

# **FIRE SAFETY SCIENCE – PROCEEDINGS OF THE TENTH INTERNATIONAL SYMPOSIUM**

*Editor*

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**INTERNATIONAL ASSOCIATION  
FOR FIRE SAFETY SCIENCE**

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The cover flames were drawn by Prof. Yuji Hasemi of Waseda University, Japan, based on photographs taken by Prof. E.E. Zukoski, formerly of California Institute of Technology, Pasadena, California, USA.

# Preface

The Tenth International Symposium on Fire Safety Science was held at the University of Maryland 19-24 June 2011. The symposium was organized by the International Association for Fire Safety Science (IAFSS) with the local organization by the Department of Fire Protection Engineering at the University of Maryland.

Around 315 registrants attended the three parallel sessions in which 109 fully peer review papers, including six invited papers, were presented. Two accepted papers were withdrawn by the authors prior to the symposium and two papers were not presented at the symposium. The presented papers are printed in this volume and are also available at the IAFSS bibliographic database site at <http://iafss.haifire.com>. Also, two poster sessions were held at the symposium where around 112 posters were presented. Additionally, three workshops were given at the start of the symposium on innovation in suppression, elevator usage during egress and pyrolysis modeling and another three workshops were given at the end of the symposium on the challenges in education, fire and escape modeling and sustainable structural design. Twenty-one countries were represented: Australia, Belgium, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Iceland, India, Italy, Japan, Korea, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom and the United States of America.

The opening ceremony was conducted by representatives from the host organization and IAFSS: Prof. Darryll Pines, Dean of the A. James Clark School of Engineering, University of Maryland and Dr. Craig Beyler, Chairman of the IAFSS.

Following the opening ceremony, Prof. Takeyoshi Tanaka, Kyoto University, delivered the Howard W. Emmons Plenary Lecture entitled “Integration of Fire Risk Concept into Performance-Based Evacuation Safety Design of Buildings”. Five other invited papers were also presented during the course of the symposium by Prof. A. Carlos Fernandez-Pello, Dr. Margret Simonson McNamee, Prof. André W. Marshall, Prof. Domingos X. Viegas and Prof. Charles M. Fleischmann.

At the award reception and banquet, Dr. Anthony Hamins, Chair of the Symposium Planning Committee, presented the Howard W. Emmons Lectureship Award to Prof. Takeyoshi Tanaka. Prof. Bogdan Dlugogorski, Chair of the 2011 IAFSS Awards Committee, presented The Philip Thomas Silver Medal of Excellence for the best paper of the previous symposium to Ning Ren, Andrew Blum, Ying-Hui Zheng, Chi Do and André Marshall for their contribution entitled “Quantifying the Initial Spray from Fire Sprinklers”. The Kunio Kawagoe Gold Medal for outstanding lifelong contributions to fire safety science was presented to Prof. James Quintiere. The IAFSS Best Thesis Award “Excellence in Research” was presented to Dr. Angus Law (Europe and Africa), Dr. Chris Lautenberger (Americas) and Dr. Kai Chen (Asia and Oceania). The 2011 IAFSS Awards Committee bestowed two ad-hoc honourable mentions, one to Chris Lautenberger, Esther Kim, Nicholas Dembsey and Carlos Fernandez-Pello, University of California, for their paper titled “The Role of Decomposition Kinetics in Pyrolysis Modeling - Application to a Fire Retardant Polyester Composite”, and the other to Roger Harrison and Michael Spearpoint, for their paper titled “Characterisation of Balcony Spill Plume Entrainment Using Physical Scale Modelling”, both published in the proceedings of the 9<sup>th</sup> Symposium. On behalf of the International FORUM of Fire Research Directors, Dr. William Grosshandler presented the V. Sjölin Award to Dr. Gunnar Heskestad, Prof. Takeyoshi Tanaka and Prof. Yuji Hasemi in recognition of their pioneering work in fire safety science for the years 2009, 2010 and 2011 respectively. Dr. Grosshandler also presented the FORUM Student Travel Awards, for the best student papers accepted for this symposium, to Zhibin Chen, Ying Zhen Li, Tomoaki Nishino, and Sindra Summoogum. The Dougal Drysdale Award for extraordinary services to the IAFSS was presented for the first time at this Symposium and was given to Mr. Terry Fay.

