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Review of Performance-Based Fire Safety Regulations in Selected Countries: Australia

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List of Acronyms

Acronym	Definition
ABCB	Australian Building Codes Board
BCA	Building Code of Australia
BCC	Building Codes Committee
BMF	Building Ministers' Forum
CCBFC	Canadian Commission on Building and Fire Codes
CIE	Centre for International Economics
COAG	Council of Australian Government
CPD	Continuing Professional Development
DTS	Deemed-to-Satisfy
DBH	Department of Building and Housing
FDS	Fire Dynamics Simulator
FPAS	Fire Protection Accreditation System
FPA	Fire Protection Association, Australia
FSVM	Fire Safety Verification Method
IGA	Intergovernmental agreement
ICC	International Code Council
IFEG	International Fire Engineering Guidelines
MBIE	Ministry of Business, Innovation and Employment
NBC	National Building Code of Canada
NCC	National Construction Code of Australia
NRC	National Research Council Canada
PBC	Performance-Based Code
PCA	Plumbing Code of Australia
SFPE	Society of Fire Protection Engineers
SFS	Society of Fire Safety
VBA	Victorian Building Authority
VM	Verification Method

Definition of Terms

The definitions below were directly taken (in full or in part) from the National Construction Code (NCC) [NCC, 2019].

Amenity: an attribute which contributes to the health, physical independence, comfort and well-being of people.

Appropriate Authority: the relevant authority with the statutory responsibility to determine the particular matter (this is similar to the Authority Having Jurisdiction or AHJ in Canada).

Assessment Method: a method that can be used for determining that a Performance Solution or Deemed-to-Satisfy Solution complies with the Performance Requirements.

Available Safe Egress Time (ASET): the time between ignition of a fire and the onset of untenable conditions in a specific part of a building. This is the calculated interval between the time of ignition of a fire and the time at which conditions become such that the occupant is unable to take effective action to escape to a place of safety.

Certificate of Accreditation: a certificate issued by a State or Territory accreditation authority stating that the properties and performance of a building material or method of construction or design fulfil specific requirements of the BCA.

Certificate of Conformity: a certificate issued under the ABCB scheme for products and systems certification stating that the properties and performance of a building material or method of construction or design fulfil specific requirements of the NCC.

Certification Body: a person or organisation operating in the field of material, product, form of construction or design certification that has been accredited by the Joint Accreditation System of Australia and New Zealand (JAZANZ).

Deemed-to-Satisfy Provisions: provisions which are deemed to satisfy the Performance Requirements.

Deemed-to-Satisfy Solution: a method of satisfying the Deemed-to-Satisfy Provisions.

Design Scenario: the specific scenario of which the sequence of events is quantified and a fire safety engineering analysis is conducted against.

Expert Judgement: the judgement of an expert who has the qualifications and experience to determine whether a Performance Solution or Deemed-to-Satisfy Solution complies with the Performance Requirements.

Fire Safety Engineering: application of engineering principles, rules and expert judgement based on a scientific appreciation of the fire phenomenon, often using specific design scenarios, of the effects of fire and of the reaction and behaviour of people.

Fractional Effective Dose (FED): the fraction of the dose (of thermal effects) that would render a person of average susceptibility incapable of escape.

Performance-Based Design Brief (PBDB): the process and the associated report that defines the scope of work for the performance-based fire safety engineering analysis and the technical basis for analysis as agreed by stakeholders.

Performance Requirement: a requirement which states the level of performance which a Performance Solution or Deemed-to-Satisfy Solution must meet.

Performance Solution[1]**:** a method of complying with the Performance Requirements other than by a Deemed-to-Satisfy Solution.

Required Safe Egress Time (RSET): the time required for safe evacuation of occupants to a place of safety prior to the onset of untenable conditions.

Verification Method: a test, inspection, calculation or other method that determines whether a Performance Solution complies with the relevant Performance Requirements

Visibility: the maximum distance at which an object of defined size, brightness and contrast can be seen and recognised.

[1] Used to be called Alternative Solution.

Executive Summary

The idea to move to performance-based or objective-based building regulations started in the 80s, but it is in the 90s and after, that some countries began putting together the structure, frameworks and content of these new regulations. Some of the countries that introduced these regulations include Australia, New Zealand and Canada.

This report summarizes the review of the Australian Building Code, one of the first performance-based building codes implemented in the world, conducted with regards to its fire and life safety provisions, including their development and regulatory framework. The objective of this review is to learn from their successes and experiences.

History of Building Codes in Australia

Up to 1990, Australia did not have a uniform regulation for the States and Territories. In 1992, the Building Code of Australia (BCA), which contained some performance requirements but was mainly a prescriptive model document, was introduced to all States and Territories and adopted as the sole document that controlled the standard of building construction in Australia. However, the restrictive nature of this regulation, led to the ministers of States and Territories pushing for a change and supporting the idea of moving towards a full performance-based building code. This resulted in the establishment of the Australian Building Codes Board (ABCB) in 1994, a Council of Australian Government (COAG) building code writing body, through the signing of an intergovernmental agreement (IGA) by all levels of government. The ABCB was given the responsibility of developing and maintaining the national building code.

In 1996, the ABCB published the first performance-based BCA 96, which was adopted into legislation in all States and Territories in 1997. Then, in 2008, a working group was struck to investigate the potential of a national code that includes other standards such as plumbing and telecommunication in addition to the BCA. In 2011, the codes for building and plumbing were consolidated into a single code by the ABCB and they formed the first National Construction Code (NCC) which incorporated both the BCA (Volumes 1 and 2 of the NCC) and the Plumbing Code of Australia (PCA) (Volume 3 of the NCC). The States and Territories adopted the NCC 2011 in May 2011. In 2012, the ABCB tasked the Centre for International Economics (CIE) to study the benefits of the introduction of the performance-based construction code and to perform an impact analysis on the regulatory reform up to that date. The study found that there was an estimate of a yearly national economic benefit of $1.1 billion because of the regulatory reform introduced since 1992.

Regulatory Framework in Australia

Since Australia is a federated system of States and Territories, the regulatory system adopts a framework that, in general, includes a law, regulations, a building code and other pertinent and related regulations. Following this framework, there are three levels of government with different functions and roles in building regulations. At the National level, the ABCB publishes the NCC/BCA which is essentially a model code and has no legal standing. Under the Australian Constitution, it is at the State or Territory level that the building code requirements in the

NCC/BCA are given legal effect. The legislation in each State and Territory consists of an Act of Parliament (Building Act) and subordinate legislation (Regulations) which give power to the NCC/BCA Performance Requirements, and contains the administrative provisions necessary to give effect to the legislation. In addition, States and Territories use various Building Acts and Regulations that are quite different and often structured differently. The States and Territories have the responsibility to enforce the laws of applying and administering the NCC/BCA.

As an example, in the State of Victoria, the Victorian Building Authority (VBA) regulates the building industry through the governance of the Building Act 1993 and the Building Regulations 2018. The Building Regulations in each State and Territory adopt and implement the technical NCC/BCA. The State and Territory-based Building Regulations set the legal provisions for building approvals, compliance and inspection, professional engineer and tradespersons registration, audits and enforcement, etc. In addition, it is the responsibility of the States and Territories to legislate the general responsibilities and duties of the different people involved in the building process, the verification required before the start of construction, during construction, and at the completion of construction, and the resolution to disputes between applicants for building approval and the building certifiers.

The third level of government is represented by the municipal/local councils who manage planning approvals on a day-to-day basis. In most cases, States and Territories delegate the appropriate authority and power of enforcing the laws to the municipal/local councils, which typically issue compliance certification and approvals of buildings at the design stage and at the completion of construction. However, most States and Territories have private certification, as an option, so that private building certifiers and surveyors can issue the building approvals, and in most States and Territories this is the dominant pathway to building approvals. Private building certifiers are required to be registered in the State and Territory in which they operate.

National Construction Code (NCC)

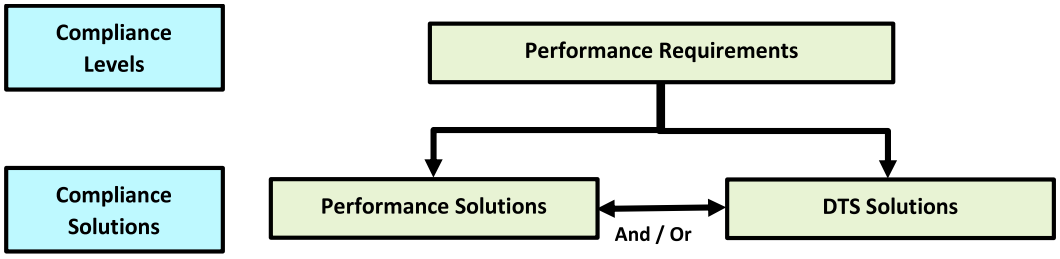
The goal of the NCC is to efficiently achieve nationally consistent objectives. Traditionally, the building regulations in Australia have been focused on health, safety and amenity for building occupants. In terms of fire safety, the objectives relate mainly to life safety of occupants, the prevention of damage to adjacent buildings, and facilities for firefighting. More recently, however, governments and society at large have recognized to use the NCC/BCA, as a means, to extend the objectives in the building regulations to include other important measures such as reducing greenhouse gas emissions, accounting for the impact of climate change, improving accessibility for people with disabilities, and reducing risks to people and buildings resulting from disasters such as bushfires (aka wildfires).

The structure of the NCC/BCA is based on multiple levels within a hierarchy. The performance hierarchy includes: Objectives, Functional Statements, Performance Requirements, and Building Solutions (see Figure 3). Only the Performance Requirements are made mandatory in the NCC/BCA through State and Territory legislation, while the Objectives and Functional Statements simply provide guidance. The NCC/BCA is comprised of the NCC/BCA Volume One, which primarily applies to Class 2 to 9 (multi-residential, commercial, industrial and public)

buildings and structures, and NCC/BCA Volume Two, which primarily applies to Class 1 (residential) and 10 (non-habitable) buildings and structures (e.g., a private garage, carport, shed). The NCC/BCA contains all technical provisions for the design and construction of buildings and other structures. Approximately 60% of the NCC/BCA clauses are related directly or indirectly to fire safety, providing guidance on matters such as fire resistance, compartmentation, access and egress, firefighting equipment, smoke management, emergency lighting, exit signs, warning systems, artificial lighting and construction in bushfire prone areas. In addition, the NCC includes a non-mandatory Guide, developed by the ABCB for building professionals, and used as a reference manual to Volume One specifically. Also, the NCC/BCA directly references many material, equipment, design, installation and performance standards, many of them being Australian Standards. The application of the NCC/BCA to new and existing buildings is under the legislation and responsibility of the States and Territories. And technical changes to the NCC are considered through the use of the Proposal for Change process and all justified proposals are reviewed and considered technically by the ABCB's Building Codes Committee (BCC). The proposed changes are then subjected to a Regulatory Impact Assessment process before they get accepted or rejected by the BCC.

Compliance with the NCC

In terms of compliance, the NCC/BCA allows for the mandatory Performance Requirements to be met via a Deemed-to-Satisfy (DTS) Solution (prescriptive requirements), a Performance Solution, or a combination of the two solutions (see figure below). It should be mentioned that a Performance Solution is typically unique and particular to each building situation that is being investigated. These types of solutions often allow more flexibility in achieving the appropriate outcomes, encourage the use of innovation in the design and technology, and a user is not obliged to adopt any particular material, component, design factor or construction method. A Performance Solution directly addresses the Performance Requirements by using various Assessment Methods made available in the NCC in order to demonstrate that all the Performance Requirements have been satisfied. These methods include: Verification Methods (VM); Comparison with the DTS Provisions; Expert Judgement; Evidence of Suitability. For the comparison with the DTS Provisions, the compliance should demonstrate that a Performance Solution for a building is better than, or at minimum equivalent to, the DTS Provisions, in order to be deemed to meet the relevant Performance Requirements. In addition, the ABCB has developed a document that can be used to guide the process for the development and justification of Performance Solutions as outlined in the NCC. ABCB has also published and called up in the NCC/BCA a new Fire Safety Verification Method (FSVM) which sets out key design fire scenarios to be evaluated as part of a fire safety engineering report.



Performance Criteria Used and Needed

Currently, the regulation in Australia does not have true quantitative performance criteria and the Performance Requirements set some descriptive or qualitative "criteria", which must be evaluated using the term "to the degree necessary". The ABCB continues to look into ways to develop some form of quantifiable performance criteria and as a longer-term strategy, the ABCB has been looking to consider introducing risk-based performance metrics as the criteria for satisfying the NCC/BCA Performance Requirements for fire safety.

Tools Used by and Education of Practitioners

Fire safety engineers and practitioners in Australia use existing and available tools and resources to assess Performance Requirements using Performance Solutions. These tools and resources include known existing handbooks (e.g., SFPE Handbook) and models (e.g., Fire Dynamics Simulator (FDS)). As well, traditionally, the approach in practice has been for fire safety engineers to use the International Fire Engineering Guidelines (2005), which was produced through an international collaborative effort between the NRC (Canada), International Code Council (USA), Ministry of Business, Innovation and Employment[2] (New Zealand) and ABCB (Australia).

Education is important for the adequate application of the NCC/BCA. An Inquiry by the Building Ministers' Forum (BMF) on the assessment of the effectiveness of compliance and enforcement systems for the building and construction industry in Australia, led the ABCB to develop/deliver a set of Continuing Professional Development (CPD) courses. This initiative was a collaboration with industry, government and subject matter experts, and the CPD courses started to be offered online in 2020. The courses are for building practitioners and address the common challenges experienced with the NCC/BCA and its requirements. In addition, the States and Territories are the ones that regulate practitioners, and each jurisdiction has followed its own approach on how engineers and designers should be regulated to practice in the building industry. Some have mandated the practices while other do not require any accreditation, registration or licensing.

Positive and Negative Impacts of Performance-based Codes

The performance-based code has been in Australia for over 20 years and Performance Solutions have become the norm in developing fire engineered designs. While some would argue that the transition to performance-based fire safety has been a major success, others believe that things have not been so positive. On the positive side, the following can be stated for the current state of this evolving process:

[2] Formerly the Department of Building and Housing (DBH).

- Fire records have generally improved with steady decline in the rate of fire deaths and levels of property damage.
- Designs of some innovative and spectacular buildings have been developed.
- The establishment of a number of fire safety engineering professional practice firms.
- The establishment of the Society of Fire Safety (SFS) within Engineers Australia.
- The development of a Code of Practice for Fire Safety Design by the SFS.
- The introduction of professional registration of fire safety engineers and practitioners in some States and Territories.
- The role of the Fire Protection Association, Australia (FPA Australia), a national body dealing with fire safety issues and practices.
- The widespread use of the International Fire Engineering Guidelines (IFEG) and fire engineering tools such as FDS and other models.

