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Fire AUSTRALIA

SPRING 2011

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About *Fire Australia*

Welcome to the Spring 2011 edition of *Fire Australia*.

Fire Australia is a joint publication of the Fire Protection Association Australia (FPA Australia), the Australasian Fire and Emergency Service Authorities Council (AFAC), the Bushfire Cooperative Research Centre (Bushfire CRC) and the Institution of Fire Engineers (IFE Australia).

We aim to bring the latest news, developments and technical information to the fire protection industry, emergency services and fire research organisations. *Fire Australia* is produced quarterly and distributed throughout Australia and New Zealand.

Letters to the editor and editorial submissions are welcome and can be sent to mark.murray@fpaa.com.au. For more details on submitting a contribution, please contact one of our editors.

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FRONT COVER PHOTO: THE REMAINS OF THE WORLD TRADE CENTER NORTH TOWER, NEW YORK, 11 SEPTEMBER, 2001, GETTY IMAGES

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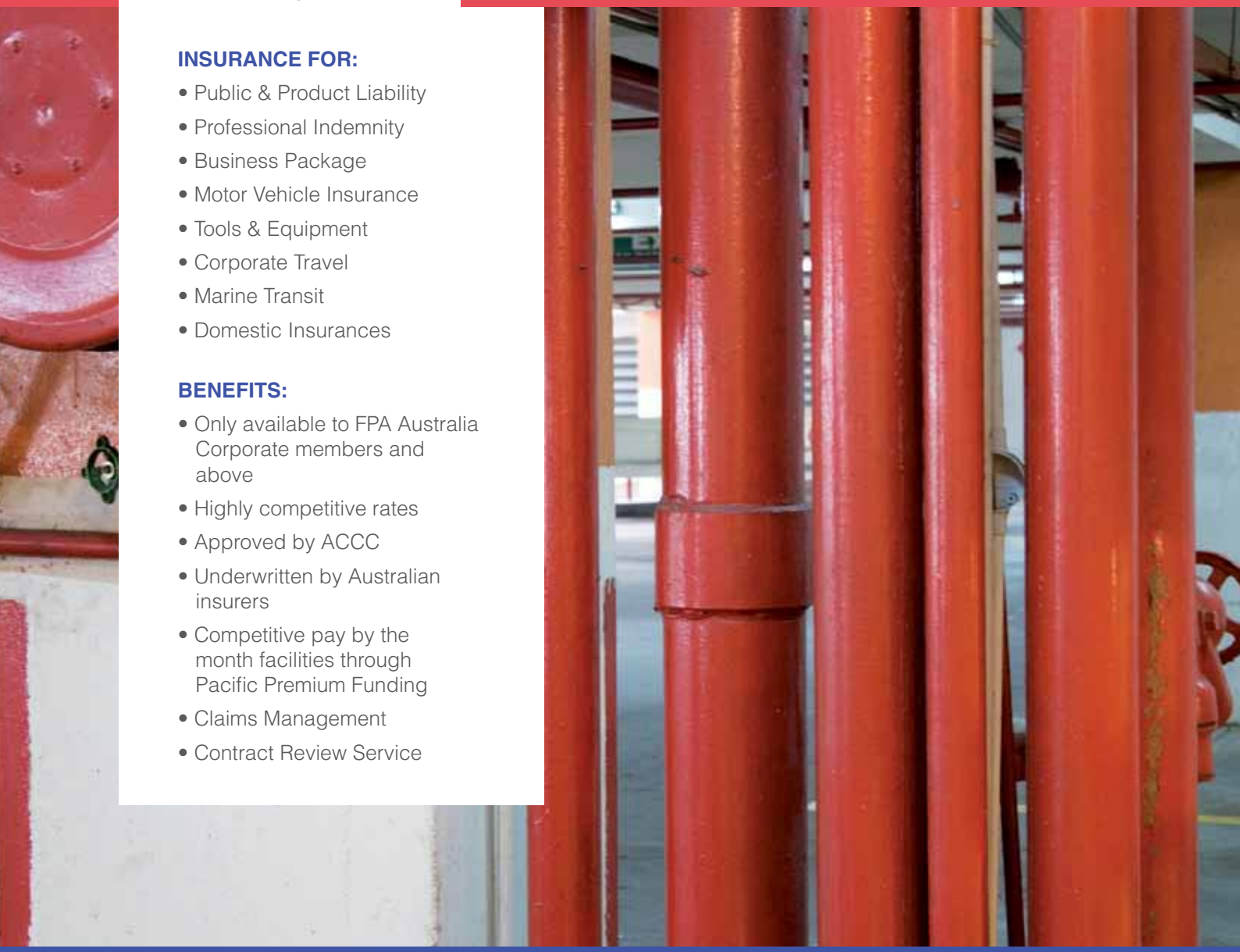

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IN THIS EDITION

Naomi Brown
CEO, Australasian Fire and Emergency Service Authorities Council (AFAC)

Welcome to the Spring issue of *Fire Australia*

An outstanding AFAC and Bushfire CRC Annual Conference was held in Sydney at the end of August, and attracted a record number of delegates from the fire and emergency services sector from Australia, New Zealand and across our region. Feedback received from our delegates indicates that overall they were impressed with the diverse program and quality of speakers.

Themed *New World, New Thinking*, the conference gave delegates the opportunity to explore the impacts of innovation and development for the industry with a plethora of new technologies being utilised. The conference also provided an opportunity to view and learn about the latest technology and equipment, with the largest Trade Expo ever staged in Australia for our industry.

This issue of *Fire Australia* features articles on the conference, our industry award winners and profiles the work of one of the leading keynote speakers, José Torero, on the lessons learnt from the collapse of the World Trade Center. Speaker presentations, posters and photos are all available online on the AFAC Knowledge Web: http://knowledgeweb.afac.com.au

One of AFAC's foundation products is the Australasian Inter-service Incident Management System (AIIMS) that is managed on behalf of the industry by AFAC. The manual has recently been reviewed and this work is in the final stages of completion, with publication of the AIIMS Third Edition, 2011 Revision.

The 2011 revisions pick up themes that arose from a number of public inquiries into the management of emergency incidents. Most significantly, a public information function has been added to emphasise the importance in any incident of communicating with affected communities and stakeholders. More commentary has also been added on the importance of safety considerations for the Incident Controller, and improved text on the appointment of Deputy Incident Controllers. Revised AIIMS manuals will be available for purchase through the AFAC online shop at www.afacshop.com.au.

AFAC is continuing to work closely with the Bushfire CRC and the Federal Government on the establishment of a Research Institute. Meetings will be arranged with all jurisdictions in coming months to ensure that momentum for the Institute continues.

Recently the Bushfire CRC released the report into last summer's Perth Hills bushfires. The report is the result of face-to-face interviews with residents in the affected areas by researchers from the University of Western Australia and provides interesting reading as we head into the bushfire season. The report is available on the Bushfire CRC website.

I hope you enjoy this edition of *Fire Australia*.

NEWS

Industry Awards Recognise Innovation and Excellence in the Emergency Services: LAURIE LAVELLE AWARD

Quinlan Webster and Leon Smith have each been presented with the prestigious Laurie Lavelle Achiever of the Year Award at the recent AFAC and Bushfire CRC Conference in Sydney, in recognition of their outstanding contribution to emergency services.

The award was presented to the recipients by Laurie Lavelle, OAM, long-standing former Chief Fire Officer of the Melbourne and Metropolitan Fire Brigades Board and inaugural CEO of AFAC.

Quinlan, Senior Station Officer for the New Zealand Fire Service, was presented his award in appreciation of his outstanding achievements in advocating and improving fire safety and awareness for the deaf and hearing impaired through programs and projects in these communities. Through the development of the Emergency '111' Deaf Text Service, Mr Webster has been able to provide the deaf and hearing impaired community vital access to the emergency services.

In recognition of Mr Webster's work, The New Zealand Fire Service has been publicly acknowledged with two major awards.

Leon, Manager for Engineering Services at the Tasmania Fire Service, has been awarded the Laurie Lavelle award for his pivotal role in the development of the Tasmania Fire Service's (TFS) rolling and sustainable quality fire truck replacement program, which has resulted in other AFAC member agencies seeking assistance in the design and building of fire trucks.

The TFS is the only Australian fire service to build its own tanker and tanker/pumper trucks. By developing the rolling and sustainable replacement program, Leon has been able to save TFS significant savings through the development of the program, and demonstrate to other AFAC member agencies that the program is sustainable.

Alan McDougall was also honoured with the Highly Commended Award for his central role in the training of hundreds of South Australians in the key principles of emergency management, including emergency risk management. Mr McDougall is the State Emergency Management Training Officer with the SA State Emergency Service.

Laurie Lavelle award winners (L-R): Laurie Lavelle, Quinlan Webster and Leon Smith.

AS 1851 Public Comment Forum

By Matthew Wright, Chief Technical Officer, FPA Australia

During late August and early September 2011, FPA Australia hosted Public Comment Forums in each State capital regarding Draft Australian Standard AS 1851 (Maintenance of fire protection systems and equipment). Most FPA Australia seminar series relate to existing publications or activities in fire protection. The Public Comment Forums represented a new proactive initiative by FPA Australia to inform the membership and industry and to encourage informed comment, prior to publication of the draft AS 1851.

The draft standard was released for comment by Standards Australia on 17 August 2011 and represents a considerable evolution from the latest 2005 version. Changes include a reduction in administrative requirements, refined maintenance activities informed by field experience and studies and aspects revised to avoid regulatory conflict.

Almost 600 people attended the Public Comment Forums and were provided with insights from the panel members in relation to:

- Local and national regulatory context in relation to building maintenance;
- An overview of the proposed changes;
- Benefits and environmental implications;
- FPA Australia strategy for coordinating public comment and implementation of the Standard in the future; and
- Technical changes – details.

Attendees included a wide spectrum of industry stakeholders including maintenance contractors, property managers and owners, certification consultants, regulators, insurers and educators. Comment on the draft Standard was encouraged via FPA Australia using an electronic process for the first time. This has proven to be popular and at the time of publication of this edition of *Fire Australia*, FPA Australia staff and FPA Australia Technical Advisory Committee TAC 1 were busy collating a significant number of comments received as a healthy indication of industries desire to assist in improving this Standard.

FPA Australia's main focus has been to refine AS 1851 to allow it to be used more readily and ensure appropriate maintenance is undertaken and recorded, and issues reported and rectified. However the Association has also identified a number of activities and documents that need to be developed post publication of the new Standard to assist industry. The Public Comment Forums assisted in raising some of these issues. Some initiatives include: raising the profile of regulatory requirements, advocating national harmonisation of these and preparing guidelines to assist with interpretation; and consistent implementation of maintenance requirements.

The closing date for public comment to Standards Australia was 19 October 2011, following which the Standards Australia committee FP001 will consider comments received. A date for publication of a new version of AS 1851 is yet to be announced.

Thank you to all the people who attended the Public Comment Forums and those who provided comment. Also thank you to the panel members who volunteered their time and expertise (Glenn Talbot – Verified, Russell Porteous – Maintenance Essentials, Andre Mierzwa – FM Global, Brett Staines – Chubb Fire & Security). Lastly, but by no means least, thank you to sponsors FlameStop and Verified. Without your contribution to subsidise costs, the forum would not have been possible.

TAKING THE NEXT STEP IN ELECTRICAL SAFETY – periodic electrical inspections

In the last 30 years, Australia has experienced a steady decline in the number of deaths linked to electricity. This downward trend can be attributed to everything from better education, improved safety procedures across some industries, better designed equipment and the strengthening of regulations.

All of these factors have contributed to reducing deaths and will remain critical components in the push to prevent further injury and fatalities.

A key factor in the battle to improve electrical safety in Australia is the ageing housing stock.

It is no secret that many older homes in Australia have original wiring and do not have Residual Current Devices (RCDs) or safety switches installed to help protect the residents.

Peak electrical industry body, the National Electrical and Communications Association (NECA), has been leading the call to governments across Australia to improve the regulations around the installation of RCDs and introduce other safety initiatives including periodic electrical inspections.

NECA's chief executive officer, James Tinslay, said governments across Australia support electrical safety but more can be done.

"NECA fully supports the installation of Residual Current Devices, or safety switches as they are commonly known in all homes and businesses throughout Australia, because they can prevent electrocutions," Mr Tinslay said.

"It is mandated in the Australian wiring rules for licensed electricians to include Residual Current Devices in all new homes and homes that have had significant renovations but unfortunately

Photoelectric Smoke Alarms to be brought in NT

The NT Government has announced changes to the Fire and Emergency Regulations to mandate the installation of photoelectric smoke alarms in all NT residences as of 1 November 2011.

The Acting Director of the Northern Territory Fire and Rescue Service (NTFRS), Mick Ayre said that the introduction of smoke alarms in every residence is a very positive move.

"The photoelectric type of alarm is strongly favoured by fire services everywhere, as they are able to detect smouldering fires that are not as quickly picked up by the ionization type of alarms," Ayre said.

"The new regulations will require all owners of residential property across the Territory to install photoelectric smoke alarms. When establishing a new lease on rental property, a landlord must ensure that a smoke alarm is installed; however the responsibility for maintaining the alarm in working order will be that of the tenant.

"The price of photo-electric alarms is now comparable with the more common ionisation alarms.

From 1 November, all residential dwellings and movable dwellings including caravans, and temporary accommodation including safari-style tents are required to have a working photoelectric smoke alarm.

Following 1 November, if you already have a smoke alarm installed in your home and it is an ionisation smoke alarm, you do not have to change to a photoelectric smoke alarm until one of the following occurs:

- Your smoke alarm ceases to work, in which case you will need to replace it with a photoelectric type smoke alarm;
- You sell your home;
- You rent out your premises or renew a tenancy; or
- You hire out your caravan.

"The new regulations are a major step forward in protecting vulnerable people and we will be posting information about smoke alarms and what the new regulations require, on our website," Ayre said.

"There will also be a significant communications and education strategy to promote the use of photoelectric alarms, to help save lives. The aim of the education campaign is to inform and educate the community about the potential life saving benefits of these devices. The community will be given sufficient time to purchase and install the required smoke alarms.

"People's sense of smell is drastically impaired while they sleep and smouldering fires may burn for some time with poisonous gases emitted that can kill a person before they are even aware of the danger.

"Too many people have lost their lives in house fires and in many cases, these homes had no smoke alarms. This to me is quite appalling as a simple smoke alarm can prevent injury and death when maintained and used properly," said Acting Director Mick Ayre.

The number of Territory buildings with smoke alarms has increased 35 to 73 per cent over the past five years and this new regulation will assist in ensuring the most vulnerable are protected as well.

For more information visit http://www.pfes.nt.gov.au/fire-and-rescue.aspx .

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this doesn't cater for many of the older homes in Australia.

"The ageing housing stock in Australia means many homes are not protected and many still have their original wiring which can be very dangerous."

It is now time for Australia to recognise the opportunity to increase electrical safety. The state-based electricity regulators need to act in unison and plan the introduction of a mandatory periodic electrical inspection regime.

An inspection regime combined with mandatory installations of RCDs will significantly strengthen electrical safety in Australia.

The Japanese Government introduced a form of mandatory periodic electrical inspections in the 1890s and this program continues to the current day.

Australia, like many parts of Europe, experienced a boom in the early 1900s and then again after World War II. Many of the homes built in these periods are not subject to periodic inspections. These homes are a potential risk with older electrical equipment and installations still being used today to service new appliances and the growing reliance on energy.

Home owners, tenants, tradesman and emergency service workers are all at risk from damaged old wiring and the omission of RCDs.

NECA has long been pushing state regulators to take the next step in increasing electrical safety and introduce an inspection regime.

"A periodic electrical inspection would not inspect every metre of cable, as clearly this would be impractical," explained MR Tinslay.

"However, it would check the condition of the switchboard, identify illegal wiring, check the positioning of insulation, look out for exposed parts of power outlets and inspect the condition of some of the wiring itself."

These inspections need not be exhaustive nor a financial burden to the resident. The key to these inspections would be the fundamental safety aspects of the electrical standard AS/NZ 3000 which must be complied with.

CONTINUED ON PAGE 8 ...

TAKING THE NEXT STEP IN ELECTRICAL SAFETY

... CONTINUED FROM PAGE 7

Since 1991 the Australian Wiring Rules have required RCDs to be mandatory in all new installations and additions to existing installations. The requirement has been built upon by some state regulators and this has added additional protection. However, even the Australian Wiring Rules recognises that RCDs are intended to augment other measures of basic protection.

It is the basic protection that electrical inspections can address. The next step is introducing over time a requirement for mandatory periodic inspections of premises when certain events take place or at fixed time intervals. The two can work together and there are many options for state regulators to introduce electrical inspections.

For example, if a house has not had a safety inspection by an electrician in 10 years it could be regulated that such an inspection is required when the house is sold, leased or where there is a change of tenant. Invariably, bank or mortgage providers require a pest and building inspection, but not a report on the electrical installation which can have fatal implications or cause damage to the property from fire.

It could also be very costly to a potential home buyer if the wiring needed replacing and this was not discovered before the purchase.

A simple inspection by a licensed electrician could identify whether a home is at risk by having dangerous old wiring or the omission of a safety switch. A regime to inspect homes would detect any serious electrical risks and help keep Australians safe.

Regulations to have safety switches installed at the time of sale or lease already exist in Western Australia and in Queensland and it is time the other states introduced these simple measures to help back-capture many of the older houses.

"Having it mandated in each state in Australia so the installation of safety switches is compulsory in all homes and not just new homes will help to reduce the number of electrocutions in Australia. The Western Australian and Queensland governments have made this sensible decision and it is time the other states followed suit," Mr Tinslay said.

"Australian governments have improved legislation and regulations for other life saving measures like seatbelts, pool fences and helmets. It is now time they do the same for electrical safety and introduce mandatory periodic electrical inspections."

NECA will continue to lead and represent the electrical industry on all electrical safety issues, and be the leading voice to government and regulators on the need for a periodic electrical inspection regime to be introduced.

HEALTH CHECKS AT THE AFAC/BUSHFIRE CRC CONFERENCE

The Country Fire Authority (CFA) in Victoria is now in the fourth year of its highly successful 'Healthwatch' program.

Offered to all CFA brigades, as well as to units of the State Emergency Services in Victoria, the program involves assessing an individual's cardiovascular risk factor level and provides information and opportunities to assist in lowering the level of risk.

Essentially, the components of the Healthwatch program include:

- Lifestyle and health questionnaire
- Resting blood pressure
- Height and weight, waist circumference and body composition
- Fasting total cholesterol, HDL, LDL, triglycerides and glucose testing
- Coronary (heart) risk percentile and absolute risk estimation
- Appropriate counselling and referral.

CFA showcased its Healthwatch program at the AFAC/Bushfire CRC conference, offering health checks to delegates. As part of the trade exhibition, health professionals on the CFA Healthwatch stand conducted 140 blood tests to test and assess cholesterol and glucose levels as well as measuring height, weight and waist measurements and taking blood pressure readings. The medical data and answers to a lifestyle questionnaire were entered into the Heart Track Online system, providing delegates with a full cardiovascular risk assessment.

Delegates and trade exhibitors also had the opportunity to have their blood pressure checked resulting in approximately 200 people visiting the stand for testing.

A number of other delegates took away the health information that was provided in a 'showbag'.

Of the 200 people who had a health check, 110 were able to see the full program in action by having their information entered into the HeartTrack online program which provides a cardiovascular risk rating. Seven per cent of delegates were found to have a high risk of heart attack within the next five years. The risk of developing cardiovascular disease in the future, of those tested, was 43 per cent. The main risk factors found were high blood pressure, high cholesterol and family history. All those found at risk were advised to follow up with a consultation with their local GP.

Many conference delegates who saw what the program had to offer, including those from overseas, were impressed and indicated a strong interest in the implementation of something similar within their service.