The IAFSS would like to thank sponsors of the symposium and would like to extend its gratitude to all the organizations, committee members, and other volunteers that assisted in making this symposium so successful. A special thanks is given to Prof. Arnaud Trouvé and the staff at the Department of Fire Protection Engineering at the University of Maryland, as well as the members of the local Symposium Arrangements Committee. They provided first class hospitality as well as an excellent forum for the exchange of ideas on fire safety science.

The IAFSS would also like to greatly thank all those involved in the review, selection, and editing of the papers for the conference. A special thanks is given to Prof. Nick Dembsey and Dr. Bert Yu, Chair and Deputy-Chair of the Program Committee, for organizing and leading the committee on the selection of papers, and all of the program committee members who interacted with authors and reviewers as well as reviewed final manuscripts to ensure all reviewer comments were addressed. Many thanks go to Mr. Greg Baker and Dr. Kai-Yuan Li who served as assistant editors. In particular Greg Baker helped the editor deal with a whole range of tricky grammar questions by having somebody to elicit a second opinion from and Kai-Yuan Li assisted with checking the page layout. The work of Mr. Terry Fay, who set up the IAFSS bibliographic database site and assembled the web-based preprint versions of the papers presented at the symposium, is greatly appreciated. Finally, the editor of the Tenth IAFSS Symposium Volume wishes to thank Dr. Björn Karlsson, editor of the Ninth IAFSS Symposium Volume, for his valuable advice and suggestions in preparing this work.

Michael Spearpoint  
Editor, Tenth IAFSS Symposium Volume  
University of Canterbury  
Christchurch  
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July 2011



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## International Association for Fire Safety Science (2008-2011)

The triennial symposia of IAFSS and the resulting volumes of *Fire Safety Science* continue to be the centerpiece of IAFSS activities. The page count in *Fire Safety Science* was increased by two pages in this volume, bringing the increases in length over the past two symposia to 50% above historic levels.

In the past three years, *Fire Safety Science* was fully integrated into CrossRef with the deposition of over 13,000 citations from *Fire Safety Science* papers into the CrossRef system. This will facilitate forward linking of citations via CrossRef, to be included in the forthcoming new version of the IAFSS Digital Archives. This feature will be valuable to users and will provide authors with important data concerning the citation of their work. The IAFSS Committee has voted to make the IAFSS Digital Archive open to the public to maximize the utility of the collection to the broader community and to disseminate the work of authors as broadly as possible.

The 10<sup>th</sup> Symposium of the IAFSS was held at the University of Maryland College Park campus. With 340 attendees, the symposium was a definite success and included three parallel sessions of peer reviewed papers in addition to the invited lectures presented to all participants in a single session format. The posters were presented in two afternoon sessions. The workshops program was expanded to include three workshops held Sunday afternoon before the start of the symposium and three workshops on Friday at the end of the symposium. All papers were available online prior to the meeting as preprints. Publication of the print version will occur within the coming months.

The success of the symposium is the result of significant efforts by many individuals and organizations. Special thanks are due to Dr. Anthony Hamins, Symposium Organizing Chair, Prof. Arnaud Trouvé, Chair of the Local Arrangements Committee; Prof. Nick Dembsey and Dr. Bert Yu, Chair and Deputy-Chair of the Program Committee; Dr. Mike Spearpoint, Volume Editor; Dr. Steve Gwynne, Coordinator for the Workshops; Prof. Bart Merci, Poster Session Coordinator; Terry Fay, Symposium Paper/Poster Website Coordinator; and Carole Franks, the IAFSS Secretariat. Thanks are due to the symposium sponsors, especially the primary sponsor, FM Global. Thanks are also due to the National Science Foundation for support of participation in the symposium by US-based students. For a complete listing of the contributors to the symposium organization, see the listing included in the front matter of *Fire Safety Science*, **10**.

