NIST Special Publication 1241

Large Outdoor Fires and the Built Environment (LOF&BE): Summary of Workshop at Interflam 2019

Sponsored by the International Association for Fire Safety Science (IAFSS)

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https://doi.org/10.6028/NIST.SP.1241

THE INTERNATIONAL ASSOCIATION FOR FIRE SAFETY SCIENCE

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August 2019

U.S. Department of Commerce
Wilbur L. Ross, Jr., Secretary

National Institute of Standards and Technology
Walter Copan, NIST Director and Under Secretary of Commerce for Standards and Technology

National Institute of Standards and Technology Special Publication 1241
Natl. Inst. Stand. Technol. Spec. Publ. 1241, 21 pages (August 2019)
CODEN: NSPUE2

This publication is available free of charge from: https://doi.org/10.6028/NIST.SP.1241

Abstract

A workshop of the permanent working group, sponsored by the International Association for Fire Safety Science (IAFSS), entitled *Large Outdoor Fires and the Built Environment* (LOF&BE) was held from 2:00 pm to 4:00 pm on Sunday June 30, 2019. The workshop was held as a part of the 2019 Interflam Conference in Egham, United Kingdom. The working group is co-led by Sara McAllister of the U.S. Forest Service, Sayaka Suzuki of the National Research Institute of Fire and Disaster, and Samuel L. Manzello of NIST's Engineering Laboratory. The IAFSS permanent working group consists of three subgroups, with subleaders appointed by Manzello, McAllister, and Suzuki, and these are prioritized into the following topics: Ignition Resistant Communities (IRC – led by Elsa Pastor, UPC), Emergency Management and Evacuation (EME, led by Enrico Ronchi, Lund University), and Large Outdoor Firefighting (LOFF, led by Raphaele Blanchi, CSIRO, unable to travel to UK). The IRC subgroup is focused on developing the scientific basis for new standard testing methodologies indicative of large outdoor fire exposures, including the development of necessary testing methodologies to characterize wildland fuel treatments adjacent to communities. The EME subgroup is focused on developing the scientific basis for effective emergency management strategies for communities exposed to large outdoor fires. The LOFF subgroup is providing a review of various tactics that are used, as well as the various personal protective equipment (PPE), and suggests pathways for research community engagement, including environmental issues in suppressing these fires. At the workshop, detailed progress was presented regarding activities of all the subgroups. An extended session was held for open discussion so that participants could provide feedback on current progress and offer suggestions for the upcoming LOF&BE workshop being organized as part of IAFSS 2020.

Key words

Large Outdoor Fires; Urban Fires; Wildland-Urban Interface (WUI) Fires; Informal Settlement Fires; Wildland Fires

Table of Contents

1. Introduction

1.1. Workshop Objectives

The International Association for Fire Safety Science (IAFSS) has approved the formation of the permanent working group entitled *Large Outdoor Fires and the Built Environment* or (LOF&BE) [1]. This report details the second official workshop of this permanent working group. The workshop at Interflam 2019 was organized as a unique partnership between IAFSS and Interflam, the two largest conferences focused on fire safety science.

1.2. Program of the Workshop

Time	Title	Speaker
2:00-2:15	Introduction	S. Manzello*, S. McAllister, S. Suzuki*
2:15-2:30	LOFF	R. Blanchi/S. McAllister*
2:30-2:45	IRC	E. Pastor
2:45-3:00	EME	E. Ronchi
3:00-4:00	Open Discussion	All participants

*denotes speaker

1.3. List of Registered Participants (Alphabetical Order by Surname)

Danielle Antonellis (Arup, UK)
Gaurav Agarwal (FM Global, USA)
Mohamed Beshir (University of Edinburgh, UK)
Nelson Bryner (National Institute of Standards and Technology, USA)
Mike Burroughs (Fire Investigation, UK)
Alexandra Bystrom (Lulea University of Technology, Sweden)
Piergiacomo Cancelliere (Italian National Fire and Rescue Service, Italy)
René Champagne (Parks Canada/York University, Canada)
Giovanni Cocchi (Arson S.R.I., Italy)
Bernard Cosh (Cosh Fire Safety, UK)
Ryan Falkenstein-Smith ((National Institute of Standards and Technology, USA)
Ragni Fjellgaard Mikalsen (RISE Fire Research, Sweden)
Merlyn Ferrer (Design Fire Consultants, UK)
Justin Francis (Queensland Fire and Emergency Services, Australia)
John Gales (York University, Canada)
Richard Gann (AGANNstFire, USA)
Islaam Gomaa (National Research Council Canada, Canada)
Mark Gratkowski (Bureau of Alcohol, Tobacco, Firearms & Explosives, USA)
Steve Gwynne (Movement Strategies, UK)
Tuula Hakkarainen (VTT Technical Research Centre of Finland, Finland)
Testuya Hayakawa (TSV, Japan)
Faraz Hedayati (Insurance Institute for Business & Home Safety, USA)
Marcelo Hirschler (GBH International, USA)
Robert Jannson McNamee (Brandskyddslaget, Sweden)
Geir Jensen (Securo AS, Norway)
Amanda Kimball (Fire Protection Research Foundation/NFPA, USA)
Egor Kuznetov (Peter the Great Saint Petersburg Polytechnic University, Russia)
Susan Lamont (Arup, UAE)

