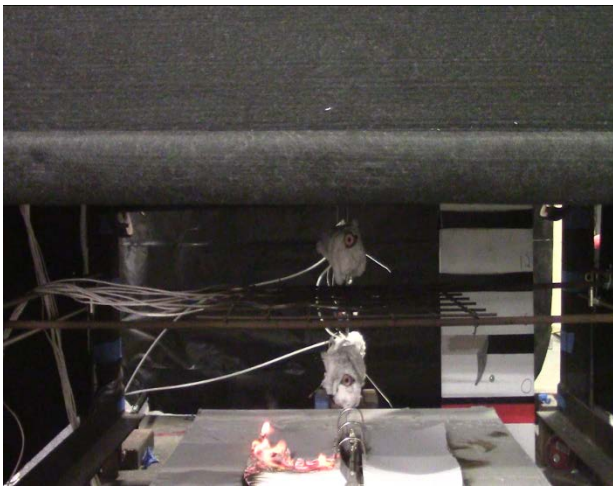
[1]From top of platform, [2]From center of platform











Test ID: 07_23_004 (EPRI) **Test Item: Duct Tape Wall**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.8 Burning Duration (s): 99 Ignition Method: Lighter

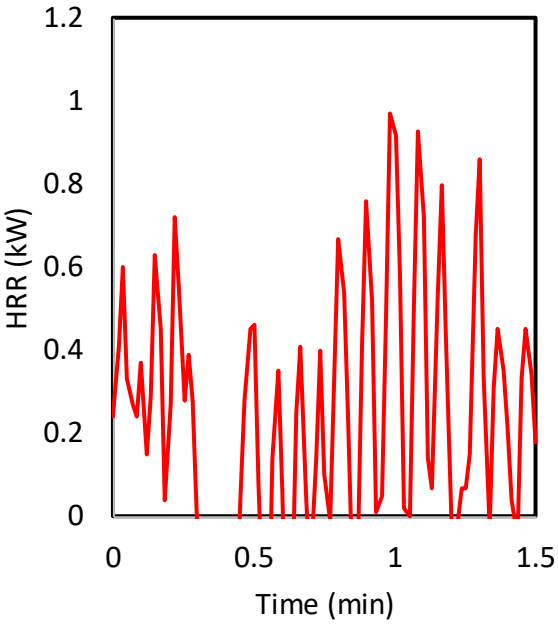
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.05

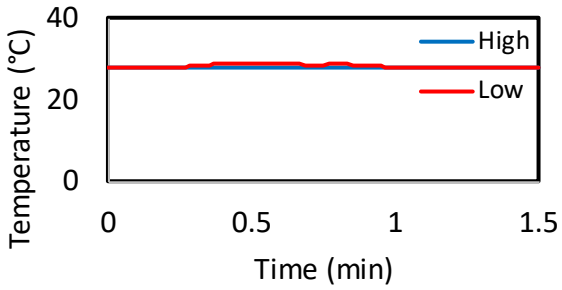
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

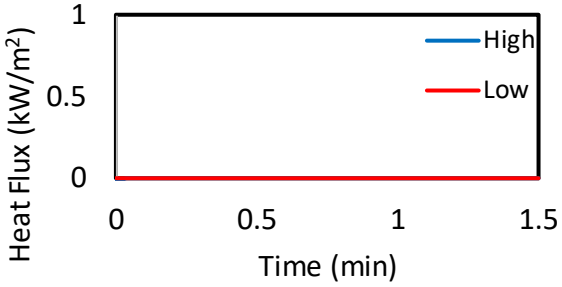
TC Grid Heights[1] (cm): 76, 122

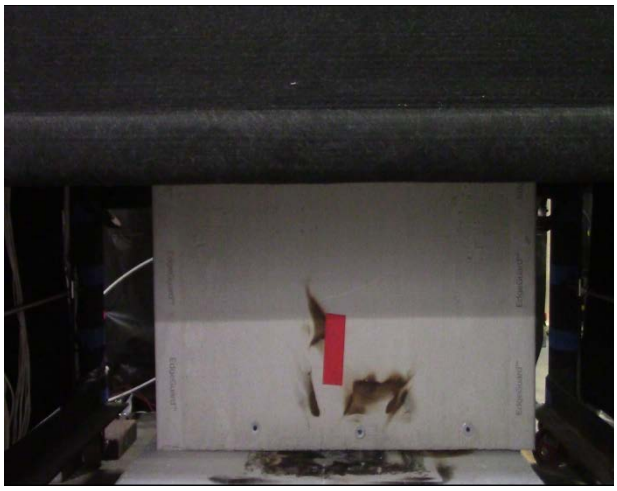
HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

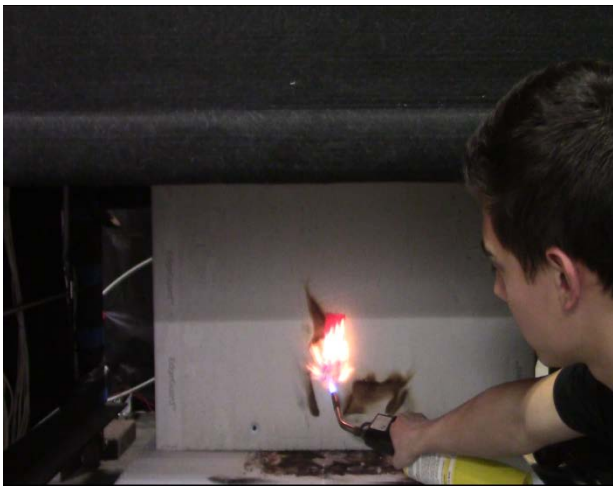
[1]From top of platform, [2]From center of platform











Test ID: 07_23_005 (EPRI) **Test Item: Short Duct Tape Air**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 0.5 Burning Duration (s): 7 Ignition Method: Lighter

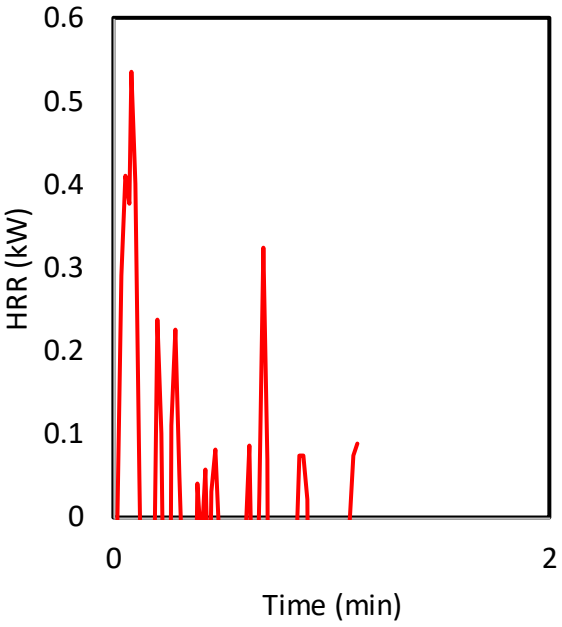
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): N/A

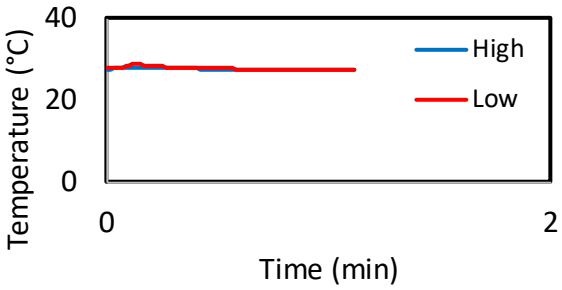
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

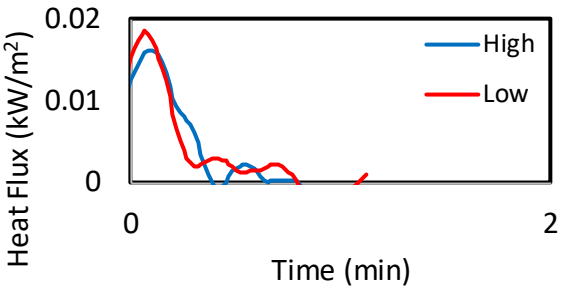
TC Grid Heights[1] (cm): 76, 122

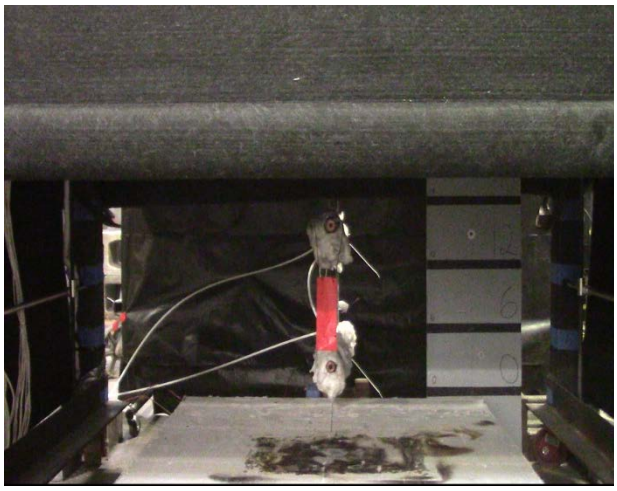
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

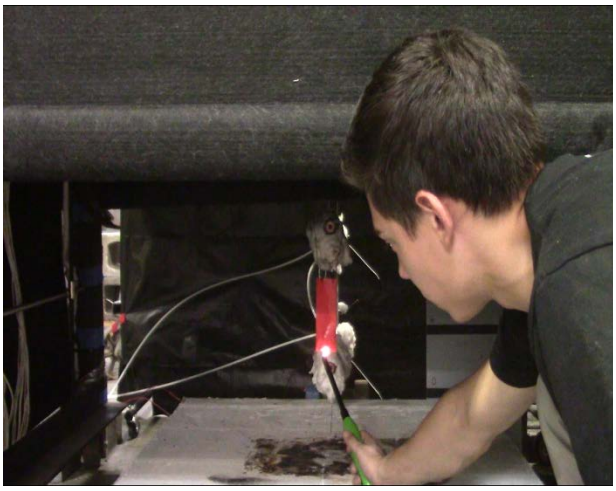
[1]From top of platform, [2]From center of platform











Test ID: 07_23_006 (EPRI) **Test Item: Short Duct Tape Air**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.02

Peak HRR (kW): 0.8 Burning Duration (s): 90 Ignition Method: Lighter

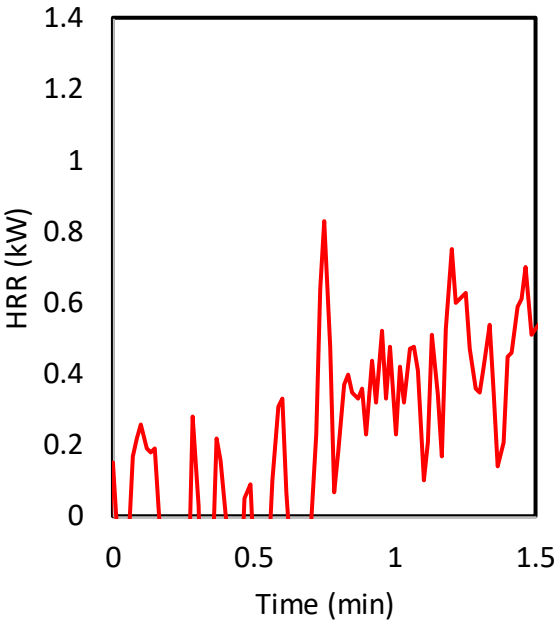
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.03

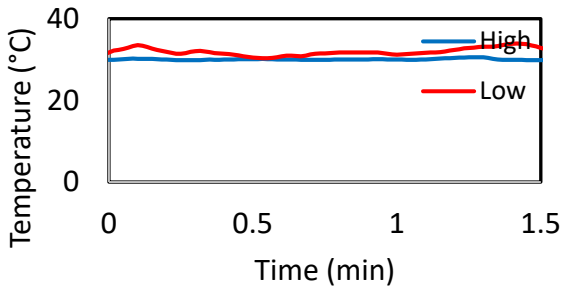
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

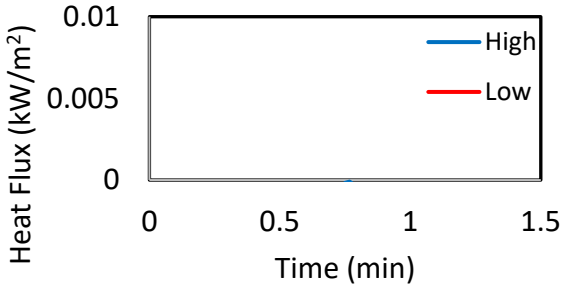
TC Grid Heights[1] (cm): 76, 122

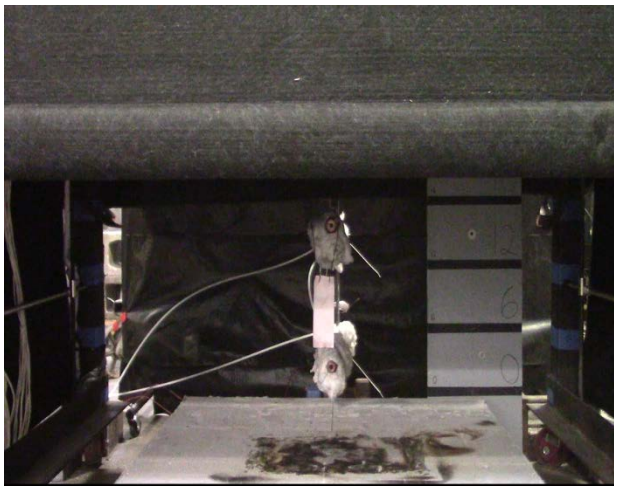
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

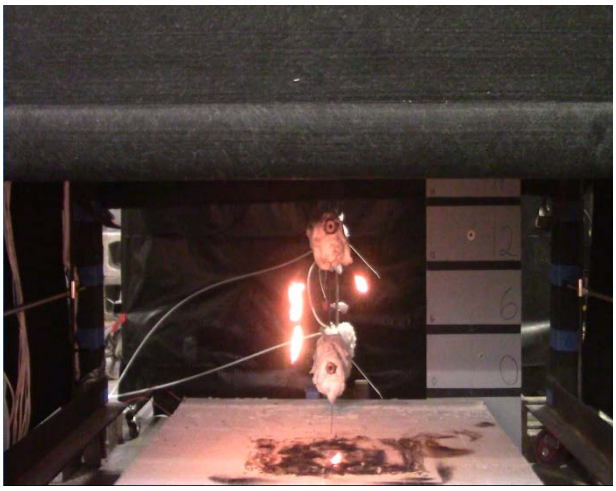
[1]From top of platform, [2]From center of platform











Test ID: 07_24_001 (EPRI) **Test Item: Bucket w/Debris**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.49

Peak HRR (kW): 7.2 Burning Duration (s): 299 Ignition Method: Wick

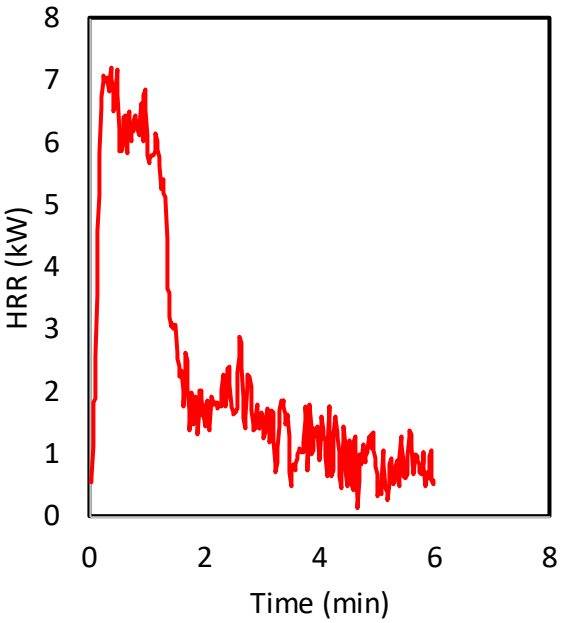
Heat of Combustion (MJ/kg): 37.3 Total Energy Release (MJ): 0.85

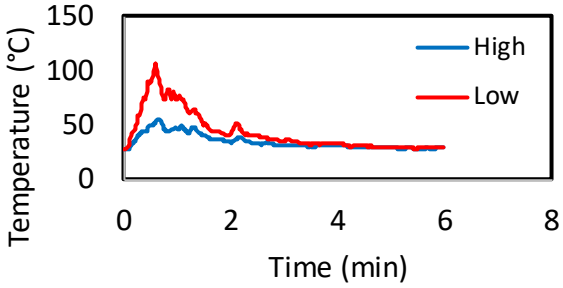
Soot Yield (kg/kg): 0.019 CO Yield (kg/kg): 0.075

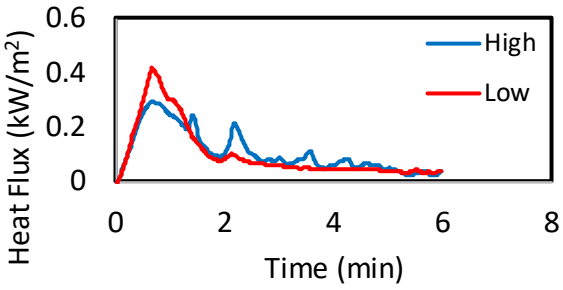
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform







Test ID: 07_24_002 (EPRI) **Test Item: Bucket w/Debris**

Max Fire Diameter (m): 0.11 Max Flame Height (m): 0.47

Peak HRR (kW): 9.5 Burning Duration (s): 4,867 Ignition Method: Wick

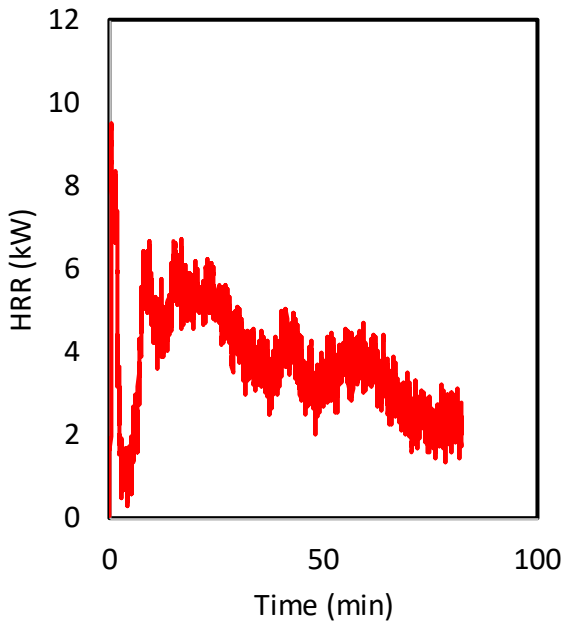
Heat of Combustion (MJ/kg): 39.4 Total Energy Release (MJ): 18.8

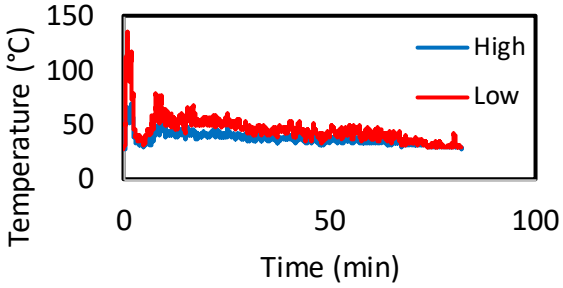
Soot Yield (kg/kg): 0.008 CO Yield (kg/kg): 0.055

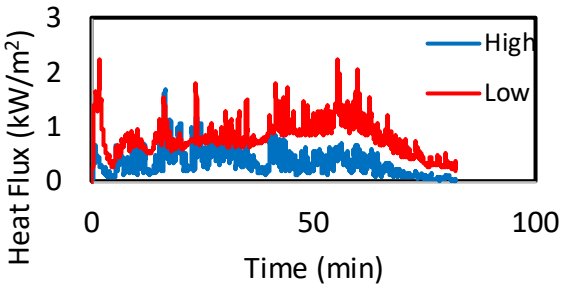
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 07_24_003 (EPRI) **Test Item: Bucket w/Debris**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.80

Peak HRR (kW): 14.7 Burning Duration (s): 2,941 Ignition Method: Wick

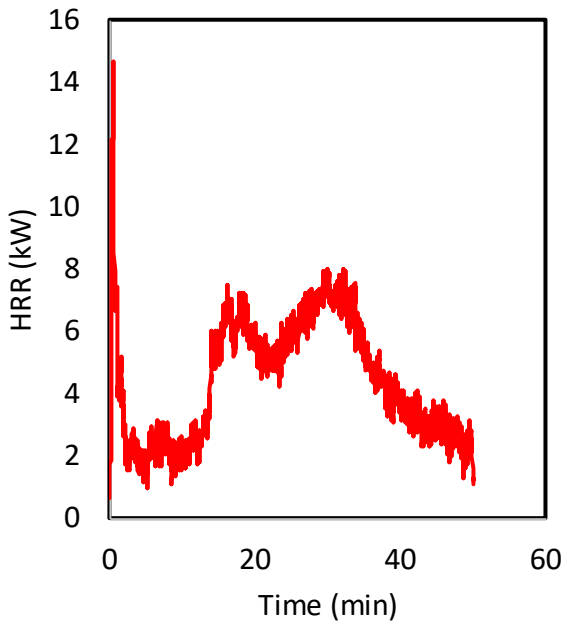
Heat of Combustion (MJ/kg): 28.1 Total Energy Release (MJ): 13.37

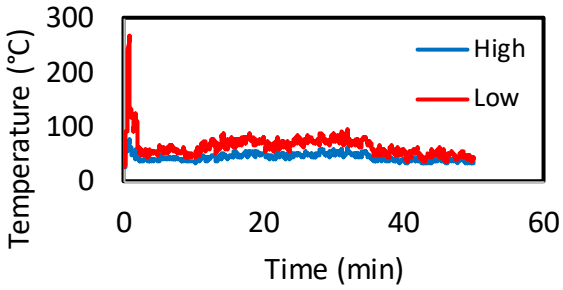
Soot Yield (kg/kg): 0.004 CO Yield (kg/kg): 0.035

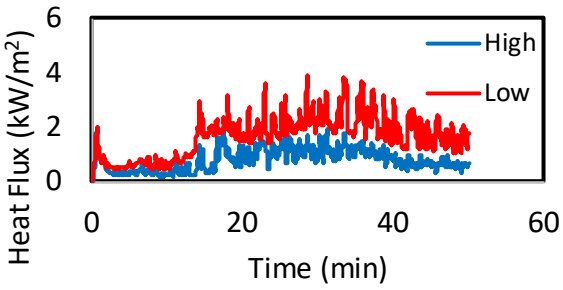
TC Grid Heights[1] (cm): 61, 107

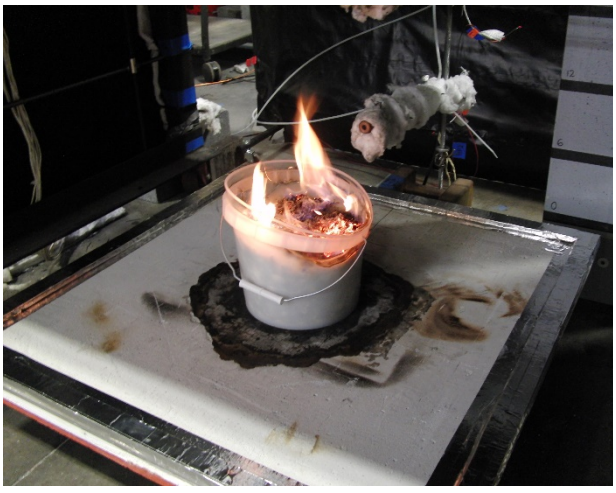
HF Gauge Heights[1] (cm): 24, 55 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_31_001 (EPRI) **Test Item: Empty Bucket**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.24

Peak HRR (kW): 10.5 Burning Duration (s): 2,615 Ignition Method: Flame

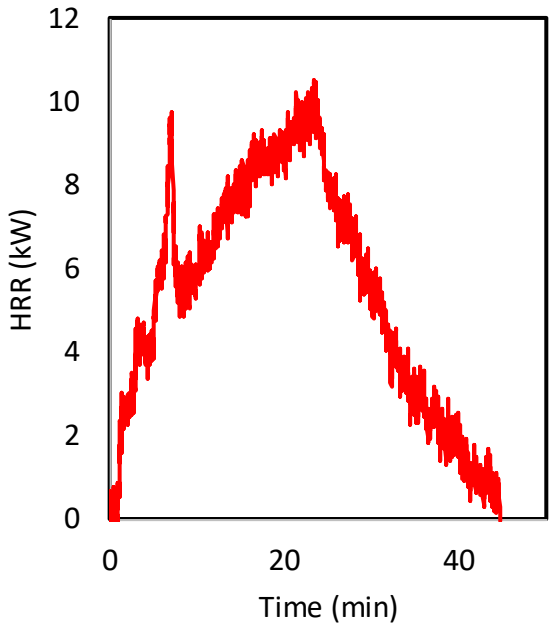
Heat of Combustion (MJ/kg): 45.5 Total Energy Release (MJ): 14.4

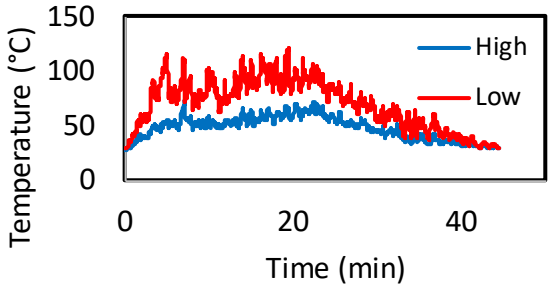
Soot Yield (kg/kg): 0.013 CO Yield (kg/kg): 0.011

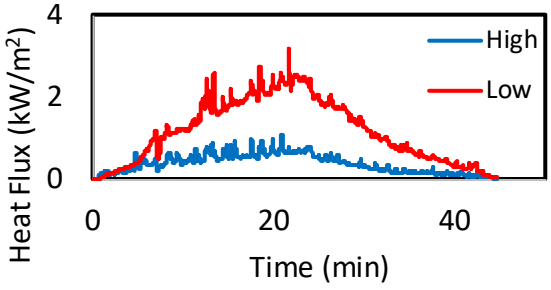
TC Grid Heights[1] (cm): 61, 107

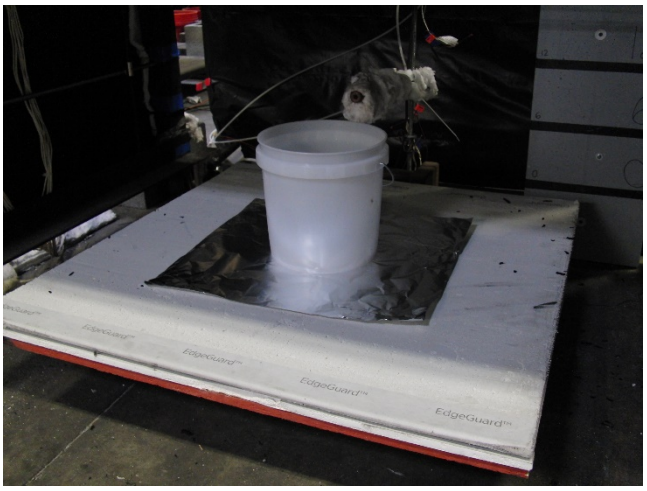
HF Gauge Heights[1] (cm): 24, 55 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 07_31_002 (EPRI) **Test Item: Empty Bucket**

Max Fire Diameter (m): 0.22 Max Flame Height (m): 0.71

Peak HRR (kW): 30.8 Burning Duration (s): 1,669 Ignition Method: Flame

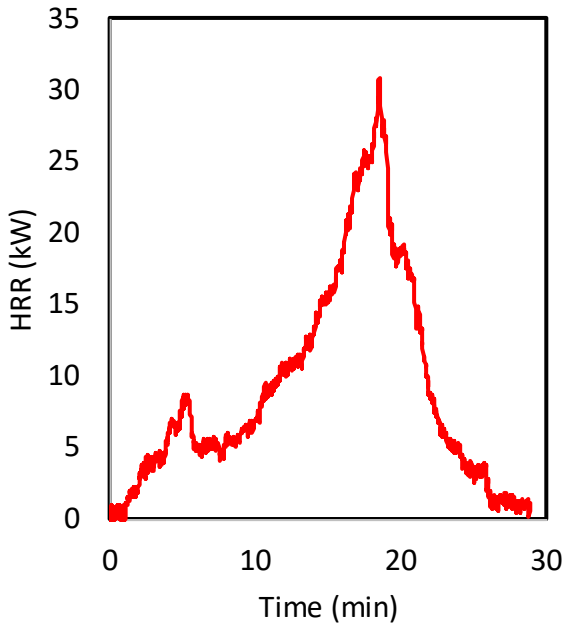
Heat of Combustion (MJ/kg): 46.6 Total Energy Release (MJ): 15.9

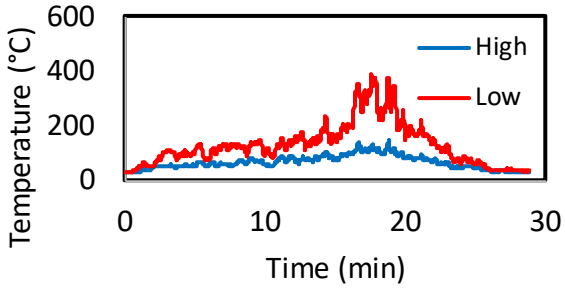
Soot Yield (kg/kg): 0.049 CO Yield (kg/kg): 0.016

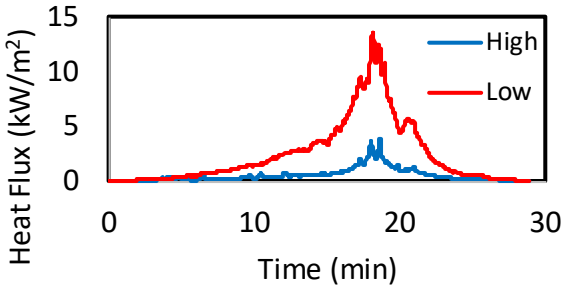
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 07_31_003 (EPRI) **Test Item: Empty Bucket**

Max Fire Diameter (m): 0.22 Max Flame Height (m): 0.51

Peak HRR (kW): 19.8 Burning Duration (s): 1,844 Ignition Method: Flame

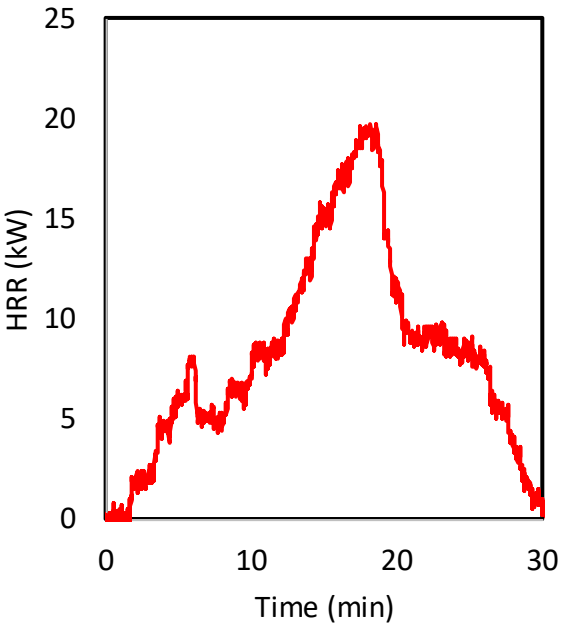
Heat of Combustion (MJ/kg): 43.5 Total Energy Release (MJ): 14.8

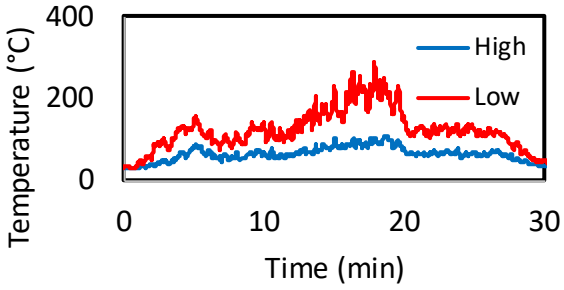
Soot Yield (kg/kg): 0.040 CO Yield (kg/kg): 0.014

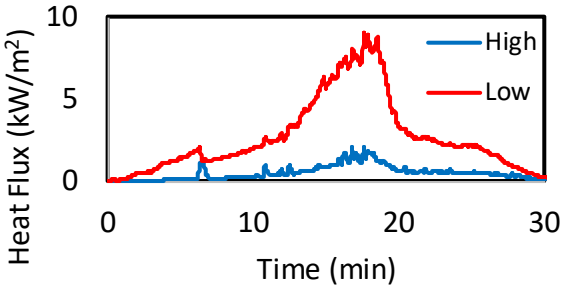
TC Grid Heights[1] (cm): 46, 91

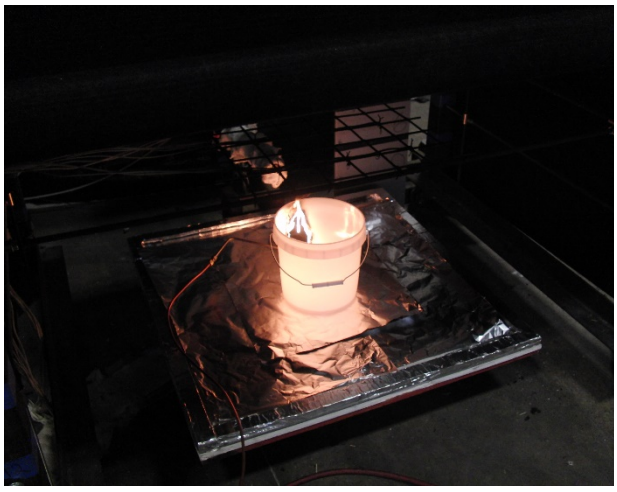
HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform









Test ID: 07_31_004 (EPRI) **Test Item: Empty Bucket**

Max Fire Diameter (m): 0.22 Max Flame Height (m): 0.53

Peak HRR (kW): 25.6 Burning Duration (s): 1,515 Ignition Method: Flame

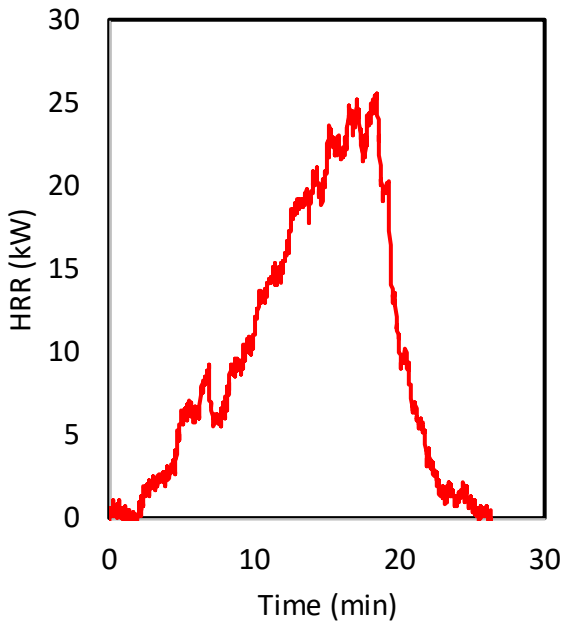
Heat of Combustion (MJ/kg): 45.6 Total Energy Release (MJ): 15.5

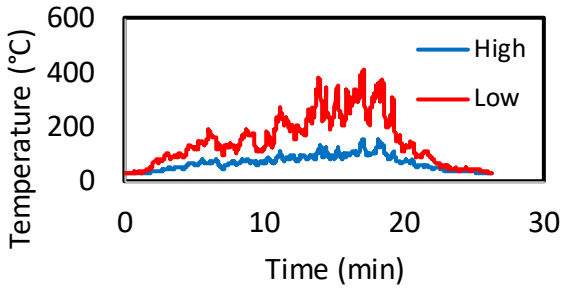
Soot Yield (kg/kg): 0.053 CO Yield (kg/kg): 0.017

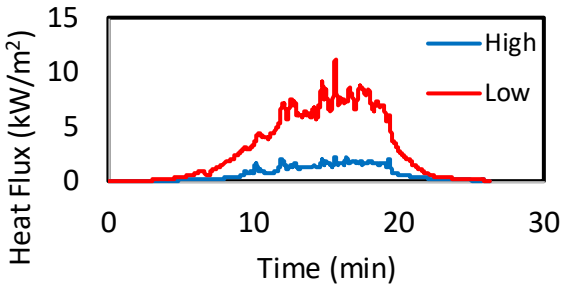
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 08_01_001 (EPRI) **Test Item: Debris Pile**

Max Fire Diameter (m): 0.43 Max Flame Height (m): 0.32

Peak HRR (kW): 23.7 Burning Duration (s): 1,299 Ignition Method: Wick

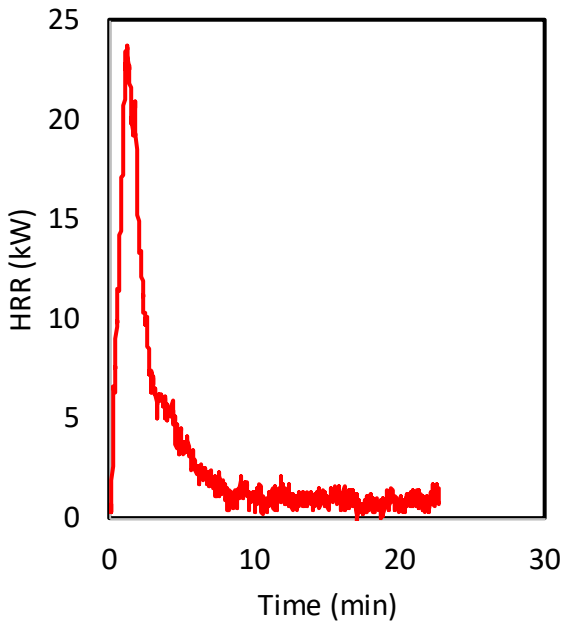
Heat of Combustion (MJ/kg): 15.8 Total Energy Release (MJ): 4.31

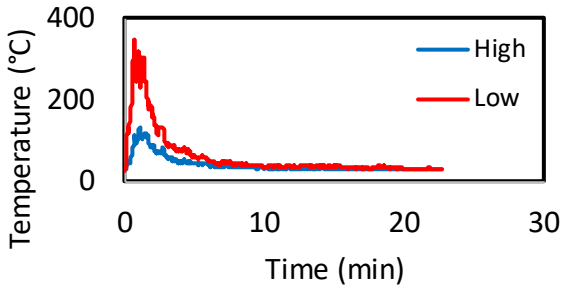
Soot Yield (kg/kg): 0.008 CO Yield (kg/kg): 0.054

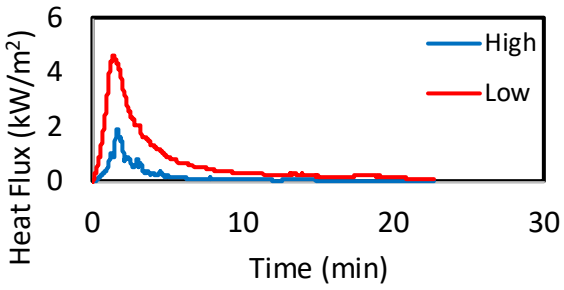
TC Grid Heights[1] (cm): 46, 91

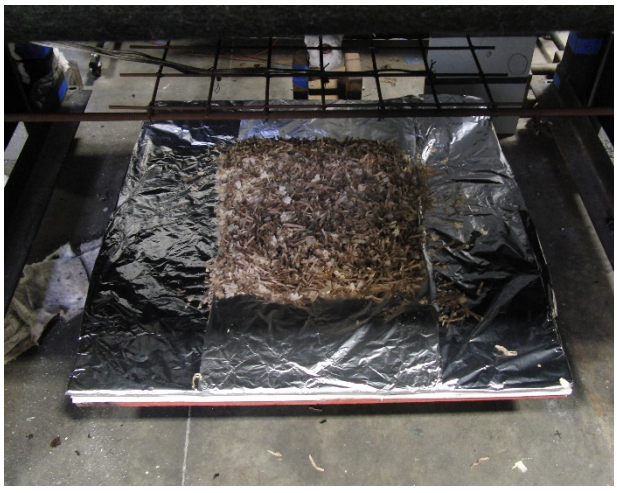
HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform









Test ID: 08_001_002 (EPRI) **Test Item: Debris Pile**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.40

Peak HRR (kW): 13.4 Burning Duration (s): 983 Ignition Method: Wick

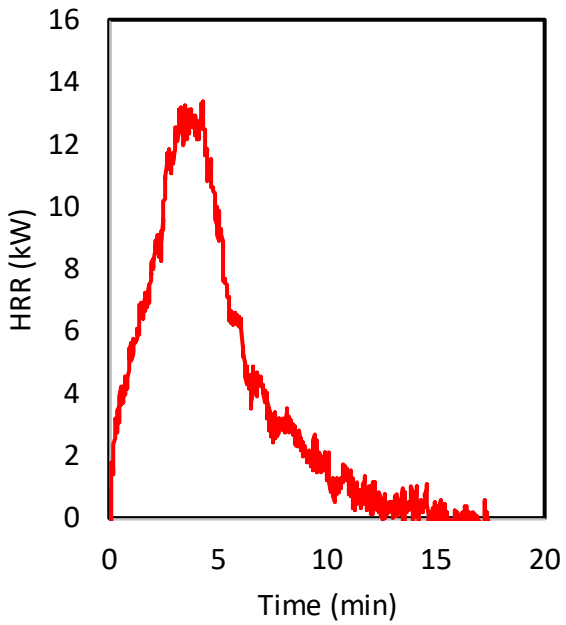
Heat of Combustion (MJ/kg): 13.7 Total Energy Release (MJ): 4.03

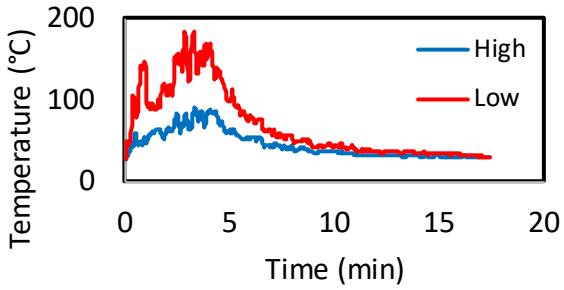
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.050

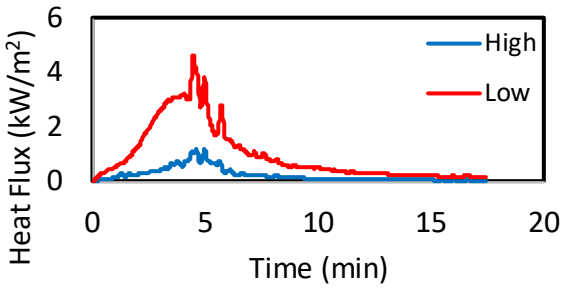
TC Grid Heights[1] (cm): 46, 91

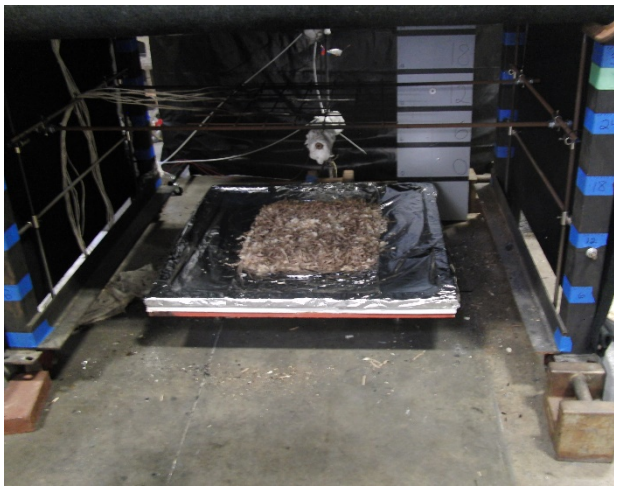
HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 22

[1]From top of platform, [2]From center of platform









Test ID: 08_01_003 (EPRI) **Test Item: Debris Pile**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.48

Peak HRR (kW): 19.1 Burning Duration (s): 643 Ignition Method: Wick

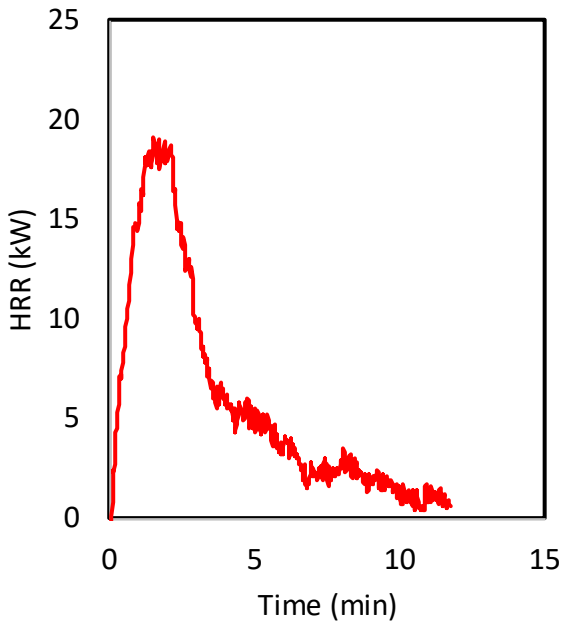
Heat of Combustion (MJ/kg): 15.1 Total Energy Release (MJ): 4.10

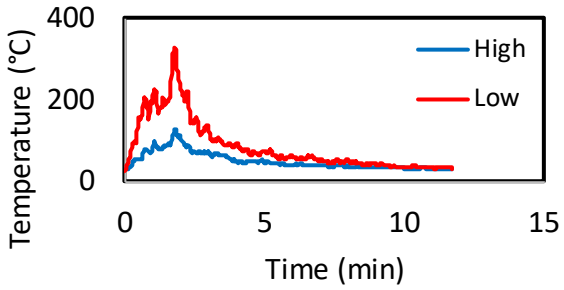
Soot Yield (kg/kg): 0.004 CO Yield (kg/kg): 0.040

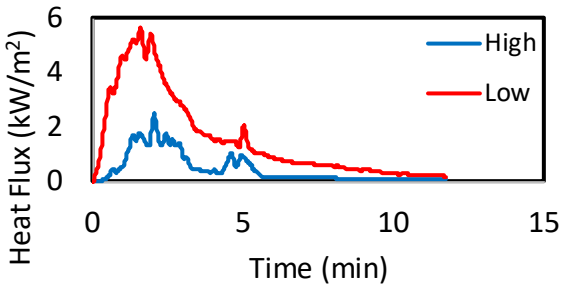
TC Grid Heights[1] (cm): 46, 91

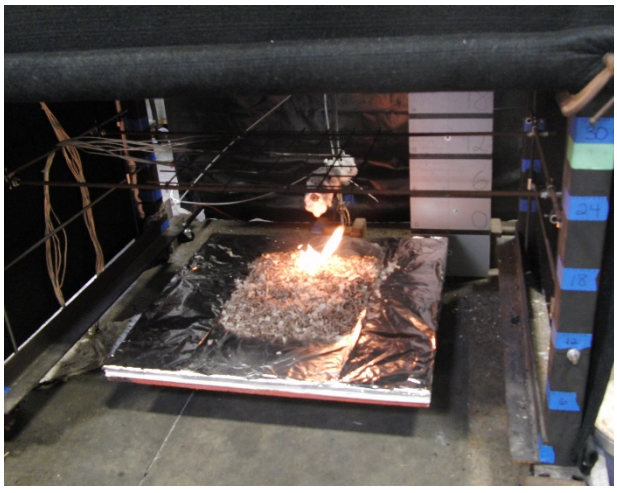
HF Gauge Heights[1] (cm): 24, 70 HF Gauge Distance[2] (cm): 22

[1]From top of platform, [2]From center of platform









Test ID: 08_01_004 (EPRI) **Test Item: Single Cone**

Max Fire Diameter (m): 0.21 Max Flame Height (m): 0.30

Peak HRR (kW): 6.0 Burning Duration (s): 2,074 Ignition Method: Flame

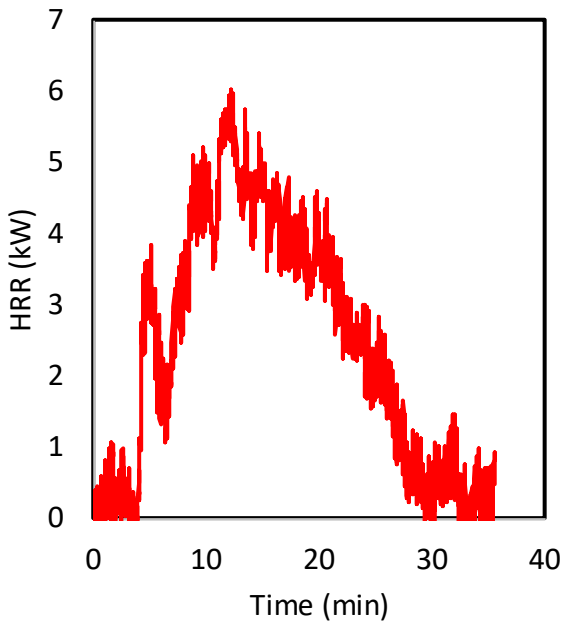
Heat of Combustion (MJ/kg): 16.3 Total Energy Release (MJ): 5.16

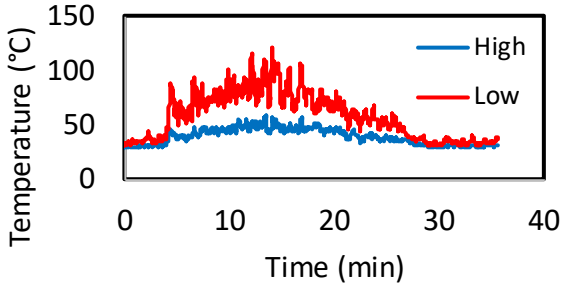
Soot Yield (kg/kg): 0.123 CO Yield (kg/kg): 0.061

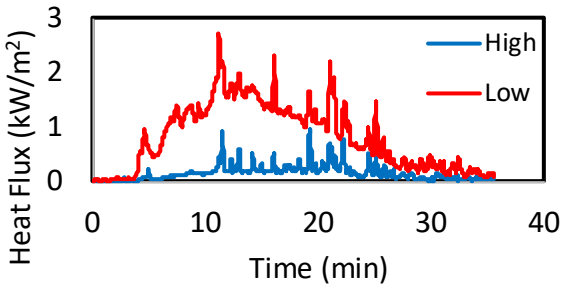
TC Grid Heights[1] (cm): 46, 91

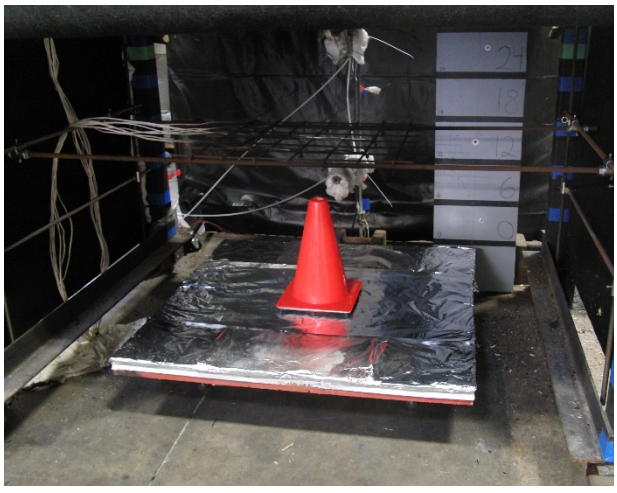
HF Gauge Heights[1] (cm): 30, 76 HF Gauge Distance[2] (cm): 23

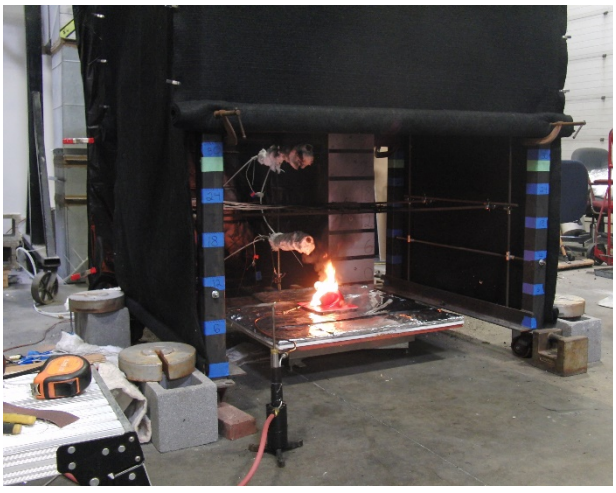
[1]From top of platform, [2]From center of platform











Test ID: 08_01_005 (EPRI) **Test Item: Single Cone**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.57

Peak HRR (kW): 9.5 Burning Duration (s): 1,911 Ignition Method: Flame

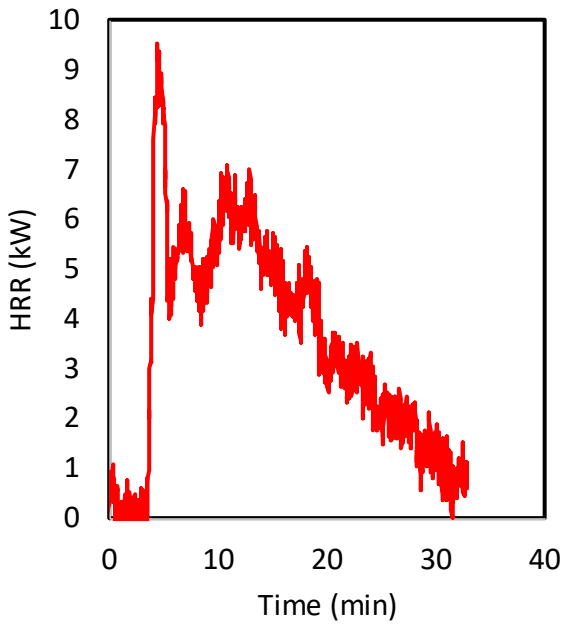
Heat of Combustion (MJ/kg): 18.8 Total Energy Release (MJ): 6.82

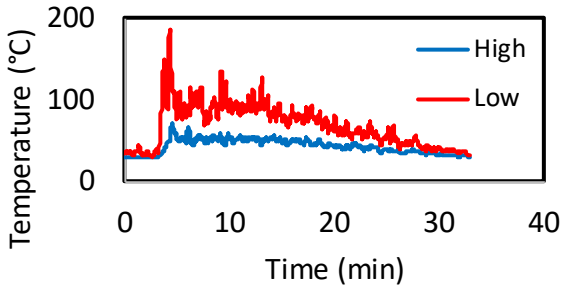
Soot Yield (kg/kg): 0.112 CO Yield (kg/kg): 0.067

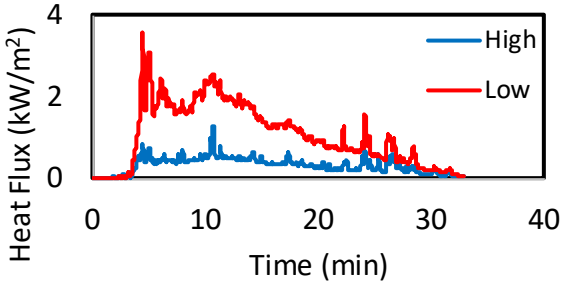
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_01_006 (EPRI) **Test Item: Single Cone**

Max Fire Diameter (m): 0.18 Max Flame Height (m): 0.38

Peak HRR (kW): 7.8 Burning Duration (s): 1,842 Ignition Method: Flame

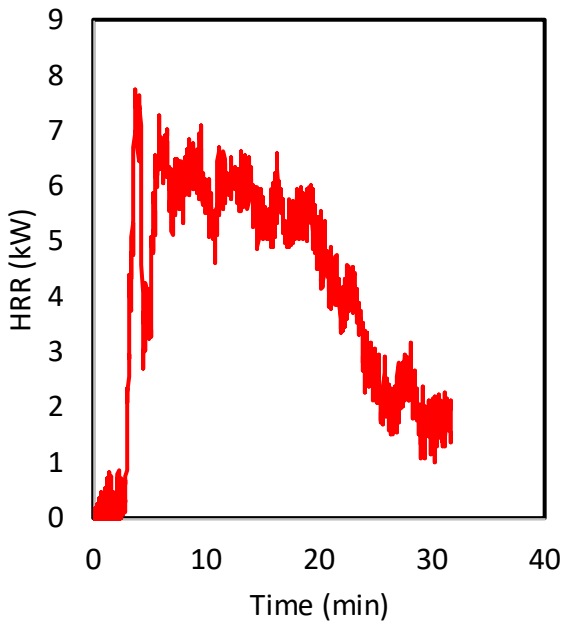
Heat of Combustion (MJ/kg): 23.0 Total Energy Release (MJ): 7.83

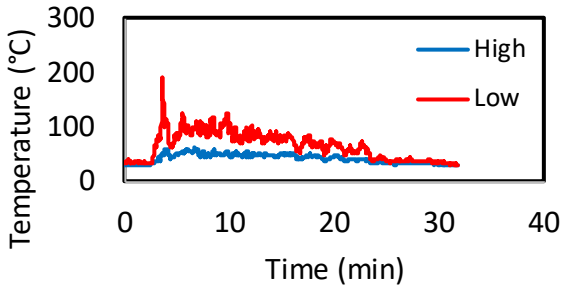
Soot Yield (kg/kg): 0.103 CO Yield (kg/kg): 0.067

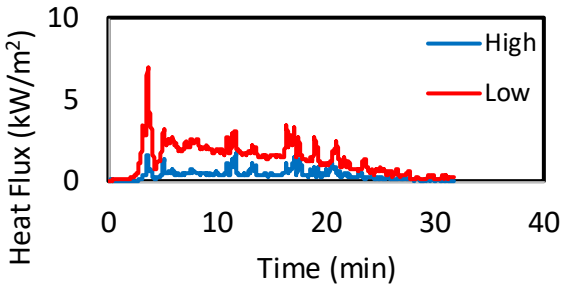
TC Grid Heights[1] (cm): 46, 91

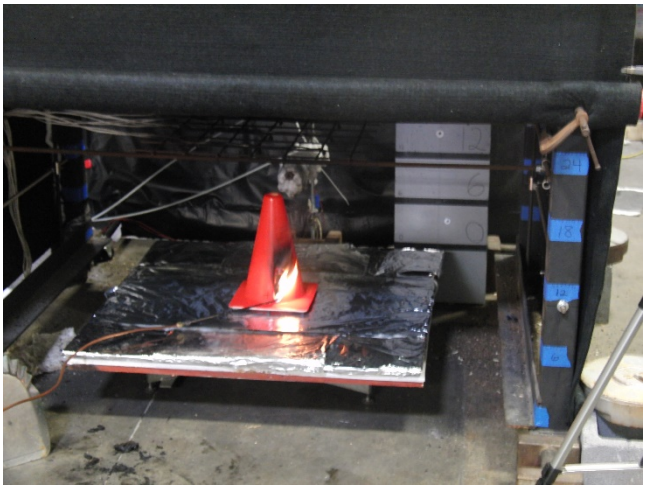
HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_02_001 (EPRI) **Test Item: Uncoiled 120 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.10

Peak HRR (kW): 1.0 Burning Duration (s): 692 Ignition Method: Flame

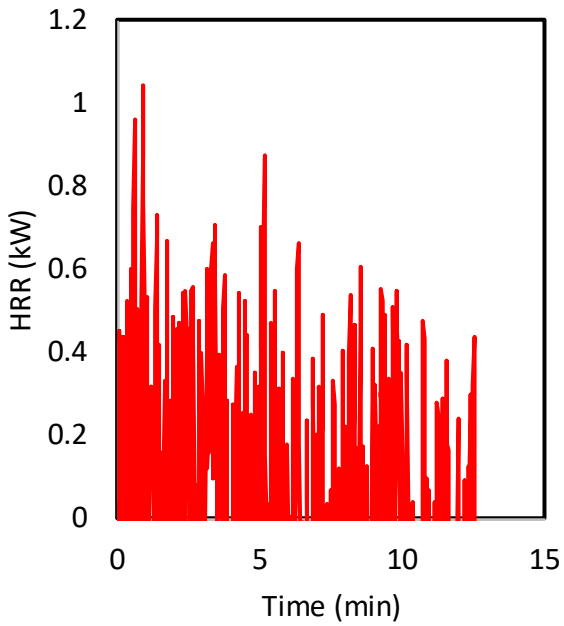
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.01

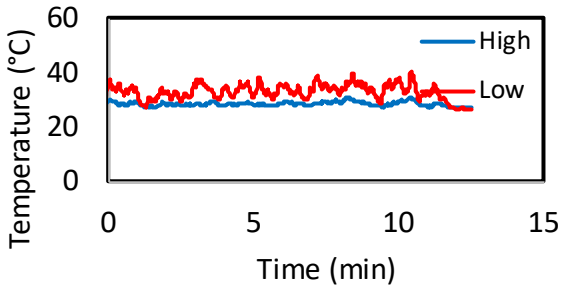
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

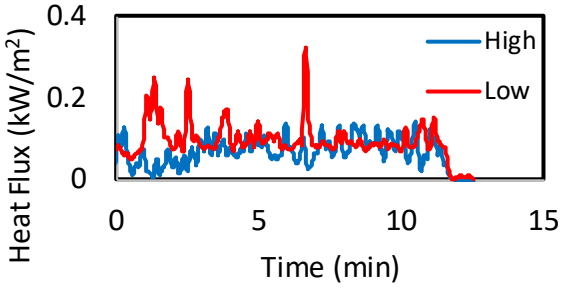
TC Grid Heights[1] (cm): 30, 76

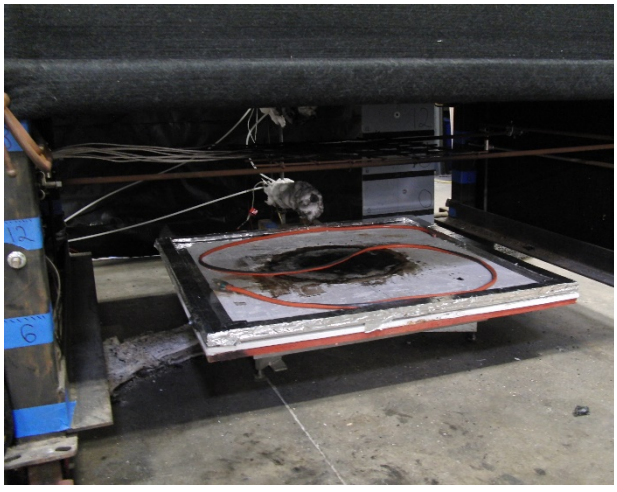
HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

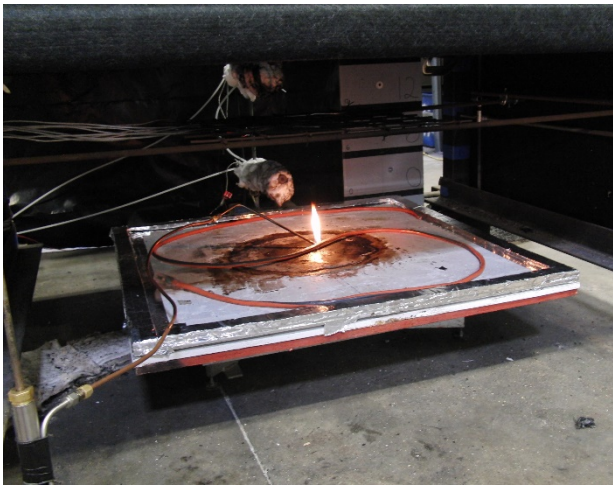
[1]From top of platform, [2]From center of platform