After a long term decline to less than 250 members, at the time of the 10<sup>th</sup> Symposium IAFSS membership reached 500 members for the first time.

Over the past few years, Prof. Mario Fontana and Prof. Bodzio Dlugogorski, with assistance of Prof. Pat Pagni, have collected and published on the website both historical and process information concerning IAFSS awards. This provides easy access to awards information and will serve the IAFSS community going forward.

At the 10<sup>th</sup> Symposium, IAFSS instituted a new award, the Drysdale Award. This award honors extraordinary service to IAFSS. This award is named for Prof. Dougal Drysdale as he retires from IAFSS Committee service in recognition of his significant accomplishments and service to the fire science community. The first award winner was Terry Fay for his development of the IAFSS digital archives system. The award is selected by the Chair of the IAFSS Committee.

During 2008-2011, planning for two new IAFSS initiatives was begun; the IAFSS Digital Community and the IAFSS Federated Search Facility. Terry Fay headed the feasibility study for the Digital Community, an enhanced online IAFSS presence, and Dr. Amanda Robbins headed the development of a prototype Federated Search facility (see <http://www.fire-information.net/wiki/tiki-index.php>). The IAFSS committee formally voted to implement these innovations at the Thursday meeting of the committee at the 10<sup>th</sup> Symposium.

The Committee and Executive Committee elected during the 9<sup>th</sup> International Symposium on Fire Safety Science in Karlsruhe, served from 2008-2011 and is as follows:

**Chair**

Dr. Craig Beyler

**Vice-Chairs**

Dr. Anthony Hamins, USA

Prof. José Torero, UK

Prof. Bogdan Dlugogorski, Australia

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Dr. Björn Karlsson, Iceland

Dr. Suresh Kumar, UK

Dr. Bart Merci, Belgium

Prof. F. Mowrer, USA

Dr. Guylène Proulx, Canada

Dr. Margaret Simonson, Sweden

Prof. J. Sun, China

Prof. Takeyoshi Tanaka, Japan

Prof. P. van Hees, Sweden (co-opted)

Committee members Prof. Mario Fontana, Prof. Patrick J. Pagni, Prof. Weicheng Fan, Dr. James Mehaffey, Prof. Geoffrey Cox, and Dr. Robert Bill retired from service to the committee at the time of the 9<sup>th</sup> Symposium. IAFSS owes a great debt of gratitude to these retiring committee members who have provided significant service to IAFSS and the fire science community. It is with great sadness that we note the untimely passing of committee member Dr. Guylène Proulx in December 2009. Her obituary is included in this volume of *Fire Safety Science*.

During the 2008-2011 term, the committee met at each symposium as well as a midterm meeting in 2010. The committee met via a parallel session held at the 2010 Interflam in Nottingham UK and the 2010 AOSFST symposium in Melbourne. This split meeting assured maximum participation by committee members from around the world.

The newsletter, edited by Dr. Jack Watts, continued to be published twice a year with substantial content from within IAFSS as well as the broader fire science community. The page count of the newsletter was 13-22 pages per issue, up from historical levels of about 8 pages. Jack instituted a team approach to the newsletter through the development of a team of associate editors from around the world (Prof. Ali Rangwala, Prof. Guillermo Rein, Dr. Michael Spearpoint, Prof. Patrick van Hees, Prof. W.K. Chow, and Prof. Ai Sekizawa) to facilitate collection of news. At the 10<sup>th</sup> Symposium Dr. Watts announced his retirement as newsletter editor and Prof. Guillermo Rein was announced as the new editor.

With its 2010 symposium in Melbourne Australia, the Asia-Oceania Association for Fire Science and Technology (AOAFST) continues to be a vibrant regional IAFSS organization. The local arrangement Chair was Prof. Ian Thomas and the program chair and co-chair were Prof. Bodzio Dlugogorski and Prof. Eric Kennedy. The current Chair is Prof. W.K. Chow of Hong Kong Polytechnic University.