Brian Lattimer (Virginia Tech, USA)
Isaac Leventon (National Institute of Standards and Technology, USA)
Johanna Liblik (Tallinn University of Technology, Estonia)
Andrew Lock (U.S. Consumer Products Safety Commission, USA)
Samuel L. Manzello (National Institute of Standards and Technology, USA/Japan)
Frank Markert (Denmark Technical University, Denmark)
Ekaterina Markus (Peter the Great Saint Petersburg Polytechnic University, Russia)
Bertrand Mathy (AGC Glass Europe, Belgium)
Sara McAllister (USDA Forest Service, USA)
Margaret McNamee (Lund University, Sweden)
Harry Mitchell (Imperial College London, UK)
Elsa Pastor (Universitat Politècnica de Catalunya, Spain)
Jake Pauls (Jake Pauls Consulting, USA)
Hugues Pretel (Institut de Radio Protection et de Sûreté Nucléaire, France)
Chandler Probert (North Carolina State University, USA)
Vincenzo Puccia (Corpo Nazionale dei Vigili del Fuoco, Italy)
Guillaume Rambaud (Commissariat à l'Énergie Atomique et aux Énergies Alternatives, France)
Lindsay Ranger (FP Innovations, Canada)
Enrico Ronchi (Lund University, Sweden)
David Rush (University of Edinburgh, UK)
Adhiraj Shinde (North Carolina State University, USA)
Pitor Smardz (INBEPO, Poland)
Anne Steen-Hanson (RISE Fire Research, Norway)
Sayaka Suzuki (National Research Institute of Fire and Disaster, Japan)
Jean-Baptiste Tramoni (Centre Technique Industriel De La Construction Metallique, France)
Juergen Troiroseh (Troiroseh Company, Switzerland)
Patrick van Hees (Lund University, Sweden)
Yi Wang (FM Global, USA)
Alex Webb (Commonwealth Scientific and Industrial Research Organization, Australia)
Jennifer Wen (Warwick University UK)
Yuki Yamauchi (Railway Technical Research Institute, Japan)
Hideki Yoshioka (National Institute for Land and Infrastructure Management, Japan)

2. Summary and Next Steps

A total of 60 global experts participated, representing institutions from Australia, Belgium, Canada, Denmark, Estonia, France, Finland, Italy, Japan, Norway, Poland, Russia, Spain, Sweden, Switzerland, United Kingdom, United Arab Emirates, and USA. The workshop began with an introductory presentation that explained what is LOF&BE, the objectives, and the overall direction and focus of the group.

LOF&BE is divided into three main approaches. Specifically, Phase 1 is the data collection aspect where each of the three subgroups are collecting all available information on codes and standards, best practices, and current research for their respective topic areas. In Phase 2, each subgroup will attempt to identify the gaps amongst codes and standards, between codes and standards and current research, and within current research. In the final Phase, called Phase 3, each subgroup will work on products to address the identified gaps.

At present, all three subgroups are still working in Phase 1, so the audience was queried as to the progress that each subgroup is achieving to this end. It was also decided by the LOF&BE team to open up the floor for a free flowing discussion.

The following is a list of key discussion points:

- Suggestions on getting the research community more involved with Codes and Standards. How to actually do this?

- How to incorporate informal settlement fires into IRC and LOFF subgroups? An important safety issue for informal settlement fires is that firefighters need to be able to cope with the collapse of sections of the entire settlements.

- Firefighters' involvement on personal protective equipment (PPE) is necessary.

- Emissions from burning vegetation and structures are different at different stages. Understanding the details as well as overview are important.

- More interaction and attendance from the fire service is needed at important international conferences focused exclusively on fire safety science, such as Interflam and IAFSS. How to actually have better interaction?

- A sociological prospective is needed for EME group.

- Questions on involvements with standard bodies. ISO TC92 has developed a specific working group (WG): ISO TC92/WG14 (Large Outdoor Fires and the Built Environment). Important research findings as part of the IAFSS LOF&BE effort will be constantly shared with the ISO TC9/WG14 activity. This is easier, as Dr. Manzello is the convener of the ISO TC92/WG14. More cross-cutting activities into other standards bodies, work is needed outside ISO TC92.

- It is important to get industry involved, construction companies and insurance companies. As in most cases, cost is really the driving factor for change.

- Simple description on what are some key work items needed in each group. In this way, the community would be in a better positon to help the overall LOF&BE effort. A specific suggestion included a list of potential projects that final year students could work on.

The LOF&BE team plan to use these valuable suggestions going forward. In particular, these will be most helpful as the next workshop is prepared as part of the IAFSS 2020 meeting to be held in Waterloo, Canada.

3. Acknowledgments

The support of the organizing committee of the 2019 Interflam Conference is greatly appreciated. In particular, the authors wish to acknowledge the help of Dr. Stephen Grayson

(Interscience Communications; Interflam Conference Chair), Ms. Sue Wolf (Interscience Communications, UK), and Ms. Teri-Leigh Peach (Fire Testing Technology, UK). The LOF&BE team would also like to personally thank Professor Patrick Van Hees of Lund University, IAFSS President for his constant support. SLM would like to thank both Drs. Grayson and Van Hees for making the integration of the IAFSS LOF&BE effort into Interflam 2019 as seamless as possible.