Test ID: 08_002_002 (EPRI) **Test Item: 3 m Coil 120 V Cord**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.10

Peak HRR (kW): 1.2 Burning Duration (s): 642 Ignition Method: Flame

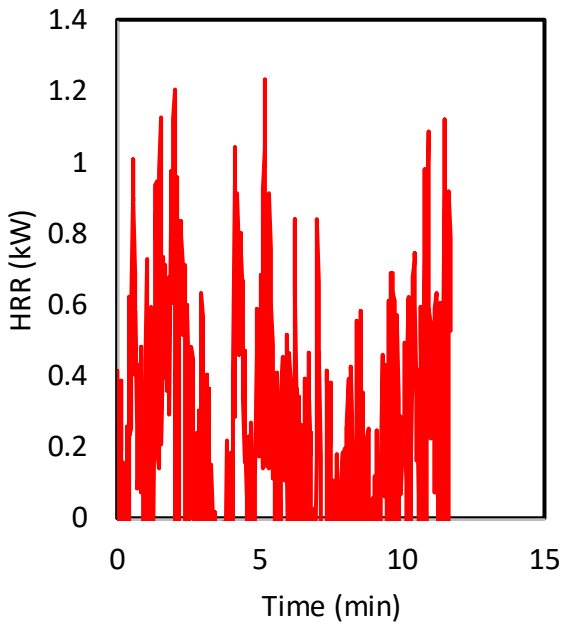
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.14

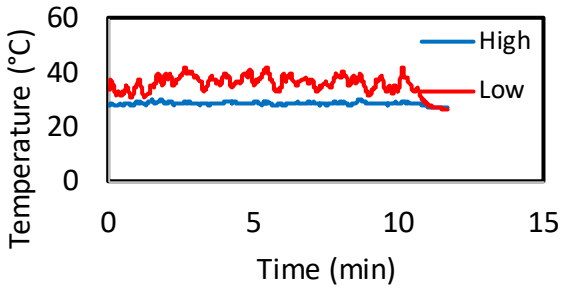
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

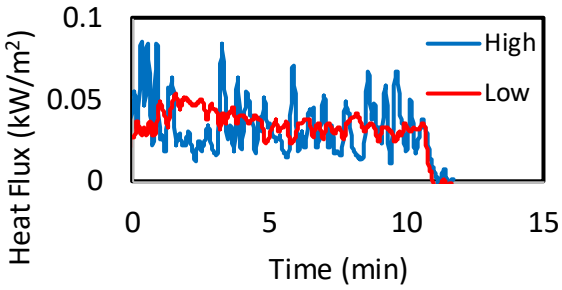
TC Grid Heights[1] (cm): 30, 76

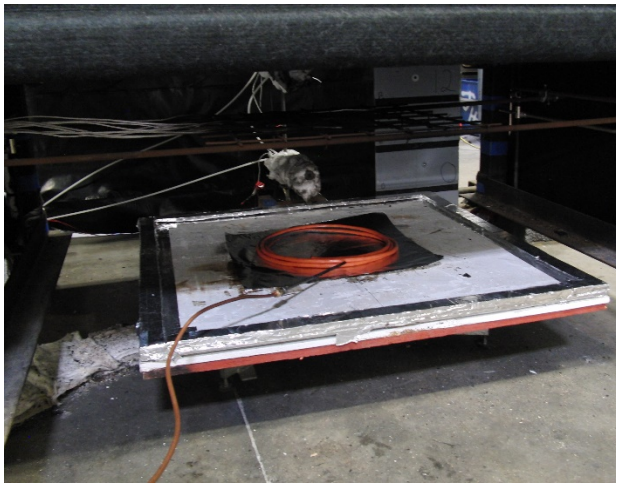
HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

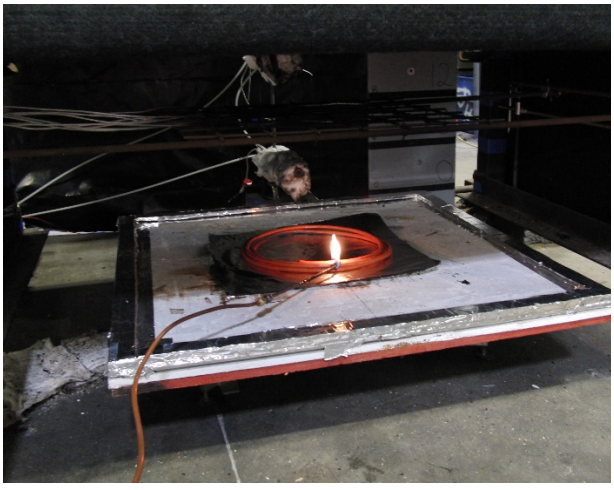
[1]From top of platform, [2]From center of platform











Test ID: 08_03_001 (EPRI) **Test Item: 3 m Coil 120 V Cord**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.10

Peak HRR (kW): 1.5 Burning Duration (s): 1,135 Ignition Method: Flame

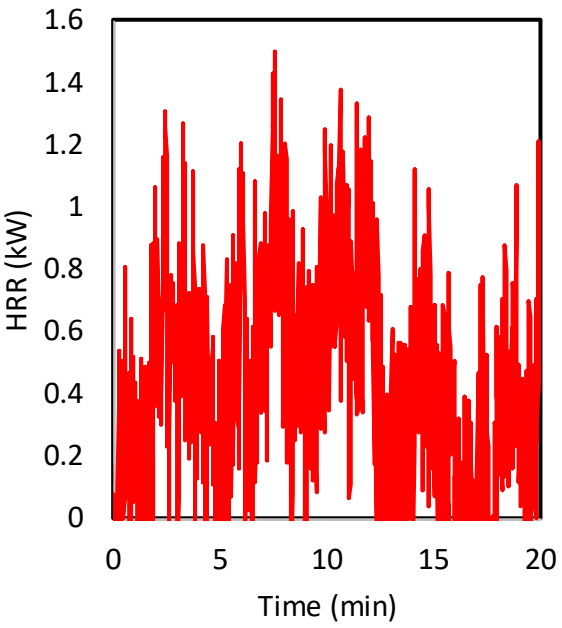
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.48

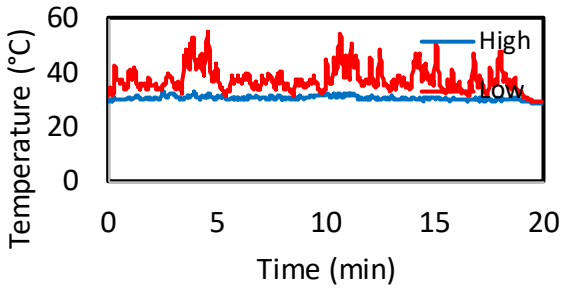
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

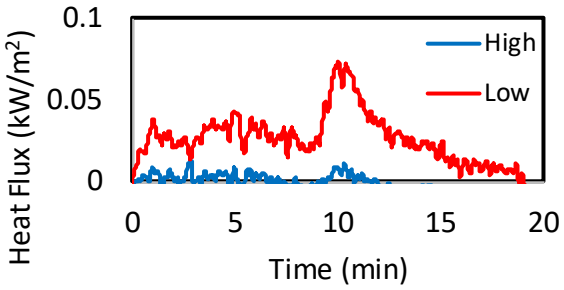
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_003_02 (EPRI) **Test Item: 3 m Coil 120 V Cord**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.15

Peak HRR (kW): 1.2 Burning Duration (s): 1,234 Ignition Method: Flame

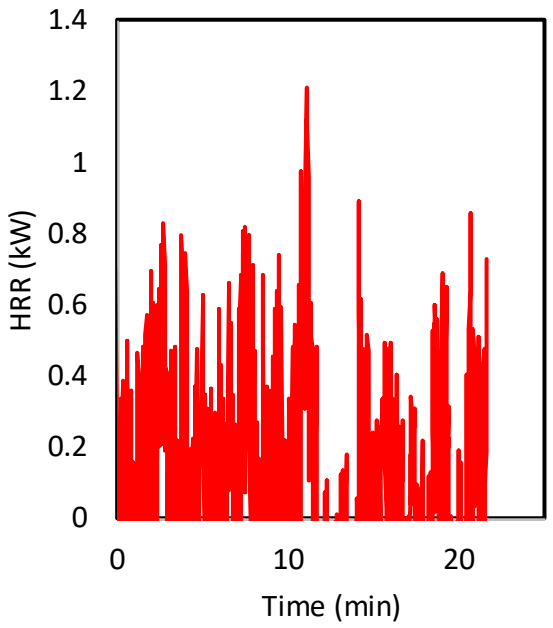
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.04

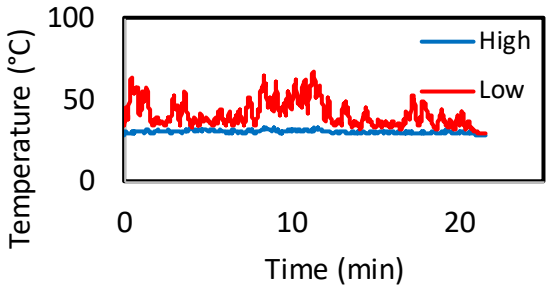
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

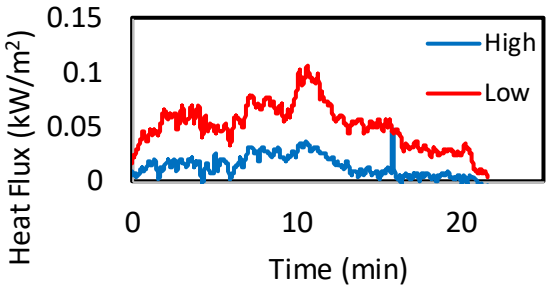
TC Grid Heights[1] (cm): 30, 76

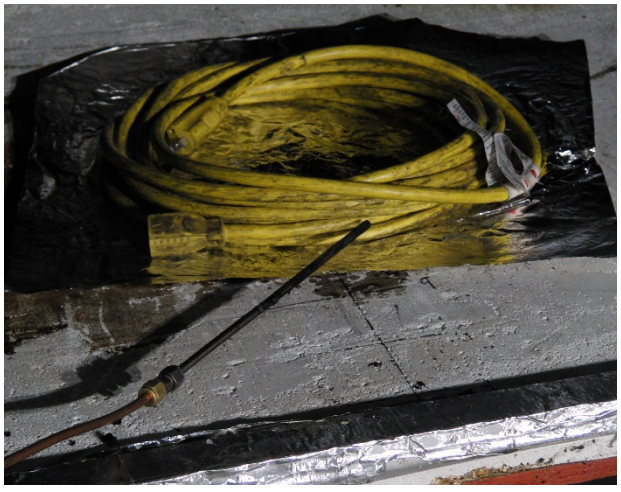
HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_03_003 (EPRI) **Test Item: 7.6 m Coil 120 V Cord**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.10

Peak HRR (kW): 1.6 Burning Duration (s): 1,073 Ignition Method: Flame

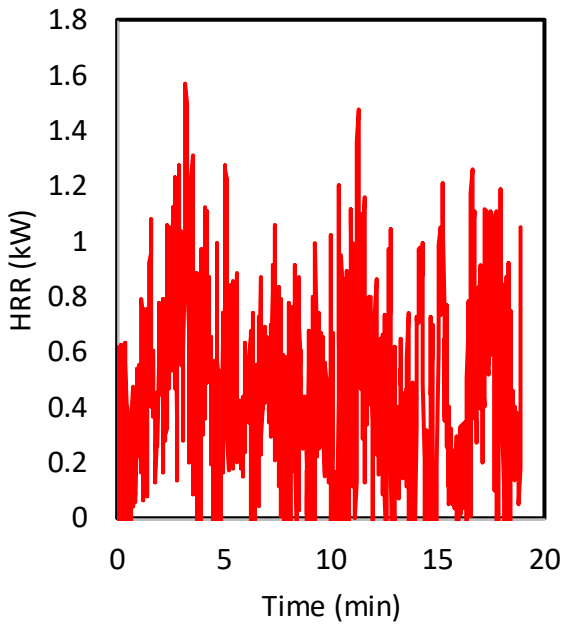
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.50

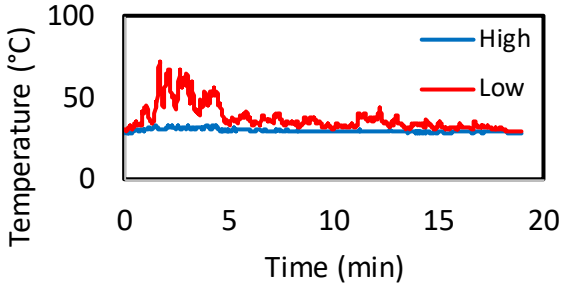
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

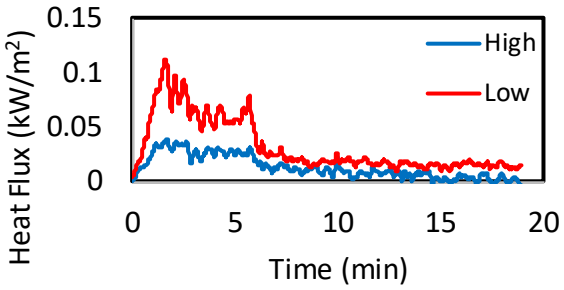
TC Grid Heights[1] (cm): 30, 76

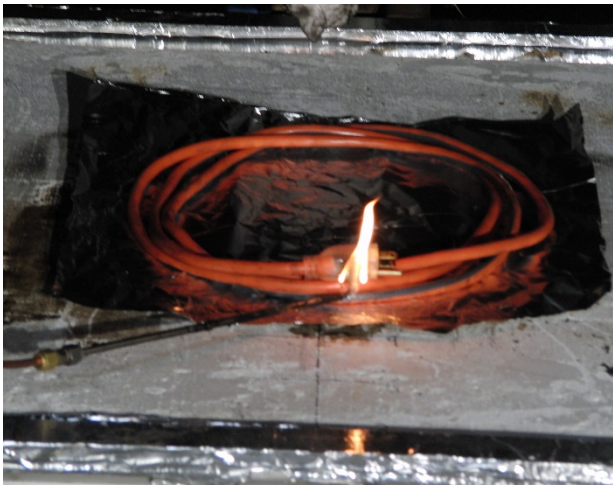
HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_03_004 (EPRI) **Test Item: 7.6 m Coil 120 V Cord**

Max Fire Diameter (m): 0.08 Max Flame Height (m): 0.15

Peak HRR (kW): 1.4 Burning Duration (s): 758 Ignition Method: Flame

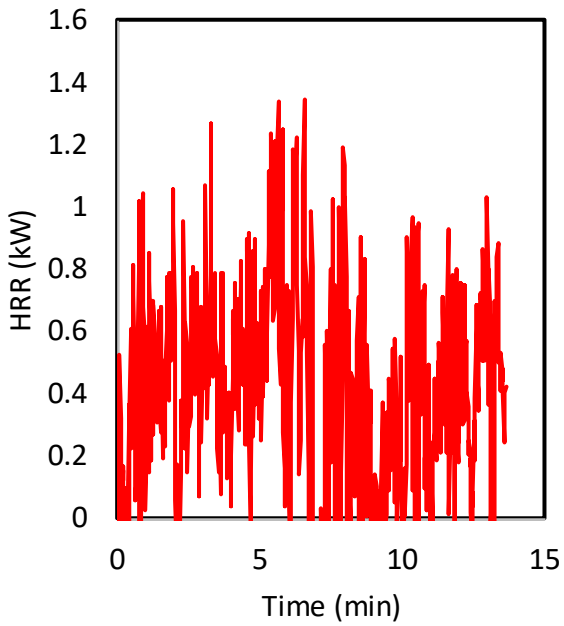
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.34

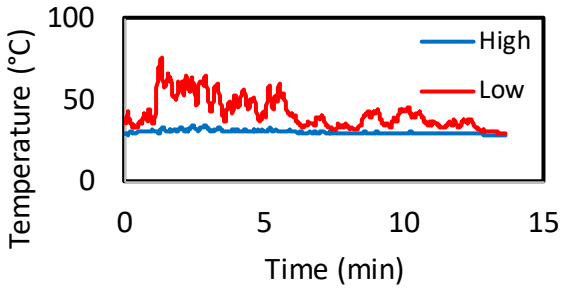
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

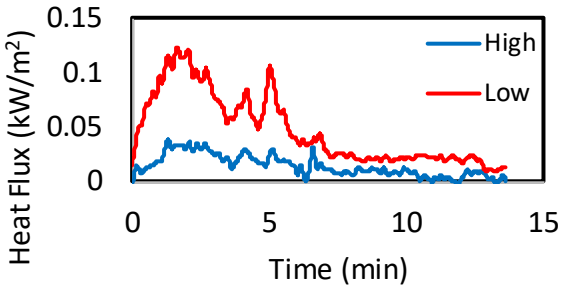
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_03_005 (EPRI) **Test Item: 7.6 m Coil 120 V Cord**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.15

Peak HRR (kW): 1.1 Burning Duration (s): 975 Ignition Method: Flame

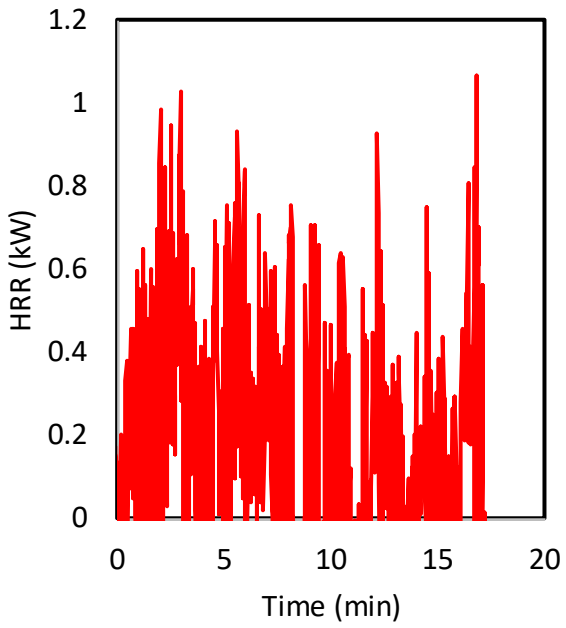
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.16

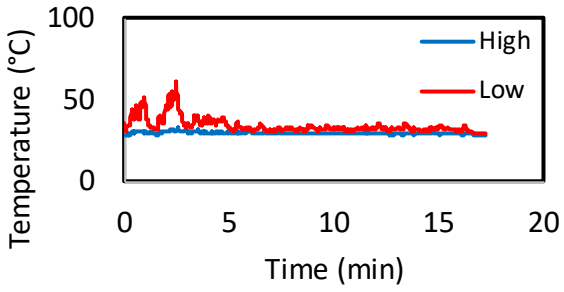
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

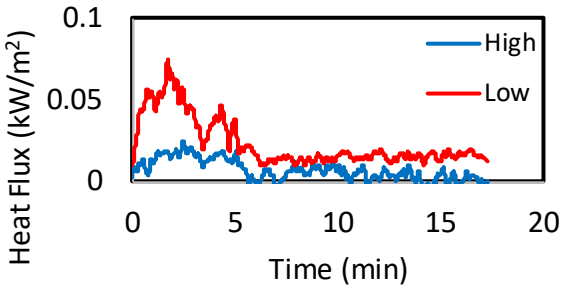
TC Grid Heights[1] (cm): 30, 76

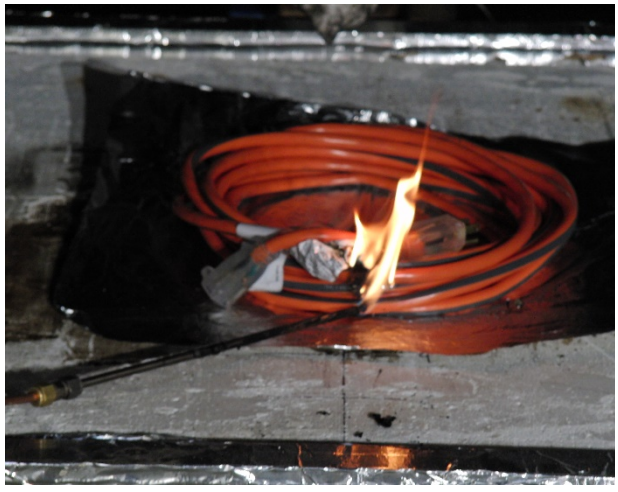
HF Gauge Heights[1] (cm): 15, 46 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_06_001 (EPRI) **Test Item: Medium Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.84

Peak HRR (kW): 68.4 Burning Duration (s): 208 Ignition Method: Wick

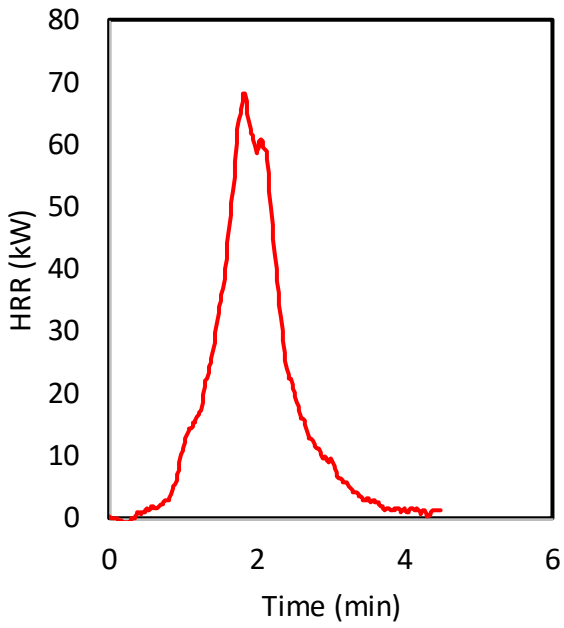
Heat of Combustion (MJ/kg): 11.1 Total Energy Release (MJ): 4.29

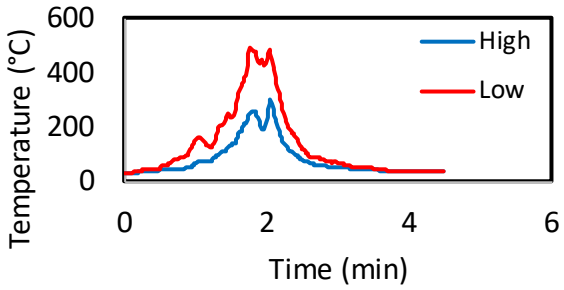
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.022

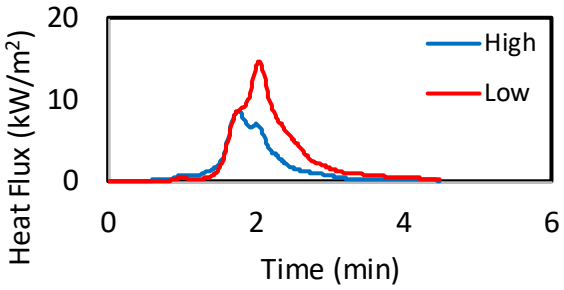
TC Grid Heights[1] (cm): 76, 122

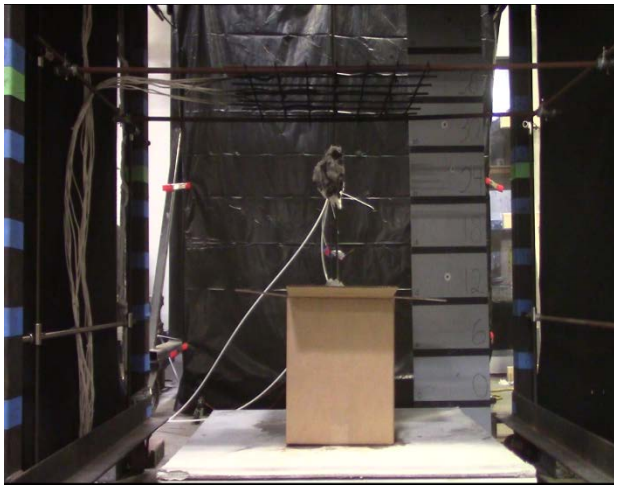
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 46

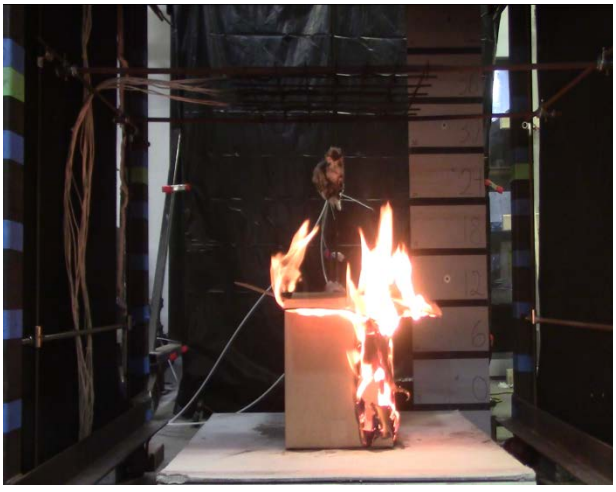
[1]From top of platform, [2]From center of platform











Test ID: 08_06_002 (EPRI) **Test Item: Medium Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.90

Peak HRR (kW): 85.7 Burning Duration (s): 216 Ignition Method: Wick

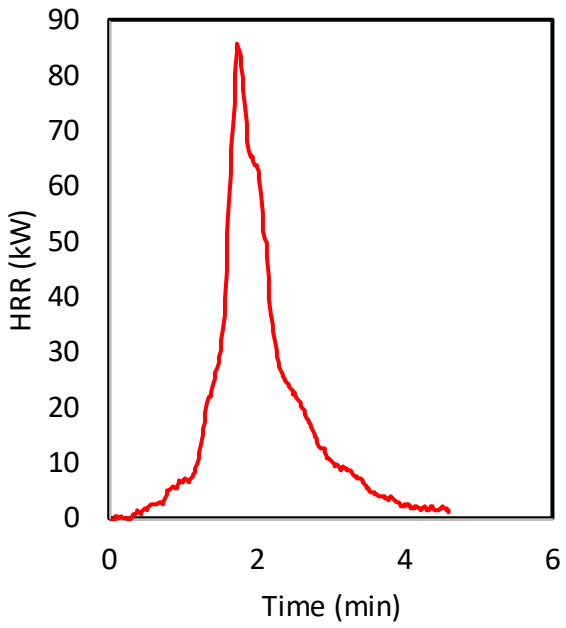
Heat of Combustion (MJ/kg): 11.8 Total Energy Release (MJ): 4.56

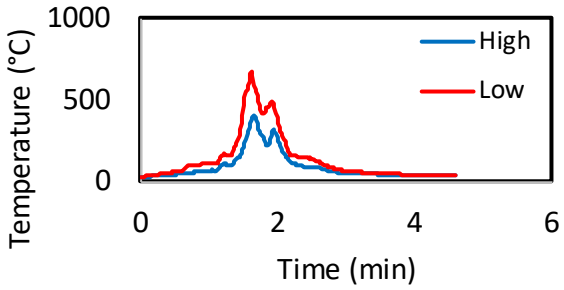
Soot Yield (kg/kg): 0.002 CO Yield (kg/kg): 0.024

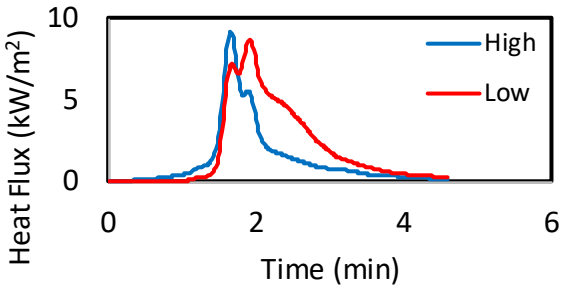
TC Grid Heights[1] (cm): 76, 122

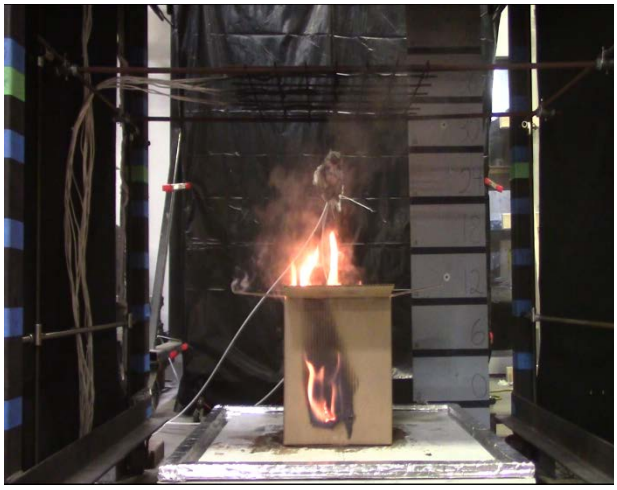
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 53

[1]From top of platform, [2]From center of platform









Test ID: 08_06_003 (EPRI) **Test Item: Medium Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.96

Peak HRR (kW): 76.9 Burning Duration (s): 261 Ignition Method: Wick

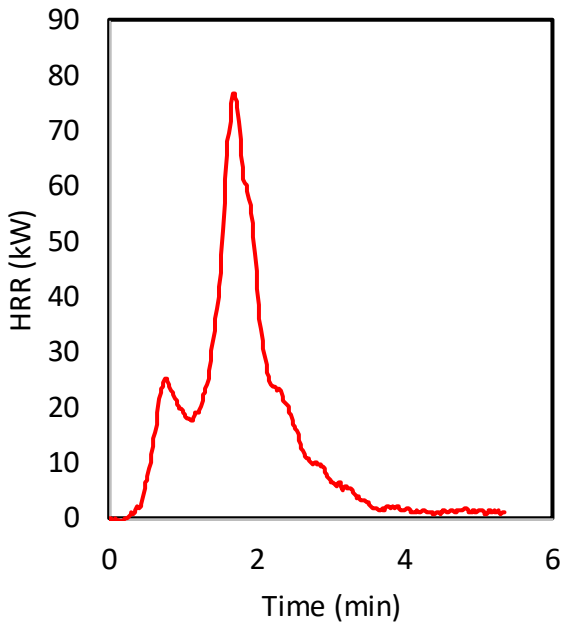
Heat of Combustion (MJ/kg): 11.9 Total Energy Release (MJ): 4.60

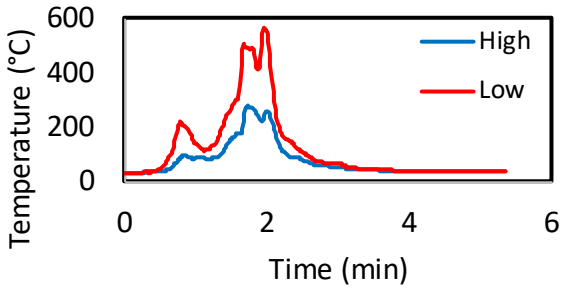
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.024

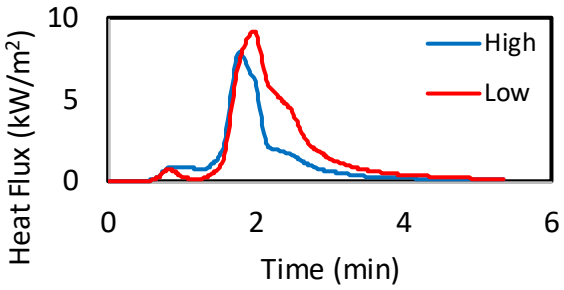
TC Grid Heights[1] (cm): 76, 122

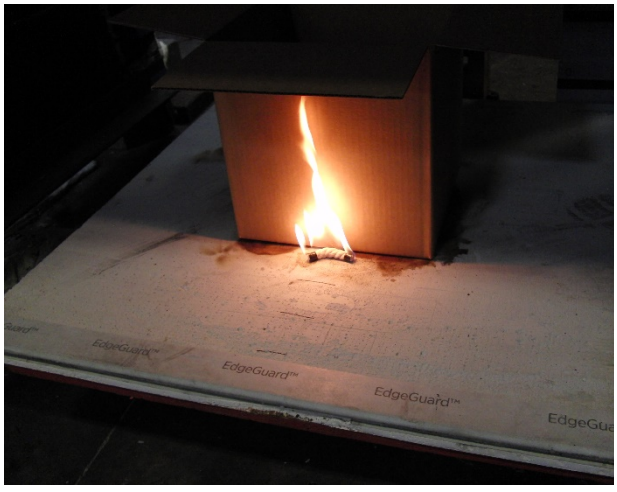
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 53

[1]From top of platform, [2]From center of platform









Test ID: 08_06_004 (EPRI) **Test Item: Medium Box w/Paper**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.96

Peak HRR (kW): 54.6 Burning Duration (s): 242 Ignition Method: Wick

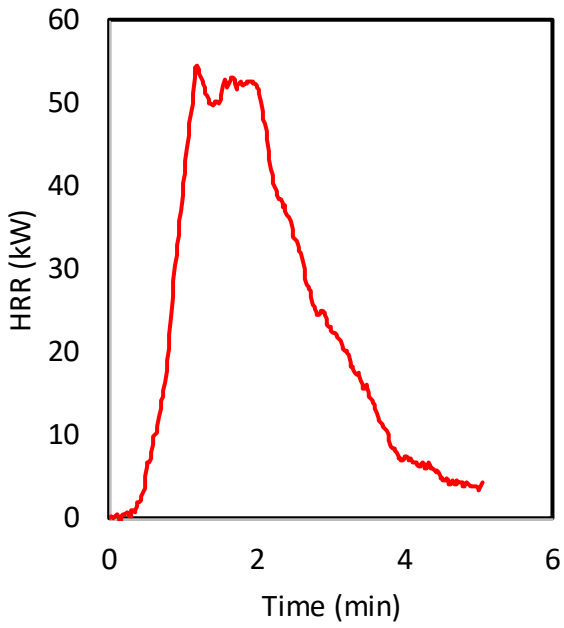
Heat of Combustion (MJ/kg): 12.8 Total Energy Release (MJ): 6.96

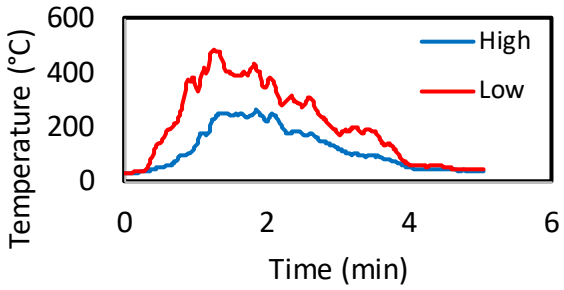
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.021

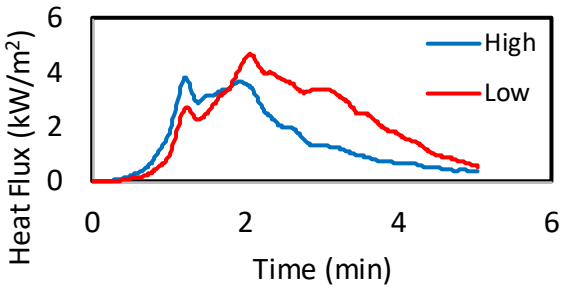
TC Grid Heights[1] (cm): 76, 122

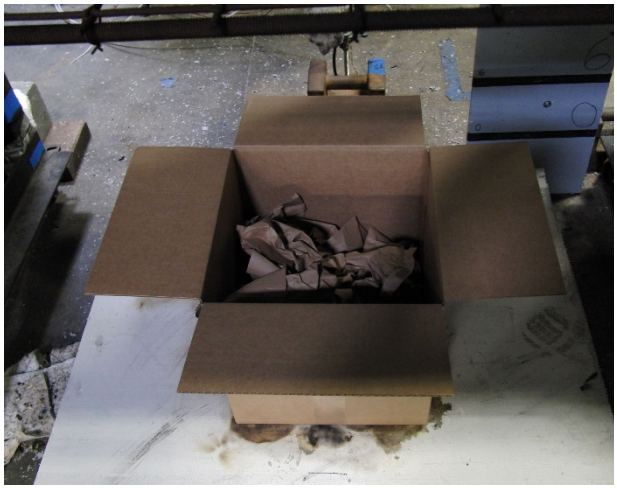
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 53

[1]From top of platform, [2]From center of platform









Test ID: 08_06_005 (EPRI) **Test Item: Medium Box w/Paper**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.02

Peak HRR (kW): 73.9 Burning Duration (s): 280 Ignition Method: Wick

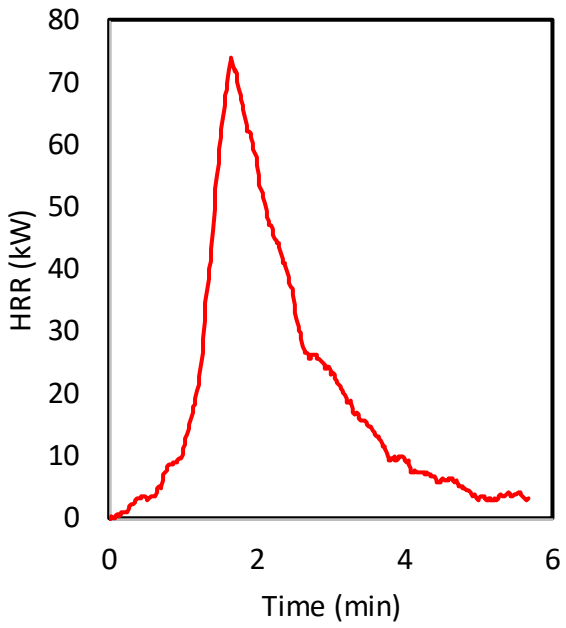
Heat of Combustion (MJ/kg): 12.4 Total Energy Release (MJ): 6.73

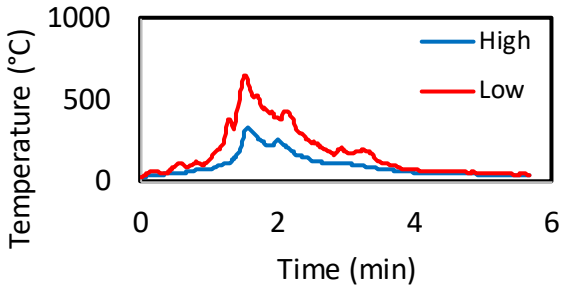
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.026

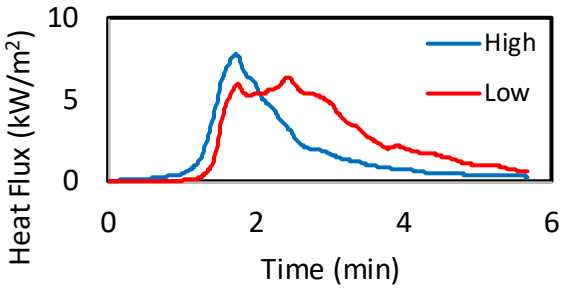
TC Grid Heights[1] (cm): 76, 122

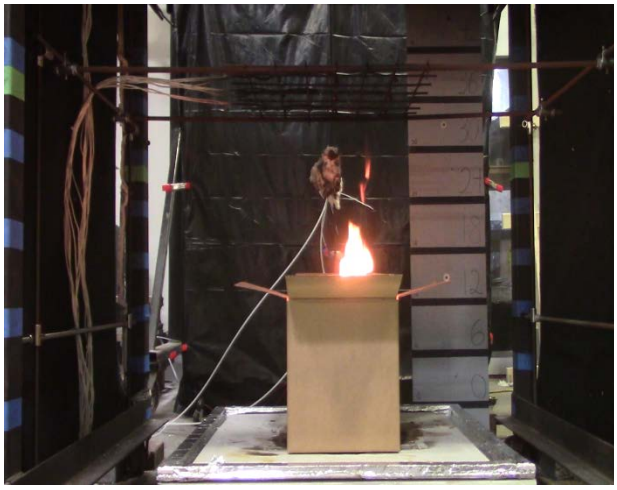
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 46

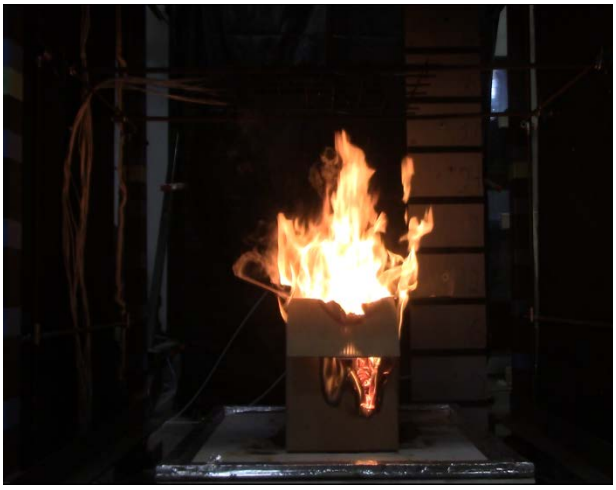
[1]From top of platform, [2]From center of platform











Test ID: 08_06_006 (EPRI) **Test Item: Medium Box w/Paper**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.06

Peak HRR (kW): 84.8 Burning Duration (s): 229 Ignition Method: Wick

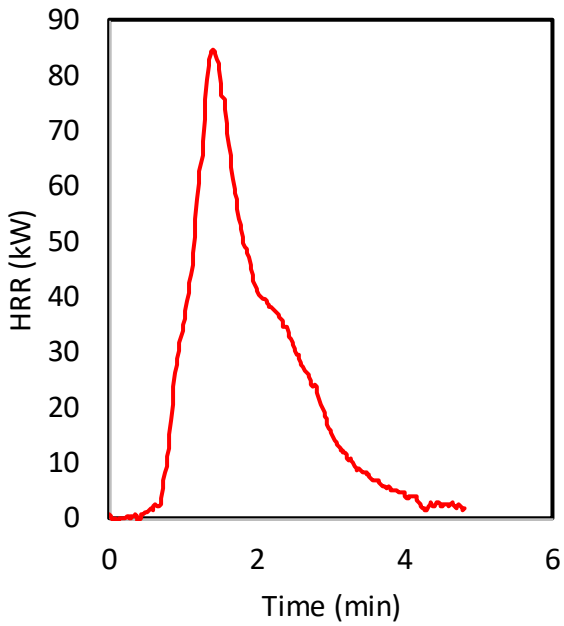
Heat of Combustion (MJ/kg): 11.9 Total Energy Release (MJ): 6.48

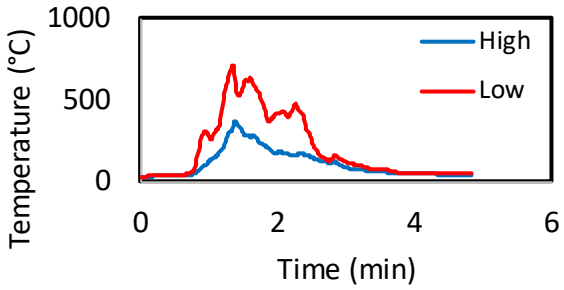
Soot Yield (kg/kg): 0.001 CO Yield (kg/kg): 0.016

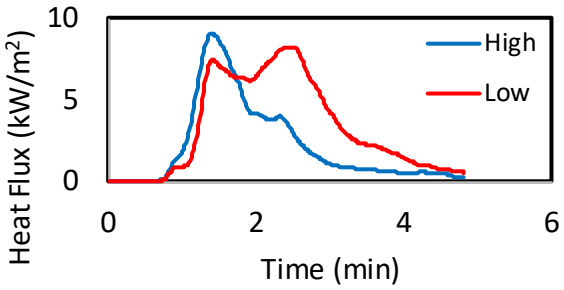
TC Grid Heights[1] (cm): 76, 122

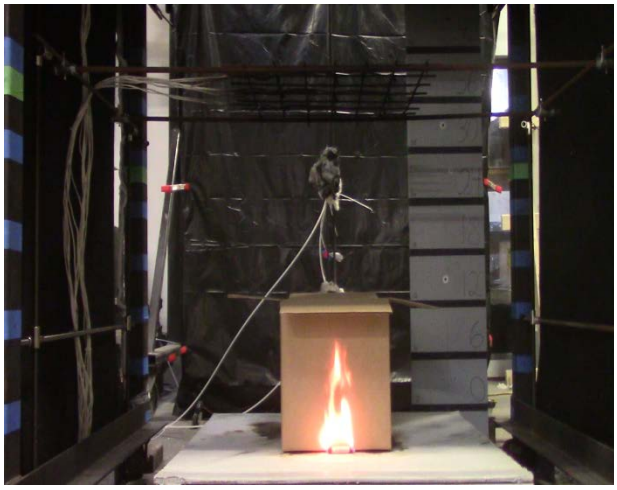
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 46

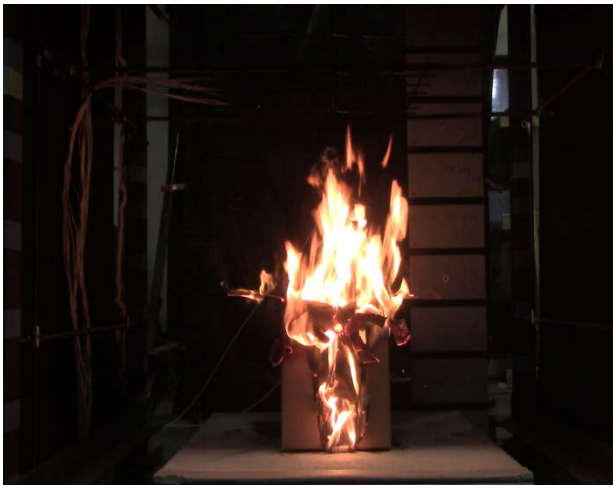
[1]From top of platform, [2]From center of platform











Test ID: 08_06_007 (EPRI) **Test Item: Medium Box w/Peanuts**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.06

Peak HRR (kW): 134 Burning Duration (s): 184 Ignition Method: Wick

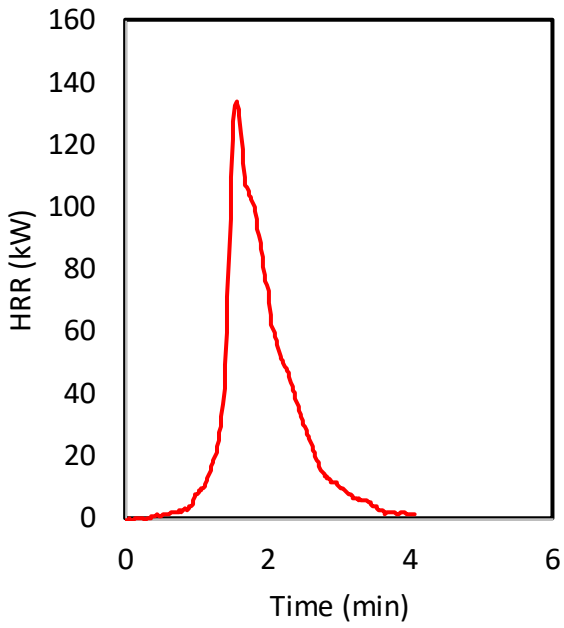
Heat of Combustion (MJ/kg): 14.9 Total Energy Release (MJ): 6.42

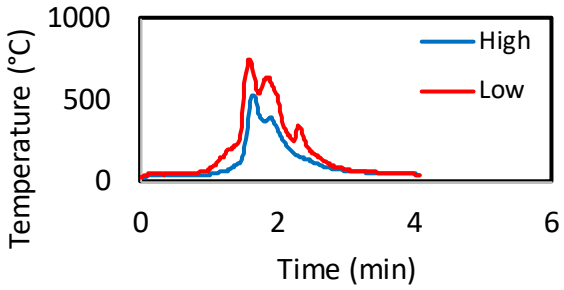
Soot Yield (kg/kg): 0.011 CO Yield (kg/kg): 0.025

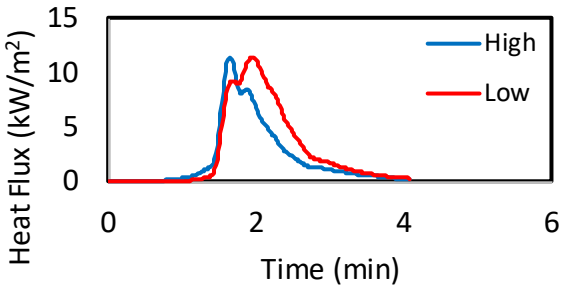
TC Grid Heights[1] (cm): 76, 122

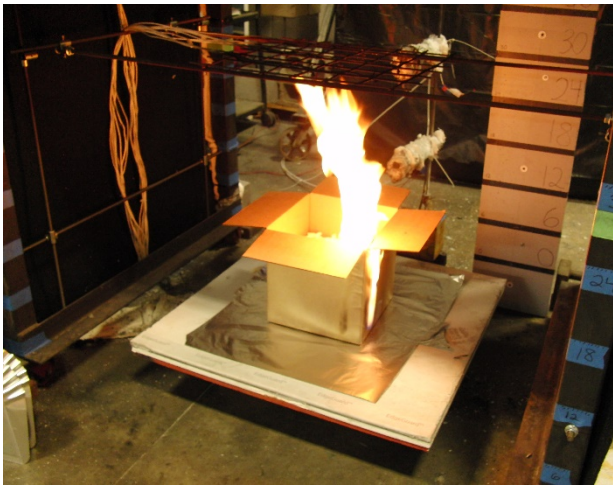
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform









Test ID: 08_06_008 (EPRI) **Test Item: Medium Box w/Peanuts**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.04

Peak HRR (kW): 114 Burning Duration (s): 207 Ignition Method: Wick

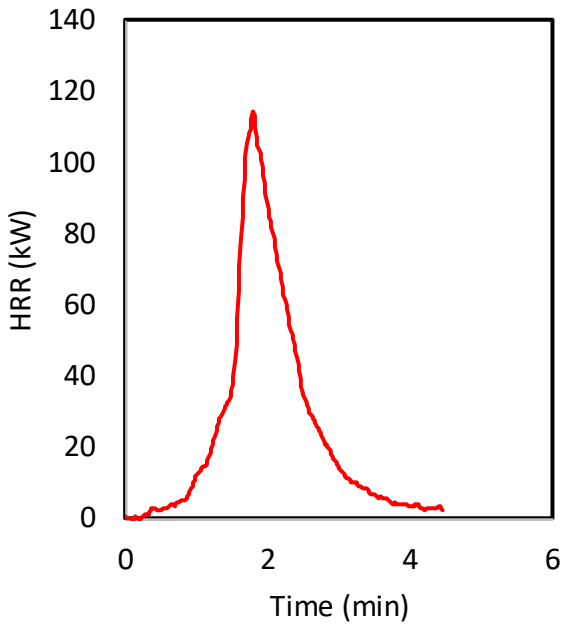
Heat of Combustion (MJ/kg): 15.4 Total Energy Release (MJ): 6.64

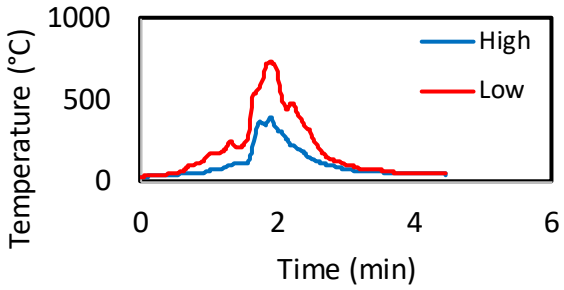
Soot Yield (kg/kg): 0.012 CO Yield (kg/kg): 0.026

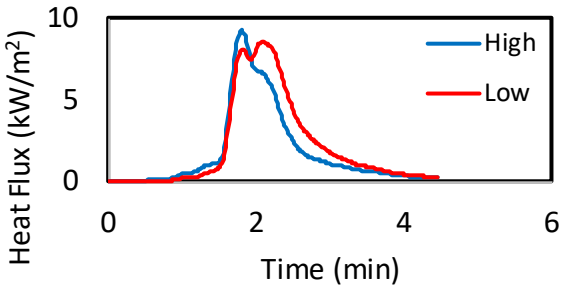
TC Grid Heights[1] (cm): 76, 122

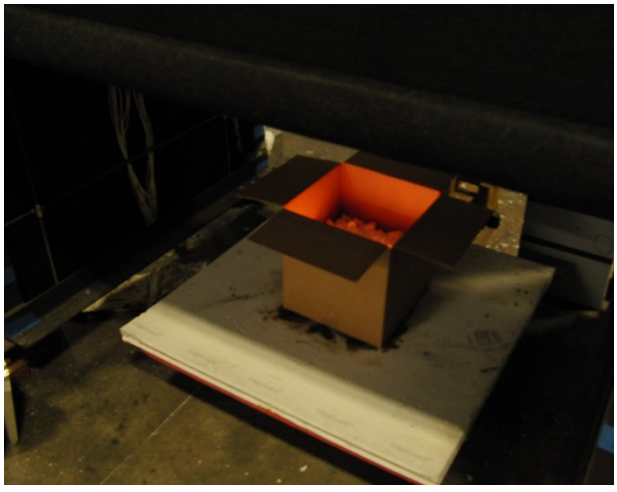
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform









Test ID: 08_06_009 (EPRI) **Test Item: Medium Box w/Peanuts**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 1.06

Peak HRR (kW): 98.0 Burning Duration (s): 219 Ignition Method: Wick

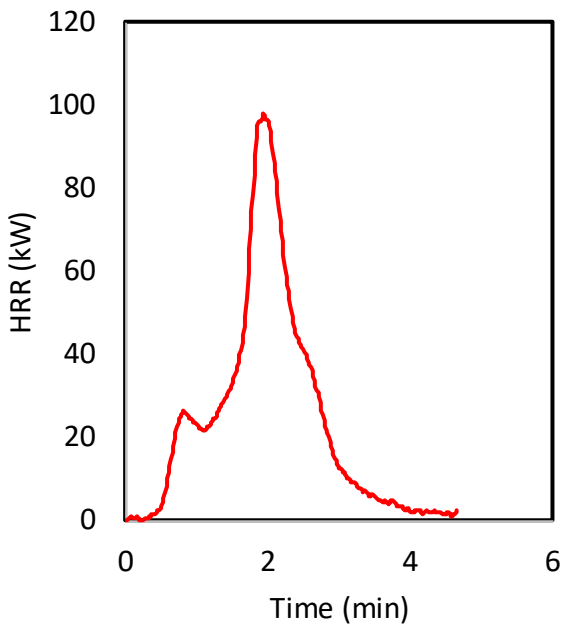
Heat of Combustion (MJ/kg): 15.3 Total Energy Release (MJ): 6.58

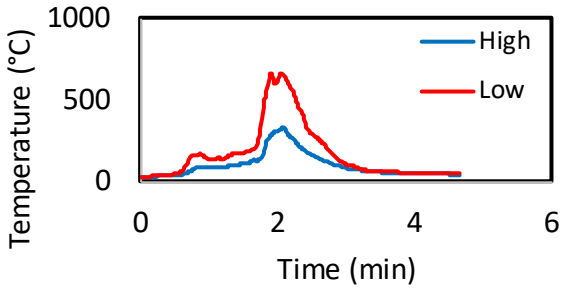
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.029

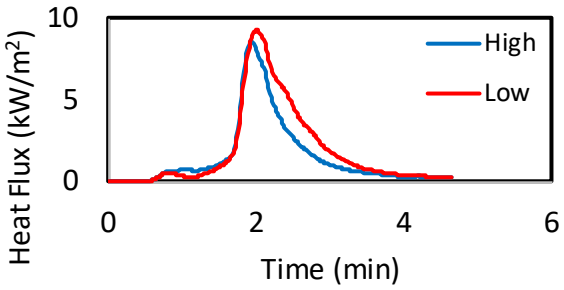
TC Grid Heights[1] (cm): 76, 122

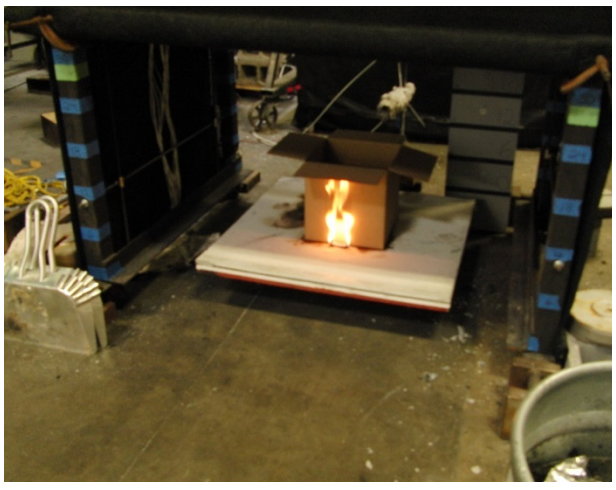
HF Gauge Heights[1] (cm): 33, 71 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform









Test ID: 08_07_001 (EPRI) **Test Item: Small Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.51

Peak HRR (kW): 28.0 Burning Duration (s): 230 Ignition Method: Wick

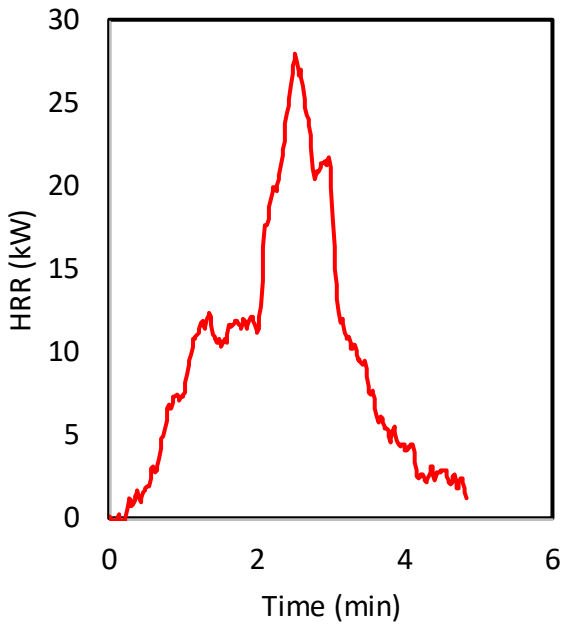
Heat of Combustion (MJ/kg): 17.6 Total Energy Release (MJ): 2.79

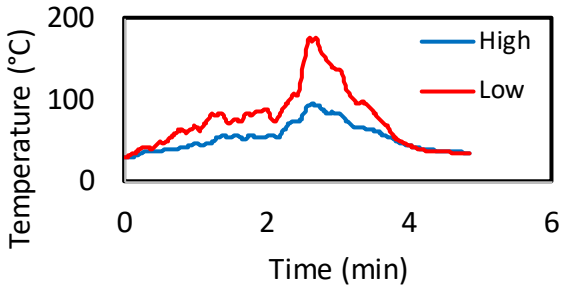
Soot Yield (kg/kg): 0.008 CO Yield (kg/kg): 0.034

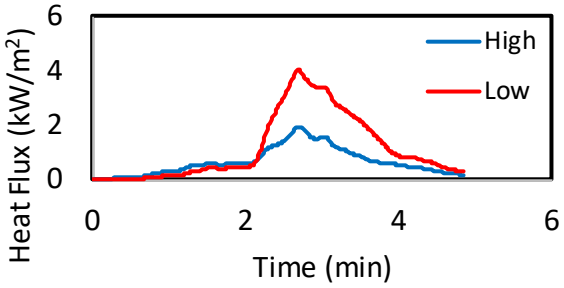
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_07_002 (EPRI) **Test Item: Small Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.63

Peak HRR (kW): 49.9 Burning Duration (s): 200 Ignition Method: Wick

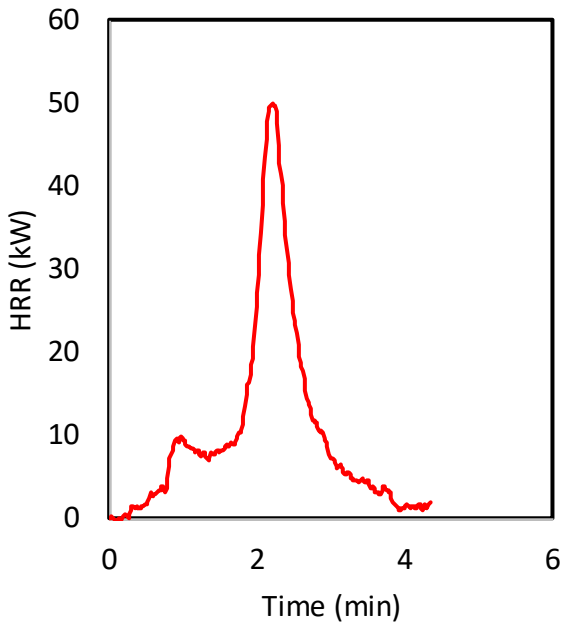
Heat of Combustion (MJ/kg): 16.8 Total Energy Release (MJ): 2.67

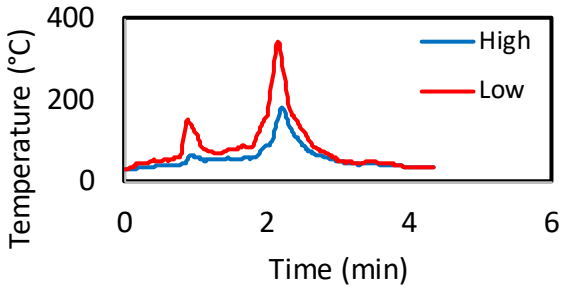
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.031

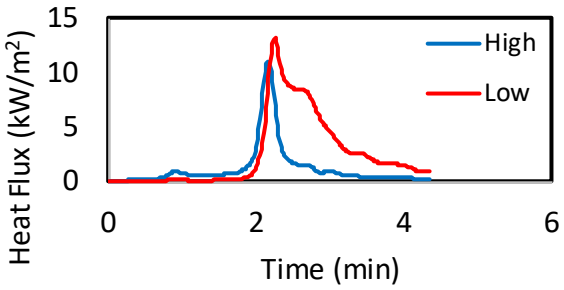
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 08_07_003 (EPRI) **Test Item: Small Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.74

Peak HRR (kW): 42.9 Burning Duration (s): 172 Ignition Method: Wick

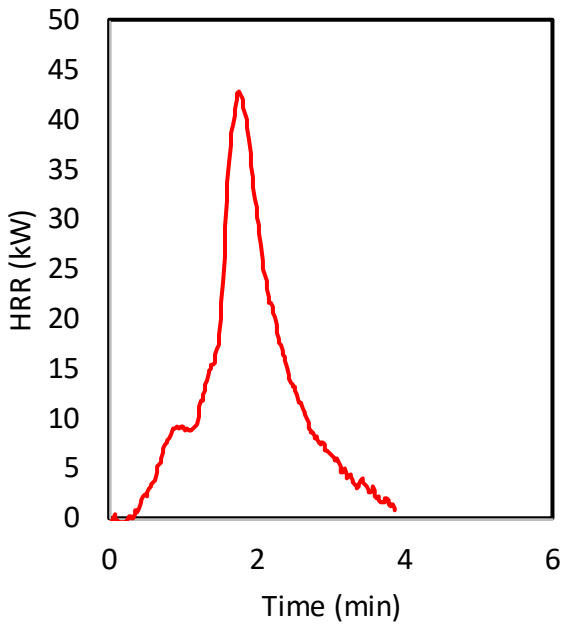
Heat of Combustion (MJ/kg): 17.1 Total Energy Release (MJ): 2.71

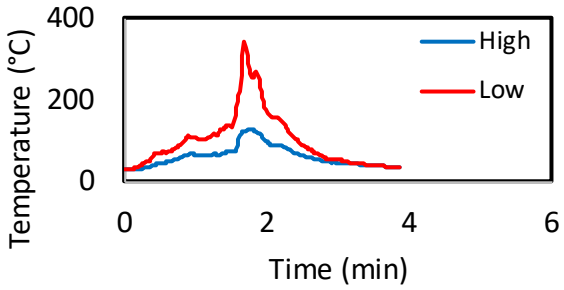
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.028