Below is a list of concerns that address the negative side:

- The role of private certification has been generally poorly managed and not well audited and enforced, which is often a failure by certifiers to act in the public interest.
- Concerns with issues associated with certifier poor performance and practices.
- Standards in education of fire safety engineers, in some cases, have appeared to be well short of world's best practice and level requirements.
- The professional registration, accreditation or licensing of fire safety engineers has been inconsistent in the various State and Territories.
- Regular audits and proper re-checking of general competence and continuing professional development of fire safety engineers and other practitioners have been almost non-existent in most States and Territories.
- Fire safety engineers may be limited to only look at some aspects of fire safety of a building and not the complete design. Some think that fire safety engineers should be required, by regulation, to review the complete fire safety design of a building and develop a fully integrated and holistic design solution.
- A NCC/BCA with no measurable Performance Requirements.
- Concerns with liability of fire safety engineers and their lack of understanding of the risks of their design, analysis and professional advice.
- Unclear national approach to the adequacy (or lack thereof) of maintenance of fire safety measures and differences in the adoption by State and Territories of national standards.
- Major problems because of changes in fire safety measures as designed versus as built due to the lack of good quality inspections.
- The lack of clarity with respect to the legislation in relation to the responsibilities and approval authority of the various state and territory fire departments.

Although, there seems to be a widespread acceptance of the benefits of performance-based design by architects, engineers, designers, practitioners, developers, and builders, there has been a constant concern in the community about the potential misuse of Performance Solutions typically to find reductions in the construction costs and potentially constructing an unsafe building and placing its occupants at risk. There is the perception that introducing Performance

Solutions puts an additional burden on the approving authorities who may not have the required knowledge to deal with the complex requirements of these Solutions. To alleviate these concerns, legislators and building professionals are looking to introduce new regulations which allow for the Performance Solutions to be rigorous and comprehensive in treating risks to occupants and in meeting all the fire safety objectives of the NCC/BCA.

On the public side, there was very little or no knowledge or public perception of performance-based design and the role of fire safety engineers until recent occurrences of some major fire events in Australia and around the world, including the Lacrosse Building façade fire in 2014 in Melbourne and the Grenfell Tower Fire in 2017 in London. These events have ignited the curiosity of the public and there seems to be a much greater public perception because of these very public building failures. As a result of some of the events, the BMF requested an expert inquiry (as stated earlier), known as the Shergold/Weir Inquiry, to assess the effectiveness of compliance and enforcement systems for the building and construction industry in Australia. The inquiry “Building Confidence” report provides 24 recommendations and a package of reforms to establish a national best practice model for compliance and enforcement. Some of the State and Territory governments are now acting on the inquiry report and consumer demands for better quality residential buildings.

Potential and Benefits of Performance-Based Codes

Finally, to gain the full benefits of fire safety engineering and support the required fire safety outcomes in buildings, some thought process and research was required. This was achieved through the now completed Warren Centre research entitled “Professionalising Fire Safety Engineering”. A total of 8 research reports have been published as part of the project. These reports include a large number of recommendations calling for a holistic or integrated approach to the fire safety design, better training of professionals and certifiers, professional accreditation and registration of all fire safety engineers, development of measurable Performance Requirements and rigorous Verification Methods to quantify performance, and reliable data for use by practitioners.

Some of the important lessons learned from the introduction of performance-based codes in Australia emphasize the fact that success requires a coordinated effort between all levels of government, professional associations, fire services, the academic and research community, certification bodies, insurance industry, and trades and contractors.

Purpose of Report

This report is one in a series of reports intended for the "*Research towards a Performance-Based Building Code"* project. The other reports in this series include:

- J. Su, *Review of Performance-Based Fire Safety Regulations in Selected Countries: New Zealand*, Report No. A1-018529.1, National Research Council Canada, 2021; and
- A.P. Robbins, *Research towards a Performance-Based Building Code Preliminary Analysis NBC Part 3 Fire and Life Safety Provisions*, Report No. A1-018529.3 National Research Council Canada, 2021.

This report summarizes the review of the Australian Building Code, one of the first performance-based building codes implemented in the world, conducted with regards to its fire and life safety provisions, including their development and regulatory framework. The objective of this review is to learn from their successes and experiences.

Review of Performance-Based Fire Safety Regulations in Selected Countries: Australia

1 Introduction

Performance-based building codes set out how buildings must perform in their intended uses as opposed to prescribing how the buildings must be designed and built. An advantage of a performance-based building code is flexibility to allow developments and innovation in building design, technology and systems.

In many countries, building regulations have been developed to minimize the impact of fires and other hazardous events on life, property, environment and economy. In the past, these building regulations tried to capture all the provisions in a few documents, which added more regulated areas, complexities and limitations. These led many countries to start thinking about changing their existing prescriptive regulations, which do not provide the understanding behind a design, to regulations that would be structured and focused on the construction of a building based on desired objectives and functions. This thought then led to a move by several countries to performance-based building regulations. The idea of moving to performance-based building regulations started in the 80s, but it was in the 90s and after, that some countries began putting together the structure, framework and content of the new building codes and corresponding new building regulations. In addition, some of the countries developed relations through various forums to exchange positive and negative experiences and dissemination of information. Now that we are more than 30 years from the initial start, the countries that have introduced full performance-based building regulations include: New Zealand, Australia, and some European countries.

The National Building Code of Canada (NBC) became an objective-based[3] building code in 2005, which provides both the prescriptive acceptable solutions and the option to develop alternative solutions (known as equivalency prior to 2005). The introduction of the objective-based code was originally envisioned as a step or a transition towards a performance-based code (PBC). Modernizing the NBC to become a more performance-based code would encourage technological innovations for the construction industry. With a desire to initiate code harmonization across Canada, this represents an opportunity to renew movement towards a full performance-based NBC.

[3] Another way of evaluating performance requirements.

In response, an overall project, Research towards a Performance-Based Building Code, was initiated with the intent to investigate and collate international approaches, experiences and benefits observed so far so they can be considered in a Canadian context.

The overall scope of this research project intends to cover fire and life safety provisions in Part 3 and earthquake provisions in Part 4 of Division B of the 2015 version of the NBC. This project will ultimately require the coordination of efforts between the research and the code development communities to identify knowledge gaps and future research needs in the areas of fire and life safety and earthquake design. It is proposed that results from this project inform the code development system and, perhaps, the discussion whether to introduce a new performance-based compliance path in the NBC, which would follow its due process, as determined by the Canadian Commission on Building and Fire Codes (CCBFC).

In support of the overall project, a review of performance-based building codes of selected countries was conducted with regards to fire and life safety provisions, including their development process and regulatory framework. The objective of this review is to learn from their lessons and experiences thus potentially help advance the development of performance-based requirements in Canada with regards to its fire and life safety provisions.

This review mainly include studies of two countries – New Zealand and Australia – to gain insight into their experiences, as these two countries have the most advanced experiences in developing performance-based codes. This report documents the results of the review of the Australian Building Code.

2 Review of the Performance-based Regulatory System in Australia

2.1 Codes System in Australia

2.1.1 History

Australia has six States and two Territories and during the early 60s, theses States and Territories tried initially to develop a building code that would cater to all the States and Territories. In 1965, Australia developed a draft model code that was called the Australian Model Uniform Building Code which then became the national Building Code of Australia (BCA).

The early model code was still not referenced by States and Territories, which used it with variations, but in 1992, the BCA 90 was introduced to all States and Territories and adopted as the sole technical document that controlled the standard of building construction in Australia. The BCA 90 consisted largely of a collection of prescriptive requirements and standards with some early elements of performance requirements. The BCA set out how a building should be designed, constructed, protected and maintained with regard to the health, safety and amenity of the public in order to comply with the provisions of the BCA 90. As an example, the maximum

travel distance to safety in the event of a fire is prescribed without real rationale behind the value used (e.g., no indication of the relation to smoke spread in a building). Therefore, the requirement can be easily satisfied, but it is difficult to show how the underlined objective has actually been met.

In the early 90s, concerns were expressed regarding the constraints of the existing prescriptive regulations, which limited the competitiveness of the construction industry, discriminated against new products and technologies, and impacted the cost of implementing the provisions. Specifically, the main drivers that led Australia to start thinking about another approach and then moving to a performance-based approach included the following:

- A general trend started emerging globally for building codes to shift to a performance based code (e.g., New Zealand and United Kingdom). There was a strong political desire to follow these examples and catch up to their reform programs.
- The first Warren Centre project on “Fire Safety and Engineering” has established an engineering and risk-based approach to fire safety design and regulation in 1989, which was reinforced by the Building Regulation Review Task Force (BRRTF) in 1991. The BRRTF was a major Australian Government initiative on reforming the whole building and construction industry.
- Reports by the Warren Centre project and the BRRTF suggested that there were clear benefits in moving away from traditional prescriptive approaches to fire safety and building regulation in terms of:
    - A better understanding of building performance and contributing factors to safety.
    - Support for more innovative and novel designs, with removal of restrictions and inflexibilities.
    - More costs effective construction costs.

This led to States and Territories ministers pushing for a change and supporting the idea of moving towards a performance-based building regulation that was scientifically-based, robust and supported by input from industry and professionals. This resulted in the establishment of the Australian Building Codes Board (ABCB)[4] in 1994 through the signing of an intergovernmental agreement (IGA) by all levels of government (Federal, States and Territories, and Local) and in collaboration with the building industry [www.abcb.gov.au, 2020].

In 1996, the ABCB developed and published the first performance-based building code, BCA 96, which was adopted into legislation in 1997 in all States and Territories in Australia. Because of tight timelines (only two years since establishing the ABCB), the drafting of the new BCA 96 had to happen very quickly and was based on the various parts of the more prescriptive BCA 90, which were used as a framework for the BCA 96, but overlaid with Objectives, Functional

[4] See more information about the ABCB in Section 2.1.3.

Requirements and Performance Requirements, generally in accordance with the Nordic hierarchy for building regulation (see Figure 3 below). Then, up to 2011, the BCA has been the only building code referenced by States and Territories in accordance with the initial IGA. But in 2008, a working group was struck to investigate the merit of a national code that included other standards such as plumbing and telecommunication in addition to the BCA. In 2011, as a first stage, the codes for building and plumbing were consolidated into a single code by the Council of Australian Government (COAG) and they formed the National Construction Code (NCC) which incorporated both the BCA and the Plumbing Code of Australia (PCA) [www.abcb.gov.au, 2020]. The States and Territories adopted the NCC 2011 in May 2011 [www.abcb.gov.au, 2020]. The identified benefits for the new national code were:

- To reform the administration of the code and improve consistency between building and plumbing regulations;
- To improve the regulatory framework nationally; and
- To respond to challenges for future policies and increase innovation.

2.1.2 Australian Building Codes Board (ABCB)

The ABCB, also called the Board, was established in 1994 at first and reaffirmed by Ministers in April 2006, and consists of eighteen members including a Chairman, the head of each Federal Government (Commonwealth), State and Territory Administration responsible for building matters, a maximum of seven industry representatives, and a representative of the Australian Local Government Association. The Board reports directly to the relevant ministers of the Australian Government and States and Territories responsible for building regulatory matters. Board members are appointed by Ministers and meet periodically to review the strategic plan and the progress and deliverables against the initially set objectives [Meacham, 2010].

The ABCB, a COAG standards writing body funded by the Federal (Commonwealth) Australian Government, States and Territories, is responsible for developing and maintaining the model NCC, leading the reform of the NCC and associated policy that is deemed necessary, conducting research into the efficiency and effectiveness of building regulatory systems and promoting the introduction of new technology by the building industry. Since its creation, the ABCB has undertaken many steps to reduce the States and Territories variations in the NCC and these steps continue to significantly benefit the community and industry by allowing cost-effective design and construction, more efficient services and on-going life safety, health and amenity for people in buildings [www.abcb.gov.au, 2020].

2.1.3 ABCB's Building Codes Committees

The ABCB has two main technical advisory committees: the Building Codes Committee (BCC) and the Plumbing Code Committee (PCC) [www.abcb.gov.au, 2020]. In particular, the BCC is a technical advisory body, which is aligned with the ABCB's mandate and operates to support a coordinated approach to building regulatory reform. The responsibilities of the BCC are to provide advice and make recommendations to the Board on technical matters relevant to the NCC/BCA and the strategic policy relevant to building control matters. The BCC also provides

the list of categorized and prioritized proposals to assist in the development of the ABCB Annual Business Plan, and advice and guidance to the ABCB Office[5] at various stages of technical projects and on the overall direction and development process.

2.1.4 Regulation Reforms and Resulting Economic Benefits

In Australia, the construction industry is one of the largest sectors in the Australian economy. Therefore, since the creation of a national single BCA in the early 90s, the ABCB has been trying to find means to limit costs of industry regulation, through the preparation of Regulatory Impact Statements (RIS), and improve productivity with the objective of delivering economic benefits at the national level. In doing so, major regulatory reforms have taken place for the building and construction industry over the past 25 years [www.abcb.gov.au, 2020].

The first major reform was in 1996 when Australia introduced its first performance-based code (as stated earlier) through the development of BCA 96 with the objective to assist States and Territories in the improvement of building design and construction by:

- Introducing greater flexibility in building design;
- Creating a greater responsiveness to innovation;
- Reducing the complexity of the Code;
- Introducing greater clarity of intent and consistency in scope;
- Improving the clarity of requirements in building approvals;
- Permitting a greater ease of use; and
- Allowing easier application to renovation projects.

Another major reform was the consolidation of the building and plumbing regulation that resulted in the NCC in 2011.

In 2012, the ABCB asked the Centre for International Economics (CIE) [CIE, 2012] to study the benefits and drawbacks of introducing a performance-based NCC. The objectives of the CIE's study were to perform an impact analysis on the regulatory reform to date and identify any potential drawbacks from realizing the full benefit of the regulation reform. The study found that there is an estimate of yearly national economic benefit of $1.1 billion[6] because of the regulatory reform introduced since 1992. Table 1 show the breakdown of the benefits.

[5] A professional, technical and administrative team that supports the Board and implement its decisions and ongoing work program.

[6] The building work done in 2010-11 and applicable to the NCC was around 80 billion (with 46% residential).

Table 1: Breakdown of Estimated Benefits by Reform [CIE, 2012]

Reform	**Estimated attributable benefits (annually) (all values are in Australian dollars)**
Single national technical code (1992)	$300 million
Performance-based building code (1996) • Commercial sector • Residential sector (housing)[7]	$780 million • $740 million • $40 million
National Construction Code (BCA and PCA, 2011)	$60 million
Total national benefits annually	$1.1 billion

Other recent reforms introduced by the ABCB include:

- Making the provisions of the NCC free online in 2015; and
- Reducing the frequency of code changes from 1-year cycle to 3-year cycle and starting this process in 2016.

2.2 Regulatory Framework

In general, the States and Territories based regulatory system in Australia adopts the following framework [IFEG, 2005]:

- **A law:** This puts in place the administrative legislation and provides the State and Territory governments with the control, authority and responsibility to issue regulations.
- **Regulations:** These set out, in detail, the procedures, assessments, approvals, inspections, certification, appeals, etc. The law or the regulations give legal authority to require the use of the building code in construction.
- **A building code:** This includes the detailed technical requirements.
- **Other regulatory:** Other pertinent documents, practice notes and publications issued by States and Territories.

2.2.1 Overall Framework

Australia is a federated system of States and Territories sitting underneath a Federal/National (Commonwealth) Government. There are three levels of government with different functions in building regulations [Johnson, 2021; ncc.abcb.gov.au, 2020], as explained below:

[7] This includes single-family houses and multi-family high-rise apartment blocks.