References

[1] Manzello, S.L., McAllister, S., Suzuki, S., Blanchi, R., Pastor, E., and Ronchi, E., (2019) Large Outdoor Fires and the Built Environment: Summary of Kick-off Workshop, NIST Special Publication 1236 https://doi.org/10.6028/NIST.SP.1236.

Appendix A: Presentations Delivered at the Workshop

THE INTERNATIONAL ASSOCIATION FOR FIRE SAFETY SCIENCE

interflam 2019

Large Outdoor Fire and the Built Environment (LOF&BE)
IAFSS Permanent Working Group

Samuel L. Manzello[1,2,3], Sara McAllister[4] and Sayaka Suzuki[3]

National Institute of Standards and Technology (NIST), USA[1]
Building Research Institute (BRI), Japan[2]
National Research Institute of Fire and Disaster (NRIFD), Japan[3]
USDA Forest Service, USA[4]
samuelm@nist.gov; smcallister@fs.fed.us; sayakas@fri.go.jp;

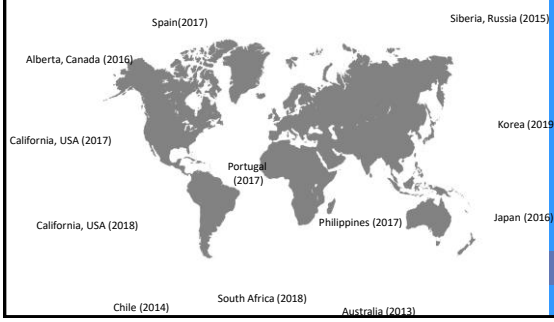
What LOF&BE means?

Large Outdoor Fires and the Built Environment (LOF&BE)

Wildland fires (or forest fires)*, wildland-urban interface (WUI) fires, urban fires**, and informal settlement fires, which pose a threat to people

Discussed in Lund workshop

*Wildland fires also include (but not limited to) Wildfires, Bushfires, Mountain fires, Grassland fires, Veld fires; depending on location
** Urban fires include post-earthquake fires



Introduction

- Over the past several decades, fire safety science research has spent a great deal of effort to understand fire dynamics within buildings
- Research into large outdoor fires, and how to potentially mitigate the loss of structures in such fires, lags behind other areas of fire safety science research
- Large outdoor fires affect many people in the world directly and indirectly, both short term and long term (e.g. evacuation, losing property, losing loved ones, breathing products of combustion)

THE INTERNATIONAL ASSOCIATION FOR FIRE SAFETY SCIENCE

Workshop & Summary Paper

- 2017 IAFSS workshop – look at problem from global perspective (Asia view, Oceania view, European view, North American view, South American view)
- Workshop Summary paper published in *Fire Safety Journal* (adding Africa view)
- Overview of the large outdoor fire risk to the built environment from each region presented
- Critical research needs for this problem in the context of fire safety science are provided

Some Important Problems?

- Fire spread in Large Outdoor fires
  - Very complex - interaction of topography, weather, vegetation, and structures
  - Structure-structure fire spread can occur under similar mechanisms as in urban fire spread as well as WUI fire spread
- Impact on fire and smoke on climate and health
  - Long term and short term effect
- Large outdoor firefighting
  - Structure/Urban firefighting PPE and tactics different than wildland fire firefighting PPE and tactics; what needs to be done for WUI fire fighting?
- Emergency management strategies
  - How or when or whether to evacuate

THE INTERNATIONAL ASSOCIATION FOR FIRE SAFETY SCIENCE

IAFSS Permanent Working Group

- IRC develop scientific basis for new standard testing methodologies indicative of large outdoor fire exposures, develop necessary testing methodologies to characterize wildland fuel treatments adjacent to communities
- EME develop scientific basis for effective emergency management strategies for communities exposed to large outdoor fires
- LOFF review various tactics used, as well as various personal protective equipment (PPE), and suggest pathways for research community engagement, including environmental issues in suppressing these fires

The overall objectives are to bring full depth of knowledge of the IAFSS community to work on these priority topics

General Approach

- Phase 1 Collect information
  - Codes and standards
  - Best practices
  - Current research
- Phase 2 Identify the 'Gaps'
  - Among codes and standards
  - Among codes and standards and current research
  - Among current research
- Phase 3 Work on 'Products' solving the Gaps

IAFSS 2020 Plans

- LOF&BE workshop
- WG (sub-groups)' efforts on Phase 1 will be presented
- We hope to get feedback from you! (which we call a part of Phase 2)