Carole Franks continues as the Secretariat and continues to provide invaluable service to IAFSS.

The next symposium in 2014 will be at the University of Canterbury, New Zealand. The symposium in 2017 will be held at Lund University, Sweden.

As of this writing, I have completed my service as Chair. It has been an eventful six years and there is much more to do to continue to enhance the service that IAFSS provides to the fire science community and the membership. The ongoing goal is to make membership in IAFSS more valuable and to enhance the contributions that IAFSS can make to the fire science community and to fire safety around the world.

Craig Beyler, Chair

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## **Award Recipients**

### **Howard W. Emmons Lectureship Award for Distinguished Achievement in Fire Safety Science**

1984	J. de Ris (NBS-CFR Award)
1985	E.E. Zukoski
1986	J.G. Quintiere (NBS-CFR Award)
1988	K. Kawagoe
1991	P.H. Thomas
1994	O. Pettersson
1997	T. Jin
1999	Y. Hasemi
2002	P.J. Pagni
2005	H.R. Baum
2008	V. Babrauskas
2011	T. Tanaka

### **Kunio Kawagoe Gold Medal for Outstanding Lifelong Contributions to Fire Safety Science**

1994	A. Robertson
1997	P.H. Thomas
1999	H.E. Nelson
2002	D. Drysdale
2005	S. Yokoi
2008	G. Cox
2011	J.G. Quintiere

### **Philip Thomas Silver Medal of Excellence for the Best Paper of the Previous Symposium**

1988	Y. Hasemi
1991	H.R. Baum and B.J. McCaffrey
1994	A. Atreya and M. Abu-Zaid
1997	B.Z. Dlugogorski, J.R. Mawhinney and V.H. Duc
1999	R.G. Rehm, K.B. McGrattan, H.R. Baum and K.W. Cassel
2002	J.P. Garo, P. Gillard, V.P. Vantelon and A.C. Fernandez-Pello
2005	D.W. Weinert, T.G. Cleary, G.W. Mulholland and P.F. Beever
2008	T. Korhonen, S. Hostikka and O. Keski-Rahkonen
2011	N. Ren, A. Blum, Y.-H. Zheng, C. Do and A. Marshall

### **IAFSS Best Thesis Award “Excellence in Research” for the Best Masters and PhD Theses**

2005	S. Lamont (Europe and Africa), A. Bar-Ilan (Americas) and W. Wenguo (Asia and Oceania)
2008	M. Knobloch (Europe and Africa), A. Rangwala (Americas) and J. Dimyadi (Asia and Oceania)
2011	A. Law (Europe and Africa), C. Lautenberger (Americas) and K. Chen (Asia and Oceania).

### **FORUM Sjölin Awards for Outstanding Contribution to the Science of Fire Safety**

1994	Lund University, Science University of Tokyo, the University of Edinburgh, the University of Maryland, and Worcester Polytechnic Institute
1999	P.H. Thomas, K. Kawagoe, H.W. Emmons, D. Rasbash and the eight organizations to which they were connected: Harvard University, NIST, FMRC, WPI, BRI, Science University of Tokyo, FRS, and the University of Edinburgh
2002	V. Babrauskas, P.F. Beever and J.G. Quintiere

2005 D. Drysdale  
2006 G. Cox  
2007 R. Gann  
2008 A. Buchanan  
2009 G. Heskestad  
2010 T. Tanaka  
2011 Y. Hasemi

**FORUM Student Travel Awards for the Best Student Papers Accepted for the Symposium**

2008 S. Ukleja and S.-H. Koo  
2011 Z. Chen, Y.Z. Li, T. Nishino and S. Summoogum

**Honourable Mentions of the 2011 IAFSS Awards Committee**

C. Lautenberger, E. Kim, N. Dembsey and C. Fernandez-Pello  
R. Harrison and M. Spearpoint

## In Memoriam



**Prof. Kazuo Akita**  
**1924 - 2009**

Prof. Kazuo Akita, Professor Emeritus of the University of Tokyo passed away on March 19, 2009 at the age of 85. According to the story by Mrs. Akita, he fell down at home and was carried to hospital by ambulance at the end of 2008, but he had felt considerable pain even before then without informing the people around him. Finally, he could not stand intense pain and fell down. He passed away just when it was decided he should move to another hospital.

