The Impact of Fire Safety Engineering and Performance Based Regulations on the Approval Process for Fire Safety in Buildings

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ABSTRACT

Building regulations are in a state of transition, from a traditionally prescriptive approach, to performance based regulations. Fire regulations for buildings are still predominantly prescriptively applied but there is an international move to performance based design and regulation. The use of performance regulations will mean that the regulatory authorities will need to come to terms with a new way of assessing the suitability of proposals for approval. As a result of research involving a literature review and interviews with approval authorities in Australia and internationally, issues relating to the use of fire engineering, performance based regulations and computer models are raised and explored. Implications for the approval authorities include the need for appropriate expertise of the approval authorities, lack of data, performance levels and verification methods, providing faster and cheaper approvals, science setting the level of fire safety and litigation. One of the principle objectives in undertaking research into fire is to improve the fire safety provisions in building regulations. There are problems in relation to the transition of fire research outcomes into the building regulations.

KEY WORDS

Performance based regulations, prescriptive regulations, fire engineering, computer models, fire safety, building regulations, approval authorities.

INTRODUCTION

The present trend towards performance based regulations and standards in building codes will impac upon the way that approval authorities assess building design. This will have special significance i relation to building regulations pertaining to fire protection.

This paper focuses upon issues that effect the approval authorities in the transition of the use o traditional prescriptive fire regulations to performance based fire regulations.

The use of performance based fire regulations will require the approval authorities to rethink th method by which new and alternative designs are assessed. These designs often involve the use of fir engineering and computer modelling techniques and are a radical departure from designs based o prescriptive requirements.

Most building codes require a design to be independently assessed to ensure that the proposal complie with the community's expectations for a safe building. These expectations are expressed through th building regulations. Assessment of fire regulations is usually undertaken either by a building regulator authority or a fire authority. This procedure varies from country to country and often from jurisdictio to jurisdiction within that country.

It is not the purpose of this paper to suggest which authorities should, or should not, play a part in th building approval process. For that reason the paper will not differentiate between the parties but us the generic term of "approval authorities" to encompass all parties whose role involves approval of fir regulations.

PRESCRIPTIVE REGULATIONS

Prescriptive regulations, also known as "deem to satisfy" regulations, dictate what solutions are to b undertaken to ensure that a building design complies with the regulations. Another definition would b that they establish specific acceptable solutions or limits that cannot be exceeded (S and S Consultant 1991).

For example, in the prescriptive provisions of the Building Code of Australia (1996), any building ove 25 metres in height is considered to be a serious fire risk and a fire sprinkler system must be installec No alternative is permitted. The provision then stipulates what sprinkler system is to be installed and t what specification e.g. location of heads, water pressure and flows etc.

Prescriptive regulations are based on traditional construction techniques, good practice, conventior controlled fire test results, experience and observations noted from real fires. To date they appear t have served the community well.

The main advantage of prescriptive regulations are that they are relatively easy to understand an comply with. Little interpretation is necessary, training in using them is straight forward and the minimise litigation in that compliance with the regulation protects both the designer and the approva authority. The approval process for prescriptive regulations are efficient in a bureaucratic sense, an rapid. This point is referred to by Brandie (1990) in a report to the Cullen Inquiry into the Piper Alph (off shore oil installation) disaster

"... it tends to be the case that it is technically 'easier' to have such standard designs approved by th authorities than would be the case if the 'non-standard' approach was taken.

The alternative non-standard approach, being at this time somewhat unconventional, would require to be carefully guided through the regulatory authorities."

This is also the case with fire regulations for the building industry, and has led to a "crutch mentality" in that building designers prefer the use of the prescriptive building codes because they are easier to understand and get approval (Corbett 1991)

On the other hand, use of prescriptive fire regulations have been criticised in that they are too restrictive to innovative design and are judged to be incomplete, inefficient, inconsistent and unduly expensive (Building Regulation Review Task Force 1991).

PERFORMANCE BASED REGULATIONS AND FIRE ENGINEERING.

Performance based regulations are being offered as the alternative format for fire regulations. Performance based regulations establish criteria designed to ensure achievement of the regulatory objectives without compulsory prescription of a specific solution (S and S Consultants, 1991).

Recent advances in fire engineering have meant that there are now the methods and expertise to use performance based regulations. "Fire Safety Engineering" means using engineering principles for evaluating fire hazards and the design of fire protection measures (Pedersen 1992).

The interest in performance based fire regulations has coincided with the advances in fire engineering. The major advance in fire engineering has been the development of computer models for determining the behaviour of fire in a building.

In spite of the complexity of fire behaviour, the intricate mathematical routines involved and the intensification of research data the enhanced capabilities of personal computers over the last twenty years has meant that there is now a medium by which fire behaviour predictions can be relatively quickly and reliably made (Quaglia 1992).