If you would like to join WG, please sign up from the link below or QR codes;

https://goo.gl/forms/0TMW2SbWi7mmHYIv1

Acknowledgement

- All the WG members

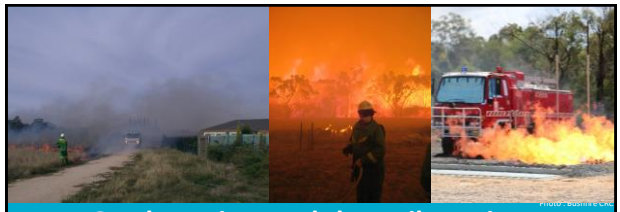
interflam 2019

THE INTERNATIONAL ASSOCIATION FOR FIRE SAFETY SCIENCE

Program

Time: June 20th 2019 (Sun) 2 PM – 4 PM
Location: 1st Floor at Windsor Building

Time	Title	Speaker
2:00-2:15	Introduction	S. Manzello, S. McAllister, S. Suzuki
2:15-2:30	LOFF	R. Blanchi / S. McAllister
2:30-2:45	IRC	E. Pastor
2:45-3:00	EME	E. Ronchi
3:00-4:00	Open Discussion	All participants



Large Outdoor Fires and the Built Environment working group

- Large Outdoor Firefighting – LOFF

Sara McAllister (USDA) / Raphaele Blanchi (CSIRO)

LAND & WATER
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INTERFLAM– Workshop 30/06/2019

Large Outdoor Firefighting – LOFF

- General aim

To develop the scientific basis for wildland/WUI fires/urban fires firefighter safety. First, including personal protective equipment (PPE), health and environmental issues in suppressing these fires. Later, various Firefighting tactics that are used, pathways for research community engagement.

Type of firefighters survey

- Survey : 37 persons from 16 countries

Type of firefighters	Number of countries
1 type of firefighters: Firefighters work for both urban and wildland (or forest) fires	11
2 types of firefighters: Structure firefighters (who work for urban fires) and wildland firefighters (who works for wildland or forest fires)	5
3 types of firefighters: Structure firefighters, wildland firefighters, and WUI firefighters	0

- We would like to thanks Anthony Collin, Ashruf Syed, Amjid hussein Gulamhussein, Sébastien Lahaye, Guillermo Rein, Alex Filkov, Faraz Hedayati, Luís Mario Ribeiro, Daniel Gorham, Hubert Biteau, Len Garis, Adi Putra, Darlene Rini, Dionysios Kolaitis, Ya-Ting T. Liao, Kuibin, Gordon Anderson, Ryan Falkenstein-Smith, Eric Link, Juan Antonio Muñoz, Elsa Pastor, Nuria Prat-Guitart, Xinyan Huang, Yu Wang, Enrico Ronchi and all the other members that have replied to the survey

Summary firefighters survey by countries

Countries	Only one kind - our firefighters work for both urban and wildland (or forest) fires	Structure firefighter (who work for urban fires) and wildland firefighters (who works for wildland or forest fires)	Structure firefighter, wildland firefighter, and WUI firefighter
Australia		X	
Canada		X	
China		X	
France	X		
Greece	X		
Indonesia	X		
India	X		
Israel	X		
Japan	X		
Kenya	X		
Malaysia	X		
Portugal	X		
Spain		X	
Sweden	X		
United Kingdom	X		
USA		X	

Protection of firefighters - PPE

Background

- Protection of firefighter is an important aspect of firefighter safety in wildland fire, urban fire and WUI fire where both the wildlands and the structures are involved

Objectives

- Develop a framework for this new combined wildland/structure fire exposure, to assess PPE requirements
- Establish a network between fire researchers and fire managers for discussion and exchange

How?

✓Develop a repository for inventories of PPE (both international and local Standards)

Source: National Park Service

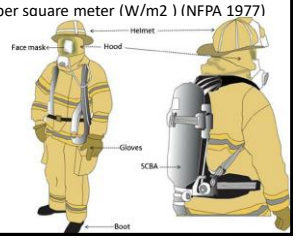
Progress PPE

- Depend on country : Structure FF only or Wildland and Structure FF
- Plethora of regulations and Standards

Type of fires	PPE objectives	Standards/ guidelines (example)
Wildland fire  Source NSW fire service	- Protect from low to medium fire exposure - Long shift and hard work Need: ->Adequate protection to reduce the exposure to heat and adequate ventilation to reduce heat stress ->Protection from injury	**International** Standards Organization (ISO) - PPE (ISO/DIS 16073-1) under development ISO TC94 SC14 (**21 Standards on Firefighters' personal equipment)** **Europe**: EN 15614:2007, Protective clothing for firefighters **USA**: NFPA 1977, Standard on Protective Clothing and Equipment for Wildland Fire Fighting, 2016 current Edition
Urban fires  Source NSW fire service	- Protect from high thermal exposure (flame and excessive heat) Need: ->Adequate protection and ventilation ->Protect from injury **->Protect from smoke (toxic gas)** **->Protect from liquid/chemicals**	**International** Protective clothing (ISO 11613:2017) ISO TC94 SC14 (**21 Standards on Firefighters' personal equipment)** **USA**: American Society for Testing and Materials (ASTM) – F23 protective clothing National Fire Protection Association (NFPA) - Fire and emergency services protective clothing - NFPA 1971- Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting (current edition 2018) **European** Committee for Standardization (CEN) - EN 1486:2007, Protective clothing for firefighters **Australia**: AS/NZS 4967:2009
WUI fires	-Protect from mixed exposure	CAL FIRE Wildland Urban Interface Book and Operating Principles Book