It is planned to include health checks at future conferences.

National Burning Project Lights Up

The Australasian Fire and Emergency Service Authorities Council (AFAC) and the Forest Fire Management Group, are working together to establish a national approach to reducing the bushfire risk to the Australian and New Zealand communities, by the comprehensive management of prescribed burning at a landscape level.

The joint project, spanning over a five year period, will provide guidance on the operational, ecological, community safety and health risks associated with prescribed burning, and consider the legislation, training, tools and knowledge, operational research and development, and safety risks of prescribed burning programs.

With any type of burning there are risks involved. There are increased expectations from governments and the community that burning be conducted by professionals to meet objectives, and that burning in the south eastern states will increase.

Specifically, the project will:

- undertake a review of the existing science and identify any knowledge gaps. This will include the indigenous knowledge about the use of fire in the landscape;
- analyse the operational risk framework within which planned burning is carried out;
- prepare a Best Practice Guideline that can be used by agencies involved in burning programs;
- deliver a national position on the use of prescribed burning by agencies; and
- review the competency, training and recognition of the skills required to conduct burning programs.

A steering committee, with representatives from Australia and New Zealand, will identify key stakeholders to actively engage with them during the project plan. The Bushfire CRC, Emergency Management Australia and AFAC member agencies and land managers will have the opportunity to participate in the project and its outcomes. The project has received National Emergency Management Projects funding for 2011-2012 from the Federal Government.

For further information contact Gary Featherston, Manager, Rural and Land Management Group, AFAC on 0428 408 144 or gary.featherston@afac.com.au

Jim McLennan recognised for leadership and mentoring

Professor Jim McLennan of La Trobe University has been presented with the Bushfire Cooperative Research Centre's Special Recognition Award for the high quality of his research leadership and his mentoring of new researchers.

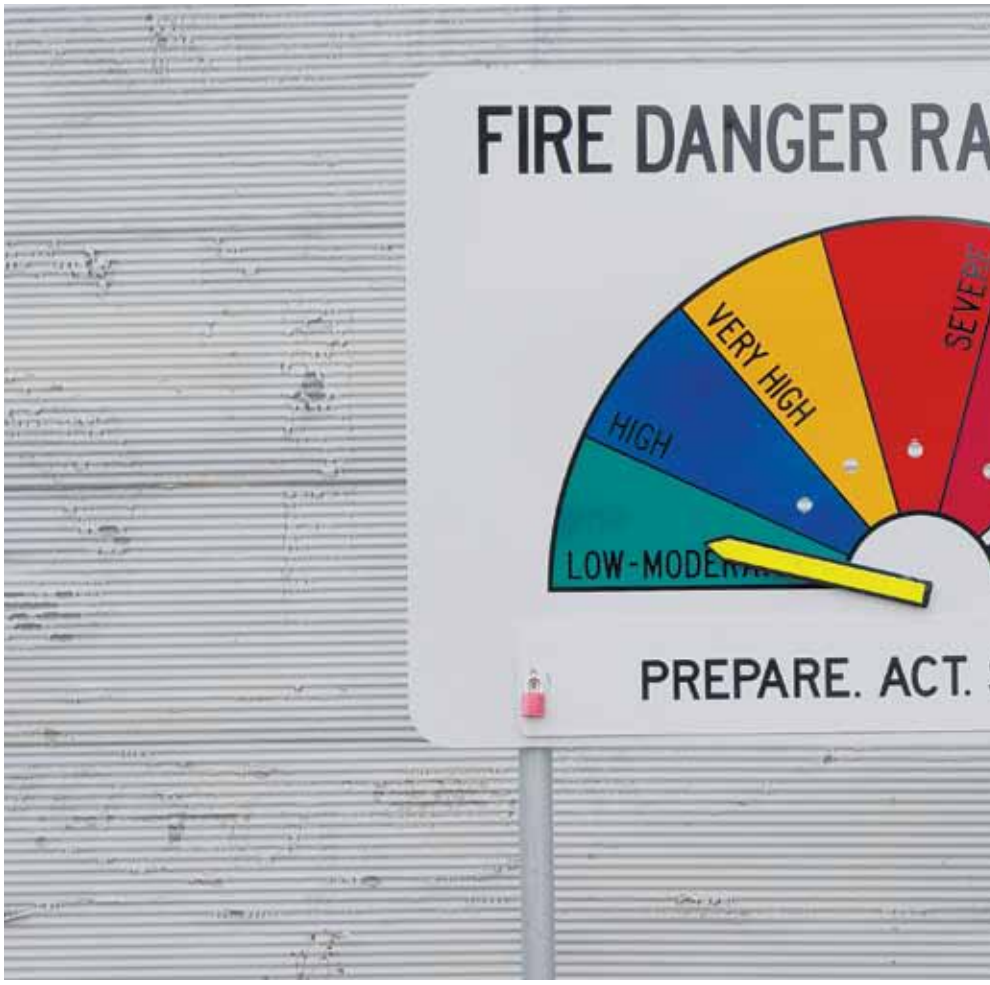
The award was presented at the AFAC-Bushfire CRC annual conference in Sydney.

Professor McLennan is Adjunct Professor in the university's School of Psychological Sciences and has specialised in bushfire decision-making and community survival.

Bushfire CRC Chief Executive Office Gary Morgan said the award recognised Professor McLennan's longstanding work with the Bushfire CRC, particularly the leadership role he took with community research interviews after the February 2009 Black Saturday bushfires in Victoria and the January and February 2011 fires near Perth.

"Jim showed significant leadership in setting up the procedures for the community interviews that produced much valuable research following these fires," Mr Morgan said.

"He acted as a mentor for the new researchers in Perth, showing them how to undertake the interviews that led to our report this month on what residents of the Perth Hills suburbs affected by the fires understood about bushfire safety."



FIRE DANGER RATING SYSTEM UNDER REVIEW

The Bushfire CRC will work with the Commonwealth Attorney General's department and the various Australian states and territories in developing science to underpin a new fire danger rating system with new funds announced by the Australian Government.

The Attorney-General, Mr Robert McClelland, has announced that the Australian Government will invest $3.6 million under the National Emergency Management Program this financial year to assist Australian communities better prepare for, respond to and recover from natural disasters and emergencies.

Included among several projects to be funded under the program this year, is the development of a new fire danger rating system to assist Australian fire agencies in planning and responding to fires.

The Bushfire CRC has appointed a project manager to oversee the National Fire Danger Rating Review and Research Project.

Australian firefighting authorities currently use Forest and Grass Fire Danger Indexes (FDI) to assess the risk of fire. The FDI describes the conditions that allow fires to start and continue burning, but does not account for all fire risk factors. For example, topography, fuel availability and fire location are not taken into account in FDI calculations. For this reason, the FDI cannot give a complete account of potential fire danger for making risk management and fire fighting decisions.

The final goal of the National Fire Danger Rating Review and Research

Project is to implement a new, scientifically based fire danger rating system. The system will be spatially explicit and include elements to reflect the potential for damage in addition to weather indices.

The new fire danger rating system will use a series of discrete modules to calculate aspects of fire risk. These modules will measure fire weather indices, such as landscape moisture and atmospheric conditions; fire behaviour indices, such as terrain and fuel characteristics; fire damage indices, such as measures of vulnerability and extent of exposure to fire; ignition factors, such as fire history and ignition mechanisms, and social factors, such as the potential impact of fire on communications and the community.

Knowledge Innovation Award

Andrew Hinton from FESA, and the Department of Sustainability and Environment, Victoria, have each been recognised for their advancement of knowledge management in the emergency services at the AFAC and Bushfire CRC Conference. Both awards are sponsored by Motorola Solutions.

Andrew, recipient of the Individual Award, has been acknowledged for his preparation of the principle capstone document which outlines the fundamental functions and philosophies of the Operations portfolio. This project included the development of FESA's Knowledge Management Framework, ensuring it aligns with FESA's higher goals for knowledge management. Mr Hinton is the Manager of Operations Doctrine at the Fire and Emergency Services Authority of Western Australia (FESA).

The Department of Sustainability and Environment, Victoria (DSE) developed the Future Fire Management Project and The Otway Bushfire Management Planning Pilot. DSE has been awarded the Agency Award for their outstanding achievements.

The Future Fire Management Project involved using cutting-edge bushfire modelling tool, PHOENIX-Rapidfire, to simulate bushfires and model their potential impacts on communities. Similarly, the Otway Bushfire Management Planning Pilot involved addressing the challenges faced in bushfire management.

Michael N'Guyen, General Manager for Motorola Solutions, presented both recipients their awards at the conference.

Congratulations to all award winners.

Craig Hynes from FESA accepts the award from Dr Michael N'Guyen from Motorola Solutions on Andrew Hinton's behalf.

Liam Fogarty from DSE accepts the award from Dr Michael N'Guyen from Motorola Solutions on behalf of DSE.

How have the failures of the WTC buildings affected tall building design?

Lessons learnt from the World Trade Center

Professor José L Torero was a keynote speaker at the recent AFAC and Bushfire CRC Conference in Sydney. The following is a synopsis from his presentation on Tuesday 30 August 2011.

The collapse of the World Trade Center (WTC) towers represents one of the most dramatic failures of modern structural engineering. Following the collapse of these tall buildings, the most exhaustive and expensive failure analysis in history was conducted in the midst of speculation, controversy and conspiracy theories.

After most cataclysmic world events, people can generally remember where they were and what they were doing as the disaster unfolded. When the first plane flew into the north tower of the WTC on 11 September, 2001, José Torero recalls getting a phone call from his brother at work. He told him to get to the TV really quickly.

"So I did, and watched in horror with the rest of the world," Torero said.

"The irony for me was that I had left the USA only 10 days earlier to start my new role at Edinburgh University as I wanted to study and collaborate with other leading fire engineers and global specialists in tall buildings. Coming to the university in Scotland allowed me to do that, but I was back in the US more quickly than I had planned.

"Like everyone else, I was just glued to the TV and when the first tower came down I thought the probability of the second tower also collapsing was quite high."

Professor Torero said that his unique perspective allowed him to cut through some of the early speculation and hyperbole.

"When you are really close to something and have a certain level of knowledge, you realise just how inaccurate and misleading the information put out through traditional news and other sources generally is in circumstances such as this," Torero explained.

"I find it quite fascinating: the more you personally know about the problem, the more you appreciate just how inaccurate the reporting is," he said.

"Add to the mix an unprecedented tragedy and the emotion attached to that, and I can understand why people wanted answers quickly. People – including government figures – were prepared to listen and believe a whole raft of theories and ill-informed conjecture, some put forward by so-called experts who used the opportunity to push their own particular agenda.

"I remember one highly-qualified person attributing the structural collapse to the high temperatures generated by the fire literally melting the steel supports. However, in the scheme of things, the fire was not that hot," Torero explained.

"Fortunately the Federal Emergency Management Agency (FEMA) report, *World Trade Centre performance building study: data collection, preliminary observations and recommendations*, was released quite quickly the following May and this was very useful," he said.

Many other reports have been subsequently released and recommendations continue to be made. More than a dozen significant reports have been released since the collapse including:

- Federal Emergency Management (FEMA) Report, *World Trade Center building performance study: data collection, preliminary observations and recommendations*, FEMA 403, May 2002
- National Institute of Standards and Technology (NIST), *National construction safety team advisory committee report to Congress*, August 2002
- NIST, NCSTAR 1, *Federal building and fire safety investigation of the World Trade Center disaster: final report of the National Construction Safety Team on the collapses of the World Trade Center tower*, September 2005
- NIST, *Final WTC 7 investigation report*, November 2008
- NIST, *Best practice guidelines for structural fire resistance design of concrete and steel buildings (NISTIR 7563)*, [draft], April 2009.

According to Torero, while the FEMA report came out quickly, getting access to more detailed fire data was quite difficult and very frustrating.

"Getting access to the detailed data that would assist us in our analysis was difficult, added to which, all research work was highly scrutinised and there were a number of investigations being carried out by different authorised bodies in parallel. The complexity and nuance in the technical aspects of the data also made it very difficult to develop simple and easily-understood analysis," he explained.

However, Torero firmly believes that disasters show us where our vulnerabilities are in our infrastructure and this forces us to review our perception of the safety inherent in our everyday environment.[1]

"People had a disbelief that the towers could just collapse, and the magnitude of the disaster really captured the fear and fuelled the rampant search to explain why it had happened," he said.

[1] JL Torero and B Lane, 'The changing face of structural design for fire', *International Fire Buyer Guide,* August 2004

Despite the catastropic impact of the attack on the World Trade Center, there was a disbelief it could result in the collapse of the two towers.

He explained the over-arching goals were:

- To investigate the building construction, the materials used and the technical conditions that contributed to the outcome of the WTC disaster
- To serve as the basis for:
  - improvements in the way buildings are designed, constructed, maintained, and used
  - improved tools, guidance for industry and safety officials
  - revisions to codes, standards and practices
  - improved public safety
- Investigation for transformation

"This latter point is critical, vital. Why? Because life still goes on," Torero said.

Seven of the 10 tallest buildings in the world have been built in the ensuing decade, including the tallest four. Eight of these buildings are outside the US. The world's tallest building, the Burj Khalifa in Dubai, was completed just last year at 828 metres (2717 feet).

The collapse of the WTC buildings occurred in an environment where design practices were being pushed from an environment of prescriptive requirements to one where structures were evaluated on their performance as predicted by engineering tools.[2] So the collapse and subsequent investigations occurred at a time of:

> ***"…a failure analysis, in the middle of a period of great innovation, strong technological, environmental and economic drivers and [with] a profession confident of its tools and an industry that has to move on."*** **JL TORERO AUGUST, 2011**

According to Torero, in the past decade a strong push towards sustainability, including energy conservation and generation, optimisation and use of green materials, has driven tall building design to levels of innovation never seen before. As a working definition of sustainability, Torero provides the following:

> *Sustainability is a managed life cycle where proactive decisions are made to reduce consumption and negative impact, from the inception of a project to the disposal of the infrastructure.*

In his mind, the WTC collapses do not reflect the definition of sustainability. After a decade of questioning and innovation, he has distilled his top 10 lessons on what is sustainable infrastructure.

Lesson 1 When addressing fire, tall buildings need to be designed embracing the Prescriptive v Performance principles.

The WTC epitomised innovation and most technical solutions were evaluated using the most sophisticated engineering tools of the time, however, fire safety was established in a purely prescriptive manner and this has not kept pace with other aspects of innovative design. The Prescription (standard/traditional) v Performance (unique/innovative) equation is out of balance when it comes to fire safety.

Lesson 2 The last decade has been a period of great innovation for tall buildings, thus fire safety cannot be based on a purely prescriptive analysis.

Using Torero's sustainability definition, there is a requirement for an optimised design process, however, Torero believes the WTC did not optimise fire safety within the structural design process.

"The failure to understand the structural behaviour in fire resulted in disproportionate and unpredictable consequences. A system (or building) is optimised only when all variables are optimised together," he explained.

Lesson 3 Tall buildings are by nature optimised structures, thus their design needs to incorporate fire safety as an integral design component.

Torero warns of the add-on approach currently used in tall building design.

"To add heat shielding and other fire mitigating technology into a design is not enough," he said.

"Fire safety *must* be considered in the first design phase and professionals brought to the table with the required knowledge to ensure the integrity of fire safety principles."

This article will not attempt to discuss the complexity of the myriad of structural design aspects and relationships that underpinned the vulnerabilities of the buildings, but in essence, Torero explained, rigid core and external columns in the design of the WTC buildings restrained thermal expansion and made trusses susceptible to buckling. Further thermal expansion caused the WTC 7 floor failures.

However, he said, to concentrate on the problems alone ignores the basic fact that while the problems need to be understood and then resolved by means of the most adequate methodologies, the WTC

[2] Ibid

demonstrated that for tall buildings, egress and structural performance are the pillars of fire safety.

"Only for tall buildings is egress of a similar time scale to the deterioration of the structure by the fire. Egress times can be reduced, but they can never be made much shorter than structural failure times," he said.

In plain English, the two key performance indicators for fire safety are egress and structural performance: the building needs to stand up for as long as it takes people to evacuate.

Lesson 4 Life safety is a structural problem – tall buildings do not conform to standard practices and structural integrity is the guarantee for safe egress.

Torero explained that his team's fire safety investigative focus led them to conclude that in the absence of an adequate structural design, enhanced egress capabilities cannot be used as compensation. They reported that the safety of tall buildings requires an explicit structural analysis, conducted using state-of-the-art engineering tools. This was reinforced by NIST recommendation 17: tall buildings should be designed to accommodate timely, full-building evacuation of occupants when required.

The WTC showed that the responsibility for integrating structural integrity to the fire safety strategy was undefined, and that the implicit assumption that thermal protection is sufficient to guarantee safety was proven inadequate.

Lesson 5 For tall buildings, the structural engineer needs to assume responsibility for the adequate performance of the structure in fire.

Torero explained that innovation introduces complexity. "Thus the drive for sustainable tall buildings is introducing fundamental changes in structural design, material selection and potential fire conditions," he said.

"The WTC demonstrated that to establish an adequate fire safety strategy there was a need for professionals of great knowledge in all fields to be involved in the first design phase, integrating fire safety into the structural integrity of the overall design."

Lesson 6 Professional competence needs to be consistent with complexity.

Torero believes the WTC investigation made it very clear that the framework educating professionals involved in the design of innovative buildings leaves a gap of knowledge when it comes to the assessment of safety. He believes we are using old thinking when it comes to fire safety still designed to operate within a prescriptive environment when the paradigm has changed.

"The current framework is not sustainable," he said.

Lesson 7 If we are to strive for sustainable tall buildings and the associated innovation, then we need to support the development of a new educational framework.

According to Torero, the WTC showed that we lack an adequate definition of competence. Our current definition not only leaves enormous knowledge gaps, but is also structured around incorrect objectives.

The ten lessons of fire sustainability

Lesson 1 Fire is an essential part of sustainability
Lesson 2 Sustainability means innovation, innovation means performance assessment
Lesson 3: Innovation means simultaneous optimisation of all variables including fire
Lesson 4: Life safety is fundamentally a structural problem
Lesson 5: The structural engineer is responsible
Lesson 6: High level skills are required in the fire/structural engineering interaction
Lesson 7: Current educational frameworks need to evolve
Lesson 8: Competence is ill-defined
Lesson 9: We know the knowledge gaps, but we have not filled them and translated them into tools and professionals
Lesson 10: We need to invest in a new definition of competence and a new breed of professionals
The full presentation is available at http://knowledgeweb.afac.com.au

Lesson 8 Our current definition of competence does not deliver the professionals needed for the fire safety strategy required for tall buildings.

"Extracting from a failure all the knowledge that will enable professionals not to make the same mistakes requires a minimum level of prior understanding," he said.

"The unprecedented magnitude and novelty of the WTC failure caught the fire safety and structural communities unprepared for the investigations that ensued."

Lesson 9 We extracted the science but not the tools or the professionals. Science has unveiled many of the phenomena that were produced, but we have not been able to transform the knowledge into a new educational framework, design methodologies and tools.

In summarising, Torero explained we have two key challenges:

- the gaps of knowledge are now evident; and
- the future of tall building design depends on our capability to continue filling these knowledge gaps at a pace faster than our capability to innovate.

The WTC showed that if we want sustainable tall buildings, we need to develop the knowledge base and the technological tools that can adequately assess the performance of a fire safety strategy.

Lesson 10 We need to incorporate this knowledge not by legislating new rules, but through adequate professional structures within a relevant definition of competence.

Torero's final words of warning: "We need to legislate, promote and invest in competence, not in standardised solutions."