- At the National or Commonwealth level, the ABCB publishes the NCC, which has various parts, including the NCC/BCA (Volume One) which provides the technical provisions in a model building code for most classes of buildings and the NCC/BCA (Volume Two) which deals with single family dwellings. Compliance with the NCC/BCA is explained in Section 2.3.8. While the NCC/BCA has common Performance Requirements, it also has State and Territorial variations to address regional differences within Australia. The NCC/BCA has no legal standing until adopted by the States and Territories.
- At the State or Territory Level, under the Australian Constitution, the building code requirements in the NCC/BCA are given legal effect and responsibly through the relevant legislation in each State and Territory. The legislation in each State and Territory consists of an Act of Parliament (Building Act) and subordinate legislation (Regulations) which give power to the NCC/BCA, and contains the administrative provisions necessary to give effect to the legislation (see Figure 1 for details). While the NCC/BCA has design Objectives and Functional Statements, only the Performance Requirements are legally binding and must be complied with for all buildings. The States and Territories manage registration of practitioners and controls over approving certifiers. They also set State and Territory planning laws. The State and Territory Building Acts and Regulations are different in every State and Territory, which can create some confusion and inefficiency for the building design and construction communities. Table 2 shows the six States and two Territories and their relevant legislations. In Section 2.2.3.3, the State of Victoria is given as an example of legislation.
- The third level of government are the municipal/local councils who manage planning approvals on a day-to-day basis. Municipal/local councils have traditionally managed approvals of buildings at the design stage and at the completion of construction, and issued all building permits, conducted building inspections, and issued certificate of occupancy. However, most States and Territories now allow private certification, as an option, so that private building surveyors, acting as certifiers and in the public interest, can issue the building approvals, demolition permits, and conduct building inspections. Private building certifiers are required to be registered in the State and Territory in which they operate. They, generally, have a certain level of qualification, need to have a defined number of years working under supervision before being registered, and are required to undertake Continuing Professional Development (CPD). They are currently subject to strict Codes of Conduct, with significant penalties for non-compliance.

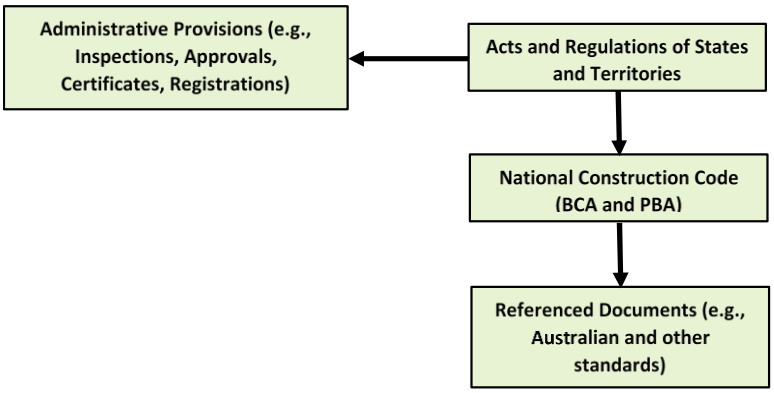


Figure 1: Regulatory Framework – Based on the figure in the [ncc.abcb.gov.au, 2020]

2.2.2 Administrative Provisions

The administration provisions that are typically covered in legislation and regulation in States and Territories include:

- Plan submission and approval procedures
- Issue of permits
- Inspections and audits
- Provision of evidentiary certificates
- Issue of certificates
- Review and enforcement of standards
- Fees and charges
- Registration of practitioners

Table 2: Jurisdictions and their Relevant Legislations [The Warren Centre, 2019].

Jurisdiction	Relevant Legislation
Australian Capital Territory (ACT)	• *Building Act 2004 (ACT)* • *Building (General) Regulation 2008 (ACT)* • *Construction Occupations (Licensing) Act 2004 (ACT)* • *Construction Occupations (Licensing) Regulation 2004 (ACT)*
New South Wales (NSW)	• *Environmental Planning and Assessment Act 1979 (NSW)* • *Environmental Planning and Assessment Regulation 2000 (NSW)*
The Northern Territory (NT)	• *Building Act (consolidated) (NT)* • *Building Regulations (NT)*
Queensland (QLD)	• *Building Act 1975 (QLD)* • *Building Regulations 2006 (QLD)* • *Professional Engineers Act 2002 (QLD)* • *Professional Engineers Regulation 2003 (QLD)*

	• *Sustainable Planning Regulation 2009 (QLD)*
South Australia (SA)	• *Development Act 1993 (SA)* • *Development Regulations 2008 (SA)*
Tasmania (TAS)	• *Building Act 2016 (TAS)* • *Building Regulations 2016 (TAS)* • *Occupational Licensing Act 2005 (TAS)* • *Occupational Licensing (Building Services Work) Regulations 2016 (TAS)*
Victoria (VIC)	• *Building Act 1993 (VIC)* • *Building Regulations 2018 (VIC)*
Western Australia (WA)	• *Building Act 2011 (WA)* • *Building Regulations 2012 (WA)*

It is worth noting that much of this legislation and corresponding regulation is in the process of changing across most States and Territories as a result of regulatory reform arising from government responses to the Shergold/Weir National Inquiry (more information provided later) and the resultant "Building Confidence Report" [Shergold and Weir, 2018] following the Lacrosse and Neo200 building façade fires in Australia [Johnson, 2021; Johnson, 2017] and the Grenfell Building Fire in the UK [Johnson et al., 2018].

2.2.3 State and Territory Legislation

2.2.3.1 General

As stated in Section 2.2.1 and shown in Table 2, States and Territories use various building Acts and Regulations that are different and often structured differently [Johnson, 2021; ncc.abcb.gov.au, 2020; The Warren Centre, 2019]. For example, in NSW, the Environmental Planning and Assessment Act covers both planning and building requirements, which are managed and enforced by one department only. In Victoria, and others, the planning and the building legislation provisions are separate and managed by two separate departments or authorities. It should be noted that Acts of Parliament are quite difficult to change, whereas Regulations can be changed more easily, and so it is the Regulations which are more frequently amended to reflect changing situations and requirements. All States and Territories typically adopt the NCC/BCA. The last adoption was the NCC 2019 amendment 1, which was the product of decisions made by both the Building Ministers' Forum (BMF) and the ABCB.

In Section 2.2.3.3, the regulation in the State of Victoria is explained briefly. More information about the State of Victoria and other States and Territories is available through the Victorian Building Authority Website (https://www.vba.vic.gov.au/) or the ABCB Website (https://www.abcb.gov.au/).

2.2.3.2 Enforcement of the NCC

As stated earlier, the NCC/BCA is a national model code that provides a legal framework and is adopted by the States and Territories in Australia. The States and Territories have the responsibility to enforce the laws of applying and administering the NCC/BCA. In most cases, the States and Territories delegate the authority and power of enforcing the laws to the municipal/local government or private sector building certifiers and surveyors. These are the Appropriate Authorities (the Authorities Having Jurisdiction (AHJs) in Canada) and can issue permits, approvals and are in charge of determining compliance with the Performance Requirements of the NCC/BCA through inspections and audits.

2.2.3.3 Example: State of Victoria

2.2.3.3.1 Building Act 1993

In the State of Victoria, the Victorian Building Authority (VBA) regulates the building industry [www.vba.vic.gov.au, 2020]. All aspects of buildings are controlled and governed by the Building Act 1993 (also known as the Act and summarized in Appendix A - Appendix A). The objectives of the Act are:

- To protect the safety and health of occupants who use buildings and public entertainment places; and
- To improve the amenity of buildings.

2.2.3.3.2 Building regulatory framework

The Act provides the framework for the Building Regulations (VIC) which sits beneath the Act as subordinate legislation and includes regulation of building construction, building standards and the maintenance of building safety features. Figure 2 shows the framework of the building regulation in the State of Victoria. In addition to the Building Act 1993, other acts such as the Domestic Building Contracts Act 1995 and the Building and Construction Industry Security of Payment Act 2002 may also apply to the building industry.

2.2.3.3.3 Building regulations

In the State of Victoria, the Building Regulations 2018 (also known as the Regulations) came into effect on June 2nd, 2018 and provide much more detail on how things work in Victoria. The regulations contain a number of requirements that relate to:

- Building permits;
- Building inspections;
- Occupancy permits;
- Enforcement; and
- Maintenance of buildings.

The Victoria's Building Regulations adopt the NCC/BCA and the Victorian variations and Appendix B provides of a summary of the Building Regulations 2018. The Regulations generally have a ten-year shelf life before undergoing a comprehensive review to confirm that they remain adequate and meet the intended objectives. The VBA is a key stakeholder in the review process and implementation of the Regulations.

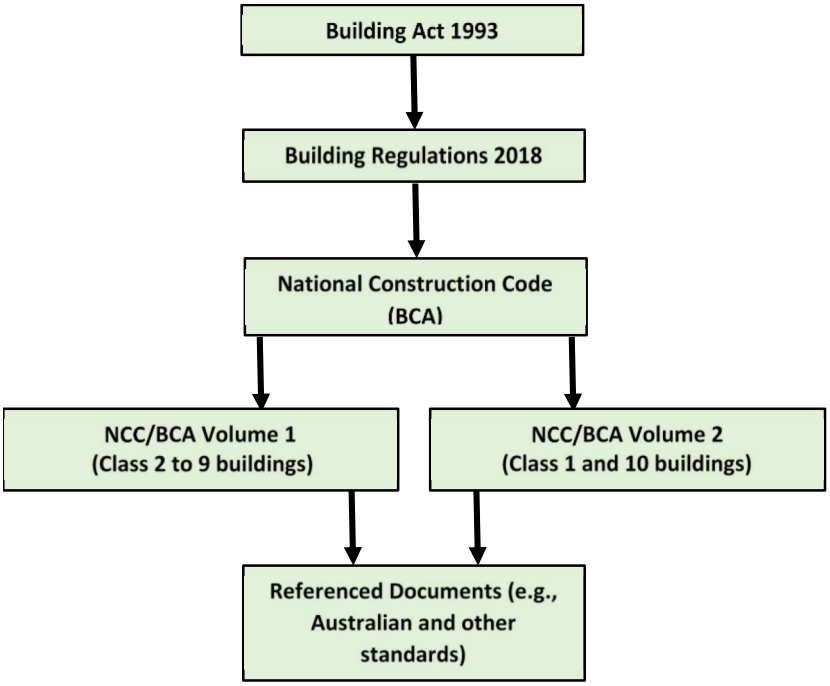


Figure 2: Framework of the Building Regulation in the State of Victoria – Based on the figure in the [www.vba.vic.gov.au, 2020]

2.2.4 Responsibilities and Duties

The responsibilities and duties of the different people involved in the building process vary between States and Territories, but can be generally summarized as follows [Meacham, 2010]:

- Building regulators: They are responsible for confirming the regulations satisfy the principles of the government laws as well as the consultation with industry and the community, at large, before making changes to regulations.
- Building owners: They are responsible for confirming that all approvals are received before any work can start on a building as well as the work is completed in accordance with the approved documents and the relevant laws. They are also responsible for ongoing maintenance of fire safety measures, fire safety management plans, and fire prevention.
- Building designers: They are responsible for checking the plans and specifications for the building work are detailed and certified for assessment and approval by the municipal/local council or private building certifier.
- Verification checkers or municipal/local council officers or private building certifiers (Appropriate Authority): They are responsible for verifying the work on the building complies with the current building regulations. They can make use of certification by others involved in the process (e.g., engineers).
- Builders: They are required to certify that they have constructed the building in accordance with the approved plans.

- Manufacturers or suppliers of materials or building components or systems: They are required to provide all necessary documents which show that the material or system complies with the relevant manufacturing or testing standards. Certified manufacturers typically have their product or system accepted by the municipal/local council or private building certifiers.
- Building occupiers and/or tenants: They are responsible for checking the maintenance of the building and the safety systems to the same level determined at the time of approval within their own area of occupation and/or ownership (e.g., within an apartment as part of a building).
- Standards organizations: They have the responsibility of confirming that their standards are up to date and reflect current building knowledge and research.
- Insurers: They may have additional requirements over and above the building regulations (e.g., installation of fire sprinklers in some situations).

2.2.5 Verification Stages during the Building Process

With the exception of minor works, verification is required before the start of construction, during construction, and at the completion of construction but before occupying the building [Meacham, 2010]. Those involved in the construction and assessment/approval process are typically required to be licensed or registered in the State or Territory where they practice, although this differs across various State and Territory jurisdictions. There are differences in the requirements for certification between jurisdictions for engineers, inspectors, professionals, builders, etc. Table 4, below, provides the requirements for practicing as a fire safety engineer in the different States and Territories in Australia.

2.2.6 Resolution of Disputes

The resolution to disputes between applicants for building approval and the municipal/local council or private building certifiers varies in the different States and Territories (i.e., some use a peer-review process, some use a fast-track system, others enable the right to appeal directly to a court) [Meacham, 2010]. The disputes are generally dealt with by a non-legal appeal body since these disputes are mostly technical and relate to compliance with the building code. Keeping these matters out of the courts provides the opportunity for a faster and cheaper appeal process.

2.3 National Construction Code (NCC)

2.3.1 Goal and Scope of the NCC

The goal of the NCC [NCC, 2019] is to permit the efficient achievement of nationally consistent objectives. The application of the goal is such that:

- There is a rigorous rationale for the regulation;
- The regulation generates net benefits to society greater than the costs; and

- The competitive effects of the regulation have been considered and the regulation should not be more restrictive than necessary in the public interest.

Traditionally, the building regulations in Australia have been focused on life safety of building occupants and the prevention of damage to adjacent buildings, while property protection was not included as a primary objective. Recently, however, governments and society, at large, have recognized the need to use the NCC, as a means, to extend the objectives in the building regulations to include measures to reduce greenhouse gas emissions, increase energy and water efficiency, improve accessibility for people with disabilities, reduce the risk to people and buildings resulting from large-scale disasters such as bushfires (aka wildfires), and to account for the impact of climate change [Meacham, 2010; NCC, 2019]. In addition, the technical provisions take into consideration the variations in climatic, environmental, geological or geographical conditions throughout Australia because of its large area and different conditions. As a result, there are a series of variations for States and Territories that are included in the NCC Schedule 1 – State and Territory Appendices.

2.3.2 Structure of the NCC

The NCC is a performance-based code with multiple levels within its hierarchy[8] [CIE, 2012]. As shown in Figure 3, the performance hierarchy includes the following parts:

- Objectives: They describe the community expectations for buildings.
- Functional Statements: They describe how buildings are to achieve the objectives.
- Performance Requirements: They outline the mandatory performance level that needs to be met for a building to meet the Objectives and Functional Statements.
- Building Solutions: The NCC allows for the 'Performance Requirements to be met via 'Deemed-to-Satisfy (DTS) Solution (prescriptive requirements), Performance Solutions, or a combination of the two approaches. The NCC also references the Australian Standards and other standards that are used for systems design and specification.

The NCC provides the minimum requirements related to safety and health, amenity and accessibility, and sustainability in the design, construction, performance and livability of new buildings[9] for Australia. The NCC includes three volumes: The NCC/BCA includes Volumes One and Two, and the NCC/PCA forms Volume Three.