Research on firefighter PPE (wildland and urban fire)

- Research on textile resistant to flame, ventilation physiology and heat management
  - Right balance between thermal protection and reducing heat stress and optimum comfort (eg McQuerry et al. 2015)
- Textile characteristics (e.g. wildland fire fighters)
  - Radiative Protective Performance (resistance to flame, radiation): reasonable maximum exposure around 7kW/m2 (NFPA 1977 revised)
  - Total Heat Loss (ventilation): 450 watts per square meter (W/m2) (NFPA 1977)
- Other considerations:
  - Strength, resist penetration by liquid, visibility
  - Performance, weight, ergonomy, design, durability, flexibility
  - Care/Maintenance
- Helmet, gloves, boot, face mask



Protection of fire fighters - Health

Background

- The impact of large outdoor fires smoke on health is an increasing concern

Objectives

- Better understanding of smoke contents and smoke dispersion to inform potential human exposure (for people at risk). Consider smoke impact for fire suppression strategies and for fires in different environments (e.g. forest, grass, peat, urban interface).
- Other health effects (fatigue,…)

How?

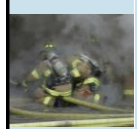
Step 1 Develop a repository presenting a summary of knowledge on smoke exposure and health impact on fire fighters in different scenarios (urban fires, wildfires, WUI fires, prescribed burning).

Progress health – smoke exposure

Type of fires	Smoke exposure and health effect	Studies examples
Wildland fire	Smoke exposure depend on: -Fire and fuels characteristics (wildland fuels) -Duration and intensity of fires -Smoke distribution (wind and topography) -Pollutants, example: • Carbon monoxide • Respirable particles • Aldehydes • VOCs Health effects: ->Short term ->Long term effect	**Australia**: Measurement of firefigter exposure to bushfire and prescribed burning smoke: E.g. Reisen, F., & Brown, S. K. (2009) Reisen et al. (2011) **Mediterranean Europe**: Characterising the health effects (long-term and short-term) of the exposure to fire smoke in firefighters that perform prescribed burns. Aldea et al. **France**: Smoke exposure of firefighters during prescribed burning: E.g. Lahaye (2011); Barboni et al. (2010) **USA**: Review of the health effects of wildland fire smoke on wildland firefighters: Adetona et al. (2016) Measurements of smoke exposure among wildland firefighters: E.g. Materna et al. (1992), Reinhardt, T. E. and Ottmar, R. D., (2004).

Progress health – smoke exposure (continued)

Type of fires	Smoke exposure and health effect	Document/ Studies examples
Urban fires	Smoke exposure : urban fuels Pollutants of concerns: CO, formaldehyde, acrolein, hydrogen chloride, hydrogen cyanide (HCN), hydrogen sulphide, hydrogen fluoride, benzene, nitrogen dioxide, sulphur dioxide and polycyclic aromatic hydrocarbons (PAHs) Health effects: ->Short term ->Long term effect	ISO TC92/SC3/WG6 ISO/TC 92/SC 3 Fire threat to people and environment **19 Standards – Examples:** ISO 13571:2012 Life-threatening components of fire -- Guidelines for the estimation of time to compromised tenability in fires ISO/TR 13571-2:2016 Life-threatening components of fire -- Part 2: Methodology and examples of tenability assessment Studies example : Health hazards of firefighters: exposure assessment Brandt-Rauf et al. (1988) ; Austin et al (2001)
WUI fires	Smoke exposure: - Mix natural and synthetics fuel such as wildland, combustible material from structure, house contents, vehicles Health effects: ->Short term ->Long term effect	**Australia**: Emissions from the combustion of major material presents in and around houses: E.g. Reisen, F. (2011); Reisen, F., Bhujel, M., & Leonard, J. (2014) Assessment fire exposures to the complex mixture of toxic air pollutants at the rural-urban interface and the likely health risks: Borgas, M. S., & Reisen, F. (2013)



Environmental impacts

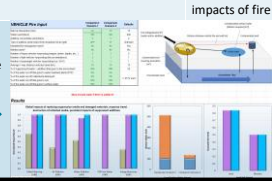
Background

- Consequences of fires suppression on the environment is an increasing concern

Objectives

- Environmental effect of suppressing those fires

Documents	Summary
ISO TC92/SC3/WG6 ISO/TC 92/SC 3 Fire threat to people and environment 19 Standards in SC3 – WG6 Examples: ISO 26367-1:2011 (new edition expected 2020, approved June 2019) Guidelines for assessing the adverse environmental impact of fire effluents ISO 19677:2019 Guidelines for assessing the adverse impact of wildland fires on the environment	Standards and Technical Reports outlining methods to assess the environmental impact of fires
Martin D., Tomida M., Meacham B. (2016) Environmental Impact of Fire, Fire Science Reviews.	Review of current work and presentation of framework to quantify environmental impacts of fire (including large outdoor fires)
Amon F., Gehandler J., McNamee R., McNamee M., Vilic A. (2019) Measuring the impact of fire on the environment (Fire Impact Tool, version 1)	Methodology (excel based) to determine the environmental impact of selected tactical choices in firefighting Sources : Margaret McNamee



Future direction

- Collecting information
- Summary of knowledge on:
  - PPE
  - Crew Protection System
  - Smoke exposure and health impact on firefighters
  - Environmental impacts
- Other topics to include (Fire fighting tactics, Various firefighting tactics are used globally to respond to large outdoor fires (wildfires, structure fires or fires that have reached the WUI, Incident commandment system, communication….) ?