FIRE ENGINEERING.

Defining the term "fire engineering" is a difficult process. The term means different things to different people. *"The definition causes difficulty because the subject nature of the fire safety engineering draws in very many academic and practical pursuits."* (Galea 1996).

An example of the varying definitions is provided by Deakin (1994):

> *The application of engineering principles, rules and expert judgement based on a scientific appreciation of the fire phenomena, the effects of fire, and of the reaction and behaviour of people, in order to:*
>
> - *save life, property and preserve the environment and heritage*
> - *quantify the hazards and risk of fire and its effects*
> - *evaluate analytically the optimum protection and preservation measures necessary to limit, within defined levels, the consequences of fire.*

Another definition was provided by Peter Johnson of Ove Arup Australia in a private communication in 1994:

> *Fire engineering is the application of fire science in a performance based approach that addresses fire safety as a total design package*

One of the most comprehensive definitions was provided by Professor Ed Galea of the University of Greenwich (UK) in 1996:

> *Fire safety engineering draws together practical expertise in the form of experience, management skills, judgement and sociological awareness and an equal measure of mathematical modelling in the form of architecture, engineering, physics etc. However, the main thrust of fire safety engineering is the development of work practices and physical environment which results in efficient life and property safety. To do this the fire safety engineer must assess risk and balance the pro's, con's and costs of alternative fire safety strategies.*

This difficulty also extends to the term "Fire Engineer". The issue of who is a fire engineer is not within the parameters of this paper, but is in itself an important issue.

THE ROLE OF THE APPROVAL AUTHORITIES.

A great deal of work is being undertaken from the engineering and technical aspects of fire safety in buildings with much work and discussion around the fire modelling data, fire testing data and the use of computers for fire modelling. Discussion in relation to the implementation and administration of performance based fire regulations is not as prevalent. In discussions that have taken place there is a concern that, whilst there are many barriers to the introduction of performance based fire regulations, the main barrier is the acceptance of this new technology by the approval authorities. Those involved in the process consider that this is a major cause for concern and that not enough attention has been given to the administration of these regulations. (Grubits, 1992; Law, 1991; Corbett,1991).

Recent research addressed two major questions (Clampett, 1997):

Do the approval authorities have the skills and knowledge to assess designs involving this new technology? If they do not, then what would be the most appropriate method for the approval authorities to gain the expertise required?

Historical and background aspects of the research were based on a literature survey. The background to the Australian situation was also based on literature survey, augmented by personal interviews.

International interviews were undertaken in countries that already have performance based building codes to reveal whether or not issues or problems, outside those revealed in the literature, arise in the practical implementation of performance based fire safety regulations.

The major issues identified and selected for further exploration were:

- Lack of data.
- Performance levels and verification methods.
- Performance based building regulations providing faster and cheaper approvals.
- Litigation.
- Science setting the standard of fire safety.
- Expertise of the approval authority.

From the more detailed exploration, it has been possible to draw conclusions about each issue.

Lack of data.

There is no doubt that fire safety engineering requires more research, data collection and collation. Opinion is divided over whether or not this lack of data should restrict the use of fire safety engineering for performance based design of fire safety systems for buildings. This division of opinion has not restricted the use of fire safety engineering for performance based design of fire safety systems for buildings in Australia nor internationally.

Approval authorities incur the responsibility of being satisfied with the suitability of the use of data and related computer models when assessing performance based fire safety system designs.

Performance levels and verification methods.

The lack of performance levels and verification methods expressed in performance based building codes makes the role of the approval authorities very difficult. What is the appropriate level of safety? What is the benchmark?. What will meet the approval criteria? All of the approval authorities interviewed, in Australia and internationally, believe that the provision of performance levels and verification methods are a fundamental and essential part of a performance based building code.

The lack of performance levels and verification methods means that without a benchmark, an approval authority must make a subjective judgement in deciding if a performance based design meets an acceptable level of safety.

Without a benchmark, an approval authority officer will require a high level of expertise in fire safety engineering design in order to make that subjective judgement.

Performance based building regulations provide faster and cheaper building approvals.

This is cited as one of the advantages of performance based building regulations. But from the literature review, and the interviews, there has been no support amongst approval authorities for this contention. The use of performance based building regulations will require the assessment of fire engineered fire safety systems. This will involve the assessment of often technical and complex information which, coupled with the lack of approval benchmarks and the need for precise documentation of the approval decision (for litigation purposes) will mean that the approval process for performance based designs will not be faster, will require more resources and therefore will not be cheaper.

Moreover, this claim does not take into account the time, cost and resources required for approval authorities to gain the additional required expertise.

Litigation.

Assessment conducted under a performance based building code will require an approval authority to exercise judgement and subjectivity. This will place the approval authority at risk of litigation.