- NCC/BCA Volume One: It primarily applies to Class 2 to 9 (multi-residential, commercial, industrial and public) buildings and structures [NCC, 2019].
- NCC/BCA Volume Two: It primarily applies to Class 1 (residential) and 10 (non-habitable) buildings and structures [NCC, 2019].

[8] This is similar to the hierarchy that was published by the Nordic Committee on Building Regulation.
[9] The requirements also apply to an existing building in which new building work is being performed (see Section 2.3.6).

- NCC/PCA Volume Three: It applies to plumbing and drainage for all classes of buildings [NCC, 2019].

The NCC/BCA provides technical provisions for the design and construction of buildings and other structures. However, it does allow the States and Territories to provide additional requirements for their specific community expectations, and does not prescribe a particular method in achieving the outcomes of the code.

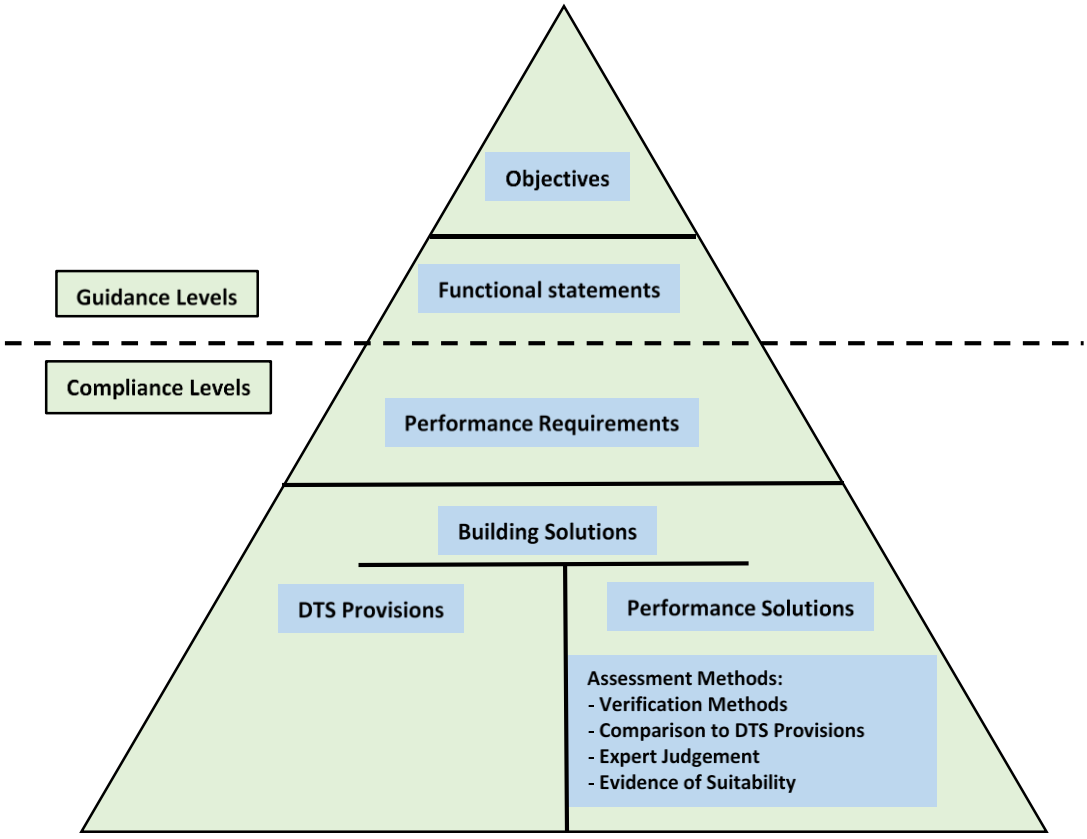


Figure 3: The NCC/BCA Hierarchy – Based on the figure in the [CIE, 2012]

In addition, the NCC includes a Guide [NCC, 2019], which is not a mandatory document, but has been developed by the ABCB for building professionals, as a companion/reference manual, to Volume One of the NCC/BCA specifically. Therefore, the Guide covers primarily Class 2 to Class 9 buildings. Volume Two of the NCC/BCA, which covers Class 1 and 10 buildings, contains guidance notes and diagrams embedded within it and hence is excluded from the Guide. The Guide is intended to support and to assist in the interpretation and clarifications of the requirements of Volume One. It contains a number of examples (in written or diagram format) which help illustrate provisions, and is formatted as closely as possible to that of the NCC/BCA. While the two companion documents (Volume One and the Guide) should be used in tandem, the comments in the Guide are not called up in legislation and should not, in any

case, override the NCC/BCA. Also, States and Territories may have variations in comparison to NCC/BCA provisions and the Guide does not cover these variations.

The classification of a building/structure (or part of a building/structure) in the NCC/BCA (see above) is determined based on the use and purpose for which the building/structure is designed, constructed or adapted and therefore it is important to confirm the accuracy of the classification to be applied. In addition, the legislation by each State or Territory, which gives the NCC/BCA the legal status, may affect the way the NCC/BCA classification is applied.

Users of the NCC/BCA include architects, designers, engineers, building surveyors/certifiers, fire authorities, and other consultants. The ABCB has released the NCC/BCA 2019 Amendment 1, which is the latest version, and has been adopted by States and Territories as of 1 July 2020.

2.3.3 Key Fire and Life Safety Provisions

The NCC/BCA contains technical provisions for the design and construction of buildings and structures, covering various subjects including structure, fire resistance, access and egress, services and equipment, and energy efficiency. State and Territory building regulations may cover additional matters such as water efficiency issues, and other issues resulting from consolidating building related requirements from other State laws such as those relating to specialist health, occupation, or accommodation uses. The table of contents of the NCC/BCA gives the following general structure [NCC, 2019]:

- Section A - General Provisions
- Section B - Structure
- Section C - Fire Resistance
- Section D - Access and Egress
- Section E - Services and Equipment
- Section F - Health and Amenity
- Section G - Ancillary Provisions
- Section H - Special Use Buildings
- Section I - Maintenance
- Section J - Energy Efficiency

For all the Sections (except A and I), there are Objectives, Functional Statements and Performance Requirements. These three levels of requirements establish the guidance necessary to identify the possible Building Solutions to achieve Compliance. Only the Performance Requirements are mandatory in the NCC/BCA, when called up in State and Territory legislation, while the Objectives and Functional Statements simply provide guidance.

Approximately over 60% of the NCC/BCA is related directly or indirectly to fire safety providing guidance on matters such as fire resistance, compartmentation, access and egress, firefighting equipment, smoke management, emergency lighting, exit signs, warning systems, artificial lighting and construction in bushfire prone areas. Some examples of the key fire provisions,

taken from Volume One and the Guide [NCC, 2019], are provided below. Additional key fire provisions are provided in Appendix C.

2.3.3.1 *C - Fire Resistance*

2.3.3.1.1 Objectives:

CO1 - The Objective of this Section is to:

a. *safeguard people from illness or injury due to a fire in a building; and*
b. *safeguard occupants from illness or injury while evacuating a building during a fire; and*
c. *facilitate the activities of emergency services personnel; and*
d. *avoid the spread of fire between buildings; and*
e. *protect other property from physical damage caused by structural failure of a building as a result of fire.*

2.3.3.1.2 Functional Statements

CF1 - A building is to be constructed to maintain structural stability during fire to:

a. *allow occupants time to evacuate safely; and*
b. *allow for fire brigade intervention; and*
c. *avoid damage to other property.*

CF2 - A building is to be provided with safeguards to prevent fire spread:

a. *so that occupants have time to evacuate safely without being overcome by the effects of fire; and*
b. *to allow for fire brigade intervention; and*
c. *to sole-occupancy units providing sleeping accommodation.*

2.3.3.1.3 Performance Requirements

a. *CP1 Structural stability during a fire: A building must have elements which will, to the degree necessary, maintain structural stability during a fire.*
b. *CP2 Spread of fire: A building must have elements which will, to the degree necessary, avoid the spread of fire.*
c. *CP3 Spread of fire and smoke in health and residential care buildings: A building must be protected from the spread of fire and smoke to allow sufficient time for the orderly evacuation of the building in an emergency.*
d. *CP4 Safe conditions for evacuation: To maintain tenable conditions during occupant evacuation, a material and an assembly must, to the degree necessary, resist the spread of fire and limit the generation of smoke and heat, and any toxic gases likely to be produced.*
e. *CP5 Behaviour of concrete external walls in a fire: A concrete external wall that could collapse as a complete panel (e.g., tilt-up and pre-cast concrete) must be designed so that in the event of fire within the building the likelihood of outward collapse is avoided.*
f. *CP6 Fire protection of service equipment: A building must have elements, which will, to the degree necessary, avoid the spread of fire from service equipment*

g. *CP7 Fire protection of emergency equipment: A building must have elements, which will, to the degree necessary, avoid the spread of fire so that emergency equipment provided in a building will continue to operate for a period of time necessary to ensure that the intended function of the equipment is maintained during a fire.*
h. *CP8 Fire protection of openings and penetrations: Any building element provided to resist the spread of fire must be protected, to the degree necessary, so that an adequate level of performance is maintained.*
i. *CP9 Fire brigade access: Access must be provided to and around a building, to the degree necessary, for fire brigade vehicles and personnel to facilitate fire brigade intervention.*

2.3.3.1.4 Verification Methods

a. *CV1 Fire spread between buildings on adjoining allotments: CV1 is a means to verify whether or not a building proposal achieves the requirements of CP2 in minimizing the risk of fire spreading between buildings on adjoining allotments. A fire in one building should not cause the spread of fire to another building, because such fire spread potentially endangers public safety, health and amenity.*
b. *CV2 Fire spread between buildings on the same allotment: CV2 is essentially the same as CV1, except that it deals with the spread of fire between two buildings on the same allotment.*
c. *CV3 Fire spread via external walls: CV3 is a means to verify whether or not a proposed external wall system achieves the requirements of CP2 in minimizing the risk of fire spreading in a building and between buildings via the external walls of the subject building.*
d. *CV4 Fire Safety Verification Method: CV4 is a means to verify the fire safety of a building in order to meet the requirements of CP1, CP2, CP3, CP4, CP5, CP6, CP7, CP8 and CP9. For further guidance, refer to the ABCB Handbook for the Fire Safety Verification Method.*

2.3.3.2 *D - Access and Egress*

2.3.3.2.1 Objectives:

DO1 - The Objective of this Section is to:

a. *provide, as far as is reasonable, people with safe, equitable and dignified access to:*
   i) a building; and
   ii) the services and facilities within a building; and
b. *safeguard occupants from illness or injury while evacuating in an emergency.*

2.3.3.2.2 Functional Statements

DF1 - A building is to provide, as far as is reasonable:

a. *safe; and*
b. *equitable and dignified,*

access for people to the services and facilities within.

DF2 - A building is to be provided with means of evacuation which allow occupants time to evacuate safely without being overcome by the effects of an emergency.

2.3.3.2.3 Performance Requirements

a. *DP1 Access for people with a disability: Access must be provided to the degree necessary.*
b. *DP2 Safe movement to and within a building: People, including those with a disability, can move safely to and within a building.*
c. *DP4 Exits: Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate.*
d. *DP5 Fire-isolated exits: To protect evacuating occupants from a fire in the building, exits must be fire-isolated to the degree necessary.*
e. *DP6 Paths of travel to exits: So that occupants can safely evacuate the building, paths of travel to exits must have dimensions appropriate.*
f. *DP7 Evacuation lifts: Where a lift is intended to be used in addition to the required exits to assist occupants to evacuate a building safely, the type, number, location and fire-isolation must be appropriate.*
g. *DP9 Communication systems for people with hearing impairment: An inbuilt communication system for entry, information, entertainment, or for the provision of a service, must be suitable for occupants who are deaf or hearing impaired.*

2.3.3.2.4 Verification Methods

a. *DV2 Access to and within a building: This Verification Method allows for a design based on occupant needs and characteristics by using a reference building to verify that the proposed building provides at least equivalent access to and within a building (DP1), as well as specific areas of a building (DP2, DP6).*
b. *DV4 Fire Safety Verification Method: Compliance with DP4, DP5, DP6 and DP7 is verified when a building is designed in accordance with Schedule 7.*

2.3.4 Schedule 7 - Fire Safety Verification Method

The ABCB published the Fire Safety Verification Method (FSVM) or VM in short, referenced in many instances in Sections 2.3.3.1 to 2.3.3.2 and Appendix C, and included it in Schedule 7 of the NCC/BCA Volume One [NCC, 2019]. The VM is detailed in [NCC, 2019] but a brief description is given below.

The VM[10] is a process for fire safety design for use by qualified fire safety engineers only. The purpose of the method is to demonstrate compliance with Performance Requirements of the NCC/BCA and the level of safety achieved by the VM should be at least equivalent to the DTS

[10] The ABCB states that the VM is not a comprehensive guide to fire safety and that the IFEG 2005 provides more comprehensive guidelines on fire safety calculation procedures.

provisions in the NCC/BCA. The VM has a companion Handbook that provides guidance on the specifics about occupant characteristics, selection of design scenarios, guidance on modelling and documentation.

The VM considers 12 design scenarios (for details, refer to Table 1.1 in Schedule 7 of the NCC/BCA Volume One [NCC, 2019]) that must be used to demonstrate compliance with the Performances Requirements. However, only those scenarios applicable to the Performance Requirements must be assessed to show compliance (for details on relevant scenarios for each performance requirement, refer to Table 1.2 in Schedule 7 of the NCC/BCA Volume One [NCC, 2019]). In addition, for the design scenarios assessed, the fire safety engineer must demonstrate that the building occupants have sufficient time to evacuate the building before the conditions become untenable. For this, the Available Safe Evacuation Time[11] (ASET) must be greater than the Required Safe Evacuation Time[7] (RSET). The ASET is calculated for using the following tenability criteria (measured at a height of 2 m above floor level):

a) a FED[12] of thermal effects greater than 0.3; or
b) conditions where, due to smoke obscuration, visibility is less than 10 m except in rooms of less than 100 m^2 or where the distance to an exit is 5 m or less, where visibility may fall to 5 m.

The VM should also follow the process for Performance Solutions described in Section 2.3.9 including the complete documentation.

2.3.5 Referenced Standards and Guidelines in the NCC

As mentioned earlier, the ABCB produces a companion Guide to the NCC/BCA Volume One, which is a non-regulatory document that provides guidance only. In addition, traditionally, the approach in practice has been for fire safety engineers to use the International Fire Engineering Guidelines (2005) [IFEG, 2005], which was produced through a collaborative effort between the following organizations (the collaborators):

- National Research Council Canada (NRC)
- International Code Council (ICC), United States of America
- Ministry of Business, Innovation and Employment,[13] New Zealand (MBIE)
- Australian Building Codes Board (ABCB)

[11] The ASET and RSET are known concept in fire safety engineering: ASET is the time between ignition of a fire and the onset of untenable conditions in a specific part of a building. RSET is the time required for safe evacuation of occupants to a place of safety prior to the onset of untenable conditions.
[12] FED (fractional effective dose) means the fraction of the dose (of thermal effects) that would render a person of average susceptibility incapable of escape.
[13] Formerly the Department of Building and Housing (DBH).