Thank you

Acknowledgement: we would like to thank all the LOFF members for their participation. A special thank you to Margaret McNamee and Fabienne Reisen for their help with the presentation

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Large Outdoor Fires and the Built Environment Working Group

IGNITION RESISTANT COMMUNITIES - IRC

Elsa Pastor

Universitat Politècnica de Catalunya

Royal Halloway
University of London – Egham
June 30, 2019

Outline

IRC

1. Background
2. Objectives and methodology
3. Work progress
   - ✓ Standards
   - ✓ Fire exposure
   - ✓ Fuel treatments

Background

IRC

- Hardening structures is essential to decrease homes losses.
- Building codes and standards already exist. However, current large outdoor fire events are revealing important weaknesses in standard testing methodologies.
  - ✓ *Are levels of hardening adequately established?*
  - ✓ *Are large outdoor fire exposures properly captured in codes and standards?*

Mati (Greece) WUI fire July 2018
© David Caballero

Objectives and methodology

IRC

AIM

To develop the scientific basis for **new standard testing methodologies** indicative of **large outdoor fire exposures**, including the development of necessary testing methodologies to characterize **wildland fuel treatments** adjacent to communities

TOPICS

IRC – 1. Regulatory Framework and standards survey
- ✓ *What is working/not working in the current regulatory framework?*
- ✓ *What is missing in current codes and standards?*

IRC – 2. Fire exposure characterization
- ✓ *What kind of data do we have? Experiments? Real fires?*
- ✓ *What kind of data we don't have but we need?*

IRC – 3. Effectiveness of fuel treatments at the WUI
- ✓ *Have current regulations been proved efficient?*
- ✓ *What type of tools/models are adequate?*

Image IRC 2.
Source: Valérie Gache, AFP, Greece WUI Fires 2018

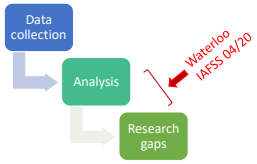
Objectives and methodology

IRC

AIM

To develop the scientific basis for **new standard testing methodologies** indicative of **large outdoor fire exposures**, including the development of necessary testing methodologies to characterize **wildland fuel treatments** adjacent to communities

METHODOLOGY



- ✓ Linear and parallel workflows in the three topics
- ✓ 3 topics (IRC-1, IRC-2, IRC-3) interconnected
- ✓ People from different countries and different backgrounds in each team

Work progress – Topic 1 – Standards Survey

IRC

1. **Documentation gathering**

Country	Document
Australia	• AS-1530.8 – 2007 – Part 1 • AS-1530.8 – 2007 – Part 2 • AS-3959 – 2018 • NASH 2014
United States	• Cal. Building Code, Ch 7A • Cal. Fire Code Ch49 WUI Fire Areas • Cal. St Fire Marshal Test St 7A1 – 7A-4 • ASTMs: E2726, E2632, E2707, E2886, E108, E119, E84
Japan	• Building Standard Law • Roof testing standard
France	• XP CEN/TS1187 - 2014
Canada	• FireSmart Guidebook - Alberta
International	• NFPA 1144 • ICC-IWUIC • FM Global – Prop. Loss. Prev DS

Work progress – Topic 1 – Standards Survey

IRC

2. Analysis

2.1 Document objectives

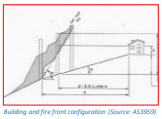
- ✓ *Fire testing std.? Construction std.? Guidebook?*

2.2 Scope of implementation

- ✓ *Author? Usability? Enforceability?*

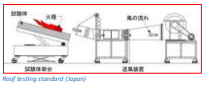
2.3 Fire exposure analysis

- ✓ *Type of fire exposure?*
  - Flame contact, flame radiation, firebrands
- ✓ *Type fire?*
  - Wildfire main front, residential fuels, structures
- ✓ *How is the fire represented (for fire testing std.)?*
  - Fuel, flame/brands characteristics
- ✓ *Exposed element?*
  - Residential/industrial properties
  - External construction elements



Building and fire front configuration (Source: AS3959)

Building and fire front configuration (Source: AS3959)



Roof testing standard (Japan)

Work progress – Topic 2 – Fire exposures

IRC

1. Data gathering

- Data on real fire exposures (fluxes and duration) for different types of fire intensities, including pre arrival of flame front, flame front exposure and combustion of residential fuels within communities, including structures.
- Well documented experiments, case studies, reports and photo/video

Source: Noah Berger

Source: The Guardian/ElizabethHue

Source: The Guardian (AFP/Getty Images)

Source: G. Chrisochodis (Athena Pics.)