About the author: Professor José L Torero is BRE Trust/RAEng Professor of Fire Safety Engineering, Director of the BRE Centre for Fire Safety Engineering and head of the Institute for Infrastructure and Environment at the University of Edinburgh. He is a Fellow of the Royal Academy of Engineering and Royal Society of Edinburgh and the 2008 recipient of the Arthur B Guise Medal from the Society of Fire Protection Engineers (US). Professor Torero has authored more than 150 journal publications and 500 technical documents in subjects that range from forest fires to spacecraft fire safety. He is editor of *Fire Safety Journal*.

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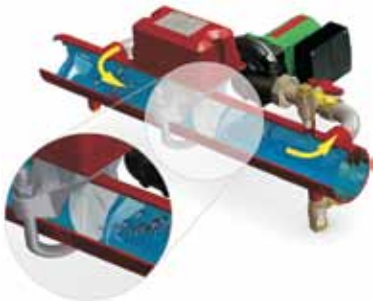

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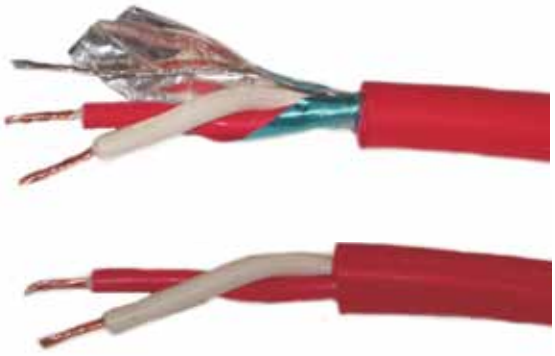

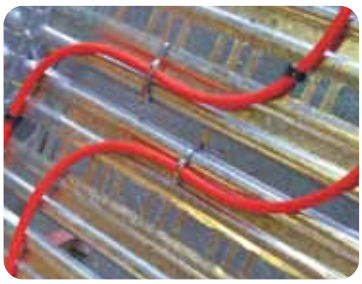

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TO STAY OR GO?

Human behaviour and decision-making in emergency situations

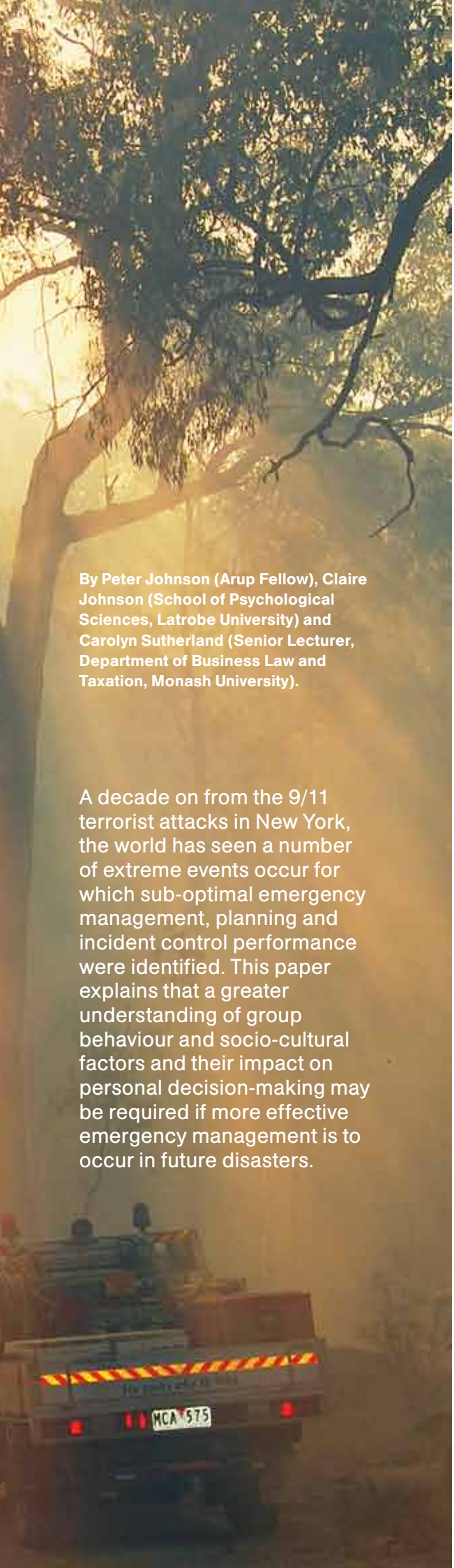

PHOTO: FPA AUSTRALIA

By Peter Johnson (Arup Fellow), Claire Johnson (School of Psychological Sciences, Latrobe University) and Carolyn Sutherland (Senior Lecturer, Department of Business Law and Taxation, Monash University).

A decade on from the 9/11 terrorist attacks in New York, the world has seen a number of extreme events occur for which sub-optimal emergency management, planning and incident control performance were identified. This paper explains that a greater understanding of group behaviour and socio-cultural factors and their impact on personal decision-making may be required if more effective emergency management is to occur in future disasters.

The Black Saturday bushfires brought the question of 'stay or go' to the fore.

The past 10 years has seen a number of extreme disasters occur internationally for which subsequent public inquiries have identified sub-optimal performance of emergency management in terms of emergency planning and incident control. These extreme events have included bushfires (wildfires), flood, tsunamis, hurricanes and floods, as well as terrorist attacks, often resulting in catastrophic loss of life and property and damage to the environment and natural habitats.

A key decision point in emergency management is whether it is preferable or not to evacuate people from potentially affected areas and when to trigger that action. At the same time, it is sometimes preferable to get people to stay within protected areas or defendable property, for example when using a building as a defensive shield in the event of some forms of terrorist bomb attacks.

The decision to 'stay or go' has implications at the public policy and emergency planning level in emergency management, across a number of domains. However, it also has particular significance at the individual level where people are making choices about whether to evacuate or not when exposed to a major threat.

The loss of 173 lives on Black Saturday, 7 February 2009, in the Victorian bushfires in southern Australia and the massive wildfires in California in this same year has brought the question of 'stay or go' into sharp focus as an issue of public policy, particularly in Australia. The policy, more correctly stated as 'prepare, stay and defend, or leave early', was particularly criticised at the 2009 Victorian Bushfires Royal Commission inquiry as giving insufficient emphasis on the risks of staying and defending, particularly in more hazardous bushfire conditions.

The study of survivors of the 2005 Hurricane Katrina in the US has also highlighted the difficulties in decision-making and the resistance of many individual people and families to evacuate, despite an official policy mandating evacuation in the event of this major community-wide threat to life. In the area of the built environment, the major terrorist attack on the World Trade Center (WTC) on 9/11 brought new attention to evacuation and survival in tall buildings during fire and related events. A number of inquiries led to research that has increased our understanding of how people behave in these situations and how evacuation can be achieved more efficiently where that choice exists.

As in the bushfire situation, there is also strong interest in building safety on the concept of 'defend in place', sometimes called 'protect in place'. The proposition is whether, at least in some circumstances, buildings can be designed and constructed so that occupants can safely remain within the building during fire and other emergencies. Research, pioneered by Proulx, has been reviewed recently by Barber for the Fire Protection Association Australia. This paper reviews some of the recent research on evacuation and the alternative choices that individuals have under a 'stay or go' type policy, with particular emphasis on factors affecting personal safety decision-making at the

individual level. The research has been informed by examination of research evidence from events such as the World Trade Center attacks (9/11) and Hurricane Katrina and the principles of 'defend in place' for buildings.

While the time frames for the threat to develop and the cues for evacuation or not are recognisably different from one domain to another, the expectation is that this examination of a broader research spectrum will increase the understanding of how individuals in communities make safety decisions and so provide a basis for improved emergency management in bushfires and other major events.

Evacuation in buildings (World Trade Center)

Clearly there has been only limited research into personal decision-making and the resultant safety outcomes in the bushfire setting.

An examination of decision-making by individuals to either to stay in a protected place or evacuate buildings similarly yields only limited research data. It is recognised that in building emergencies, the onset of life threatening conditions may occur far more quickly than in bushfires although in the initial phases of a high-rise building fire, many residents may be remote from the fire source and have few if any fire cues in the first instance. As well, there is no practical sense in which people would evacuate a building before a fire starts, unlike in the case of bushfire.

Nevertheless, as authors we have considered it useful to interrogate some specific aspects of the research literature on human behaviour and decision-making in building fires. In particular, we were looking for factors that might influence persons to make a decision to evacuate or, in some cases, not to evacuate but consider staying within a protected area of the building under a 'defend in place' strategy.

Much of the literature on building evacuation and human behaviour focuses on the design of buildings and their fire safety measures such as alarm systems, protected corridors, exit stairs and more recently use of elevators for evacuation, generally expressed in engineering terms.

The World Trade Center disaster was a catalyst for investigations into occupant activites during an evactuation.

PHOTO: DET. GREG SEMENDINGER, NYC POLICE AVIATION UNIT

Related areas of research include:

- The mechanics of people movement and examination of travel speeds, response time and demographic factors of age, obesity and disability.
- Emergency management strategies, evacuation procedures and communication systems.
- The development of regulations as well as codes and standards for emergency evacuation.

Less of the building evacuation research is focused on the psychological or sociological factors which are likely to be influential in the decision-making of individuals or groups of individuals to evacuate or remain within a building. Nevertheless, while Proulx, in her chapter in the SFPE Handbook on evacuation, concentrates more on pre-movement times and the impact of the quality of alarm and communication systems, she does qualitatively address some of the occupant activities which can delay the start of travel through an exit system. However, two recent major research studies by Gershon and Galea et al into the behaviour of building occupants in the 9/11 WTC incident, which featured as presentations at the Cambridge Human Behaviour in Fire Symposium in 2009, have shed some valuable new light on occupant decision-making that might be applicable to emergency management in broader domains.

The Gershon research was based on a series of semi-structured interviews with over 1000 WTC survivors. She identified a number of causal factors which affected both a delayed initiation of evacuation and an increased time for evacuation. She also identified a number of facilitators and barriers to evacuation at the individual, organisational and structural (environmental) level and made recommendations at each of these three levels as to how the impact of the barriers may be reduced in the future.

Key risk factors which were observed to contribute to delays in making a decision to evacuate were:

- seeking out others for mutual support and information sharing;
- personal concerns about own health and ability to evacuate;
- individual behaviour which delayed the start of evacuation, e.g., gathering items, making phone calls, shutting down computers or changing shoes; and
- uncertainty about the evacuation route including exit locations, egress endpoints or whether to use elevators.

Risk factors which were identified as increasing the length of time for evacuation included:

- lack of training and poor emergency preparedness;
- inappropriate footwear for stair descent;
- complex building design;
- sub-optimal workplace emergency safety climate;
- inadequate communication system infrastructure; and
- inadequate emergency procedures for people with health and other disability conditions.

As examples, Gershon, in her presentation at Cambridge, showed data such as:

- 26 per cent of people had pre-existing disability or other medical conditions that they felt created

problems for them to use the stairs for evacuation;
- 94 per cent had never evacuated those buildings by stairs; and
- 89 per cent did not know where the stairs would lead.

Galea et al also undertook a major study of WTC survivors through a series of 271 interviews, resulting in almost 6000 pages of transcripts. While this team examined frequency of stops during evacuation and issues of crowd densities and fatigue, as well as travel speeds on stairs, part of this study was an attempt to understand more fully the social and organisational factors that influence evacuation activity.

During the response time before evacuation commenced, WTC occupants appeared to undertake two types of tasks: information-seeking tasks and action tasks.

There is a strong alignment of these tasks with those found by Gershon. Examples of the information-seeking tasks found by Galea et al included:
- sought environmental information
- sought information from authority figures
- waited for further information.

Actions tasks included:
- collecting items
- instructing others to evacuate
- shutting down computers
- securing items, locking safes
- changing footwear.

This WTC study team made a number of recommendations, with two specific conclusions regarding decision-making of individuals, namely:
- improving and hardening emergency communications could greatly reduce evacuation delays by removing (or reducing) the need to perform Information-Seeking Tasks; and
- improved training could reduce evacuation delays by removing the number of Action Tasks prior to commencing evacuation.

If this human behaviour and decision-making is typical of many buildings both in the US and in other countries, then emergency evacuation preparedness policies and procedures are clearly not resulting in appropriate actions by building occupants or efficient evacuation. And it raises the question of whether we should try to evacuate buildings at all, and under what circumstances evacuation is an appropriate practice.

'Defend in place' in buildings

Recent international research by Barber into high-rise buildings has suggested an alternative to evacuation. This alternative is to remain in place in a protected area of a building rather than evacuate. This can be summarised by the basic decision to either 'stay or go'. This approach has been extensively researched by Proulx and, as a concept, has emerged through a number of investigations of fires in buildings by Proulx and others earlier, such as MacDonald. In a number of these investigations occupants died in corridors and stairs attempting to evacuate, often late because of longer pre-movement times.

While staying or going has a different risk associated with each, on balance Proulx has recommended that occupants, at least in high-rise residential buildings, are generally safer if they stay in their apartments unless directly threatened by a fire in their immediate apartment. She suggested occupants do not react well to fire alarms, especially in residential units and they should stay in apartments and undertake 'protect in place' activities. She stressed, however, that the building must be of a non-combustible construction, have central alarms and communication systems and ideally have other features such as automatic sprinklers.

In commercial buildings in Australia, Barber found there are generally well-established procedures, systems and a management team to direct evacuations. However, for residential buildings, at least in Australia, while building codes such as the Building Code of Australia may set code requirements for emergency warning systems and evacuation plans, in practice, many people will fail to evacuate. In some countries such as the UK and Hong Kong, evacuation is not encouraged in residential buildings, although protected stairs and other fire safety measures are provided.

In a survey of occupants of three high-rise residential buildings in Australia, Barber found only 23 per cent evacuated the last time the fire alarm sounded in their building. From Barber's research into decision-making of Australian residents, he found the decision to evacuate was dependent upon:
- additional cues such as the presence of flame or smoke;
- the arrival of fire brigades on the ground or in the building; and
- perception by residents of the effectiveness of the fire protection features within the building.

Barber also noted a number of other factors which influenced a resident's decision to stay or evacuate, including:
- previous experience of false alarms
- poor weather
- floor height of residence (nobody above the 10th floor had evacuated on alarm in Barber's survey)
- lack of understanding of alarms and fire plans
- behaviour of neighbours
- time of day
- age, family and cultural factors.

Importantly, Barber's research showed that for those who eventually chose to evacuate, they generally did so around three to seven minutes after the alarm. This was potentially the worst possible period to evacuate because at that time, if there had been a fire, it may have grown significantly and to a dangerous level, but was not yet to a point where it was fully controlled by sprinklers or the fire brigade.

This problem of failure to evacuate or lateness of evacuation prompted Barber to question whether it is really necessary to evacuate residents for a fire emergency in well protected high-rise buildings at all, unless directed by the fire brigade. By 'well protected', the implication is that the building has

Improved training and communications could reduce evacuation delays in building fires.

strong structural protection, good compartmentation, automatic sprinklers, and other measures typical of new high-rise residential construction in Australia.

This concept of no evacuation or limited evacuation for only those few near the fire source is the 'defend in place' or 'protect in place' principle for high-rise residential buildings, based upon the idea of residents being safer in their apartments than if evacuated, unless directed to evacuate by the fire brigade. This concept is not necessarily new, having been utilised in North America previously. This concept has also been effectively practised in the UK and Hong Kong for many years, with generally a good fire and life safety record. Barber believes that the principle of 'protect in place' would be successful in Australian residential buildings with their high levels of protection and be a better alternative to the largely unsuccessful evacuation policies and procedures currently promoted. This approach would also make for much simpler decision-making for most people, provided training and communication systems are effective.

Based on the investigations presented at Cambridge on the WTC 9/11 disaster by Gershon and Galea et al and the research by Proulx and Barber, a number of key concepts have emerged in relation to building occupant decision-making and evacuation behaviour. They include the following:

- many people had pre-existing medical conditions, obesity or other disabilities, which affected their decision to evacuate or not;
- the majority of people are likely to never have evacuated their office or residential building using the stairs, do not know all the stair locations, or are unlikely to know where the stairs will lead;
- people will exhibit a range information gathering and action tasks before considering whether to 'stay or go' and beginning evacuation, meaning the risk with late evacuation is greater than if people stayed;
- strong group influence means many will wait for others to make decisions to leave or stay before acting themselves;

"If 9/11 was a failure of imagination, then Katrina was a failure of initiative."

- there is often likely to be a poor 'safety climate' or 'safety culture' amongst building populations;
- unless very well designed, buildings are likely to lack protected communication systems – they may not be hardened against damage – and their failure can contribute to lengthy pre-movement times; and
- overall, there appears to be a lack of 'situation awareness' and emergency preparedness amongst people in buildings during fires and other emergencies.

Given we have had a requirement in building codes and standards for a range of egress measures in buildings, including alarms and communication systems as well emergency management procedures and training, a key question remains as to why decision-making by individuals in bushfires and building incidents continues to be problematic.

Hurricane Katrina

Some research that provides some further insight into the life safety decision-making required for people to evacuate or protect themselves in place comes out of the 2005 catastrophe in the US that resulted from Hurricane Katrina. The official US Congress inquiry stated, "If 9/11 was a failure of imagination, then Katrina was a failure of initiative. It was a failure of leadership." This government inquiry emphasised that there was a failure of agility in emergency decision making. Response plans at all levels of government lacked flexibility and adaptability.

The Congress inquiry focused on decision-making and the failures in emergency planning and incident control at the government and organisational level. However, research that concentrated on decision-making at the individual level was undertaken by Stephens et al, with interviews of survivors from Hurricane Katrina. This team of researchers interviewed 79 survivors. They also interviewed many relief workers and lay observers to investigate their perceptions of survivors' attitudes and behaviour towards evacuation.

In response to rising flood waters and threats to life from Hurricane Katrina, officials in New Orleans instituted a mandatory evacuation. Despite the official call for evacuation of all residents, the survivor interviews showed:

- more than 50 per cent chose not to evacuate;
- those who chose not to evacuate were generally from lower socio-economic groups;
- among the non-leavers, only 50 per cent owned a vehicle, few knew people outside the city and many had limited financial or other resources;
- the hurricane came at the end of the welfare month when many people on fixed incomes had little money for fuel, food or alternative lodging;
- many who did not leave exhibited strong reliance on group decision-making, lacked independent thinking, and felt they could not take individual control of the situation; and
- those who did evacuate were more typically middle-class (90 per cent) and owned a vehicle (100 per cent).

There were some strong views among relief workers and other observers about those who chose to leave and those who chose to stay. These views included:

- those who chose to stay were often described as passive (lazy and dependent), irresponsible (careless and negligent) and inflexible (stubborn);
- on the other hand, those who evacuated were described as independent (self-reliant and in control), responsible (conscientious), and action-oriented (prepared and planning); and
- leavers were described as influencing agents and stayers as lacking agency and less sensible in their actions.

This research has shown that US emergency services were based on the misconception that all survivors were 'free agents' who were unconstrained by their socio-cultural environment. Many in the lower socio-economic groups exhibited strong interdependence, relied upon others for decision-making and had limited options due to their lack of resources and positions in the socio-economic structure. There may be a direct parallel to this behaviour and decision-making in the bushfire setting.

The researchers concluded:

> *"Rather than ask why stayers made 'bad choices', or inquire what was 'wrong' with stayers, relief workers should have asked what actions were possible in the resource-limited contexts of stayers.*
>
> *Understanding that many people who stayed in the hurricane-affected area could not simply choose to evacuate, could have promoted a more timely and effective disaster prevention and relief effort."*

This research may hold part of the answer to why so many people stay rather than evacuate in events such as building fires, the Victorian bushfires and other emergencies, even where policies, procedures and training appear to have been provided. Whereas emergency management policies and plans in the past may have considered communities as a group of homogeneous responders, all able to respond and act independently, a new paradigm appears to be required in which we consider how different socio-cultural groups in our communities will react to emergency situations and the training and information that is provided if we are to be more successful.