The ABCB has indicated its intent to publish a new version of the guidelines for Australia sometime in the future, with a first draft now in preparation.

Also, the NCC/BCA directly references many material, equipment, design, installation and performance standards throughout the document. Table 3 provides a list of the referenced standards along with the applicable provisions and the targeted Volume; See Schedule 4 in the NCC/BCA for further details [NCC, 2019].

Table 3: Referenced Standards in the NCC/BCA [NCC, 2019]

No.	Date	Title	Volume One	Volume Two
AS 1428 Part 1	2009	Design for access and mobility — General requirements for access — New building work (incorporating amendments 1 and 2)	D2.10, D2.15, D2.17, D3.1, D3.2, D3.3, D3.6, D3.9, D3.10, D3.12, Spec D3.10, E3.8, F2.4, G4.5, Schedule 3	Schedule 3
AS 1428 Part 1	2001	Design for access and mobility — General requirements for access — New building work	H2.7, H2.8, H2.10, H2.15	N/A
AS 1428 Part 1 (Supplement 1)	1993	Design for access and mobility — General requirements for access — Buildings — Commentary	H2.2	N/A
AS 1428 Part 2	1992	Design for access and mobility — Enhanced and additional requirements — Buildings and facilities	H2.2, H2.3, H2.4, H2.5, H2.7, H2.10, H2.11, H2.12, H2.13, H2.14	N/A
AS 1428 Part 4	1992	Design for access and mobility — Tactile ground surface indicators for the orientation of people with vision impairment	H2.11	N/A
AS/NZS 1428 Part 4.1	2009	Design for access and mobility — Means to assist the orientation of people with vision impairment — Tactile ground surface indicators (incorporating amendments 1 and 2)	D3.8	N/A
AS 1530 Part 1	1994	Methods for fire tests on building materials, components and structures — Combustibility test for materials See Note 2	Schedule 3	Schedule 3
AS 1530 Part 2	1993	Methods for fire tests on building materials, components and structures — Test for flammability of materials (incorporating amendment 1) See Note 2	Schedule 3	Schedule 3
AS/NZS 1530 Part 3	1999	Methods for fire tests on building materials, components and structures — Simultaneous determination of ignitability, flame propagation, heat release and smoke release	Schedule 3, Schedule 6	Schedule 3, Schedule 6

AS 1530 Part 4	2014	Methods for fire tests on building materials, components and structures — Fire resistance tests for elements of construction See Note 2	A5.6, C3.15, C3.16, Spec C1.13, Spec C1.13a, Spec C3.15, Spec D1.12, Schedule 3, Schedule 6	A5.6, 3.7.3.3, Schedule 3, Schedule 6
AS 1668 Part 1	2015	The use of ventilation and air conditioning in buildings — Fire and smoke control in buildings (incorporating amendment 1)	C2.12, C3.15, Spec C2.5, D1.7, Spec E1.8, E2.2, E2.3, F4.12, Spec E2.2b, Spec G3.8	N/A
AS 1670 Part 1	2018	Fire detection, warning, control and intercom systems — System design, installation and commissioning — Fire See Note 4	C3.5, C3.6, C3.7, C3.8, C3.11, D2.21, E2.3, G4.8, Spec C3.4, E2.2, Spec E2.2a, Spec E2.2d, Spec G3.8	3.7.5.2, 3.7.5.6
AS 1670 Part 3	2018	Fire detection, warning, control and intercom systems — System design, installation and commissioning — Fire alarm monitoring See Note 4	Spec E2.2a, Spec E2.2d	N/A
AS 1670 Part 4	2018	Fire detection, warning, control and intercom systems — System design, installation and commissioning — Emergency warning and intercom systems See Note 4	EV3.2, E4.9, Spec G3.8	N/A
AS 1720 Part 4	2006	Timber structures — Fire resistance for structural adequacy of timber members	Schedule 5	Schedule 5
AS 1735 Part 11	1986	Lifts, escalators and moving walks — Fire rated landing doors	C3.10	N/A
AS 1905 Part 1	2015	Components for the protection of openings in fire-resistant walls — Fire-resistant doorsets (incorporating amendment 1)	C3.6, Spec C3.4	N/A
AS 1905 Part 2	2005	Components for the protection of openings in fire-resistant walls — Fire-resistant roller shutters	Spec C3.4	N/A
AS 2118 Part 1	2017	Automatic fire sprinkler systems — General systems (incorporating amendment 1)	CV3, E1.3, Spec E1.5, Spec E1.5a	N/A
AS 2118 Part 4	2012	Automatic fire sprinkler systems — Sprinkler protection for accommodation buildings not exceeding four storeys in height	E1.3, Spec E1.5, Spec E1.5a	N/A
AS 2118 Part 6	2012	Automatic fire sprinkler systems — Combined sprinkler and hydrant systems in multistorey buildings	E1.3, Spec E1.5	N/A
AS/NZS 2293 Part 1	2018	Emergency lighting and exit signs for buildings — System design, installation and operation	E4.4, E4.8, Spec E4.8, H3.15	N/A

AS 2419 Part 1	2005	Fire hydrant installations — System design, installation and commissioning (incorporating amendment 1)	C2.12, E1.3, Spec E1.5a, H3.9	N/A
AS 2441	2005	Installation of fire hose reels (incorporating amendment 1)	E1.4	N/A
AS 2444	2001	Portable fire extinguishers and fire blankets — Selection and location	E1.6, H3.11	N/A
AS 2665	2001	Smoke/heat venting systems — Design, installation and commissioning	Spec E2.2c, Spec G3.8	N/A
AS/NZS 2918	2018	Domestic solid fuel burning appliances — Installation See Note 11	G2.2	3.10.7.0, 3.10.7.4, 3.10.7.5
AS/NZS 3013	2005	Electrical installations — Classification of the fire and mechanical performance of wiring system elements	C2.13	N/A
AS 3786	2014	Smoke alarms using scattered light, transmitted light or ionization (incorporating amendment 1 and 2) See Note 7	Spec E2.2a	3.7.5.2, 3.7.5.6
AS 3959	2018	Construction of buildings in bushfire-prone areas	G5.2	3.10.5.0
AS 4072 Part 1	2005	Components for the protection of openings in fire-resistant separating elements — Service penetrations and control joints (incorporating amendment 1) See Note 9	C3.15	3.7.3.3
AS 5113	2016	Classification of external walls of buildings based on reaction-to-fire performance (incorporating amendment 1)	CV3	N/A
AS 5637 Part 1	2015	Determination of fire hazard properties — Wall and ceiling linings	Spec C1.10, Schedule 3	Schedule 3
AS ISO 9239 Part 1	2003	Reaction to fire tests for floorings — Determination of the burning behaviour using a radiant heat source	Schedule 3	Schedule 3
ASTM E2073-10	2010	Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings	Spec E4.8	N/A
FPAA101D	2018	Automatic Fire Sprinkler System Design and Installation — Drinking Water Supply	CV3, C1.5, C1.13, C2.1, C2.6, C2.7, C3.5, C3.6, C3.7, C3.8, C3.11, Spec C1.1, Spec C1.10, D1.3, D1.12, D2.21, D2.25, E1.3, Spec E1.5, Spec E1.5a, E2.2, Spec E2.2a,	N/A

			G3.1, G3.6, Spec G3.8, H1.2	
FPAA101H	2018	Automatic Fire Sprinkler System Design and Installation — Hydrant Water Supply	CV3, C1.5, C1.13, C2.1, C2.6, C2.7, Spec C1.1, Spec C1.10, E1.3, Spec E1.5, Spec E1.5a, E2.2, Spec E2.2a, G3.1, G3.6, Spec G3.8, H1.2	N/A
NASH Standard	2014	Steel Framed Construction in Bushfire Areas (incorporating amendment A)	N/A	3.10.5.0

2.3.6 Application of the NCC/BCA to Existing Buildings

The application of the NCC/BCA to existing building is legislated by the States and Territories via their Building Acts and Regulations and therefore varies based on location [Meacham, 2010]. The application of the NCC/BCA is generally not retrospective. There is not a separate code for existing buildings. That is, buildings do not need to be changed every time a new version of the NCC/BCA in published. However, in general, when there is a change to the classification of the building or there is a major renovation to the existing building, the most recent NCC/BCA applies. A major renovation may be ruled, in some States or Territories, as a change of 50% or more in the building volume over a 3-year period. In addition, States and Territories may require an upgrade to the latest provisions when there is a perceived increase in risks due to recent events (e.g., multiple deaths in a fire) or the introduction of new government laws (e.g., access to existing buildings for people with disabilities). As an example, the State of Victoria required the installation of sprinklers in all existing aged care buildings. Most States and Territories give discretion for the approval body (i.e., the municipal/local council or private building certifier) to allow minor additions or alterations to comply with previous editions of the NCC/BCA where there are no adverse effects on fire safety provisions.

2.3.7 Proposals for Technical Changes in the NCC

Technical changes to the NCC are considered through the use of the Proposal for Change (PFC) process [ncc.abcb.gov.au, 2020]. Technical changes can be made to the NCC/BCA. Technical change proposals do not include matters related to policies or government decisions. The PFC process uses existing best practice regulatory principles so that rigour is used in assessing proposals.

2.3.7.1 Proposal for a Change

To propose a change, the proposer is required to provide justification in support of their proposal including the potential impacts due to the change. The justification should include:

- A description of the proposal;

- An explanation of the problem it is designed to resolve;
- Evidence of the existence of the problem;
- How the proposal is expected to solve the problem;
- What alternatives to regulation have been considered, and why they are not preferred;
- Who will be affected and how they will be affected; and
- Any consultation that has taken place.

2.3.7.2 Consideration of the Proposal

Anyone may submit a proposal to change or amend the provisions of the NCC/BCA. However, all proposals are reviewed and considered for tabling at a meeting of the BCC, and are then subjected to a Regulatory Impact Assessment process (see [abcb.gov.au, 2020] for information on how to conduct an impact analysis). If the proposal is considered to have merit and is in line with the scope of the code, the BBC may recommend that changes be included in the public comment draft of the NCC/BCA. There should be allowance for sufficient time for the PFCs to be considered in the upcoming version of the code. The information submitted may be made available to the ABCB and its Committee but not to the general public unless required by law.

2.3.7.3 Submission of the Proposal

Guidelines on how to prepare a proposed change are available on the ABCB website as well as the PFC Template that is used to fill the required information.

2.3.8 Compliance Process in the NCC

As stated previously, the NCC contains all the Performance Requirements that specify the mandatory requirements and minimum levels for the construction of buildings. In addition, in support of the Performance Requirements, the NCC also provides some General Requirements, which are mandatory requirements as well, and relate to aspects of how to apply the code including its interpretation, reference documents, the acceptance of design and construction and the classification of buildings. A building is said to comply with the NCC if it satisfies all the Performance Requirements [ncc.abcb.gov.au, 2020].

One of the key components of the performance-based NCC is that a user (e.g., designer) is not obliged to adopt any particular material, component, design factor or construction method. This important feature give the user a choice of multiple pathways for compliance.

2.3.8.1 Compliance with the NCC

As illustrated in Figure 4, the NCC performance flowchart shows that a building can achieve compliance with the Performance Requirements using either a Deemed-to-Satisfy (DTS) Solution, a Performance Solution, or a combination of the two solutions [ncc.abcb.gov.au, 2020] as mentioned in Section 2.3.2.

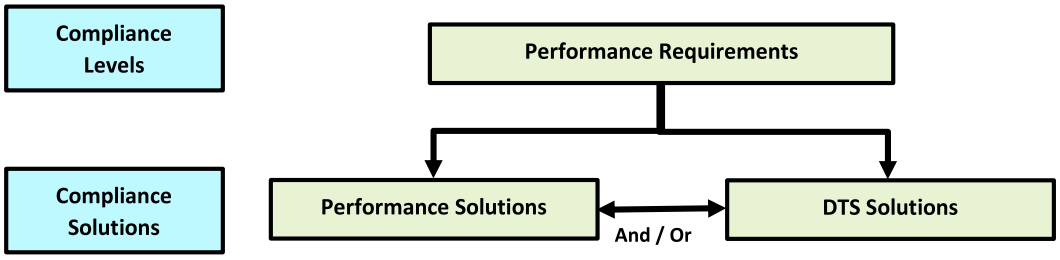


Figure 4: NCC Compliance - Based on the figure in the [ncc.abcb.gov.au, 2020]

2.3.8.1.1 Deemed-to-Satisfy Solution (Complying with DTS Provisions)

The concept of a Deemed-to-Satisfy Solution is a process of compliance with the mandatory Performance Requirements as it provides a solution which designers can adopt which is "deemed to comply". This provides confidence to both the designers and the Appropriate Authority that the solution will meet the mandatory Performance Requirements. A DTS Solution follows a set of very specific prescriptions that inform of what, when and how to perform a process. It uses the DTS Solutions from the NCC/BCA, which include materials, components, design factors, and construction methods that, if used, are deemed to meet the Performance Requirements set by the code. For a detailed description of the DTS provisions, refer to the appropriate Sections in the NCC/BCA Volume 1 and Volume 2 [NCC, 2019].

2.3.8.1.2 Performance Solution (Formulating a Performance Solution)

Formulating a Performance Solution is unique and particular for every situation that is being considered or investigated. These types of solutions often allow more flexibility in achieving the appropriate outcomes and encourage the use of innovation in the design and technology. A Performance Solution directly addresses the Performance Requirements by using one or more of the Assessment Methods that are made available in the NCC/BCA in order to demonstrate that all the Performance Requirements have been satisfied. The compliance can also be shown to be at minimum equivalent to the DTS provisions, which is the target for a performance solution.

2.3.8.1.3 Assessment Methods

The Assessment Methods are part of the mandatory General Requirements of the NCC/BCA. They are used to determine whether a solution complies with the relevant mandatory NCC/BCA Performance Requirements. As shown in Figure 5, four Assessment Methods (Verification Methods, comparison with the DTS Provisions, use of Expert Judgement or Evidence of Suitability) are available to the code users and may be used individually or in combination to demonstrate compliance with the Performance Requirements [ncc.abcb.gov.au, 2020].