Work progress – Topic 2 – Fire exposures

IRC

2. Data classification (I)

Fire phase		Type of exposure
Pre-arrival of flame front		Firebrands
Wildfire front exposure		Direct flame contact and radiation
		Firebrands
Combustion of residential fuels	Vegetation	Firebrands
		Direct flame contact and radiation
	Non-natural fuels	Firebrands
		Direct flame contact and radiation
	Structures(1)	Firebrands
		Direct flame contact and radiation

(1) In large urban fires (e.g. those occurred after earthquakes), the fuel involved in the main fire front will be mainly structures, although other residential fuels can also be involved.

Work progress – Topic 2 – Fire exposures

IRC

2. Data classification (II)

Flames

Fire Source	Description of the main fuel characteristics	DATA AVAILABLE						Reference
		HRR /MLR	Radiative flux	Convective flux	Flame height	Residence time	Other…	
Wildland fuels								
Ornamental vegetation								
Non-natural fuels								
Structures								

Firebrands

Fire Source	Description of the main fuel characteristics	DATA AVAILABLE					Reference
		Mass flux	Shower duration	Mass distribution	Ember dimensions	Other…	
Wildland fuels							
Ornamental vegetation							
Non-natural fuels							
Structures							

Work progress – Topic 2 – Fire exposures

IRC

3. Envisaged results – Flames Example

	Radiative flux	Convective flux	Flames height	HRR	Residence time
Wildland fuels					
Crown fire	~300 kW/m²	~ 40 kW/m²	~ 25 m	1 - 10 MW/m	~40 - 100 s
Surface fire	~ 41 – 176 kW/m²	~ 100 - 130 kW/m²	~1,5 – 3 m		
(Frankman et al., 2012; Wotton et al 2012; Cruz et al., 2011; Butler et al. 2004; Rehms et al., 2002)					
Ornamental vegetation					
Single tree/bush	~ 25 – 55 kW/m²			0.05 – 0.4 MW/kg	~40 - 100 s
(Mell et al., 2009; Hurley 2016)					
Structures					
Houses	~ 40 – 150 kW/m²			5 – 45 MW	~1 -7 h
(Maranghides&Johnson, 2008; Trelles&Pagni, 1997; Rehms et al., 2003)					

Work progress – Topic 3 – Fuel treatments

IRC

1. Documentation gathering and classification (I)

Scales definition

Work progress – Topic 3 – Fuel treatments

IRC

1. Documentation gathering and classification (II)

1) Theoretical considerations and modelling studies

2) **Guidelines/recommendations** on wildland treatments around WUI areas issued by land-management agencies

3) **Empirical investigations** of wildland treatments effectiveness around WUI areas in wildfire conditions

4) **Guidelines/recommendations** on WUI-fuel treatments in WUI perimeters issued by agencies

5) **Empirical investigations** of WUI-fuel treatments effectiveness in WUI perimeters

6) *Fire resistant gardening **guidelines***

7) ***Evidences** of efficiency*

Work progress – Topic 3 – Fuel treatments

IRC

2. Analysis

- Reports, guidelines, recommendations, leaflets on fuel treatments

✓ *Type of document?*
✓ *Country?*
✓ *Type of fuel structure/ecosystem to be treated?*
✓ *Fuel treatment description and scale? (Far wildland, wildland surrounding communities, perimeter fringe, etc.)*

- Empirical investigations: well documented experiments, case studies, reports and photo/video

✓ *Type of ecosystem and fuel structure*
✓ *Fire weather*
✓ *Fuel treatment*
✓ *Fire behaviour descriptors*
✓ *Efficiency indicators*

Work progress – Topic 3 – Fuel treatments

IRC

2. Analysis - Examples

- Empirical investigations: well documented experiments, case studies, reports and photo/video

- Agents Rurals (Catalan Fire Rangers)
- Evidences of real fuel treatment efficiency

✓ *Mediterranean ecosystems – Pinus halepensis forest (Catalonia)*
✓ *Fuel treatment (30 m): canopy cover < 35%; distance between tree trunks > 6 m; no horizontal continuity between canopies; no dead branches at 1/3 height; shrubbly layer < 15 %; isolated shrubs at 3 m distance*

Work progress – Topic 3 – Fuel treatments

IRC

2. Analysis - Examples

- Empirical investigations: well documented experiments, case studies, reports and photo/video

✓ *Mediterranean ecosystems – Pinus halepensis forest (Catalonia)*
✓ *Fuel treatment: canopy cover < 35; distance between tree trunks > 6 m; no horizontal continuity between canopies; free of dead branches at 1/3 height; shrubbly layer < 15 %; isolated shrubs at 3 m distance*

✓ *Fire behaviour descriptors: flame height*
✓ *Efficiency indicators: flame height reduction: 20 times*

IRC

Thanks to all IRC members for their nice work and commitment!

Thanks for your attention!

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Large outdoor fires and the Built Environment
IAFSS group Workshop at Interflam 2019

Emergency Management and Evacuation sub-group updates

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Background

Why an emergency management and evacuation sub-group?