In Australia, where performance based fire regulations have only just been invoked, it is not possible to make an assessment of how real this threat is. Opinion about the risk varies. American authorities perceive it a real threat, while the Europeans are waiting for it to be tested in a court.

Australian approval authorities perceive it as a real threat and believe that it will curtail the use of performance requirements, and thus ensure a conservative approach to approvals.

Increased expertise by approval authority staff will address the threat of litigation to some degree but it is not possible to say to what extent this can be achieved.

Science setting the standard of fire safety.

If an approval authority does not have the expertise to assess a performance based design, then the role may fall to an expert organisation that does have the expertise.

If the approval of performance based fire safety regulations passes to an expert organisation that does not have the statutory responsibility, this may mean that the protection of the fire safety expectations of the community is not being seen to be undertaken. The role is perceived by the public to be the responsibility of the authority normally concerned with fire safety.

Approval authorities must increase their expertise to ensure that they are included in the building approval process, not only to protect their own roles, but also to meet the expectations of the community.

Expertise.

The consensus view of the interviewees was that, to cope with the introduction of performance based fire regulations and the use of fire safety engineering approval authorities must increase their expertise in fire safety engineering. This can be achieved by obtaining the expertise from outside the organisation through use of expert consultants; or increasing their own expertise by employing experts or training existing staff.

The implications of these options can undermine the regulatory role of an approval authority, place a burden on its resources, and be at odds with traditional staffing practices.

Defining what expertise is required is a fundamental issue that must be addressed by approval authorities. At the very least, all approval authority staff should undertake a short course or training in the principles of performance based regulations and fire safety engineering. It is important that the approval authorities recognise that the assessment of performance based designs is a radical change from the assessment of prescriptive based designs.

The use of performance based fire regulations and fire safety engineering will also impact on the inspection and enforcement role of the approval authorities. The inspection of fire safety systems designed to engineering principles will require more expertise than the inspection of traditional conventional systems required by prescriptive provisions.

Given the relatively new concept of performance based fire regulations and the dynamic nature of fire safety engineering, approval authorities undertaking assessments should have the services of qualified fire safety engineers.

This would require the availability of suitable tertiary level education in fire safety engineering. In Australia this is a significant problem. The lack of these courses (and the lack of courses available through distance learning) restricts the opportunity for approval authority staff to increase their expertise.

Whilst an obvious solution would be to increase the availability of fire safety engineering courses, there is already a lack of interest in attending such courses. There is evidence, both in Australia and internationally, that support and attendance at these courses wane as demand is satisfied. This raised resource problems for the education providers..

Approval authorities are generally being reactive and not pro-active. They are waiting for performance based regulations to be implemented before taking any action to address the issue of expertise..

RESEARCH TO REGULATION.

A fundamental reason for undertaking fire research is to enable fire regulations to be updated and more accurately address the effects of fire. The transition of fire research into regulation use is not an easy and straightforward path.

Once the research outcomes are completed, it is the role of the regulator to incorporate the outcomes into the regulations. This is hampered by many problems, among them are: outcomes presented in non user friendly format (e.g. technical jargon or too scientific in its presentation); differing expert opinion of the research outcomes; research incomplete or not able to reach a conclusion; industry bodies adversely effected by the research; political agendas; lack of understanding of regulators of research principles and realities; and frustration by researchers of often slow regulatory change processes.

CONCLUSIONS.

A number of conclusions can be made with respect to the issues addressed in this paper.

- *Lack of data.*

Research into fire safety engineering should consider the role of the approval authorities, by developing more user friendly systems. Approval authorities should also take a more pro-active approach to fire safety engineering research.

- *Performance levels and verification methods.*

A priority of the fire safety engineering and building regulatory community should be the formulation of performance levels and verification methods for performance based building regulations.

- *Performance based building regulations provide faster and cheaper approvals.*

Approval authorities should generate information which will permit comparative research into the relative effectiveness of building approval under both performance and prescriptive regulations.

- *Litigation.*

The incidence of litigation arising from performance based fire safety system approvals should be carefully monitored.

- *Science setting the standard of fire safety.*

The role of expert consultants, in assessing performance based designs, should be clarified in relation to any limitations of their role and the legal status of their advice.

Approval authorities should consider to what extent their approval role is under threat by referring to an expert organisation, designs for assessment or advice.

- *Expertise of the approval authority.*

To cope with the implementation of performance based fire regulations and the use of fire safety engineering design techniques, approval authorities must increase their expertise in fire safety engineering. Defining what expertise is required is a priority that must be addressed by the approval authorities.

- *Research to regulation*

If fire research is to have a beneficial effect on building regulations, the transition of research to regulation needs to be planned, communicated and presented in a manner that will enable the transition to be smooth and efficient.

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