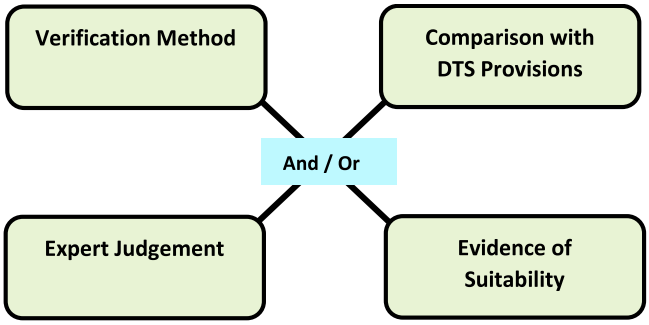


Figure 5: Compliance with the NCC - Based on the figure in the [ncc.abcb.gov.au, 2020]

1. Verification Methods: This Assessment Method consists of tests, inspections, calculations or other methods, which are used to determine whether a proposed solution complies with the relevant Performance Requirements. The Verification Methods generally include a quantifiable benchmark or predetermined acceptable criteria that the solution must achieve. Although, the NCC/BCA contains Verification Methods for the user, any other method that is not included in the NCC/BCA may also be used, as long as they are deemed suitable by the Appropriate Authority. Some information about the different methods is provided as follows:
   - **A test**: A test is meant to verify that a product or system achieves a certain level of performance. For example, testing a structural element in a building to determine its actual fire resistance performance. This is different from the Evidence of Suitability below, which typically makes use of an accredited laboratory.
   - **An inspection**: An inspection is typically a visual examination to confirm that a component is constructed or installed in a manner to satisfy the level of performance. Generally, inspections should be carried out by appropriately qualified people.
   - **A calculation**: These are engineering calculations, including computer modelling or hand calculations, which may be used to verify that a design can satisfy the relevant Performance Requirements.
   - **Other verification methods**: This allows any other suitable method to prove that a design, construction or individual component meets a Performance Requirement. There may be many options available for use as Other Verification Methods. However, an agreement with the Appropriate Authority must be obtained for the Verification Method to be acceptable.

2. Comparison with the DTS Provisions: This Assessment Method allows a comparative analysis to demonstrate that a Performance Solution for a building is better than, or at minimum equivalent to the DTS Provisions in order to be deemed to meet the relevant Performance Requirements. To conduct the comparison, the DTS Provisions and Performance Solution will both be required to be subjected to the same level of analysis using the same methodology. This allows the building designer and Appropriate Authority to compare the Performance Solution against the DTS Provisions and determines whether the Performance Solution provides, at least, the same level of performance using the DTS Provisions. As an example, the technical analysis may be carried out using a calculation

method (e.g., computer modelling) to show that the Performance Solution is equal to or better than the DTS Provision and therefore compliance is achieved and the proposed solution satisfies the NCC/BCA Performance Requirements.

3. Expert Judgement: This involves the use of subjective judgement that may not necessarily be supported by any technical calculations or where it is difficult to test the criteria against a calculation (e.g., models). This judgement is based on the qualifications and experience of an expert[14] using various reference material and documents to support a conclusion that the proposed solution complies with the Performance Requirements. This is typically applied when the Performance Requirements are difficult to quantify or to determine if a Performance Solution is "good enough".

4. Evidence of Suitability (described in A2.2): This Assessment Method is also known as Documentary Evidence and can generally be used to show evidence in order to support that a material, product or design satisfy the Performance Requirements or DTS Provisions. The form of evidence that may be used includes one of more of the following:
   - A report from an accredited testing laboratory or a registered testing authority.
   - A certificate of conformity or a certificate of accreditation.
   - A certificate from a professional engineer or appropriately qualified person.
   - A current certificate issued by a product certification body that has been accredited by the Joint Accreditation System of Australia and New Zealand.
   - Any other form of documentary evidence that adequately demonstrates suitability such as detailed manufacturer's specifications.

2.3.9 Process for Performance Solutions

For a consistent design process, the ABCB has developed a document [www.abcb.gov.au, 2020] that can be used to guide the process for Performance Solutions as outlined in the NCC. This process can be used for simple and complex Performance Solutions and is a collaboration between the various project stakeholders with the goal to agree on a pathway for a design that provides an acceptable outcome. The documentation to support any Performance Solution must be sufficient. The process is outlined below:

1. **Prepare a Performance-Based Design Brief (PBDB)**: This is the first document that is developed in collaboration with the involved stakeholders. It shows the proposed performance-based design and approval process. Once approved, the PBDB becomes the basis for the implementation of the proposed design.
2. **Carry out analysis**: The Performance Solution must be evaluated in accordance with the Assessment Methods outlined in Section 2.3.8.1 above. Any adopted solution will require its

[14] Experts do not stamp drawings and reports. But they are often required to sign off a report with a signature on the first page of the report.

own specific analysis and the assessment should be conducted as agreed in the PBDB. Various tools may be used, including: 1) comparative or absolute analysis; 2) qualitative or quantitative analysis; 3) calculations; 4) testing; 5) modelling.

3. **Evaluate results**: The analysis should show that multiple design scenarios have been considered, evaluated and analyzed. The evaluation should make use of the agreed performance or acceptance criteria as specified in the PBDB and the results of any uncertainties or sensitivities. If the results are not conclusive, further evaluation and analysis may be required. A final report documenting the outcomes of the evaluation, including conclusions, is prepared
4. **Prepare a final report**: The final report should demonstrate that compliance with the Performance Requirements, as agreed in the PBDB, has been achieved. A typical final report may include the following:
    - An overview of the PBDB: Scope of the project; Stakeholders; Applicable Performance Requirements and Deemed-to-Satisfy Provisions; Assessment Methods used; Approaches and methods of analysis; Assumptions made; Performance or Acceptance criteria agreed to by stakeholders.
    - Analysis, modelling and/or testing carried out: Method of analysis used; Calculations and outcomes, Sensitivities, redundancies and uncertainty studies carried out; Results obtained and relevance to the PBDB.
    - Evaluation of results including: Comparison of results with Performance or Acceptance criteria; Additional sensitivity studies undertaken, if any; Expert judgement applied, if any, and its justification.
    - Conclusions: Specifications of the final design that are deemed to be acceptable; Confirmation that the Performance Requirements are met; Limitations to the design and any conditions of use.

2.3.10 Performance Criteria

2.3.10.1 Performance Criteria Used

Currently, the regulation in Australia does not have true quantitative performance criteria. As stated earlier, the Performance Requirements, which are the only legal mandatory requirements, set some descriptive or qualitative “criteria”, which must be evaluated using the term “to the degree necessary” [Johnson, 2014] (i.e., the requirements are not really quantifiable or measureable).

Based on a research study, funded by the ABCB, the Fire Safety Verification Method (described in Section 2.3.4) was developed, published and included in the NCC/BCA Volume One Schedule 7 [NCC, 2019]. This was the ABCB’s attempt to “quantify” some of the levels of performance in buildings by setting out key design fire scenarios and tenability criteria to be evaluated in assessing performance-based designs [NCC, 2019]. According to Johnson [Johnson, 2021], the method has been scarcely used and not very popular.

In addition, according to Johnson [Johnson, 2017], the ABCB longer term strategy has been to consider introducing risk-based performance metrics as the criteria for satisfying the NCC/BCA

Performance Requirements for fire safety and other hazards, based on quantitative individual risk and societal risk (F-N curve), which could be controversial. Meacham [Meacham, 2008] and Johnson [Johnson, 2017] stated that the most important considerations to use a risk informed approach for regulation are:

- The need to better connect between tolerable risk, performance expectations and design criteria, and
- The requirement for 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.

2.3.10.2 Research to Support the Development of Performance Criteria

When the BCA 96 was originally published as a performance-based code, some research was undertaken to support the original Performance Requirements and to demonstrate that the DTS provisions met those Performance Requirements. This research was never fully completed or published by the Australia Fire Code Reform Centre and the BCA 96 was published without that research support.

Presently, there is a need for a major collaborative research program in Australia and other countries, to develop risk informed processes for building regulation for fire safety, if this concept is to be used for performance metrics. In line with this, the ABCB continues to look into ways to develop these quantifiable performance criteria, and has started to fund studies [Johnson, 2021; Johnson, 2017] on data, tenability and case studies, as well as the required tools and methodologies, in relation to the introduction and quantification of risk-based metrics for Performance Requirements, for use by fire safety engineers. This information is tentatively scheduled to be included in the next version of the regulation (i.e., NCC/BCA 2022).

2.3.11 Tools and Resources Used by the AHJ's and Industry

Similar to other countries around the world, fire safety engineers and practitioners in Australia use existing and available tools and resources to assess Performance Requirements using Performance Solutions and considering the scenario-based time line analysis of ASET/RSET. These tools and resources include the use of fire engineering tools such as the Society of Fire Protection Engineering (SFPE) Handbook, Fire Dynamics Simulator (FDS), egress models to quantify ASET/RSET, and some structural fire performance analysis [Johnson, 2021]. As mentioned earlier, the ABCB published the Verification Method and included it in the NCC/BCA Volume One Schedule 7 [NCC, 2019] as a potential method to be used. One of the biggest issues in Australia is the lack of consistently published national and local fire statistics which could help in defining ignition frequencies, potential occurring scenarios, and measurable impacts of consequences. In addition, the education of fire safety engineers representing the Appropriate Authority has not been up to standard and in general their responses to approvals show a lack of understanding of fire safety engineering; See Section 2.3.12 below on Education and Practice.

2.3.12 Education and Practice

2.3.12.1 NCC Continuing Professional Development (CPD)

In response to the Building Confidence Report [Shergold and Weir, 2018], the ABCB, in collaboration with industry, government and subject matter experts, has developed NCC CPD courses for building practitioners in order to address the most common challenges experienced with the NCC and meeting its requirements [www.abcb.gov.au, 2020].

The CPD courses help the NCC users support and reinforce their knowledge. The courses are provided online, add value to the users and their clients, and can be completed at any time and from any location. Courses on compliance, design and engineering and construction and installation have been rolled out in 2020 and were introduced for:

- Compliance practitioners including building surveyors and inspectors.
- Design practitioners including architects, designers and engineers.
- Construction practitioners including builders and site/project managers.

According the ABCB website, more CPD courses are expected to be rolled out online.

2.3.12.2 Requirements for Practice in States and Territories

In addition to the above and since the adoption of the NCC/BCA by the building regulations, it is now the responsibility of the States and Territories to regulate practitioners. Each jurisdiction has followed its own approach on how engineers and designers should be regulated to practice in the building industry. Table 4 shows the requirements for practicing as a fire engineer in the different States and Territories in Australia [The Warren Centre, 2019].

Table 4: Requirements for Practicing as a Fire Safety Engineer in Australia [The Warren Centre, 2019]

Jurisdiction	***Regulator***	***Accreditation, registration or licensing for design fire safety engineer***	***Accreditation, registration or licensing for peer review or certification by fire safety engineer as part of the approval process***	***Statutory requirement to consult with Fire Brigade for fire safety engineer***	***Offences where fire safety engineer not used by owner, or where practitioner not registered or licensed***
ACT	*Environment, Planning & Sustainable Development Directorate*	NO	NO	*N/A*[*]	*N/A*
NSW	*Building Professionals Board*	YES *(accreditation in prescribed cases)*	YES *(competent fire safety practitioner, in*	*YES (in prescribed cases)*	*YES (in some cases)*

			prescribed cases)		
NT	*Building Practitioners Board*	NO	NO	*N/A*	*N/A*
QLD	*Board of Professional Engineers*	YES *(registration)*	YES *(registration)*	*YES (in prescribed cases)*	*YES (professional engineering service)*
SA	*Department of Planning, Transport and Infrastructure*	NO	NO	*N/A*	*N/A*
TAS	*Consumer, Building and Occupational Services*	YES *(license)*	YES *(license)*	*NO*	*YES*
VIC	*Victorian Building Authority*	YES *(registration)*	YES *(registration)*	*YES (in prescribed cases)*	*NO (unless practitioner using title 'engineer')*
WA	*Department of Mines, Industry Regulation and Safety, Building and Energy Division Building Commission)*	NO	NO	*N/A*	*N/A*

*N/A means Not Applicable

Also, with most States and Territories preparing new legislation and regulations in response to the Shergold/Weir "Building Confidence Report" [Shergold and Weir, 2018], it is expected that fire safety engineers and many other practitioners will be required to be accredited by their professional organizations and be registered by the government regulators in order to be given the authority to practice.

2.4 Impacts, Perception and Acceptance, and Potential Benefits of the PBC

2.4.1 General Impacts

2.4.1.1 Positive Impacts and Successes

Over the past 20+ years, the restrictive NCC/BCA prescriptive DTS provisions have directed fire safety engineers to use a substantial number of Performance Solutions in support of fire safety design. This has meant that Performance Solutions have become widespread and the norm in Australia for all occupancy building types [Johnson, 2014].

Some would argue that the transition to performance-based fire safety design has been a major success and the positive impacts and outcomes for this move (for the current state of this evolving process) are listed below [Johnson, 2014; Johnson, 2017]:

- The fire record has generally continued to improve with steady trending down in the rate of fire deaths and levels of property damage and losses across Australia over the past 20+ years.
- The design of some wonderful innovative and spectacular buildings including:
    - Federation Square and the NAB Building in Melbourne,
    - 1 Bligh Street and 1 Shelley Street in Sydney,
    - 111 Eagle Street in Brisbane, and
    - Many Australian designed international projects such as the Beijing Aquatic Centre (Water Cube).
- A number of fire safety engineering professional practice firms were established across Australia.
- The Society of Fire Safety (SFS) was established within Engineers Australia and has been a major success as a learned society of professional practitioners and engineers.
- The development of a Code of Practice for Fire Safety Design [Code of Practice for Fire Safety Design, 2006] by the SFS to set practice standards.
- A strategy developed for the introduction of professional registration of fire safety engineers and other building practitioners, although not nationally consistent across all States and Territories.
- The role of the Fire Protection Association, Australia (FPA Australia), a national body dealing with fire safety issues and practices, with the following recent actions:
    - Providing more training opportunities and access to courses and assessments to practitioners.
    - Encouraging, with success, States and Territories to adopt the AS1851 standard of fire protection maintenance.
    - Introducing widely the national voluntary Fire Protection Accreditation System (FPAS) scheme [FPAS, 2013], for trade and industry practitioners, including engineers. The purpose was to confirm appropriate qualifications and competence for all practitioners during their practices.
    - Assisting the State of Victoria in the development of a whole new building act and regulations.
- The update and the wide use of the International Fire Engineering Guidelines (IFEG) [IFEG, 2005] as the process document to execute projects.
- The widespread use of fire engineering tools such as FDS and other models.
- Some policy makers argued 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.

2.4.1.2 Negative Impacts and Barriers

Although there has been widespread use of performance-based design, it could also be argued that there have been features of the fire safety design and construction landscape in Australia which have not been so positive and there have been concerns (mostly directed to regulatory and administrative processes in the States and Territories, audit and enforcement) that have resulted in major government inquiries [Johnson, 2017; Johnson, 2018]. Warning signs have been out there for some time [Johnson, 2018] and Meacham [Meacham 2013; Meacham, 2010] stated that fire safety engineering was at the crossroads and performance-based building codes and standards allowed innovation that was outpacing practice, with no clear performance metrics, a lack of competency, and insufficient audit and enforcement. In addition, Torero [Torero, 2012] said that fire safety engineering is not as developed as other professions such as structural engineering and that there is a lack of competence amongst fire safety engineers in the use of numerical methods.