Implications for Emergency Management in Bushfires

Evidence from bushfire inquiries as well as investigations of other disasters has shown that there is a need for improvement in safeguarding people and communities from natural hazards, such as fires and floods, as well as protecting them from malicious acts and terrorism. In the case of bushfires in Australia, there has been justified criticism of the leave early or stay and defend policy. This paper has identified some common threads in aspects of human behaviour and decision-making, from other fields of emergency management, which appear to shed some light on what might be a more effective approach to personal safety in bushfires.

The Royal Commission and Bushfire CRC investigations into the Victorian bushfires have made a number of major recommendations which parallel the inquiry recommendations from the 9/11 WTC event and Hurricane Katrina. They highlight the need for:

- improved planning and preparedness to stay or go – i.e., leave early or stay and defend;
- improved timeliness and quality of warnings and other information;
- improving understanding of the threat and greater situation awareness;
- a need for more effective training and education; and
- greater attention to creation of a safety culture.

However, despite similar recommendations from many earlier bushfire inquiries in Australia and considerable efforts over many years in public training and education, improvements in safety outcomes for many in bushfire prone communities appear not to have eventuated. Could it be that the decision-making associated with what some emergency management policy makers might see as just the two alternatives to 'stay or go', is in fact far more complex. Emergency management programs might need to be more flexible and adaptive and better recognise what decisions people have to make, the time pressures involved and the factors that may influence those decisions.

Some of the key reasons for this greater complexity may be:

- the speed of attack and severity of bushfires are not entirely predictable, meaning the decision-making environment may be dynamic and changing quickly;
- the risks associated with various decision options may be considerably different, but not sufficiently clear to some people;
- for many people, leaving early before there is any fire threat is not considered a practical option because of business or other factors;
- many people do not understand the threat of bushfires or have had no past experience to gauge the level of threat;
- as in fires in buildings, many will require multiple cues before considering whether to leave;
- some groups of people within a community will not have the physical or cognitive ability to stay and defend their property, factors which could affect their ability to evacuate quickly;
- others may have strong influences like a desire to protect property, or a lack of insurance that drives them to stay, even if their property is not fully defendable; and
- like in New Orleans and Hurricane Katrina, people from different socio-economic backgrounds have

Inquiry findings post-Hurricane Katrina found response plans at all levels of government lacked flexibility and adapatability.

New research suggests evacuation is not always the safest option in the face of catastrophic fire events.

different abilities to absorb complex information and have different levels of access to resources. Many require the support of others in a group to make effective decisions.

Rather than thinking that all people will either leave early, or stay and defend themselves and their property, effective emergency management planning and incident control in bushfires should assume that there will be at least four different scenarios:

- those who leave early before there is a fire in their region at all;
- those who wait until they see the fire approaching but still have time to evacuate or get to a place of relative safety;
- those who wait until the ember attack or fire front is so close that there is considerable danger but still choose to evacuate; and
- those who choose to stay and defend, whether their property is defendable or not.

Given that in relation to bushfires, as in building fire safety and emergency management, major investments in training and education appear not to have led to a very high level of acceptance of the recommended practices, it would seem a new approach is needed that is more aligned with people's expected decision-making. For the bushfire situation, we have argued in another paper that if most people will not leave early, and many are likely to stay and defend their property or leave late, then to better protect people, the best bushfire emergencies response should be structured:

- stronger planning policies to prevent development in higher bushfire prone areas and/or requirements for better siting of dwellings;
- increased application of building standards for bushfire protection such as AS 3959, which may need to be strengthened even further;
- greater attention to fuel reduction and bush-free, set back areas to minimise radiation and ember hazards;
- a requirement for a proper, well-designed fire bunker for every dwelling in bushfire prone areas;
- properly protected community refuges for the more vulnerable, particularly the aged, the young and disabled in our communities; and
- greater attention to people safety management and less attention to firefighting on days of very high fire risk.

Further study and research of the psychological and sociological factors involved in decision-making at the individual level, combined with better recognition of these decision processes at the community, organisational and government policy level, appear likely to improve overall safety outcomes in major bushfires into the future.

Conclusions

This research into the decision-making of individuals during bushfire incidents does appear to be informed by consideration of other similar 'stay or go' considerations in other domains. A number of major conclusions can be drawn.

In buildings, we have continually strengthened our codes and standards and regulated increasing levels of fire protection by mandating requirements for fire safety management and maintenance with improved safety outcomes. There is a recognition in some countries, and for some buildings, that evacuation is not the safest option and that human decision-making is influenced by many factors. This supports a 'defend in place' strategy.

In other major catastrophic events such as 9/11 and Hurricane Katrina, we have seen how a range of factors can affect safety decision-making and delay or prevent evacuation.

"a range of factors can affect safety decision-making and delay or prevent evacuation"

While leaving early is clearly the safest option for most people in bushfire prone communities, there are practical and other reasons why this option is not preferred by many people. For the bushfire situation in Australia, voluntary measures and limited uptake of education and training opportunities has left many exposed, especially amongst the more vulnerable in our communities. Developing understanding of people behaviour and decision-making suggests more regulatory control of a range of measures will be needed to achieve improved safety outcomes in bushfires in Australia.

Finally, further study of the psychological and sociological factors which impact on decision-making by people in these types of emergencies would appear to offer complementary benefits to the study of policy at the organisational and government level.

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The day the towers fell

Leading fire engineer Jonathan Barnett was a part of the investigation team that analysed the events which led to the collapse of the twin towers of the World Trade Center. He recently spoke at a series of luncheons for FPA Australia which marked the 10th anniversary of 9/11.

By Mark Murray, Communications Officer, FPA Australia

We probably all remember where we were on the day the World Trade Center (WTC) buildings came crashing down in New York City. The sight of two passenger jets slamming into America's tallest buildings gripped the world with fear and uncertainty in what was the greatest act of terrorism ever seen.

The events of 9/11 didn't stop high-rise buildings being built globally. In China, Hong Kong and the Middle East, buildings standing between 400 and 700 metres tall have gone up since the attacks, so the challenges of tall building design and their protection against such incidents remains at the forefront of planning for designers and engineers.

FPA Australia conducted a national luncheon series in September to mark the 10th anniversary of the tragic terrorist attacks, focusing on the research, investigations and lessons learnt in emergency management and tall building design since that horrific day.

The luncheons, held in Brisbane, Sydney and Melbourne, involved presentations from leading fire engineering experts Peter Johnson and Jonathan Barnett.

Johnson, an ARUP Fellow, spoke about the lessons we can learn from an emergency management perspective from disasters such as 9/11, Hurricane Katrina and the Black Saturday bushfires.

Barnett, AECOM National Leader for Fire

Engineering, is a recognised expert and has been involved in many fire investigations and litigations around the world.

It was 10 years ago since he received a call from the American Society of Civil Engineers, asking if he wanted to be a part of the official investigation team that would examine the events which led to the collapse of the twin towers from an engineering perspective.

Speaking at the luncheons, he re-lived the sheer size and grandeur of the twin towers before they were destroyed and gave attendees an insight into some of the engineering aspects of the buildings. The WTC site covered a remarkable 20 acres, with each block of the towers covering about an acre alone. The 110-story towers were officially opened as part of the WTC Complex in April 1973, using a tube-framed structural design. At the time of completion, both towers were the tallest buildings in the world.

"Structurally, the towers consisted of an outer core of closely spaced columns, and an inner core of columns," Barnett said.

"The inner core carried all of the shafts, and half of the floor load. The outer core carried the other half of the floor load, plus the entire wind load. We don't normally design like that, but these were unique buildings built differently than normal high-rise buildings that are typically designed today."

Interestingly, Barnett explained that the twin towers were originally designed to be able to sustain a hit from a Boeing 707 aircraft.

"In the sixties, the structural engineer of the WTC, Leslie Robertson, was asked this question: 'If a 707, which was the largest jet of the day, crashed into your towers, what would happen?'

"He did some calculations and concluded that they would remain standing, which they did after the planes hit them. The fires, of course, were another story."

Barnett revealed that the fires in both buildings were not as horrific as they appeared to the naked eye and on television. Had fire crews been able to gain adequate access to the fire floors fast enough, the buildings may have stood. However, in the case of both the North and South Towers, this became virtually impossible. Hundreds of firemen, burdened by carrying over 45 kilograms of clothing and equipment, had to scale 92 and 77 floors respectively by foot to reach the fire floors.

The average firemen carrying 45kg of gear takes an hour to climb 25 flights of stairs. At that rate, the firefighters were looking at a three to four hour hike to reach the impact floors in either building.

"In New York, they have runners on the brigade, and one of the runners, just wearing sneakers and carrying a radio, ran up and made it to the fire floor of the North Tower," he said.

"He got on the radio and called down to his officer and said 'I need two engine companies, we'll put this out in a few minutes'.

"So they were not large fires, they were horrible, but they were certainly in the capability of the New York Fire Department to deal with if they could have gotten to the floors."

Barnett explained that when the hijacked airliners rammed into the North and South Towers, the explosions blew fireproofing off the buildings' columns and trusses.

Searing flames fed by thousands of gallons of jet fuel had begun to soften the exposed steel, with temperatures reaching 2000˚C inside the impact zones. It took 100 minutes after the impact for the North Tower's inner core to buckle under the heat and less than an hour for the South Tower.

"The aircrafts disintegrated on impact, leaving bits of jet fuel flying everywhere and aluminium shrapnel," Barnett said.

"The shrapnel knocked off interior finishings throughout the impact floors, and also knocked all of the spray vermiculite fireproofing off of the steel.

"Given the massive amount of steel that had the fireproofing knocked off, the towers had been reduced to a bare steel building that could not stand very long in the case of a fire."

For a designer of a high-rise building, the part of an aircraft that is of greatest concern, should one hit a building, is the area between the engines, as this is where the bulk of the mass lies. In the case of the North Tower, American Airlines flight 11 flew perpendicular to the side of the building, with the three exit stairs of the building located directly in the path of the major mass of the aircraft. All three exit routes were destroyed on impact, leaving 1335 people located above the impact floors trapped. This proved to be fatal. In the case of the South Tower, things were different, with 18 people miraculously walking to safety from above the impact floors, though 630 died.

Barnet explains: "In the South Tower, the plane came into the wall and hit the tower on an angle, not perpendicular like the plane in the North Tower. Two of the three exit stairs in the South Tower were damaged by the impact, but one, on the far corner of the building, had minimal damage and 18 people above the impact floor were able to use that stair and escape. They got lucky."

Interestingly, the right-hand engine of the plane smashed right through the corner of the South Tower landing several blocks away from the WTC. It missed a petrol station on Murray Avenue by no more than 10 metres.

Ten years on from the tragedy, Barnett said many things have been learned and will be implemented in the redevelopment of the WTC site, which is currently underway.

"Although it's never nice to be discussing and talking about the events of 9/11, I think it is great to be talking about the lessons that have been learnt from the event," he said.

"To be talking about what we have learnt and what we can do better is an upbeat thing.

"The Freedom Tower is being built now which is 1770 feet tall, which is an exciting building. Much of the lessons learnt from the World Trade Centre are being applied to that building design."

***9/11 Ten Years On – What have we Learnt?* was a seminar luncheon hosted by FPA Australia. For more information on the presentations, please contact FPA Australia at events@fpaa.com.au**

Jonathan Barnett

GRASS GROWTH THE HIGHEST IN YEARS:

this fire season could be difficult

Each year, fire and weather experts meet to discuss the likely bushfire conditions for the coming season. David McLoughlin of the Bushfire CRC reports on this year's southern seasonal workshop.

They gathered in Adelaide from around the country for a two-day workshop; 23 experts from the nation's fire and land management agencies and the Bureau of Meteorology. Their mission: to predict the bushfire outlook for the coming fire season based on the weather so far this year, the likely weather for the next three months and the volume of fuels in grasslands and forests. The result of their workshop; the Bushfire Cooperative Research Centre's S*outhern Australian Seasonal Bushfire Outlook* for the 2011-12 fire season, predicting above-normal potential for grass fires across the middle of Australia from the Indian Ocean coast in the west to the Pacific Ocean in southern Queensland and to the western edge of the Great Divide in New South Wales.

The grass, which attendees heard was waist-high and even shoulder-high in places, had grown furiously following last summer's very wet La Niña event. In fact, so high was the grass in places that a team in the outback checking it could not initially find their four-wheel drive after they walked away from it.

Many Australians have dimming memories of fast-moving, intensely burning grass fires, went the discussions. Most fires in the past decade were in forests. This season had the potential to be another 1974, when close to a quarter of Australia's land area burnt. The difference between 1974 and now was a lot of tourists in central Australia, especially visiting such places as Lake Eyre and Birdsville. On the other hand, there were more tankers, dozers and planes in the area than in 1974. Warnings needed preparing now.

"We didn't get any significant fires last season because it was so wet," says Simon Heemstra, of the New South Wales Rural Fire Service, in remarks repeated by most present. "Now we have a lot of grass, so we're gearing up for significant grass fires across most of inland New South Wales."

These seasonal outlook workshops, supported by the Bushfire CRC, have been held each year since 2006. There are now three each year. The first held is the Northern Workshop, covering Australia north of the Tropic of Capricorn. It looks at the outlook for all the Northern Territory and the north of Western Australia and Queensland. The reason for the timing is that the fire season starts much earlier in the far north. This year's northern workshop was held in Kununurra in the far northwest of WA and led to the publication of the *Northern Australia Seasonal Outlook* in early August. The Southern Workshop was held in late August and led to the *Southern Outlook* being published on 28 August. The latest development is a New Zealand Workshop, held for the first time late last year and leading to the publication of the first *New Zealand Outlook* last December, to be repeated this year.

The Adelaide workshop was chaired by Rob Sandford, Assistant Chief Officer of the South Australia Country Fire Service. It followed a logical structure that started with a review of the previous workshop and Outlook, moved to national and state overviews of the weather and fire conditions to date and the predicted weather as the new season begins, and concluded with state-by-state and territory predictions.

Mark Chladil, the Fire Management Planning Officer with the Tasmania Fire Service and a veteran of the Australian and New Zealand workshops, leads a brisk discussion about how "fire potential" should be described in the *Outlook*.

"It's not simply a function of weather and climate," he says. "It's a summary of weather and climate, fuel abundance and availability, recent fire history and the firefighting resources that are available in an area. Taking all these things into account, the designation of fire potential is between normal conditions, and above or below normal conditions."

By consensus, they decide to amend the definitions section of the *Outlook* to remove some small

ambiguities from earlier editions, making it read: "Fire potential: The chance of a fire or number of fires occurring of such size, complexity or other impact which requires resources (from both a pre-emptive management and suppression capability) beyond the area in which it or they originate. Fire potential depends on many factors including weather and climate, fuel abundance and availability, recent fire history and firefighting resources available in an area."

That done, Grant Beard, senior climatologist with the Bureau of Meteorology's National Climate Centre in Melbourne, reviews weather and climate patterns since last year's workshop and considers the climate outlook for the coming three months, based on the Bureau's various predictive models.

"After years of drought, La Niña – the Big Wet – has eliminated some of the rainfall deficit in the southeast," he says. "January to March was very wet over much of southern Australia. With the passing of La Niña, drier weather patterns returned to the southeast and southwest from April. August to date has been warmer than average over the southern half of the country, significantly so in the southeast."

He says La Niña peaked in January and disappeared by May. Currently, the ENSO (El Niño Southern Oscillation) index is neutral between La Niña (which traditionally brings rain) and El Niño (which can bring drought), however, atmospheric patterns of winds and cloud show some La Niña features[1].

"An El Niño now is basically impossible, as the index is on the cool side of neutral, but we may see a late La Niña develop. Historically, half the La Niñas are followed by another the next year, but if it does happen, it's likely to be much weaker that the strong event of the last year."

"The Bureau's official spring seasonal outlook indicates an increased chance of below-average rainfall in central to southeast South Australia and the adjacent fringes of New South Wales and Victoria," he says, putting up a comprehensive series of maps and graphics on the screen. In contrast, a wetter season is more likely in southwest Western Australia and far southwest Queensland. This outlook is largely driven by the Indian Ocean temperature patterns. The maximum temperature outlook shows an increased chance of a warmer than normal season in tropical areas and a small region straddling the South Australia/Victoria border.

Following the climate outlook, the word round the table is "grass".

"The last time we saw grass this high was in the 1950s," says Queensland Fire and Rescue's Ferg Adrian. "We're pretty concerned about it. It's curing a month ahead of time."

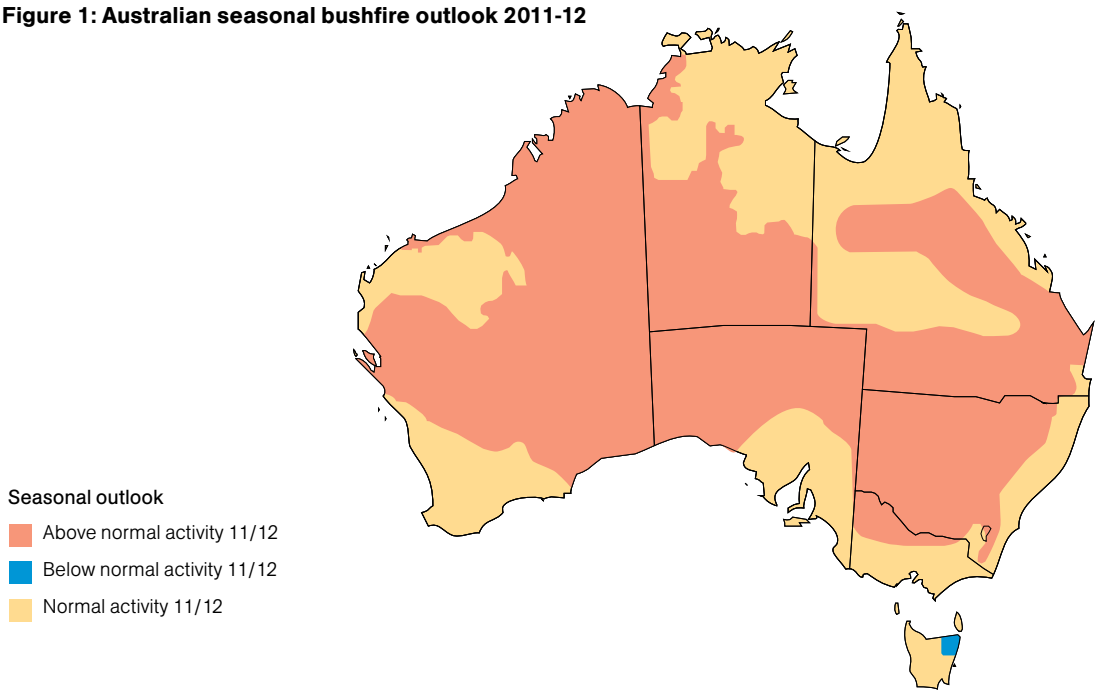
On the second day, experts from each state and territory huddle in groups to draft the text from their jurisdiction for the Outlook. Additionally, everyone contributes to the map of Australia which goes with the Outlook, showing which areas can expect above normal bushfire potential, which can expect normal and which can expect below-normal. The shaded areas are drawn generally rather than specifically – it is meant to be a broad-brush map, not one that tries to predict the outlook for particular towns or shires. For that reason, no towns are named on the map, not even capital cities.

The only area with predicted below-normal potential is the northeast of Tasmania. The rest of that isle is tipped as normal potential. This does not mean there will be no fires, just that any that start are likely to be within the ability of local resources to fight.

The predictions from the map in August's Northern Outlook are updated and added to the new map, which now shows more than half of mainland Australia in

Left: Senior Climatologist Grant Beard finishing his forecasts. Below: Workshop participants working on the map.