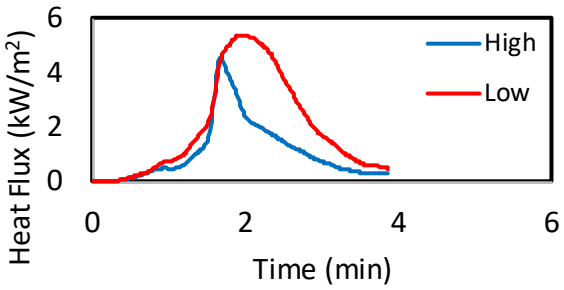
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_07_004 (EPRI) **Test Item: Small Box Empty**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.65

Peak HRR (kW): 46.5 Burning Duration (s): 203 Ignition Method: Wick

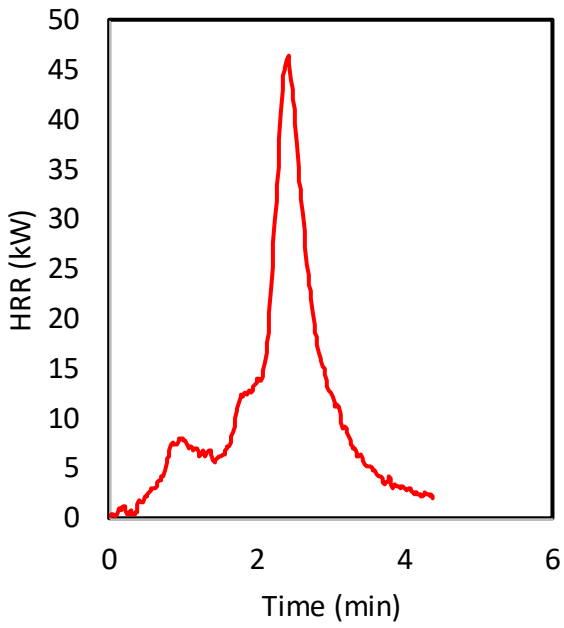
Heat of Combustion (MJ/kg): 17.2 Total Energy Release (MJ): 2.72

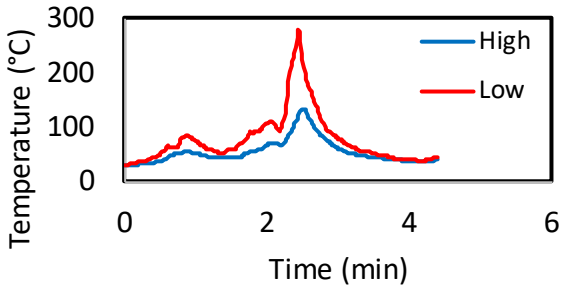
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.031

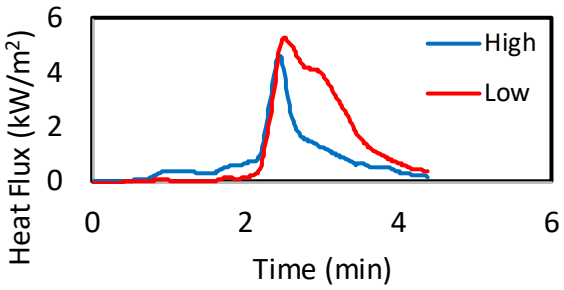
TC Grid Heights[1] (cm): 76, 122

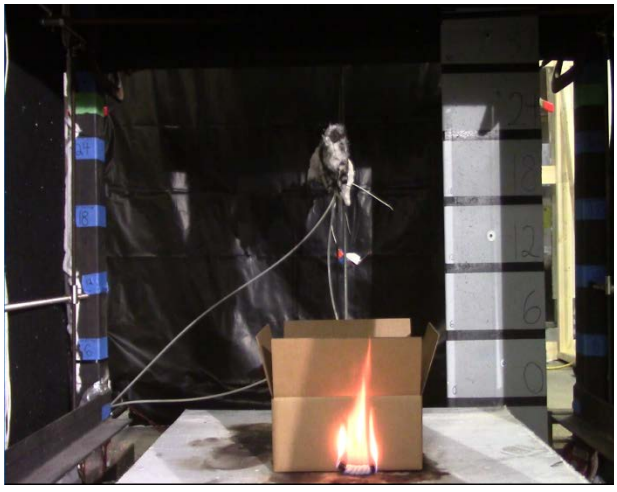
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

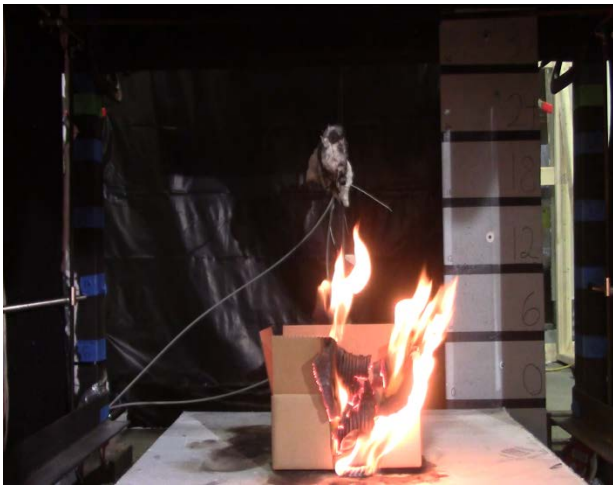
[1]From top of platform, [2]From center of platform











Test ID: 08_07_005 (EPRI) **Test Item: Small Box w/Paper**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.61

Peak HRR (kW): 48.3 Burning Duration (s): 156 Ignition Method: Wick

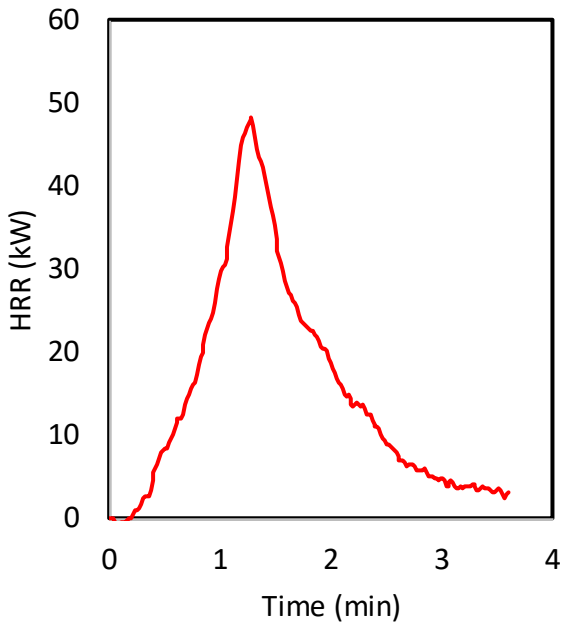
Heat of Combustion (MJ/kg): 16.0 Total Energy Release (MJ): 3.26

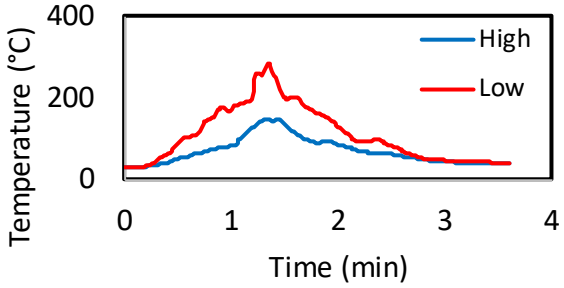
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.024

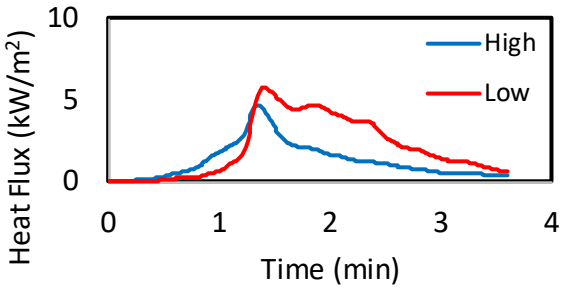
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_07_006 (EPRI) **Test Item: Small Box w/Paper**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.63

Peak HRR (kW): 43.2 Burning Duration (s): 140 Ignition Method: Wick

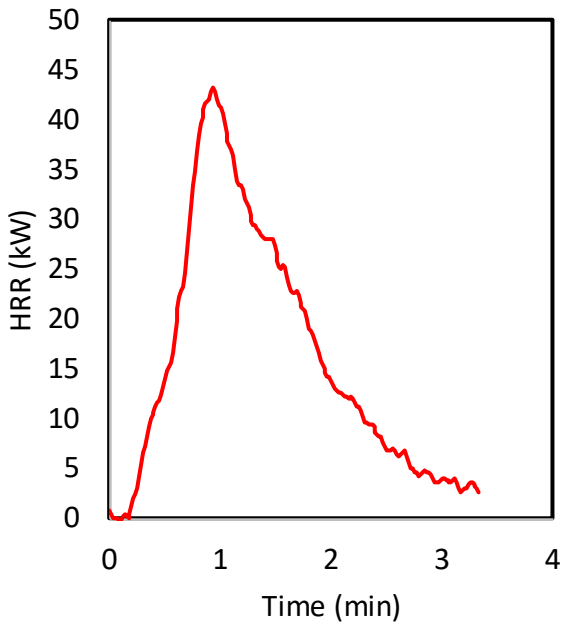
Heat of Combustion (MJ/kg): 15.7 Total Energy Release (MJ): 3.21

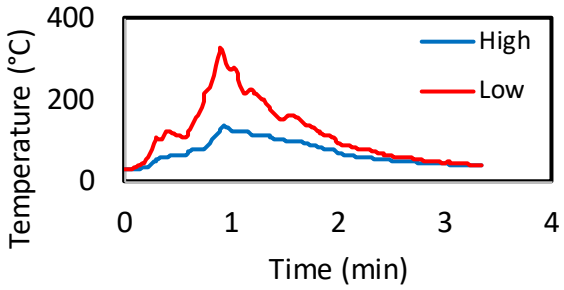
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.027

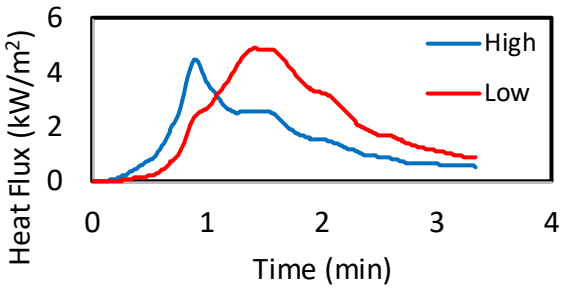
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_07_007 (EPRI) **Test Item: Small Box w/Paper**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.63

Peak HRR (kW): 50.2 Burning Duration (s): 181 Ignition Method: Wick

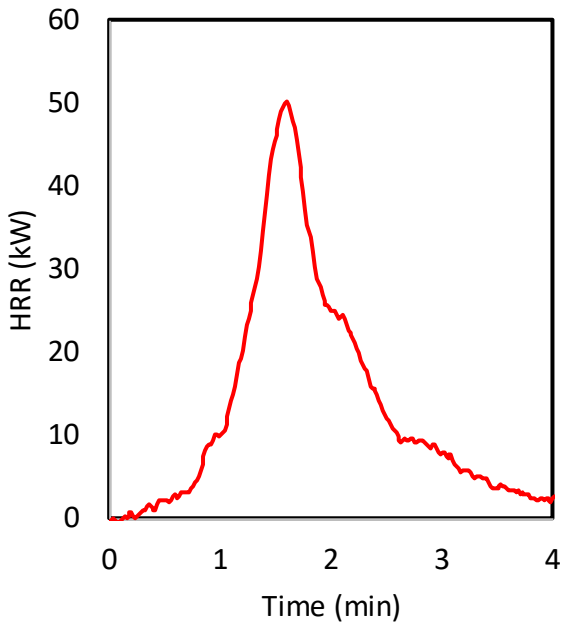
Heat of Combustion (MJ/kg): 15.8 Total Energy Release (MJ): 3.22

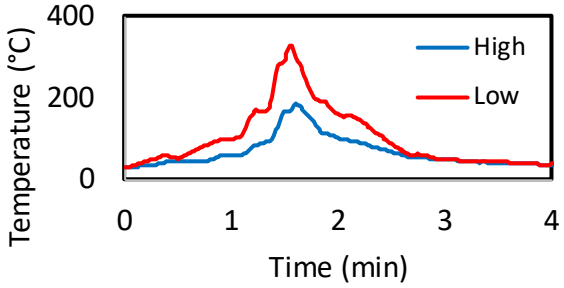
Soot Yield (kg/kg): 0.012 CO Yield (kg/kg): 0.029

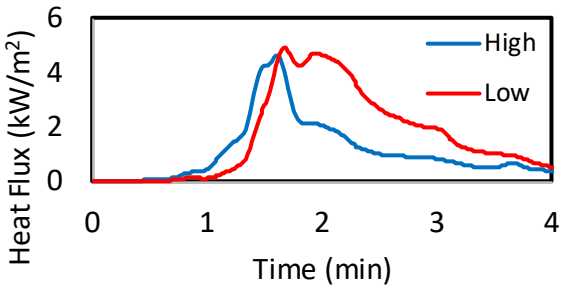
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_07_008 (EPRI) **Test Item: Small Box w/Peanuts**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.74

Peak HRR (kW): 51.6 Burning Duration (s): 182 Ignition Method: Wick

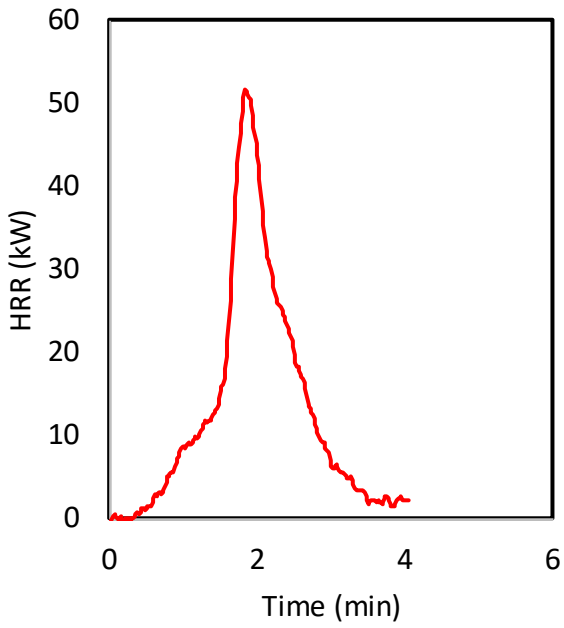
Heat of Combustion (MJ/kg): 16.8 Total Energy Release (MJ): 3.05

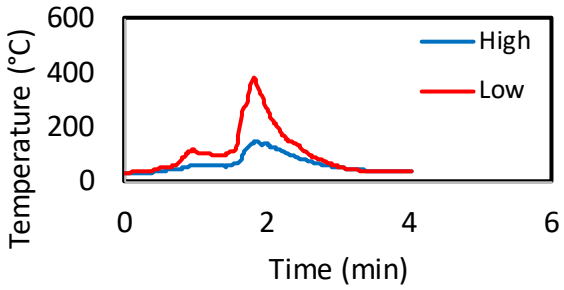
Soot Yield (kg/kg): 0.013 CO Yield (kg/kg): 0.026

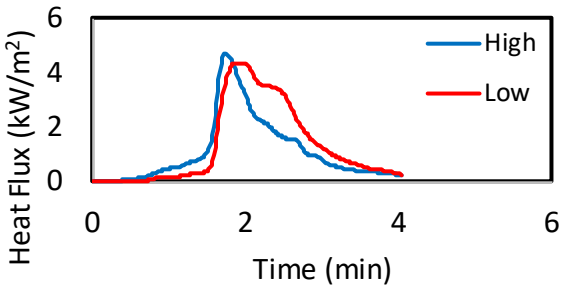
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 53

[1]From top of platform, [2]From center of platform







Test ID: 08_007_09 (EPRI) **Test Item: Small Box w/Peanuts**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.63

Peak HRR (kW): 57.9 Burning Duration (s): 172 Ignition Method: Wick

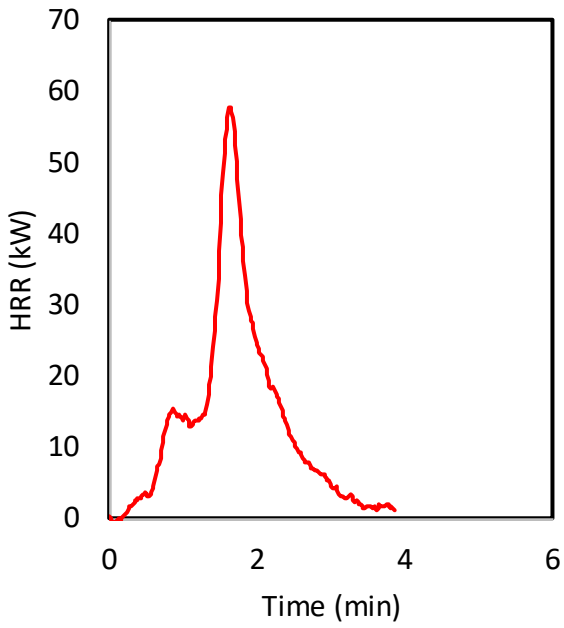
Heat of Combustion (MJ/kg): 16.7 Total Energy Release (MJ): 3.03

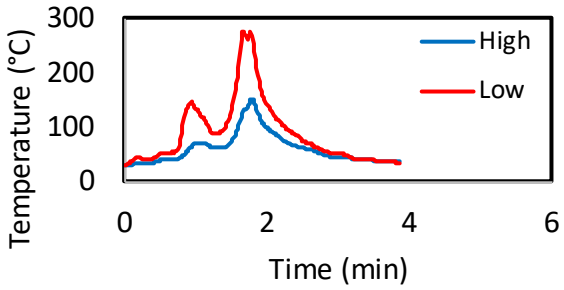
Soot Yield (kg/kg): 0.015 CO Yield (kg/kg): 0.031

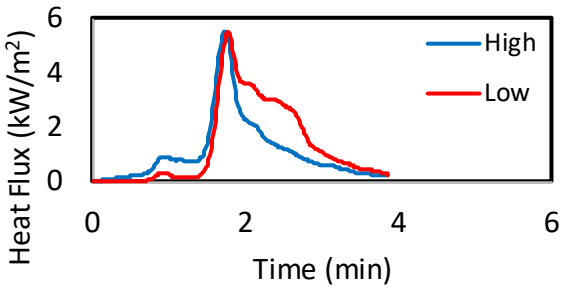
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 53

[1]From top of platform, [2]From center of platform







Test ID: 08_07_010 (EPRI) **Test Item: Small Box w/Peanuts**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.74

Peak HRR (kW): 71.4 Burning Duration (s): 202 Ignition Method: Wick

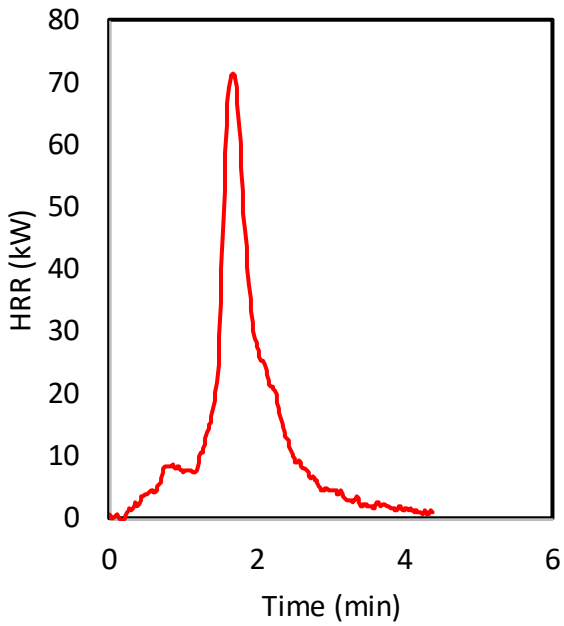
Heat of Combustion (MJ/kg): 17.2 Total Energy Release (MJ): 3.12

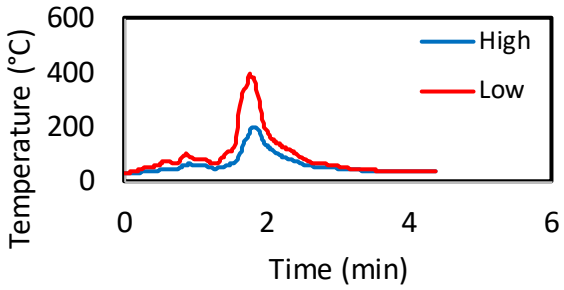
Soot Yield (kg/kg): 0.016 CO Yield (kg/kg): 0.030

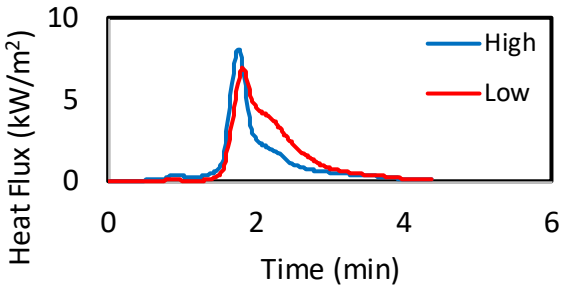
TC Grid Heights[1] (cm): 76, 122

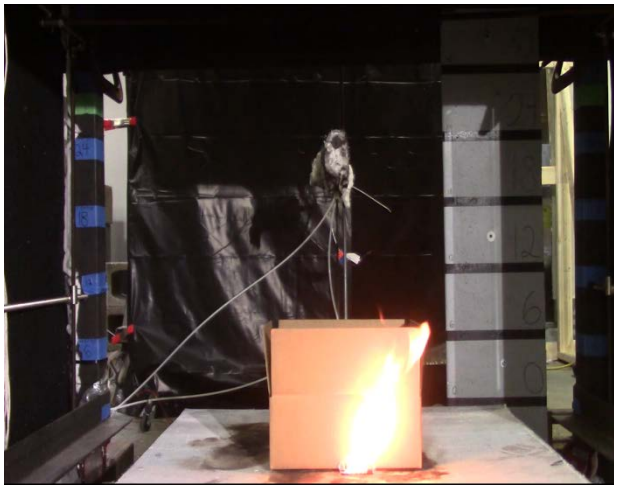
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 53

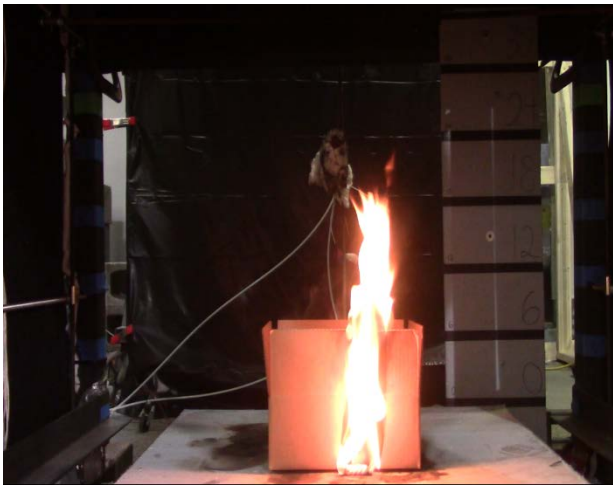
[1]From top of platform, [2]From center of platform











Test ID: 08_08_001a (EPRI) **Test Item: Metal Chair**

Max Fire Diameter (m): 0.41 Max Flame Height (m): 0.27

Peak HRR (kW): 14.3 Burning Duration (s): 1,383 Ignition Method: Flame

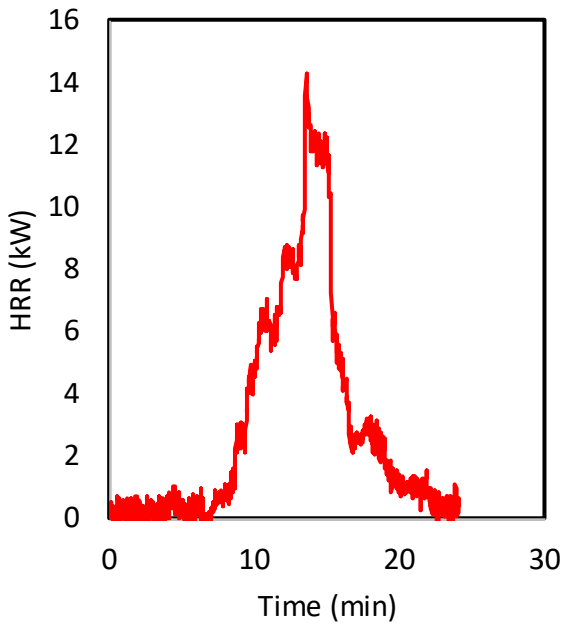
Heat of Combustion (MJ/kg): 15.7 Total Energy Release (MJ): 4.27

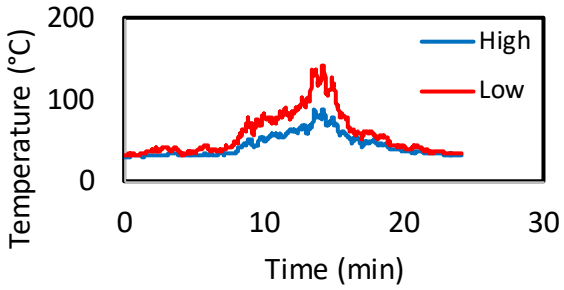
Soot Yield (kg/kg): 0.043 CO Yield (kg/kg): 0.035

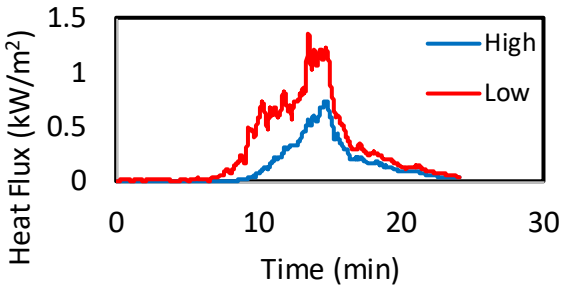
TC Grid Heights[1] (cm): 91, 122

HF Gauge Heights[1] (cm): 46, 84 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_08_001b (EPRI) **Test Item: Metal Chair**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.41

Peak HRR (kW): 15.5 Burning Duration (s): 1,614 Ignition Method: Flame

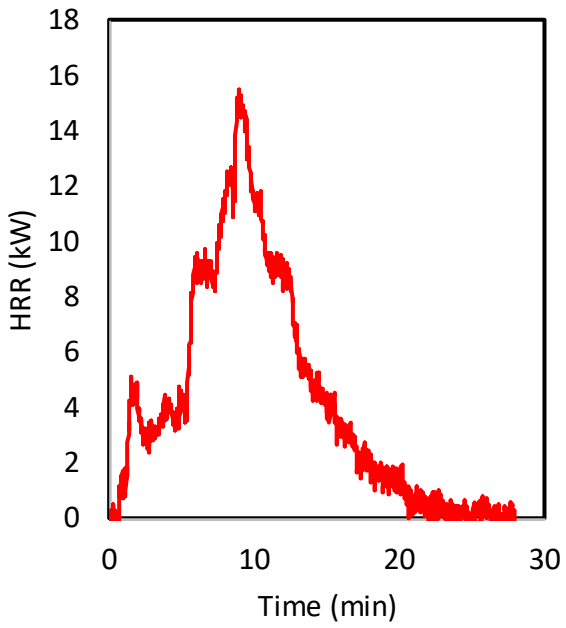
Heat of Combustion (MJ/kg): 31.1 Total Energy Release (MJ): 7.05

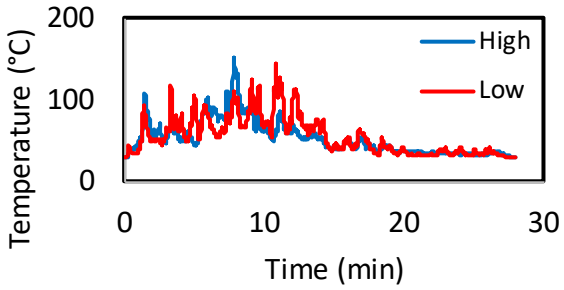
Soot Yield (kg/kg): 0.059 CO Yield (kg/kg): 0.039

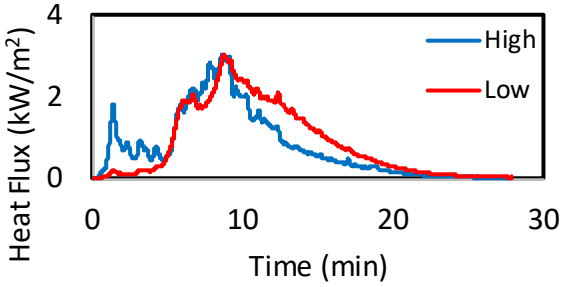
TC Grid Heights[1] (cm): 91, 122

HF Gauge Heights[1] (cm): 46, 84 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_008_02a (EPRI) **Test Item: Metal Chair**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.43

Peak HRR (kW): 13.6 Burning Duration (s): 775 Ignition Method: Flame

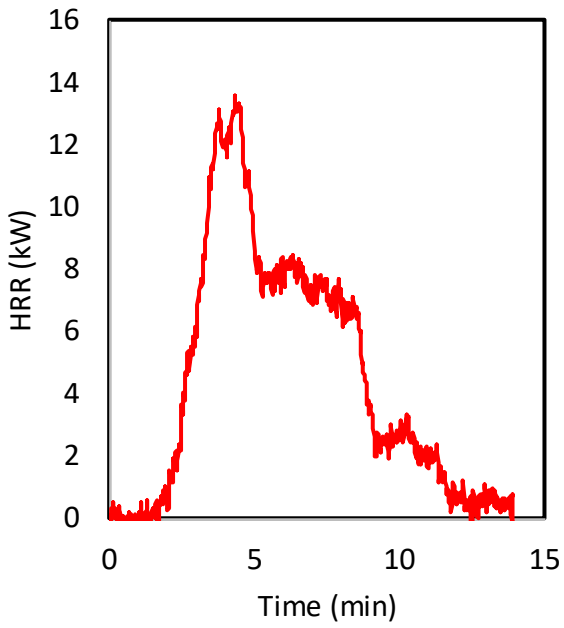
Heat of Combustion (MJ/kg): 16.4 Total Energy Release (MJ): 3.71

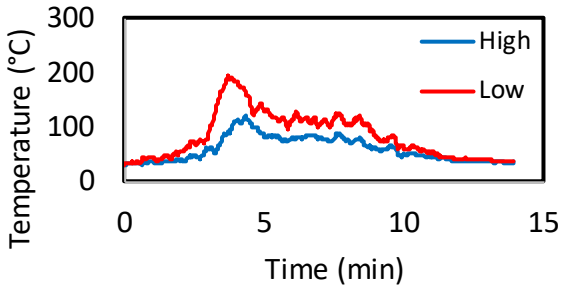
Soot Yield (kg/kg): 0.053 CO Yield (kg/kg): 0.032

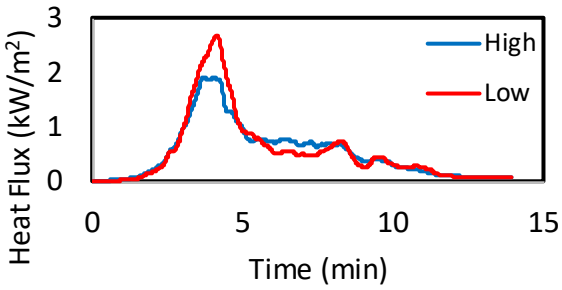
TC Grid Heights[1] (cm): 91, 122

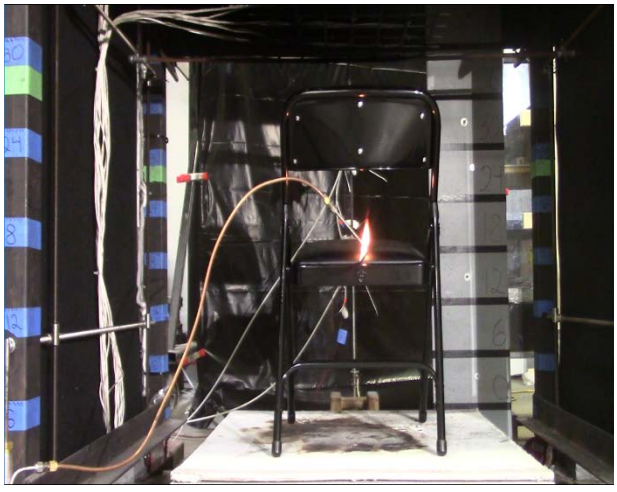
HF Gauge Heights[1] (cm): 46, 84 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 08_08_002b (EPRI) **Test Item: Metal Chair**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.39

Peak HRR (kW): 7.4 Burning Duration (s): 1,479 Ignition Method: Flame

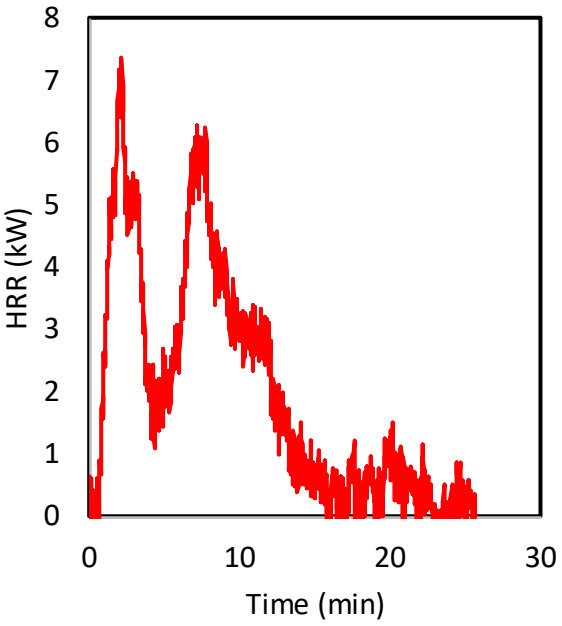
Heat of Combustion (MJ/kg): 26.3 Total Energy Release (MJ): 2.98

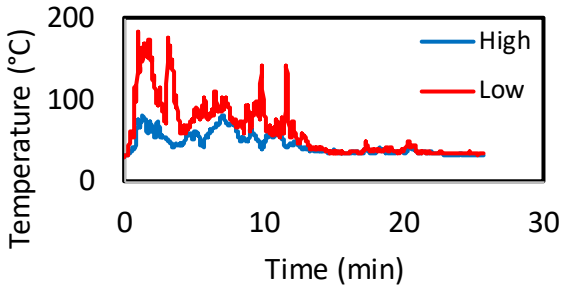
Soot Yield (kg/kg): 0.094 CO Yield (kg/kg): 0.044

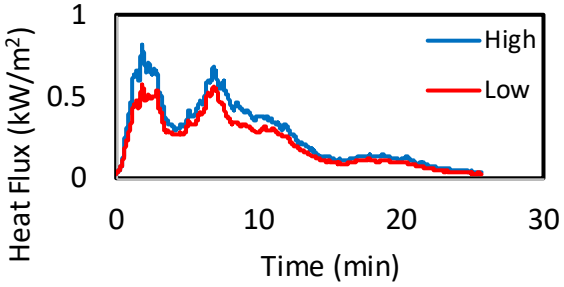
TC Grid Heights[1] (cm): 91, 122

HF Gauge Heights[1] (cm): 46, 23 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_08_003 (EPRI) **Test Item: Metal Chair**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.56

Peak HRR (kW): 23.2 Burning Duration (s): 1,203 Ignition Method: Flame

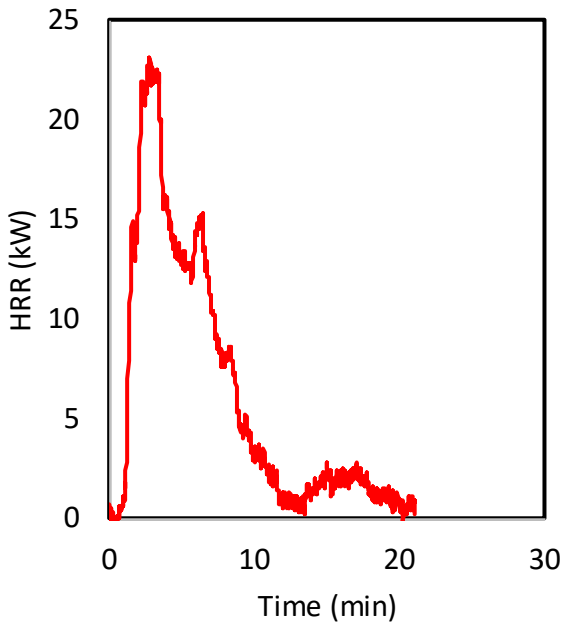
Heat of Combustion (MJ/kg): 22.6 Total Energy Release (MJ): 7.70

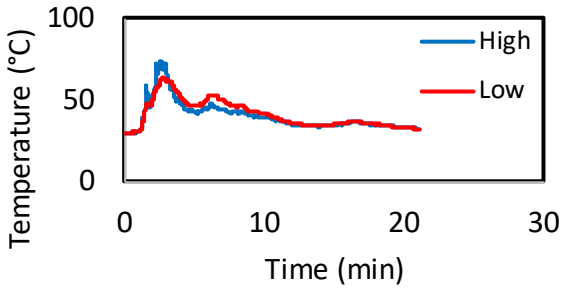
Soot Yield (kg/kg): 0.061 CO Yield (kg/kg): 0.072

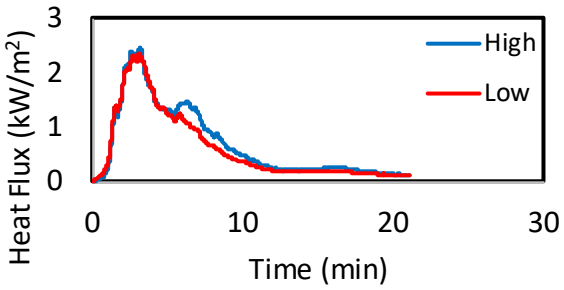
TC Grid Heights[1] (cm): 107, 122

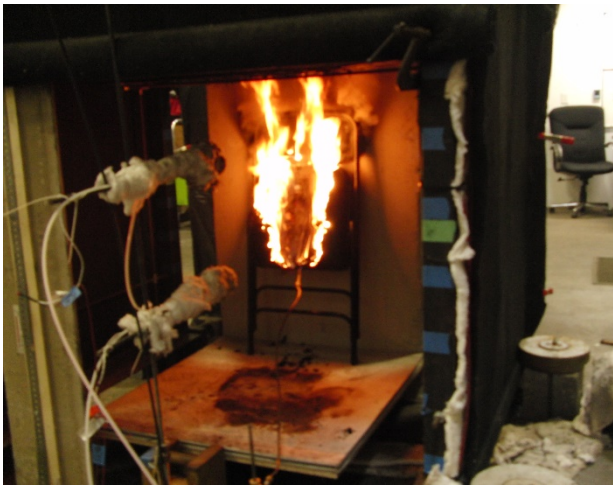
HF Gauge Heights[1] (cm): 46, 84 HF Gauge Distance[2] (cm): 63

[1]From top of platform, [2]From center of platform









Test ID: 08_08_004 (EPRI) **Test Item: First Aid Kit**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.43

Peak HRR (kW): 30.8 Burning Duration (s): 2,793 Ignition Method: Flame

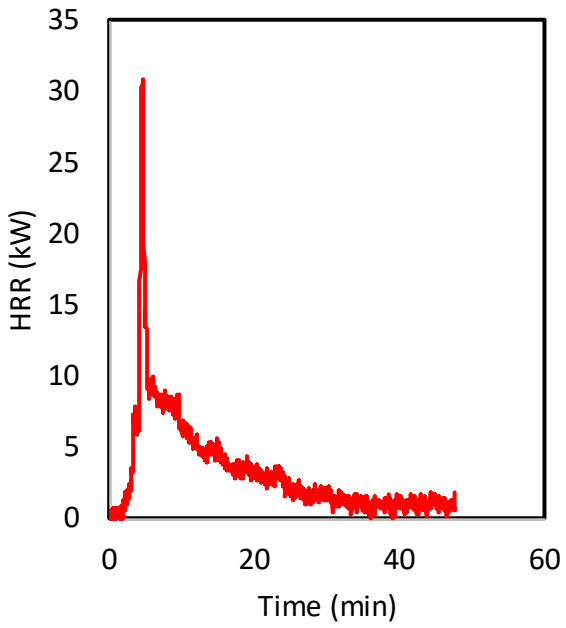
Heat of Combustion (MJ/kg): 23.0 Total Energy Release (MJ): 9.38

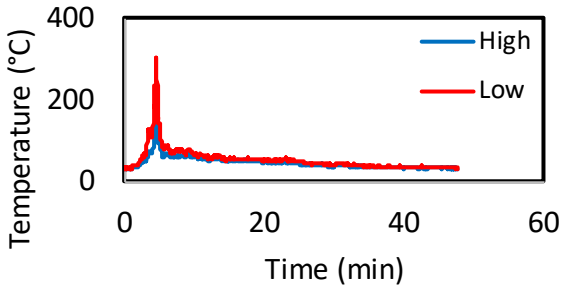
Soot Yield (kg/kg): 0.022 CO Yield (kg/kg): 0.025

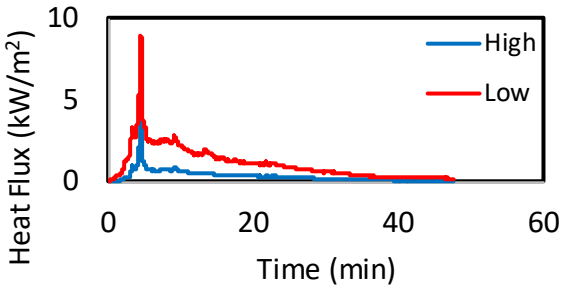
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 08_09_001 (EPRI) **Test Item: First Aid Kit**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.56

Peak HRR (kW): 14.8 Burning Duration (s): 3,969 Ignition Method: Flame

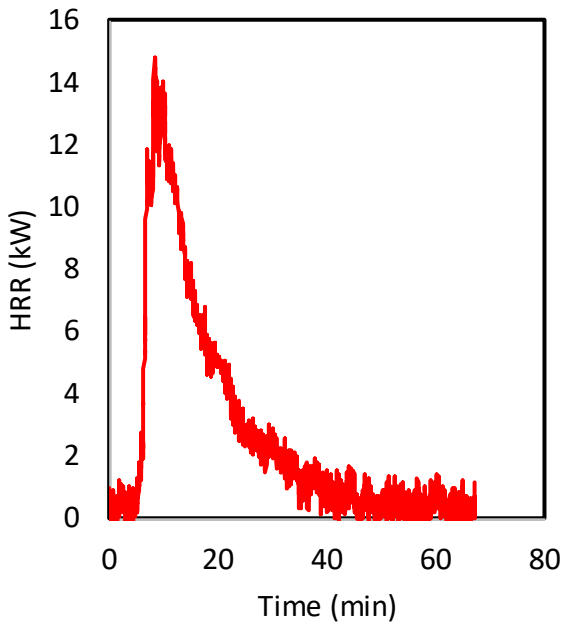
Heat of Combustion (MJ/kg): 27.4 Total Energy Release (MJ): 11.18

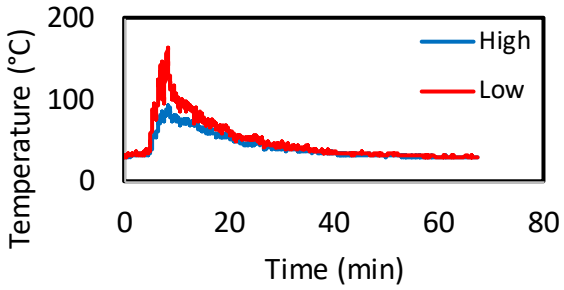
Soot Yield (kg/kg): 0.037 CO Yield (kg/kg): 0.033

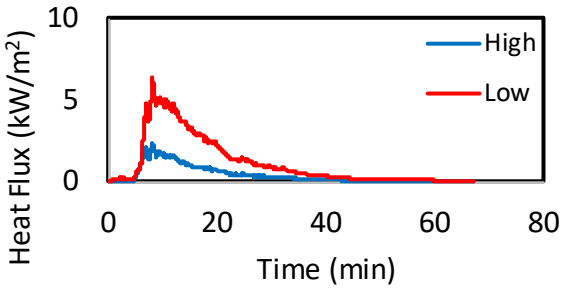
TC Grid Heights[1] (cm): 76, 122

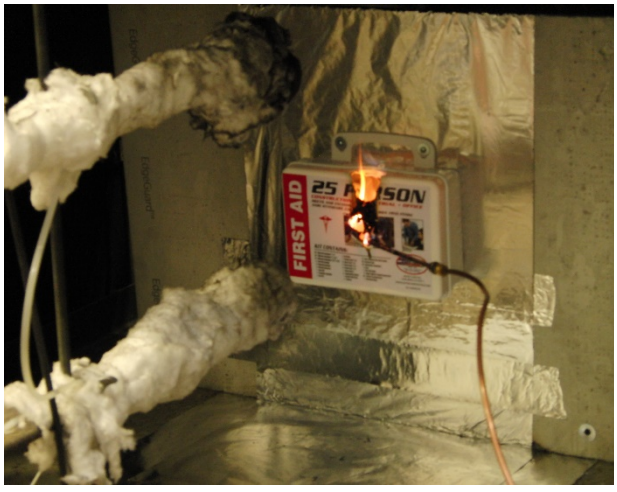
HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform









Test ID: 08_09_002 (EPRI) **Test Item: First Aid Kit**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.56

Peak HRR (kW): 14.8 Burning Duration (s): 4,122 Ignition Method: Flame

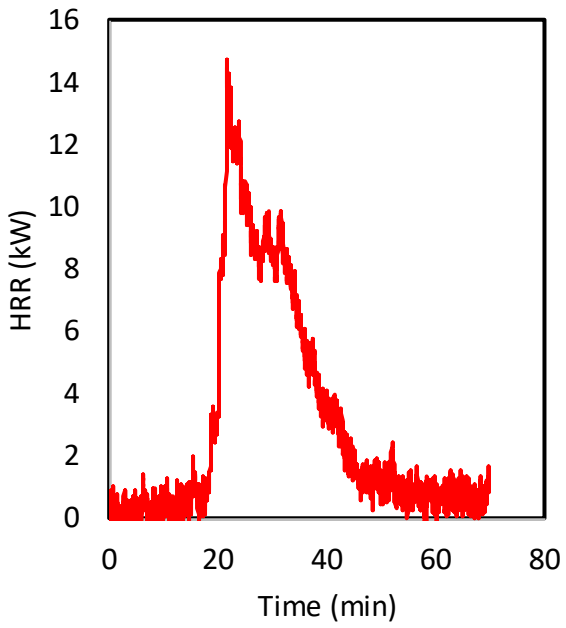
Heat of Combustion (MJ/kg): 25.5 Total Energy Release (MJ): 12.7

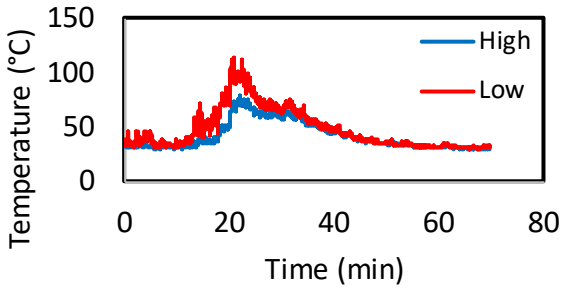
Soot Yield (kg/kg): 0.025 CO Yield (kg/kg): 0.022

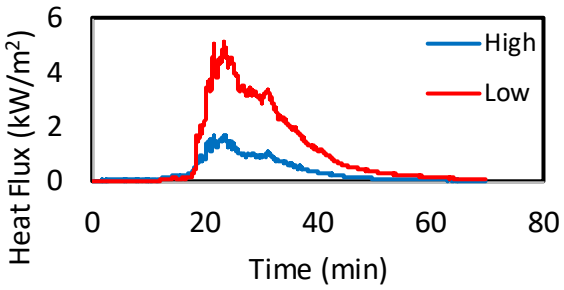
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 08_09_003 (EPRI) **Test Item: 15.2 m Coil Chain**

Max Fire Diameter (m): 0.08 Max Flame Height (m): 0.05

Peak HRR (kW): 1.7 Burning Duration (s): 3,932 Ignition Method: Flame

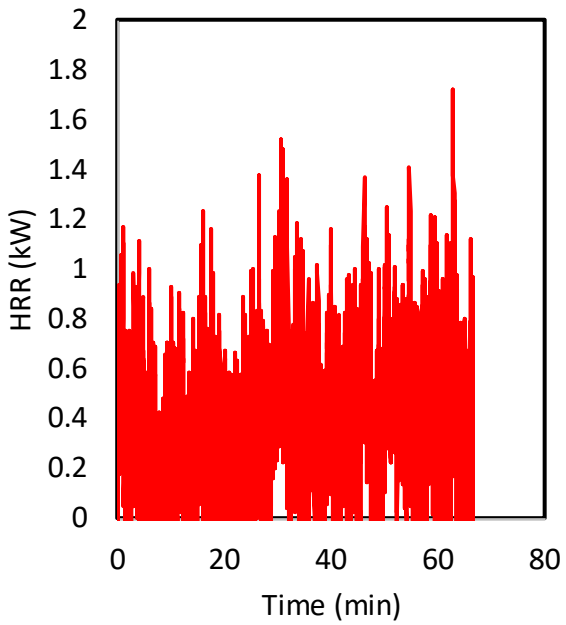
Heat of Combustion (MJ/kg): 33.2 Total Energy Release (MJ): 1.51

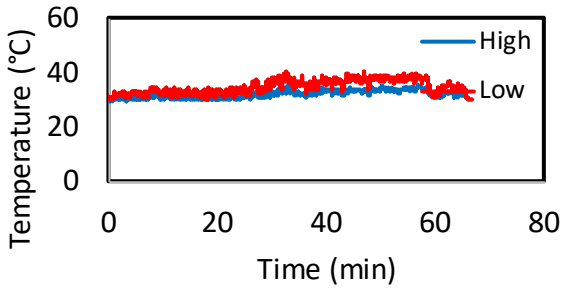
Soot Yield (kg/kg): 0.017 CO Yield (kg/kg): 0.019

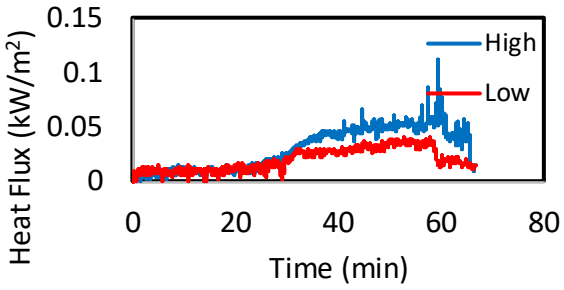
TC Grid Heights[1] (cm): 76, 122

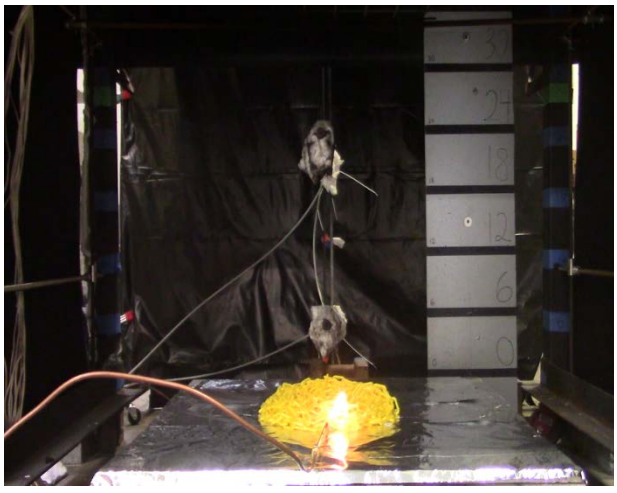
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 08_13_002 (EPRI) **Test Item: 15.2 m Coil Chain**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.09

Peak HRR (kW): 1.1 Burning Duration (s): 4,060 Ignition Method: Flame

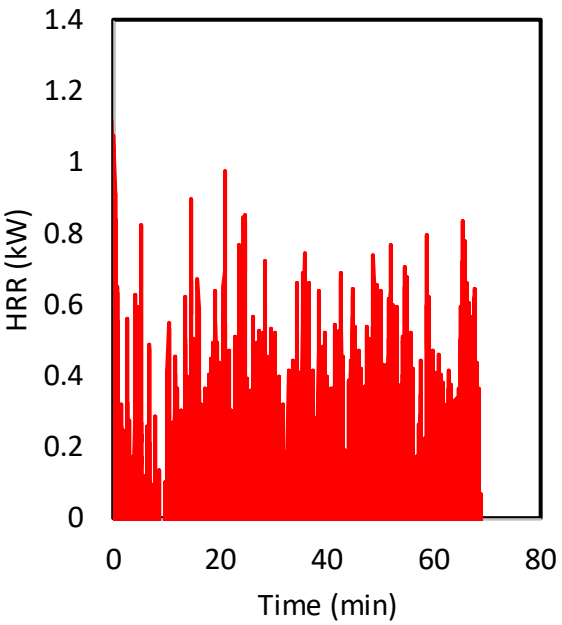
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.16

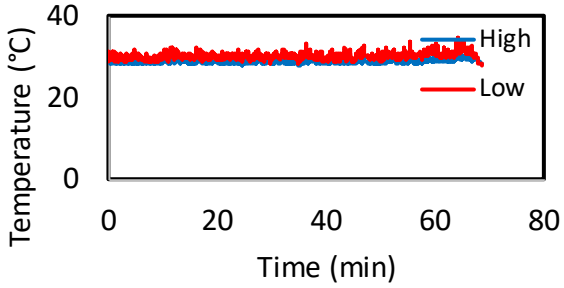
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

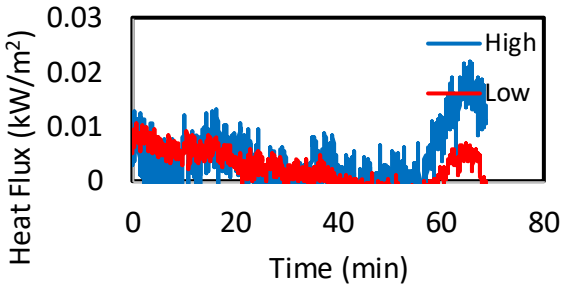
TC Grid Heights[1] (cm): 76, 122

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 53

[1]From top of platform, [2]From center of platform







Test ID: 08_14_002 (EPRI) **Test Item: 4 Cones**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.22

Peak HRR (kW): 15.8 Burning Duration (s): 5,400 Ignition Method: Flame

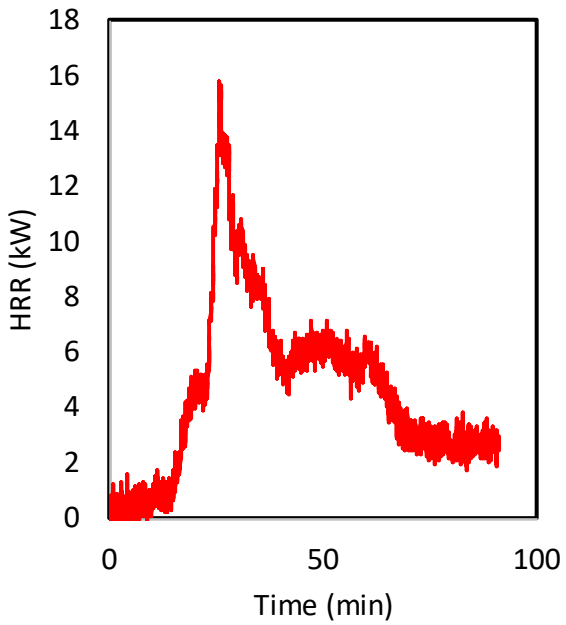
Heat of Combustion (MJ/kg): 18.4 Total Energy Release (MJ): 25.06

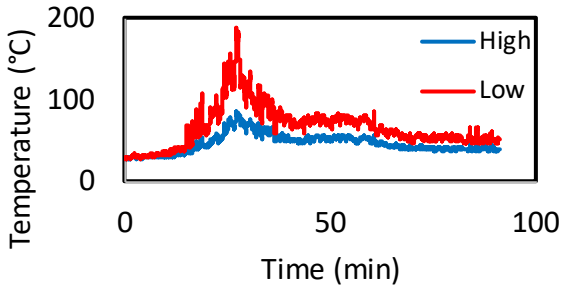
Soot Yield (kg/kg): 0.122 CO Yield (kg/kg): 0.065

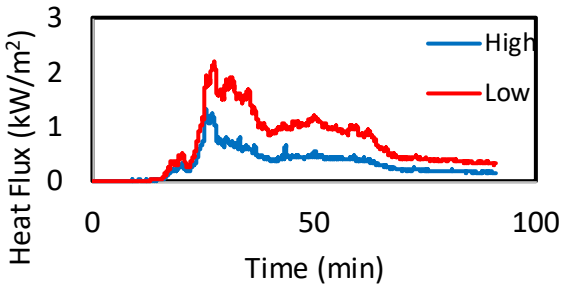
TC Grid Heights[1] (cm): 76, 122

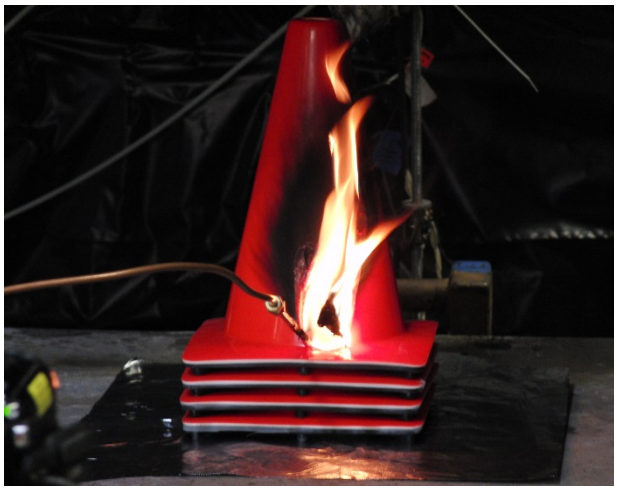
HF Gauge Heights[1] (cm): 38, 76 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 08_15_001 (EPRI) **Test Item: 4 Cones**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.48

Peak HRR (kW): 5.2 Burning Duration (s): 3,326 Ignition Method: Flame

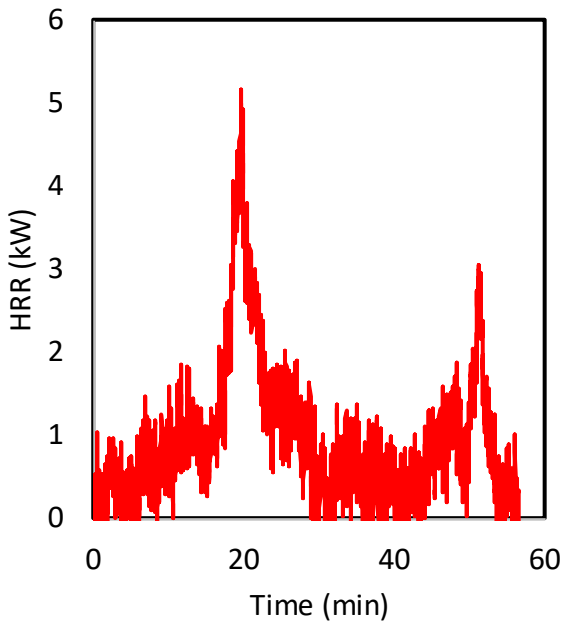
Heat of Combustion (MJ/kg): 15.6 Total Energy Release (MJ): 3.19

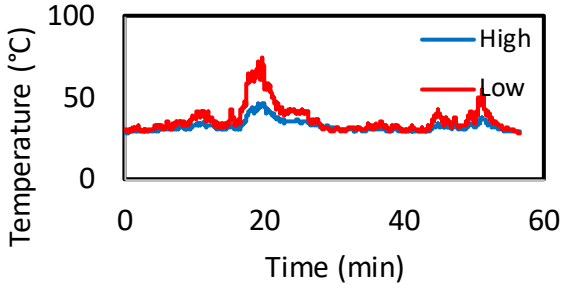
Soot Yield (kg/kg): 0.101 CO Yield (kg/kg): 0.056

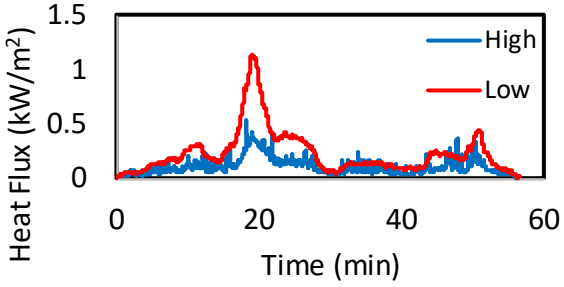
TC Grid Heights[1] (cm): 76, 122

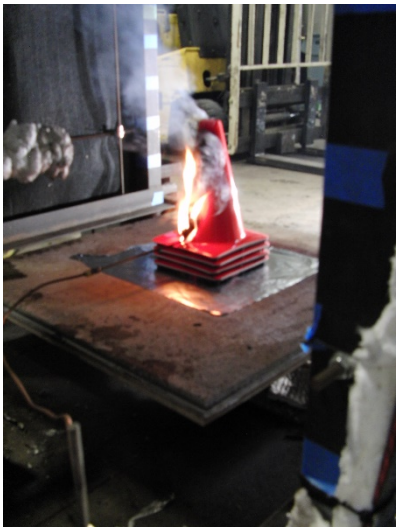
HF Gauge Heights[1] (cm): 38, 76 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 08_15_002 (EPRI) **Test Item: 4 Cones**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.65

Peak HRR (kW): 16.5 Burning Duration (s): 5,240 Ignition Method: Flame

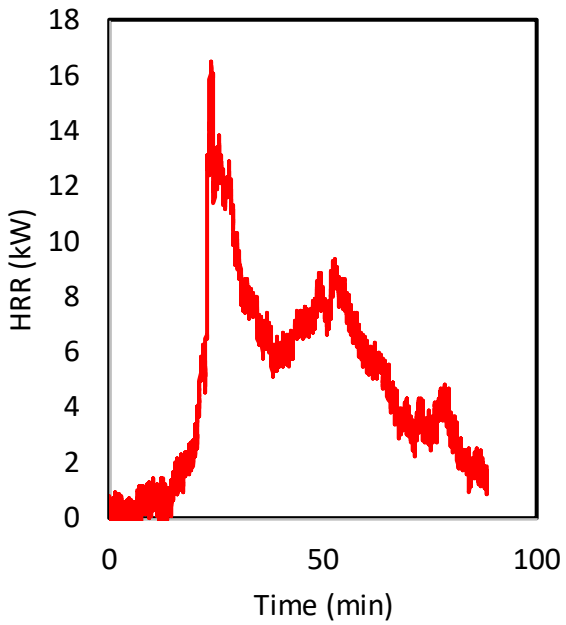
Heat of Combustion (MJ/kg): 17.7 Total Energy Release (MJ): 26.04

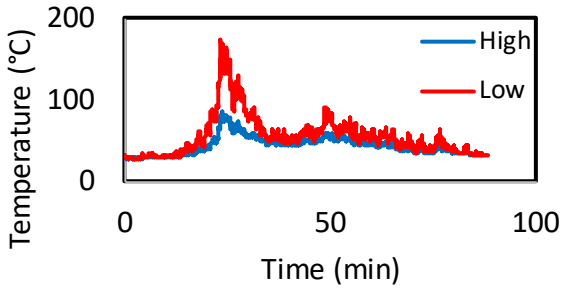
Soot Yield (kg/kg): 0.099 CO Yield (kg/kg): 0.063