Some of the issues of concern for the fire safety community (e.g., professionals, industries) that have emerged, and which may have an effect of life safety, property protection and business continuity, include [Johnson, 2021; Johnson, 2017; Johnson, 2018]:

- The role of private certification was introduced in 1997 by some States and Territories but has been generally poorly managed, which is, consequently, a failure to act in the public interest. There has been a clear and serious conflict of interest in some States and Territories for the building design permits and occupancy certificates issued by private building surveyors, who are involved in identifying the Performance Solutions, and issue the approvals on those same buildings (e.g., certifiers should only check designs and approve them). This has been identified in government reports with little significant policy change or rigour in enforcement.
- Concerns with issues associated with certifier poor performance and practices, which resulted in a major review and audit of certification practices in Queensland [Queensland Government, 2011] and Victoria [Victorian Auditor-General, 2011].
- Standards in education of fire safety engineers appeared to be short of world's best practice and level requirements. An international fire safety engineering survey by Meacham [Meacham, 2018] and Alvarez et al. [Alvarez et al., 2013] indicated that not all persons undertaking fire safety engineering and building design have been fully qualified. In addition, some fire safety engineering education programs have been of very good quality and accredited (e.g., University of Queensland) but other programs have been of lesser quality and academic rigour.
- The professional registration, accreditation or licensing of fire safety engineers has been inconsistent in the Australian States and Territories (i.e., it is required in some States and Territories and not in others). This typically results in inconsistent levels of real fire engineering skills required for practicing engineers.
- Although the professional registration of fire safety engineers was introduced in some States and Territories, regular audits and proper re-checking of general competences and continuing professional development of fire safety engineers and other practitioners have been almost non-existent in most States and Territories.

- Sometimes, departures from the DTS provisions are justified by practitioners who are not accredited fire safety engineers while, in reality, specialist fire safety engineer should be driving this process.
- In general, fire safety engineers may be limited to only look at some aspects of fire safety of a building. Typically, fire safety engineers address egress, with extended travel distances to safety, and smoke control but they accept the DTS provisions for compartmentation, fire sprinklers and fire properties of materials (e.g., combustible façades). It is very difficult to confirm if the use of this combination provides adequate overall design. So, potentially, fire safety engineers should be required, by regulation, to review the complete fire safety design of a building and develop a fully-integrated design solution. This permits a holistic fire safety design with all relevant design decisions being considered together at the various stages. In this situation, it is easier to raise questions, for example, with an architect who suggests a combustible façade element for energy efficiency.
- A NCC/BCA with provisions that have no measurable Performance Requirements (e.g., use of term “required to the degree necessary”).
- Low or insignificant use of quantitative risk assessment to justify fire engineered building designs.
- Little audit and enforcement of fire safety engineering practices by regulators or professional associations in performance-based fire engineering design or professional practice.
- Concerns related to the liability (of lack thereof) of fire safety engineers, which should not be transferred to others.
- An area that is not well addressed in the FPAS scheme, mentioned above, is the building passive systems (e.g., poor practices in sealing penetrations and structural fire protection) and this usually compromises compartmentation in buildings.
- An unclear national approach to the adequacy (or lack thereof) of maintenance of fire safety measures and differences in the adoption by States and Territories of the national standards.
- Design of sprinkler and detection systems by fire practitioners who have no recognized qualifications or proper supervised experience.
- Major problems due to changes in fire safety measures as designed versus as built because of the lack of good quality inspections and reluctance to involve fire safety engineers in commissioning and final inspections.
- There is a lack of clarity with respect to the legislation in relation to the responsibilities of the fire departments to protect life, property and the environment. Fire departments do not seem to have any approval authority but are used mostly as referral agencies (i.e., may conduct a review and provide recommendations), which may create delays in approving projects. This can also lead to incompetency of the approving staff, higher review fees, and may impact the building regulation.

2.4.2 Social Perception and Acceptance

There has been a widespread acceptance of the benefits of performance-base design by architects, engineers, practitioners and other design professional as well as developers and builders. However, an article in 2012 by Porteous [Porteous, 2012], did state that there are constant concerns in the community about the potential misuse of Performance Solutions driven by reducing construction costs, which may lead to unsafe building construction which could place its occupants at risk.

Developing Performance Solutions requires specialized skills of fire safety engineers and these solutions require approval by a suitably qualified independent party to determine compliance. In general, the Performance Solutions should be developed and approved, in collaboration with all relevant stakeholders (e.g., fire safety engineers, architects, fire service, building owners and end users, regulation consultants, insurers and the Appropriate Authority) and in accordance with the IFEG 2005 [IFEG, 2005] to verify that the solutions meet the NCC/BCA and to minimize potential safety problems. There is the perception that the introduction of Performance Solutions puts an additional stress and burden on any approving authorities (e.g., building surveyors) who may not have the required knowledge to deal with the complex requirements of these solutions. To alleviate these concerns, legislators and building professionals should allow for Performance Solutions to be rigorous and comprehensive in treating risks to occupants and in meeting the objectives of the NCC/BCA.

On the public side, there was very little or no knowledge or public perception of performance-based design and the role of fire safety engineers until recent occurrences of some major fire events in Australia and around the world, including the Quakers Hill nursing home fire in Sydney, which ultimately led to 18 deaths in 2011, the Bankstown fire in Sydney in 2012, the Lacrosse Building façade fire, Melbourne, in 2014, which started by a single cigarette on a balcony and flame spread rapidly up the external wall cladding[15], the massive fire in a vehicle tyre recycling plant in Victoria in 2016, the Neo200 cladding fire in Melbourne in 2019, and the Grenfell Tower Fire in London in 2017, which resulted in substantial loss of life, property damages and considerable operational challenges to firefighters, and other major fires in 50-60 high rise buildings around the world (many involving combustible façades) [Johnson, 2021; Johnson, 2017; Johnson, 2018]. These events have ignited the curiosity of the public and there seems to be a much greater public perception because of these very public building failures, and many have been asking if the new building design approach for fire safety is adequate. In the particular cases of some buildings with combustible façades, it seems that Performance Solutions may have been used and justified, but it is not clear if the risk of external fire spread was recognized in the fire safety design with combustible external building cladding [Johnson, 2018]. The big question for fire safety engineers is: how can we identify the critical issues and find the effective solutions to improve fire safety and avoid these situations from occurring in the future? These events have also required changes, new requirements, and changes to standards

[15] A recent judgment ordered the owners be immediately paid Australian $5.7 million in damages.

and regulations (e.g., sprinklers in aged care facilities in the state of New South Wales), new standard AS5113 for the fire testing and classification of building façades [AS5113, 2016]), but the efforts have been reactive policy changes that could have easily been foreseen as being needed to reduce risks, based on Australian and global experience with these types of fire incidents [Johnson, 2017].

As a result of some of the above mentioned events, the BMF requested an expert investigation and launched an inquiry, known as the Shergold/Weir Inquiry [Shergold and Weir, 2018], to assess the effectiveness of compliance and enforcement systems for the building and construction industry across Australia [Shergold and Weir, 2018; Johnson, 2018]. The assessment was co-lead by Professor Peter Shergold and Ms Bronwyn Weir and a broad stakeholder consultation was undertaken to consider issues impacting the effective implementation of the NCC. The report provided 24 recommendations and a package of reforms to establish a national best practice model for compliance and enforcement [Shergold and Weir, 2018]. Specifically, Enright [Shergold and Weir, 2018], one of the contributors to the inquiry report, highlighted the many serious concerns related to fire safety engineering or related practice in Australia including:

- Poor education and low levels of competence
- Loose registration and accreditation
- Fire safety engineering being unrestricted building work - being done by others
- Lack of independence and competence of certifiers
- Inadequate product certification, including for combustible cladding
- Lack of proper audit and enforcement of practitioners
- Reverse engineering – searching for tools to solve last minute construction problems
- Moral hazard – putting cost savings before safety
- Lack of construction monitoring by fire safety engineers

The NSW government and other State and Territory governments are now acting on the Shergold/Weir “Building Confidence” inquiry report [Shergold and Weir, 2018] and there are consumer demands for better quality residential buildings.

2.4.3 Potential Benefits of Performance-Based Design and Related Future Developments

To gain the potential full benefits of performance-based fire safety design and satisfy the required fire safety outcomes in buildings, the following may be needed [Johnson, 2018]:

- The use an integrated approach where fire safety engineers should be involved at the various stages of the project including planning and concept design with the opportunity to look at the whole building design. This could lead to innovation and cost-effective solutions without missing the required levels of fire safety.
- Encouraging fire safety engineers to get involved in the various project stages, especially early concept design, but also all aspects that are part of the integrated

design and building construction process (this is the case in NSW but not in other States and Territories).
- The achievement of fire safety engineering as a full profession similar to other mature disciplines such as structural engineering.
- Better training of fire safety engineers to attain best practice levels of competence and ethics.
- Better trained and technically qualified certifiers who are independent and make use of peer-review processes when warranted.
- Pushing for reform of the practices of regulatory authorities in relation to design and product certification, education and competence of fire safety engineers, audits and enforcement of professional practice, and ethical behaviour.

Some future aspects that may provide positive signals to fire research, and new approaches to regulation, fire safety design and approvals, include [Johnson, 2014]:

- Making the Performance Requirements measurable and being able to quantify overall fire safety in terms of individual and societal risk levels tolerable to communities and societal expectations. Risk informed criteria have been utilized by a range of countries as per Meacham [Meacham, 2008] but further information and research are required to better understand this concept.
- Developing robust Verification Methods to “quantify” performance. These should be used by accredited fire safety engineers only, specific to the existing code and verified against the DTS provisions, and based on Australian or local data and international practices.
- The immediate need for collaborative research programs in Australia and other countries, to develop a risk informed process for fire safety building regulation, which includes: methodologies for quantitative risk assessment; national databases that include frequencies of fires and failure rates of fire protections systems; well-trained fire safety engineers who can make full use of quantitative risk assessment to quantify performances; and an accreditation process for fire safety engineers to establish quality fire engineering practices.

Some of the above needs were achieved through the now completed Warren Centre research entitled “Professionalising Fire Safety Engineering”, in which a total of 8 research reports have been published and which include a large number of recommendations.

3 Summary

The following points provide a summary of the information discussed in the core of the report:

3.1 Codes System in Australia

In Australia, there was a prescriptive building code before the Building Code of Australia (BCA) 90. In the early 90s, the BCA 90 was the first national model code, used by all Stated

and Territories, and had some performance-based provisions but it was not a full performance-based building code. It was until 1996, after the establishment of the ABCB in 1994, that the BCA 96 was officially published as the first full Performance-based building code, and legislated by the Australian States and Territories in 1997, with detailed Performance Requirements for all hazards, including fire, and included prescriptive provisions as Deemed-To-Satisfy as one way, but not the only way, of meeting the Performance Requirements. In 2011, the codes for building and plumbing were consolidated into a single code by the ABCB and they formed the first NCC, which incorporated the BCA and the PCA. The States and Territories adopted the NCC in 2011. A 2012 study found that the regulatory reform introduced since 1992 had an estimated annual national economic benefit of $1.1 billion.

3.2 The Regulatory Framework

Under the Australian Constitution, building regulations are the responsibility of the States and Territories. The building regulations consist of: a) The State and Territory Building Acts or primary building law, which sets the building control system in the jurisdiction, legal provisions for building reviews and approvals, the rights and responsibilities of building practitioners, inspections/certification of the work, enforcement and appeal procedures; and b) The technical building standards, namely the NCC/BCA as the mandatory code.

The States and Territories Building Acts that regulate the administrative provisions dealing with the application and enforcement of the NCC/BCA are typically different between jurisdictions in the verification regimes but, in general, the following apply for all:

- For new and major building work, plans for the proposed work are submitted to the Appropriate Authorities (municipal/local councils or private building certifiers) for assessment/approval prior to the start of work;
- The municipal/local council or private certifier can inspect the work during construction and can rely on work certification by engineers or qualified persons;
- For new and major building work, the completed building cannot be occupied unless the municipal/local council or private certifier has certified that the building is suitable for the intended use (e.g., fire safety aspects are installed and operational) and an occupation certificate is issued;
- Building control officers must be qualified, and private certifiers must be licensed by government and carry professional indemnity insurance;
- In general, the building owner is primarily responsible for compliance with the building regulations;
- The building owner or representative can appeal to non-legal technical review body where there is disagreement with the municipal/local council or private certifier; and
- Most States and Territories have provisions in building regulations requiring the building owner or representative to maintain the building and keep all safety features operational to the standard applicable at the time of building approval.

In Australia, compliance at a project level is provided by municipal/local council or private certifiers, which are the Appropriate Authority (or AHJ). Each State and Territory has some provision for reference of some or all parts of fire safety engineering design to the authorities, depending on the regulations. All State and Territories require some form of fire safety engineering report to be submitted at the design stage, but until recently, only the State of NSW has had a mandatory regulatory requirement for a fire safety engineer to be involved in final inspections and certify the completed fire safety construction. All enforcement action for unprofessional or fraudulent conduct is the responsibility of State and Territory regulators.

Further, it is the responsibility of the States and Territories to legislate the general responsibilities and duties of the different people involved in the building process, the verification required before the start of construction, during construction, and at the completion of construction, and the resolution to disputes between applicants for building approval and the building certifiers.

3.3 National Construction Code (NCC)

The goal of the NCC is to achieve, efficiently, national consistent objectives. Traditionally, the Australian building regulations have been focused on health, safety and amenity for building occupants. The fire safety objectives related mainly to life safety of building occupants, the prevention of damage to adjacent buildings, and facilities for firefighting. More recently, however, there was a recognition to extend the objectives in the building regulations to include measures to reduce greenhouse gas emissions, to account for the impact of climate change, improve accessibility for people with disabilities, and reduce the risk to people and buildings as a result of disasters such as bushfires (aka wildfires).

The structure of the NCC is based on multiple hierarchical levels and includes Objectives, Functional Statements, Performance Requirements, and Building Solutions (DTS and/or Performance Solutions). Only the Performance Requirements are mandatory via State and Territory legislation.

The NCC/BCA is comprised of two volumes (Volume One and Volume Two). The ABCB also publishes a non-regulatory Guide to act as a companion document or reference manual to the NCC/BCA Volume One with detailed explanatory information for building professionals. The life and fire safety technical provisions are very similar to other building codes around the world, and include active and passive provisions, fire detection and alarm, smoke control, exits, fire hydrants, structural fire protection, compartmentation, etc. The State and Territory Building Regulations set the requirements for fire safety management and system maintenance. Many Australian Standards and other standards for fire systems design and specification are referenced in the NCC/BCA. In addition, the traditional approach in practice has been for fire safety engineers to use the International Fire Engineering Guidelines (2005). The ABCB has indicated they will produce a new version of the guidelines for Australia in the near future.

Technical changes to the NCC/BCA are considered through the use of the Proposal for Change process, but all justified proposals are reviewed by the ABCB's BCC before they get accepted or rejected. They are also typically subjected to a Regulatory Impact Assessment process.

For compliance, the NCC/BCA allows for the mandatory Performance Requirements to be met via a DTS Solution (prescriptive requirements), a Performance Solution, or a combination of the two solutions. To satisfy the Performance Requirements, there are no true quantitative performance criteria but only descriptive or qualitative "criteria" by the use of the term "to the degree necessary". It should be noted that with the original BCA 96, research to demonstrate that the DTS provisions met those Performance Requirements was undertaken but never fully completed or published and the code was issued without that research support. In addition, efforts were undertaken to "quantify" the level of performance in building, which resulted in issuing a Verification Method which sets out key design fire scenarios and tenability criteria to be evaluated in assessing a Performance Solution. The ABCB continues to look into ways to develop some form of quantifiable performance criteria. To this end, ABCB is now considering introducing risk-based performance criteria and started funding the support research on data, tenability and case studies in relation to the potential introduction of these criteria for the Performance Requirements for potential inclusion in NCC/BCA 2022.

