APPROPRIATE, ACCEPTABLE OR ADEQUATE:

HOW MUCH IS ENOUGH?

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ABSTRACT

The views expressed in this paper are those of the author and are not necessarily those of the New Zealand Fire Service or of the New Zealand Department of Building and Housing.

BACKGROUND

Performance-based building codes have been introduced around the world since the mid-1980's with the view of promoting innovation and driving down costs in construction. Though the legal frameworks in the various countries where such codes have been introduced differ, the basic principles are essentially the same. In contrast to earlier building code regimes, alternative methods of complying with codes are possible subject to the building complying with a set of performance requirements determined by the appropriate regulator. Typically these performance requirements are not quantitative and make use of words such as appropriate, adequate, to the degree necessary, sufficient and so forth. For the most part calculation methods to comply with the performance requirements are not provided. The designer, peer reviewer and the authority having jurisdiction must interpret the meanings of these words in each and every case. Their views may differ. This process generates uncertainties for the regulator (and therefore the public) around exactly how much safety has been incorporated into buildings, and uncertainty for the designer in that there is the potential for inconsistencies between different peer reviewers and authorities interpreting the same code.

When the New Zealand Building Act was redrafted in 2004, a requirement was placed upon the regulator, in this case the New Zealand Department of Building and Housing, to develop a measurable building code that removed these uncertainties and allowed the regulator to determine unequivocally for designers and building code officials the level of safety required in buildings. This paper describes some of the thinking that has been undertaken in order to deliver the fire safety performance clauses of the New Zealand Building Code in this form.

KEY CONCEPTS

The Department of Building and Housing set up a series of small teams to address the challenges of developing measurable performance clauses. The fire team consisted of four or five fire engineers with research, consultancy, firefighting and regulatory experience supported by Department of

Building and Housing officials and policy analysts. Their job was to develop the performance clauses, and an associated framework for the assessment of buildings for compliance with the Building Code.

The objectives of the Building Act are to limit the probability that, as a result of the design, construction, use or demolition of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury, risk of illness or loss of wellbeing. The purpose of the Building Code is to establish what unacceptable loss of these attributes would amount to, by means of a set of functional requirements. For fire these mean that buildings must incorporate features that must limit the risk (amongst other things):

- of an accidental fire or explosion occurring
- of fire or explosion impacting areas beyond its point of origin
- of people being delayed from moving to a place of safety during a fire or other emergency
- of injury to firefighters or other emergency services personnel during evacuation and firefighting operations
- of adverse effects to other property

In developing performance requirements the key principle applied was that they should be evidence-based and risk-informed. Account was taken of the likelihood of undesirable events occurring and their consequences, using factual data wherever possible to underpin them. Where factual evidence was lacking or unreliable, research work was commissioned, and residual uncertainty about risk was treated in a precautionary way.

DESIGN FIRES

In meeting the above requirements to limit risk, the key challenge, and the one where there is great potential for variability between designers, is the determination of the design fire and assumptions around it. The Regulator took the view that design fires should be determined within the Code, in a manner analogous to structural, earthquake and wind loads, as representative of the threat to the building that must be resisted by its design. In other words, under the new framework designers would not be free to develop their own design fires. Nine fire scenarios have been identified for use in the conceptual framework based on NFPA 5000 approach. The scenarios selected are similar to, but not exactly the same as, those in NFPA 5000. The design fire scenario in the framework has to be defined in all of its phases, as these will be relevant to different parts of the design process, such as detection, occupant escape and structural collapse. In any given building, the framework requires most of the design fire scenarios to be addressed, but some elements of the analysis can be avoided: for example, introducing smoke detection into the design for sleeping accommodation avoids the need to address the smouldering fire scenario.

The design fire has to be specified not only in terms of heat release rate over time, but also in terms of production of toxic species and soot so that the effect on occupants escaping can be assessed. The key attributes of people's behaviour in building fires including reaction and movement times also have to become part of the fire scenario.

ACCEPTANCE CRITERIA

The framework does not determine the methods that should or must be used to assess a design based on the design fire scenarios and occupant characteristics. In a measurable Building Code it is, however, necessary to define the acceptance criteria that would enable a designer to show that the performance requirements have been met. These criteria would include acceptable exposure of people escaping to heat, low visibility and toxic gases.

PERFORMANCE GROUPS

The functional requirements above are framed around limiting the risk of undesirable outcomes, not removing the risk altogether. In that context it is recognised that some buildings will be damaged in some events, but that the amount of damage expected, or tolerated, is related to the size or probability of the event. It is also clear that society expects some buildings to perform better than others, and tolerates less impact. For example, it may be tolerable for a large warehouse to collapse in a serious fire, but we would expect a hospital to remain operational. So the response of the building to the design fires outlined above may be different depending on the nature of the building. The regulator has therefore formalised this approach by allocating buildings into 'performance groups' and stating the tolerable outcomes of a serious event for each group.

TEST CASE BUILDINGS

In developing the framework for the measurable Building Code, the goal is to deliver buildings that provide the same level of safety that society has come to expect - not more and not less. But prescriptive requirements for Building Code compliance provide the rules for construction: they do not declare the level of safety that is achieved. Therefore the framework has to be benchmarked against buildings known to be compliant. The team selected a set of 12 buildings that complied with the Code and tested the fire framework against them. These included assembly, commercial and residential occupancies. The precautionary approach adopted in areas where research data was lacking resulted in the framework failing to show that many of these building types were compliant. Some supplementary research work was undertaken to clarify the issues. Work continues to establish where the framework can be improved..

CONCLUSION

The framework being considered for performance-based fire design would change the way we design for fire safety, but it would not necessarily alter the way we build.

Stating performance requirements, design fire characteristics and fire scenarios would provide a mechanism to exercise control over the level of fire safety that must be achieved in buildings. All fire designers would have the information to help achieve a uniform approach and greater consistency of safety levels across the entire fire engineering industry.