Performance Based Design and Fire Safety Engineering in Australia

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Introduction

In the period in Australia up until 1997, fire safety design had largely been based on compliance with the prescriptive or Deemed-To-Satisfy (DTS) requirements of the Building Code of Australia (BCA)[1], although for a limited number of projects a form of performance based design was undertaken through a process of variations or modifications to the DTS provisions for each specific project.

However, from the end of the 1980s, fire safety design and engineering in Australia started to change in an international era when there was a growing interest in performance based building codes as part of government micro-economic reform agendas.

Developments in Australia, summarized for a New Zealand conference [2], included:

- The Warren Centre project (1989), which suggested a risk and engineering based approach to fire safety design should be adopted to allow more cost effective design
- The establishment of the not-for-profit Fire Code Reform Centre (FCRC) in 1994, co-ordinating fire research in support of a performance based BCA and use of risk assessment for fire engineering analysis
- The creation of the Australian Building Codes Board (ABCB) to develop the first performance based BCA which was published in 1996
- The adoption of BCA 96 into legislation in all states and territories in Australia in 1997
- The parallel introduction of private certification for building approvals in the building regulations of some states of Australia, also in 1997.

This was a period of excitement and strong interest in fire research, new fire safety engineering firms established, and education courses for fire safety engineers established at University of Western Sydney (UWS) and Queensland University of Technology (QUT), following an earlier established course at Victoria University (VU) in 1992/3.
From the end of the 1990s until the present time, fire safety engineering has been practiced widely in Australia, and many wonderful performance-based buildings have been designed in this period. However, some would argue that professional practice standards have failed to advance and fire research has almost disappeared in Australia. Others would argue on some fire safety matters, things have not only failed to develop further but may even have gone backwards. Equally, there have been developments internationally in fire safety engineering, such as verification methods and some use of risk assessments methods, which have largely bypassed Australia to date.

This paper looks at how performance based design practice and fire safety engineering has progressed (or not) in Australia over the past 15 years, as well as other related fire safety and industry issues which have an overall impact of fire and life safety outcomes.

There is also a look ahead to the future in Australia and what changes may occur in the next decade if some tentative initiatives in research and professional practice are brought to fruition.

**Fire Safety Engineering - Last 15 Years**

This period of performance based design and fire safety engineering up until the present time may be characterized as some form of progress through the following developments:

- The very tightly prescriptive DTS provisions of the BCA have encouraged widespread development of fire engineered designs with a number of Alternative Solutions for all occupancy types of buildings across Australia.
- Full use of the performance based provisions of the BCA has resulted in the design of some great buildings such as:
  - Federation Square and the NAB Building in Melbourne,
  - 1 Bligh Street and 1 Shelley Street in Sydney,
  - 111 Eagle Street in Brisbane, and
  - Many others Australian designed international projects such as the Beijing Aquatic Centre (Water Cube).
- A wide range of fire safety engineering professional practice firms have developed across Australia, some practicing internationally.
- Widespread use of fire engineering tools such as Fire Dynamics Simulator (FDS), STEPS and other egress models, and some structural fire performance analysis.
- A well regarded Society of Fire Safety (SFS) has been established within Engineers Australia as a learned society of professional practitioners and others interested in fire safety engineering.
- The SFS has developed a Code of Practice for Fire Safety Design [3] to help set professional practice standards, and there is wide use of the International Fire Engineering Guidelines (IFEG) [4] as the process document to be used in projects.
- Performance based designs of road tunnels has been undertaken, and use made of scenario driven risk assessment methodologies which were incorporated in the new performance based AS4825 Fire Safety in Tunnels published in 2011 [5].
- The rate of fire deaths and levels of property damage across Australia has continued to trend down over the past 15 to 20 years.[6]
Professional Concerns

However, there are features of the fire safety design and construction landscape in Australia which some would argue have not been so positive. While some major policy makers would contend that the performance based era and private certification of buildings has increased construction efficiency, reduced approval times, and made buildings more cost effective to build and operate, some issues have started to emerge which are of concern to the fire safety engineering community. These issues include:

- Private certifiers involved in building design and identification of Alternative Solutions, including for fire safety, and also approval of the same projects, leading to significant and serious conflicts of interest. This seems to occur with some practitioners and more in some states of Australia than others.
- Resultant concerns with issues associated with certifier performance and practices, leading to a major review of certifier practice in Queensland [7], and a major Auditor –General’s report highlighting poor certification practices in Victoria [8].
- Standards in education of fire safety engineers at VU and UWS which now appear to be well short of world’s best practice, in part possibly due to low entry level requirements. The QUT course has been dis-continued.
- Some states and territories still having no registration or accreditation of fire safety engineers.
- A mix of registered fire safety engineers practicing who have National Professional Engineering Registration (NPER), Institution of Fire Engineers (IFE) C.Eng qualification, state based Registered Building Practitioner (RBP) registration, or equivalent with different levels of real fire engineering skills required.
- A BCA with Performance Requirements which are not measureable, and still use terms such as fire safety provisions required “to the degree necessary”.
- Little significant use of quantitative risk assessment to justify fire engineered designs in buildings.
- Little if any proper audit and enforcement of FSE practices by regulators or professional associations in performance based fire engineering design or professional practice.

One area of concern emerging for fire safety engineers in terms of the profession in Australia and other countries is the issue of professional liability for fire safety design work. Enright [9] has highlighted one aspect of this in a recent paper, where he addresses the responsibility, and liability, of fire safety design practitioners under the Building Acts and Regulations on the one hand, and the Safety by Design legislation under the various Occupational Health and Safety (OH&S) Acts. It is only very recently that many fire safety engineers in Australia have even acknowledged that they understand the safety by design OH&S implications and responsibility they have for fire protection design during construction and/or occupied buildings. It may take some future legal cases, which have perhaps yet to emerge, to change professional practice to ensure it is a matter included in all fire safety strategies.
Another liability issue raised in the UK but perhaps with implications in Australia is the view that if the fire safety design has been approved by the certifier for construction, inspections and commissioning have been conducted by or on behalf of the certifier, and an occupancy certificate has been issued, then the fire safety engineer has no responsibility for the design. A very recent paper in the UK by Bullock and Monaghan [10] highlights the fact that, at least in that country, fire safety engineers cannot transfer all the liability to others. Again, at this stage in Australia, there have not been sufficient legal precedents to show the extent of legal liability retained by fire safety engineers.

Other Fire Protection and Industry Concerns

At the same time there are other issues which, while not directly influenced by fire safety engineering, ultimately may potentially have an impact on loss of life, increased property damage loss, or business interruption or lead to political responses or regulatory change. These include:

- Some major fires and life losses in buildings largely designed to DTS provisions, not necessarily those with Alternative Solutions and fire engineered design solutions
- Design of sprinkler and detection systems by fire practitioners with no recognized qualifications or proper supervised experience.
- Major problems with changes in fire safety measures between design and final construction, without proper scrutiny due to a lack of good quality inspections and a reluctance to involve fire safety engineers in commissioning and final inspections. This situation is now evident in some recent legal cases
- Inadequate maintenance of fire safety measures, with no clear national approach, changes to the national standard AS1851 on maintenance [11], and differing levels of state and territory adoption
- A conflict remaining in relation to property protection between the fire safety objectives of the BCA, which are life, other property and provision of facilities for fire-fighting, and the legislation in relation to the responsibilities of the Fire Brigades to protect life, property and the environment – this continues to cause approval issues and delays for building projects.
- Fire brigades being mostly referral agencies, not approval authorities, but with considerable financial and resource pressures, especially in recent times, creating resultant delays in projects. At times these issues have been linked to a lack of highly competent staff, high fees for review, and/or other issues, which has raised questions about their future role in building regulation.

One bright prospect for current and future practice is the role being played by an ever growing and effective Fire Protection Association, Australia (FPA Australia). This national organization and peak body for fire safety matters in Australia has taken the following actions in recent times:

- Pressed all states and territories to adopt the latest AS1851 standard of fire protection maintenance, with recent successes in adoption in major states like Queensland
• Significantly increased the training opportunities and access to courses and assessments for a wide range of trade and industry practitioners
• Introduced the national Fire Protection Accreditation System (FPAS) scheme [12], initially for inspect and test (maintenance) personnel, but ultimately for all trade and industry practitioners up to engineering degree level, including detection and sprinkler systems designers, to ensure appropriate qualifications and competence
• Created a national register of bushfire planning consultants who have met qualification and accreditation requirements
• Assisted the state of Victoria in the development of a whole new building act and regulations, as well as practitioner registration bodies

This will help to increase the likelihood that the fire safety measures recommended by fire safety engineers as part of fire safety strategies for building and infrastructure projects are likely to given proper detailed design and specification, proper commissioning, and robust maintenance.