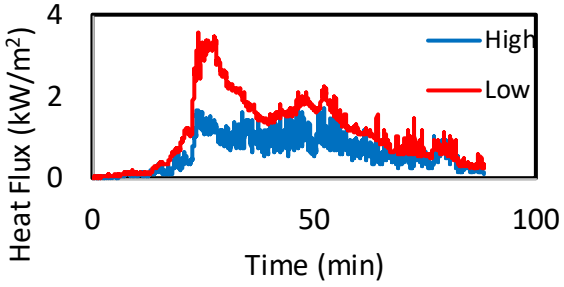
TC Grid Heights[1] (cm): 76, 122

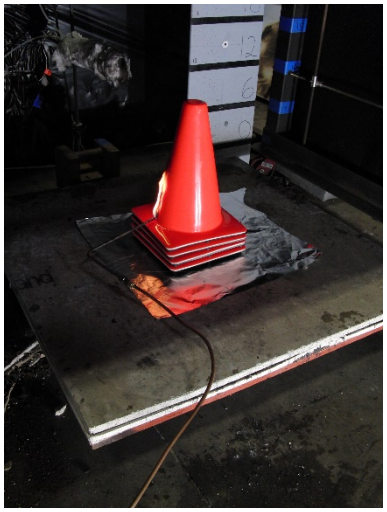
HF Gauge Heights[1] (cm): 38, 76 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 08_15_003 (EPRI) **Test Item: HVAC Filter**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.44

Peak HRR (kW): 19.3 Burning Duration (s): 293 Ignition Method: Wick

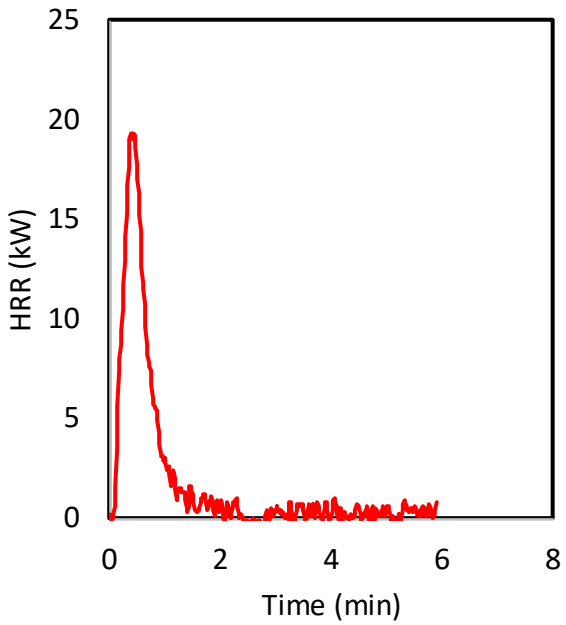
Heat of Combustion (MJ/kg): 30.3 Total Energy Release (MJ): 0.69

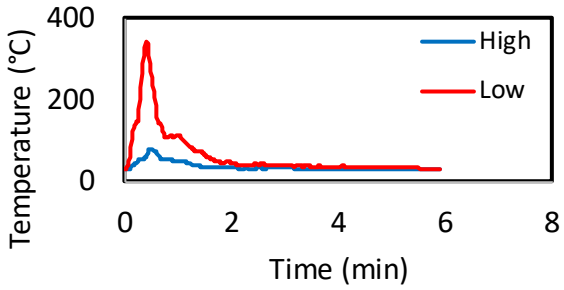
Soot Yield (kg/kg): 0.033 CO Yield (kg/kg): 0.019

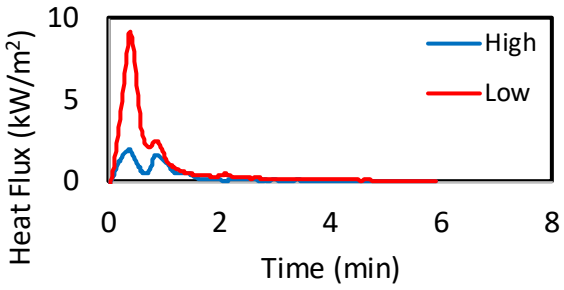
TC Grid Heights[1] (cm): 30, 76

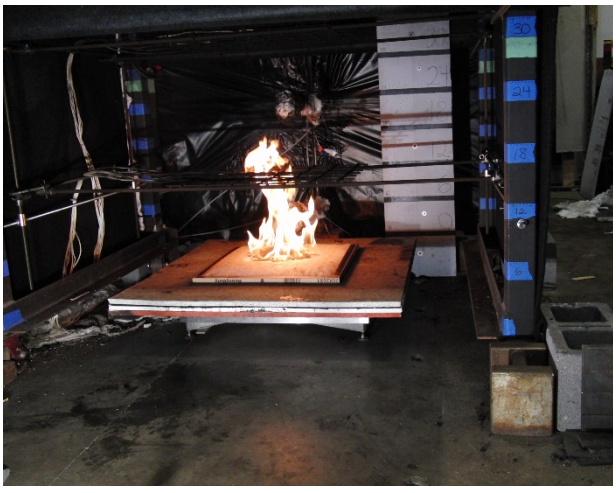
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 27

[1]From top of platform, [2]From center of platform









Test ID: 08_15_004 (EPRI) **Test Item: HVAC Filter**

Max Fire Diameter (m): 0.38 Max Flame Height (m): 0.42

Peak HRR (kW): 20.0 Burning Duration (s): 945 Ignition Method: Wick

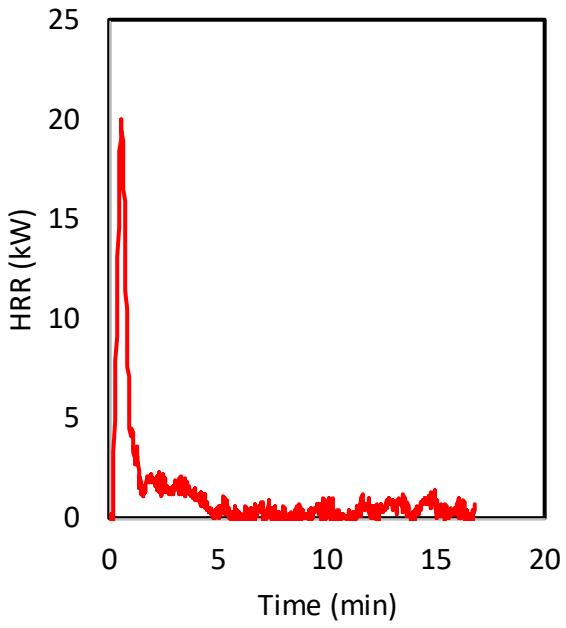
Heat of Combustion (MJ/kg): 26.1 Total Energy Release (MJ): 1.18

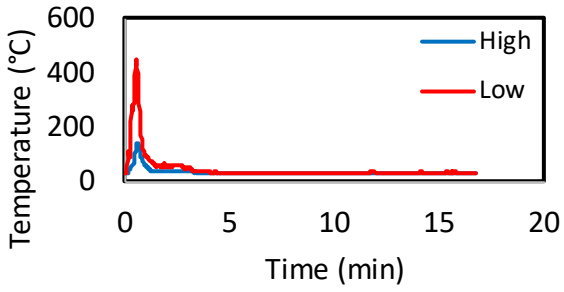
Soot Yield (kg/kg): 0.018 CO Yield (kg/kg): 0.041

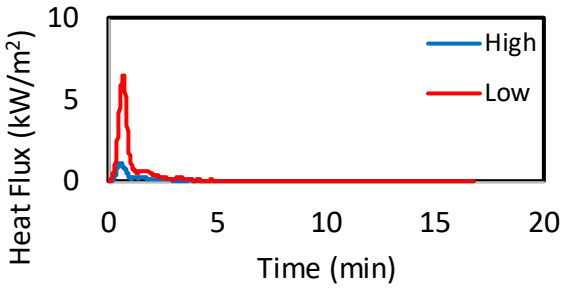
TC Grid Heights[1] (cm): 30, 76

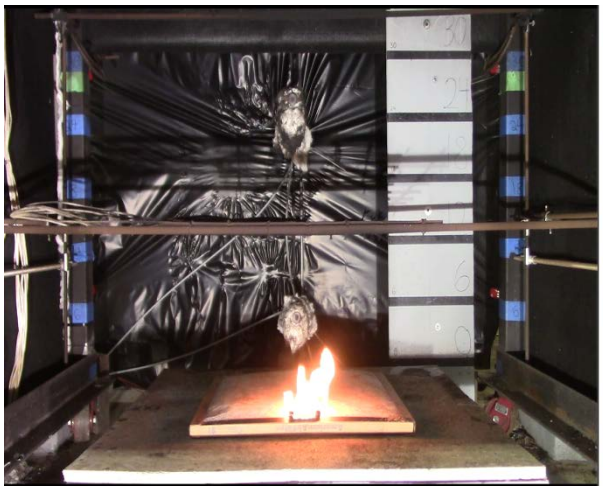
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 27

[1]From top of platform, [2]From center of platform









Test ID: 08_15_005 (EPRI) **Test Item: HVAC Filter**

Max Fire Diameter (m): 0.38 Max Flame Height (m): 0.31

Peak HRR (kW): 13.5 Burning Duration (s): 461 Ignition Method: Wick

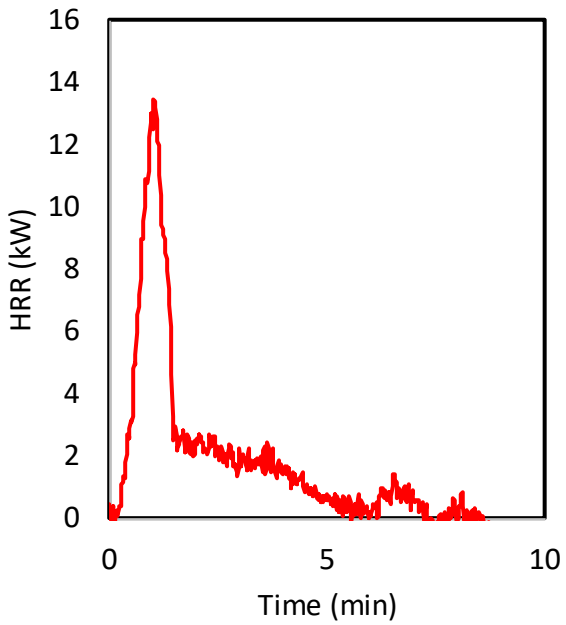
Heat of Combustion (MJ/kg): 22.0 Total Energy Release (MJ): 1.00

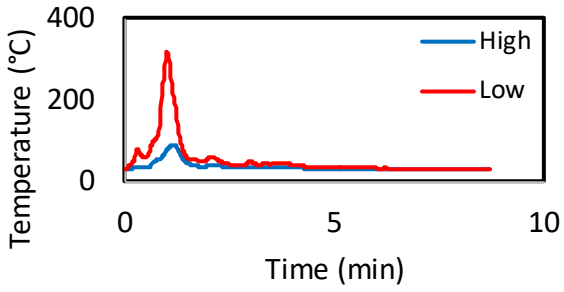
Soot Yield (kg/kg): 0.016 CO Yield (kg/kg): 0.037

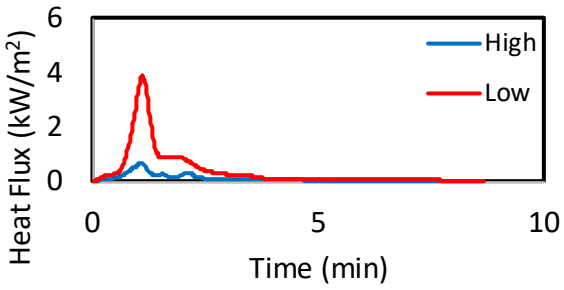
TC Grid Heights[1] (cm): 30, 76

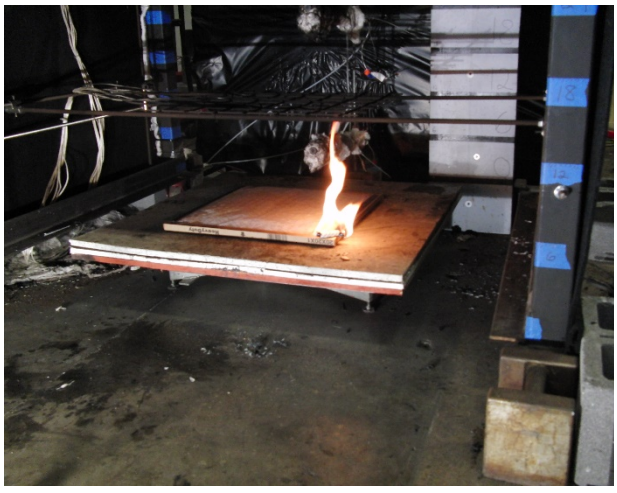
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 27

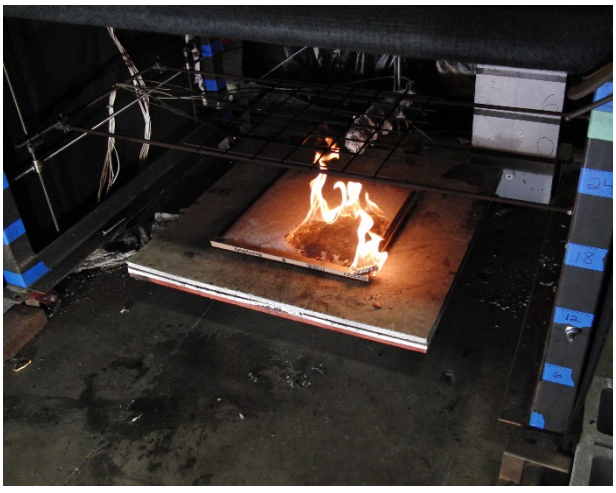
[1]From top of platform, [2]From center of platform











Test ID: 08_16_001 (EPRI) **Test Item: Uncoiled Small Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 3.0 Burning Duration (s): 531 Ignition Method: Wick

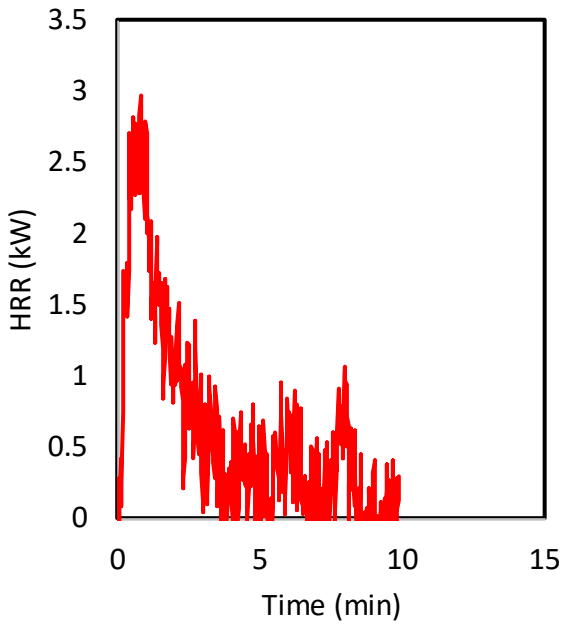
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.36

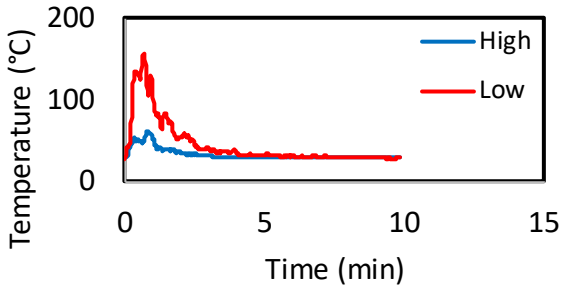
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

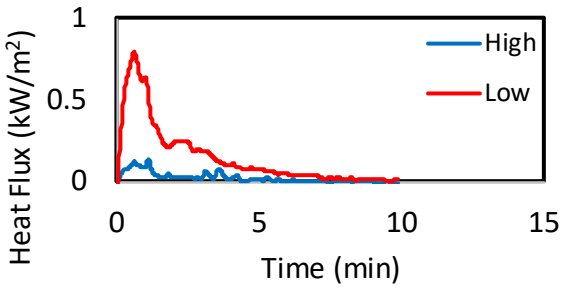
TC Grid Heights[1] (cm): 30, 76

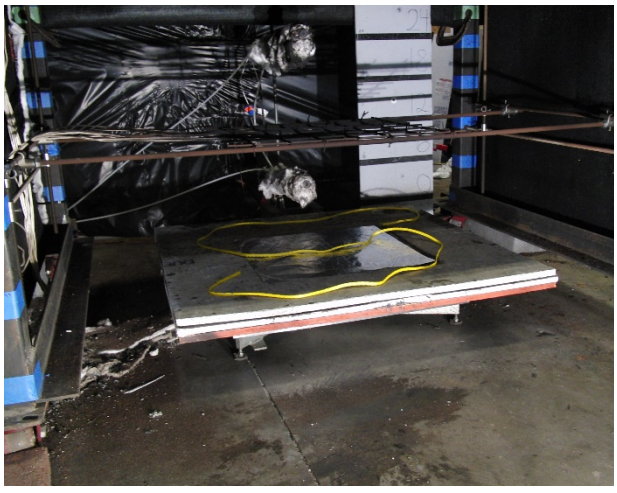
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

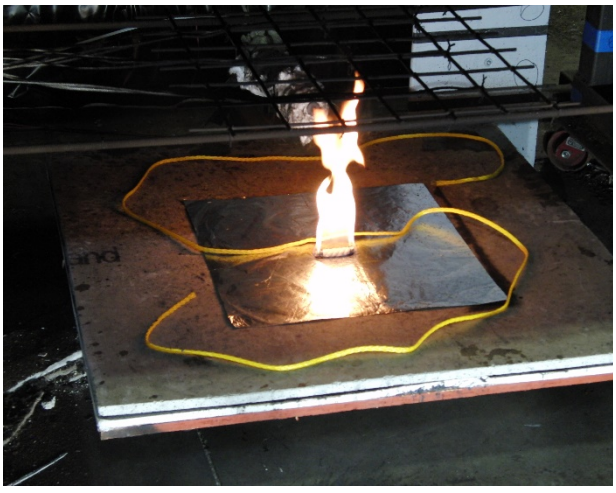
[1]From top of platform, [2]From center of platform











Test ID: 08_16_002 (EPRI) **Test Item: Uncoiled Small Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 2.9 Burning Duration (s): 270 Ignition Method: Wick

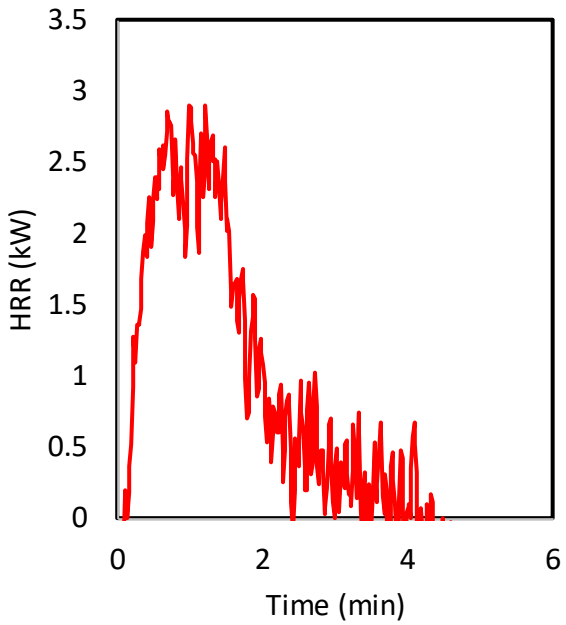
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.23

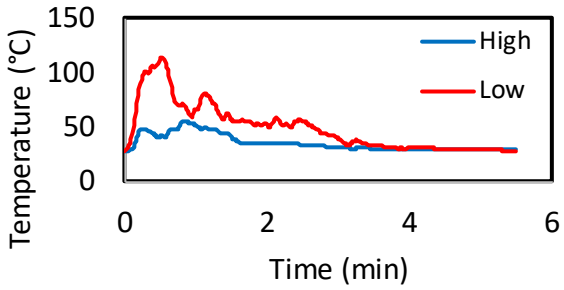
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

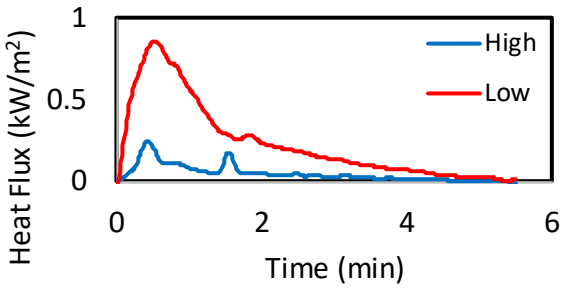
TC Grid Heights[1] (cm): 30, 76

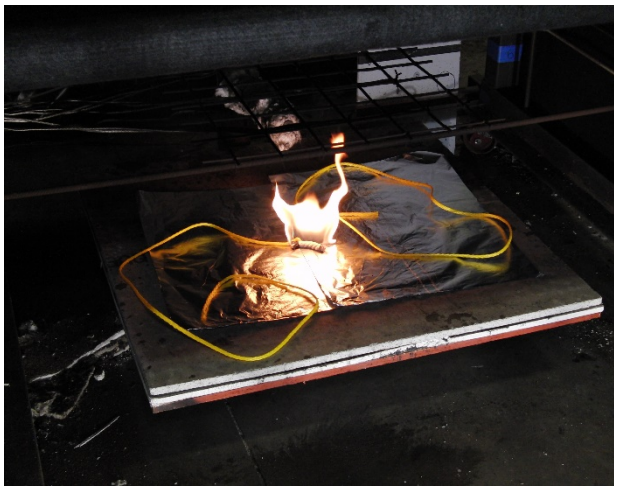
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

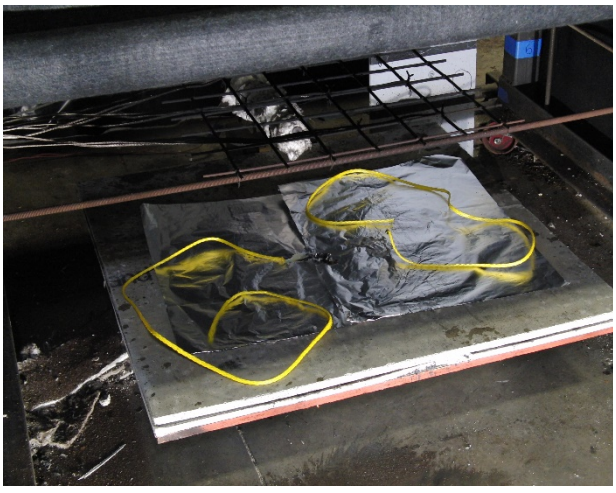
[1]From top of platform, [2]From center of platform











Test ID: 08_16_003 (EPRI) **Test Item: Uncoiled Small Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 3.6 Burning Duration (s): 761 Ignition Method: Wick

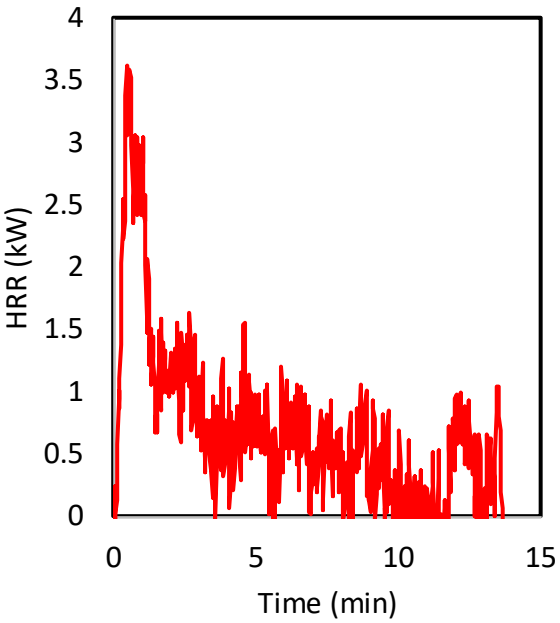
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.56

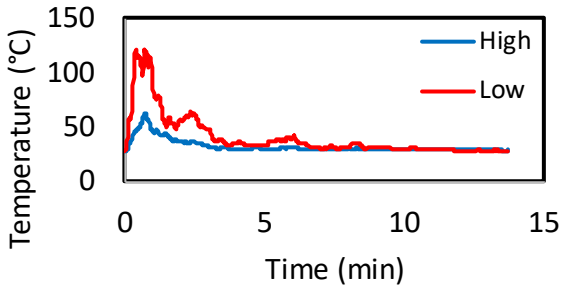
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

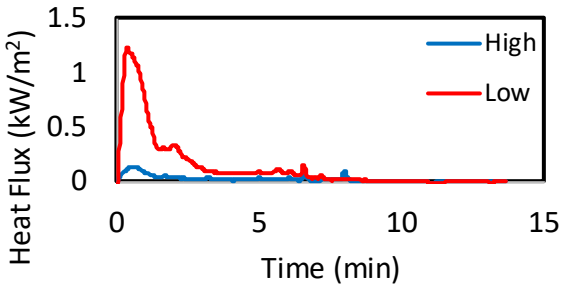
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_16_004 (EPRI) **Test Item: 7.6 m Coil Small Rope**

Max Fire Diameter (m): 0.28 Max Flame Height (m): 0.11

Peak HRR (kW): 2.8 Burning Duration (s): 1,289 Ignition Method: Wick

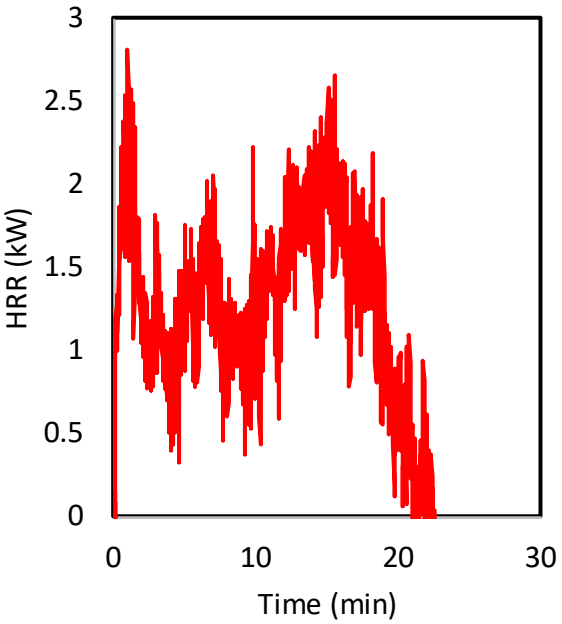
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 1.73

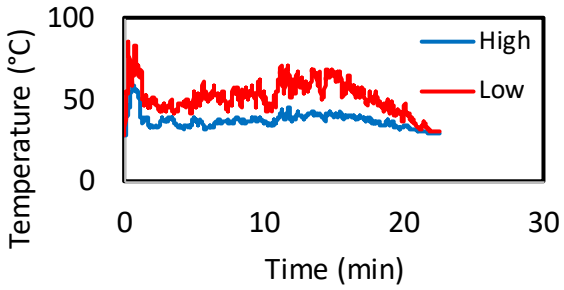
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

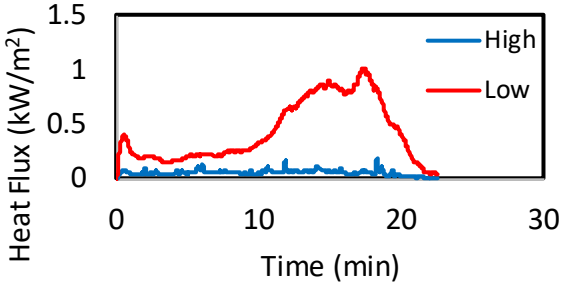
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_20_001 (EPRI) **Test Item: 7.6 m Coil Small Rope**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.22

Peak HRR (kW): 4.0 Burning Duration (s): 1,190 Ignition Method: Wick

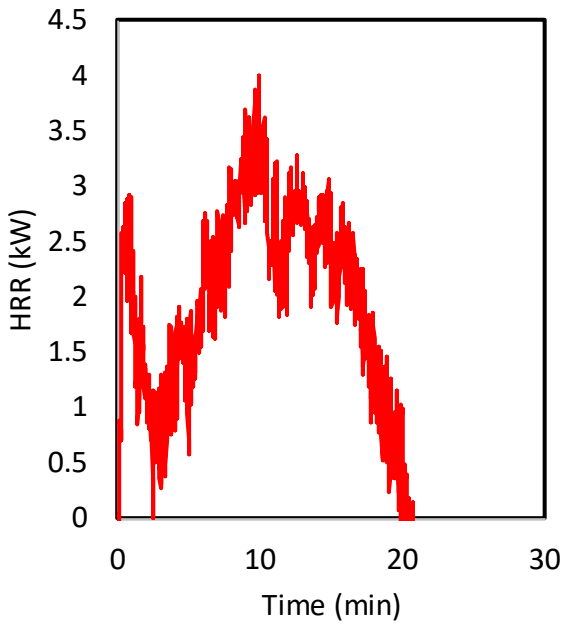
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 2.43

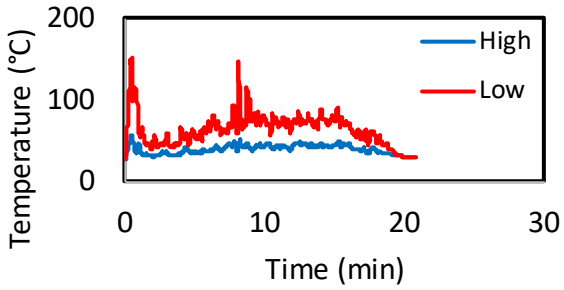
Soot Yield (kg/kg): 0.024 CO Yield (kg/kg): 0.013

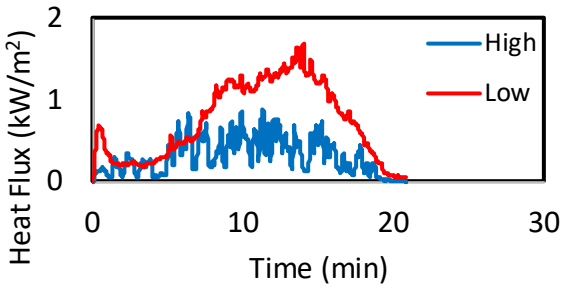
TC Grid Heights[1] (cm): 30, 76

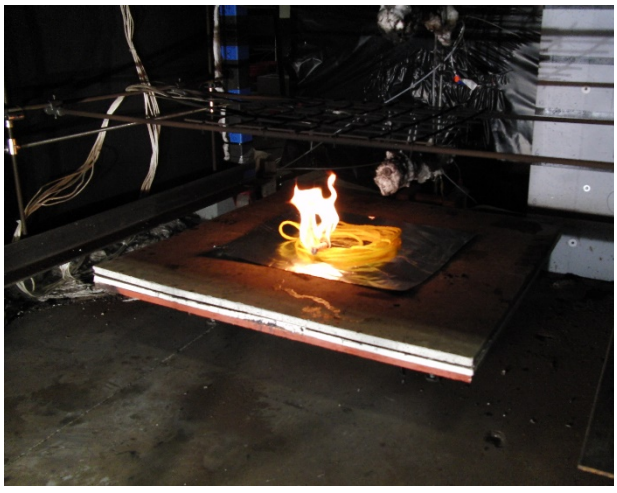
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_20_002 (EPRI) **Test Item: 7.6 m Coil Small Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.24

Peak HRR (kW): 4.5 Burning Duration (s): 980 Ignition Method: Wick

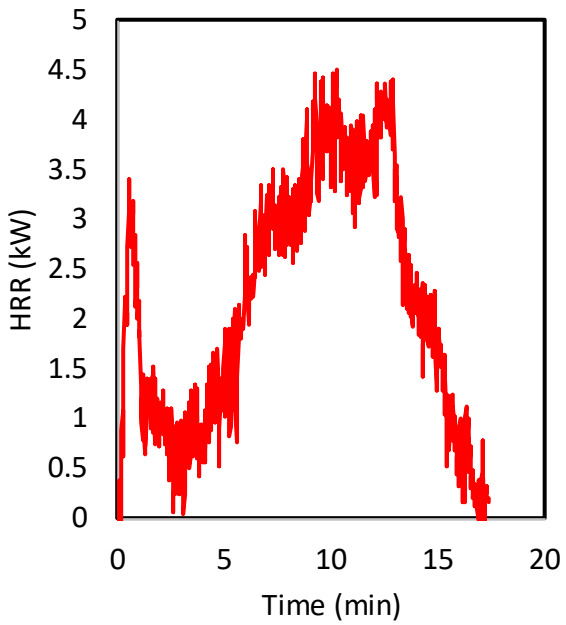
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 2.25

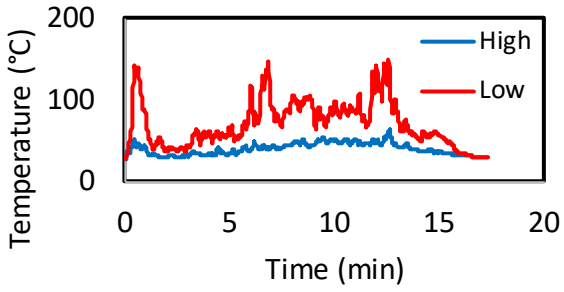
Soot Yield (kg/kg): 0.037 CO Yield (kg/kg): 0.012

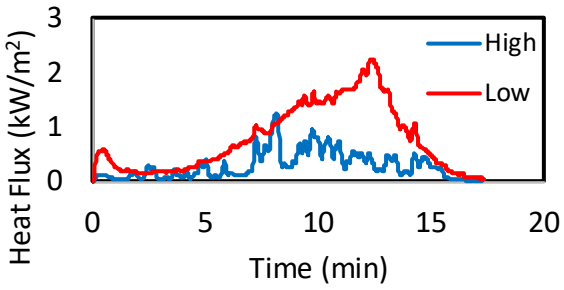
TC Grid Heights[1] (cm): 30, 76

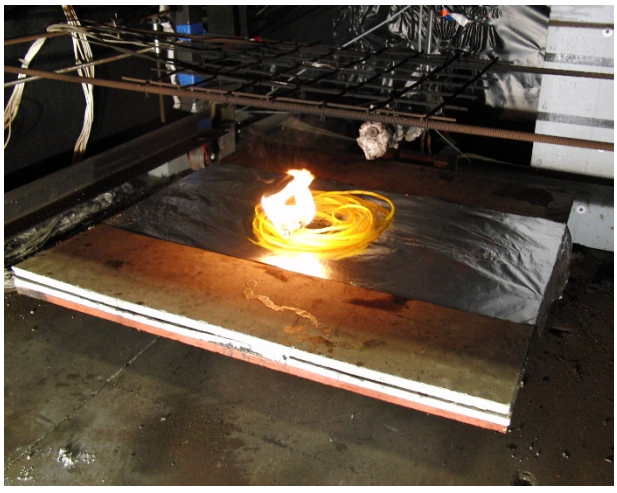
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

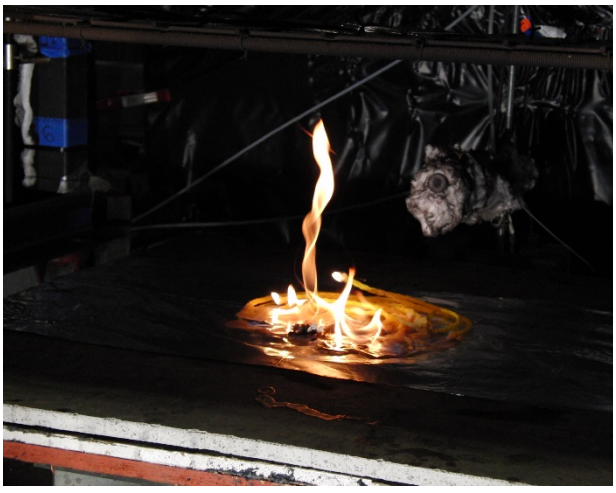
[1]From top of platform, [2]From center of platform











Test ID: 08_20_003 (EPRI) **Test Item: 15.2 m Coil Small Rope**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.29

Peak HRR (kW): 9.5 Burning Duration (s): 1,452 Ignition Method: Wick

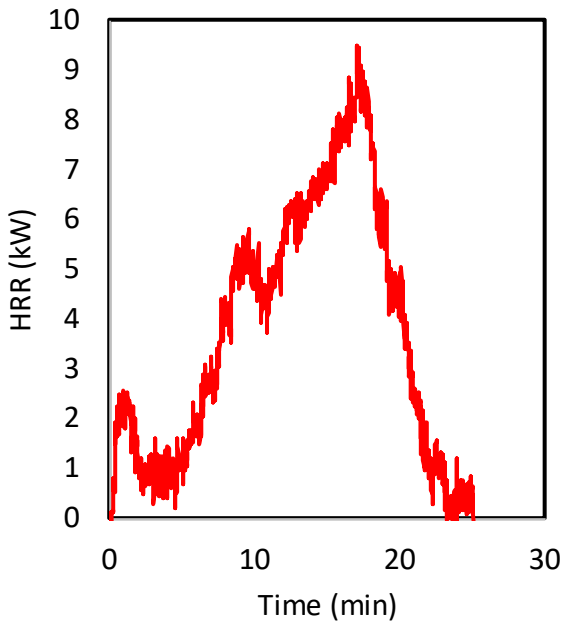
Heat of Combustion (MJ/kg): 44.3 Total Energy Release (MJ): 5.63

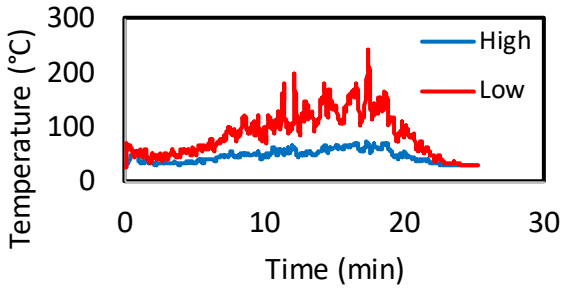
Soot Yield (kg/kg): 0.055 CO Yield (kg/kg): 0.014

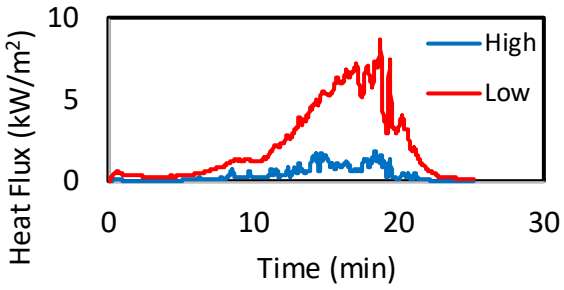
TC Grid Heights[1] (cm): 30, 76

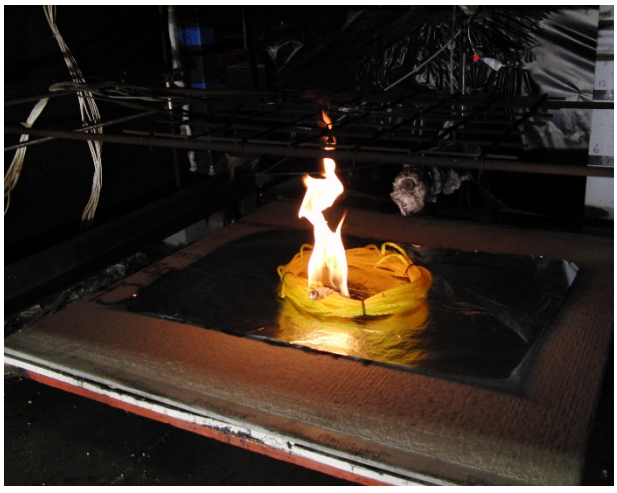
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_20_004 (EPRI) **Test Item: 15.2 m Coil Small Rope**

Max Fire Diameter (m): 0.28 Max Flame Height (m): 0.33

Peak HRR (kW): 13.4 Burning Duration (s): 1,054 Ignition Method: Wick

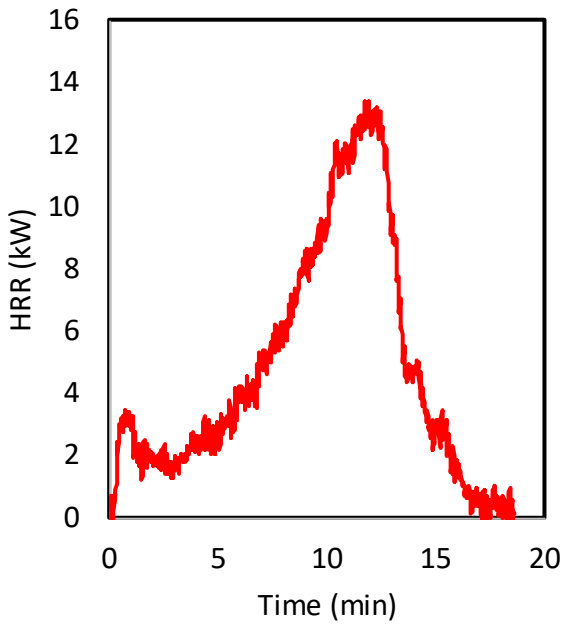
Heat of Combustion (MJ/kg): 39.0 Total Energy Release (MJ): 5.31

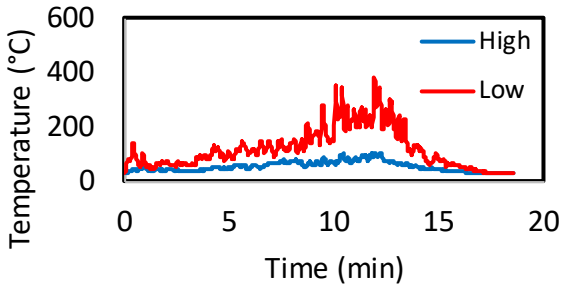
Soot Yield (kg/kg): 0.056 CO Yield (kg/kg): 0.013

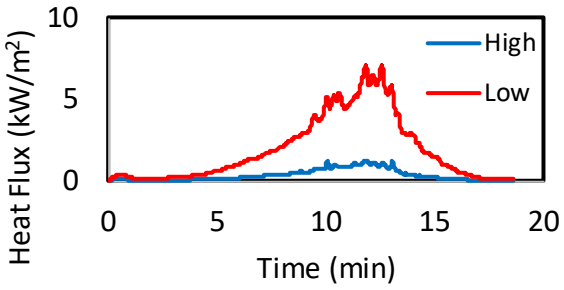
TC Grid Heights[1] (cm): 30, 76

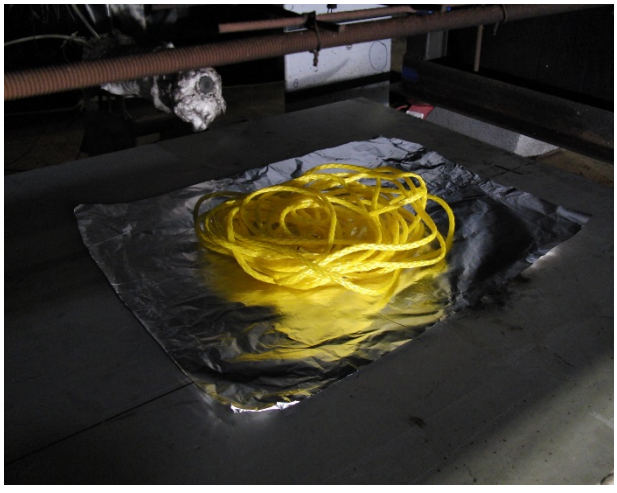
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 28

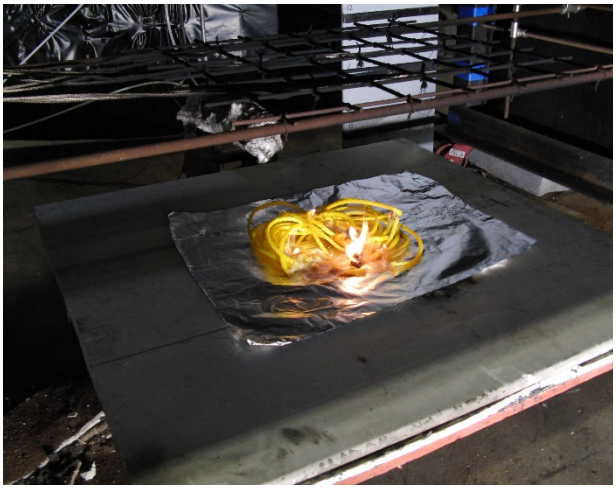
[1]From top of platform, [2]From center of platform











Test ID:08_20_005 (EPRI) **Test Item: 15.2 m Coil Small Rope**

Max Fire Diameter (m): 0.31 Max Flame Height (m): 0.42

Peak HRR (kW): 14.8 Burning Duration (s): 909 Ignition Method: Wick

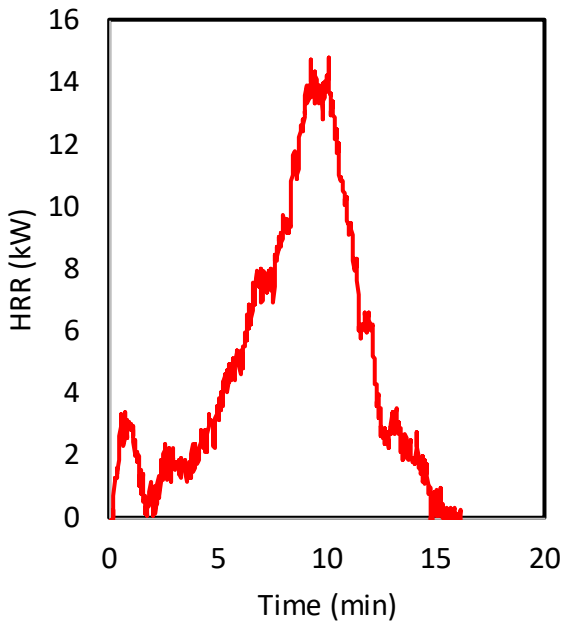
Heat of Combustion (MJ/kg): 41.3 Total Energy Release (MJ): 4.77

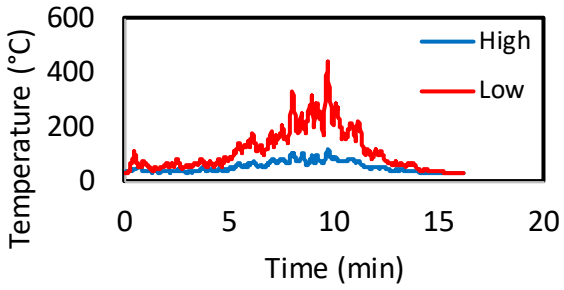
Soot Yield (kg/kg): 0.061 CO Yield (kg/kg): 0.015

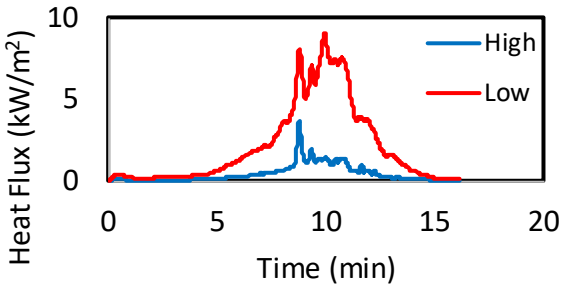
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 28

[1]From top of platform, [2]From center of platform







Test ID: 08_21_001 (EPRI) **Test Item: Uncoiled Large Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.31

Peak HRR (kW): 3.2 Burning Duration (s): 395 Ignition Method: Wick

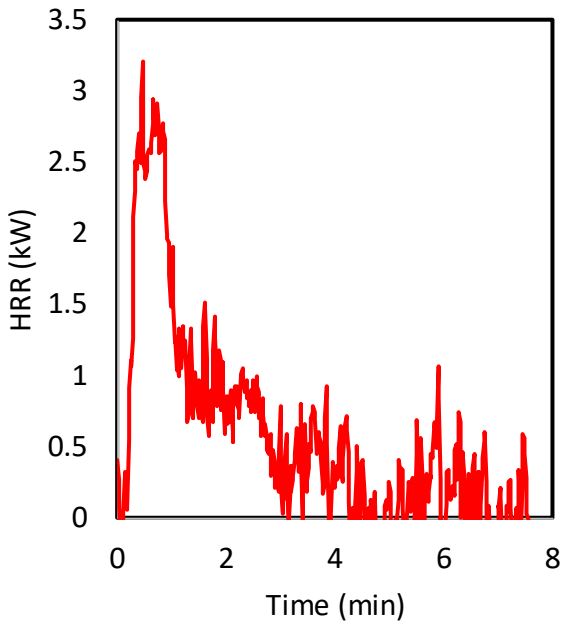
Heat of Combustion (MJ/kg): 31.0 Total Energy Release (MJ): 0.26

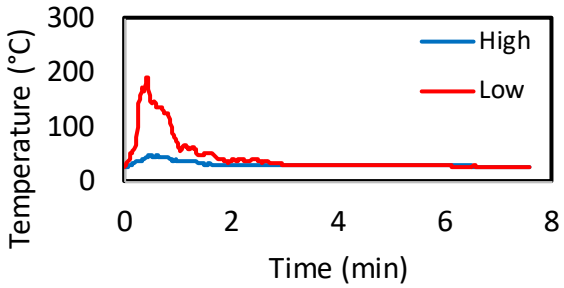
Soot Yield (kg/kg): 0.027 CO Yield (kg/kg): 0.005

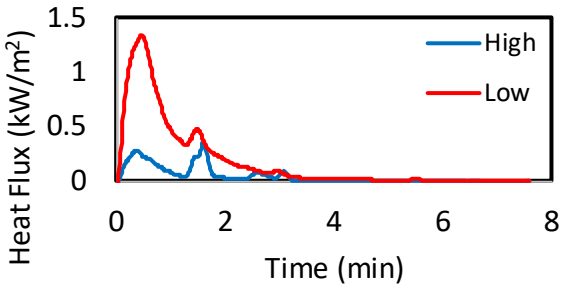
TC Grid Heights[1] (cm): 30, 76

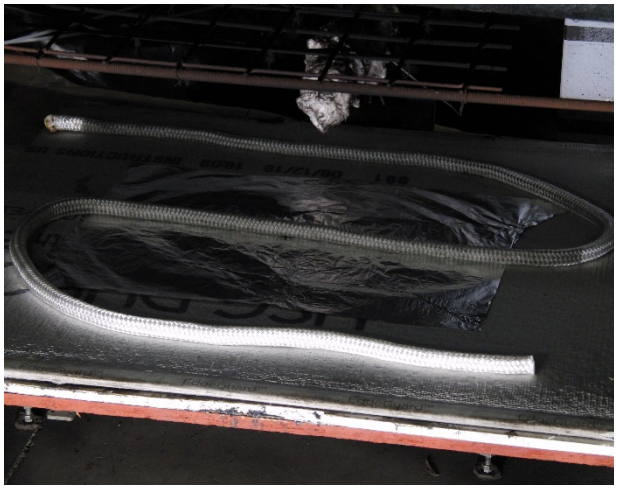
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_21_002 (EPRI) **Test Item: Uncoiled Large Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.20

Peak HRR (kW): 2.8 Burning Duration (s): 294 Ignition Method: Wick

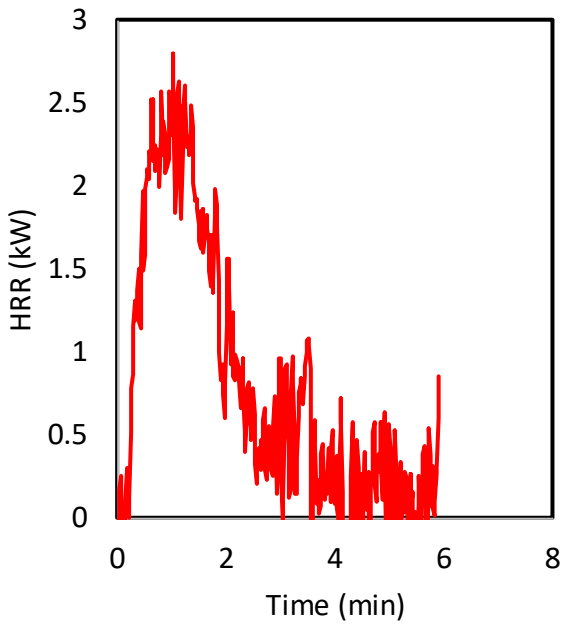
Heat of Combustion (MJ/kg): 41.9 Total Energy Release (MJ): 0.28

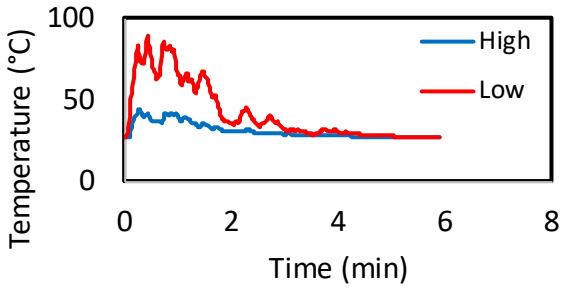
Soot Yield (kg/kg): 0.019 CO Yield (kg/kg): 0.000

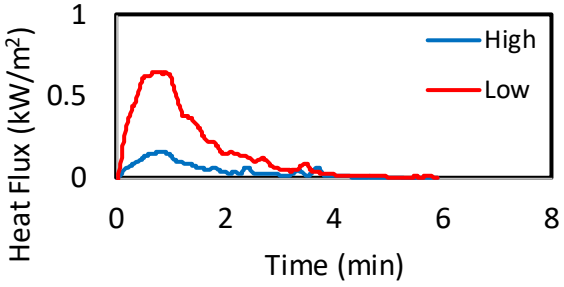
TC Grid Heights[1] (cm): 30, 76

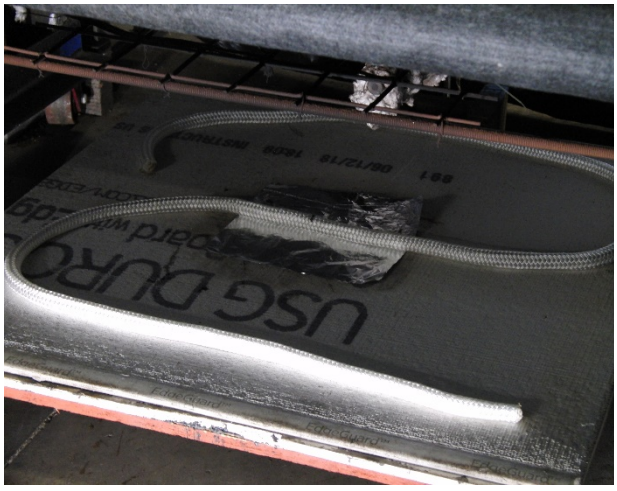
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_21_003 (EPRI) **Test Item: Uncoiled Large Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.20

Peak HRR (kW): 2.7 Burning Duration (s): 854 Ignition Method: Wick

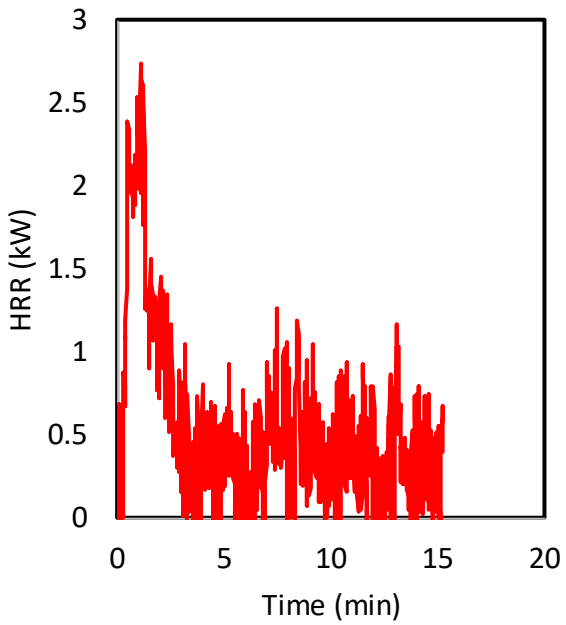
Heat of Combustion (MJ/kg): 36.8 Total Energy Release (MJ): 0.50

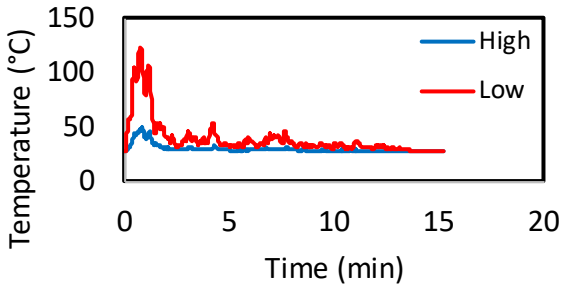
Soot Yield (kg/kg): 0.016 CO Yield (kg/kg): 0.000

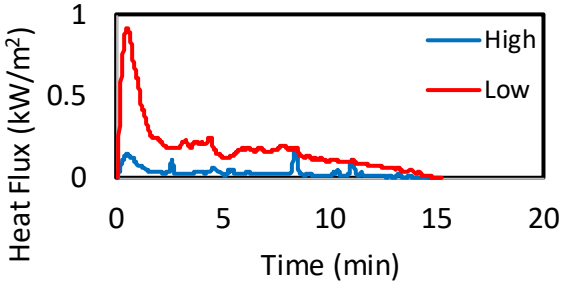
TC Grid Heights[1] (cm): 30, 76

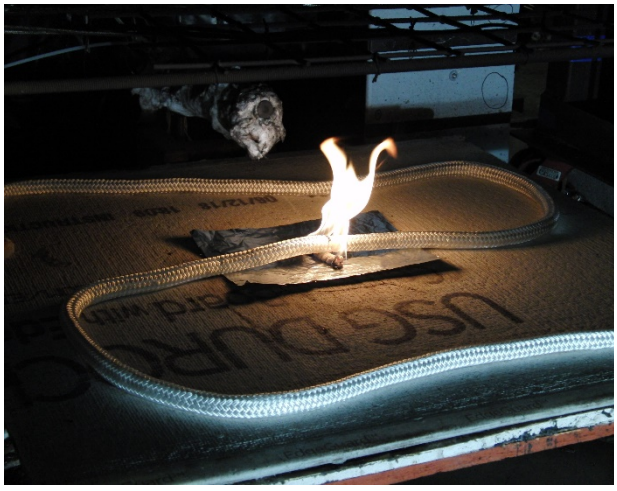
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_21_005 (EPRI) **Test Item: 7.6 m Coil Large Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.24

Peak HRR (kW): 2.4 Burning Duration (s): 1,025 Ignition Method: Wick

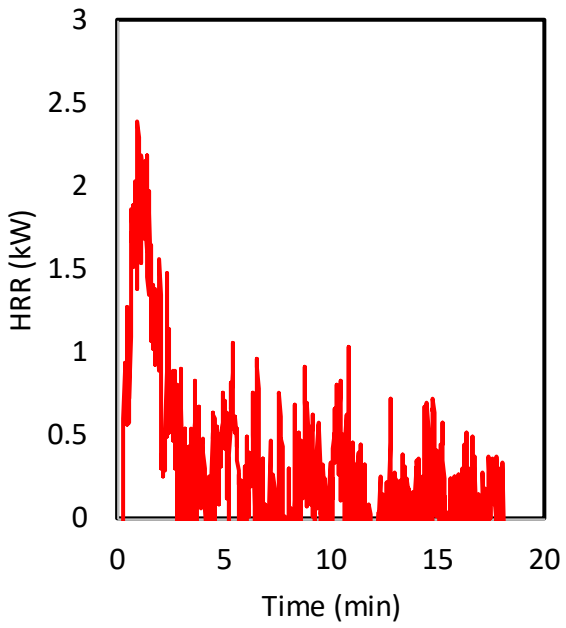
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.27

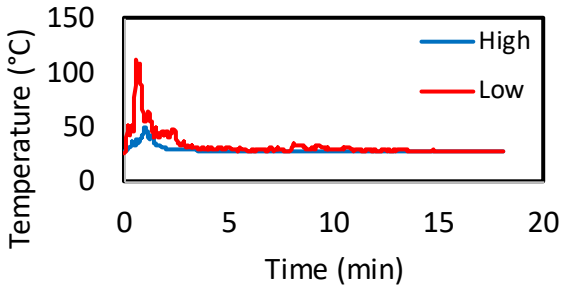
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

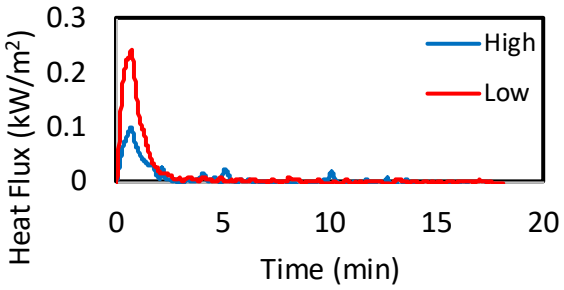
TC Grid Heights[1] (cm): 30, 76

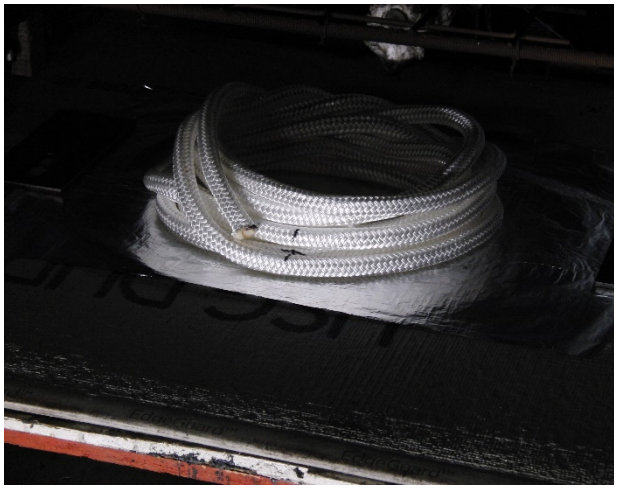
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_21_006 (EPRI) **Test Item: 7.6 m Coil Large Rope**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.57

Peak HRR (kW): 57.8 Burning Duration (s): 2,920 Ignition Method: Wick

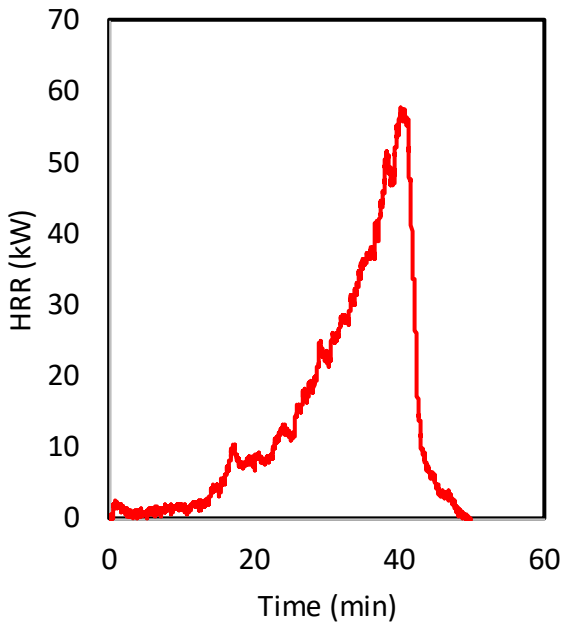
Heat of Combustion (MJ/kg): 25.7 Total Energy Release (MJ): 42.55