Figure 1: Australian seasonal bushfire outlook 2011-12



bold orange signifying in particular the areas with the worrying grass growth, a lot of which has been unable, by the meeting to be reduced ,with controlled burns.

In **South Australia**, above average fire potential is indicated in the western part of the West Coast, North East Pastoral and North West Pastoral districts due to rainfall received and conducive growing conditions. For the remainder of the state including the southern settled areas the most likely scenario is for near average levels of fire activity. Resource implications of an average to above average fire danger season may see the need for firefighting resources for a longer period of time.

Tasmania is expecting below normal fire season potential in the northeast up to the end of November. Normal fire season potential is expected for the rest of the state. Grass fuel curing may increase the fire potential in the north later in the season. Below average moisture conditions persist in the southwest.

Grass growth across **Victoria** is prolific and widespread, representing a return to conditions more consistent with the long term average. After the prolonged dry spell, agricultural stocking rates are low, and this is expected to contribute to the incidence of fast moving grass fires.

Western Australia's Mid-west, Desert and Nullarbor have extensive areas of high fuel, in some areas among the highest on record, resulting in above average fire potential. The southwest has a legacy "of deep soil moisture deficiency and if the rainfall does not continue to be average or above average, this region may move from normal fire potential to above normal.

Above normal fire potential is assessed for a large area of southern **Queensland** including the Beaudesert, Boonah, Lockyer and Brisbane Valleys through to the Sunshine Coast north to above Wide Bay and west. This includes most southern Queensland inland grassland areas to the Northern Territory and South Australian border.

In **New South Wales** and the **Australian Capital Territory** there is heavy continuous grass fuel loads through most areas west of the Great Dividing Range and the tablelands. Above normal fire potential has been assessed inland due to dry conditions in the last few months plus increased likelihood of drier than average outlooks for spring. Coast and eastern ranges have received significant rainfall and, given forecast average precipitation during spring, the fire season is expected to be average.

The map is finished, the various texts are agreed and written. The Bureau's Grant Beard finishes writing his climate predictions which form a major part of the Outlook. The CFS's Rob Sandford thanks everyone for the smooth way they got everything together. And then it is over until next year's workshop, likely to be in Sydney.

The Seasonal Outlook is published as a Bushfire CRC fire note and can be found on the organisation's website at www.bushfirecrc.com/firenotes

[1] Since the Adelaide workshop, the Bureau has updated its ENSO index. The 12 October update says: "Conditions in the tropical Pacific Ocean are consistent with the early stages of a late-forming La Niña event. If the current cooling persists, as is expected, then 2011-12 will be recorded as the second La Niña in as many years. Current observations and model predictions indicate that this La Niña is likely to be weaker than the strong 2010-11 event."

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RISKS, FORECASTS AND FIRE WEATHER IN BOWRAL

By Nick Goldie, science journalist and active member of the Colinton Rural Fire Brigade

Following the Bushfire CRC and AFAC conference at Darling Harbour, 80 delegates left Sydney late on 1 September for the New South Wales Southern Highlands to attend the 2011 Fire Weather and Risk Workshop at the Peppers Craigieburn Resort at Bowral. This was a three-day meeting for professional fire managers, meteorologists and fire weather researchers. Around 35 speakers gave presentations to the workshop. There was a strong presence from the Bureau of Meteorology (BoM), Geoscience Australia, CSIRO, the rural fire services, rural land management as well as the universities, the Bushfire CRC and the commercial sector. Organisers of the workshop were Bob Cechet of Geoscience Australia, Rick McRae of the ACT Emergency Services Agency and Graham Mills from the BoM.

At the previous Fire Weather workshop, many years before, tensions had come to the surface and the "operationals", losing patience with the "theoreticals", staged a walk-out on to the pleasant lawns of Craigieburn. This time, while there were brisk arguments, harmony prevailed and at the end of the workshop, all parties were happy. Indeed, there was general agreement about the need for a follow-up workshop in two years.

This is not to say that there were no differences. The most spirited discussions were about old methods versus new: How well has NextGen, the Graphical Forecast Editor, served us in its first years of operation? Do we have an effective metric for lightning strikes, dry and wet? Just what do we know, or need to know, about foehn winds? And what does the future hold for bushfire research?

One of the most stimulating presentations came by way of the US Navy. What has the Navy to do with bushfires? Dr Mike Fromm, a meteorologist with the Naval Research Laboratory in Washington, explained that for a number of reasons, the Navy has a particular concern about stratospheric aerosols, which may be produced in large quantities by forest fires. So the Navy is interested.

Mike Fromm is clearly an enthusiast for his subject, and has some intriguing questions. Why do some fires "blow up" while others, in apparently the same circumstances, remain relatively docile? Why do they blow up late in the day, rather than in the heat of noon? And most puzzlingly, why do big fires "pulse"? He showed spectacular graphics from the Big Desert (Victoria) fire of 2002 and from Black Saturday (Victoria) in 2009, and he came tantalisingly close to linking the vast pileus cloud caps tipped with ice, supported on a rushing pyrocumulonimbus

Fire Weather and Risk Workshop participants, Peppers Craigieburn Resort, September 2011.

column above the blaze, to the fire behaviour itself. It's a chicken, he said, and an egg. The fires affect the clouds and the clouds, generating their own winds and weather, affect the fires.

Bushfire CRC research student, Mika Peace (Bureau of Meteorology and University of Adelaide), brought the meeting down to earth with her description of the 2010 Layman-Ballan fire near Margaret River, Western Australia: a routine burn which behaved in a non-routine way. It was not so much the extra area burned that was the problem, she said, but the unexpected ferocity of the fire. It left three-quarters of the forest seriously scorched, led to questions in the state parliament, and to a bill reaching $750,000 and counting.

What caused the blow-up? There was just a gentle breeze that day, said Mika, and it was quite cool. But otherwise harmless factors came together and created the disaster – sea breezes, convergence, vertical circulation and a pool of dry air high above.

It is claimed, facetiously, that foehns make the Swiss bad-tempered when the hot dry wind comes off the mountains. But are foehns relevant to Australia? According to Dr Jason Sharples (ADFA at the University of NSW), hot dry winds mean bad fire weather, and foehns are extremely relevant in those parts of Australia where there are real highlands – the south coast of NSW, Gippsland, the Australian Alps and the Canberra region.

Dr Sharples' work, as part of the Bushfire CRC HighFire Project, found that this is because of the extreme changes in temperature and humidity that can occur. Twelve degrees rise in an hour is quite normal during a foehn, says Jason. Unexpectedly, he says, the high country is normally much dryer than land below 1500 metres and, equally unexpectedly, the high country can be at its driest early on a summer morning. This foehn-related behaviour is of great significance to firefighters and anyone planning a hazard reduction burn.

A recurring issue at the workshop was the nature of fuel. How much moisture comes from a eucalypt canopy when it is fully engaged? How can a fire manager assess grassland? Grant Pearce of the New Zealand Crown Research Institute, SCION, described the latest of several projects concerned with grass curing in Australia and New Zealand. This is especially relevant to the extended grasslands of 2011, such as those of the Monaro where African lovegrass poses a threat from Canberra to the Victorian border. Grass curing research is today a matter of satellite technology. There is still the need for on-ground validation, however, so the Bushfire CRC is engaged in defining standards. A real need, said Grant, is to produce accurate maps, not just of grass, but including practical reference points such as towns, rivers and roads.

Grahame Douglas is climate change and sustainability coordinator for the New South Wales Rural Fire Service and a Bushfire CRC PhD student. He started his career as an environmental biologist before moving on to fire-related matters. Fire authorities are taking an increasing interest in environmental integrity, says Grahame, while the trends show increasing drought – and therefore increasing numbers of bushfires. There is more acceptance that fire is a part of the Australian landscape, he says, but we will certainly have to adapt to a changing world and a changing climate.

Communications manager of the Bushfire CRC David Bruce looked into the future of bushfire and fire weather research. The Bushfire CRC was originally funded until 2010 and then received additional funding to investigate issues arising from the Black Saturday fires, but only until 2013. Both the Australian Senate and the Victorian Bushfires Royal Commission have recommended that there be a continuation of bushfire research by some form of fire research institute.

Intumescent coatings for commercial infrastructure

The intumescent coatings industry in Australia has evolved dramatically over recent years. Understanding compliance with legislation and performance issues is the key to achieving a system that will perform should a fire occur.

By Dr Allan Jowsey MEng AIFireE MSPFE
fire engineering manager, International Paint

Steel can provide designers with increased flexibility in comparison with traditional construction materials. However, regardless of the material used in buildings, fire safety remains of paramount importance. Materials, including concrete, will spall and steel will lose strength in the event of a fire with the potential to result in damage to property and, in the worst case, loss of life.

Intumescent coatings react in the presence of intense heat to form an insulating layer, protecting underlying structural steel and extending the duration of its structural integrity. They form part of a range of products available to designers to achieve the fire-resistance requirements of projects.

Traditional methods of fireproofing, such as cementitious coatings and gypsum boards, can only be applied on site and are often considered aesthetically unappealing for visually-exposed steelwork and are labour intensive to apply. Intumescent coatings allow for easy off-site and on-site application during construction and provide an attractive finish that does not compromise intricate designs and shapes created from the steel. This allows maximum architectural expression for structures such as airports, stadiums, leisure facilities, hospitals and office buildings.

As with any fire protection product, it is important to understand intumescent coatings to ensure correct specification and one that is fit for purpose. This article outlines some of the key issues that architects, engineers, fabricators, applicators and approving authorities should be aware of when dealing with such coatings.

Structural steel during erection on site prior to application of an intumescent coating.

Overview of the intumescent industry

Intumescent coatings are used on structural steelwork across the world in a variety of iconic buildings. When initially introduced into Australia there were a limited number of products. These were all solvent-borne and had difficulty protecting to a fire resistance level of two hours. More recently low-odour, water-borne intumescents, primarily geared for on-site application, have been introduced. It is now common to achieve two hours' fire protection with thin-film acrylic intumescents. Thick-film epoxy intumescents have the ability to provide in excess of two hours' fire resistance and due to their high durability and resilience, they provide a good solution for off-site application and external exposed steelwork.

Increased competition among intumescent coating manufacturers has led to more innovative products becoming available in the market. Traditionally, competition has focused on achieving the lowest dry-film thickness. While that trend is still evident, new systems are also focusing on improving application techniques together with faster curing times, shortening over-coating intervals and application in a reduced number of coats.

The increased use of performance-based design or fire engineering approaches, to justify to an approving authority a potential reduction in fire resistance levels from those prescribed in the Building Code of Australia, has led to a greater opportunity for intumescent coatings.

The pace of development within the intumescent coatings market has led to this fire protection material becoming competitive with other forms of fire protection and offers designers a viable, alternative solution.

Structural response and Fire Resistance Levels

Structural steel reduces in strength and stiffness with increased temperature. This can have a detrimental effect on the stability of a structure. Unprotected steel will heat very rapidly in a fire. The aim of an intumescent coating is to insulate the steel and keep it relatively cool for the required Fire Resistance Rating.

The response of a steel structure in a fire can be further influenced by the maximum temperature attained, the degree to which it is loaded, its restraint and the mechanical properties of the steel itself.

The term Fire Resistance Rating or Fire Resistance Level (FRL) is associated with the ability of a building element to perform its function as a barrier or structural component for a specified time during the course of a fire. It is often specified in combination with a limiting steel temperature as set by a qualified engineer. Across the globe durations vary with legislation, but in Australia typical periods are 30, 60, 90 or 120 minutes.

The fire resistance rating for a building is set out in the Building Code of Australia and its basis is strongly related to the risk of fire (occupancy use), the height of the structure and the provision of a suppression system. It is critical to understand the correct legislative requirements for a project.

A qualified engineer can determine the limiting steel temperature for each structural member by calculation in accordance with AS 4100 *Steel structures* and AS 1170.1 *Minimum design loads on structures – Dead and live loads and load combinations.*

Intumescent coatings can cover a wide range of structural sections including universal beams and columns, circular and rectangular hollow sections and concrete-filled tubes. Depending on the type of intumescent coating, it is possible to protect members for up to three hours fire resistance. Manufacturers also assess their products over a wide range of limiting temperatures – known as Multi-Temperature Assessments (MTAs). These may typically be 350°C to 750°C and can permit qualified engineers to specify temperatures of their structural elements as part of an optimised and performance-based design.

Fire types

While it is acknowledged that real fires are influenced by a number of parameters including fuel source, ventilation and suppression, the fire protection industry has adopted standard 'fire curves' to account for different types of fire.

These tests have been developed to compare and contrast product performance against a benchmark fire exposure.

Cellulosic fires are fuelled by combustibles such as wood, paper and textiles that are commonly encountered in day-to-day situations. They are typically associated with buildings and commercial infrastructure.

Hydrocarbon fires, or pool fires, are fuelled by oil and gas and have a very rapid heat rise. They can be extremely turbulent as they entrain oxygen to maintain combustion.

Jet fires are a particular group of hydrocarbon-fuelled fires expelled from an orifice under high pressure. They can have high erosive forces in addition to high heat fluxes above those experienced in open pool fires.

Epoxy intumescents are used where there is a risk of hydrocarbon and jet fires. Thin-film acrylics are typically used where there is risk of a cellulosic fire, although an epoxy coating may be required for durability purposes, such as corrosion risks in aggressive exterior environments.

The FRLs prescribed in the Building Code of Australia are typically derived from the cellulosic 'Standard Fire' exposure.

Intumescent coating technology

Intumescent coatings work by undergoing a chemical reaction when heated to form an expanded, thermally insulating layer. The coatings include an acid source, typically phosphorous-based, a carbon source and one or more blowing agents dispersed in a suitable resin system. At temperatures of around 200°C the acid and carbon source react to form a carbonaceous melt that is expanded by gases generated during the thermal decomposition of the blowing agents, resulting in a sponge-like char.

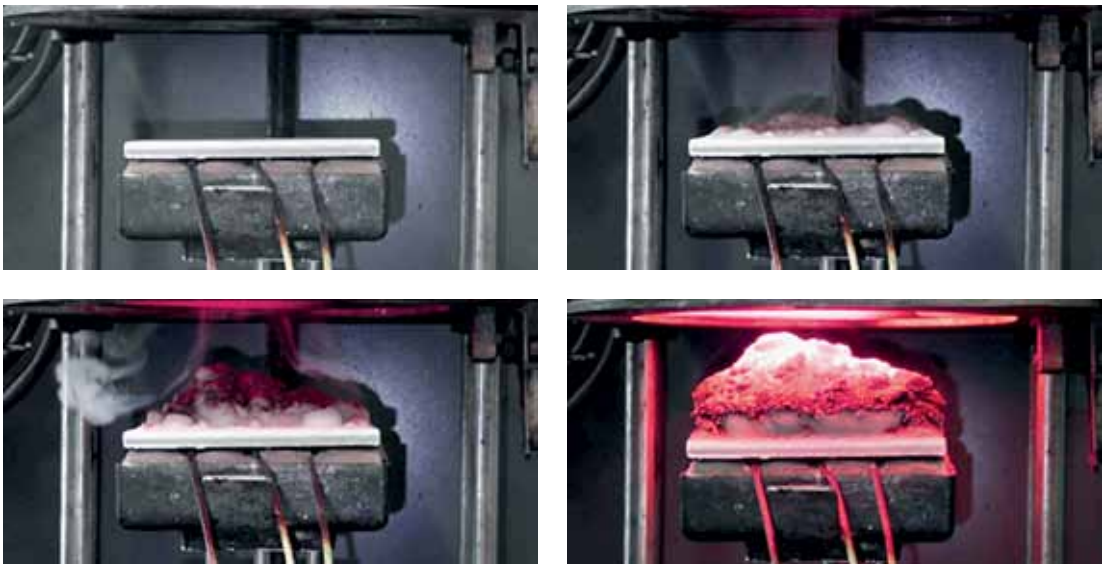
Intumescents are available in categories that include thin-film water-borne or solvent-borne acrylics and thick-film epoxies. The choice of which to use on a specific project is dependent on factors that include:

The fire resistance rating and fire exposure type. Prescribed by the Building Code of Australia and


Cellulosic fire


Hyrdrocarbon fire


Jet fire



Typical expansion of a thin-film water-borne acrylic intumescent subject to radiant heating.

or alternate performance based assessment and influenced by the occupancy use of the structure.

Legislative requirements including the fire test standard. Strongly linked to global geographic location, with fire test standards being referenced in design documents. For example, the Building Code of Australia calls for materials to be tested to AS 1530.4 and assessed in compliance to AS 4100.

Durability and anti-corrosion requirements. The degree of environmental exposure of the steel is important in selecting an intumescent coating. Environmental Classifications are set out in AS 2312 and AS 4312.

Cosmetic finish. Manufacturers often supply sample panels or undertake mock-up areas to demonstrate the levels of finish available, including top-coat colour ranges.

On-site or off-site application. Linked to construction sequencing and use of trades on site. Intumescent coatings are available that are dedicated to either one application or both.

Surface preparation. Steel may be galvanised, abrasive blast-cleaned to SA 2.5 in accordance with ISO 8501-1 or AS 1627 Class 2, and treated with an appropriate primer if required. It is important to understand compatibility of intumescent coatings over primers: if in doubt, consult a manufacturer.

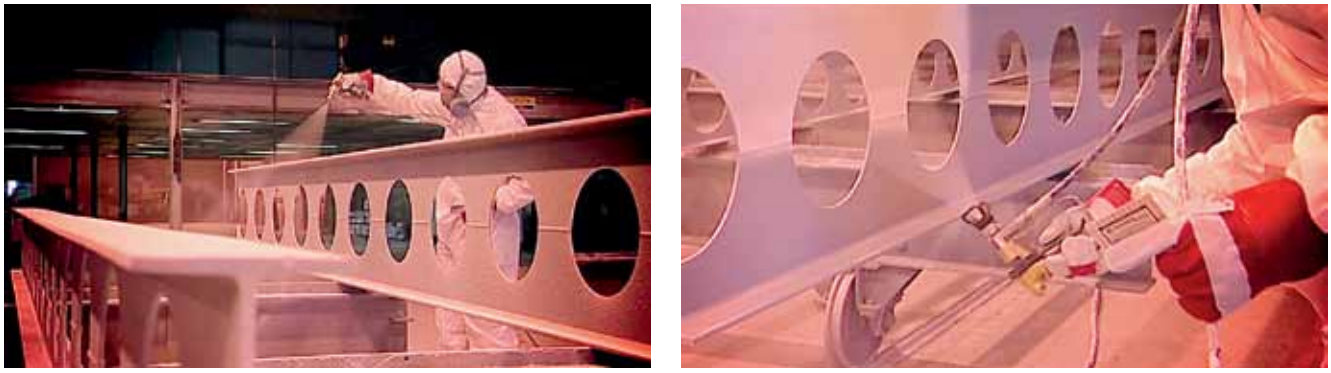
Drying times and over-coating intervals. Important in construction sequencing. Together with the thickness of paint that can be applied in one application, this dictates the duration to get a finished application.

Sustainability credentials. As part of adding to a building's sustainability aspirations, intumescent coatings are available as solvent-free and chlorine-free, together with low volatile organic compound (VOCs) content.

It is common for intumescent coating manufacturers to work closely with their clients throughout projects to ensure a product is chosen that fits with the fire resistance rating requirements, meets the durability specifications and aligns with construction timeframes. Manufacturers will typically produce a range of documentation for their products which outlines performance credentials. These are typically in the form of product datasheets, material safety datasheets, application guidelines and independent testing reports and assessment certificates.

Fire testing, assessment and certification

Regardless of where an intumescent coating is used,



Application of thin-film acrylic intumescent by single-leg airless spray.

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it is important that it has undergone rigorous testing to a relevant fire test standard and assessed against a recognised methodology. Fire protection products require extensive testing, as approval regimes and certification requirements vary across the globe.