Investigate strategies used around the world for emergency management in case of large outdoor fires

wikimedia.org

Key issues

- Evacuation vs stay and defend
- Different locations (e.g., WUI, city, informal settlements, etc.)
- Different populations (e.g., number, cultural issues, history of fires, etc.)
- Local/global conditions/variables

Overall EMEvac activities

Understanding of the problem

- Literature review (ongoing)
- Development of standard templates for analysis (ongoing)
- Review of case studies (ongoing)

Analysis of the problem

- Inventory of strategies/regulatory frameworks (planned)
- Inventory of tools (planned)
- Gaps, research roadmap, assessment of strategies/tools (planned)

Ongoing literature review

We want to understand what we know (and **what we do not know**)

Collecting available literature. Sorted by

1) Data/Survey/Interviews [19 papers]
2) Evacuation modelling [29 papers]
3) HB and recommendations [17 papers]
4) Non-fire relevant lit [19 papers]
5) Case studies (to be developed)

If you are aware of relevant material, please join us!

Case studies

Issues that have been identified

- Inconsistencies in reported information
- Reliability of sources (e.g. news, etc.)
- Variability in evacuation scenarios (WUI fires, city fires, informal settlement fires, etc.)
- Difficult to retrieve information
- Need for an overview on evacuation cases worldwide

Case studies

Solution

- **Standard template** for the review of cases worldwide to ensure consistency (modified version based on earlier work by Ronchi et al, 2017)
- Ongoing work to build a **database** on LOF&BE evacuation scenarios
- **Peer review** each other cases
- **Members'** participation to help building this up

Ronchi, E., Rein, G., Gwynne, S., Wadhwani, R., Intini, P., & Bergstedt, A. (2017). *e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation*. Quincy, MA (USA): Fire Protection Research Foundation.

Case studies

Case studies collected so far

Case study	Year	Country	Type of fire	Who reported this case?
Laerdalsoyri	2014	Norway	Urban	Martin Kristoffersen
Atlas	2017	USA	Wildfire/WUI	Stephen Wong
Camp	2018	USA	Wildfire/WUI	Stephen Wong
Carr	2018	USA	Wildfire/WUI	Stephen Wong
Hill	2018	USA	Wildfire/WUI	Stephen Wong
Nuns	2017	USA	Wildfire/WUI	Stephen Wong
Ranch	2018	USA	Wildfire/WUI	Stephen Wong
River	2018	USA	Wildfire/WUI	Stephen Wong
Tubbs	2017	USA	Wildfire/WUI	Stephen Wong
Woolsey	2018	USA	Wildfire/WUI	Stephen Wong
Itoigawa	2016	Japan	Urban	Tomoaki Nishino & Sayaka Suzuki
Swinley	2011	UK	Wildfire/WUI	Harry Mitchell
Dalarna/Jämtland/Gävlaborg	2018	Sweden	Wildfire/WUI	Johanna Fransson
Västmanland	2014	Sweden	Wildfire/WUI	Ronchi et al
Calci/Vicopisano	2018	Italy	Wildfire/WUI	Sandra Vaiciulyte
Fort McMurray	2016	Canada	Wildfire/WUI	Ronchi et al
Okanagan	2003	Canada	Wildfire/WUI	Ronchi et al

Case studies

Case studies collected so far

Case study	Year	Country	Type of fire	Who reported this case?
San Diego	2007	USA	Wildfire/WUI	Ronchi et al
La Gomera	2012	Spain	Wildfire/WUI	Ronchi et al
Victoria	2009	Australia	Wildfire/WUI	Ronchi et al
Madeira	2016	Portugal	Wildfire/WUI	Ronchi et al
Cadiz	2016	Spain	Wildfire/WUI	Sandra Vaiciulyte
Colorado Springs	2012	USA	Wildfire/WUI	Maria Theodori
Gatlinburg	2016	USA	Wildfire/WUI	Maria Theodori
Nelson	2019	New Zealand	Wildfire/WUI	Ruggiero Lovreglio
Creek	2017	USA	Wildfire/WUI	Stephen Wong
Rye	2017	USA	Wildfire/WUI	Stephen Wong
Skirball	2017	USA	Wildfire/WUI	Stephen Wong
Thomas	2017	USA	Wildfire/WUI	Stephen Wong
British Columbia	2017	Canada	Wildfire/WUI	Chunyun Ma
Haifa	2016	USA	Wildfire/WUI	Ronchi et al

Case studies

More case studies?

Constantly growing (31 cases so far) with help of EMEvac members…

Case study	Year	Country	Type of fire	Who reported this case?
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…

…more case studies are welcome

Case studies

Goal

- Build a broad knowledge on LOF&BE evacuation cases worldwide
- Collect a constantly growing number of cases
- Expand the number of scenarios (e.g. informal settlements, unconventional evacuation means)
- Expand number of regions covered
- Improve the template (log of comments of people filling in the template)
- Have a *living* database of the EMEvac group that can **grow and improve** over time

Next steps for IAFSS2020

- Proceed with case study database building
- Provide an overview on the case studies reviewed
- Template development for other issues (e.g. model reviews, evacuation strategies/regulatory issues)

Further long term goals

- Build a research roadmap on EMEvac based on consolidated knowledge
- Development of test case scenario(s) to evaluate the capabilities and limitations of existing tools to aid emergency management
- Enhancement of accessibility of existing and future evacuation data-sets
- Summary of inventory of existing tools for aiding emergency management

THANK YOU!

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