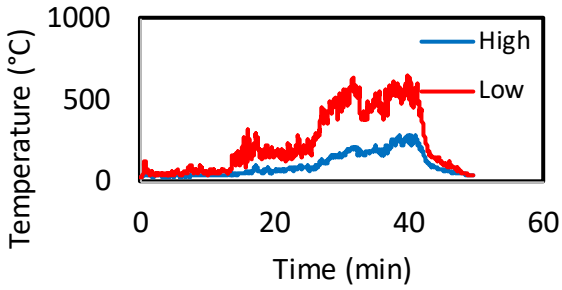
Soot Yield (kg/kg): 0.031 CO Yield (kg/kg): 0.009

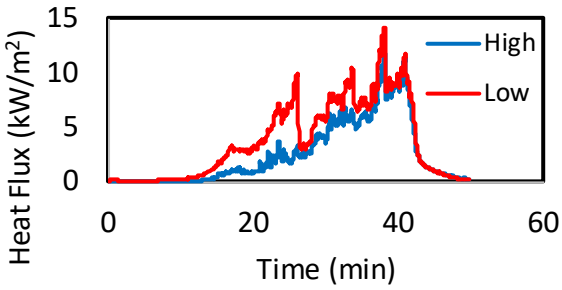
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_21_007 (EPRI) **Test Item: 7.6 m Coil Large Rope**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.28

Peak HRR (kW): 2.7 Burning Duration (s): 439 Ignition Method: Wick

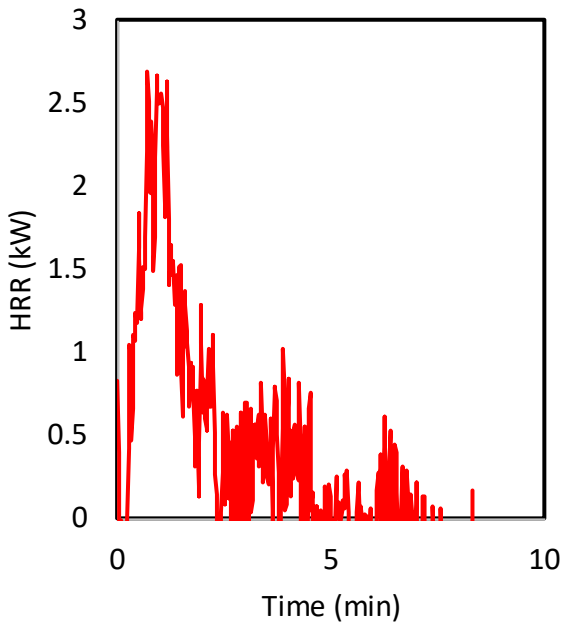
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.16

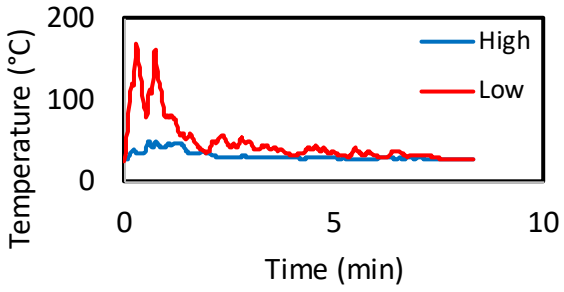
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

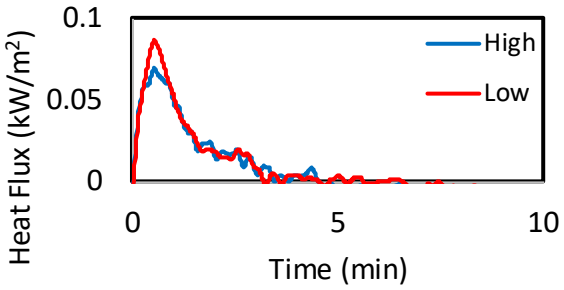
TC Grid Heights[1] (cm): 30, 76

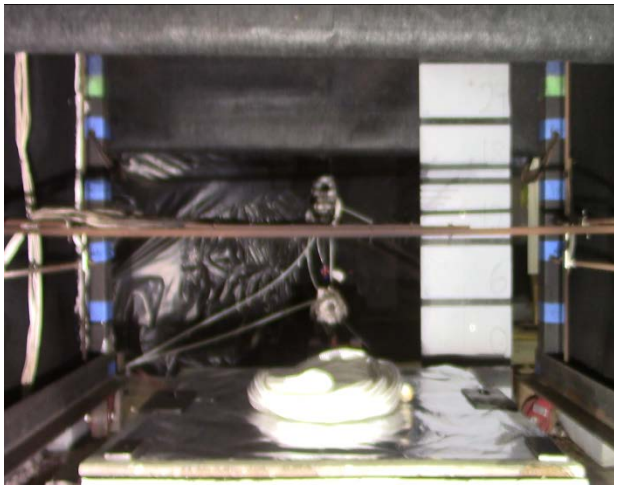
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 61

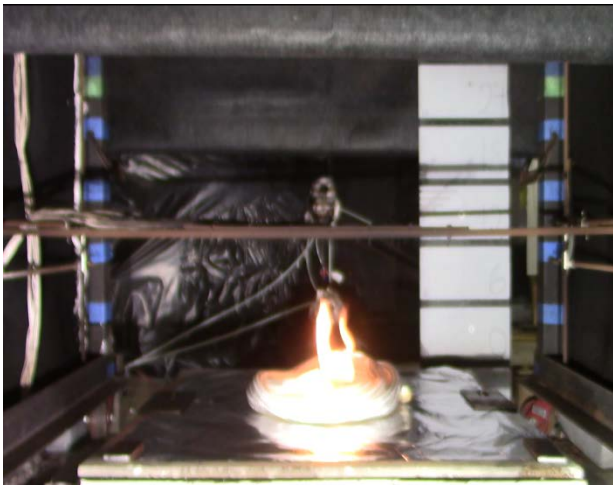
[1]From top of platform, [2]From center of platform











Test ID: 08_22_001 (EPRI) **Test Item: Duct Tape Roll**

Max Fire Diameter (m): 0.14 Max Flame Height (m): 0.53

Peak HRR (kW): 20.3 Burning Duration (s): 2,528 Ignition Method: Wick

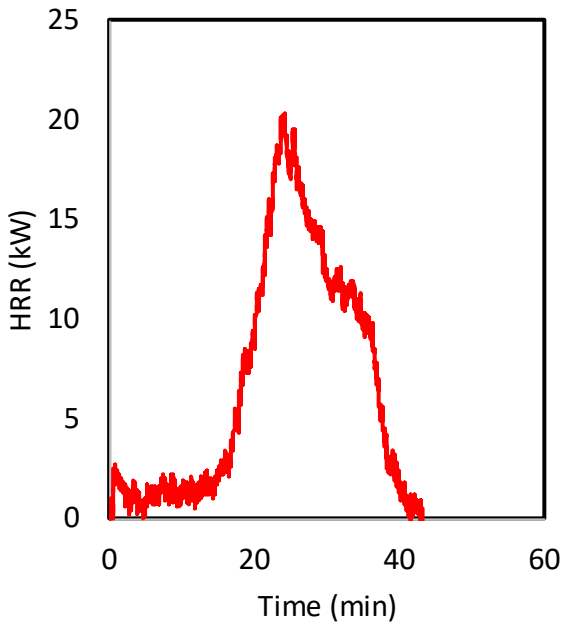
Heat of Combustion (MJ/kg): 38.2 Total Energy Release (MJ): 17.39

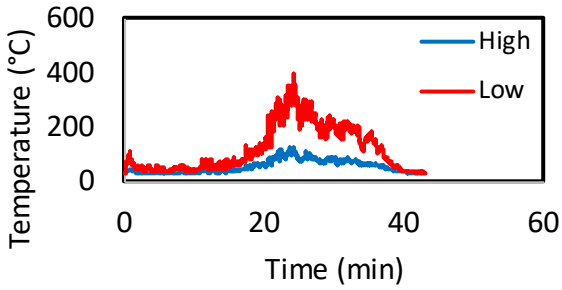
Soot Yield (kg/kg): 0.113 CO Yield (kg/kg): 0.040

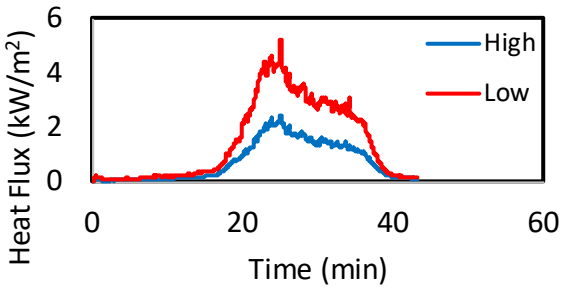
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_22_002 (EPRI) **Test Item: Duct Tape Roll**

Max Fire Diameter (m): 0.05 Max Flame Height (m): 0.31

Peak HRR (kW): 3.4 Burning Duration (s): 241 Ignition Method: Wick

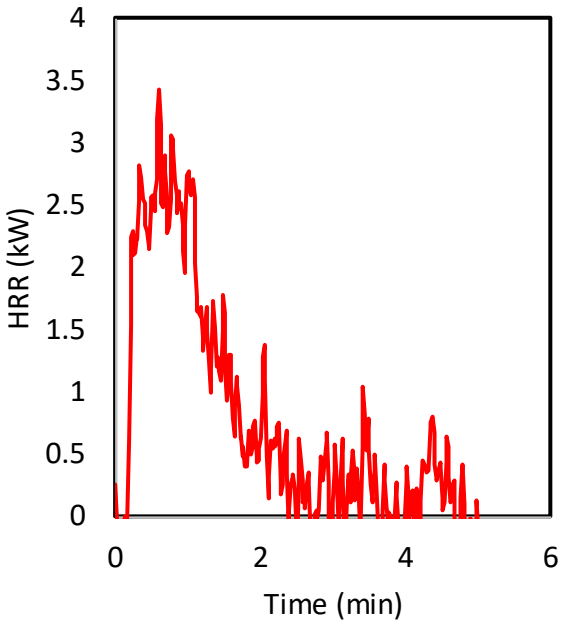
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.23

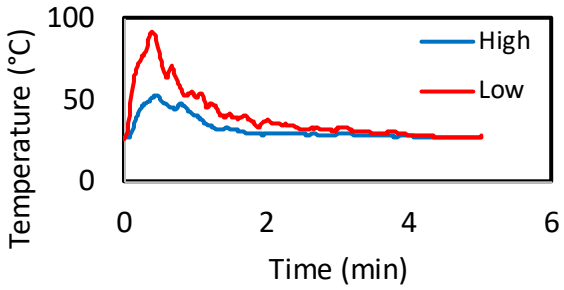
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

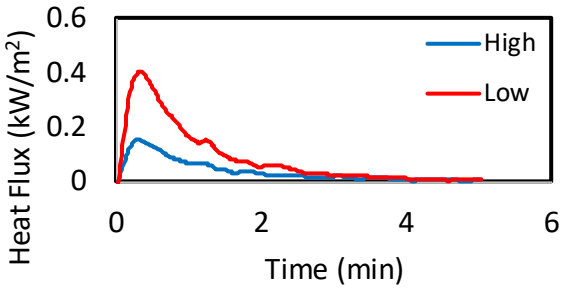
TC Grid Heights[1] (cm): 46, 91

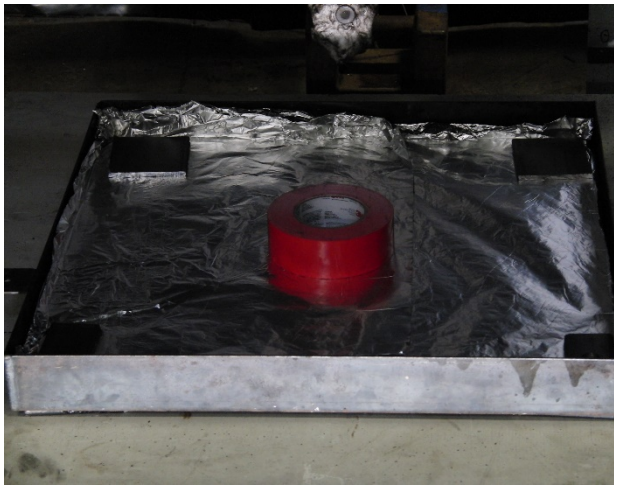
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 08_22_003 (EPRI) **Test Item: Duct Tape Roll**

Max Fire Diameter (m): 0.11 Max Flame Height (m): 0.44

Peak HRR (kW): 17.9 Burning Duration (s): 2,387 Ignition Method: Wick

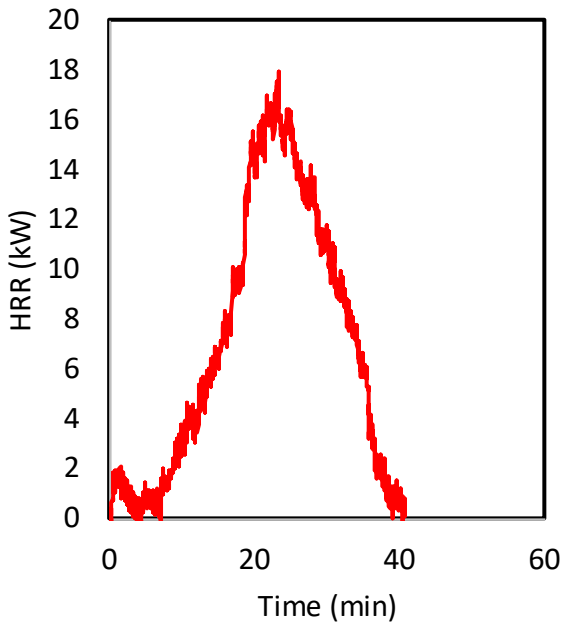
Heat of Combustion (MJ/kg): 39.6 Total Energy Release (MJ): 17.05

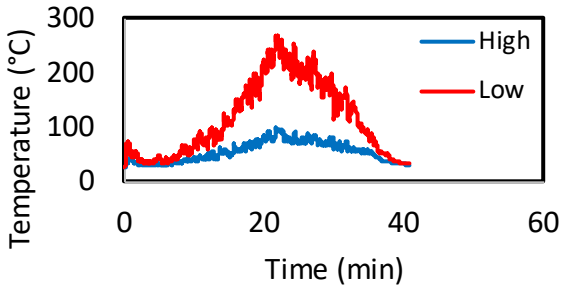
Soot Yield (kg/kg): 0.130 CO Yield (kg/kg): 0.042

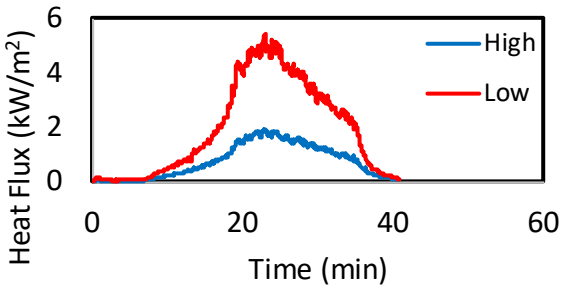
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform







Test ID: 08_22_005 (EPRI) **Test Item: Single Oil Pad**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 3.2 Burning Duration (s): 285 Ignition Method: Wick

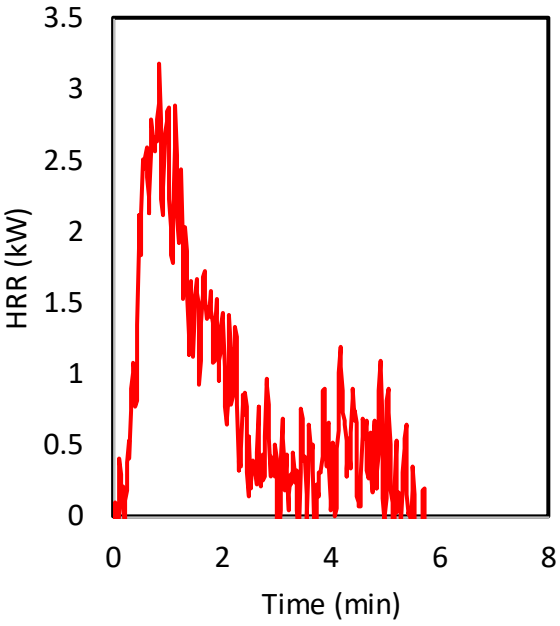
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.28

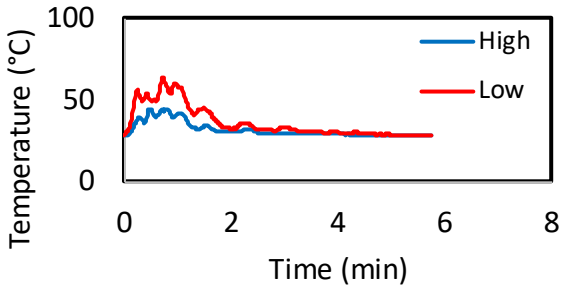
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

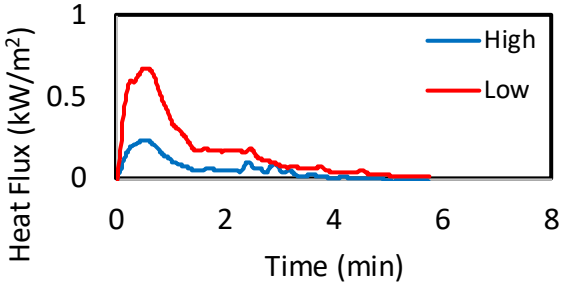
TC Grid Heights[1] (cm): 46, 91

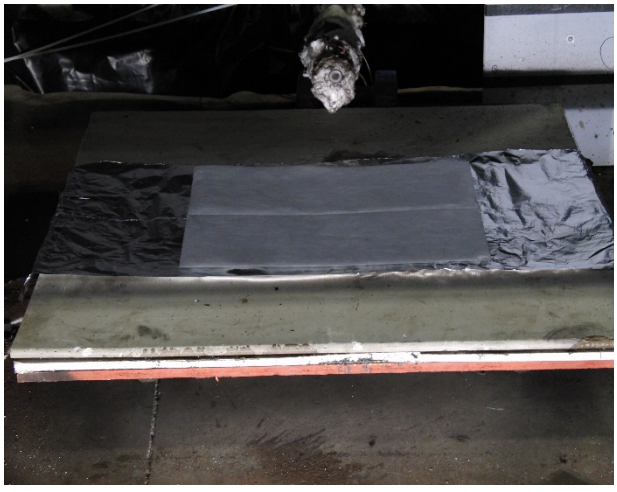
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 25

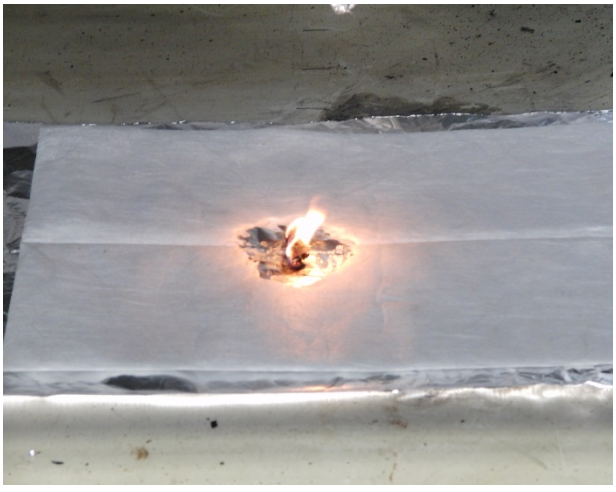
[1]From top of platform, [2]From center of platform











Test ID: 08_22_006 (EPRI) **Test Item: Single Oil Pad**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.20

Peak HRR (kW): 3.6 Burning Duration (s): 285 Ignition Method: Wick

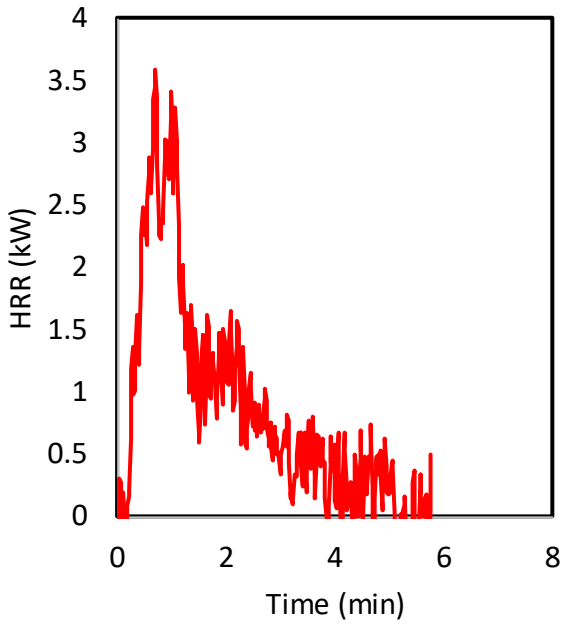
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.29

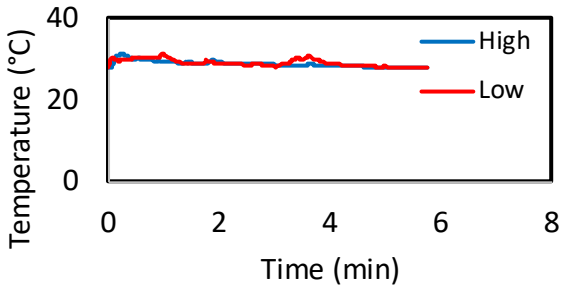
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

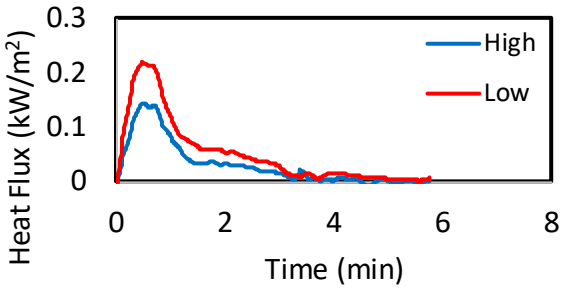
TC Grid Heights[1] (cm): 46, 91

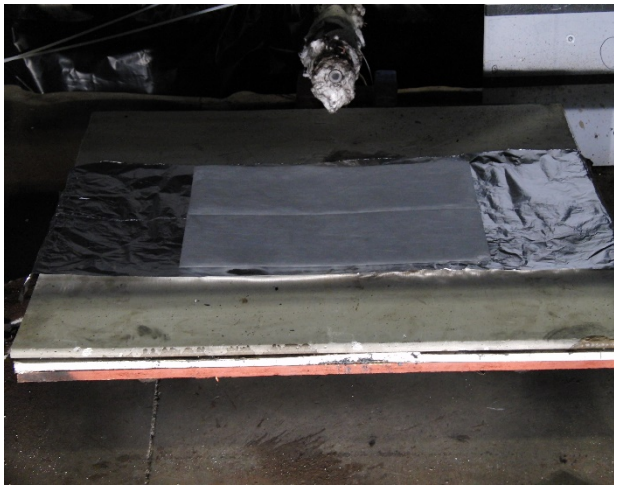
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 25

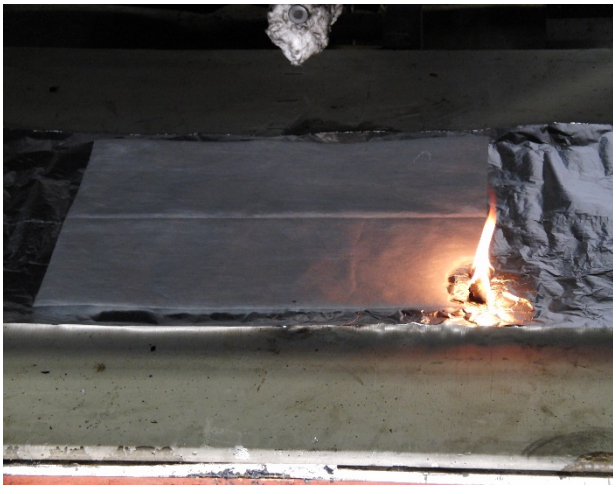
[1]From top of platform, [2]From center of platform











Test ID: Test Item:

Test ID: 08_22_007 (EPRI) **Test Item: Single Oil Pad**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 3.2 Burning Duration (s): 248 Ignition Method: Wick

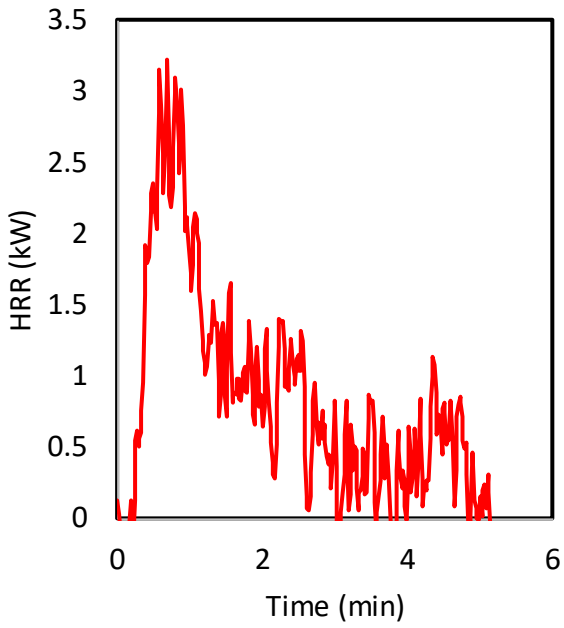
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.26

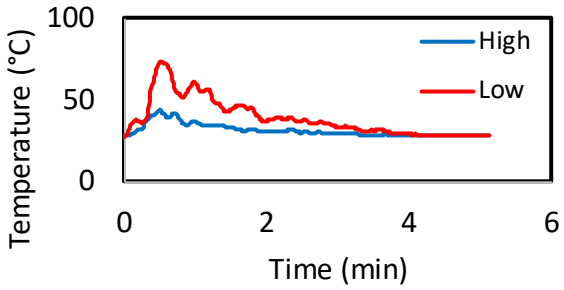
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

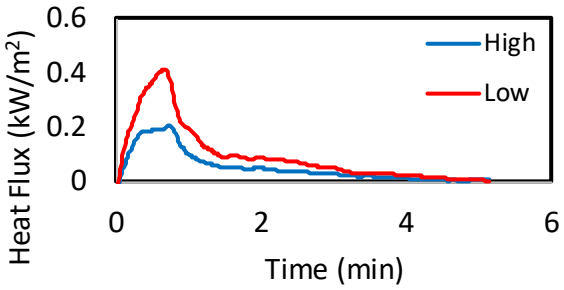
TC Grid Heights[1] (cm): 46, 91

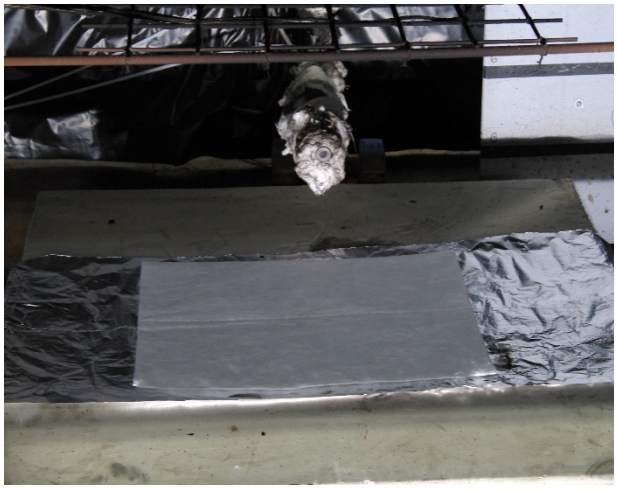
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 25

[1]From top of platform, [2]From center of platform









Test ID: 08_23_001 (EPRI) **Test Item: 4 Oil Pads**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 2.4 Burning Duration (s): 528 Ignition Method: Wick

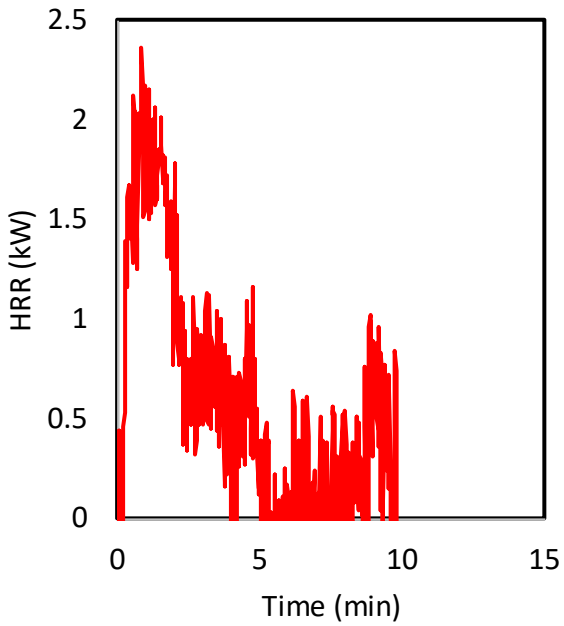
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.34

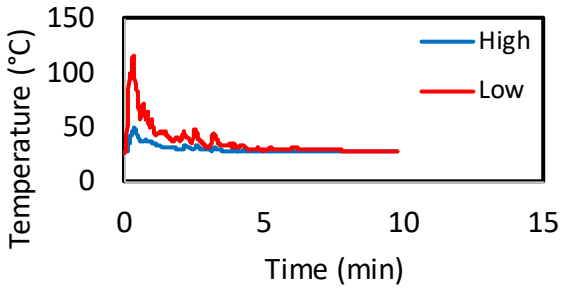
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

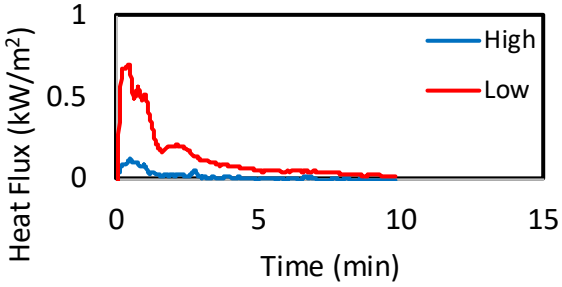
TC Grid Heights[1] (cm): 30, 76

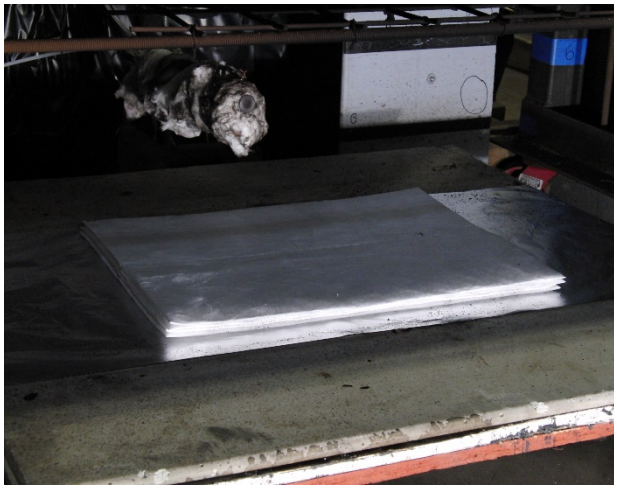
HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_23_002 (EPRI) **Test Item: 4 Oil Pads**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.20

Peak HRR (kW): 2.3 Burning Duration (s): 454 Ignition Method: Wick

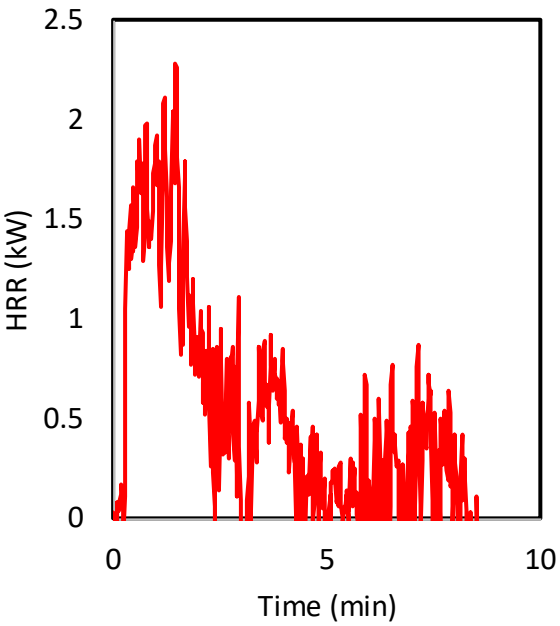
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.26

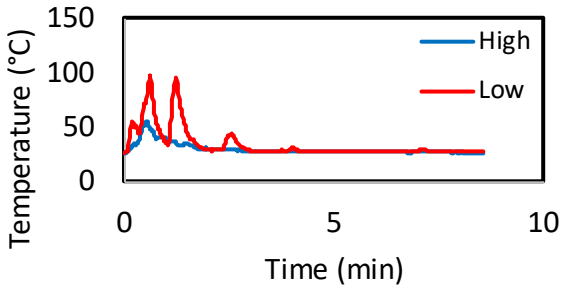
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

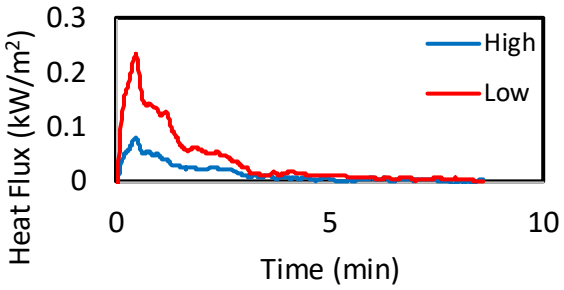
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_23_003 (EPRI) **Test Item: 4 Oil Pads**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.20

Peak HRR (kW): 2.8 Burning Duration (s): 778 Ignition Method: Wick

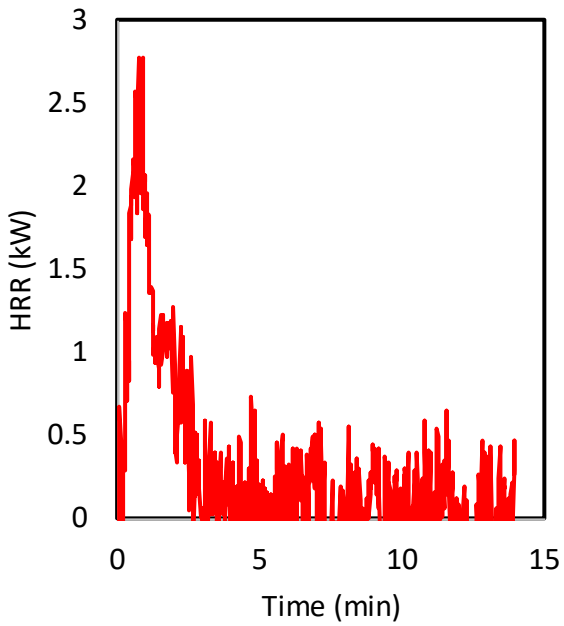
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.19

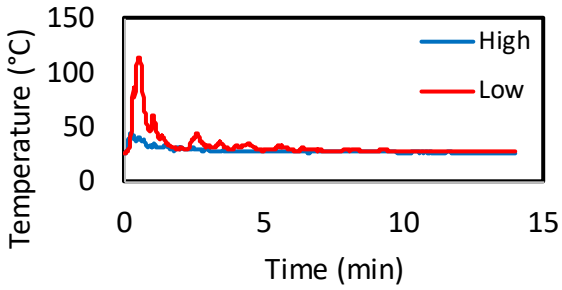
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

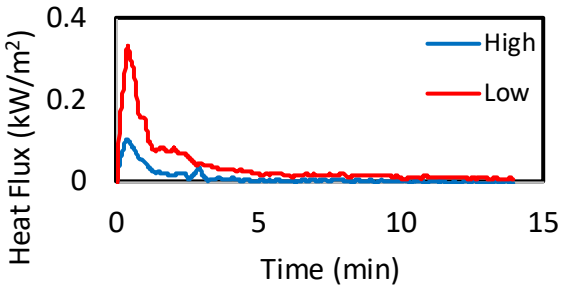
TC Grid Heights[1] (cm): 30, 76

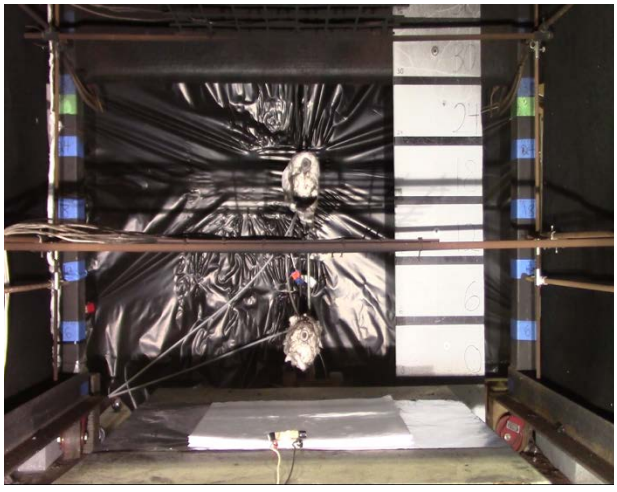
HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_23_004 (EPRI) **Test Item: Single Oil Pad w/Oil**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 2.3 Burning Duration (s): 606 Ignition Method: Wick

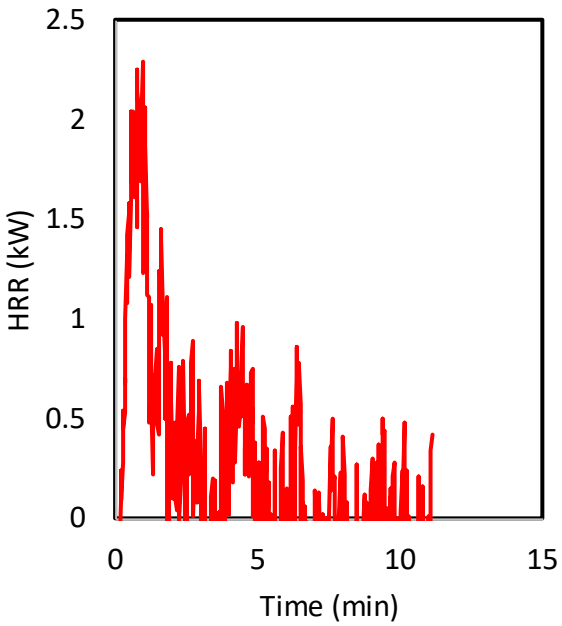
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.13

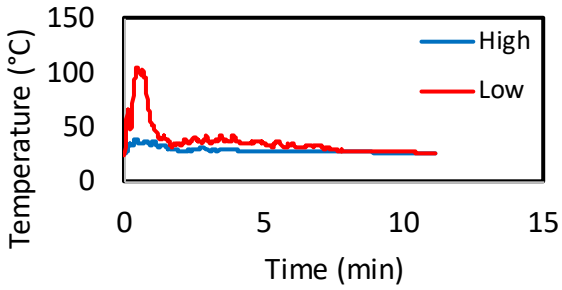
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

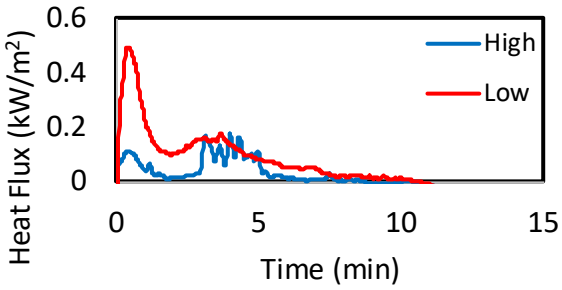
TC Grid Heights[1] (cm): 30, 76

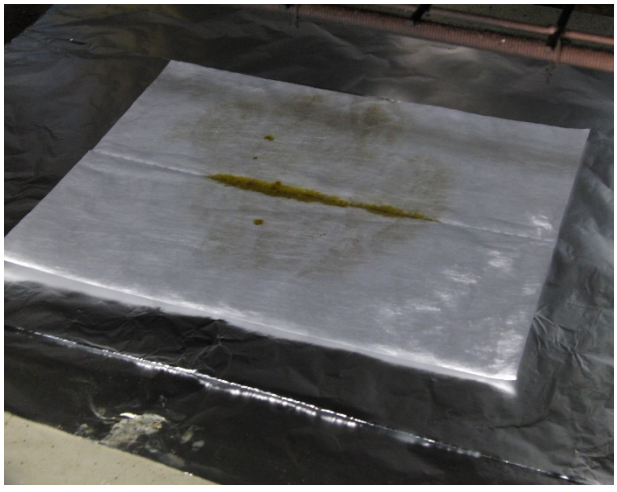
HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

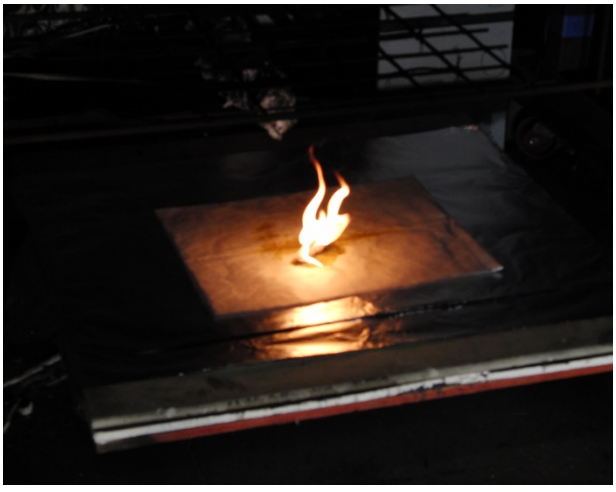
[1]From top of platform, [2]From center of platform











Test ID: 08_23_005 (EPRI) **Test Item: Single Oil Pad w/Oil**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 2.5 Burning Duration (s): 267 Ignition Method: Wick

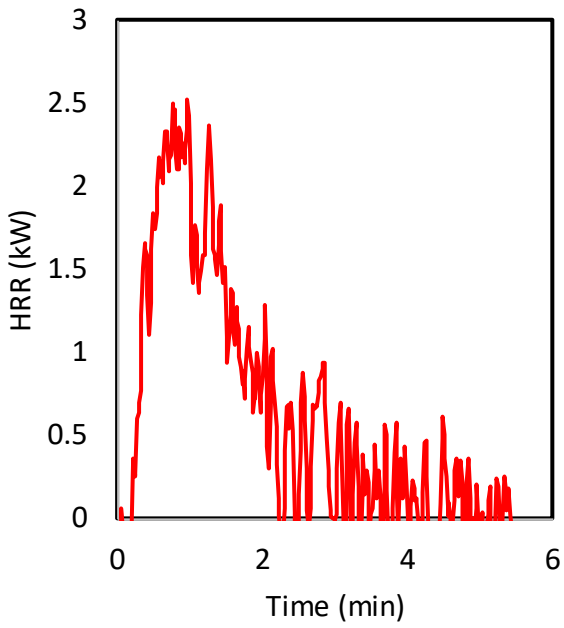
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.20

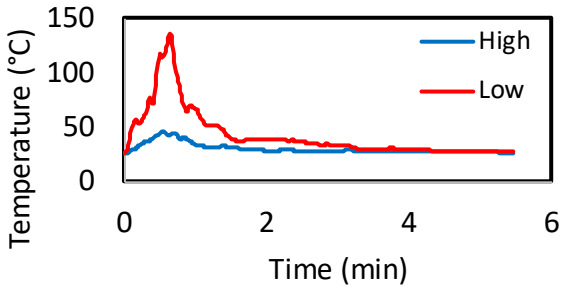
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

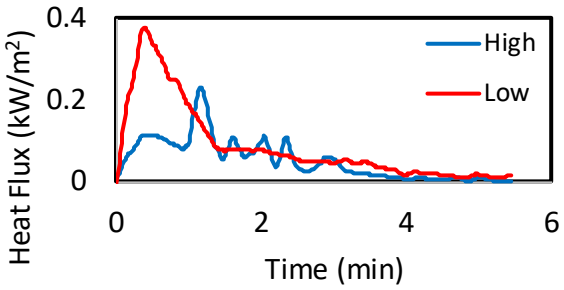
TC Grid Heights[1] (cm): 30, 76

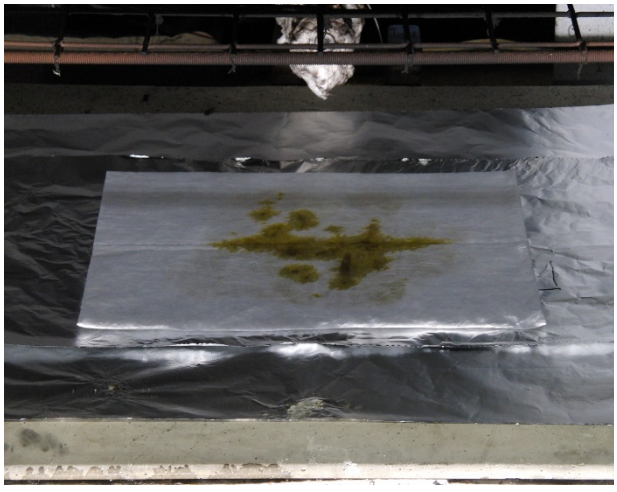
HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

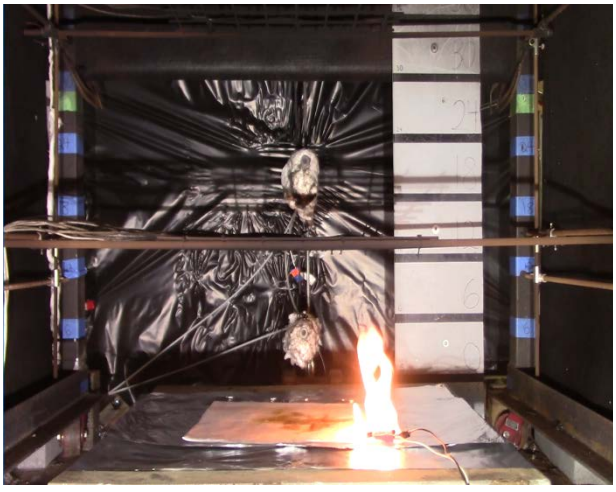
[1]From top of platform, [2]From center of platform











Test ID: 08_23_006 (EPRI) **Test Item: Single Oil Pad w/Oil**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 3.3 Burning Duration (s): 626 Ignition Method: Wick

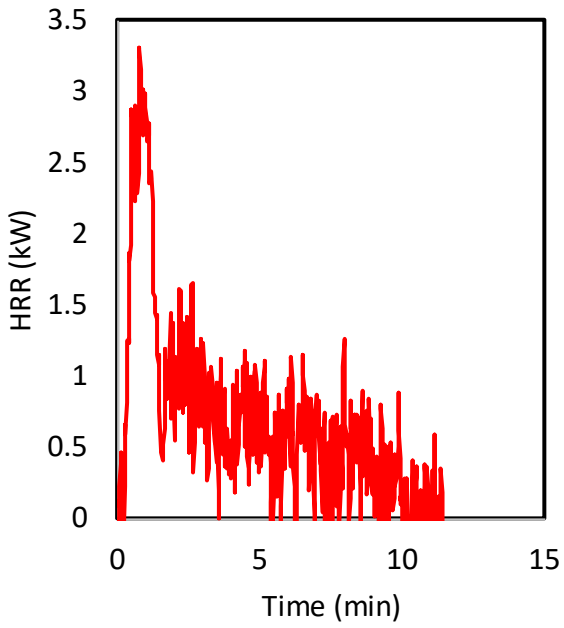
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.47

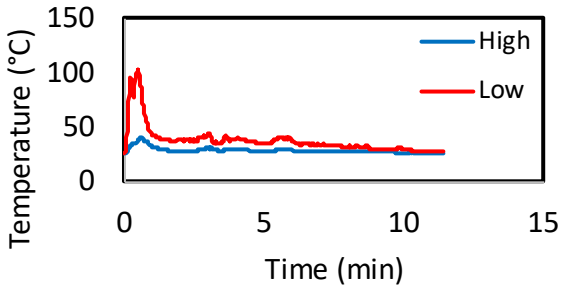
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

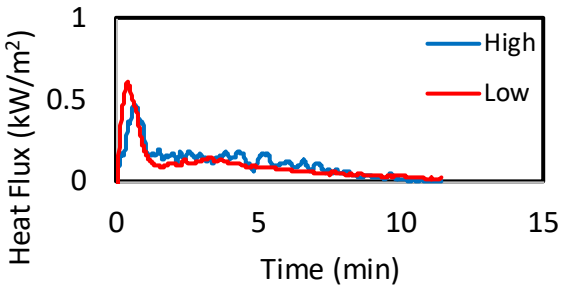
TC Grid Heights[1] (cm): 30, 76

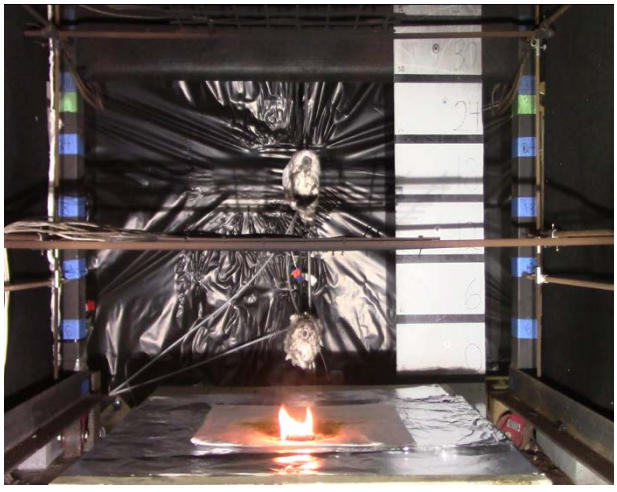
HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

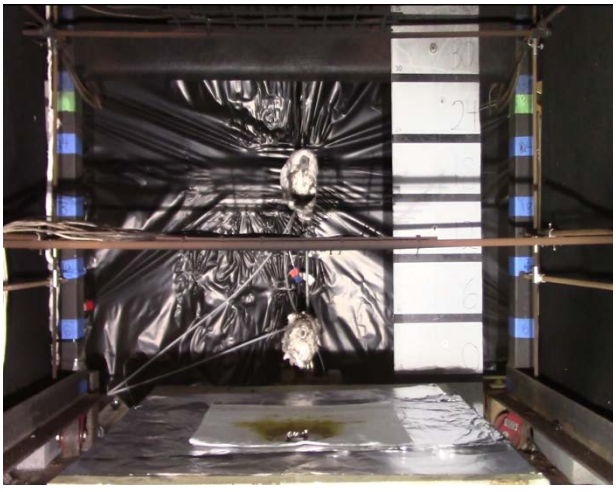
[1]From top of platform, [2]From center of platform











Test ID: 08_23_007 (EPRI) **Test Item: 4 Oil Pads w/Oil**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.27

Peak HRR (kW): 3.2 Burning Duration (s): 947 Ignition Method: Wick

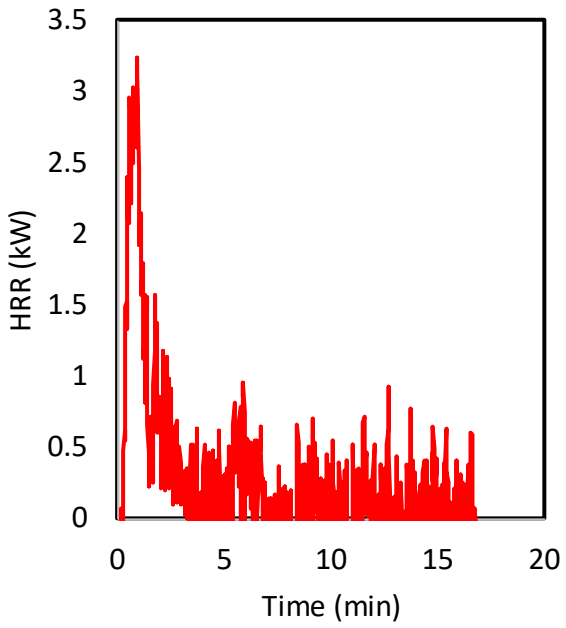
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.23

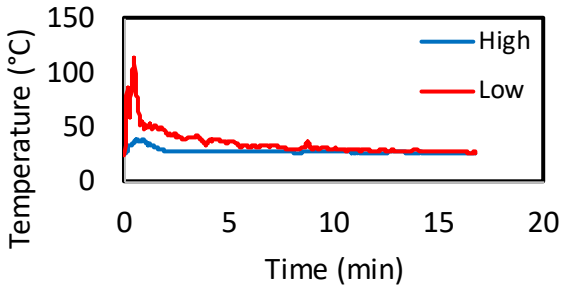
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

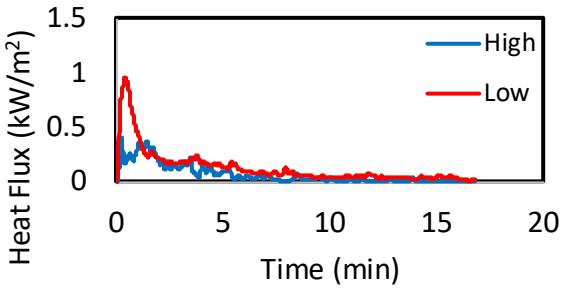
TC Grid Heights[1] (cm): 30, 76

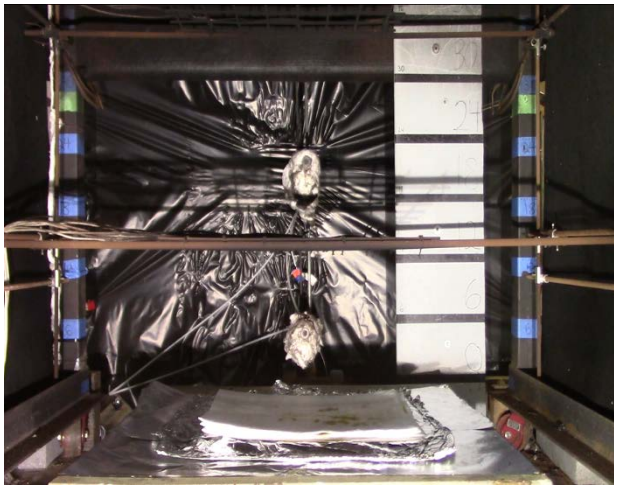
HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

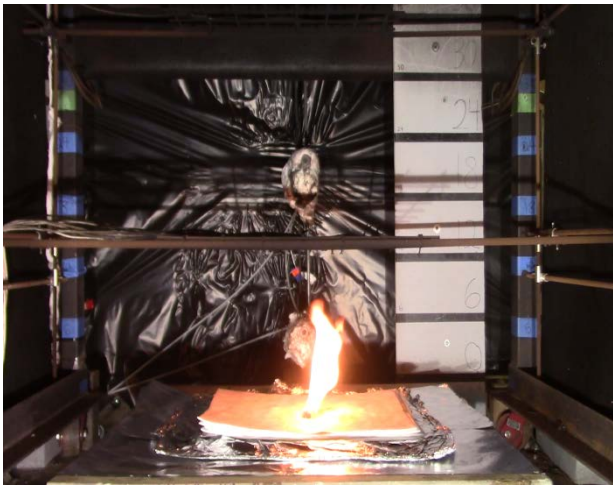
[1]From top of platform, [2]From center of platform











Test ID: 08_23_009 (EPRI) **Test Item: 4 Oil Pads w/Oil**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.25

Peak HRR (kW): 2.7 Burning Duration (s): 887 Ignition Method: Wick

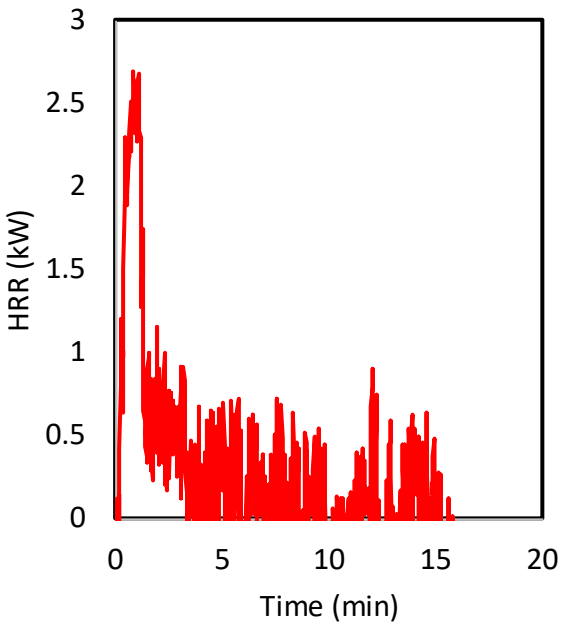
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.23

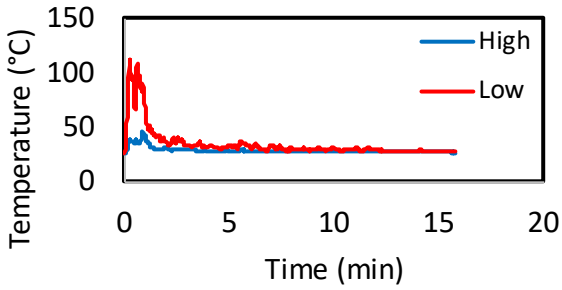
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

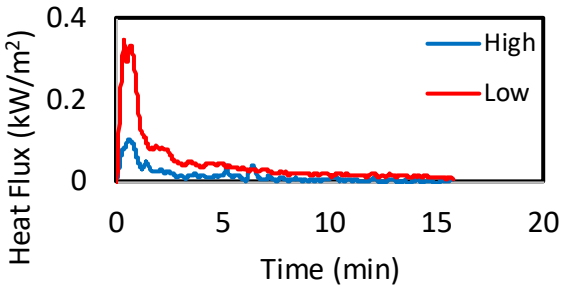
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 50 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_24_001 (EPRI) **Test Item: Lift Slings**

Max Fire Diameter (m): 0.38 Max Flame Height (m): 0.32

Peak HRR (kW): 17.3 Burning Duration (s): 1,847 Ignition Method: Wick

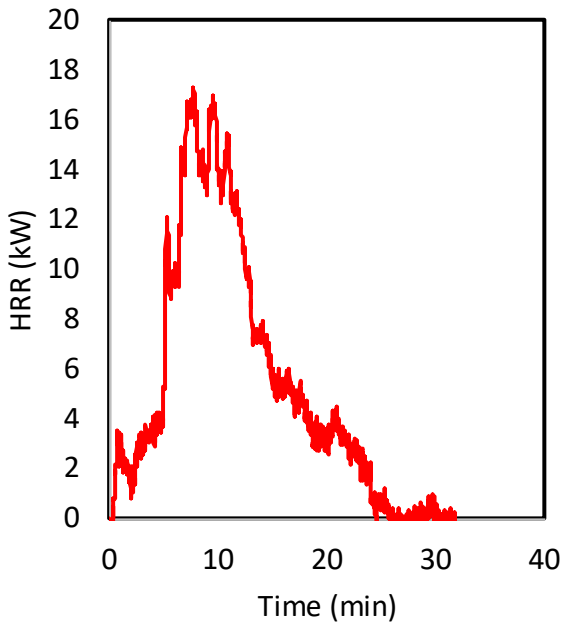
Heat of Combustion (MJ/kg): 19.1 Total Energy Release (MJ): 10.03

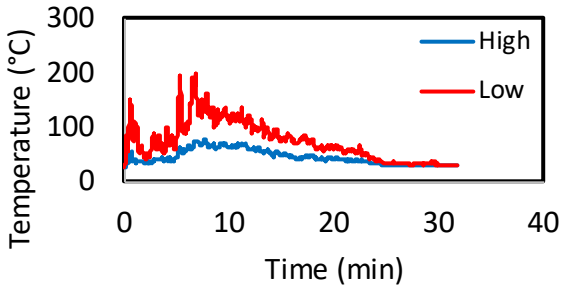
Soot Yield (kg/kg): 0.059 CO Yield (kg/kg): 0.029

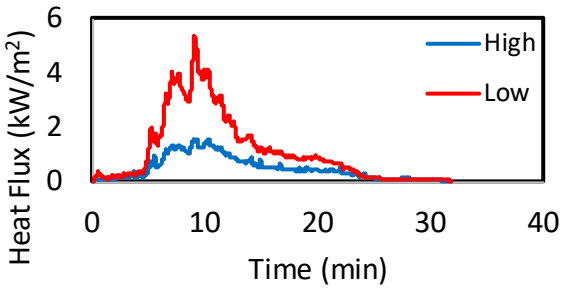
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_24_002 (EPRI) **Test Item: Lift Slings**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.43

Peak HRR (kW): 19.2 Burning Duration (s): 1,368 Ignition Method: Wick

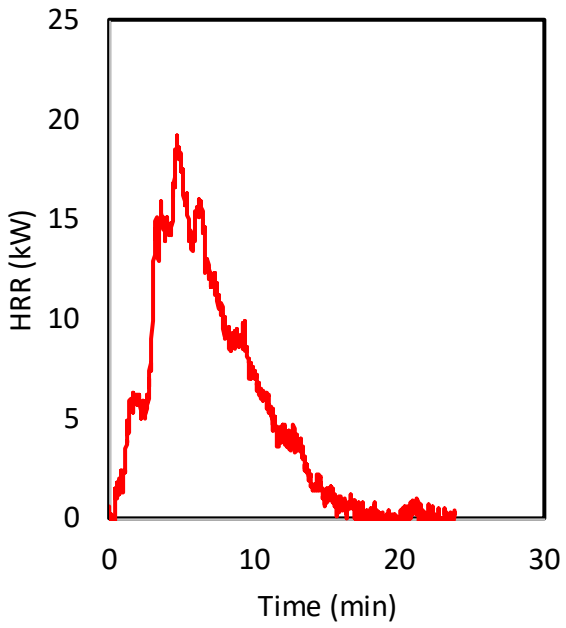
Heat of Combustion (MJ/kg): 19.5 Total Energy Release (MJ): 7.33

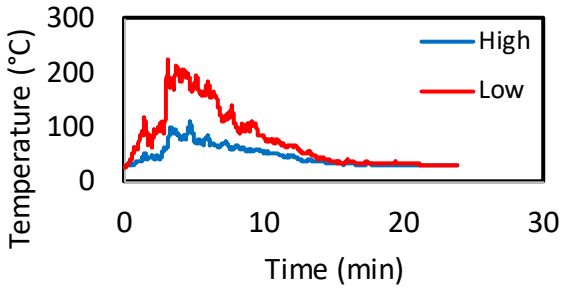
Soot Yield (kg/kg): 0.047 CO Yield (kg/kg): 0.023

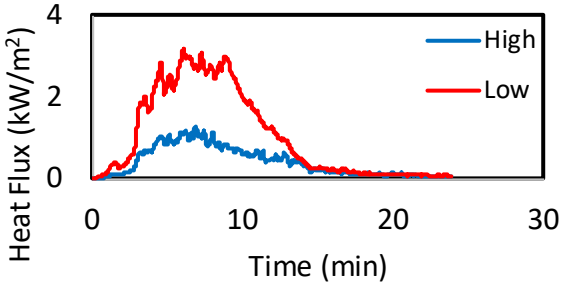
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 41

[1]From top of platform, [2]From center of platform







Test ID: 08_24_003 (EPRI) **Test Item: Lift Slings**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.51

Peak HRR (kW): 15.9 Burning Duration (s): 1,066 Ignition Method: Wick

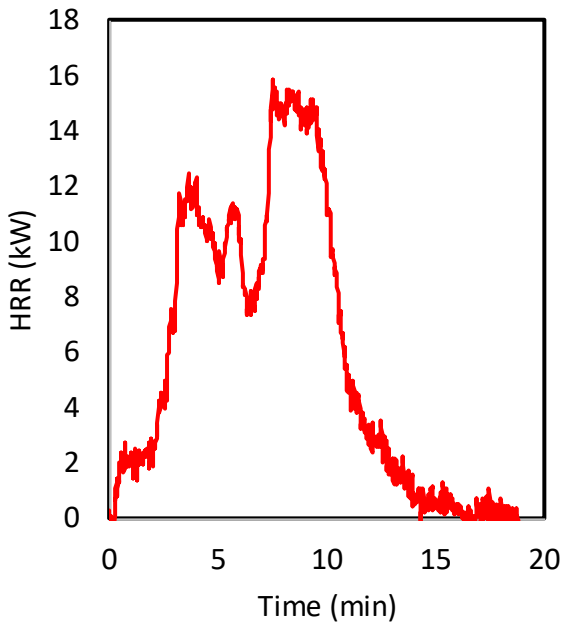
Heat of Combustion (MJ/kg): 20.1 Total Energy Release (MJ): 6.47