Mrs. Akita said that Prof. Akita was a stubborn person, and when I heard that, I was deeply impressed and thought that as a person with a strong will, he did not want to bother others. There may be many people who have the impression that Prof. Akita always looked serious, but this is not true. Whenever we went to his home for New Year holidays etc., he looked very joyful and told various stories that have nothing to do with research. He pleasantly provided us with his extensive knowledge especially when discussing the fire in Edo. He later turned these stories into a book.

Prof. Akita worked for National Research Institute of Fire and Disaster, Fire and Disaster Management Agency from 1961 to 1967. He was engaged in liquid and solid combustion study and achieved research results recognized worldwide particularly for his pioneering work and leadership in pool fires and fire modeling from the 1950s to the 1970s.

After he had concurrently worked for the University of Tokyo for some years, he moved to the university in 1967 and dedicated himself to teaching and leading students. After the Hokuriku tunnel fire in 1972 that killed 30 people he took the leadership of real scale fire experiments and created the foundation for the instruction manual corresponding to train fires in a tunnel.

In relation to the Japan Association for Fire Science and Engineering, he played a role as an officer from about 1967, four years after the society had become a corporation. He was involved in the editing of the Bulletin of research papers of the Japan Association for Fire Science and Engineering for a long time, and created the basis of the bulletin. Later he acted as a Vice-Chairperson from 1988-1989 and a Chairperson from 1990-1991. Prof. Akita was also one of the founders of the international forum of fire research preceding the establishment of IAFSS.

He was a very strict teacher for us students because his principle was “letting students think for themselves.” He was especially strict about written work, and I still remember that he corrected our conference papers in minute detail. I suppose that he is having a wry smile in heaven about this poorly-written text. I want to express our deep gratitude for his strict guidance, praise his achievements, and I respectfully offer my condolences.

(Based on a translation by Ai Sekizawa from the obituary in KASAI, the official Journal of Japan Association of Fire Science and Engineering, Vol. 59 No. 2, April 2009 originally by Dr. Ichiro Nakaya, Japan Testing Center for Construction Materials)

## In Memoriam



**Prof. Yoichi Uehara**  
**1930 - 2009**

Prof. Yoichi Uehara, Professor Emeritus of the Yokohama National University passed away on August 8, 2009 at the age of 78. For the past several years he had been repeatedly hospitalized and/or released under home healthcare. We had worried about his state of health and we finally had the sad news. We knew that he was unwilling to show his illness in public as he was a very dandy gentleman, but now I regret the loss of opportunity to see him again.

Prof. Uehara was widely known both in Japan and abroad as a researcher in chemical fires. He was Chairperson of the Japan Association for Fire Science and Engineering, the Japan Society for Safety Engineering, and the Safety Engineering Research Communication Committee of the Science Council of Japan. He exerted himself to create places of international academic exchange. He worked toward the launch of the International Association for Fire Safety Science (IAFSS), the International Fire Safety Science Symposium, the Asia-Oceania Fire Science and Technology Symposium, and the Asia-Pacific Symposium on Safety, etc. Prof. Uehara was the Treasurer of IAFSS from 1991 to 1997 and IAFSS Vice-Chair from 1997 to 2002. The above photograph was taken at the 7<sup>th</sup> IAFSS symposium held in the United States in 2002, where he was awarded the prize for his distinguished service in IAFSS.

In relation to the Japan Association for Fire Science and Engineering, he served on the Academic Promotion Committee, the Editorial Committee, and the International Relations Committee for many years, and assumed an officer on the board of directors from 1973 to 1974 and for a further three terms, from 1993 to 1996. He was also the 17<sup>th</sup> Chairman of Japan Association for Fire Science and Engineering from 1995 to 1996.