The Future
There are some factors which potentially are coming together which might signal a rejuvenation of fire research, and new approaches to regulation, fire safety design and approvals.

Some of these issues or potential changes which are now being considered include:
• The investment boom in mining in Australia appears over and governments are looking to the construction industry to take some of the investment growth
• There is a belief by some that construction investment can be increased substantially by more performance based design and quantification of performance not just for fire safety but all health and safety performance requirements for buildings
• Making the Performance Requirements measurable and being able to quantify overall fire safety is thought to be a longer term goal, quantifying safety using F-N risk curves to address individual and societal risk levels tolerable to the Australian community for all health and safety measures in the BCA, including fire safety measures
• In the short term, an ABCB project is underway to develop a Verification Method (VM) to “quantify” performance in some form. This VM is likely to be similar to the NZ one [13], but needs to be developed specifically to match the BCA, needs to be tested and verified against the BCA DTS requirements, needs to be based on Australian data, needs to consider other international practice, and should only be used by accredited fire safety engineers.

This approach is consistent with the emerging trend to contemplate or use risk assessment procedures to evaluate a range of health and safety aspects of buildings. This is highlighted in a paper by Raw et al [14] where they have developed a risk evaluation procedure to allow consistent comparison of all health and safety hazards in buildings.
In a related manner, Meacham [15] has undertaken much research and acted as advisor to regulatory bodies internationally on the issues of risk informed, performance based approach to building regulation. He has highlighted that a range of countries have utilized risk informed criteria, such as return periods, for levels of damage from sustained wind speeds, seismic events and floods.

He has highlighted two important considerations should this risk informed approach be considered for regulation, namely:

- There needs to be a better connection between tolerable risk, performance expectations and design criteria, and similarly
- A strong linkage between quantified performance levels and performance criteria on the one hand, and societal expectations in terms of risk mitigation measures and building performance outcomes on the other hand.

This suggests that there now needs to be a major collaborative research program in Australia, which is linked to similar international efforts, to develop this risk informed process for building regulation for fire safety and other health and safety measures as appropriate. This program and its related activities need to include the following:

- Methodologies need to be developed and agreed for fire quantitative risk assessment (QRA), and a comprehensive national database needs to be developed. The QRA approach was started but not finished at the time of the Fire Code Reform Centre (FCRC), and that work might form the basis for further development
- These methodologies need to be able to link the frequency of fire incidents and rates of failure of fire safety measures and fire protection systems to known fatality and injury rates in a realistic fashion
- Education of fire safety engineers in Australia will need to be lifted to best international practice standards if the full benefits of quantified Performance Requirements and QRA techniques are to be effectively utilized to bring the national construction industry benefits envisaged.
- A full and proper accreditation process will need to be developed for fire safety engineers in Australia that reflects world’s best practice in a form that can be adopted by all states and territories to ensure the quality of fire engineering practice.

Conclusions

Australia has seen a great deal of performance based design of buildings using fire safety engineering over the past 15 years. Many excellent buildings have been designed, and many policy makers would claim that we have created a more cost effective building design and construction industry. The fire statistics continue to show a trend towards reducing loss of life and property.
Others would suggest that there are significant industry concerns, fire research has fallen away, and professional practice and education has not kept pace with international developments, and new initiatives are needed.

This could be an exciting time for fire safety if the research, regulatory and professional practice opportunities outlines in this paper are realized. Organizations like SFS/EA, FPA Australia, Fire Brigades, universities, Property Council of Australia (PCA) along with the ABCB could be major contributors to these changes. Links to other global developments and international best practice would only enhance these developments.

Another Warren Centre project or another FCRC type organization may be one way to organize co-ordinated national action and galvanize interest and enthusiasm across the construction industry.

References


[4] IFEG (2005), International Fire Engineering Guidelines; DBH, NZ; ABCB, Australia; NRC, Canada; ICE, USA.


[15] Meacham, Brian J., Risk-Informed Performance-Based Approach to Building Regulation, 7th International Conference on Performance-Based Codes and Fire Safety Design Methods, SFPE, Bethesda, MD, USA