Intumescent products to be used on load-bearing elements of construction in Australia must be tested to AS 1530 *Methods for fire tests on building materials, components and structures Part 4: Fire-resistance test of elements of construction*. This standard tests a representative specimen when exposed to heat under controlled conditions in a furnace.

The size and construction of a fire test specimen would ideally represent the element in its intended position in a building. Typically, loaded beams are tested horizontally, with protection applied to three sides and with the top flange directly in contact with a floor slab. Columns are tested vertically, with the protection applied to all sides. This leads to the terms '3-sided' and '4-sided' exposure when dealing with fire protection to steelwork.

A test program for unloaded sections is required to explore the relationship between fire resistance, dry-film thickness and section size. A typical program may include at least 10 sections, including short beams, short columns and tall columns. To address the issue of adhesion to the substrate under deflection (stickability), additional loaded member tests are required to complement the unloaded member tests.

Methods of assessing the performance of fire protection materials have been developed that enable the thickness of protection for a wide range of situations to be predicted, based on a limited number of specimens as defined in a fire test.

Using the results of a program of fire tests in accordance with AS 1530.4 on both loaded and unloaded specimens, AS 4100 sets out a methodology in terms of a mathematical procedure and acceptance criteria. This approach can then be applied to the test results, which enables predictions of required dry-film thickness (DFT) to be made for a range of structural sections.

Certification bodies such as Certifire Australia provide confidence via independent evaluation that an intumescent product complies with the minimum regulatory requirements and also meets a stringent set of conditions. Independent third-party certification provides a quality mark that is designed to enable manufacturers to clearly demonstrate the superiority of their products versus non-certified products. Additionally, these bodies can perform type and audit testing conducted on independently sampled products and independent factory production control inspection. When requested by design teams and as part of the documentation required on a project, manufacturers of intumescent coatings will provide up-to-date available evidence of testing to demonstrate compliance with specification requirements.

Summary

The fire-resistance level for a structure is important to enable evacuation of occupants and to provide assurance to attending firefighters. Passive fire protection materials are available to meet the required level as set out in the Building Code of Australia for a given structure, which subsequently need to be tested to AS 1530.4 and assessed to AS 4100.

Intumescent coatings provide a proven method to achieve a required fire-resistance rating. Before a specific coating can be chosen however, it is important to ensure that the coating meets the specifications and is fit for purpose.

The choice of system needs a number of factors to be considered, including anti-corrosion performance, interior or exterior use, application on-site or off-site with associated construction sequencing and degree of aesthetic appearance.

Equally important as the product performance characteristics, is the independent certification to back up a manufacturer's claims of an intumescent coating's performance in standard fire tests.

Intumescent products are subject to extensive testing to a wide range of global test standards and these tests and their associated assessments, together with independent third-party certification, provide confidence that a product will be fit for purpose and meet expectations.

Architects, engineers and approving authorities should request appropriate documentation to substantiate a product's performance, not only for intumescent coatings but for any type of passive fire protection.

The intumescent coatings market in Australia has evolved over a relatively short period of time with respect to traditional fire protection materials. That evolution is set to continue as manufacturers draw on new technologies with the aim of producing more effective products and environmentally sustainable systems.

Large floor furnace capable of testing loaded beams.

A steel section coated with a primer (left) and an intumescent coating (right).

Around 150 booths in the trade expo covered 7000 square metres of the Sydney Convention and Exhibition Centre, making it the largest trade expo for emergency services in the southern hemisphere and a record for any AFAC event.

The AFAC and Bushfire CRC annual conference

The AFAC and Bushfire CRC annual conference attracted a record number of almost 1500 fire and emergency personnel from Australia, New Zealand, the Pacific Islands, Japan, the United States, Europe and elsewhere at the Sydney Convention and Exhibition Centre from 29 August to 1 September.

The conference, themed New World, New Thinking, gave the delegates many opportunities to explore the impacts of innovation and development in technology so as to better plan, respond to and manage fire and natural hazards in the future.

Naomi Brown, Chief Executive Officer of AFAC, said she was delighted with the conference: "The program was fantastic. Lots of the sessions were crowded which is a sign that we chose outstanding presenters. The feedback I've had from many participants tells me that delegates were really pleased with the quality of the whole event," she said.

Bushfire CRC Chief Executive Officer, Gary Morgan, said his organisation's research was best valued when it was taken up and understood by end-user partners: "The annual conference more than met our expectations of getting the research out and into our industry."

The busy week began with professional development workshops. Tuesday and Wednesday were packed with panels and presentations across four venues in the sprawling centre. Thursday's focus was the Bushfire CRC Science Day, where more than 200 participants heard from 35 researchers on the latest in fire science.

AFAC President Lee Johnson, Commissioner of the Queensland Fire and Rescue Service, set the tone for the conference with his opening address on the future for emergency management in Australia. Delegates heard from expert speakers and researchers from Australia and around the world on topics focused on the conference theme, such as the use of technology in the fire and emergency services, using the internet and social media to engage communities, disaster response, management and maintenance, volunteering and bushfire prevention.

Invited keynote speaker, Ben Self of Blue State Digital, who specialises in media and technology for political candidates, non-profit organisations and companies, spoke on the use of internet and social media in emergency services.

"I think it's great that people are interested in technology and using social media to try to build different types of relationships with their customers," he said.

The conference, in its 18th year, was also an opportunity to view and learn about the latest technology and equipment, with a huge trade display.

Photos, speaker presentations and conference feedback can be found at http://knowledgeweb.afac.com.au

Bushfire CRC research students.

Delegates view the latest in mapping and technology at the Spatial Technologies PDP session.

Delegate quotes

"I sat in on the **resilience** and **leadership** presentation...the depth of their knowledge they have been able to share is first rate."

"I thought the most interesting thing was using **Google** ads and that a lot of the emergency services haven't really clicked into that idea of using those advertising areas on Google."

"Love the **networking!**"

"As a first timer, thank you for the **excellent** speakers I have had the pleasure to absorb great experiences from."

"I used the Dräger Knowledge Lounge. **Fantastic** idea."

Entertainment at the Conference Gala Dinner.

The Dräger Knowledge Lounge where delegates had the opportunity to meet speakers.

Tweets

#afac2011 Ben Self. Social media is better used to build new volunteers and activists.

Great feel to this fire conference – #AFAC2011. Unique in the world and so valuable.

#afac2011 Ben Self says don't rely on FB for disaster prevention. Better that people talk to their neighbours. Old fashioned approach!

A big challenge for our future is the use of social media in emergencies – are we ready for it – we have a long way to go #Afac2011.

#Afac2011 is booming & provocative. Audience is challenged to ensure thinking keeps up with the serious run of big emergencies.

@rebeltalbert tells #afac2011 social media accounts are just some of the 29 channels NSWRFS use to send out emergency info.

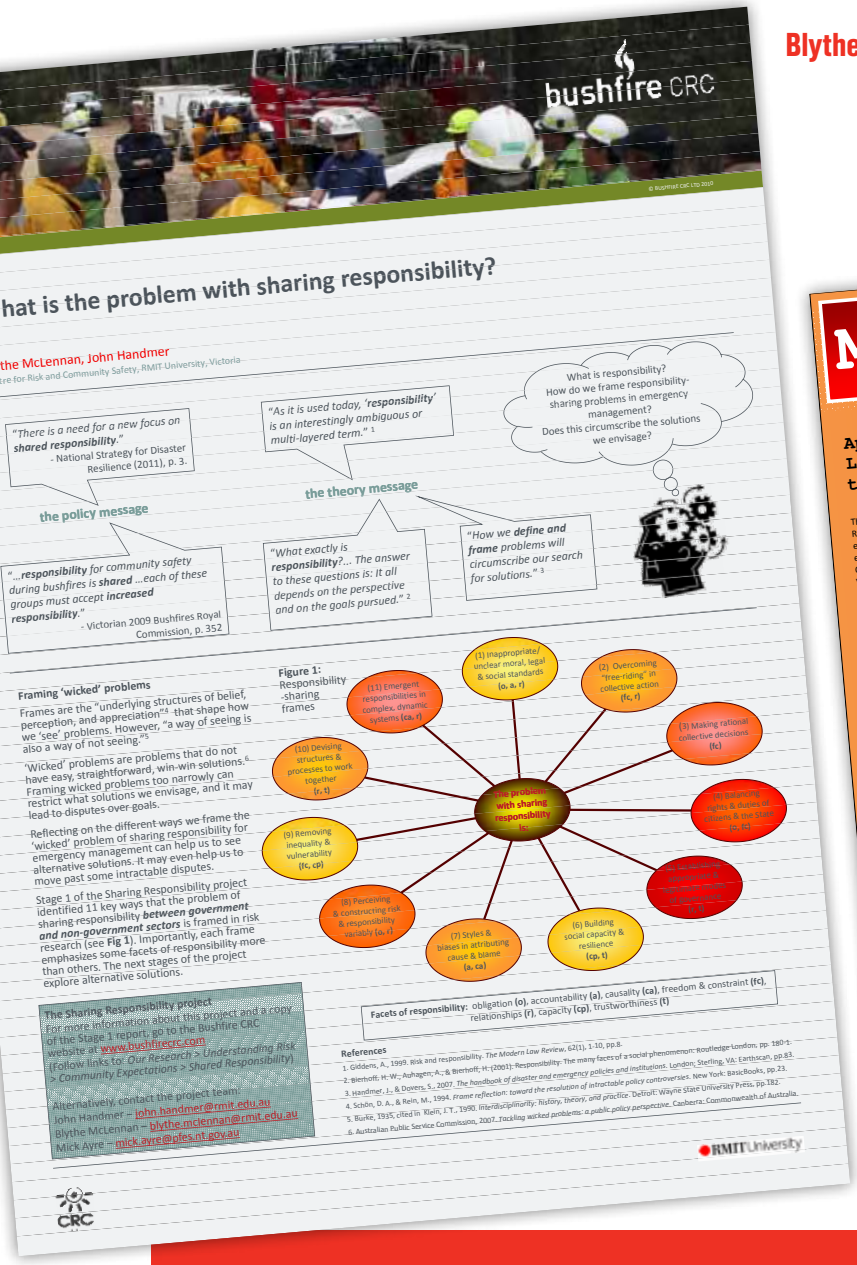
Fast Facts

Delegates sent the organisers **250** texts and **185** tweets during the conference
The exhibitors' trade hall occupied **7000** square metres of floor space
150 trade booths
Largest trade expo in the southern hemisphere for emergency services
121 speakers
114 poster submissions

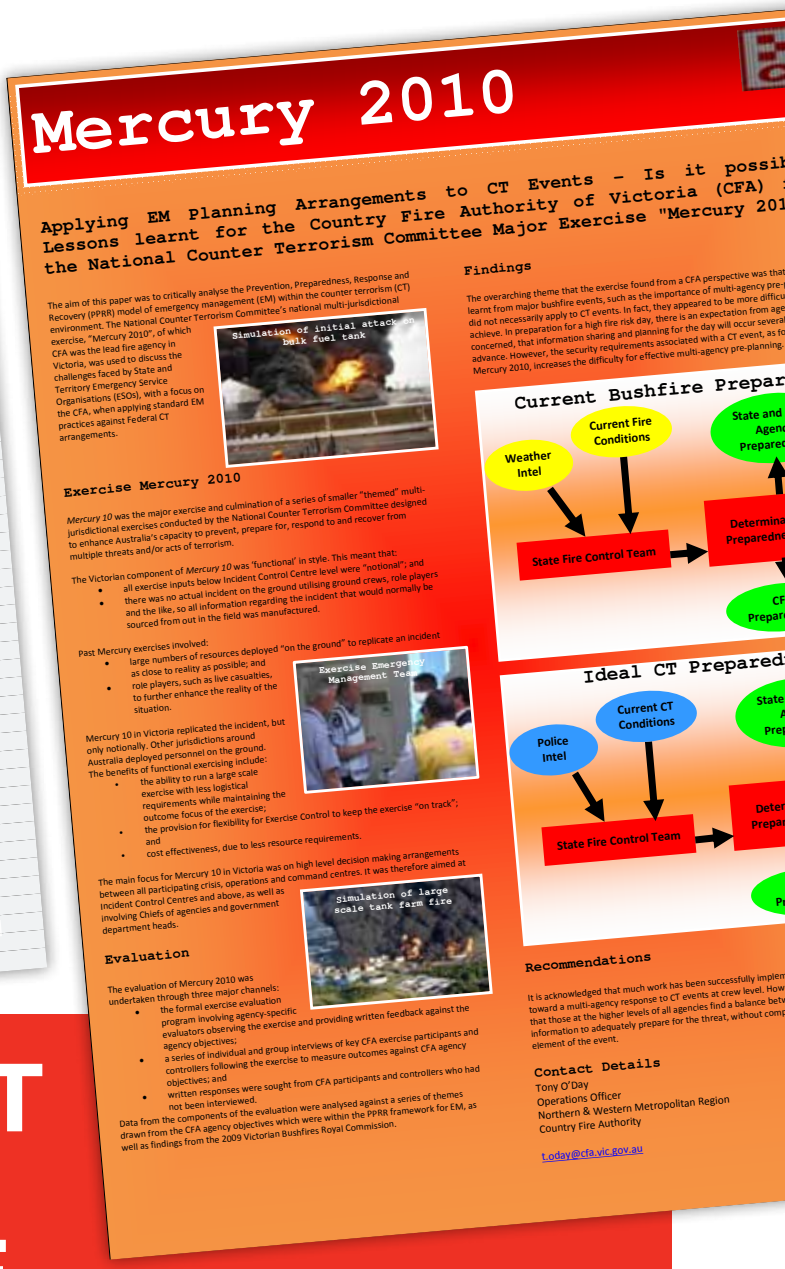
Justice Crew perform at the Opening Ceremony.

L-R: Len Foster, Chairman Bushfire CRC; Laurie Lavelle, inaugural CEO of AFAC; Lee Johnson, AFAC President; Hon. Michael Gallacher, Minister for Police and Emergency Services; Gary Morgan, CEO Bushfire CRC; Naomi Brown, CEO AFAC.

Blythe McLennan



Tony O'Day



POSTERS A HIT AT SYDNEY CONFERENCE

One of the highlights of each AFAC and Bushfire CRC conference is the poster display. The posters provide a report on research or an organisational project that entices the reader to make contact with the author for more information. The posters provide an alternative way for researchers to share their thoughts and experiences with others.

A total of 114 posters were on display in Sydney – 57 from Bushfire CRC researchers and students, 22 from AFAC and 35 from other agencies. New to the 2011 conference was the introduction of two awards – one voted by a panel of expert judges and the other voted by delegates.

Winner of the judges' vote was Bushfire CRC researcher Blythe McLennan of RMIT University for her poster *What is the problem with sharing responsibility?*

Winner of the delegate-voted poster was Tony O'Day of the Country Fire Authority, Victoria, for his poster *Applying emergency management planning arrangements to counter-terrorism events*.

The awards were presented at the conference closing ceremony.

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Fire Australia 2011

11 fireAustralia conference & exhibition

The Fire Australia 2011 Conference and Exhibition, to be held at the Adelaide Convention Centre from 16-18 November, is set to be the largest in the event's history.

Fire Australia is the premier fire protection industry conference and exhibition in Australia, attracting key personnel, peers and significant representation from businesses, government and associations. The 2011 conference will fully explore current issues relevant to the event's theme – The Essentials of the Future: Education & Maintenance.

Each year sees repeat delegates and new industry members congregate, network and socialise at the conference, providing an excellent opportunity to meet clients and colleagues face to face. The conference is organised jointly by the Fire Protection Association Australia (FPA Australia) and the Institute of Fire Engineers Australia (IFE).

"The Fire Australia Conference and Exhibition is one of the showcase events on the fire protection calendar and continues to grow in size each year," Scott Williams, FPA Australia Chief Executive Officer, said.

"This year's conference theme of education and maintenance is particularly important and the scale of the program is reflective of this.

"Education and maintenance are considered essential for the future development and stability of the industry and issues surrounding them, including potential problems and the scope of practices moving forward, will be discussed in depth at Fire Australia 2011.

"We are expecting our largest number of exhibitors and we have added further innovations to the program which has it shaping as our most successful yet."

The program will include both local and international keynote speakers and will primarily address the education and aintenance theme, some of which include:

- Can training and education keep up with changing technology, practices and Standards?
- How trained and educated technicians can save time and money for clients.
- Who trains the trainers – is the cycle robust?
- Educating my workforce – cost versus benefits.
- Formal training versus experience – the age old dispute.
- Proactive versus Reactive maintenance and upgrades.
- Compliance maintenance versus equipment performance.
- Maintenance of alternative solutions – what are the protocols?
- Maintenance shortcuts – are efforts to save costs compromising safety?
- Working with poorly documented installations and maintenance.
- Dealing with disrepair – what is the responsibility of the service company?
- Is there a need for nationalising maintenance requirements?
- Civil, criminal and duty of care responsibility – are you aware, are you covered?
- Enforcing compliance – who do we look to?

In addition to this, various other key issues will

be included and discussed to ensure delegates receive comprehensive industry knowledge.

Last year's conference, at the Gold Coast Conference and Exhibition Centre, attracted almost 400 delegates and 50 exhibitors. The theme surrounded 'Communities & infrastructure – protecting our assets', focused on society's assets, heritage and resources. Another theme, 'Fire protection: the great debate', saw a new approach to the presentation format.

Fire Australia 2011 will see speakers from across Australia and overseas converge in the South Australian capital. Organisers have aimed to ensure all presentations are contemporary and current, affording all delegates additional knowledge and information. With a single stream of presentations, all delegates will be present for every speaker. A new addition to the program in 2011 will be the inclusion of breakout workshops, permitting attendees to discuss and provide feedback on topical issues.

"We wanted to build on some of the advancements we made at last year's conference, and the breakout workshops will provide delegates an extra level of engagement," Williams said.

The conference location, the Adelaide Convention Centre, idyllically located between the city's CBD and the banks of the River Torrens, will house all aspects of the conference. This centre ranks as one of Australia's best convention venues, offering environmentally friendly energy, lighting and materials. The dates of the event are well suited to provide delegates the opportunity to stay for the weekend in Adelaide or the surrounding area.

The program will incorporate two-and-a-half days of presentations, workshops and social activities, including a cocktail reception, conference dinner hosted by renowned Australian entertainer Shane Bourne and a farewell lunch, ensuring plenty of networking opportunities. There is also a partner's program that provides three days of activities exploring Adelaide and surrounding areas.

Sponsorship and exhibition opportunities are currently available. 2011 will see the largest exhibition Fire Australia has ever seen, with over 60 booths available, a meet the speaker lounge, internet kiosks and café style catering. There are plenty of high exposure locations but those wanting multiple booths are advised to book early to avoid disappointment.

Currently more than half the exhibition has been sold to a wide array of organisations across many different sectors of the industry, providing attending

delegates an excellent opportunity to remain abreast of current products and services.

"This year also sees a wider range of sponsorship options for organisations to affiliate themselves with the conference and receive varying levels of exposure," Williams said.

"Primarily, there are now three levels of major sponsors, silver, gold and platinum, plus the addition of lunches, tea breaks, lanyards and the internet kiosks.

"We believe there is now a sponsorship opportunity to suit everyone's budget and marketing objectives."

To date, sponsorship has been received from several key industry companies, including Boss Fire & Safety, Coopers Fire, Alan Wilson Insurance Brokers, Chubb Fire & Security, Pertronic Industries, Fire Protection Technologies and Ampac Technologies.

Both FPA Australia and IFE Australia assist in the sourcing of key speakers and promotion of the conference and exhibition, which attracts more than 30 presentations, over 40 exhibiting organisations, several hundred delegates and an array of sponsors.

