



NIST Technical Note NIST TN 2251

Wind-driven Fire Spread to a Structure from Firewood Piles



Erik L. Johnsson
Kathryn M. Butler
Marco Fernandez
Mariusz Zarzecki
Wei Tang
Shonali Nazare
Daniel Barrett
Michael Pryor
Alexander Maranghides

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.TN.2251>



**NIST Technical Note
NIST TN 2251**

Wind-driven Fire Spread to a Structure from Firewood Piles

Erik L. Johnsson
Kathryn M. Butler
Marco Fernandez
Shonali Nazare
Alexander Maranghides
*Fire Research Division
Engineering Laboratory*

Mariusz Zarzecki*
Wei Tang*
Daniel Barrett*
Michael Pryor*

**Former NIST associate; all work for this publication was done while at NIST.*

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.TN.2251>

March 2023



U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

NIST TN 2251
March 2023

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

NIST Technical Series Policies

[Copyright, Fair Use, and Licensing Statements](#)

[NIST Technical Series Publication Identifier Syntax](#)

Publication History

Approved by the NIST Editorial Review Board on 2022-03-27

How to Cite this NIST Technical Series Publication

Johnsson EL, Butler KM, Fernandez M, Zarzecki M, Saar W, Nazare S, Tang W, and Auth E, (2022) Wind-driven Fire Spread to a Structure from Firewood Piles. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Technical Note (TN) NIST TN 2251. <https://doi.org/10.6028/NIST.TN.2251>

NIST Author ORCID iDs

Erik L. Johnsson: 0000-0003-1170-7370

Kathryn M. Butler: 0000-0001-7163-4623

Shonali Nazare: 0000-0002-0407-5849

Marco Fernandez: 0000-0002-4227-8866

Alexander Maranghides: 0000-0002-3545-2475

Contact Information

erik.johnsson@nist.gov

kathryn.butler@nist.gov

Abstract

NIST is studying how combustible landscape features around a home burn to better understand their levels of hazard and potential roles in spreading wildland-urban interface (WUI) fires. A series of field experiments was conducted to examine the effects of burning firewood piles on fire spread toward a structure under conditions that may be encountered during a WUI fire. The fire behavior of a variety of firewood species in multiple configurations was studied under various wind conditions. The 62 experiments conducted included long range firebrand travel and fire spread mitigation experiments. Wood species included kiln-dried maple, oak [dried and not dried (“green”)] and eastern white pine. Configuration variations included woodpile height, orientation, and elevation on a rack. A wind machine provided a mean wind speed between a nominal 6 m/s and 14 m/s (13 mi/h to 31 mi/h). The woodpiles were ignited by a propane burner on the ground at the end farthest from a small structure located between 0.91 m and 7.32 m (3 ft to 24 ft) downwind of the woodpile. A target mulch bed at the base of the structure evaluated the ability of firebrands produced by the burning woodpile to ignite spot fires that could threaten the structure.

The experiments in this study demonstrated that firewood piles can be rapid sources of spot fire ignitions and can easily spread fire to nearby structures. Rapid fire growth on and substantial flames from the woodpiles were found for all wood species and configurations. Fire behavior was classified as high hazard for igniting spot fires under all wind conditions.

In all cases, spot fire generation was affected by the wind field; the structure created both upward flow (enhanced by buoyancy) and a vortex that deposited firebrands next to the structure. During all experiments, the burning woodpile produced firebrands that ignited spot fires in the target mulch bed. In long range experiments, firebrands from a woodpile caused ignitions over 26 m (85 ft) downwind.

This study of the fire hazard of woodpiles is part of a series designed to better inform standards and codes regarding placement of landscape features around homes that are at risk of exposure to wildland-urban interface fires.

Keywords

Embers; firewood piles; woodpile fires; firebrands; fire spread; structural ignition; structure vulnerability; wildland urban interface fires; wind-driven fires; WUI fires.

Table of Contents

1. Introduction.....	1
1.1. Motivation	1
1.2. Background.....	2
1.2.1. Structure Vulnerabilities	3
1.2.2. Landscape Feature Fire Studies	3
1.3. Approach	3
1.4. Objectives	4
2. Experimental Design.....	5
2.1. Research Location and Site Description.....	5
2.2. Wind Field Generation	6
2.2.1. Wind Machine	6
2.2.2. Flow Straightener	7
2.3. Target Shed and Mulch Bed.....	8
2.3.1. Target Shed	8
2.3.2. Target Mulch Bed.....	9
2.4. Firewood and Preparation	11
2.4.1. Firewood Rack	12
2.4.2. Firewood Conditioning.....	12
2.5. Ignition Source	14
2.6. Measurements	15
2.6.1. Wind Speed Profiles.....	15
2.6.2. Ambient Wind Speed and Direction.....	16
2.7. Data Acquisition	17
2.7.1. Wind and Temperature Data	17
2.7.2. Digital Video and Photographic Records	17
2.8. Experimental Procedures	18
2.8.1. Weather Conditions.....	18
2.8.2. Preparation	19
2.8.3. Operations	19
2.9. Research Scope	21
2.9.1. Parameter Summary	21
2.9.2. Separation Distance from Structure.....	23
2.9.3. Wind Speed and Direction.....	25
2.9.4. Tree Species	25
2.9.5. Woodpile Height.....	25