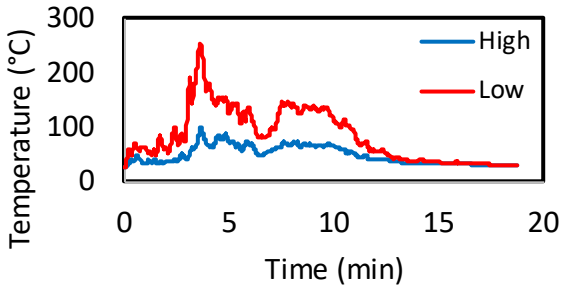
Soot Yield (kg/kg): 0.050 CO Yield (kg/kg): 0.022

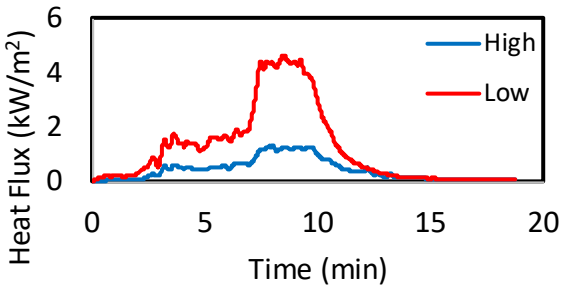
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 15, 61 HF Gauge Distance[2] (cm): 41

[1]From top of platform, [2]From center of platform







Test ID: 08_24_004 (EPRI) **Test Item: Uncoiled Chain**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.10

Peak HRR (kW): 1.3 Burning Duration (s): 385 Ignition Method: Flame

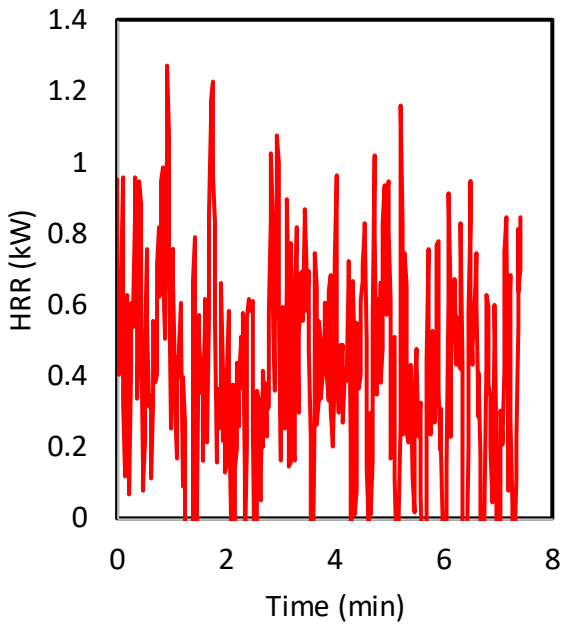
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.17

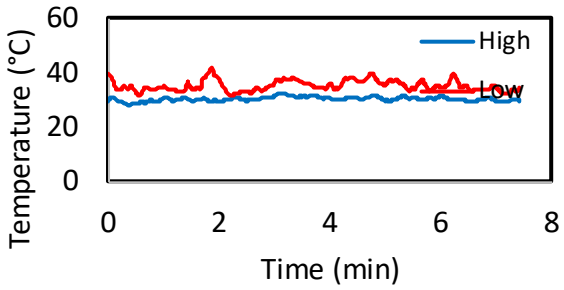
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

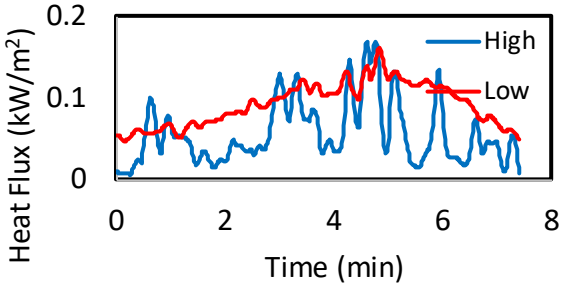
TC Grid Heights[1] (cm): 30, 61

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_24_005 (EPRI) **Test Item: Uncoiled Chain**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.10

Peak HRR (kW): 1.1 Burning Duration (s): 372 Ignition Method: Flame

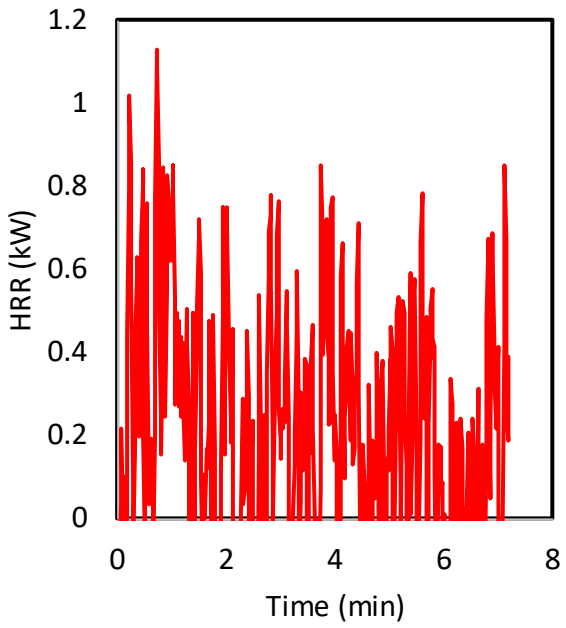
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.07

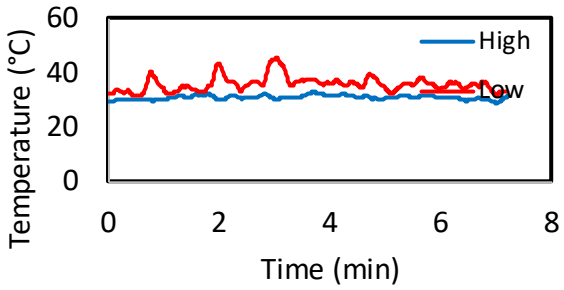
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

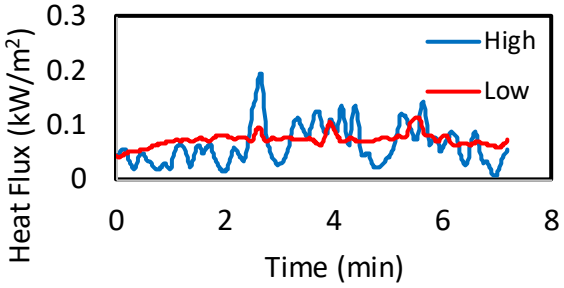
TC Grid Heights[1] (cm): 30, 61

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_24_006 (EPRI) **Test Item: Uncoiled Chain**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.08

Peak HRR (kW): 1.1 Burning Duration (s): 294 Ignition Method: Wick

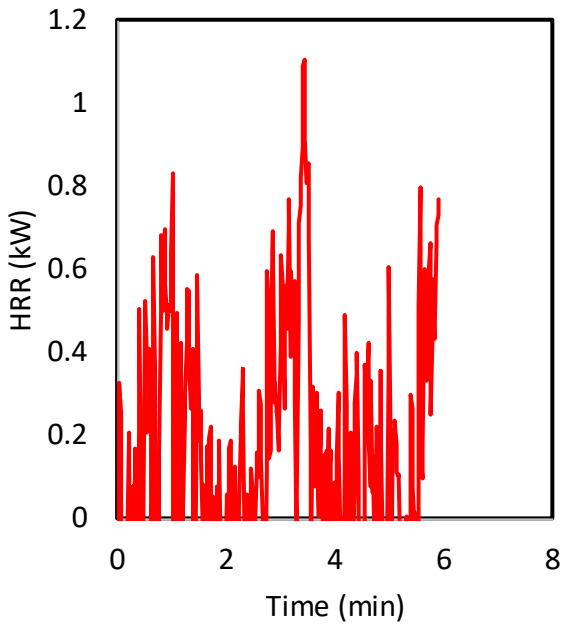
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.05

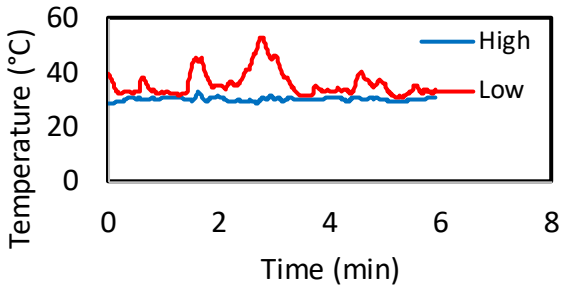
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

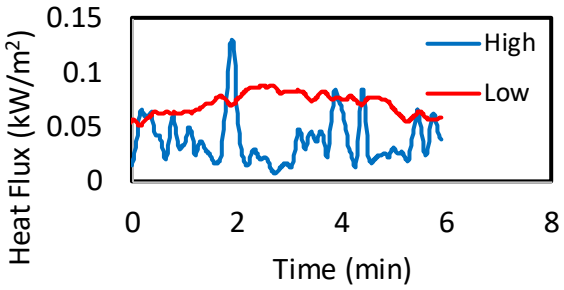
TC Grid Heights[1] (cm): 30, 61

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_27_001 (EPRI) **Test Item: 7.6 m Coil Tubing**

Max Fire Diameter (m): 0.08 Max Flame Height (m): 0.15

Peak HRR (kW): 1.4 Burning Duration (s): 340 Ignition Method: Flame

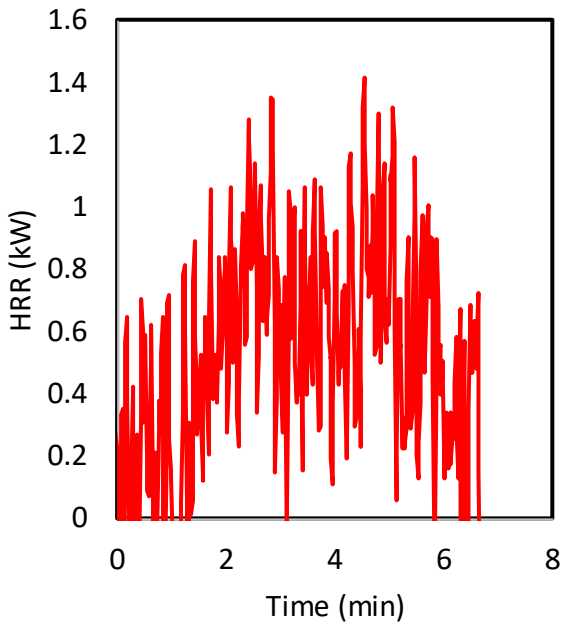
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.21

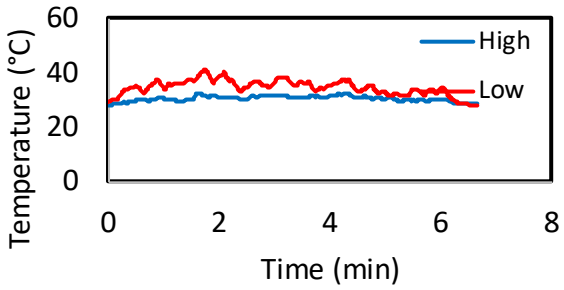
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

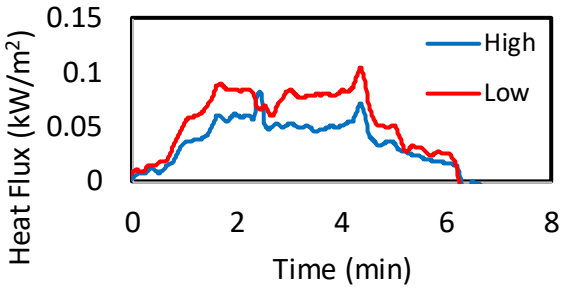
TC Grid Heights[1] (cm): 46, 91

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_27_002 (EPRI) **Test Item: 7.6 m Coil Tubing**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.11

Peak HRR (kW): 1.2 Burning Duration (s): 520 Ignition Method: Flame

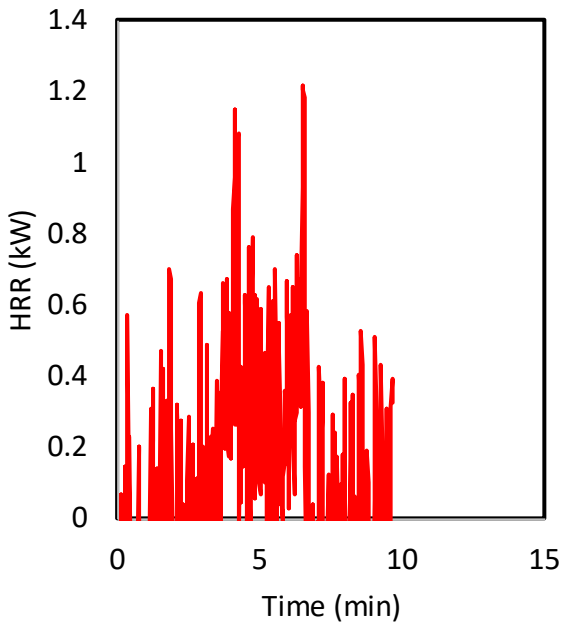
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.01

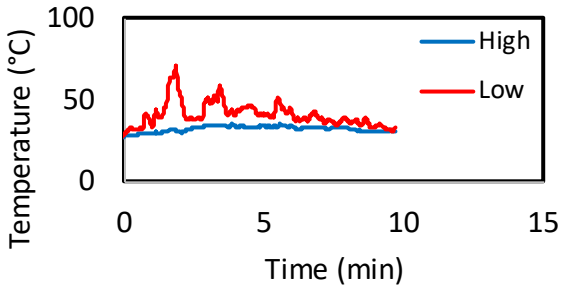
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

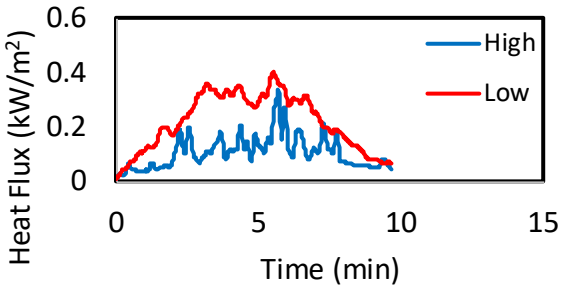
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_27_003 (EPRI) **Test Item: 7.6 m Coil Tubing**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 0.13

Peak HRR (kW): 1.5 Burning Duration (s): 1,356 Ignition Method: Flame

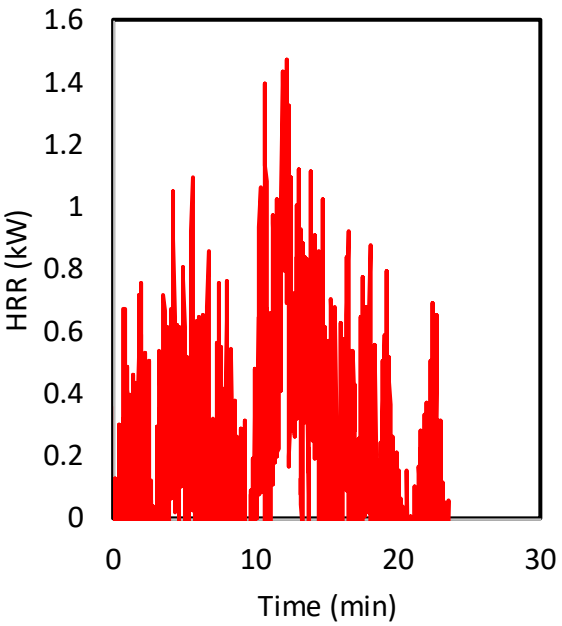
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.19

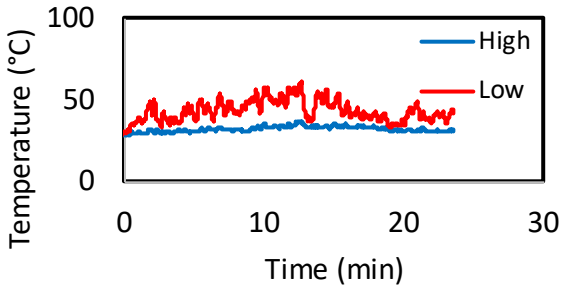
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

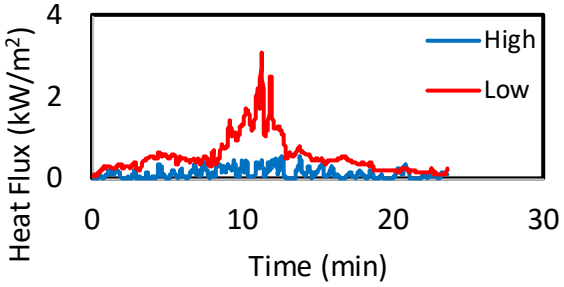
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_27_004 (EPRI) **Test Item: 15.2 m Coil Tubing**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.13

Peak HRR (kW): 1.4 Burning Duration (s): 1,082 Ignition Method: Flame

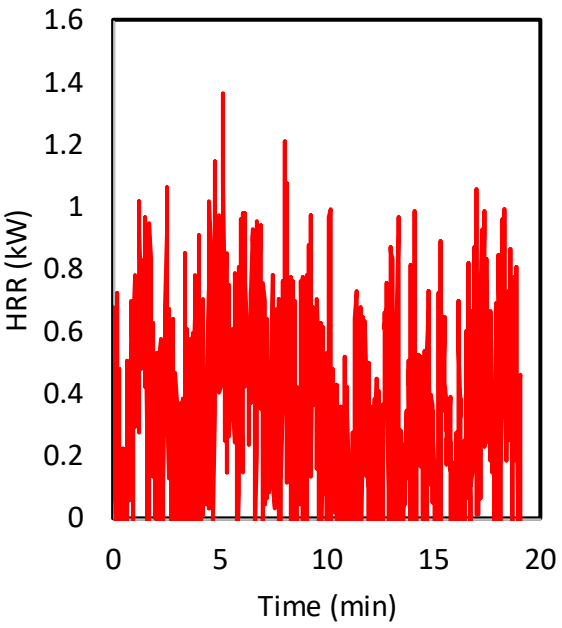
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.38

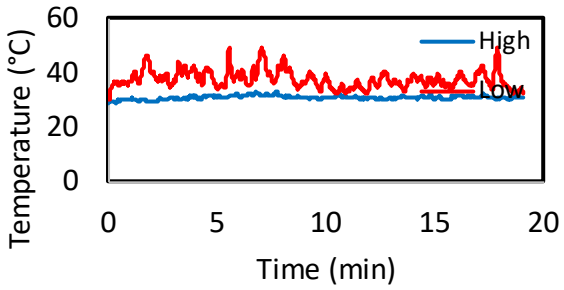
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

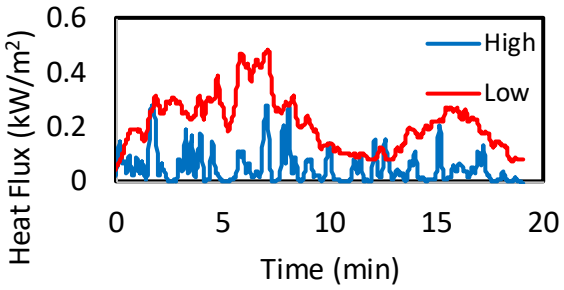
TC Grid Heights[1] (cm): 30, 76

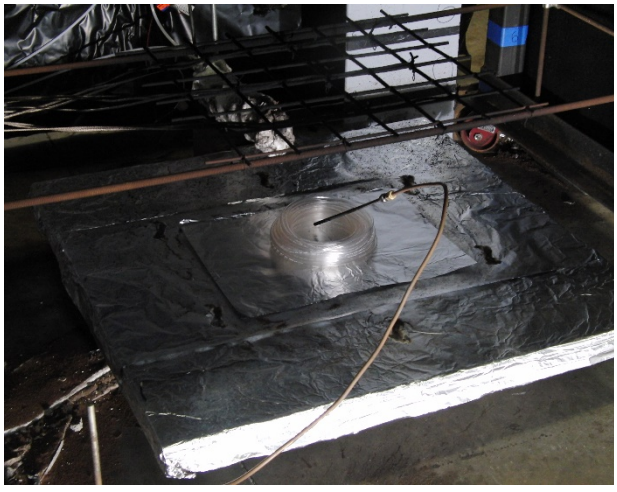
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_27_005 (EPRI) **Test Item: 15.2 m Coil Tubing**

Max Fire Diameter (m): 0.13 Max Flame Height (m): 0.10

Peak HRR (kW): 1.7 Burning Duration (s): 569 Ignition Method: Flame

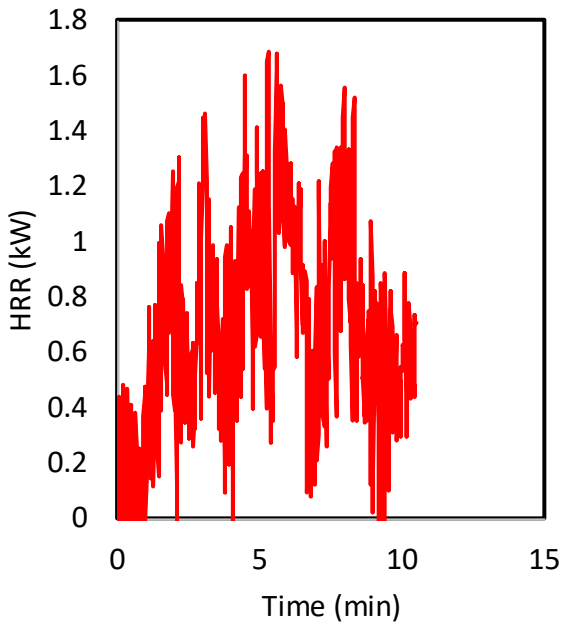
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.42

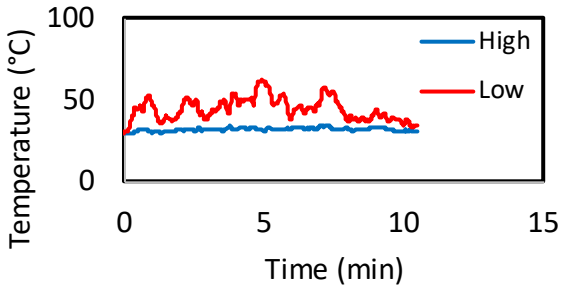
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

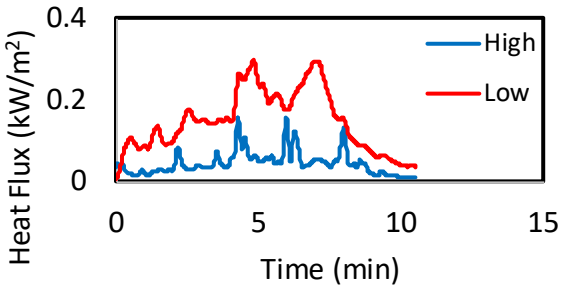
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_28_001 (EPRI) **Test Item: 15.2 m Coil Tubing**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.02

Peak HRR (kW): 1.3 Burning Duration (s): 795 Ignition Method: Flame

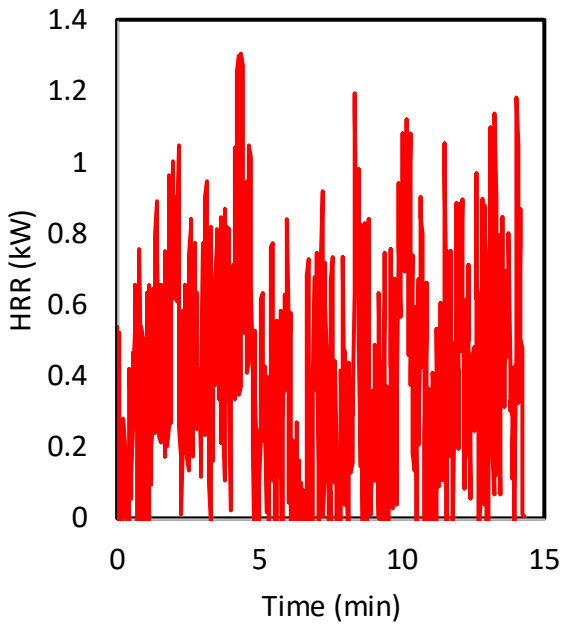
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.34

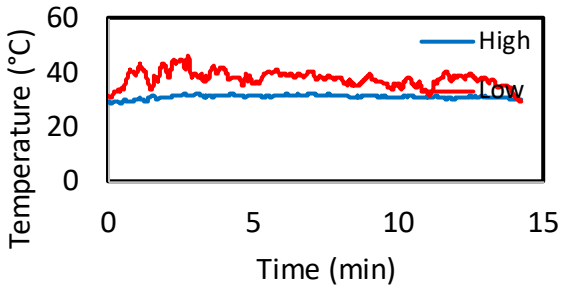
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

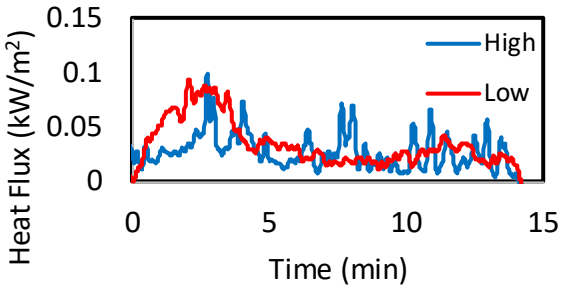
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_28_002 (EPRI) **Test Item: Uncoiled Tubing**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.08

Peak HRR (kW): 0.8 Burning Duration (s): 106 Ignition Method: Flame

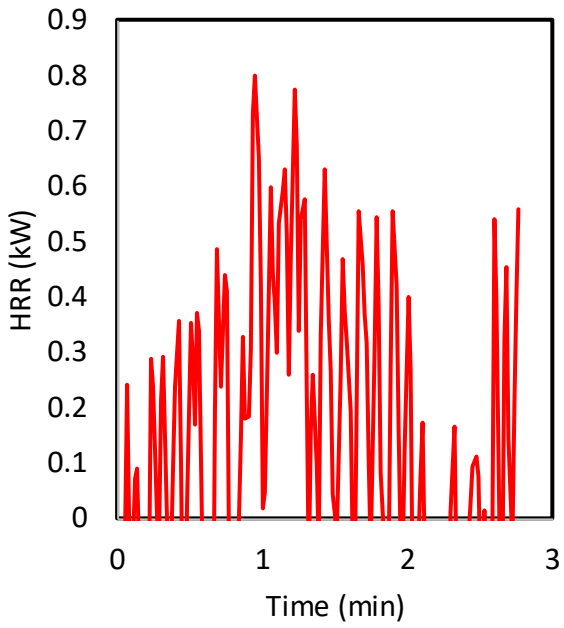
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.02

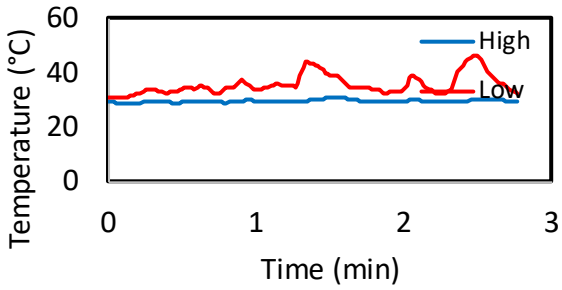
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

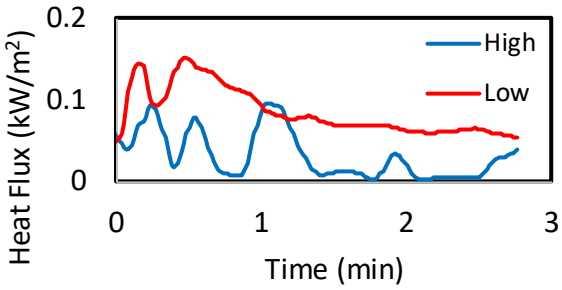
TC Grid Heights[1] (cm): 30, 76

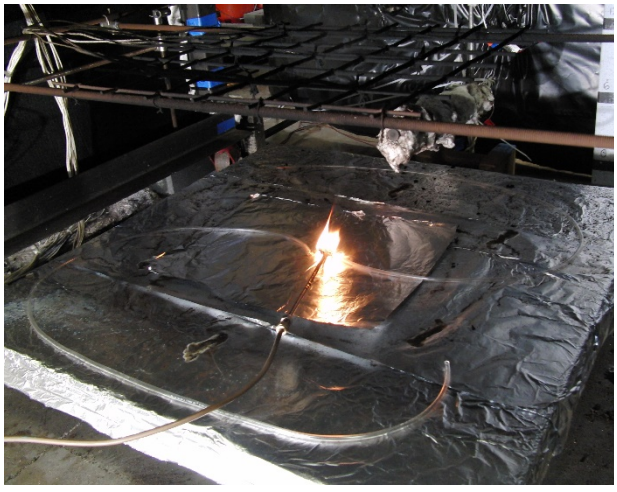
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_28_003 (EPRI) **Test Item: Uncoiled Tubing**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.08

Peak HRR (kW): 1.3 Burning Duration (s): 94 Ignition Method: Flame

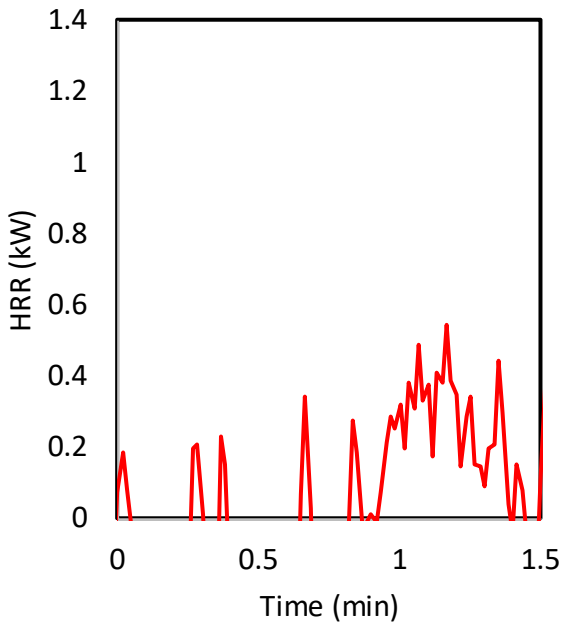
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.03

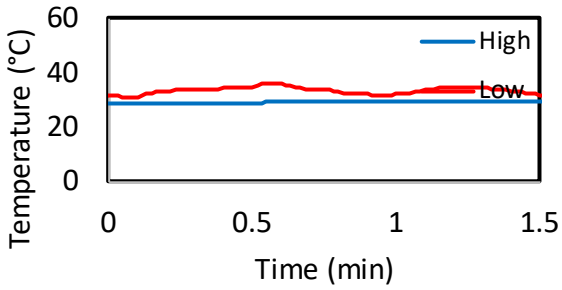
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

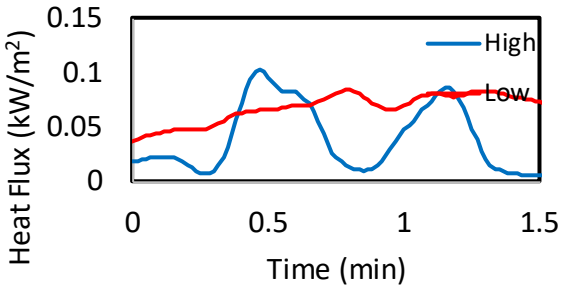
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_28_004 (EPRI) **Test Item: Uncoiled Tubing**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.05

Peak HRR (kW): 0.9 Burning Duration (s): 53 Ignition Method: Flame

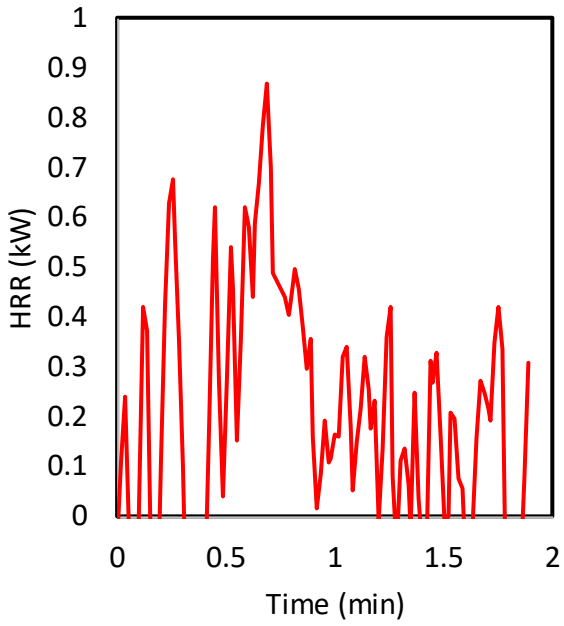
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.02

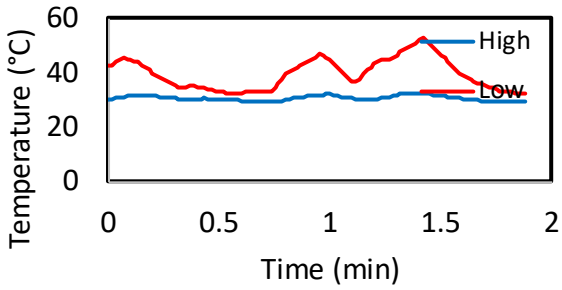
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

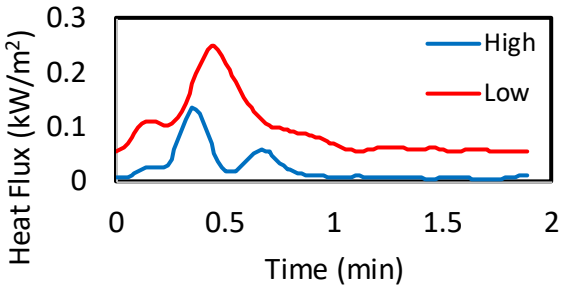
TC Grid Heights[1] (cm): 30, 76

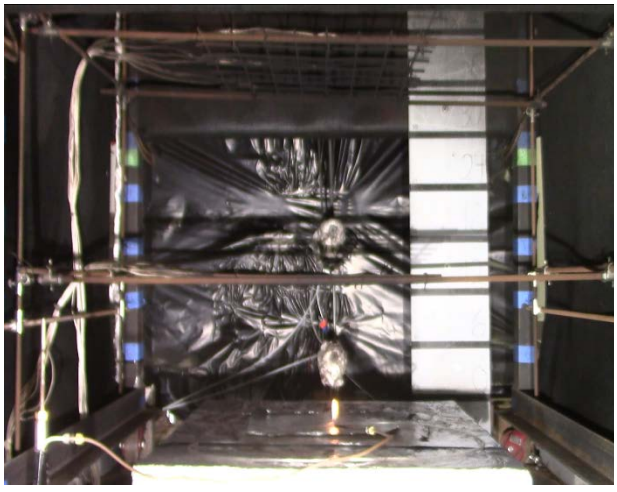
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

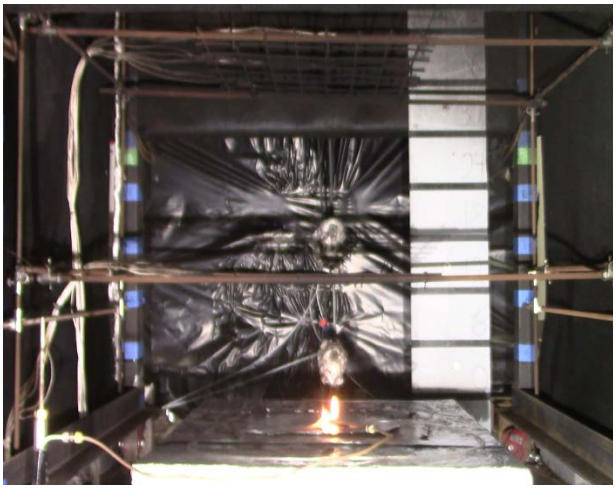
[1]From top of platform, [2]From center of platform











Test ID: 08_28_005 a to c (EPRI) **Test Item: Welding Blanket Folded**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.08

Peak HRR (kW): ~1 Burning Duration (s): 1,036 Ignition Method: Flame

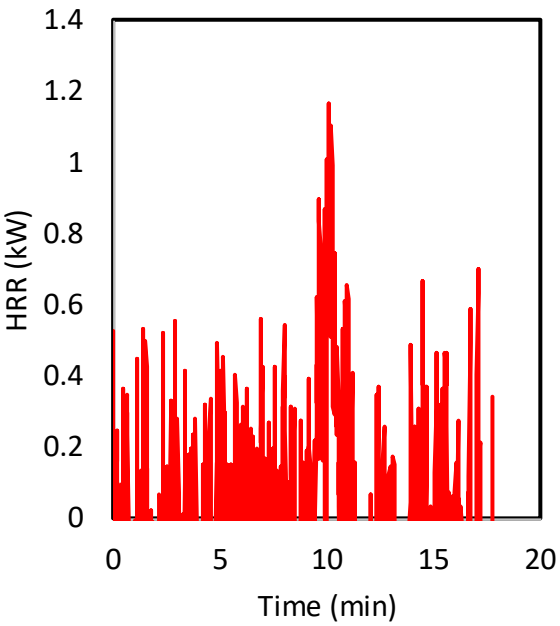
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.0

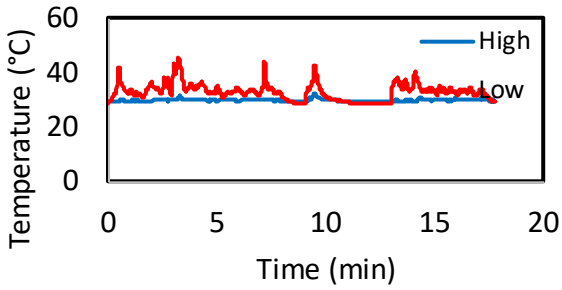
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

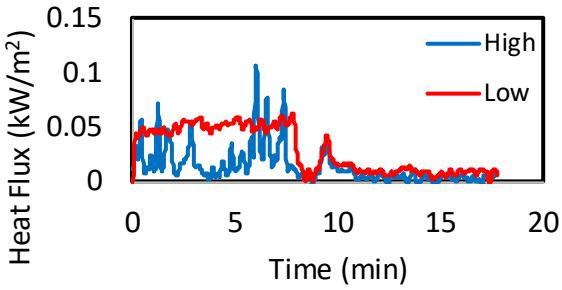
TC Grid Heights[1] (cm): 30, 76

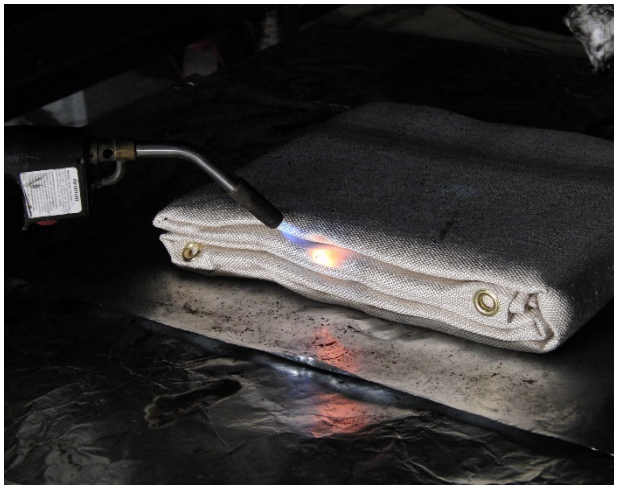
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 08_28_006 (EPRI) **Test Item: Long Duct Tape Air**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.08

Peak HRR (kW): 1.2 Burning Duration (s): 1,023 Ignition Method: Lighter

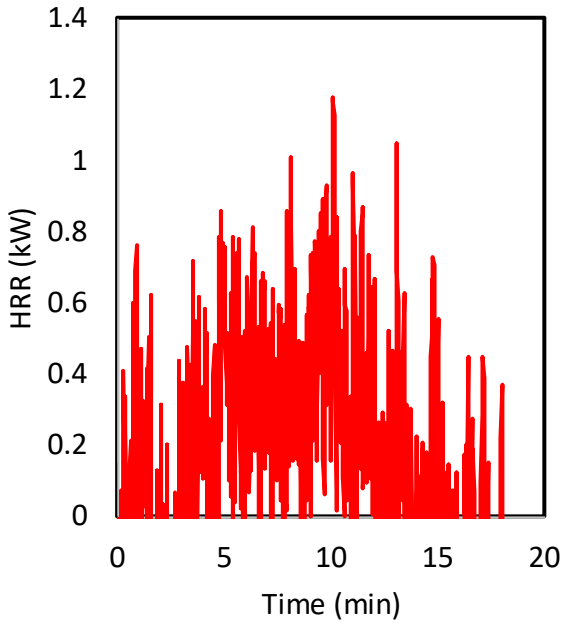
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.13

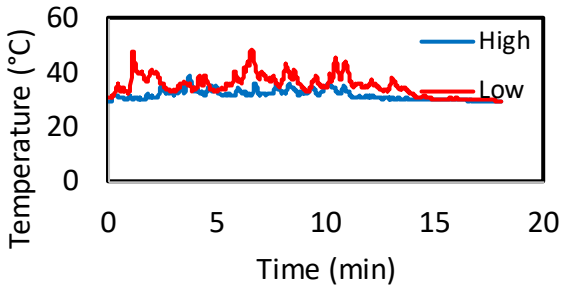
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

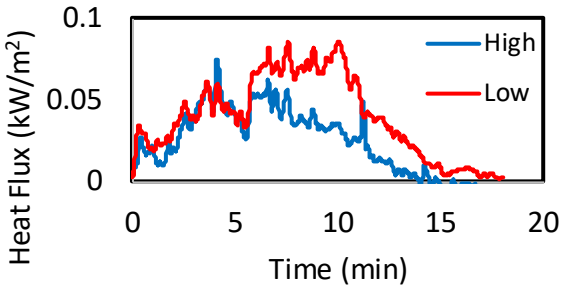
TC Grid Heights[1] (cm): 30, 76

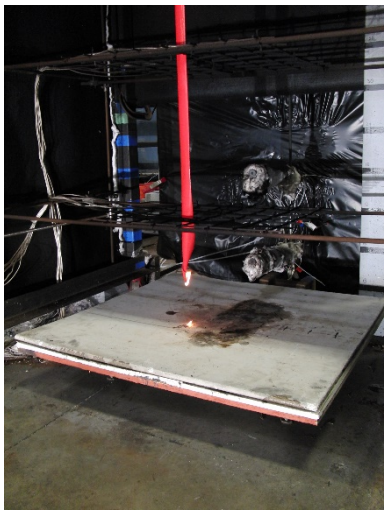
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

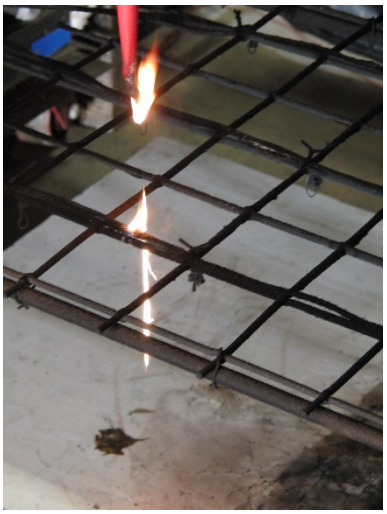
[1]From top of platform, [2]From center of platform











Test ID: 08_28_007 (EPRI) **Test Item: Long Duct Tape Air**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.05

Peak HRR (kW): 1.0 Burning Duration (s): 391 Ignition Method: Lighter

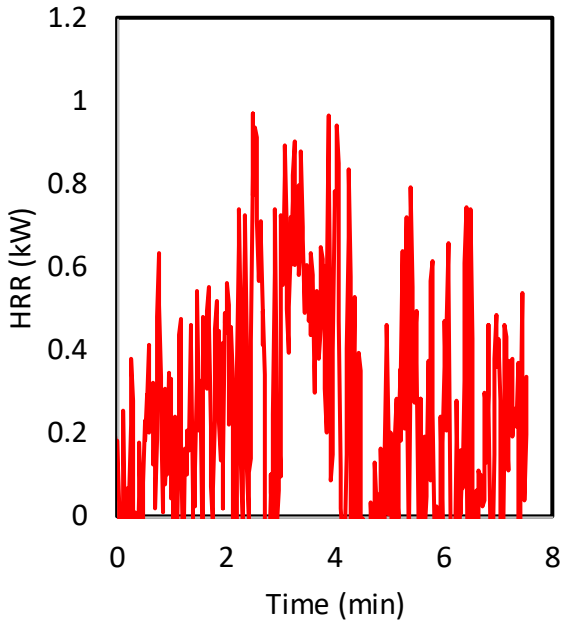
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.11

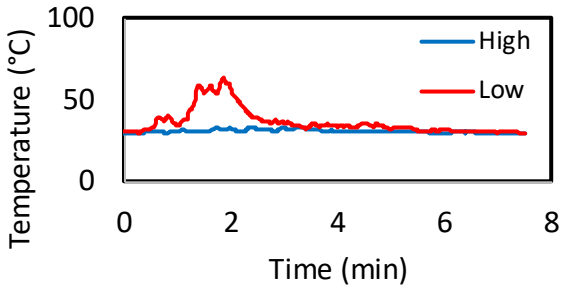
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

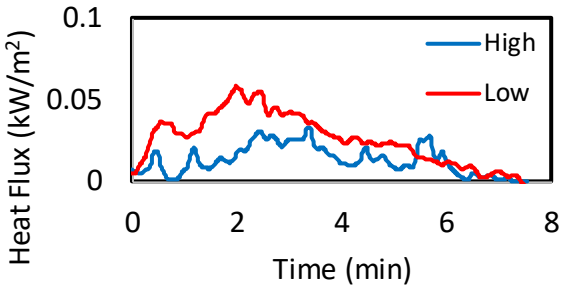
TC Grid Heights[1] (cm): 30, 76

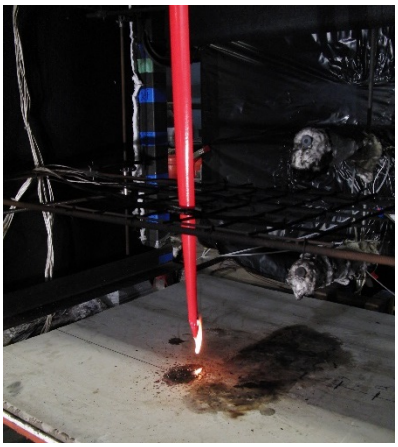
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

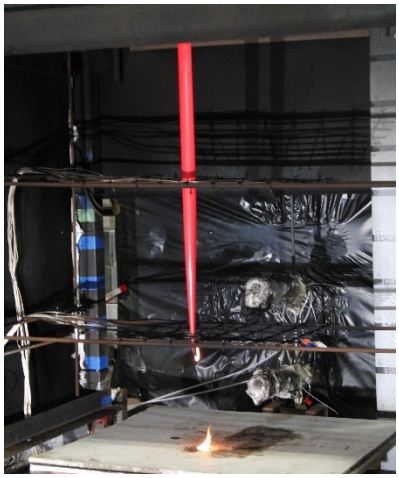
[1]From top of platform, [2]From center of platform











Test ID: 08_28_008 (EPRI) **Test Item: Long Duct Tape Air**

Max Fire Diameter (m): 0.03 Max Flame Height (m): 0.12

Peak HRR (kW): 1.5 Burning Duration (s): 853 Ignition Method: Lighter

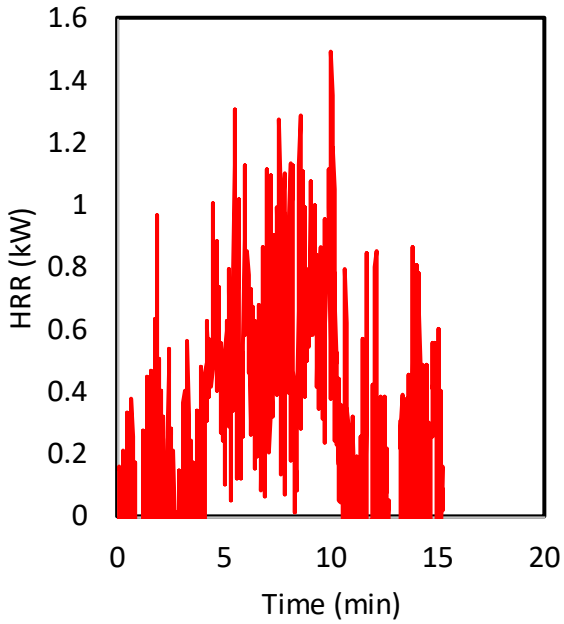
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.24

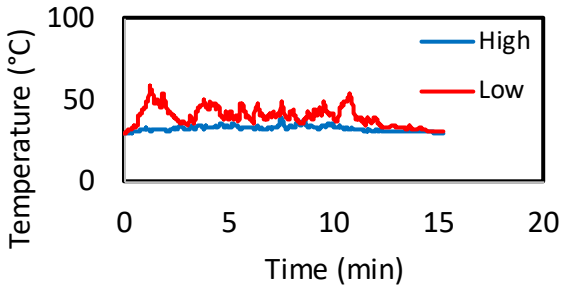
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

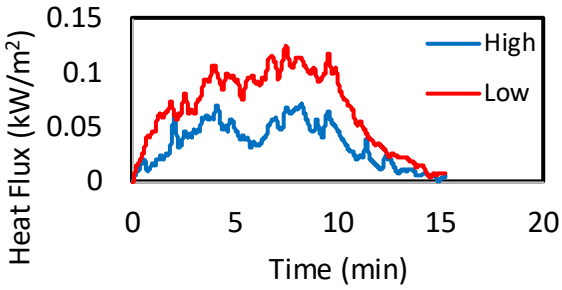
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform







Test ID: 08_29_001 (EPRI) **Test Item: Plastic Tarp Folded**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.31

Peak HRR (kW): 2.9 Burning Duration (s): 718 Ignition Method: Wick

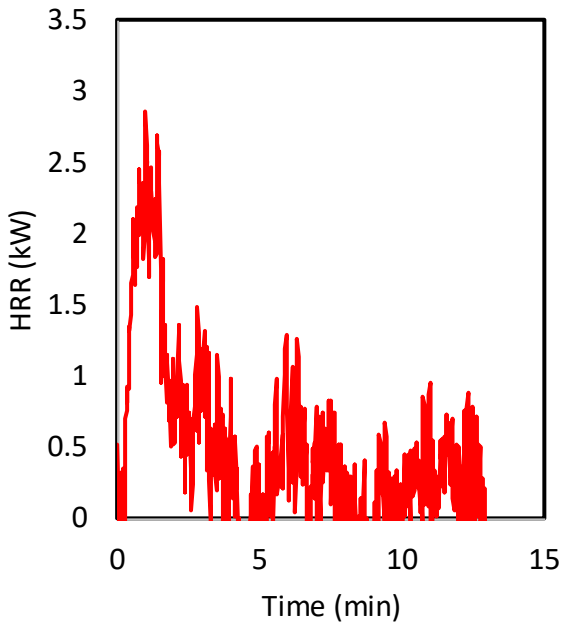
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.36

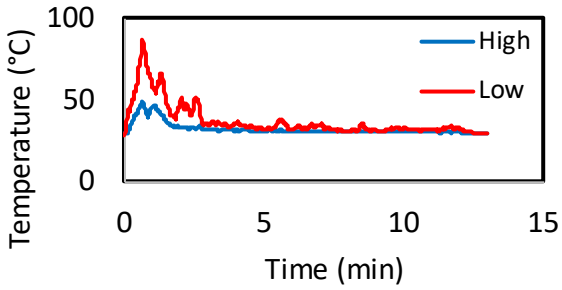
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

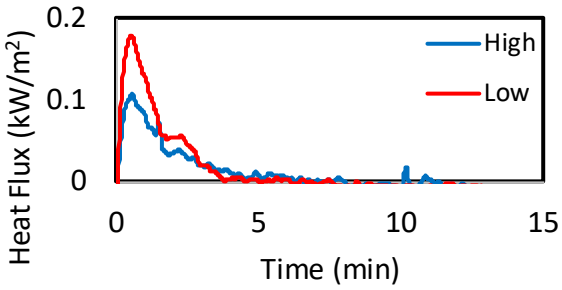
TC Grid Heights[1] (cm): 46. 91

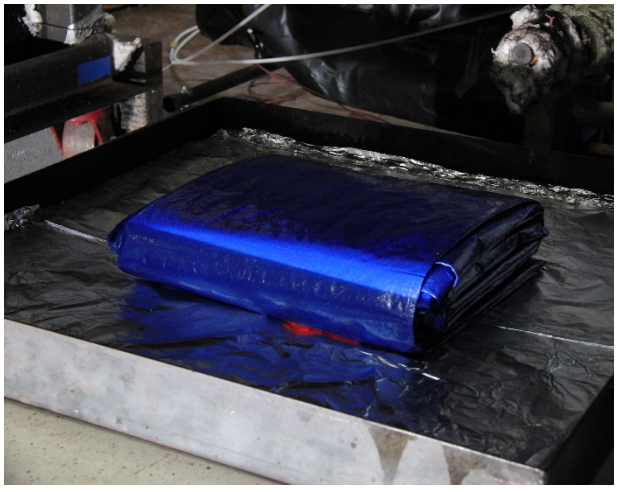
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 08_29_002 (EPRI) **Test Item: Plastic Tarp Folded**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.63

Peak HRR (kW): 60.2 Burning Duration (s): 3,899 Ignition Method: Wick

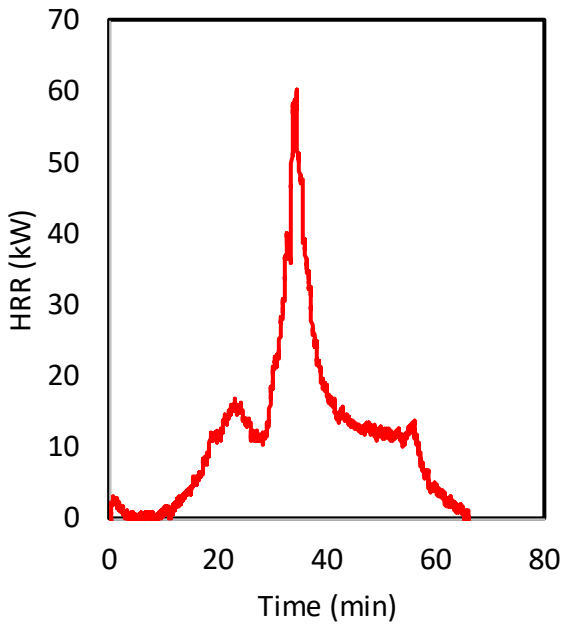
Heat of Combustion (MJ/kg): 46.6 Total Energy Release (MJ): 46.6

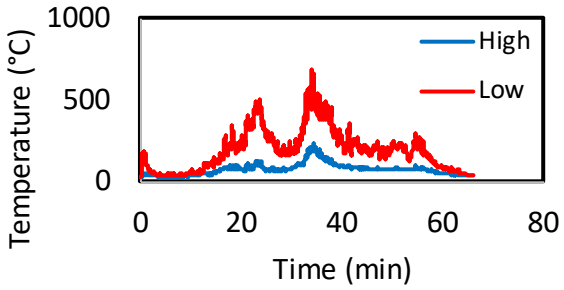
Soot Yield (kg/kg): 0.053 CO Yield (kg/kg): 0.015

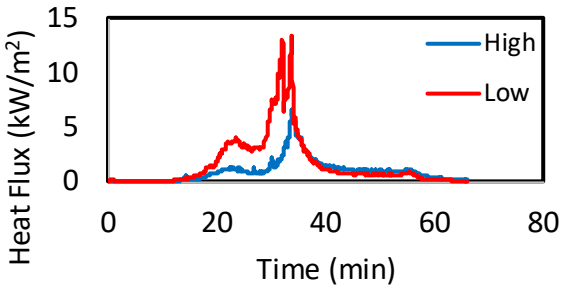
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 08_29_003 (EPRI) **Test Item: Plastic Tarp Folded**

Max Fire Diameter (m): 0.30 Max Flame Height (m): 0.56

Peak HRR (kW): 57.4 Burning Duration (s): 3,123 Ignition Method: Wick

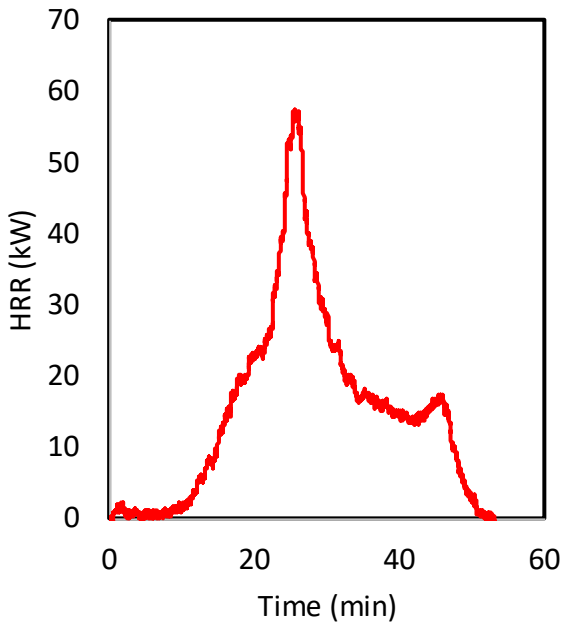
Heat of Combustion (MJ/kg): 45.7 Total Energy Release (MJ): 48.6

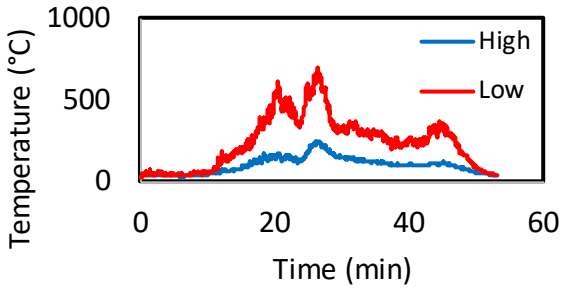
Soot Yield (kg/kg): 0.060 CO Yield (kg/kg): 0.18

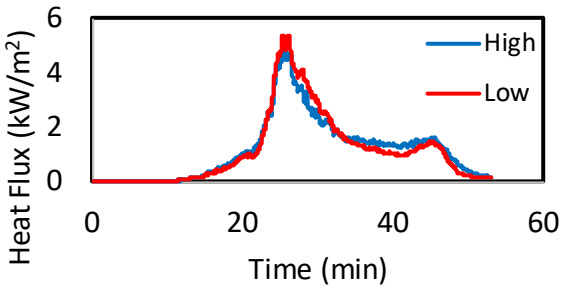
TC Grid Heights[1] (cm): 30, 76

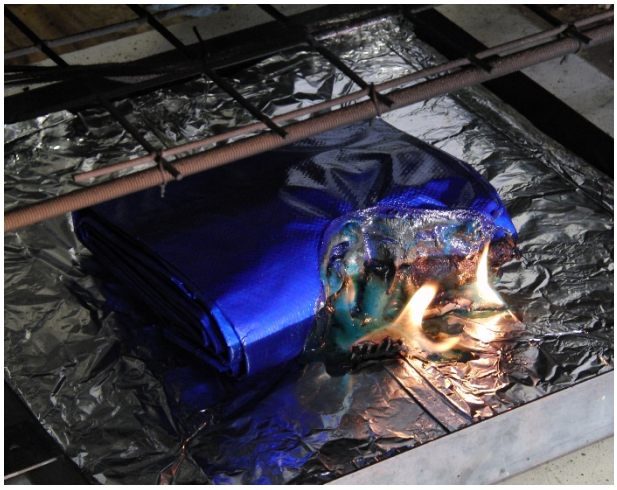
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform









Test ID: 08_29_004 (EPRI) **Test Item: Power Spider**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.19

Peak HRR (kW): 1.3 Burning Duration (s): 864 Ignition Method: Flame

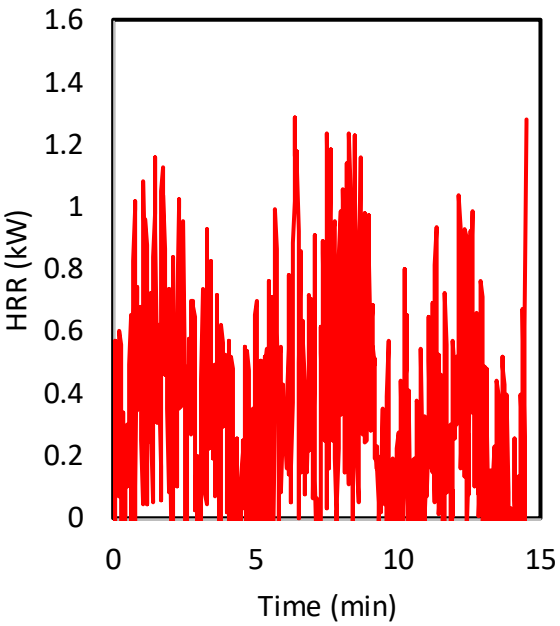
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.56

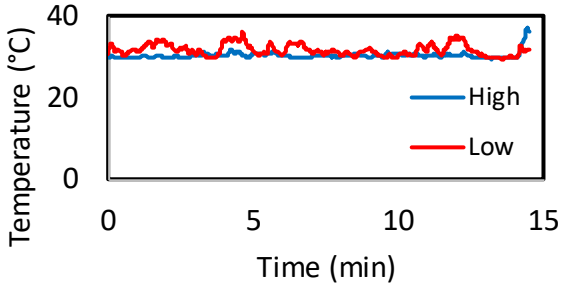
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

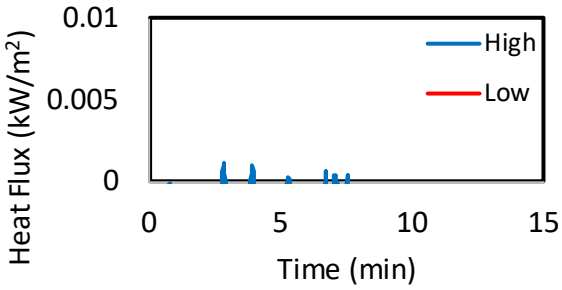
TC Grid Heights[1] (cm): 46, 76

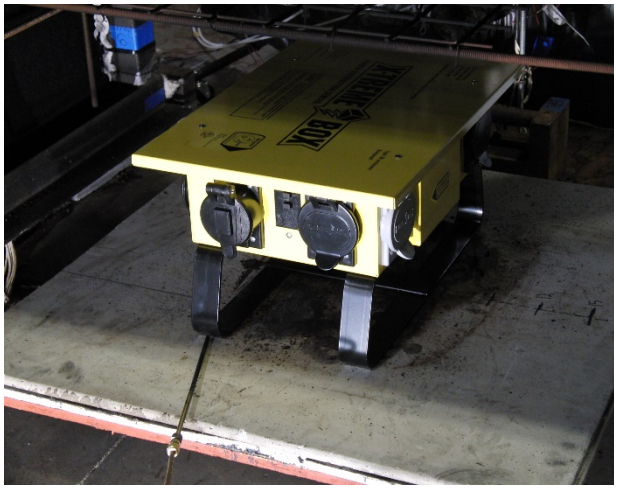
HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 46