Registrations are still being taken for the event. Each delegate registration includes full access to all sessions, admittance to the welcome cocktail reception, conference dinner and farewell lunch, plus a delegate's satchel including copies of all the presentations.

For updated information, sponsorship and exhibition availability and to download the various brochures (Exhibition and Sponsorship & Delegate Registration), visit the conference website: www.fireaustralia.com.au or call FPA Australia on +613 9890 1544.

FPA AUSTRALIA

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Fire Australia 2011 is a Fire Protection Association Australia & Institute of Fire Engineers Australia joint project

11

fireAustralia
conference & exhibition

Fire Australia is the premier fire protection industry conference and exhibition attracting key personnel, peers and significant representation from businesses, government and associations.

With speakers from across Australia and overseas all presentations are contemporary and current, affording all delegates additional knowledge and information.

Sponsorship and exhibition opportunities are now available. For more information about all aspects of the conference please visit the website: www.fireaustralia.com.au

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Principles of fire safety: part 5
OPERATION OF EMERGENCY WARNING SYSTEMS

For many of us, the first time we learn about an emergency, is when we hear the tell-tale signs of an emergency warning system in operation.

By Russ Porteous, CEO, Maintenance Essentials

An emergency warning system is a life safety system installed to safeguard occupants from illness or injury by warning them of a fire or emergency, and to safeguard occupants during the orderly evacuation of a building in an emergency. They assist in these two functions by:

- Providing mass notification of an emergency; and
- Providing a method to communicate with and direct building occupants, in the event of an emergency.

The term emergency warning systems is used in this article as a generic term to describe three types of systems described in the Building Code of Australia (BCA) as follows:

- Building Occupant Warning System
- Sound and Intercom Systems for Emergency Purposes
- Emergency Warning & Intercommunication System (deprecated)

Emergency warning systems alert occupants in an emergency by broadcasting a warning message or tones over a network of monitored loud speakers. Speakers are distributed throughout a building to ensure:

- warning messages and tones satisfy a specific sound pressure level (volume) and are distinctly audible throughout all required areas of the building; and
- warning messages are intelligible to (clearly understood by) the occupants.

Building Occupant Warning System

A Building Occupant Warning System (also known as an occupant warning system) is a type of emergency warning system that is designed and installed in accordance with Clause 6 of Specification E2.2a of the BCA and Clause 3.22 of Australian Standard AS 1670.1.

A Building Occupant Warning System can be one of the following:

- A sound system for emergency purposes designed and installed in accordance with Australian Standard AS 1670.4; or
- Electronic sounders or an amplified sound systems producing an evacuation signal.

These systems may be supplemented by additional visual or tactile signals to augment the emergency evacuation signal.

Sound systems and intercom systems for emergency purposes

A sound system and intercom system for emergency purposes is different to a building occupant warning system. These systems are typically installed:

- in a building with an effective height of more that 25m; or
- in a Class 3 buildings having a rise in storeys or more than 2 and used as a residential part of a school or accommodation for the aged, children or people with disabilities; or
- in a Class 3 building used as a residential aged care building; or
- in a Class 9a building having a floor area of more than 1000m^2 or a rise in storeys of more than 2; or
- in a Class 9b building used as a school and having a rise in storeys of more than 3, or used as a theatre, public hall or the like, having a floor area of more than 1000m^2 or a rise in storeys of more than 2.

Historically these systems were also described as an Emergency Warning & Intercommunication System (EWIS). This term and the relevant Australian Standard AS 2220 have, however, been deprecated in favour of a "sound system and intercom system for emergency purposes".

A sound system and intercom system for emergency purposes must be designed in accordance with the requirements of Australian Standard AS 1670.4 and AS 2220.

Typical features and functions of an emergency warning system

An emergency warning system comprises either electronic sounders (applicable to Building Occupant Warning System only) or a network of loudspeakers and/or visual warning devices distributed throughout the building. Loudspeakers and/or visual warning devices are connected to control and indicating equipment (c.i.e.).

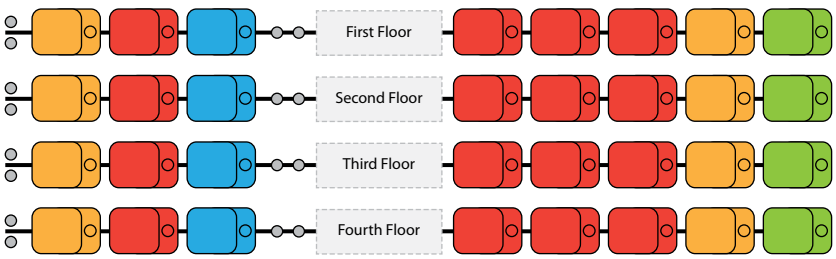
The control and indicating equipment that forms the 'brains' of an emergency warning system generally comprises the following components:

1. Cabinet
2. Primary Power Supply Unit & Battery Charger
3. Secondary Power (Batteries)
4. Control Electronics
5. Illuminated Indicators
6. Input Interface & Control
7. Input Termination & Monitoring
8. Output Termination & Monitoring
9. Evacuation Zone Amplifiers

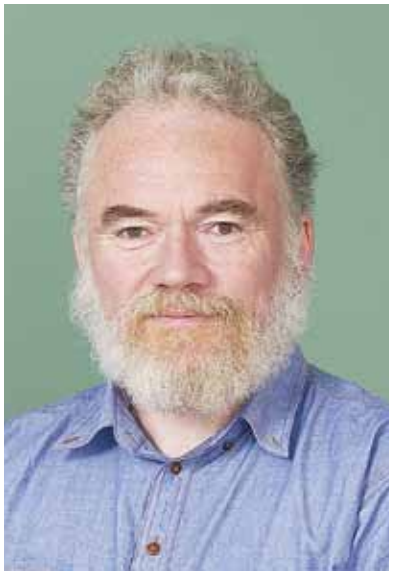
Each manufacturer of a sound and intercom system for emergency purposes differentiates themselves from other manufactures by the features and layout of the user interface. The illustration below shows a typical interface with two distinct sets of controls;

- Sound System controls on the left; and
- Intercom System controls in the right.

continued on page 57



The horizontal rows in this configuration illustrate an evacuation zone.



Learning, improving and blaming

Science and bushfires

Among the overall reactions to a major fire event of importance to fire services, are three which do not mesh well: learning about the event; improving community safety; and laying blame. These reflect the efforts of coroners, the media, researchers and scientists. They fall at differing places along a spectrum of rationality. The most rational reaction, science, takes by far the longest time.

In a paper presented to the 2011 AFAC & Bushfire CRC Conference, Rick McRae of the ACT Emergency Services Agency (ACTESA) discusses this from the perspective of the 2003 Canberra fires. This article represents the personal views of the author, not of ACTESA.

After a catastrophic fire event, there are three distinct modes of reaction in the Australian community, which includes the fire industry. These are, in no particular order: learning about what happened; improving how the community is protected from such events; and laying blame on someone for letting things happen.

Typically learning is done by researchers, who gather information about the event and apply standard tools to compare it to past events. Research often manifests in our industry as incrementally adding to what is already known. Note that this is a recipe for small changes, not radical changes.

Not often enough, scientific studies are carried out to see if our understanding of the event was fundamentally flawed and can be expanded. Science may be characterised as slow and impenetrable to most practitioners in the bushfire industry, but it does have the potential for forging major change.

The need to improve is often initially driven by the arrival of the duty coroner and attendant police officers, or governments announcing administrative reviews or royal commissions. Where there is room to do so without exposure to legal implications, industry-based reviews are also initiated. However, the greater the need for our industry to improve, the less control it has over the process.

The need for blame is often initiated by the popular media and driven by lawyers, who seek to sign up litigants, which may occur early or late in the scheme of things. The actions that ensue may be considered in the context of a rationality spectrum. Science sits at the high end of this spectrum. Research should also be at the high end, but is increasingly found elsewhere. Coronial inquiries are intended to be on the high side, but their performance in recent years has arguably shown otherwise. Litigation by definition, initially, falls at the low end of the spectrum. Reviews fall where the competing forces at the time allow them to fall.

We must question the wide spread along this spectrum of coronial inquiries. This reflects politics, the media, judicial perceptions and the influence of experts. These experts from the research area have a wider spread which also needs to be questioned. This manifests as a willingness to state: "I know what happened", before the science has been done.

To improve these modes of reaction, we must firstly scope out the science to be done, so that key areas are tagged as 'pending'. Opinions expressed within these areas must reflect the fact that science is yet to be concluded. We must also address the role of experts in the need to blame, which flows naturally from disagreement in opinion. If we truly knew how fires behave, we would never find experts on opposites sides in a courtroom. A strong industry role in maintaining a pool of independent experts may be needed.

In order to show why these issues need attention and how to tackle them, I would like to review some facts arising from the 2003 Bushfire Coronial Inquiry in the Australian Capital Territory.

The basis of the coroner's findings, built from testimony by experts, is a chain of logic presented in adversarial circumstances to the witnesses. "We knew the weather, as it had been forecast. We knew how to predict what a fire would do under those conditions because we knew the fuel loads and the terrain. With that prediction we can get close to the actual outcome. Therefore you should have done the same. Had you done so, the outcome could have been mitigated."

The foundations of this argument are knowledge of weather, terrain, fuel and fire behaviour. It also assumes precise and unambiguous interpretation of inputs to the calculations. In other words, on the specified conditions, anyone doing the calculations would reach the same results. It also assumes that the tools used are valid, unique and not open to question. Any practitioner in this arena will appreciate the fallacies embedded in these assumptions. Anyone versed in courtroom drama knows the pitfalls of ex post facto arguments. Using such arguments, the fog of uncertainty that pervades incident management teams in escalating situations can be conveniently ignored.

The science that has arisen from the 2003 ACT fires now covers 11 papers in refereed science journals, with

two published in 2010, three in 2009 and the others in 2006 and 2007. In these papers a number of concepts that are new for the Australian wildfire community have been posited and have proven to be of a suitable standard for publishing in a peer-reviewed science journal. These concepts include pyro-tornadogenssis, the dominance of lee-slope eddies, violent pyro-convection, dry slots, fire channelling and foehn winds.

Of these none were openly discussed in the coronial inquiry. Dry slots were aired in the media during the inquiry, and what is now termed pyro-tornadogenesis was referred to on the first page of proceedings only. Had they been discussed, the logical outcome of the inquiry may well have been that as violent pyro-convection had only been confirmed in Australia in the Big Desert Fire of 2002, there were no procedures in the industry to handle such events. Of course, the science had not been done then. If the inquiry had waited for the science, then the findings may have been more favourable for the long-term protection of the Australian community.

The next benchmark fire event was Black Saturday. This was watched with concern by pyro-convection researchers around the world. Like the Canberra fires, Black Saturday is leading to new understanding of the behaviour of particulates in the upper atmosphere, of value not just to firefighters but to climatologists and cosmologists. Would Black Saturday have benefited if there had been more focus on the science, and less on the legal arguments, that came from the 2003 fires? Many of the key concepts behind the development of extreme fires were discussed in the published literature and in conference proceedings at that time. This knowledge could have made it clear that suppression was futile and the combination of elevated fire danger and the vertical structure of the atmosphere would, through processes such as fire channelling, lead to plume-driven fires. Consequently, many operational strategies could have been different. In both fire events surface fire tools can be tweaked to give close to predicted final outcome, but they give no insight into how that outcome came about.

It is not simply a requirement for researchers to write their papers. The results need to be interpreted into meaningful learning outcomes for the thousands of fire officers who may be tasked with making the calls at the 'next big one'. Another problem that besets our industry is the one-size-fits-all mindset, the opposite of a willingness to canvass alternative ideas. To demonstrate: imagine a sudden wind-change causes a fire tanker to be burnt over. Why did this happen? The standard explanation is a poorly forecast wind change. This carries with it the claim, "if only the forecast had been better, we could have got them out of there!"

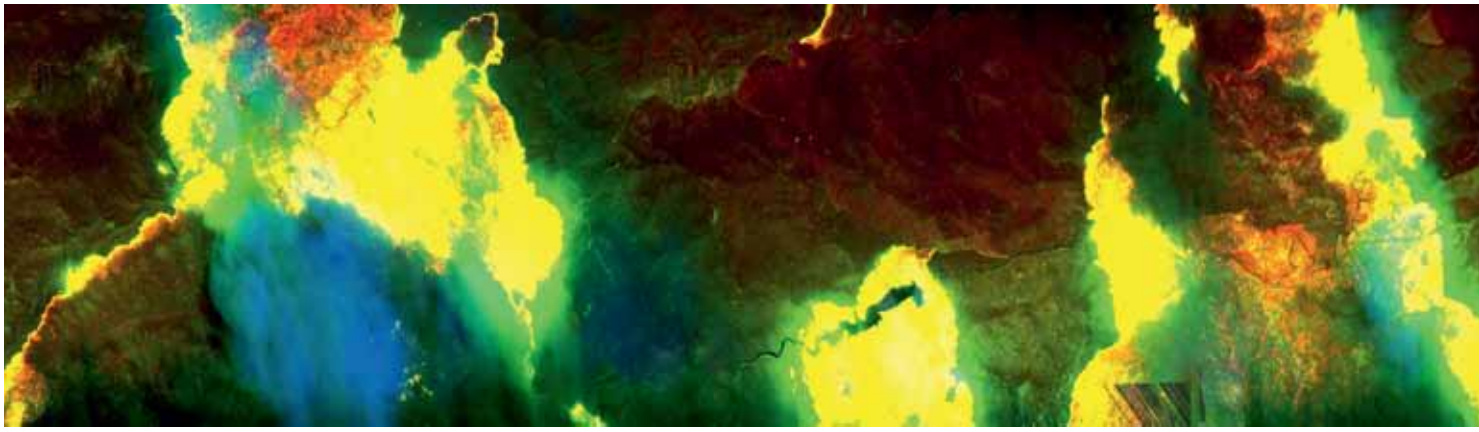
On the lee side of a ridge there can be a distinct wind flow called a lee-slope eddy. When the winds are low, these eddies may be absent, but when the winds are strong they are almost certain. So as the winds pick up in the afternoon, there may come a point where a small increase in winds causes a sudden, and critical, switch in wind regime. This results in a sudden wind change. It does not require a synoptic wind change. Equally if these eddies are in place there will be a point on the side of a ridge where we could be just outside of the eddy regime. A slight backing of the wind direction could move such a site into the eddy field, creating the sudden wind change. A slight wind shift is a natural result of thermal mixing and does not require a wind change. So, we can have three different processes that produce the same disastrous result on the ground.

The application of scientific understanding of these processes allows us to collect evidence that rules out one or more of these explanations and acts to support others. Thus we reach a valid conclusion as well as lessons that may be meaningful in the future. It is necessary to state that while it may take months for researchers to compare possibilities, the crew leader on the day may have minutes.

Science is about raising hypotheses so that they may be challenged and weeded out if they prove unsound. From the end-user's perspective, science is paired with the notion of evidence-based policy. This says that a policy should only be adopted if it has scientifically-validated evidence behind it. The vast majority of the policy used in wildfire management has not been scientifically validated. While it is tempting for many old hands to claim that they know what fires do, the cautionary tale of the unexpected wind change discussed earlier shows that what is usually called bad luck is actually a set of routine phenomena that need to be identified and expected to occur.

Perhaps an even more salient point is that our species has been playing with fire for perhaps millions of years. In all of that time, fire channelling has not been identified. The science arising from the 2003

Fire balls may have been recorded in multispectral linescans of fires, and consistent mechanisms for their formation have been identified.



fires has shown that fire channelling has been defying incident management teams in many countries and has killed many people. In fact it is the big-ticket lesson from the 2003 fires and nobody knew about it until 2004. It killed people on Black Saturday. Unless we listen to the science it will kill people in the next Australian extreme fire.

It is for the goal of learning real lessons from fire events that we must turn to science. We must recognise our fundamental ignorance on key matters of fire behaviour. How many have had a discussion about fire balls? How many concluded that they are an old wives tale? How many know that they have been studied and found plausible by researchers from Manchester, in collaboration with local scientists? How many know they may have been recorded in multispectral linescans of fires, and that consistent mechanisms for their formation have been identified? It really does come down to 'what we know that we know', 'what we know that we don't know' and 'what we don't know that we don't know'. Fires have taught us a lot and have a lot to teach us. None of our understanding of fires has come from a courtroom.

If the various species of inquiry are to be truly aimed at learning lessons and making the community safer in the face of the next event, then it is unthinkable that they would not seek to be in synchrony with the passage of science. It is equally unthinkable that they should not form a stronger link with science. Remember that science is about striving to be disproved. As many in the industry would know, giving evidence in court as an expert witness is about not being disproved. It is about vigorous defence of any claims made.

It is this difference that permits the court proceedings to be decoupled from the science. It has pushed us into an arena where the expert with greater gravitas can win the debate in court. There may be a yawning chasm between charisma and science. Over time, the repeated victory of appearance over substance can also lead to the creation of dogma – a set of facts that is accepted and no longer challenged. Dogma is also staunchly defended against the unbelievers. This is the most dangerous possibility in all of the matters that I have discussed: the unthinking resistance to new thinking, that arises so easily from a comfortable, shared mindset.

There is a limit to how far we can go in basing our practices on experience. We in Australia have made astonishing advances this way, but we are now hitting the wall, in the athletic parlance. We are going through extreme fires, possibly the harbingers of climate change. We are facing events for which we really have no experience base. We are finding that business components, like fire weather, are far more technical than most of us would wish them to be. We are increasingly having our business practices challenged in public inquiries.

We run the risk of squandering the unique opportunity for science offered to us in recent years, as governments pledge increased funding for learning lessons. We, collectively, are in charge of the research agenda and we need to do better. We must stop using that agenda to shore up our established ideas. We must be open to challenge.

I would like to provide some positive suggestions for the future.

Firstly, the science that has come from the 2003 fires owes much to the tasking on that day of the multispectral linescanner, then on contract to the New South Wales Rural Fire Service. This is a type of scientific device of immense value to Situation Units in IMTs and for post-analyses. Without high quality, multispectral, rectified datasets it is difficult to unravel the complexities of extreme fires. These must be augmented by photographs, videos, satellite images, weather time sequences and whatever else is out there on the day. We must be willing to acquire such capabilities and task them. The primary data of value to science may not be acquirable after the fact.

Secondly, we must be able to see the scientific hypotheses that are opened up by such datasets. We need staff widely-read on the range of ideas in the literature. They need to be able to list and compare alternatives. They need to be able to recognise the possibilities for testing ideas from high-quality field data. This requires a national collaboration that goes far beyond what is possible today. As another view of this point, we need to go from a state where eight staff members means eight opinions to a state where one staff member might have eight hypotheses.

Thirdly, we must staunchly defend the process of testing those ideas in the face of media demands, political imperatives and legal gravitas. We must, as it is the only way to provide protection for our communities in the future.

It is worth remembering what's been said before at conferences by Naomi Brown, Justice Kirby and Michael Eburn, and of stated positions on these matters:

"Our membership is deeply concerned that these inquiries are trending towards apportioning blame rather than finding outcomes that lead to an improvement in the way other emergencies are managed.

"All reviews and investigations into bushfire events at any level, internal or independent, need to focus on learning and not blame. The inquiry approach needs to focus on this outcome, in the interests of all involved. Coronial inquests into bushfire matters, other than deaths, may not be the most suitable form of inquiry."

So I'll finish with a challenge to all of you – the people responsible for managing wildfire in what may become known as the era when frequent, violent, pyro-convection became the norm in Australia. When you get ready for the next fire season, put onto your checklist the following:

1. Review the relevant bushfire science.
2. Check whether your Standard Operating Procedures for use in a major fire event incorporate the new learnings.
3. Make sure that you can deploy or access remote sensing data.
4. Ensure that that data is available to assist decision-making during major fires.

