**VULNERABLITY MAPPING OF A HOUSE FROM AN IDEALISED FOREST FIRE**

##### Proposals to the Society of Fire Protection Engineering, October 2021

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# 1. The Research Team

*Chief Investigator* for the project is Professor of Fire Modelling Khalid Moinuddin from Victoria University (VU), Melbourne, Australia. Dr Mahmood Rashid will be *Associate Investigator* and Mr Amila Wickramasinghe will be an engaged PhD student for this project.

This project will draw on specialized wildfire modeling expertise within Victoria University. We are confident we have the expertise and resources to complete the project as specified below within the time scale outlined.

## 1.1 Prior Relevant Experience

Professor Moinuddin has strong relevant track records of international peer-reviewed research publications (<https://scholar.google.com/citations?user=RnXzZ_kAAAAJ&hl=en&oi=ao> ), have attracted significant funds from the Bushfire and Natural Hazard CRC (BNHCRC), Australian Research Council (ARC), Australian defense industry, Australian fire & building regulatory bodies and local industry partners (see Sections 8.1 and 8.2), and successfully managed large and complex research projects. Dr. Rashid has a very good publication record (<https://scholar.google.com/citations?hl=en&user=-9QzmpoAAAAJ> ). He is an extremely capable numerical code developer and has strong expertise in physics-based wildfire modeling.

## 1.2 Personnel Expertise

*Khalid Moinuddin* is a proven leader in fire modelling both building and wildland setting and an editorial board member of the leading fire journal, Fire Safety Journal. So far he attracted AU$2.3 million in external funding (with other researchers). He widened VU's research spectrum from applied only to fundamental as well. His fundamental research works include simulation of gasification of solid fuels and combustion of the gaseous form, turbulent fluid motion using various large eddy simulation (LES) based models, evaporation of the sprinkler/ water mist droplets etc. He is a leading researcher in implementing several submodels in physics-based model Fire Dynamics Simulator (FDS) such as an eddy diffusivity convective heat transfer model, an explicitly filtered LES model, an improved firebrand drag model and a leaf area density (LAD) configuration. Today VU’s fire research group is in a strong position to conduct research in a wide spectrum from fundamental to applied areas and contribute its fundamental research outcome to applied research and in turn into practical applications. He established three major streams of research: (a) improvement and application of a three-dimensional (3D) physics-based bushfire model (b) fire safety engineering in naval applications and (c) fire properties of building materials and vegetative fuels. He supervised of seven PhD students to completion and currently supervising another three including Mr Wickramasinghe. He will provide the conceptual design and necessary directions for issues arising during the project. He will be accountable for the success of this project and report and communicate the results and findings to the SFPE.

*Mahmood Rashid* is a post-doctoral researcher and received his doctoral degree in Computer Science (Artificial Intelligence), Masters in Computer Science (Data Mining) and Bachelors in Mechanical Engineering. Prior to work at VU, he worked as a post-doctoral researcher at University of Massachusetts, USA. He has excellent programming skill and recently implemented a wind reduction factor (known as wind adjustment factor in USA) in an operational wildland fire propagation model. He is also capable of using FDS. He will be involved in FDS code modification to implement a firebrand generation model and subsequently carry out FDS simulation of dynamic forest fire to determine firebrand and heat flux on a structure.

*Amila Wickramasinghe* is a PhD student and his project involves mapping of firebrand and heat flux on structures in the Wildland-Urban Interface from a static fire of Eucalyptus forest in Australian context. In his study firebrands are manually inputted in FDS modelling.

# 2. Project Approach

## 2.1 Goals and objectives

## 2.2 Scope

This study will address the following issues:

1. Implement a firebrand generation submodel in FDS based on fuel mass loss rate
2. Validate the implemented model against a single Douglas tree fire experiment conducted at National Institute of Standard and Technology (NIST) comparing dry fuel mass loss rate and firebrand landing on collecting trays
3. Simulate fire propagations in an idealised forest consisting Douglas trees standing on surface fuel and mapping vulnerability (in terms of firebrand flux and heat flux) on a structure at the end of a forest.

## 2.3 Technical Approach

The following tasks will be undertaken to achieve the project goals:

### 3.1 Implementing a firebrand generation submodel in FDS.

### 3.2 Validate submodel

### 3.3 Forest fire modeling for vulnerability mapping on a structure

### 3.4 Analysing the results and documentation

The results of the project will be analysed and a detailed report of the project and conclusions will be submitted. The analysis will quantitatively assess the smoke detection performance prediction methodology and serve to validate the approach. The accuracy of the approach will be characterized and the limitations of the methodology will be identified relative to key variables. An analysis of the applicability of results to various occupancy types will also be carried out.

# 4 Personnel and Apparatus

**Personnel:** Chief Investigator (Thomas), the two Associate Investigators (Moinuddin and Li) and other CESARE staffs.

**Apparatus:** Part of CESARE’s three storey test building located in LSFTF will be converted to host an electronic facility. CESARE has high performance PCs to conduct the FDS simulations. CESARE also has the equipment required for the measurements mentioned above available.

# 5 Schedule and cost

**Budget:** Complete Project:$221,000 US, Partial Project (scope a & b): $158,000 US.

**6. References**

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Sorensen, C. M. and Feke, G. D. The morphology of macroscopic soot. *Aerosol Science and Technology*, vol. 25, pp. 328-337, 1996.

**7. List of publications (Published refereed papers & conference proceedings)** (last five years only)

* 1. **Ian Thomas**

Thomas, I. R., Moinuddin, K. A. M., and Bennetts, I. D., The Effect of Fuel Quantity and Location in Small Enclosure Fires. *Journal of Fire Protection Engineering* (to be published in *Vol. 17*) 2006.

Bennetts, I. D., Moinuddin, K. A. M., Goh, C. C. and Thomas, I. R. Testing and factors relevant to the evaluation of the structural adequacy of steel members within fire-resistant elevator shafts. *Fire Safety Journal****,*** *Vol. 40 No.8*, pp. 698-727, 2005.

Thomas, I. R., Moinuddin, K. A. M. and Bennetts, I. D., Fire development in deep enclosure. Paper No. 304, *8th International Symposium on Fire Safety Science****,*** China, 2005.

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**7.3 Jun-de Li**

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**8. List of Research Funding** (last five years only) (Australian dollars)

* 1. **Ian Thomas**

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Waking to a fire: Optimising the smoke alarm signal. Bruck D. & Thomas I. R. ARC Linkage Project Grant 2006-2007 $65,389 from ARC, $65,400 from industry partners.

Domestic Smoke Alarm Literature Study. Thomas I. R., 2006 Bushfire CRC Ltd. $28,500

Optimising the smoke signal for the aged. Bruck D. & Thomas, I. R., US National Fire Protection Foundation, 2005-2006. $98,000.

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Fire Risk Evaluations of Commercial Buildings. Bennetts I. D. & Thomas I. R. ARC Linkage Grant 2005-2006. $242,800.

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FIRE-RISK Modelling. Thomas, I. R. 2003 Australian Building Codes Board $89,000

Low Rise Class 3 Timber Buildings. Thomas, I. R. 2002 Australian Building Codes Board. $21,450

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* 1. **Jun-De Li**

Investigating the flow characteristics of the flame rester in the compact smoke detectors , 2002, Vision Systems Ltd, $5,700.

Investigating the characteristics of the aspirator network of laser smoke detectors, 2001, Vision Systems Ltd, $16,500.