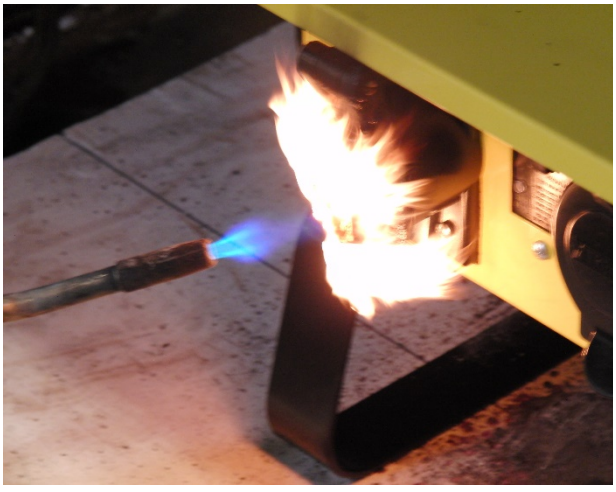
[1]From top of platform, [2]From center of platform











Test ID: 08_30_001 (EPRI) **Test Item: Power Spider**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.0

Peak HRR (kW): 5.7 Burning Duration (s): 1,003 Ignition Method: Flame

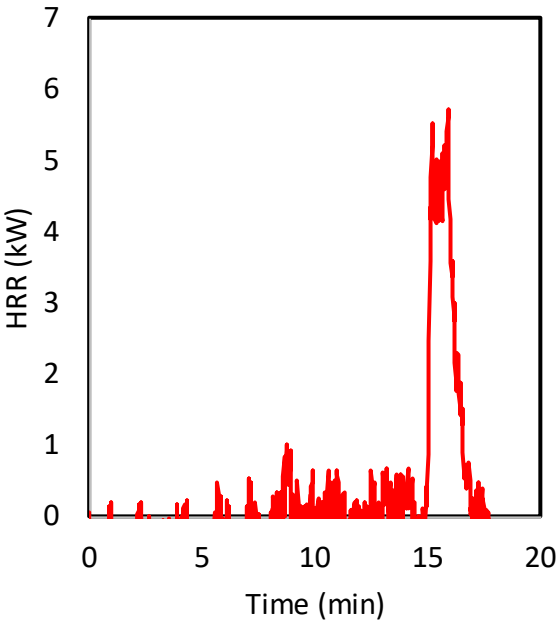
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.15

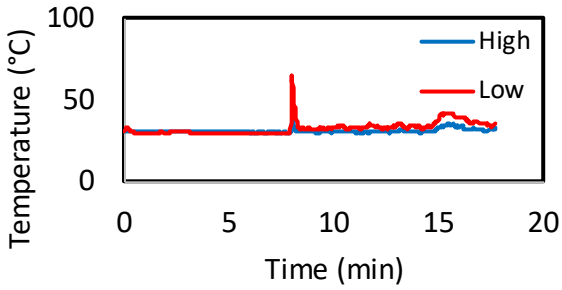
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

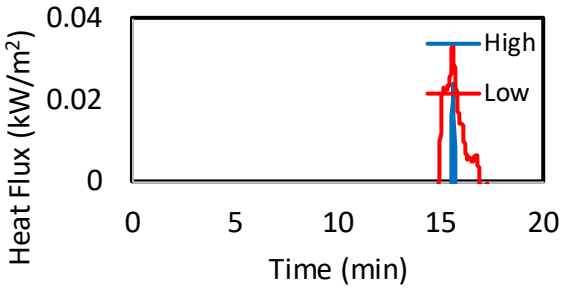
TC Grid Heights[1] (cm): 46, 76

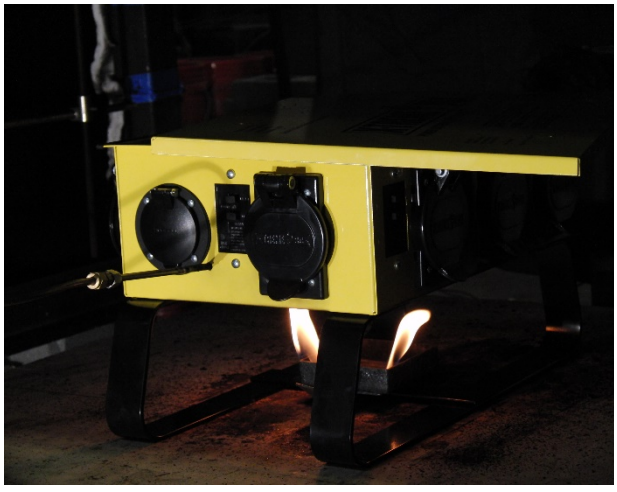
HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 46

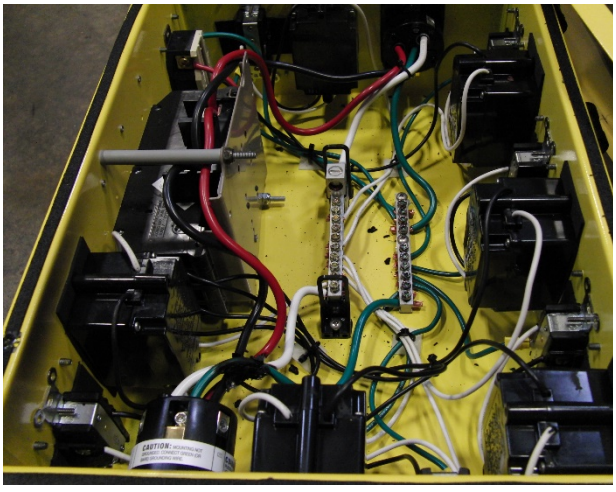
[1]From top of platform, [2]From center of platform











Test ID: 08_30_002 (EPRI) **Test Item: Canvas Tarp Folded**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.30

Peak HRR (kW): 2.8 Burning Duration (s): 365 Ignition Method: Wick

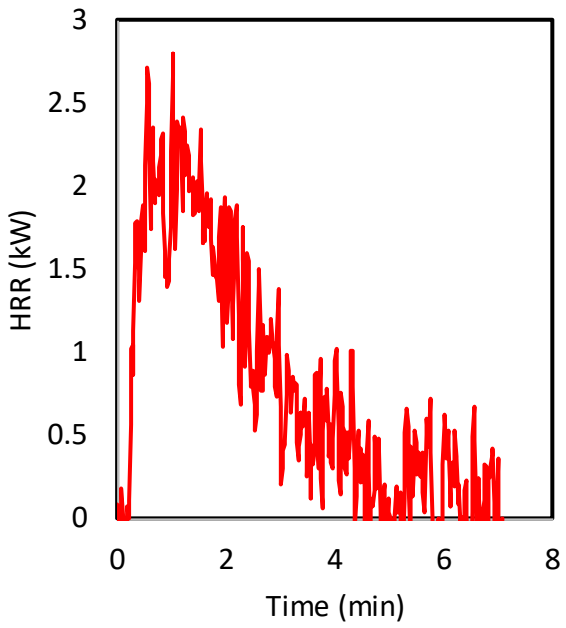
Heat of Combustion (MJ/kg): 19.4 Total Energy Release (MJ): 0.33

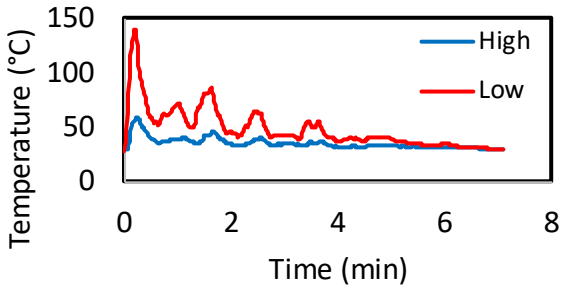
Soot Yield (kg/kg): 0.011 CO Yield (kg/kg): 0.015

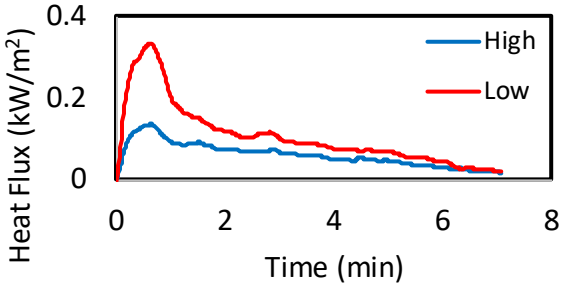
TC Grid Heights[1] (cm): 46, 76

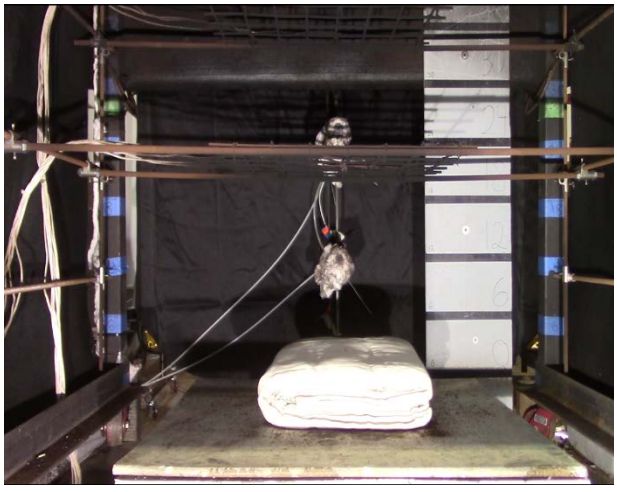
HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 08_30_003 (EPRI) **Test Item: Canvas Tarp Folded**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.14

Peak HRR (kW): 3.2 Burning Duration (s): 479 Ignition Method: Wick

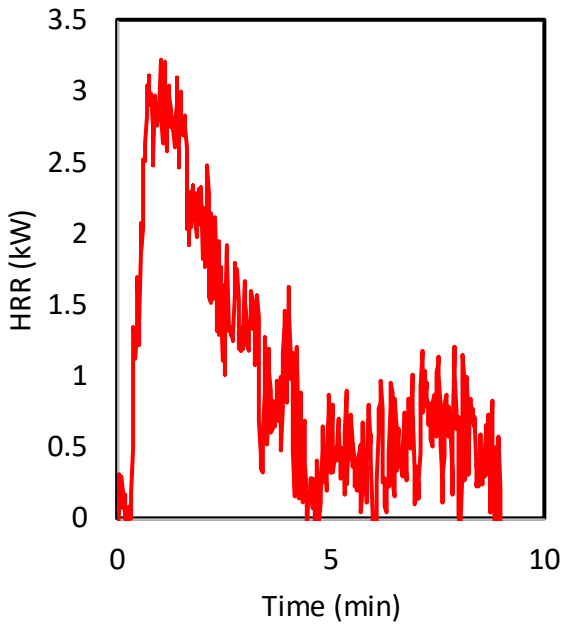
Heat of Combustion (MJ/kg): 23.5 Total Energy Release (MJ): 0.55

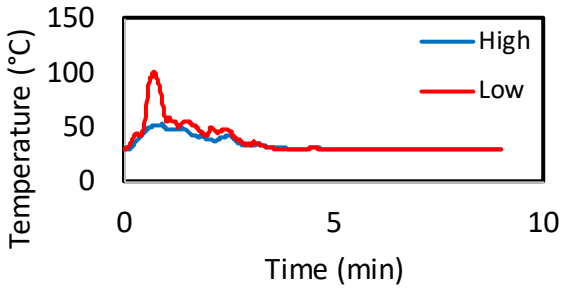
Soot Yield (kg/kg): 0.010 CO Yield (kg/kg): 0.041

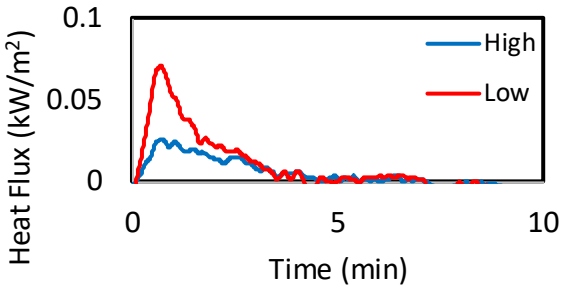
TC Grid Heights[1] (cm): 46, 76

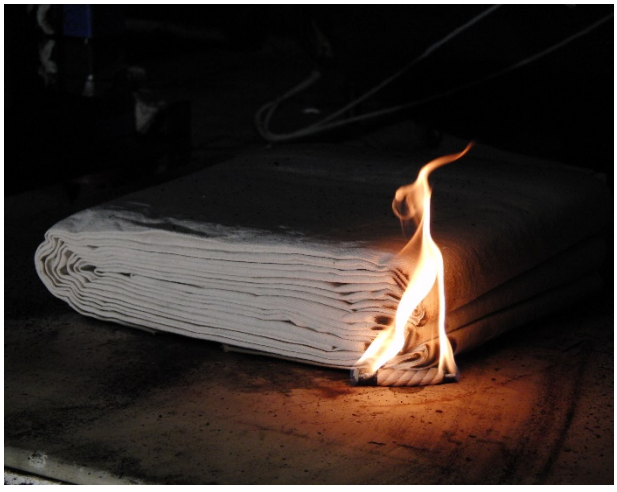
HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 08_30_004 (EPRI) **Test Item: Canvas Tarp Folded**

Max Fire Diameter (m): 0.10 Max Flame Height (m): 0.30

Peak HRR (kW): 2.5 Burning Duration (s): 376 Ignition Method: Wick

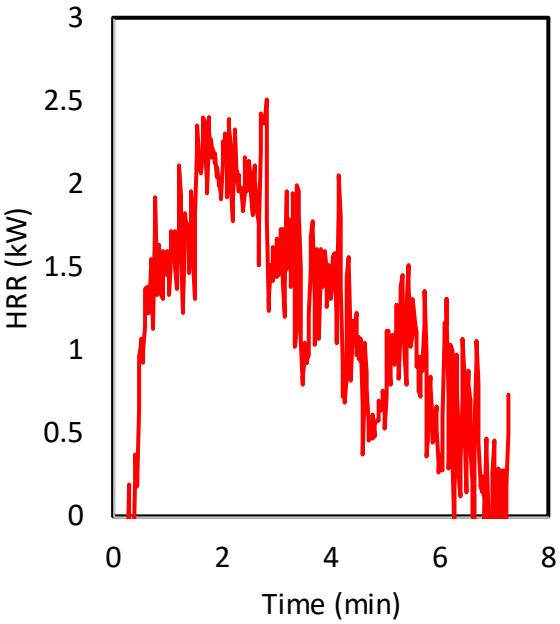
Heat of Combustion (MJ/kg): 11.6 Total Energy Release (MJ): 0.50

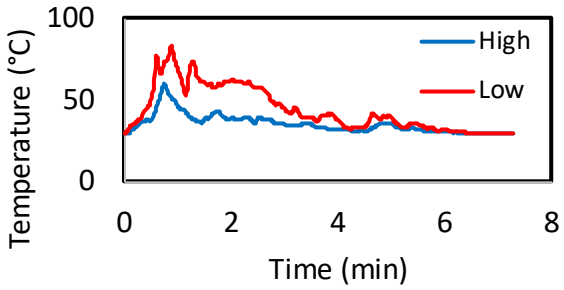
Soot Yield (kg/kg):0.004 CO Yield (kg/kg): 0.020

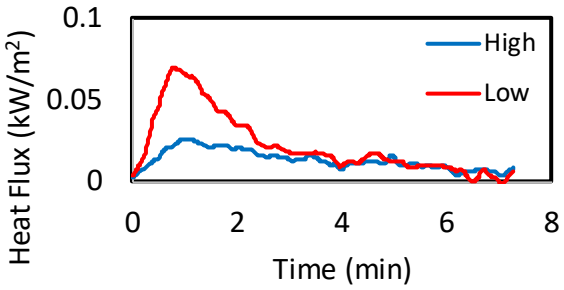
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 30, 61 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 08_30_005 (EPRI) **Test Item: Oxy-Acetylene Hose**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.10

Peak HRR (kW): 3.2 Burning Duration (s): 541 Ignition Method: Flame

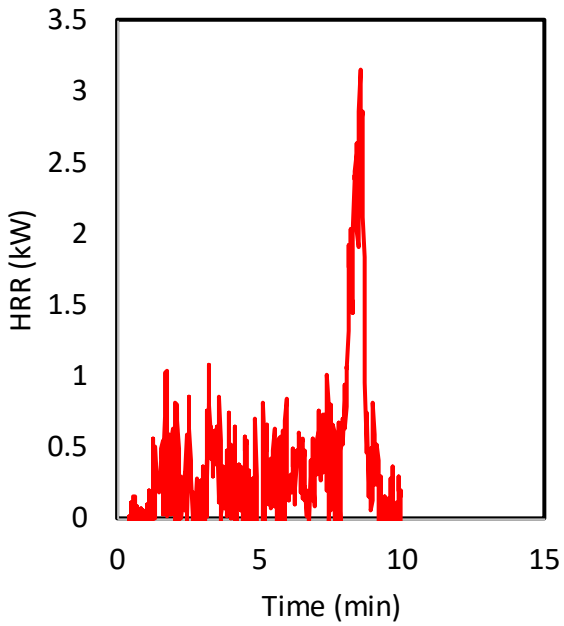
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.19

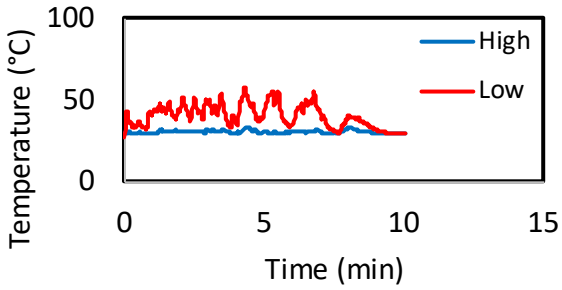
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

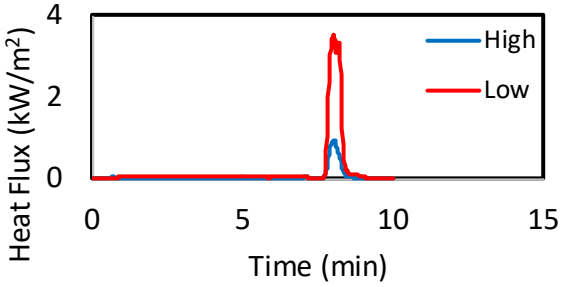
TC Grid Heights[1] (cm): 30, 76

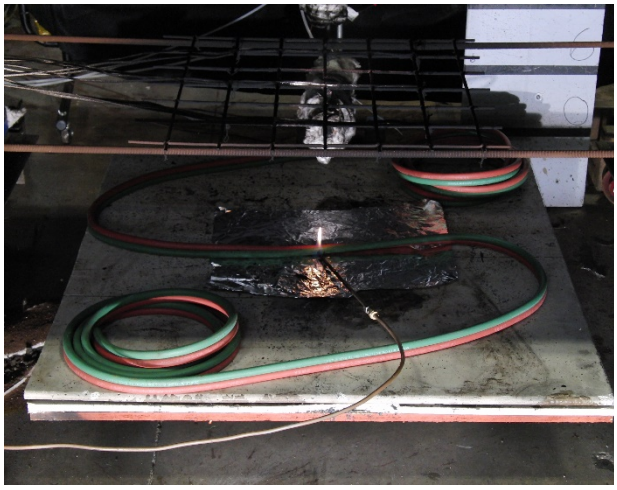
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 09_04_001 (EPRI) **Test Item: Oxy-Acetylene Hose**

Max Fire Diameter (m): 0.01 Max Flame Height (m): 0.12

Peak HRR (kW): 1.7 Burning Duration (s): 648 Ignition Method: Flame

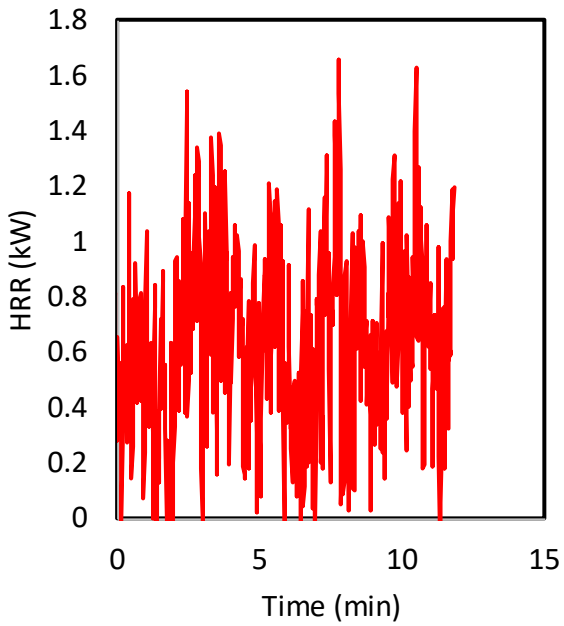
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.55

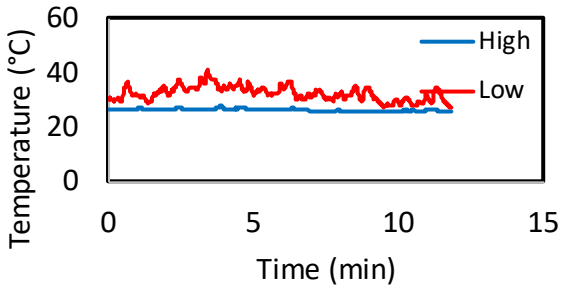
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

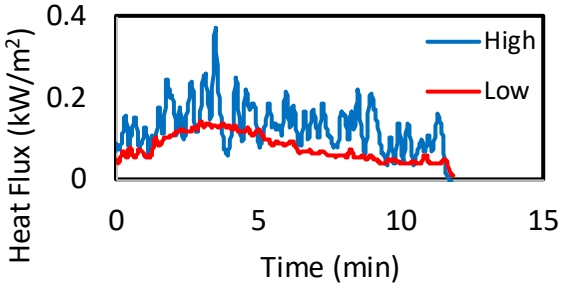
TC Grid Heights[1] (cm): 30, 76

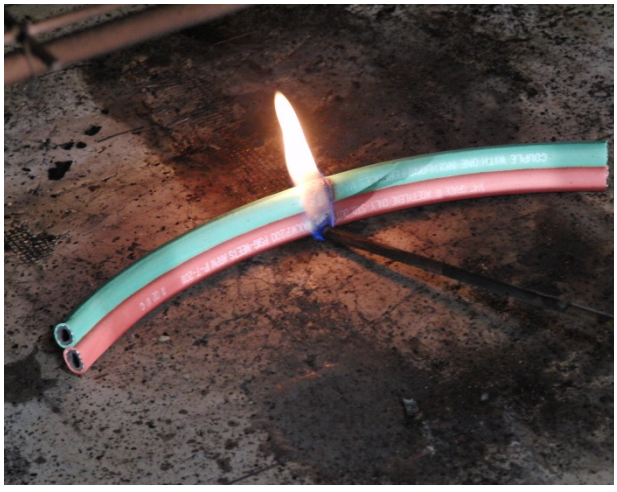
HF Gauge Heights[1] (cm): 11, 42 HF Gauge Distance[2] (cm): 23

[1]From top of platform, [2]From center of platform









Test ID: 09_04_002 (EPRI) **Test Item: Single PPE**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.37

Peak HRR (kW): 16.8 Burning Duration (s): 2,345 Ignition Method: Wick

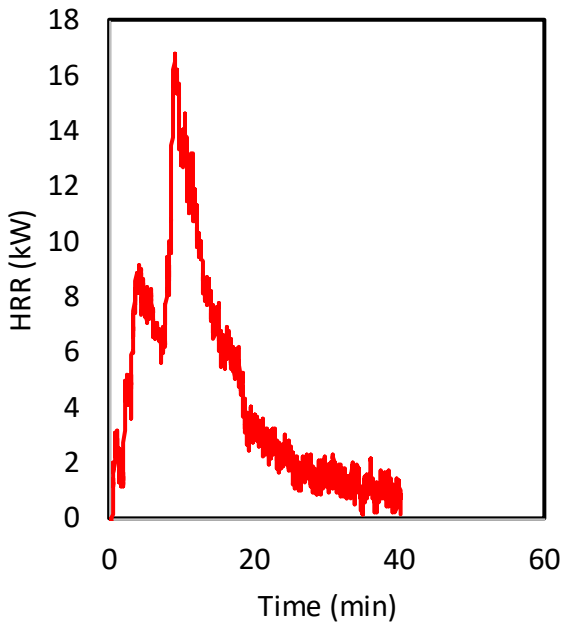
Heat of Combustion (MJ/kg): 34.3 Total Energy Release (MJ): 10.82

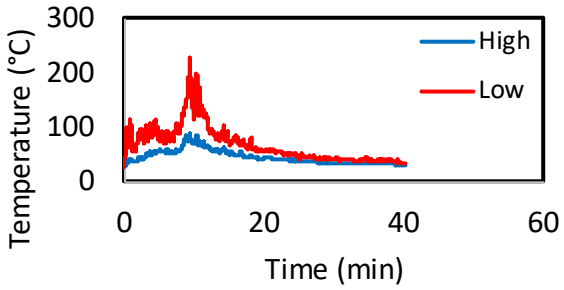
Soot Yield (kg/kg): 0.093 CO Yield (kg/kg): 0.056

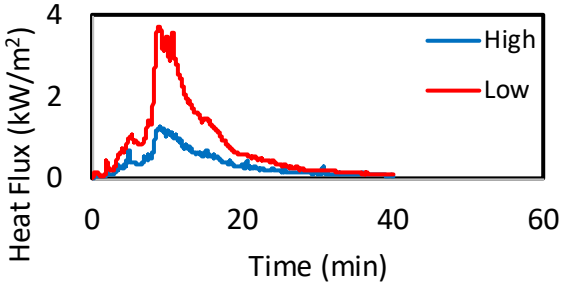
TC Grid Heights[1] (cm): 46, 91

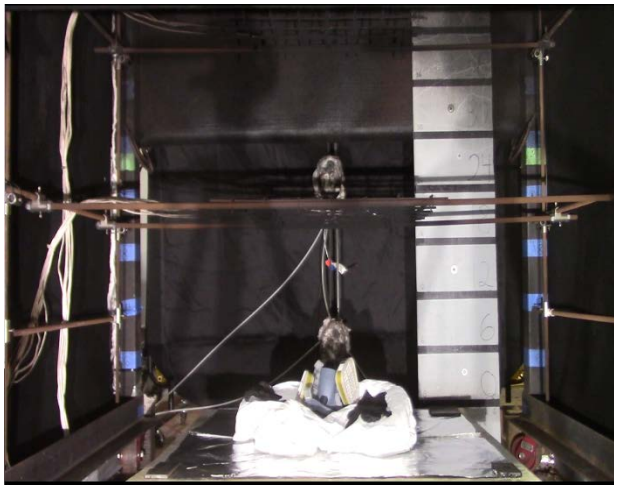
HF Gauge Heights[1] (cm): 20, 66 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 09_04_003 (EPRI) **Test Item: Single PPE**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.52

Peak HRR (kW): 25.9 Burning Duration (s): 1,463 Ignition Method: Wick

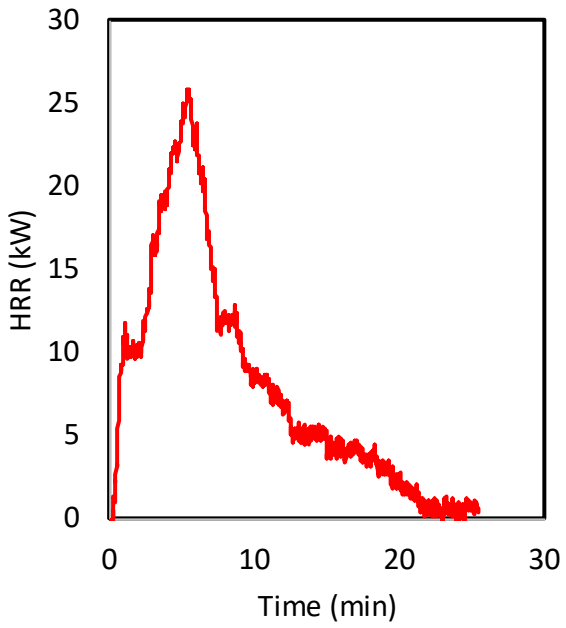
Heat of Combustion (MJ/kg): 33.2 Total Energy Release (MJ): 11.96

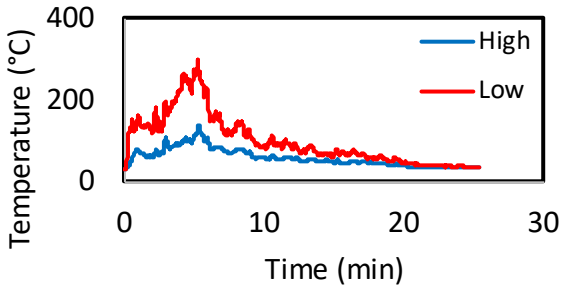
Soot Yield (kg/kg): 0.106 CO Yield (kg/kg): 0.051

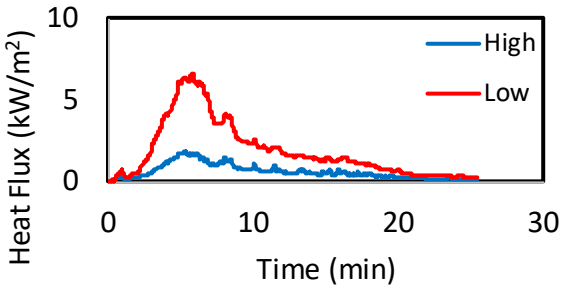
TC Grid Heights[1] (cm): 46, 91

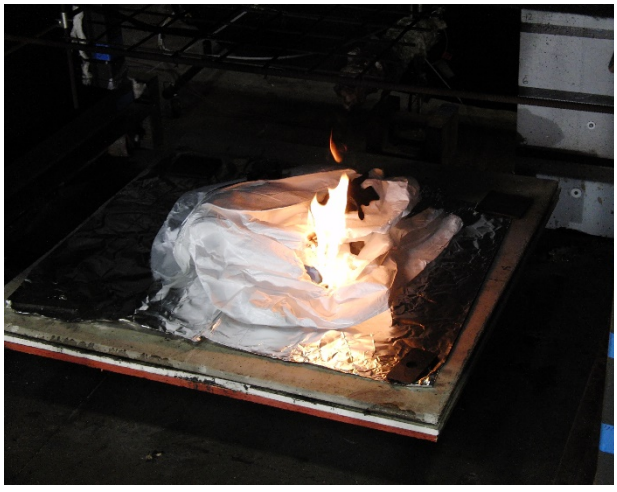
HF Gauge Heights[1] (cm): 20, 66 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 09_04_004 (EPRI) **Test Item: Single PPE**

Max Fire Diameter (m): 0.46 Max Flame Height (m): 0.41

Peak HRR (kW): 20.3 Burning Duration (s): 1,421 Ignition Method: Wick

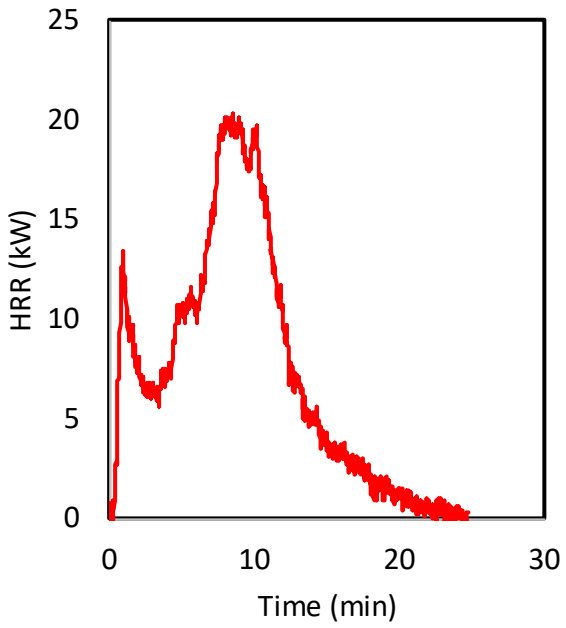
Heat of Combustion (MJ/kg): 32.7 Total Energy Release (MJ): 10.63

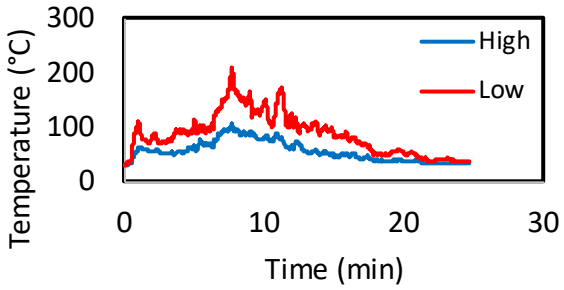
Soot Yield (kg/kg): 0.104 CO Yield (kg/kg): 0.045

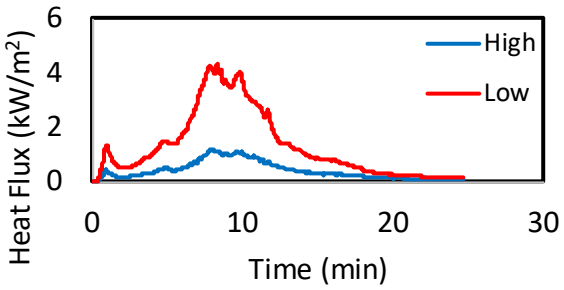
TC Grid Heights[1] (cm): 46, 91

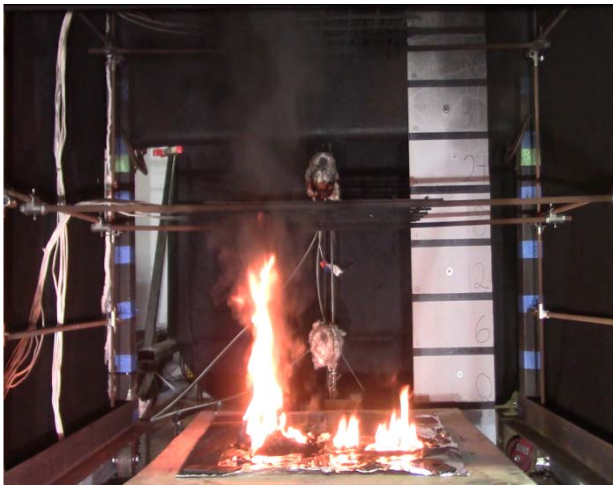
HF Gauge Heights[1] (cm): 20, 66 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 09_05_001 (EPRI) **Test Item: Metal Trash Quarter**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.06

Peak HRR (kW): 95.3 Burning Duration (s): 507 Ignition Method: Wick

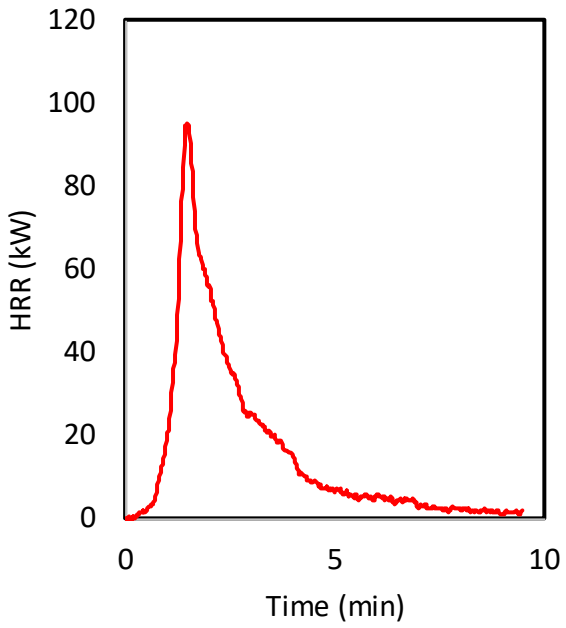
Heat of Combustion (MJ/kg): 20.8 Total Energy Release (MJ): 8.94

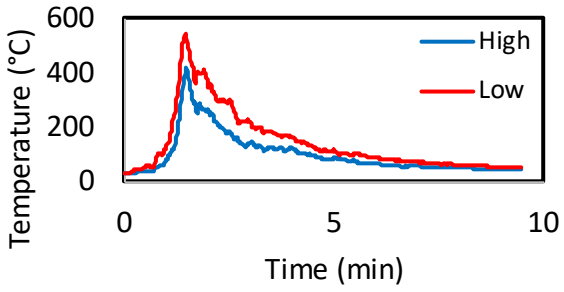
Soot Yield (kg/kg):0.009 CO Yield (kg/kg): 0.022

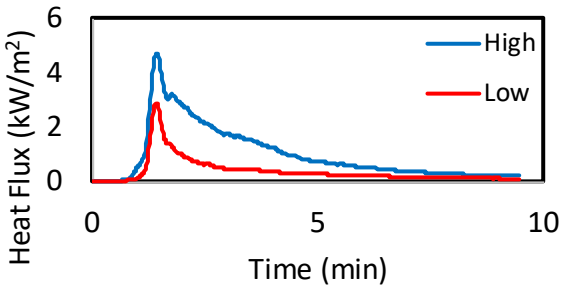
TC Grid Heights[1] (cm): 91, 117

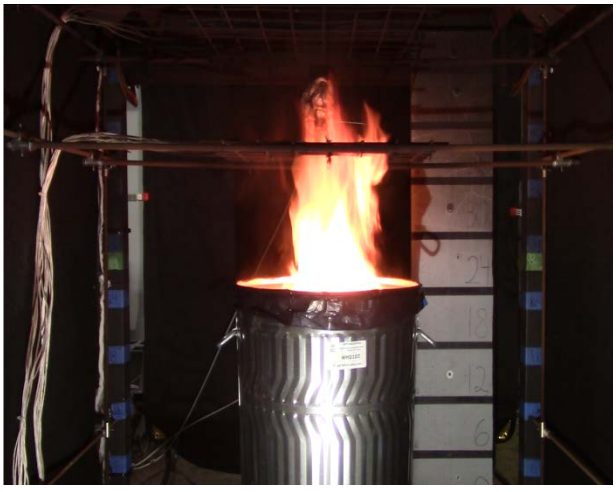
HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 09_05_002 (EPRI) **Test Item: Metal Trash Quarter**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.97

Peak HRR (kW): 82.1 Burning Duration (s): 676 Ignition Method: Wick

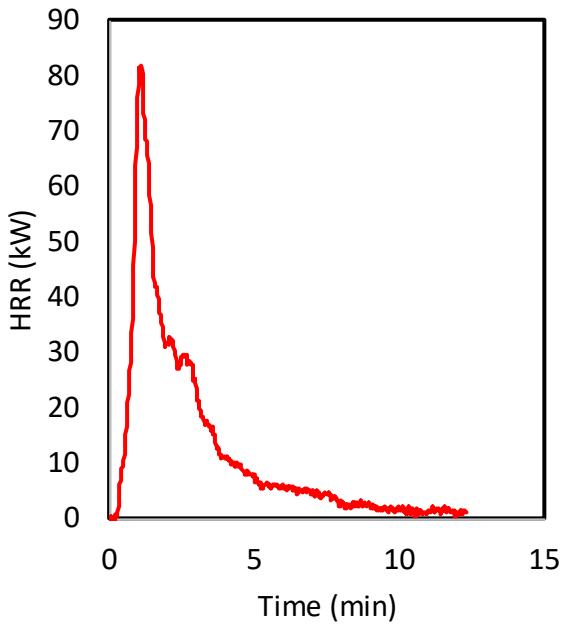
Heat of Combustion (MJ/kg): 20.9 Total Energy Release (MJ): 8.99

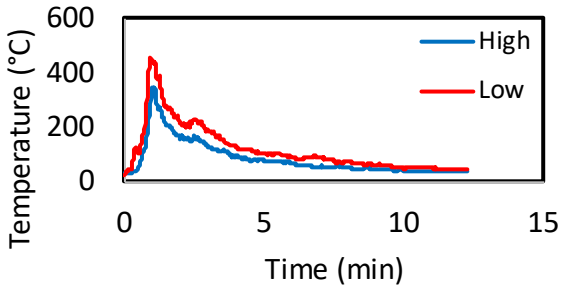
Soot Yield (kg/kg): 0.011 CO Yield (kg/kg): 0.024

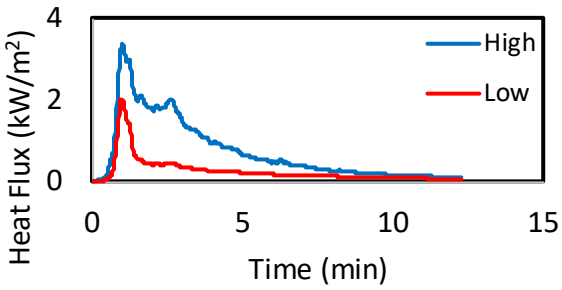
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 09_05_003 (EPRI) **Test Item: Metal Trash Quarter**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.08

Peak HRR (kW): 75.5 Burning Duration (s): 488 Ignition Method: Wick

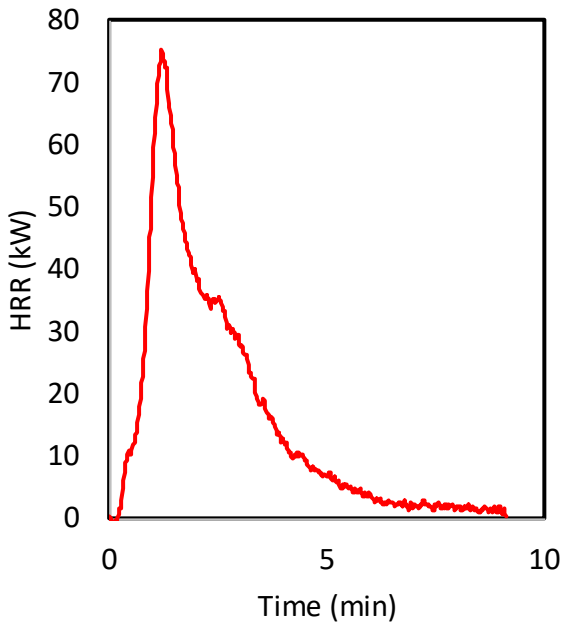
Heat of Combustion (MJ/kg): 20.2 Total Energy Release (MJ): 8.73

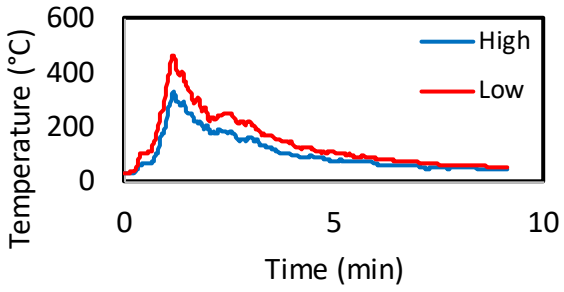
Soot Yield (kg/kg): 0.010 CO Yield (kg/kg): 0.020

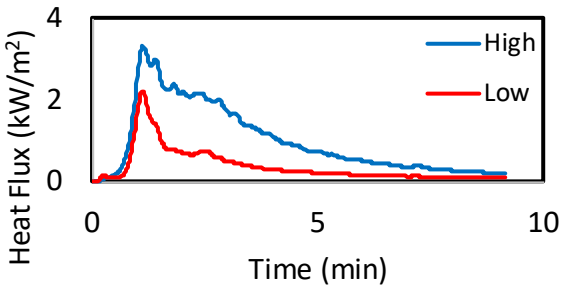
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform







Test ID: 09_05_004 (EPRI) **Test Item: Metal Trash Half**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 1.09

Peak HRR (kW): 86.9 Burning Duration (s): 716 Ignition Method: Wick

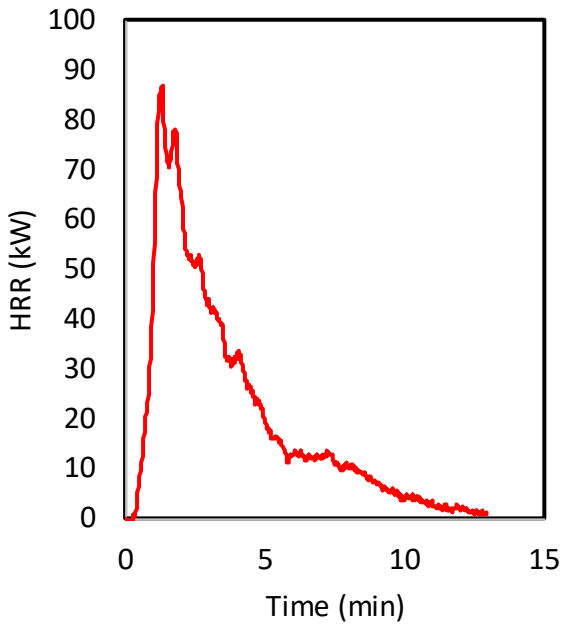
Heat of Combustion (MJ/kg): 19.2 Total Energy Release (MJ): 15.67

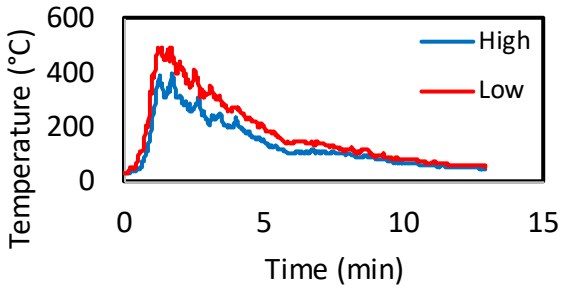
Soot Yield (kg/kg): 0.006 CO Yield (kg/kg): 0.023

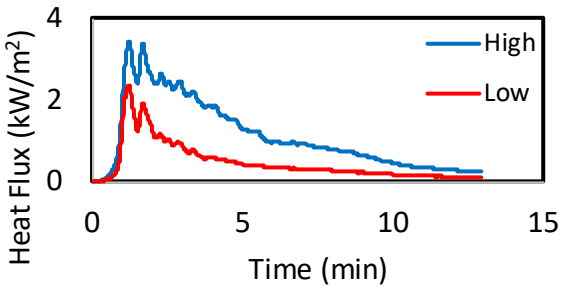
TC Grid Heights[1] (cm): 91, 117

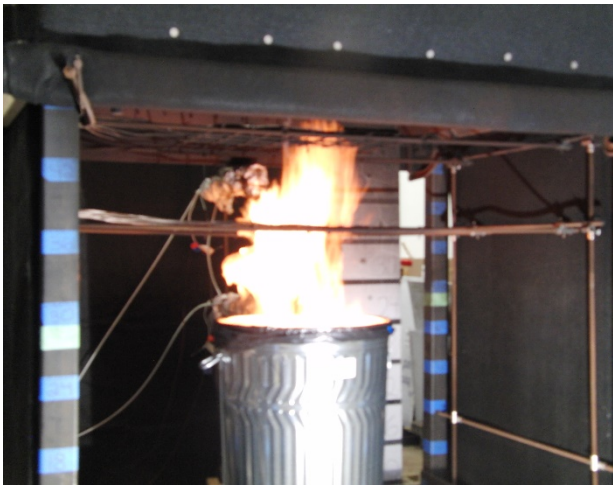
HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 09_05_005 (EPRI) **Test Item: Metal Trash Half**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.06

Peak HRR (kW): 83.4 Burning Duration (s): 764 Ignition Method:

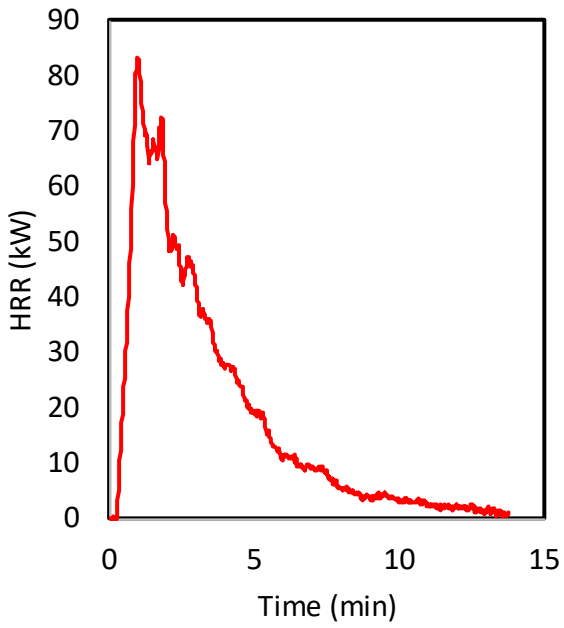
Heat of Combustion (MJ/kg): 19.1 Total Energy Release (MJ): 15.14

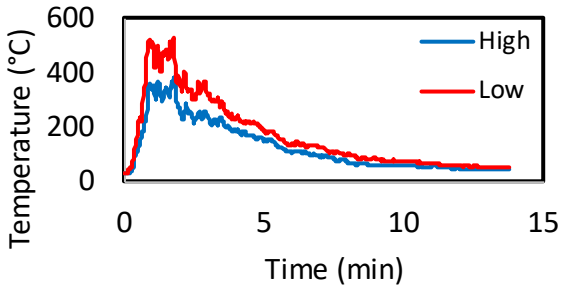
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.028

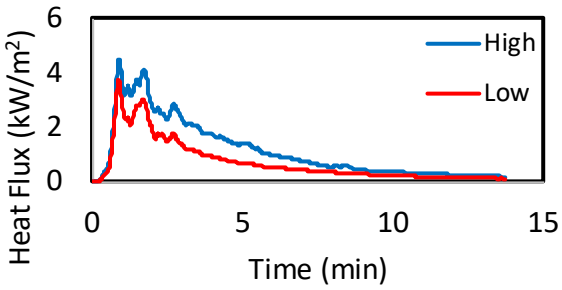
TC Grid Heights[1] (cm): 91, 117

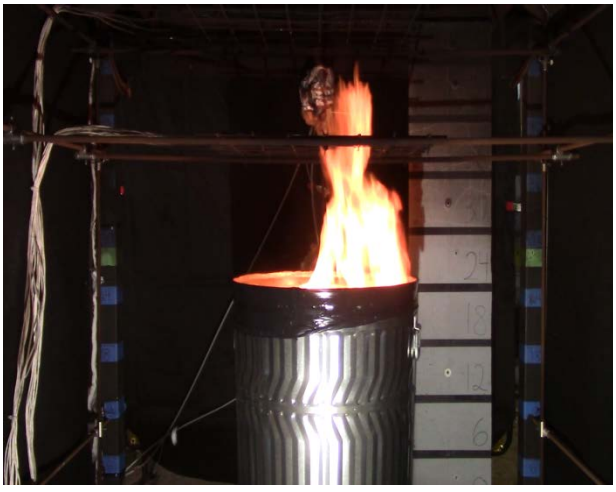
HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform









Test ID: 09_05_006 (EPRI) **Test Item: Metal Trash Half**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.12

Peak HRR (kW): 86.5 Burning Duration (s): 569 Ignition Method: Wick

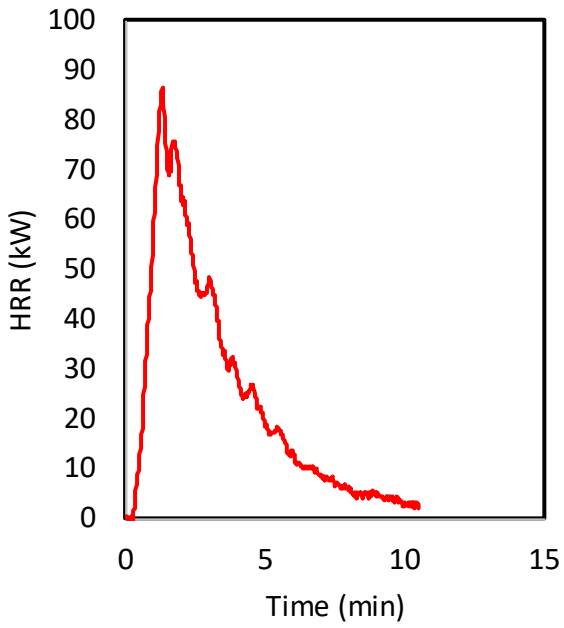
Heat of Combustion (MJ/kg): 18.8 Total Energy Release (MJ): 14.90

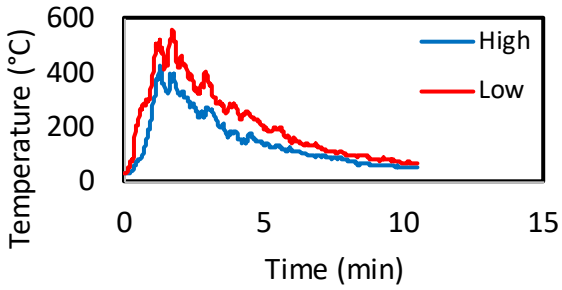
Soot Yield (kg/kg): 0.005 CO Yield (kg/kg): 0.023

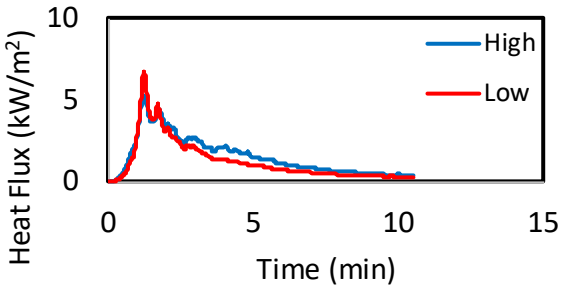
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 09_05_007 (EPRI) **Test Item: Metal Trash Full**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.12

Peak HRR (kW): 61.0 Burning Duration (s): 1,520 Ignition Method: Wick

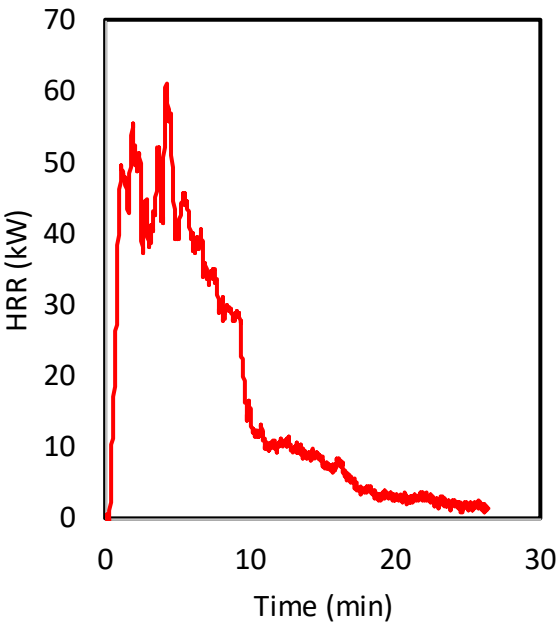
Heat of Combustion (MJ/kg): 18.4 Total Energy Release (MJ): 27.52

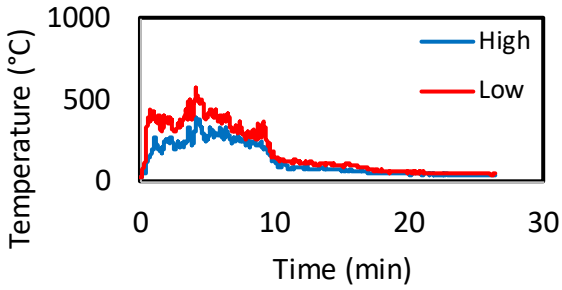
Soot Yield (kg/kg): 0.013 CO Yield (kg/kg): 0.040

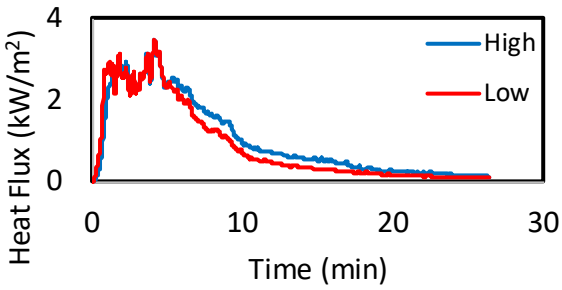
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 38

[1]From top of platform, [2]From center of platform







Test ID: 09_06_001 (EPRI) **Test Item: Metal Trash Full**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 1.27

Peak HRR (kW): 81.1 Burning Duration (s): 1,465 Ignition Method: Wick

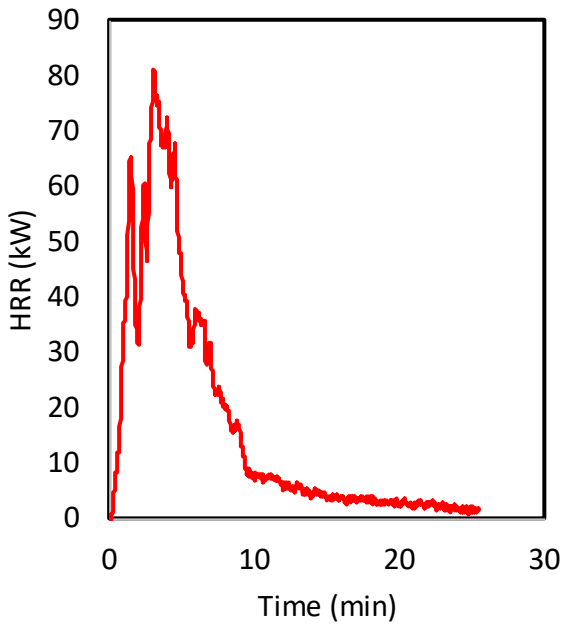
Heat of Combustion (MJ/kg): 17.5 Total Energy Release (MJ): 25.42

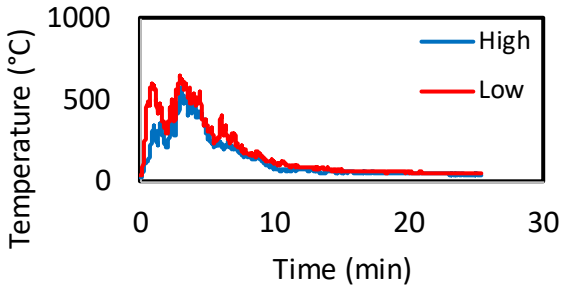
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.038

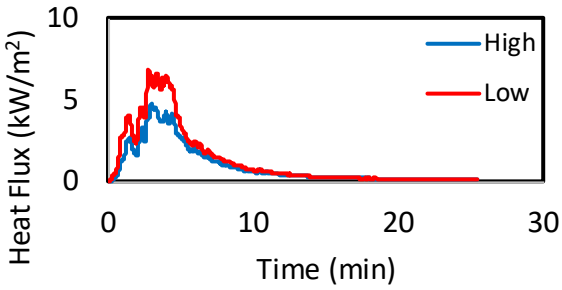
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 09_06_002 (EPRI) **Test Item: Metal Trash Full**

Max Fire Diameter (m): 0.21 Max Flame Height (m): 1.46

Peak HRR (kW): 60.9 Burning Duration (s): 1,512 Ignition Method: Wick

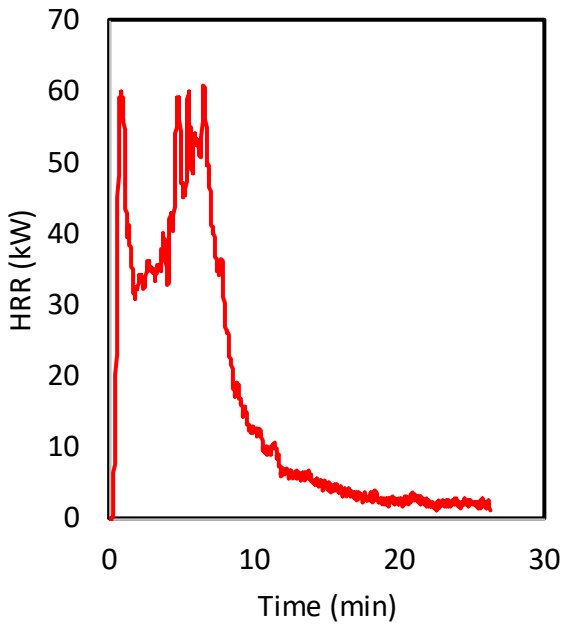
Heat of Combustion (MJ/kg): 17.7 Total Energy Release (MJ): 25.67

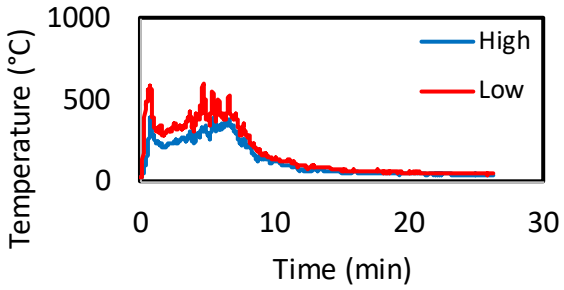
Soot Yield (kg/kg): 0.014 CO Yield (kg/kg): 0.036

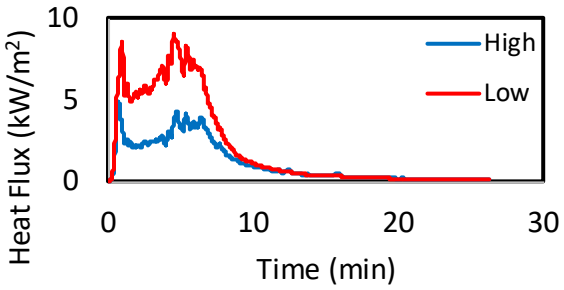
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 09_06_003 (EPRI) **Test Item: Metal Trash Full Lid**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.89

Peak HRR (kW): 15.7 Burning Duration (s): 2,196 Ignition Method: Wick

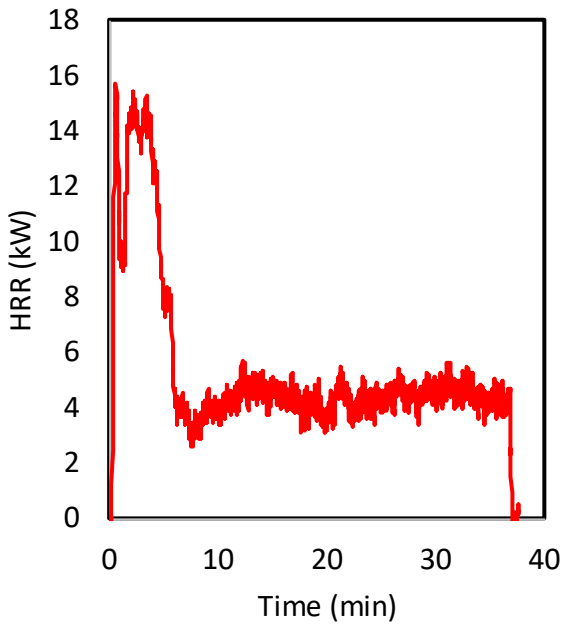
Heat of Combustion (MJ/kg): 9.3 Total Energy Release (MJ): 11.96

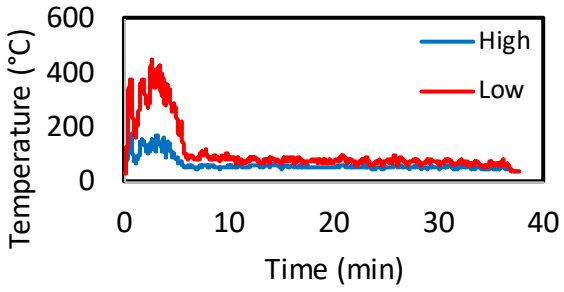
Soot Yield (kg/kg): 0.033 CO Yield (kg/kg): 0.176