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Perth Hills residents saw bushfire as a general risk, but not a threat to them

By David McLoughlin, communications officer, Bushfire CRC

Many Perth Hills residents recognised a bushfire was possible in their area before the February 2011 fires, but did not see it as a threat to their own lives or properties, a study of residents has found. Those who had recognised fire was a direct threat to them – after attending a Bushfire Ready Group, for example – did more preparation before the fires than others.

These are some of the major findings of the *Final report on the February 2011 fires in Roleystone, Kelmscott and Red Hill Research Project*, conducted by Bushfire Cooperative Research Centre researchers at the University of Western Australia (UWA) for the Fire and Emergency Services Authority of Western Australia (FESA).

Two major bushfires devastated separate areas of the Perth Hills on the weekend of 5 and 6 February. One, in the suburbs of Red Hill, Herne Hill, Millendon, Baskerville and Gidgegannup, became known as the Red Hill-Brigadoon fire. The other occurred in Roleystone and Kelmscott. This fire destroyed 71 homes and damaged a further 39. The Bureau of Meteorology issued a Fire Weather Warning and a Total Fire Ban was declared for all the fire-affected areas before the fires started.

FESA asked the Bushfire CRC to conduct a study of the affected communities to learn what they knew about bushfire safety prior to the fires, how they interpreted and responded to fire services messages sent before and during fires, and how they understood their role in fire safety.

Face-to-face interviews were conducted with residents of 425 households in, around or near the fires. Following the interview process, an extensive questionnaire was mailed out to a random selection of 3000 residents of the affected suburbs, producing a response rate of over 30 per cent.

Bushfire CRC deputy chief executive and research director, Richard Thornton, said the findings were similar to those of research conducted after the February 2009 Victorian Black Saturday fires.

"In those fires, a majority of the population knew it was going to be a bad day, but a bad day for somebody else."

Dr Thornton said the Perth Hills study finding, that residents involved with a Bushfire Ready Group made significantly more preparations than those who were not, "demonstrates the importance of these kinds of groups."

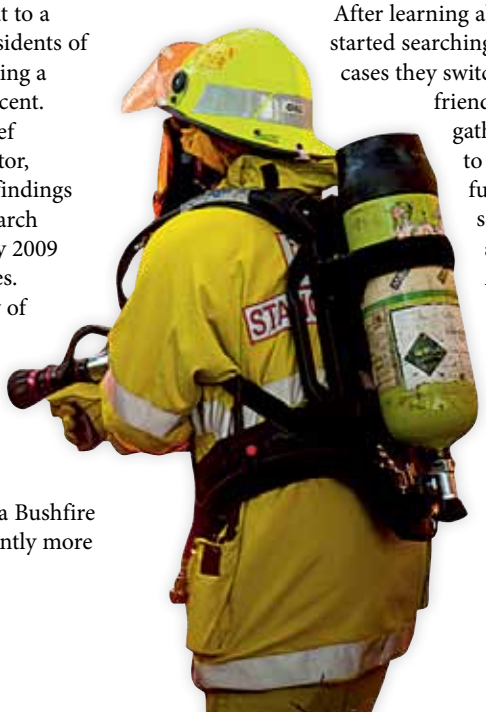
The research team comprised of Mr Jonathan Heath, Dr Claire Nulsen, Mr Patrick Dunlop, Dr Patrick Clarke, Dr Petra Bürgelt and Professor David Morrison of the School of Psychology, University of Western Australia. The methodology they used for the community surveys was based on Bushfire CRC surveys conducted after the 2009 Victorian Black Saturday fires, developed by a team led by Professor John Handmer of RMIT University and Professor Jim McLennan of La Trobe University.

It was the single largest research project involving bushfire-affected community members yet conducted in Western Australia. The researchers say they were made very welcome by the residents.

For most residents in the Kelmscott–Roleystone area, seeing smoke was the first warning sign that a fire was threatening the area, the report says. Upon learning about the fire, about 33 per cent of the interviewed residents decided to leave their homes quickly, well before the fire reached their homes. Though 19 per cent in this area were able to successfully defend their homes against the fire, 28 per cent reported that they left their homes only just in time.

Experiences for residents in the Red Hill–Brigadoon areas were quite different. Many first learned about the fire either because they could smell smoke or because a friend, family member or neighbour contacted them to alert them. Of the 63 residents interviewed in this area, 35 per cent decided to leave their properties well before there was a chance of them being fire affected, while 40 per cent were able to successfully defend their home. Even so, 22 per cent reported that they had left their properties only just in time.

After learning about the fire, residents typically started searching for more information. In most cases they switched the radio on, telephoned friends, neighbours or family, as well as gathering up their valuables to take to safety. When seeking or receiving further information from official sources about the fire, the most accessed sources were StateAlert, ABC Radio, the FESA website, emergency services personnel and other radio stations. However, when residents were asked about the most important official source of information, only 10 per cent of residents responded that the StateAlert was the most important.



Approximately half of the

Firefighters at the Roleystone fire.

residents in the Kelmscott–Roleystone and Red Hill–Brigadoon areas activated their home fire defences (such as sprinklers and generators). Of those who decided to leave their home at the last minute, many residents seemed to be waiting for emergency services personnel to tell them to evacuate. Further, approximately 60 per cent of those interviewed reported that they expected to receive some sort of official warning about the fire, with some residents not feeling the need to independently consult official sources for further information during a bushfire.

Residents engaged in a number of preparatory actions in both the lead-up to and on the day of the fire, including actions such as clearing gutters, discussing the risk with neighbours or locals, having independent power, water supplies and protective clothing and mapping out a fire plan or evacuation route. The most-cited source of information used by residents for their bushfire preparation in the mail-out survey was the *Prepare. Act. Survive* pamphlet sent out by FESA. During the interviews, 'common sense' and 'experience living in the community' were commonly cited as preparation tools by residents.

Associations between the number of preparatory actions per household and other factors revealed some interesting findings. Residents living on larger block sizes engaged in more preparatory measures than those on smaller block sizes. In conjunction with this, there was a significant increase in the number of actions of residents who were or had been involved in a Bushfire Ready Group. Perception of degree of threat to life and property was associated with the number of preparatory actions; a high level of threat perception was associated with a greater number of preparatory actions per household. Perception of the likelihood of a bushfire to a resident's town or suburb did not have any association with the number of preparatory actions per household, demonstrating the importance of asking the right question.

Residents reported a number of barriers that prevented them from being more prepared than they would have liked to be for possible bushfire. A common response was that monetary constraints prevented households from being as prepared as they would have liked to be: "Money. I haven't been able to afford a generator". Other barriers included: finding regulations and bureaucracy too difficult to either understand or to work with; lack of time; complacency; lack of experience; age and health-related difficulties; frustration over other residents' lack of preparation; and being in a rental situation.

Awareness of Total Fire Ban among residents was 67 per cent. However, this was not always from definitive knowledge of a ban. Residents reported a 'common sense' mentality due to prevailing weather conditions or from not knowing the difference between a fire ban and a total fire ban.

Rice Bar fire in Carlton

An estimated damage bill of over $15,000 was the result of an accidental fire at the Rice Bar on Swanston Street, Carlton.

A fire broke out in the kitchen of the restaurant, which is located on the ground floor of an apartment block housing around 200 occupants.

The fire is believed to have been started in the wok stove tray just before midnight on 9 June 2010.

A total of 21 firefighters attended the blaze.

Following the fire, investigators from the MFB Fire Investigation and Analysis Unit conducted an inspection of the building. During that inspection, issues were identified relating to fire safety which could pose a threat to occupants and assist in the spread of fire.

Lucky escape for school in Yarra Ranges

At 9:26pm, 5 July last year, the Metropolitan Fire and Emergency Services Board (MFB) received the first of a number of exchange telephone calls regarding a fire at the Pembroke Secondary College in Mooroolbark. The caller stated that the fire was in an area of the college where recent construction works had been undertaken.

Two MFB pumpers and one Country Fire Authority (CFA) pumper were the first appliances to be despatched. The first fire crew arrived approximately six minutes later, to find a single storey, classroom wing of the college well alight. Up to 10 fire trucks battled the blaze, with the CFA and MFB combining forces to bring it under control. The fire took approximately 22 minutes to bring under control and fire crews were present until 11:30pm ensuring the fire was completely extinguished.

Firefighters performed a Level 2 asbestos decontamination on a number of firefighters due to the presence of asbestos.

During the course of fighting the fire, the Education Department was notified.

The fire destroyed three classrooms in a part of the college due to be demolished and caused smoke logging to another two.

An arson chemist was called to examine the charred ruins of the building the following morning to determine what sparked the blaze. A Victoria Police spokesman said the fire was being treated as suspicious. Police guarded the school overnight before the arson chemist examined the scene.

There were no reported injuries in the blaze, but fire crews took extra care with regard to asbestos.

As the classrooms were marked for demolition, the estimated cost of fire damage was actually put at nil. The MFB did not receive notification from EdSec as, due to the impending demolition, there were no monitoring devices present.

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continued from page 47

According to Australian Standard AS 1851.4:2004, an evacuation zone is a subdivision of the premises that can be evacuated separately from any other subdivision.

This separation is achieved by providing one unique amplifier and speaker circuit for each evacuation zone. An amplifier for an evacuation zone is rated to provide a defined amount of power, measured in watts (w) to the speaker circuit.

Loudspeakers can be purchased with a two or three power settings, also measured in watts. The greater the number of speakers, the greater the power requirements (demand) on the amplifier.

Typically loudspeakers are permanently fixed into position and distributed throughout the evacuation zone within a building typically at ceiling height in quantity and distribution to satisfy two criteria:

1. a warning signal sound pressure level exceeding 10dB above ambient sound pressure level and not less than 65dB and not more than 105dB; and
2. at all places within the evacuation zone where the ambient noise figures are less than 85dB, the speech intelligibility shall be equal to or greater than 0.5 STI (speech transmission index).

At this point a little science is required to explain the terms used such as sound, sound pressure, sound pressure level, noise and intelligibility.

1. Sound is the pressure variation caused by a sound wave.
2. The magnitude of the variations of the air pressure from the static or normal air pressure is a measure of the sound pressure level, measured in decibels (dB).
3. The number of cyclic pressure variations per second is the frequency of sound, measured in hertz (Hz).
4. Noise is considered to be sound caused by an array of random activities of different sound pressure levels and frequencies.

Measuring sound pressure

In measuring sound pressure levels, the human ear is not equally sensitive to all frequencies, meaning that humans perceive some sounds louder than others depending on the frequency. As a result the measure of sound pressure is frequency-weighted so that the measured sound pressure level correlates more closely to perceived sound pressure level by a human.

In the measurement of loudness, an A-weighting frequency filter is commonly used to emphasize frequencies around 3–6 kHz, where the human ear is most sensitive. A-weighting attempts to match the response of the human ear to noise, and A-weighted sound pressure levels are labelled dBA.

Measuring speech intelligibility

Intelligibility is a measure of the degree to which speech can be understood. Intelligibility is affected by many factors including spoken clarity, explicitness, lucidity, comprehensibility, precision, quantity & quality of speakers, area acoustics and background noise. Developed in the early 1970s, the Speech Transmission Index (STI) is a machine measure of intelligibility whose value varies from 0 (unintelligible) to 1 (excellent intelligibility).

Operation of an emergency warning system

An emergency warning system is generally configured to be activated automatically on an alarm signal activated by:

- an automatic fire sprinkler system; or
- a fire detection and alarm system; or
- an emergency control point.

On receipt of an alarm signal, the emergency warning system is typically activated as follows:

1. Building Occupant Warning System

Typically a building occupant warning system is configured as a single amplifier/circuit and on the receipt of an alarm, the entire loudspeaker circuit is activated.

2. Sound systems for emergency purposes

A sound system for emergency purposes is more often than not a system that has two or more evacuation zones fitted. In this case, the typical operation is for the system in the evacuation zone corresponding to the source of the alarm signal is operated firstm followed by a delay, after which the next adjacent zone is operated. The cascading sequence is then repeated until all evacuation zones have been operated, or the system has been manually disabled.

Sound systems for emergency purposes may also be fitted with verbal messages to provide additional warning to occupants. These messages may also be configured to assist occupants in multi-lingual environments.

These systems may also be used for non-emergency purposes such as public address, or background music. In these cases, the system is designed in such a way as to ensure the CIE can override these features in an emergency condition.

Maintenance

The maintenance of these two types of evacuation systems does vary slightly according to Australian Standard AS 1851:2005 depending on the system being designed to AS 1670.1 or AS 1670.4. Please consult the relevant Australian Standard and the manufacturer's specifications for detailed maintenance obligations.

In summary, emergency warning systems are designed and installed to alert and evacuate building occupants of an emergency. This is typically conducted in accordance with a defined set of emergency response procedures. Emergency warning systems are versatile systems than can also be used for other purposes such as public address and background music.

About the Author: Russ Porteous if the CEO and one of the founders of Maintenance Essentials. He has over 22 years experience in the installation and maintenance of fire and essential safety measures. Russ is a contributor to a variety of Australian Standards including AS 1851 for the Maintenance of Fire Protection Systems and Equipment.

Fire Sector Report

FP-001 fire maintenance

The public comment draft of a new edition of AS 1851 Maintenance of fire protection systems and equipment has been released for public comment. FP-001 will meet shortly to review comment received and work towards a ballot draft of the document.

FP-002 fire alarms and detection

Adoption of ISO 7240-16 Sound system control and indicating equipment; adoption of ISO 7240-20 Aspirating smoke detectors to AS 7240.20; adoption of ISO 12239 Smoke alarms using scattered light, transmitted light or ionisation.

FP-004 fire sprinklers

The revision of AS 2118.1 Automatic fire sprinkler systems – general systems was approved through the last round of Standards Australia prioritisation.

FP-008 fire pumps and tanks

Revision of AS 2941-2008 Fixed fire protection installations – pumpset systems.

FP-011 fire maintenance

The committee has commenced its revision of AS/NZS 4487-1997 Pyrogen fire extinguishing systems to a generic condensed aerosol standard.

FP-009 Hydrants

Work is continuing on the revision of AS 2419.1 Fire hydrants – system design & installations and also AS 2419.3 Fire hydrant installations – fire brigade booster connections. The committee has completed work now on most sections and a public comment draft is expected early in 2012.

FP-020 bushfires

Amendment 3 to AS 3959 is being prepared for publication.

FP-024 bushfire water spray systems

New Australian Standard for bushfire water spray systems. Committee work is progressing well with a meeting in July to review a first draft. We are aiming to commence a public comment draft by December 2011. The committee is meeting again in September and a public comment draft is expected in the early part of 2012.

Standards Australia Project Proposal process

Standards Australia accepts proposals to amend, revise and develop new Australian Standards through a formal proposal process. Key points to take note of are as follows.

- All project work is initiated by a Standards Australia Project Proposal. It must demonstrate an agreed scope, net benefit to the Australian community and broad stakeholder support.
- Standards project-related work is funded in one of two ways; by Standards Australia or external of Standards Australia.
- Standards Australia-funded project work must be submitted through the Standards Australia Project Prioritisation process. This process has two submission intakes per year, the first closing in February/March and the second in September/October. The dates vary slightly each year. Standards Australia advertises these dates through its website, through bulletins and through advice to Standards Australia members and councillors. Externally-funded work can be initiated at any time through the year.
- National Sector managers are available to assist with the preparation of a proposal.
- Key to the consideration of a Project Proposal through either pathway is the demonstration of net benefit to the Australian community (i.e., demonstration of why the work needs to be done: how the proposed work relates to economic matters, public health and safety, environmental, competition and social and community outcomes).

All projects undertaken by Standards Australia must demonstrate net benefit. For projects funded by Standards Australia, the net benefit case is key to the assessment undertaken through the prioritisation process. Details on this process are available at http://www.standards.org.au/DevelopingStandards.aspx

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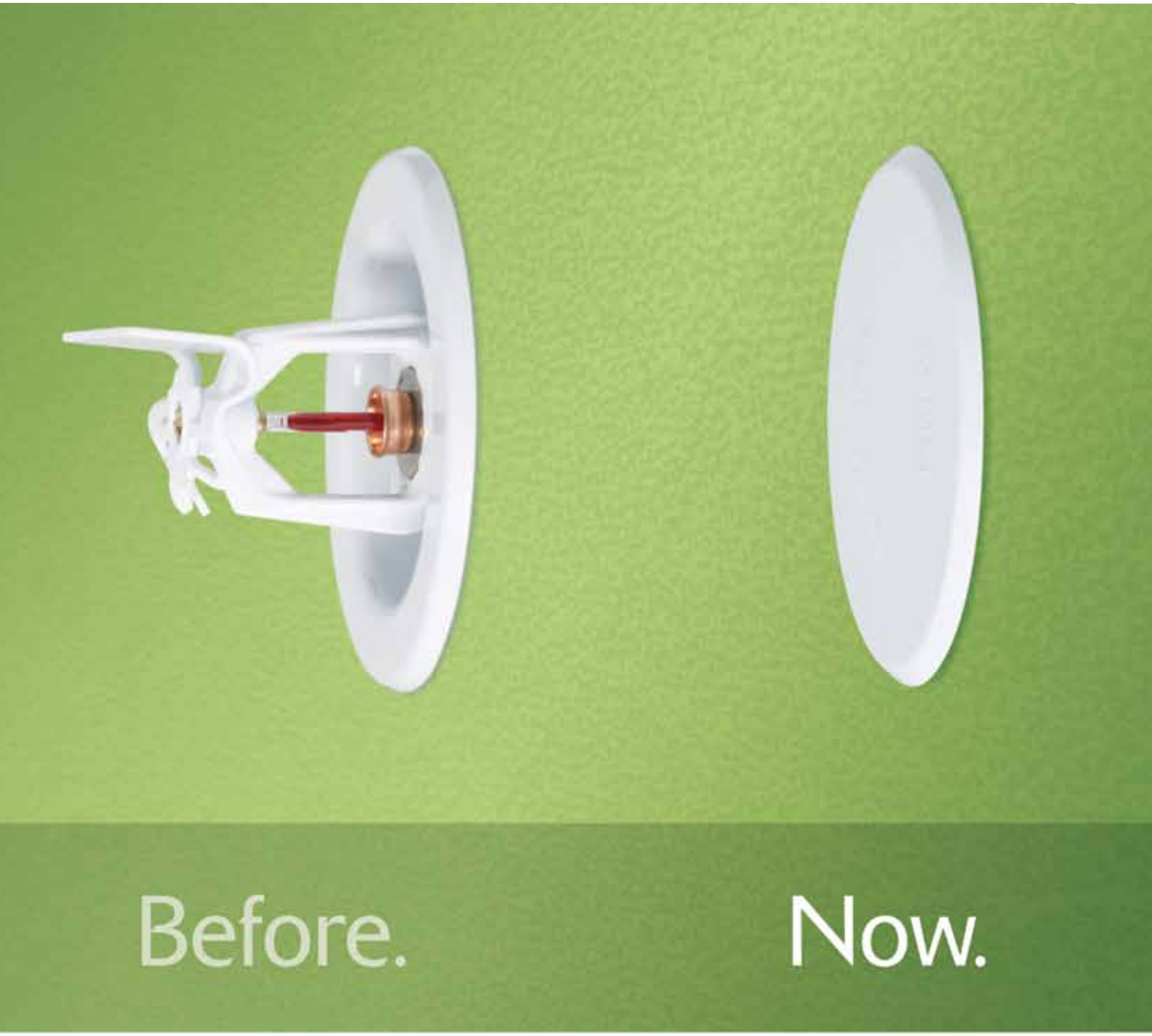

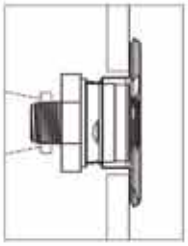

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