Prof. Uehara did not complain about every little thing and the atmosphere of his laboratory was very free. Students enjoyed the liberal atmosphere, but Prof. Uehara was a reliable person and a tower of strength for anyone in trouble. I think that as a mentee of late Prof. Kenichi Fukui, who was a Nobel Prize winner, Prof. Uehara gave appropriate guidance that matched our ability, although I am afraid that he may have been very disappointed with our poor theory development. I sincerely thank Prof. Uehara for his warm guidance, remember the achievements during his lifetime and give heartfelt condolences.

(Based on a translation by Ai Sekizawa from the obituary in KASAI, the official Journal of Japan Association of Fire Science and Engineering, Vol. 59 No. 5, October 2009 originally written by Dr. Hideo Ohtani, Professor, the Yokohama National University)

## In Memoriam



**Dr. Guylène Proulx**  
**1960 - 2009**

The international fire protection community lost an outstanding researcher when Dr. Guylène Proulx passed away on December 1, 2009, three months after being diagnosed with cancer.

Guylène was a student of the late Jonathan Sime and continued in his tradition of thorough scientific research on human behavior in fire. After receiving her Ph.D. in architectural planning/environmental psychology from the Université de Montréal in 1992, Guylène was Manager of the Human Factors project within the Fire Research Program, at the Institute for Research in Construction, National Research Council Canada (NRC) for 18 years.

Her research included investigations of a broad range of critical topics: human response to fire alarms, fire alarm audibility and signal recognition, effectiveness and impact of voice communication messages on evacuation, typical actions taken after fire alert, evacuation movement, timing of escape, time to start evacuating, social interaction during emergency, performance of fire warning systems and photoluminescent marking, evacuation strategies for various occupancies and peoples with disabilities.

Guylène was a great communicator of fire safety science and an ambassador of the fire protection community to raise public awareness of fire safety. She gave more than 300 presentations to the fire protection community and general public and her groundbreaking research had a profound impact on fire safety worldwide.

Guylène was also a great teacher and mentor, and was especially encouraging to young researchers entering the field. She served as an Adjunct Research Professor at Carleton University and an Adjunct Associate Professor of Fire Protection Engineering at Worcester Polytechnic Institute.

Guylène served on the IAFSS Management Committee, the SFPE Board of Directors, and was a technical editor for the NFPA *Fire Protection Handbook*. She was also a member of the ASME A17 Task Group on Use of Elevators for Occupant Egress, a member of the Human Factors and Ergonomic Society and served on the Editorial Board of *Fire Technology*. She was an expert member on the Fire Protection Research Foundation advisory task group for the project on audibility of smoke alarms for the elderly, and an expert advisor to the Battelle/Center for Disease Control research team developing survey strategies for interviewing fire victims. She helped organize the first four International Symposia on Human Behaviour in Fire as a member of the program committee.

Guylène was the recipient of numerous awards from NRC and the Government of Canada for efforts in sharing research findings and promoting fire safety, including the 2007 Public Service Award of Excellence from the Government of Canada. On December 30, 2009, Her Excellency the Right Honourable Michaëlle

Jean, Governor General of Canada, announced that Guylène was one of 25 newly appointed Officers (O.C.) to the Order of Canada, one of the country's highest civilian honours. Based on the recommendation of the Advisory Council for the Order of Canada, Guylène was appointed Officer "for her contribution to fire safety research during her career with the National Research Council of Canada, especially her studies on photoluminescent material, smoke alarms, and human behaviour during emergencies."

Guylène Proulx's generosity will be remembered by the international fire community. She was one of the pre-eminent researchers in the field of human behaviour in emergencies and was also a wonderful, warm and friendly person who brightened up conferences with her bright personality and positive attitude. She will be greatly missed.