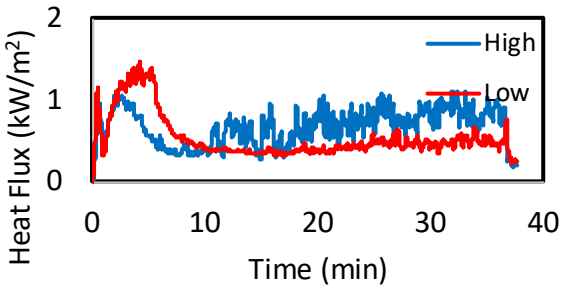
TC Grid Heights[1] (cm): 91, 117

HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 51

[1]From top of platform, [2]From center of platform







Test ID: 09_06_004 (EPRI) **Test Item: Metal Trash Full Lid**

Max Fire Diameter (m): 0.15 Max Flame Height (m): 1.08

Peak HRR (kW): 21.2 Burning Duration (s): 515 Ignition Method: Wick

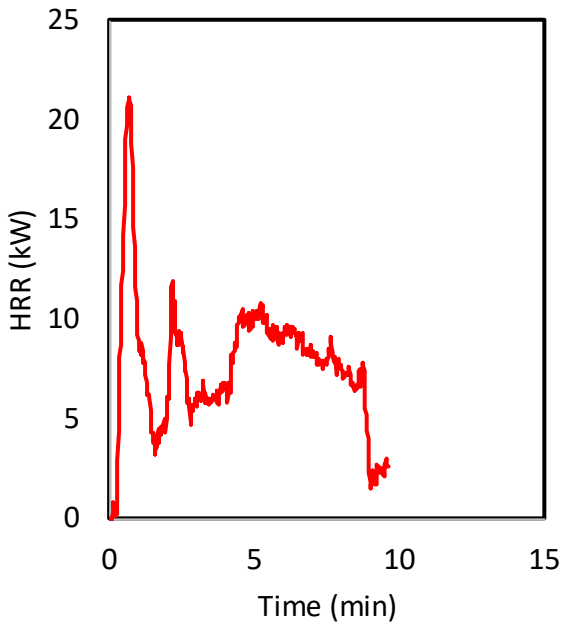
Heat of Combustion (MJ/kg): 9.7 Total Energy Release (MJ): 4.40

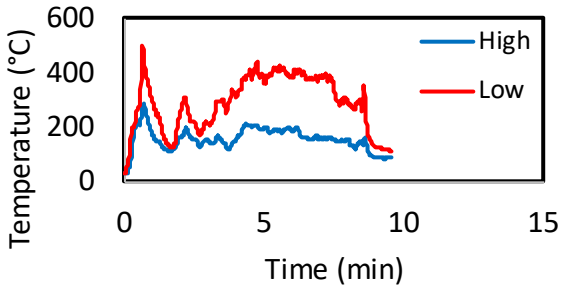
Soot Yield (kg/kg): 0.004 CO Yield (kg/kg): 0.028

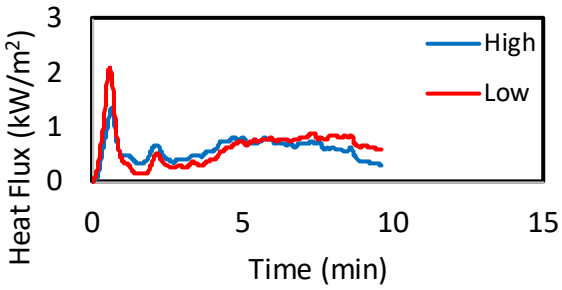
TC Grid Heights[1] (cm): 91, 117

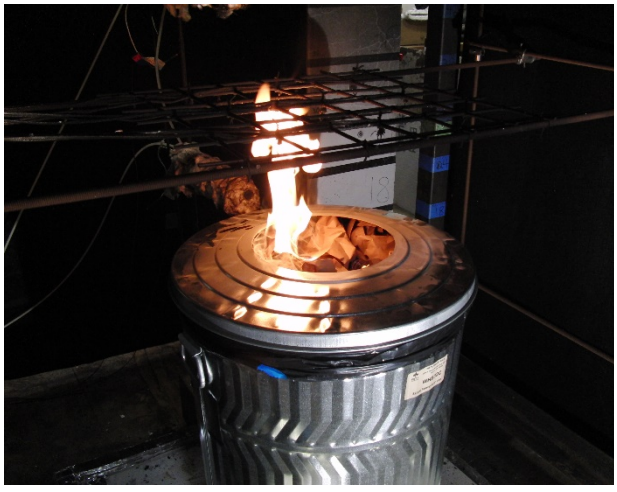
HF Gauge Heights[1] (cm): 69, 114 HF Gauge Distance[2] (cm): 51

[1]From top of platform, [2]From center of platform









Test ID: 09_07_001 (EPRI) **Test Item: 7.6 m Coil Chain**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.20

Peak HRR (kW): 26.1 Burning Duration (s): 4,908 Ignition Method: Flame

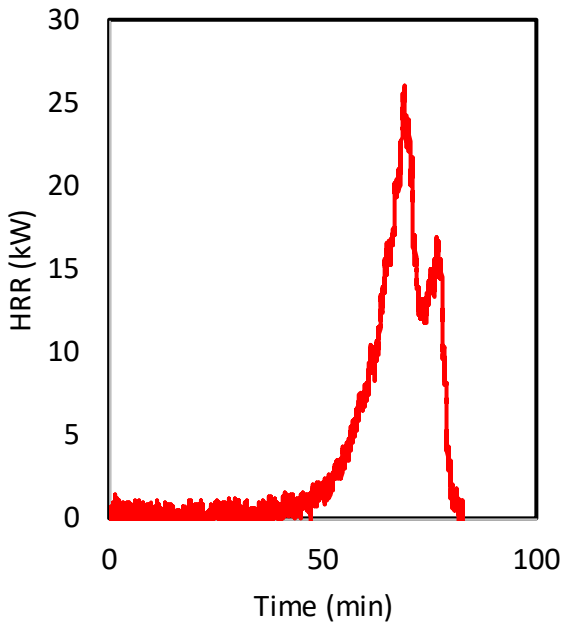
Heat of Combustion (MJ/kg): 48.9 Total Energy Release (MJ): 21.20

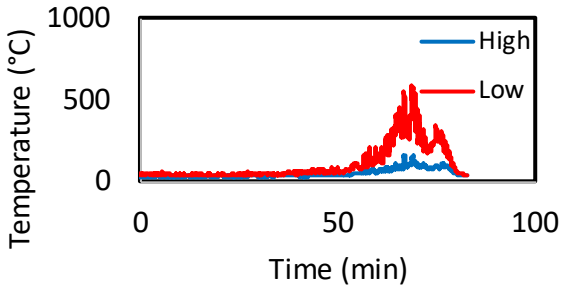
Soot Yield (kg/kg): 0.051 CO Yield (kg/kg): 0.014

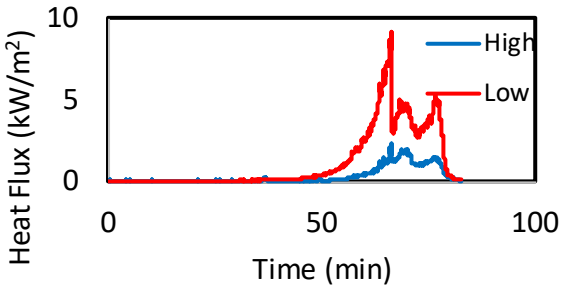
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 09_07_002 (EPRI) **Test Item: 7.6 m Coil Chain**

Max Fire Diameter (m): 0.29 Max Flame Height (m): 0.54

Peak HRR (kW): 23.9 Burning Duration (s): 3,883 Ignition Method: Flame

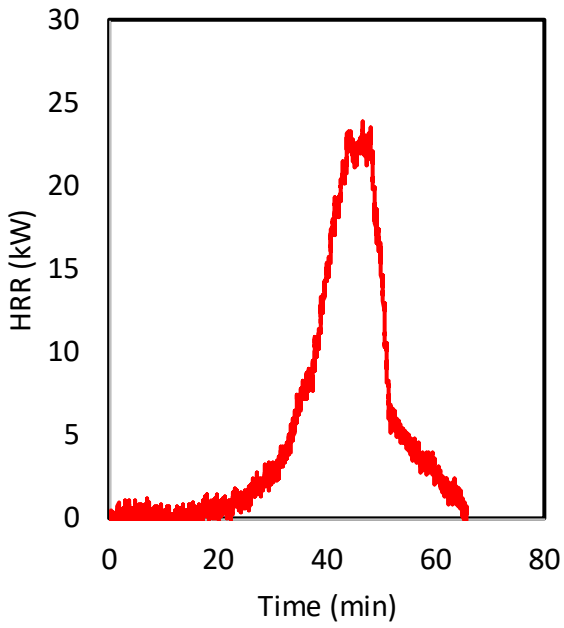
Heat of Combustion (MJ/kg): 51.3 Total Energy Release (MJ): 21.28

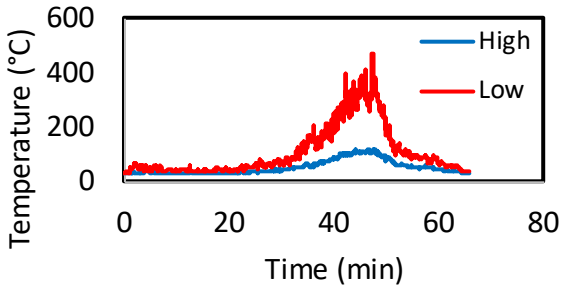
Soot Yield (kg/kg): 0.045 CO Yield (kg/kg): 0.012

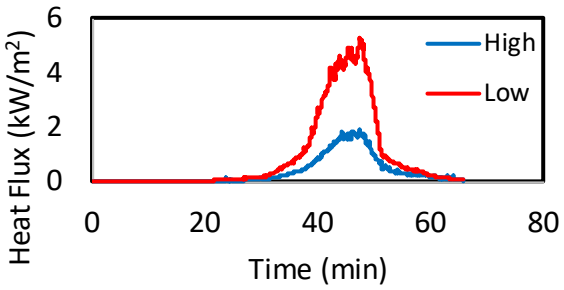
TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 09_10_001 (EPRI) **Test Item: 7.6 m Coil Chain**

Max Fire Diameter (m): Max Flame Height (m): 0.54

Peak HRR (kW): 37.2 Burning Duration (s): 3,405 Ignition Method: Flame

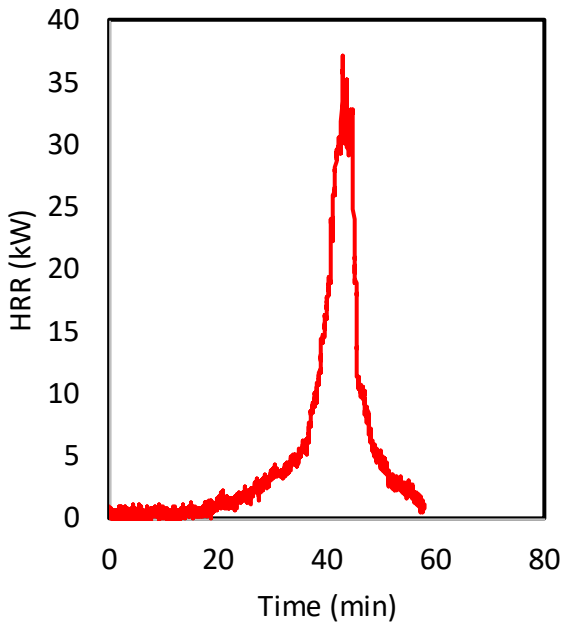
Heat of Combustion (MJ/kg): 42.6 Total Energy Release (MJ): 18.2

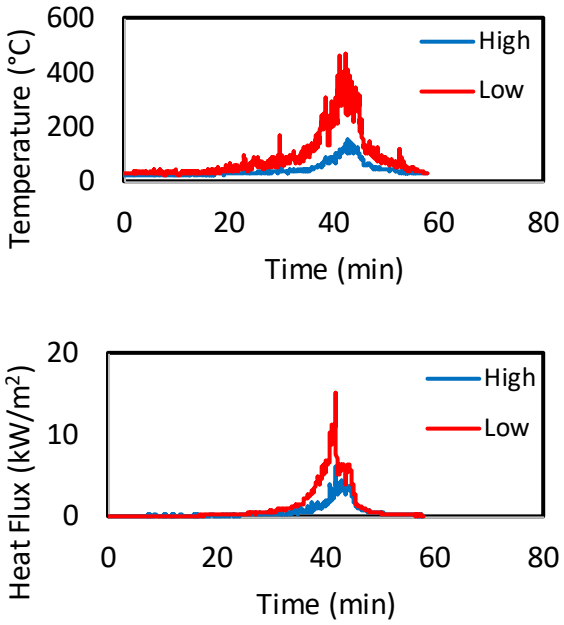
Soot Yield (kg/kg): 0.080 CO Yield (kg/kg): 0.020

TC Grid Heights[1] (cm): 30, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform





Test ID: 09_10_002a to e (EPRI) **Test Item: Wood Block Flame**

Max Fire Diameter (m): 0 Max Flame Height (m): 0

Peak HRR (kW): ~1 Burning Duration (s): 3,159 Ignition Method: Flame

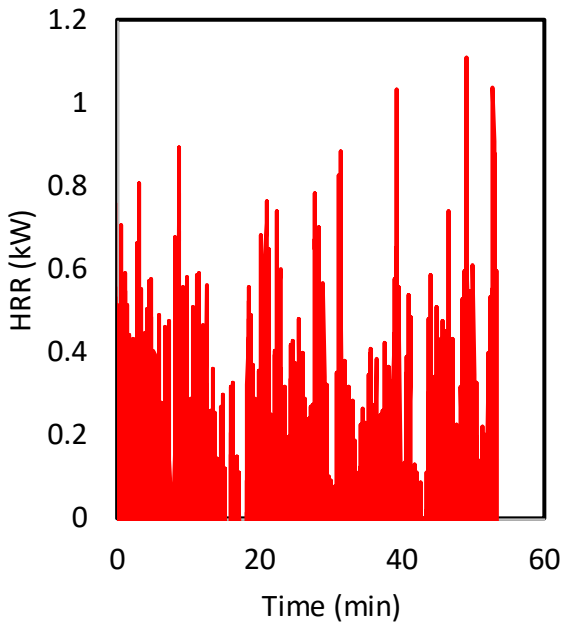
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 0.0

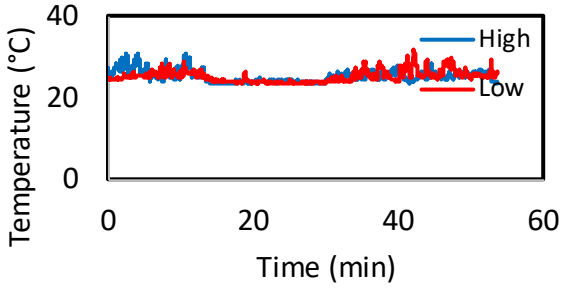
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

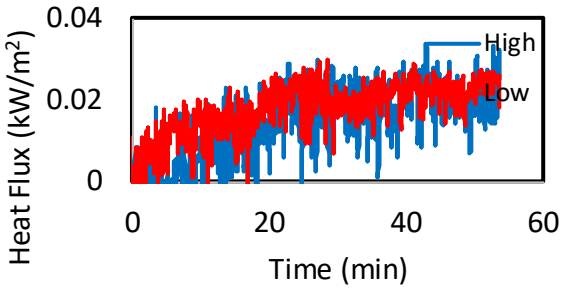
TC Grid Heights[1] (cm): 30, 76

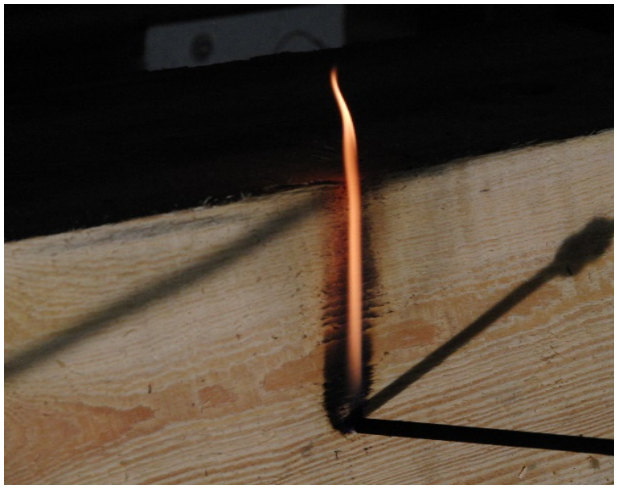
HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

[1]From top of platform, [2]From center of platform









Test ID: 09_10_004 (EPRI) **Test Item: Laptop**

Max Fire Diameter (m): 0.17 Max Flame Height (m): 0.27

Peak HRR (kW): 17.6 Burning Duration (s): 1,575 Ignition Method: Flame

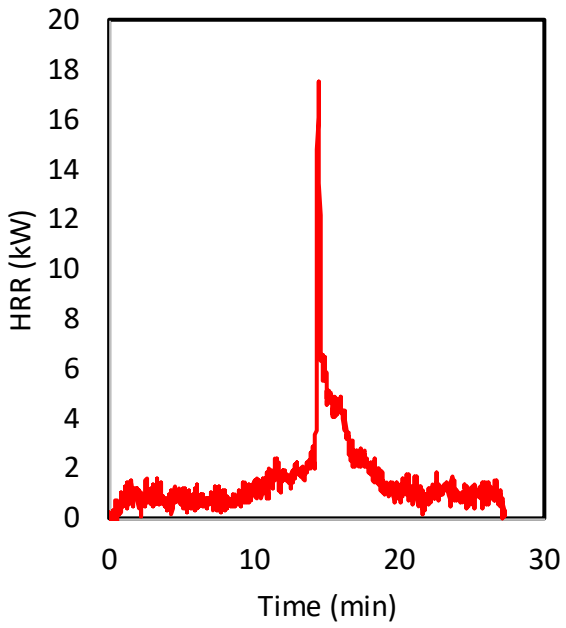
Heat of Combustion (MJ/kg): 37.7 Total Energy Release (MJ): 2.54

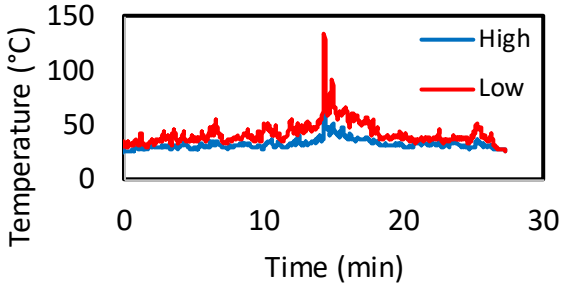
Soot Yield (kg/kg): 0.034 CO Yield (kg/kg): 0.026

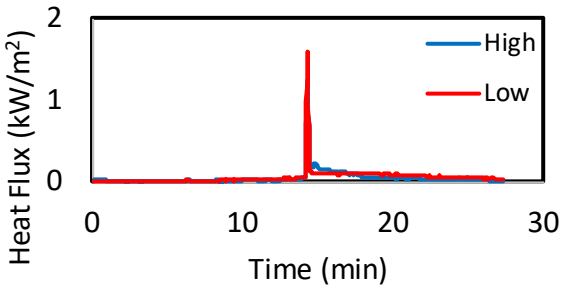
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 09_11_001 (EPRI) **Test Item: Laptop**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.39

Peak HRR (kW): 14.8 Burning Duration (s): 1,729 Ignition Method: Flame

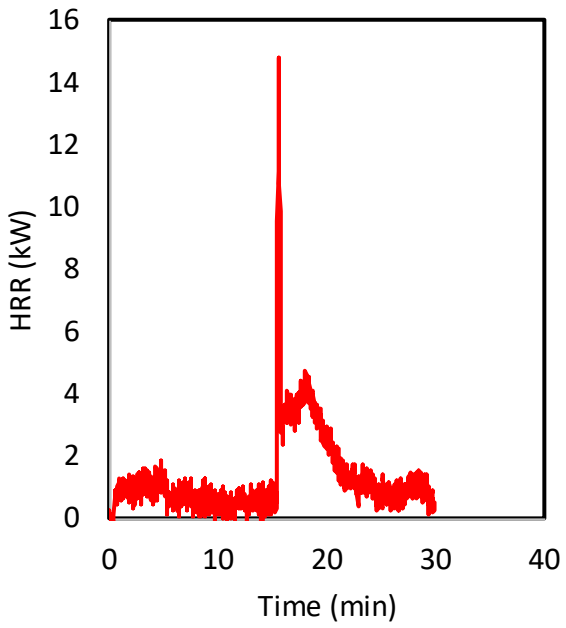
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 2.41

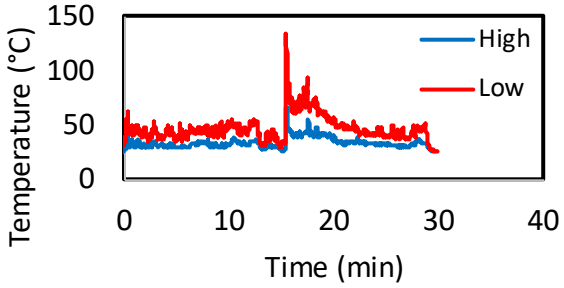
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

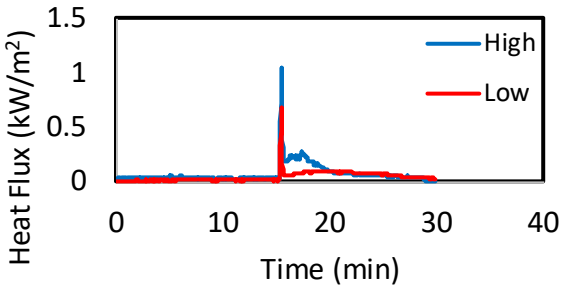
TC Grid Heights[1] (cm): 46, 76

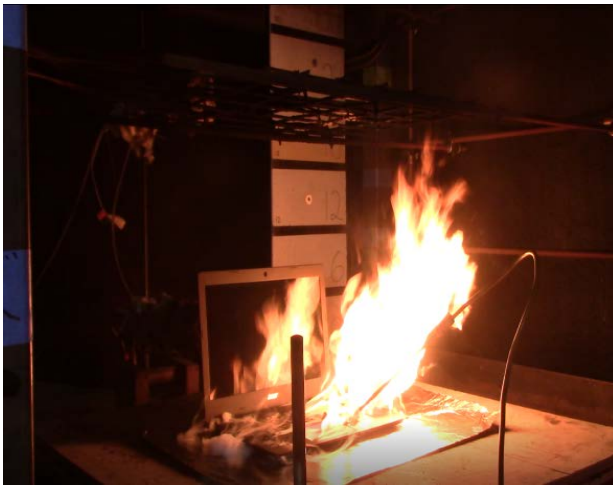
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 09_11_002 (EPRI) **Test Item: Laptop**

Max Fire Diameter (m): 0.09 Max Flame Height (m): 0.24

Peak HRR (kW): 4.2 Burning Duration (s): 2,515 Ignition Method: Flame

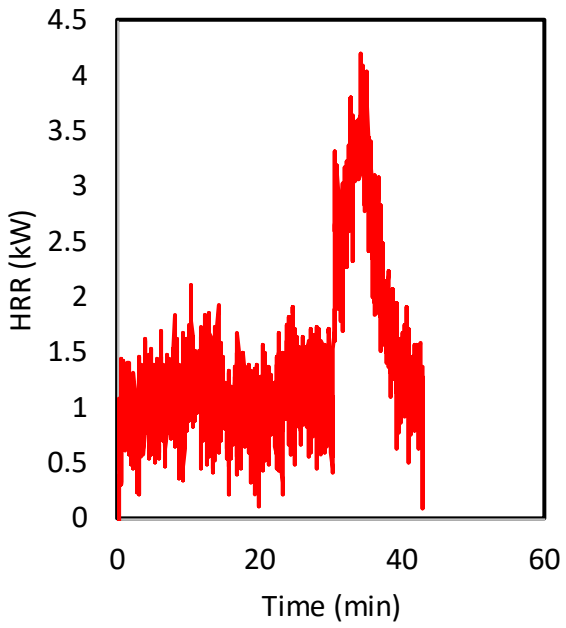
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 3.58

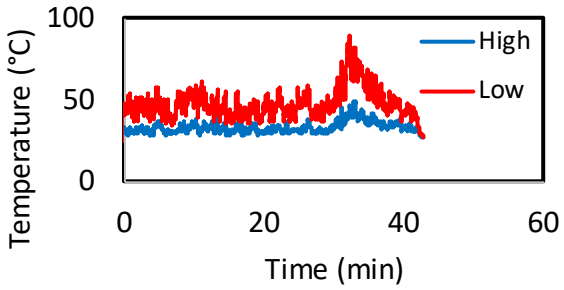
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

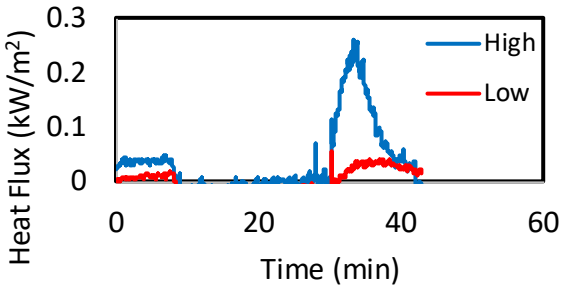
TC Grid Heights[1] (cm): 46, 76

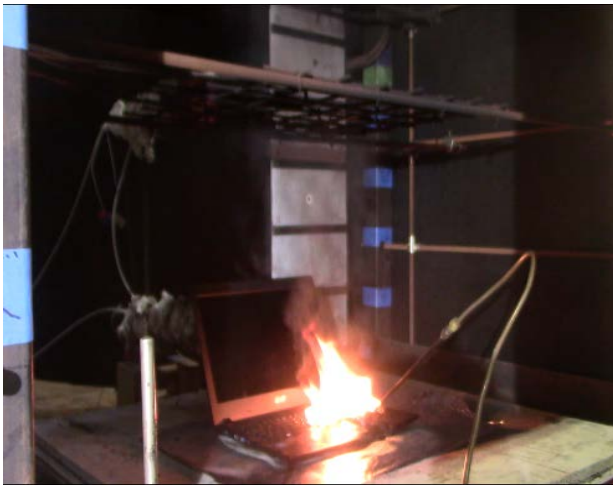
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 09_10_003 (EPRI) **Test Item: Wood Block Panel**

Max Fire Diameter (m): N/A Max Flame Height (m): N/A

Peak HRR (kW): 1.7 Burning Duration (s): 2,592 Ignition Method: Panel

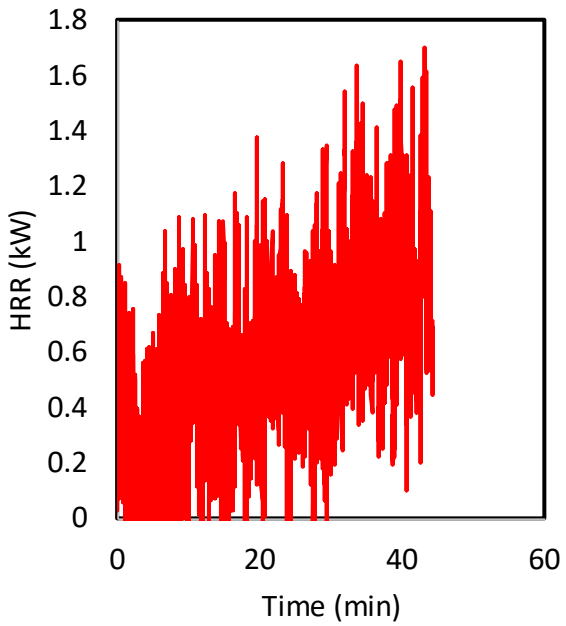
Heat of Combustion (MJ/kg): 2.2 Total Energy Release (MJ): 1.58

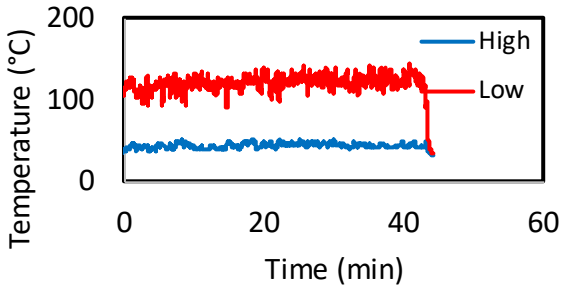
Soot Yield (kg/kg): 0.005 CO Yield (kg/kg): 0.041

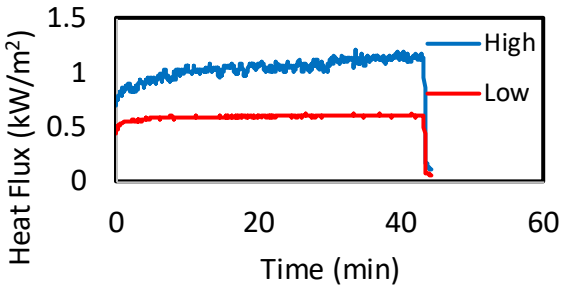
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

[1]From top of platform, [2]From center of platform







Test ID: 09_11_003 (EPRI) **Test Item: Wood Block Panel**

Max Fire Diameter (m): 0 Max Flame Height (m): 0

Peak HRR (kW): 1.3 Burning Duration (s): 2,823 Ignition Method: Panel

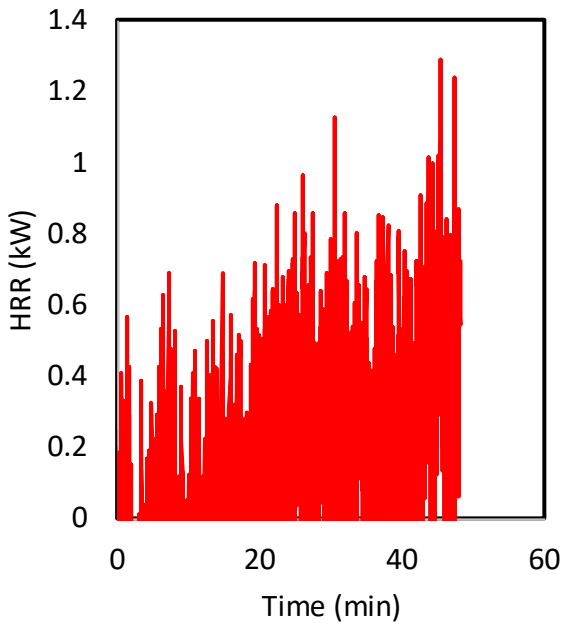
Heat of Combustion (MJ/kg): 0.7 Total Energy Release (MJ): 0.33

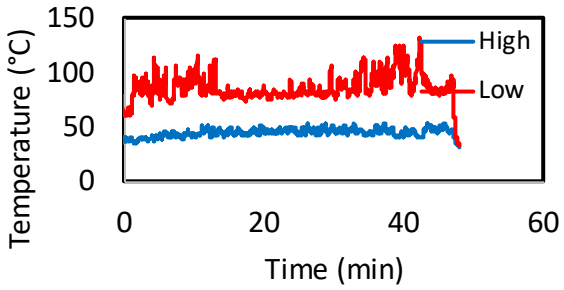
Soot Yield (kg/kg): 0.007 CO Yield (kg/kg): 0.053

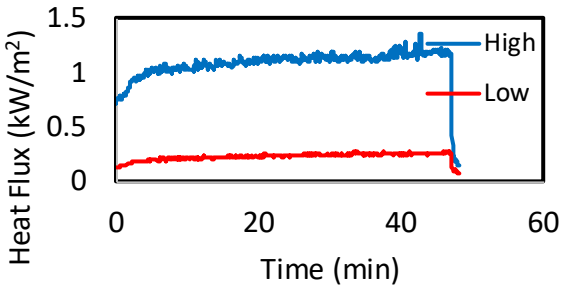
TC Grid Heights[1] (cm): 46, 76

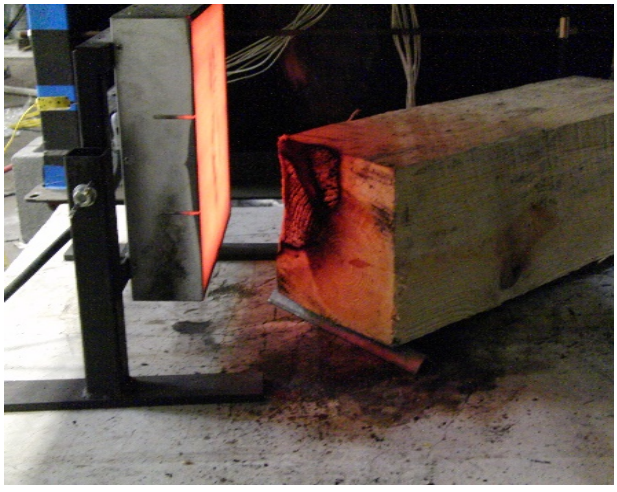
HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

[1]From top of platform, [2]From center of platform









Test ID: 09_11_004 (EPRI) **Test Item: Wood Block Panel**

Max Fire Diameter (m): 0 Max Flame Height (m): 0

Peak HRR (kW): 1.4 Burning Duration (s): 3,002 Ignition Method: Panel

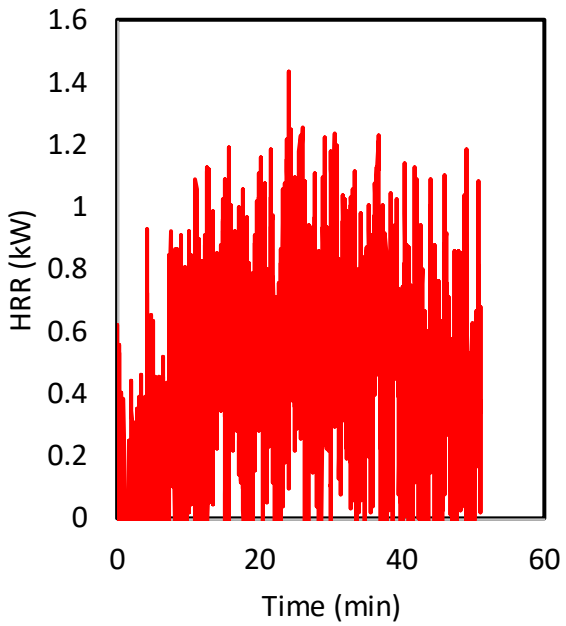
Heat of Combustion (MJ/kg): 9.3 Total Energy Release (MJ): 1.27

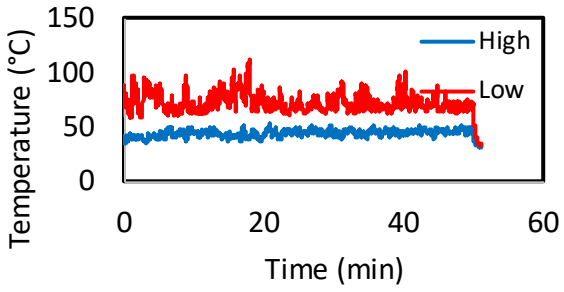
Soot Yield (kg/kg): 0.031 CO Yield (kg/kg): 0.318

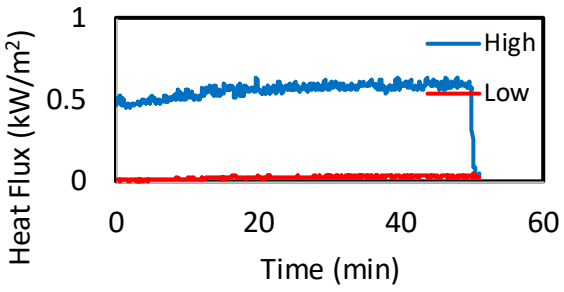
TC Grid Heights[1] (cm): 46, 76

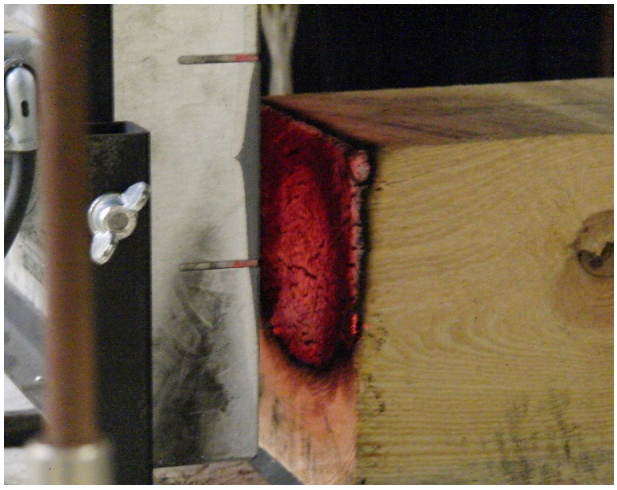
HF Gauge Heights[1] (cm): N/A HF Gauge Distance[2] (cm): N/A

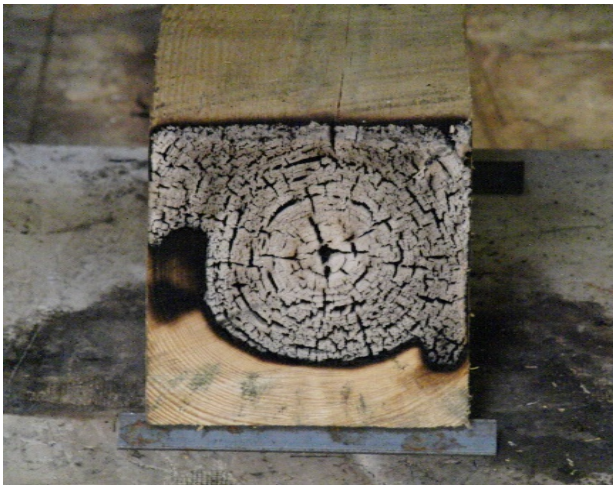
[1]From top of platform, [2]From center of platform











Test ID: 09_12_001 (EPRI) **Test Item: Tablet**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.46

Peak HRR (kW): 12.6 Burning Duration (s): 2,206 Ignition Method: Flame

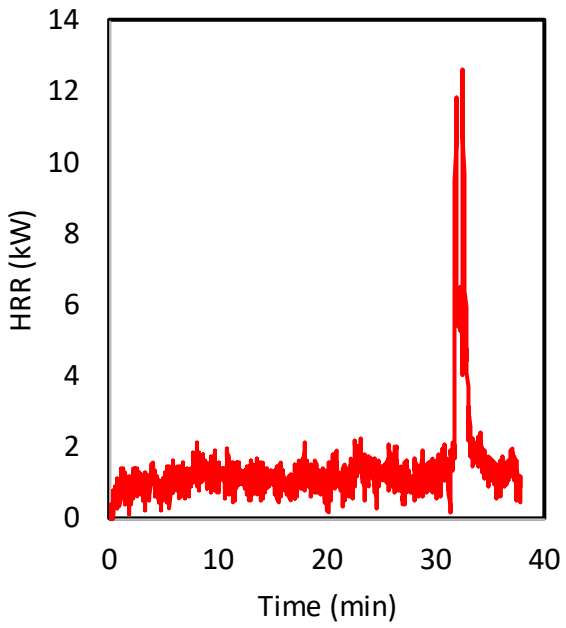
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 3.06

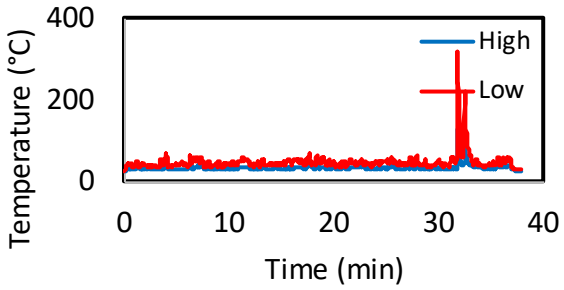
Soot Yield (kg/kg): 0.026 CO Yield (kg/kg): 0.044

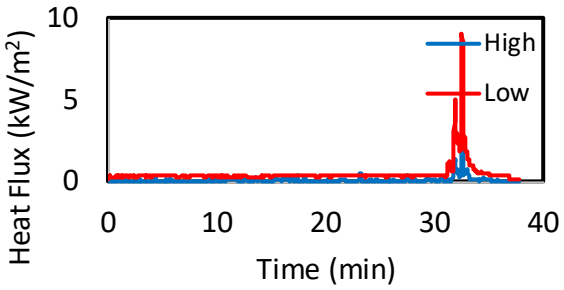
TC Grid Heights[1] (cm): 46, 76

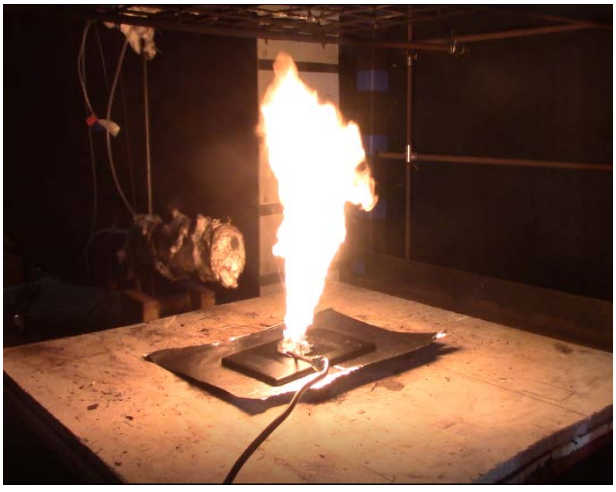
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform









Test ID: 09_12_002 (EPRI) **Test Item: Tablet**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.52

Peak HRR (kW): 16.3 Burning Duration (s): 1,254 Ignition Method: Flame

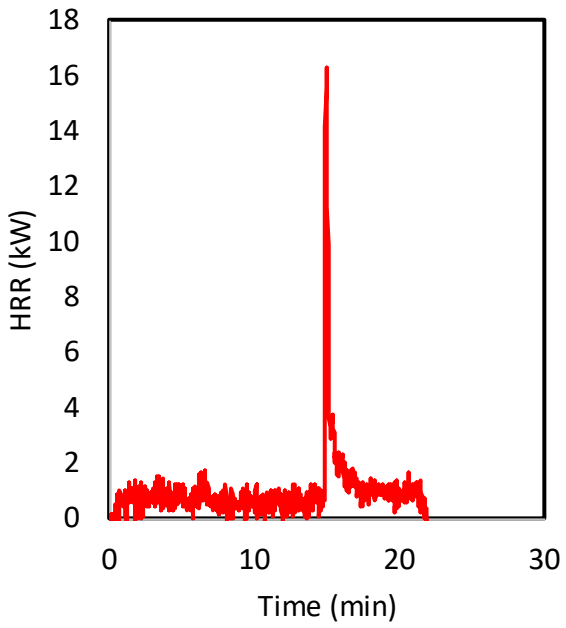
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 1.28

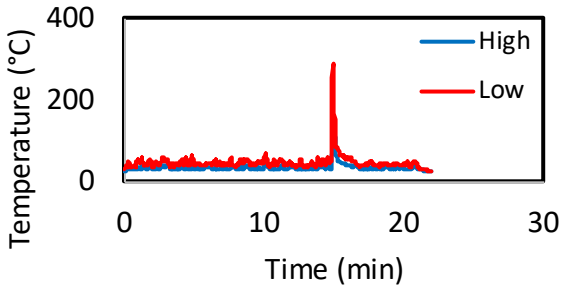
Soot Yield (kg/kg): 0.029 CO Yield (kg/kg): 0.035

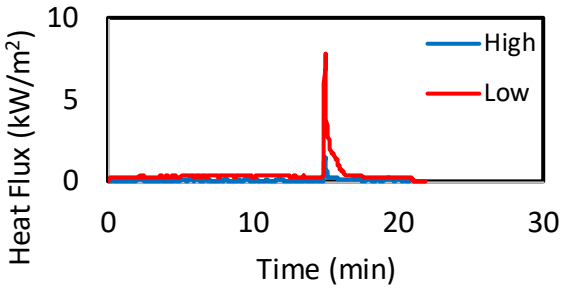
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 09_12_003 (EPRI) **Test Item: Tablet**

Max Fire Diameter (m): 0.25 Max Flame Height (m): 0.51

Peak HRR (kW): 22.0 Burning Duration (s): 706 Ignition Method: Flame

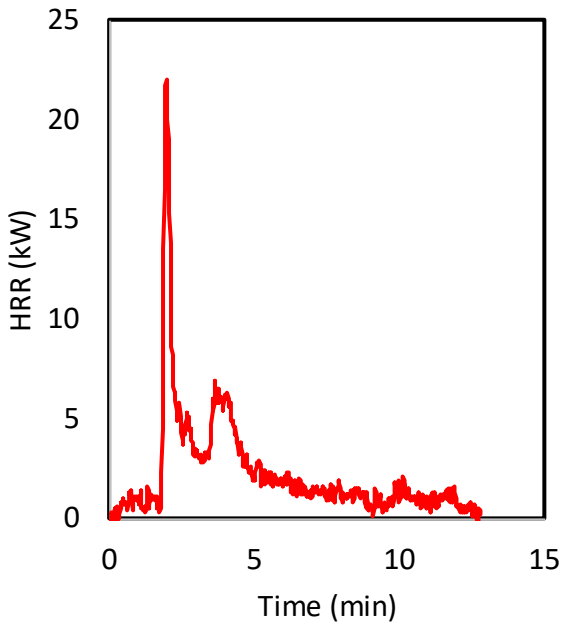
Heat of Combustion (MJ/kg): 32.4 Total Energy Release (MJ): 1.71

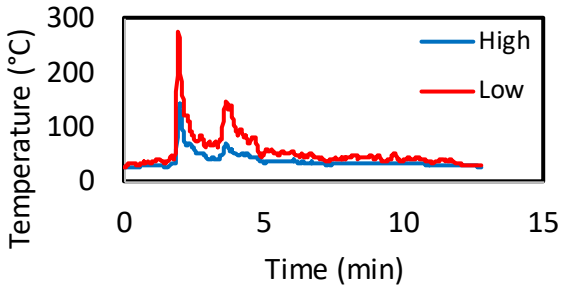
Soot Yield (kg/kg): 0.057 CO Yield (kg/kg): 0.05

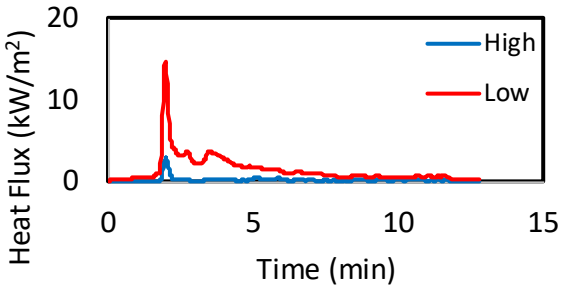
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 30

[1]From top of platform, [2]From center of platform







Test ID: 09_12_004 (EPRI) **Test Item: Tablet + Plastic Case**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.76

Peak HRR (kW): 33.9 Burning Duration (s): 3,479 Ignition Method: Flame

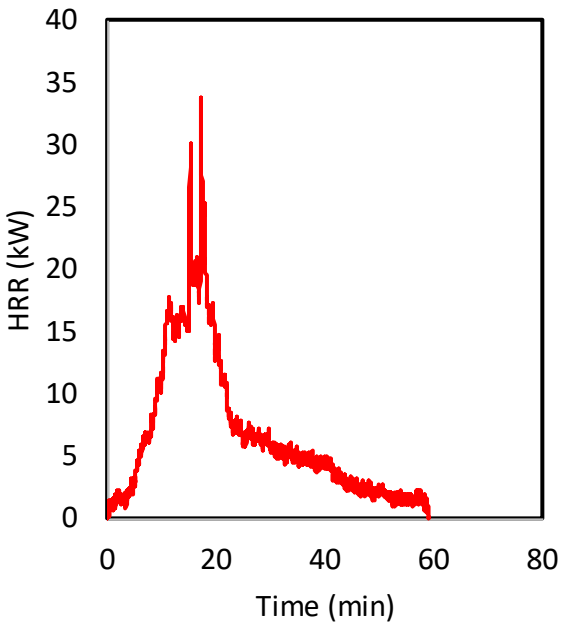
Heat of Combustion (MJ/kg): 29.8 Total Energy Release (MJ): 23.65

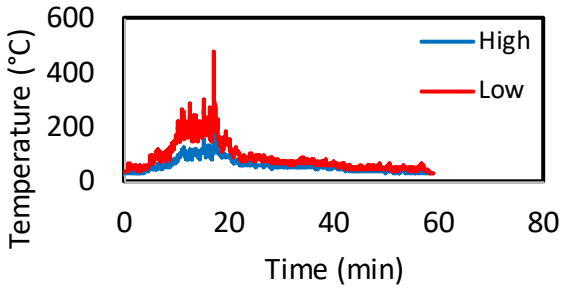
Soot Yield (kg/kg): 0.055 CO Yield (kg/kg): 0.041

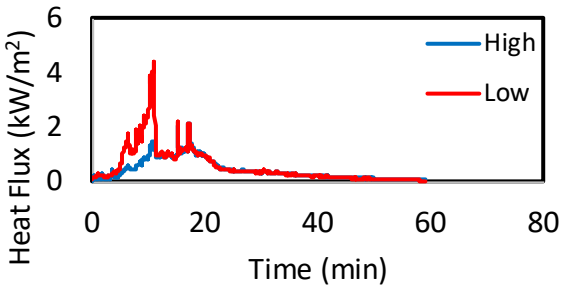
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform







Test ID: 09_12_005 (EPRI) **Test Item: Tablet + Plastic Case**

Max Fire Diameter (m): 0.36 Max Flame Height (m): 0.52

Peak HRR (kW): 20.3 Burning Duration (s): 4,079 Ignition Method: Flame

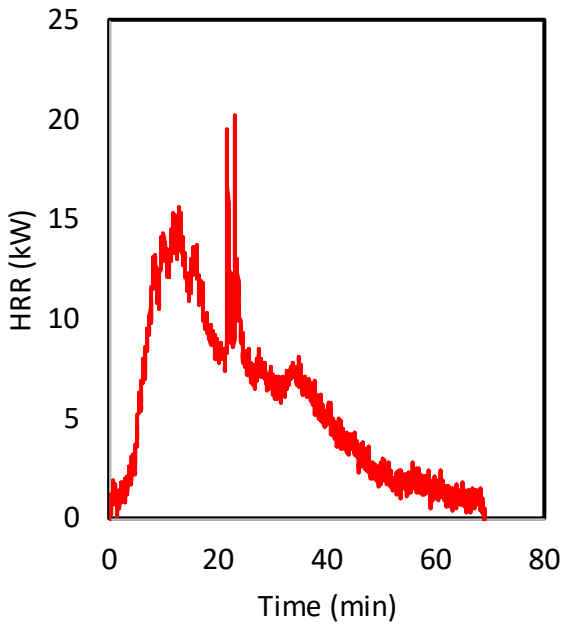
Heat of Combustion (MJ/kg): 34.8 Total Energy Release (MJ): 23.65

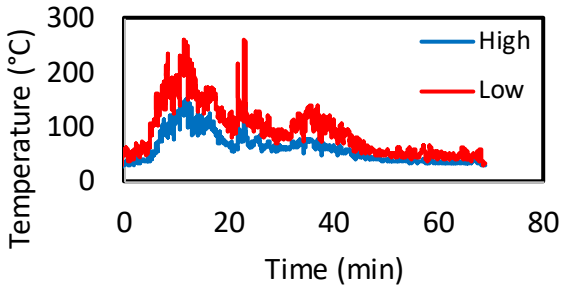
Soot Yield (kg/kg): 0.037 CO Yield (kg/kg): 0.045

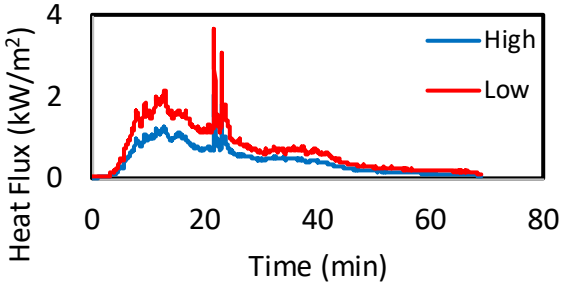
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







Test ID: 09_12_006 (EPRI) **Test Item: Tablet + Metal Case**

Max Fire Diameter (m): 0.20 Max Flame Height (m): 0.52

Peak HRR (kW): 9.1 Burning Duration (s): 1,088 Ignition Method: Flame

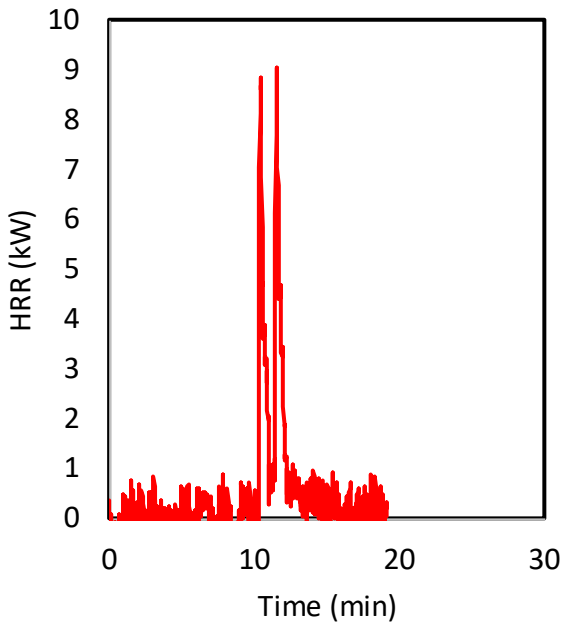
Heat of Combustion (MJ/kg): N/A Total Energy Release (MJ): 17.1

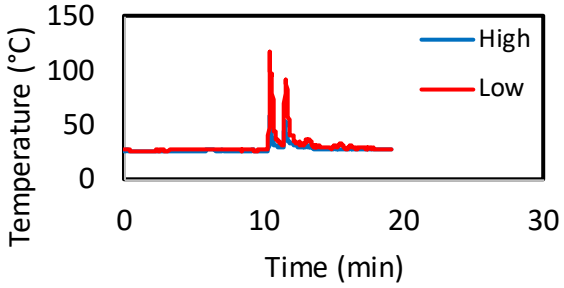
Soot Yield (kg/kg): N/A CO Yield (kg/kg): N/A

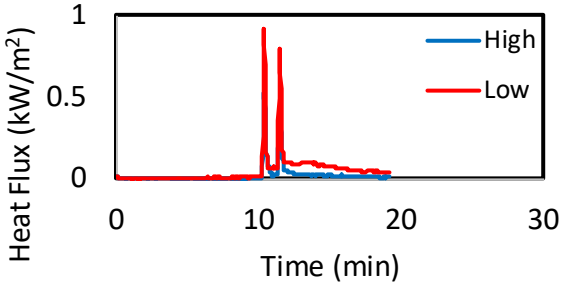
TC Grid Heights[1] (cm): 46, 76

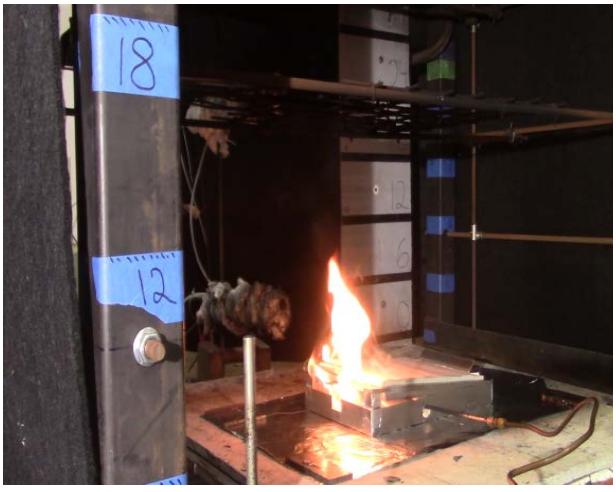
HF Gauge Heights[1] (cm): 11, 57 HF Gauge Distance[2] (cm): 46

[1]From top of platform, [2]From center of platform









Test ID: 09_19_001 (EPRI) **Test Item: Tool Bag**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.99

Peak HRR (kW): 55.7 Burning Duration (s): 5,665 Ignition Method: Flame

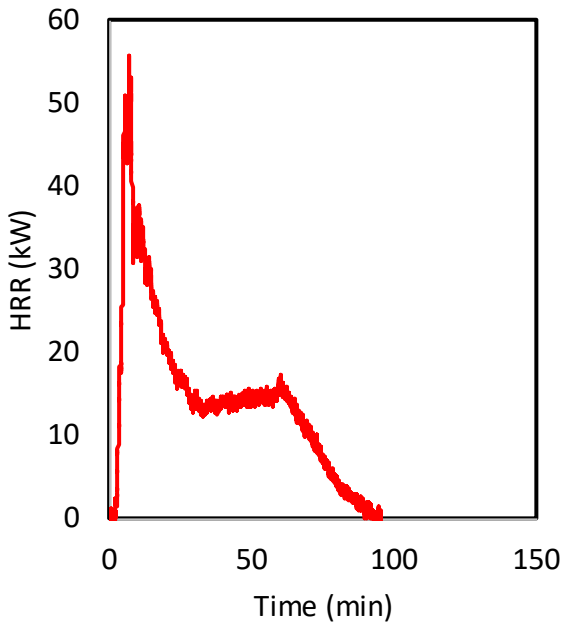
Heat of Combustion (MJ/kg): 19.3 Total Energy Release (MJ): 81.7

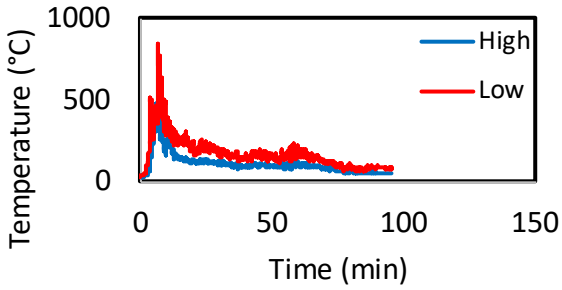
Soot Yield (kg/kg): 0.057 CO Yield (kg/kg): 0.062

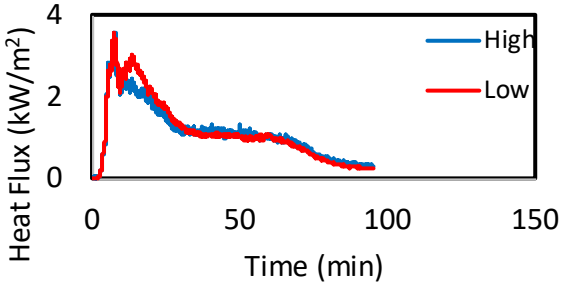
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 25, 71 HF Gauge Distance[2] (cm): 69

[1]From top of platform, [2]From center of platform







Test ID: 09_19_002 (EPRI) **Test Item: Tool Bag**

Max Fire Diameter (m): 0.51 Max Flame Height (m): 0.99

Peak HRR (kW): 50.5 Burning Duration (s): 6,275 Ignition Method: Flame

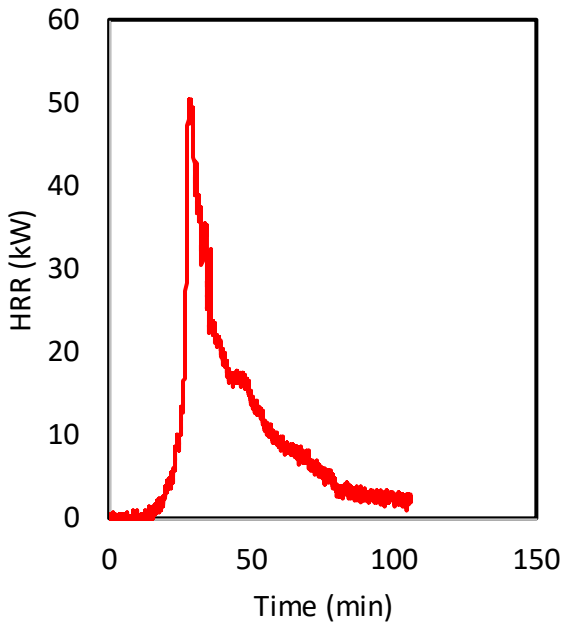
Heat of Combustion (MJ/kg): 18.1 Total Energy Release (MJ): 59.23

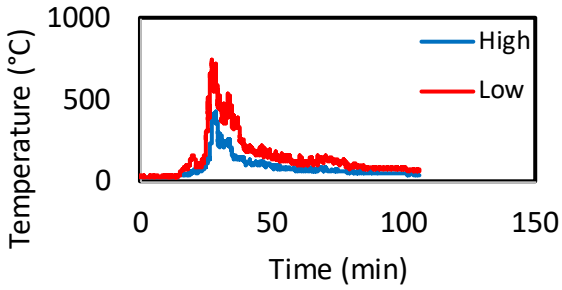
Soot Yield (kg/kg): 0.094 CO Yield (kg/kg): 0.051

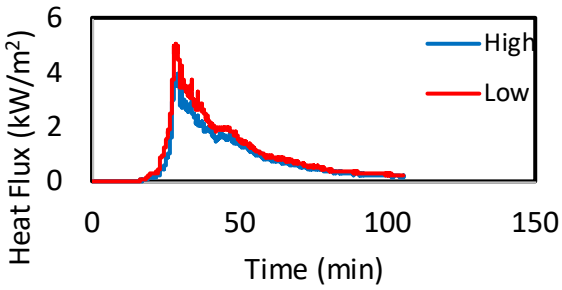
TC Grid Heights[1] (cm): 46, 76

HF Gauge Heights[1] (cm): 25, 71 HF Gauge Distance[2] (cm): 61

[1]From top of platform, [2]From center of platform







NRC FORM 335
(12-2010)
NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER
(Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-2232

2. TITLE AND SUBTITLE

Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants

3. DATE REPORT PUBLISHED

MONTH	YEAR
March	**2020**

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

A. Lindeman (EPRI), M. Randelovic (EPRI), D. Stroup (NRC), J. Floyd (Jensen-Hughes), M. DiDomizio (Jensen-Hughes), K. McGrattan (NIST), M. Bundy (NIST)

6. TYPE OF REPORT

Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)

Division of Risk Analysis
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Electric Power Research Institute
3420 Hillview Avenue
Palo Alto, CA 94304

10. SUPPLEMENTARY NOTES

M.H. Salley, NRC Project Manager

11. ABSTRACT (200 words or less)

As part of the initial guidance for performing a fire probabilistic risk assessment (FPRA) contained in NUREG/CR 6850, the appendices in Volume 2 provided guidance on modeling the heat release rate of ignition sources. Follow-on research has improved the realism for the heat release rates used for electrical cabinets (NUREG 2178, Volume 1, and NUREG/CR 7197), cables (NUREG/CR 6931 and NUREG/CR 7010), and pumps, motors, and transformers (NUREG 2178, Volume 2). Transient ignition sources have not yet seen additional research targeting the realism of heat release rates. Since transient fires represent a significant fraction of the fire risk at nuclear power plants, there is value to the industry in improving the realism of how these fires are modeled. This report documents testing performed to address this gap. The report begins by reviewing the existing guidance for transient fires and actual operating experience of U.S. nuclear power plants. These data were used to develop a large experimental program involving 99 transient fuel packages with repeat tests for a total of 290 tests. Data collected during the experimental program included heat release rate, heat of combustion, minor product yields, flame height, plume temperature, and heat flux. Test data were used to determine the vertical and horizontal zones of influence for each test and to assess the performance of the Fire Dynamics Tools (NUREG-1805) correlations for plume temperature, flame height, and heat flux.
A companion report will provide specific guidance on applying the test data to a FPRA.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Fire probabilistic risk assessment (FPRA), Fire risk, Transient fires, Fire testing, Heat release rate (HRR), Zone of influence (ZOI)

13. AVAILABILITY STATEMENT

unlimited

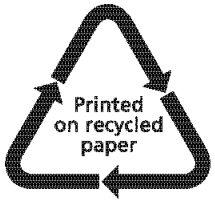
14. SECURITY CLASSIFICATION

(This Page)
unclassified

(This Report)
unclassified

15. NUMBER OF PAGES

16. PRICE



Federal Recycling Program

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS

NUREG-2232 Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants March 2020