(Contributed by Rita Fahy based on a version by Joseph Su, NRCC published in a previous IAFSS newsletter)

# **Symposium Committees**

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## **10<sup>th</sup> Symposium Awards Committee**

*Chair* Prof. B.Z. Dlugogorski

*Members*

Prof. W.K. Chow  
Prof. J. Quintiere  
Prof. T. Tanaka  
Prof. J. Torero

For the selection of the recipient of the Kunio Kawagoe Gold Medal, the 2011 IAFSS Awards Committee has been assisted by Prof. E. Galea, Prof. T. Hakkaraianen and Prof. P. van Hees, who replaced Prof. J. Quintiere, Prof. T. Tanaka and Prof. J. Torero on the committee.

## **10<sup>th</sup> Symposium Workshops Coordinator**

Dr. S. Gwynne



## **10<sup>th</sup> Symposium Local Arrangements Committee**

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William Davis	Yuji Kudo	Peter Sunderland
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### **EMMONS PLENARY LECTURE**

A. Trouvé

### **INVITED LECTURES**

A. Hamins  
N. Dembsey  
M. Spearpoint  
S. Gwynne  
B. Merci

### **WATER MIST/SPRAY SUPPRESSION**

G. Liao  
B. Ditch

### **HUMAN PERCEPTION AND RESPONSE**

E. Kuligowski  
M. Ball

### **TOXIC HAZARD**

M. Simonson-McNamee  
A. Stec  
B. Dlugogorski  
R. Hull

### **FIRE SUPPRESSION**

C. Wieczorek  
G. Linteris  
A. Marshall  
Y. Xin

### **TUNNEL FIRES**

H. Ingason  
P. van Hees

### **IGNITION/EXTINCTION**

M. Simonson-McNamee  
K. McGrattan

### **SPRINKLER SUPPRESSION**

H-Z. Yu  
A. Marshall

### **SMOKE TRANSPORT**

B. Weckman  
H. Pretrel

### **FLAME SPREAD**

M. Simonson-McNamee  
K. McGrattan

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P. Boulet  
E. Blanchard

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P. Sunderland  
Y. Yamauchi

### **PYROLYSIS**

N. Liu  
N.K. Fong

### **FIRE DYNAMICS**

P. Sunderland  
R. McDermott

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H. Ingasson  
B. Karlsson

### **COMPARTMENT FIRE FLOWS**

G. Rein  
P. Pagni

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A. Sekizawa  
J. Hall

### **STRUCTURAL FIRE PERFORMANCE**

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M. Fontana  
J. Milke  
L. Bisby

### **COMPARTMENT FIRES**

S. C. Kim  
A. Dodd  
C. Lautenberger  
W. Jahn

### **BUILDING FIRE SPREAD**

T. Korhonen  
J. Vaari

### **TERMOGRAVIMETRIC ANALYSIS**

S. Manzello  
A. Matala

## **FIRE AND SMOKE DETECTION**

J. Newman

M. Khan

## **FLAME EXTINCTION**

M. Delichatsios

J. Williamson

## **EVACUATION MODELING**

T. Korhonen

R. Fahy

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D. Gottuck

Y. Oka

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J. Floyd

K-Y. Li

## **EVACUATION BEHAVIOR**

D. Nilsson

A. Sekizawa

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W.K. Chow

T. Tanaka

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K. McGrattan

C. Fleischmann

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Z. Magnone

M. Avila

J. Crocker

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P. DesJardin

B. Lattimer

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B. Sundström

R. Hull

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A. Jeffers

M. Janssens

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### **Suppression: “Rethinking Water Based Fire Suppression: Discovering Opportunities for Innovation”**

A. Marshall  
G. Liao

### **Human Response: “How will People Use Elevators for Evacuation during a Building Fire”**

E. Kuligowski  
A. Sekizawa

### **Fire: “Approaches for and Challenges in Parameter Estimation for Pyrolysis Models”**

M. Janssens  
P. van Hees

### **Models: “Fire & Escape Modeling – from bits and bytes to safe buildings”**

P. Thompson  
J. Floyd

### **Education: “The Challenges of Fire Safety Education to Train Highly Qualified Fire Protection Engineers and Scientists”**

G. Hadjisophocleous  
K. Harada  
B. Karlsson

### **Structures: “How Can Sustainability be Achieved through Fire Safe Structural Design”**

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L. Bisby

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