In Australia, similar to many countries, existing and available tools, such as FDS, are used by practitioners, including the AHJ and industry, to show compliance with the Performance Requirements. However, there is a definitive lack of data on Australian fire statistics for use by industry professionals. States and Territories regulate practitioners with each jurisdiction following its own approach on how engineers and designers should practice in the building industry, and the AHJ's education and understanding of fire safety engineering needs more improvement.

3.4 Impacts, Perception and Acceptance, and Potential Benefits of the NCC

On the positive side, the full advantages of performance-based design have been undertaken to produce some innovative designs and spectacular buildings. Also the establishment of the Fire Society within Engineering Australia has been a major success as a learned society. On the negative side, not all persons undertaking fire safety engineering have been fully qualified and enforcement has known gaps. While some fire safety engineering education is accredited and is of very good quality, other programs have been of lesser quality and academic rigour. Professional registration or licensing has been patchy around the State and Territories and private certification has been plagued with conflicts of interest, failure to act in the public interest, and other competency issues widespread. In addition, fire safety engineering should be developed as a profession (similar to others) for successful reforms.

There has been a widespread acceptance of the benefits of performance-based design by architects and other design professional as well as developers and builders but little or no knowledge or public perception of performance-based design and the role of fire safety engineers until the Lacrosse and Neo200 fires in Australia and the Grenfell fire in the UK. With these events, much greater public perception happened through these public building failures. Governments in States and Territories are now acting on the Shergold/Weir "Building Confidence" inquiry report and consumer demands for better quality residential buildings in particular in relation to fire safety. The fires in the Lacrosse building in Melbourne and Grenfell Tower in London have identified a number of challenges to authorities and fire safety engineering professions globally. Many reforms are required in relation to fire safety engineering to meet these challenges. One potential response is to adopt an integrated approach to fire safety engineering that may reduce the likelihood of such fires. The approach should, however, be mandated by regulation to protect public safety.

Finally, to gain the full benefits of fire safety engineering and support the required fire safety outcomes in buildings, the Warren Centre put forward a number of recommendations calling for an holistic or integrated approach to fire safety design, better training of professionals and certifiers, professional accreditation and registration of all fire safety engineers, development of measurable Performance Requirements and rigorous Verification Methods to quantify performance, and reliable data for use by practitioners.

Some of the important lessons learned from the introduction of performance-based codes in Australia emphasize the fact that success requires a coordinated effort between all levels of government, professional associations, fire services, the academic and research community, certification bodies, insurance industry, and trades and contractors.

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Appendix A - Building Act 1993, Version No. 129, No. 126 of 1993 - Summary

The building Act 1993 version 129 consists of 14 main parts and multiple divisions and sub-divisions for the building industry with the purpose of how people can use buildings safely and without endangering their health.

In part 1, the primary purposes, objectives, critical definitions of some terminologies employed in the regulations and rules, and the Act's commencement are described.

The primary purposes of the Act are;

a) to regulate building work and building standards,
b) to provide for the accreditation of building products, construction methods, building components, and building systems,
c) to provide an efficient and effective system for issuing building and occupancy permits and administering and enforcing related building and safety matters, and resolving building disputes
d) to regulate building practitioners and plumbers
e) to regulate plumbing work and plumbing standards
f) to provide for the accreditation, certification, and authorization of plumbing work, products, and materials
g) to regulate cooling tower systems
h) to limit the periods within which building actions and plumbing actions may be brought

The main objectives of this Act are;

a) to protect the safety and health of people who use buildings and places of public entertainment
b) to enhance the amenity of buildings
c) to promote plumbing practices that protect the safety and health of people and the integrity of water supply and wastewater systems
d) to facilitate the adoption and efficient application of national building and plumbing standards
e) to facilitate the cost-effective construction and maintenance of buildings and plumbing systems
f) to facilitate the construction of environmentally and energy-efficient buildings
g) to aid the achievement of an efficient and competitive building and plumbing industry

In part 2, the building industry standards regarding *regulations, local laws, the effect of planning programs, and accreditation of building products* are explained:

- **Building regulations**: It focuses on prohibiting or regulating the construction, use, maintenance, demolition, and removal of buildings, buildings' safety, the use and maintenance of places of public entertainment. This part may require the carrying out of building work in terms of performance, types of material, construction methods, and maintenance on existing buildings and building work and exits by the Governor in Council or local government.
- **Local laws**: Empowering the provincial government to make, amend, or revocate the local law concerning the building regulation in the municipal district.
- **Accreditation of building products**: A building product, construction method, design, component, or system connected with building work and accredited by the Building Regulations Advisory Committee or any other person or body prescribed for this section. The accreditation remains in force for the period of up to 3 years specified by the Building Regulations Advisory Committee. This accreditation can be revised from time to time by the committee.
- **Certificates of accreditation and authority to keep a register of accredited building products**: Issuing a certificate of accreditation and maintaining a record for a building product, construction method, design, component, or system accredited by the Building Regulations Advisory Committee.
- **Building regulations concerning swimming pools**: rules about the construction, installation, maintenance, safety, and operation of swimming pools and associated services, safety equipment, swimming pool barriers, and associated services.

In part 3, the building permits regarding *penalties for any offenses relating to carrying out building work, application of building permits by municipal or private surveyors, types of building permits for different types of* are described:

- ***Division 1*** relates to the penalties for any offenses by building practitioners or architects, owners of the land, and other persons carrying out the building works.
- ***Division 2*** concerns the application made for a building permit by building surveyors on behalf of the building owner or the land. In this division, the application's information is required to be sent to the government, and the criteria of notice of the application are presented.
- ***Division 3*** is related to issuing the permits with/without conditions, refusing conditions of the permits, types of permits, exceptions, and requirements regarding occupancy permits, the amount of deposit securing work completion for infrastructure recovery, and general development charges. Besides this division, builders' specifications (a building practitioner, the building or landowner, and an architect) concerning specific construction works are provided. Change in the building or land ownership, a notice of ending builders' engagement, and owner-builder restrictions are presented too.
- ***Divisions 4 and 5:*** in these sections, the building works related to the style, manner of construction, and material of the building, the structural adequacy of the building, the requirements necessary to make reasonable provision for the amenity of the building, and the safety and health of people using the building. Moreover, the conditions

regarding altering or demolishing buildings and registering and recording the building permit to the Council are provided.

In part 4, the inspection of buildings regarding *penalties for any offenses during the work, directions to fix building work, authorized persons for improving building works, and certificates for final inspection* are explained:

- ***Divisions 1, 2, and 3*** relate to the builder's notification to the building surveyors to complete different mandatory notification stages of the work. Any charges to the builders or the owner concerning any offenses are explained as well. Besides, in divisions 2 and 3, the directions and conditions related to the persons involved in the fixing building works, methods in giving directions either oral or written, the compliance or non-compliance of the builder or owner by the authority's directions, and finally, any certifications showing if the occupancy is possible under the building Act or the building regulations.

In part 5, the occupation of buildings and the places of public entertainment are explained in three main divisions:

- ***Division 1*** focuses on issuing the occupancy permits with/without conditions, refusing the permits, and the number of charges for any offenses for violating the occupying the non-permitted places of the building.
- ***Division 2*** explains the conditions for the persons not to conduct public entertainment in a place of public entertainment unless the authority has issued an occupancy permit. The charges for any offenses for occupancy in the public entertainment places, issuing the permit with/without conditions, and refusing occupancy permits. In this section, special provisions such as the municipal building surveyor's approval and setting up the registered entities' temporary structures are presented. Furthermore, this division states that the municipal building surveyor of a municipal district may cause any place of public entertainment in that municipal district for which an occupancy permit has been issued under this division to be inspected from time to time to determine whether or not the permit is being complied with.
- ***Divisions 3, 4, and 5*** explain the temporary occupation of buildings regarding the issuing permits, required documents for getting temporary occupancy.

In part 6, the appointment of private building surveyors, their functions and duties, offenses related to surveyors, transferring of responsibilities to other surveyors, the selection of manager for the private building surveyors business, and the powers and duties of the manager are explained:

- ***Division 1*** relates to private surveyors' functions for issuing building permits, carrying out inspections of buildings and building work, and issuing occupancy permits and temporary approvals. It also directs the builders or the landowners on how and when to appoint a surveyor. It points out the charges may be incurred to both builders and surveyors if a surveyor is unregistered or not allowed to act.

- ***Decisions 2 and 3*** describe the surveyor appointment's termination conditions and the transferring of duties to a second surveyor. As well, if there is any conflict of interests or to protect the interests of other persons, a manager for a private building surveyor's business should be appointed by the authority under conditions I) such as the private building surveyor has requested the appointment of a manager, II) the private building surveyor's registration under this Act has been suspended or canceled, III) the private building surveyor has died, IV) the private building surveyor has ceased to carry out the functions of a private building surveyor. The conditions of selecting a manager and the powers of an appointed manager might be completing the business's existing work, incur any expenses that are reasonably related to the conduct of the business, etc. These divisions also focus on how the newly appointed manager should be trained to access the existing documents, enter the buildings, operate equipment or facilities, etc.

In part 7, the conditions of protecting an adjacent property, the duties of the owners for the work protection, work not to be carried out until protection requirements met, emergency procedures and an appointment of an agent for the work protection, the insurance arrangements are explained:

- The owner requires to perform work protection in respect of an adjoining property before or during the carrying out of building work for which a building permit is required must before commencing the building work. Moreover, suppose an owner cannot be found or is incapable of acting. In that case, the owner may apply to the Minister to appoint a suitable person to act as agent for the adjoining owner during the adjoining owner's absence or incapacity.

- At any time for the carrying out of building work, the relevant building surveyor must make available to the adjoining owner, on request, for inspection, without charge, any plans, drawings, and specifications of the proposed building work in the possession or control of the relevant building surveyor.
- Before any protection work is commenced in respect of an adjoining property, an owner must ensure that a contract of insurance is in force against
    - damage by the proposed protection work to the adjacent property,
    - any liabilities likely to be incurred to adjoining occupiers and public members during the building work and for 12 months after that building work is completed.
- Finally, in this part, before the commencement of any protection work, the owner or the owner's agent in company with the adjoining owner or the adjoining owner's agent must make a full and adequate survey of the adjacent property. Also, adjoining the owner and adjoining the occupier will not obstruct the owner. They must agree on the adjoining owner's expenses or adjoining occupier for the inconvenience, loss, or damage suffered by the adjoining owner.

In part 8, the building safety and standards under three main divisions are explained:

- ***Divisions 1 and 2*** explain the emergency order conditions by municipal building surveyors if there is a danger to life or property. Therefore, An emergency order may

direct an owner or occupier to evacuate a building or land or a place of public entertainment within a specified time or times. An emergency order may also prohibit any person from entering, using, or occupying a building, land, or a place of public entertainment for the period determined by the municipal building surveyor. Such an order may require the owner of a building or land or a place of public entertainment to cause an inspection of that building, to test material used in that building or place, and to notice the builders or owners or occupants for evacuation.

- ***Division 3*** focuses on the penalties a person may be charged due to disobey the emergency evacuation orders, the conditions that workers or owners can continue the building works without a permit, the recovery costs, police officers' help for the evacuation of buildings.

In part 9, the conditions that immune commissioners and staff, building surveyor, and members of public authorities for any liabilities, limitation of actions for any damage or loss concerning defective building works, and insurance for building works are explained:

Divisions 1 and 2 describe that A Commissioner or any person appointed or engaged by the authority is not liable for anything done or omitted to be done in good faith in carrying out a function under the Act.

Also, in division 2, a building action cannot be brought more than ten years after the date of issue of the occupancy permit regarding the building work (whether or not the occupancy permit is subsequently cancelled or varied) if an occupancy permit is not issued.

However, a building action may be brought more than 10 years but less than 12 years after the date of issue of the occupancy permit in respect of the building work (whether or not the occupancy permit is subsequently canceled or varied) or, if an occupancy permit is not issued and if the building action is a cladding building action (a building action in connection with, or otherwise related to, a product or material that is, or could be, a non-compliant or non-conforming external wall cladding product).

Division 3 focuses on the order by the Minister which require building practitioners in specified categories or classes of building practitioners or persons or any part of a class or category of building practitioners to be covered by insurance and specify the kinds and amount of insurance by which building practitioners and persons in each specified category or class or part of a category or class are required to be covered. In this section, the conditions and the penalties for any offenses for the insurance coverage are stated.

It also asserts that if an order requires a builder to be covered by insurance relating to the carrying out of domestic building work or managing or arranging the carrying out of domestic building work, the insurance required by the order must be provided by a designated insurer. In the other parts of division 3, the insurance requirements for a home sold before completion and owner-builders are explained.

Division 4 focuses on the subrogation as financial assistance concerning cladding rectification work on the building to the building owner. Also, when the financial aid is paid to the payee, the Crown is subrogated to all the rights and remedies of the payee against any person about the installation or use of any non-compliant or non-conforming external wall cladding product or other building work that required the cladding rectification work to be undertaken.

In part 10, the rights of building appeals boards for building and occupancy permits, fixing building works, temporary occupation, appointing private surveyors, work protection, building notices and orders, disputes about inspections, and application requirements for building works.

Division 1 is related to the rights of appeals for the owner of a building that may appeal to the Building Appeals Board against the refusal or deemed refusal of a permit for the building work or occupancy, or carrying out protection work or an adjoining owner, or authority's failure of the private surveyor.

Division 2, 3, and 4 describe the appeals' request conditions and the disputes over the inspections for the matters such as emergency protection work, insurance, cost of supervising of building works, disputes between owners and adjoining owners. In division 4 specifies the conditions that an adjoining owner who suffers inconvenience, loss, or damage during protection work under Part 7 may apply to the Building Appeals Board for an order determining the amount (if any) of compensation for that inconvenience, loss, or damage as well as Modification of building regulations and design.

Divisions 5 and 6 focus on the powers and the agreements among the building owners and the stakeholders, and the establishment and membership of Building Appeals Board conditions and requirements.

In part 10, the conditions related to a registered building practitioner's appointment, and the penalties associated with an unregistered building practitioner's appointment, the conditions of suspension and disqualification for a building practitioner are stated.

In part 11, the licensing conditions of building employees for carrying out the building work, and the penalties associated with unregistered employees, the conditions of suspension and disqualification for employees are pointed out.

In part 12 - this part consists of 12 divisions related to the role of the Minister for building administration, the establishment of authority, the functions of the authority, the board and the staff, the amount of fund for the authority, the role of authority, and advisory committee, and the council (to administer building provisions in its municipal district), and the plumbing requirements and conditions for the building works are stated.

Division 1 – the role of Minister for issuing the guidelines for the permits and fees of building works, directions to building surveyors, guidelines for the design and siting of dwellings, determination of an area which is subject, or which is likely to be subject, to bushfires are taken into account.

Also, the Minister may declare that an external wall cladding product is prohibited from being used by any person in the course of carrying out any building work in connection with the construction of a building.

Divisions 2, 3, and 4 point out the functions and establish the advisory committee's building regulations, the board, the staff requirements, and inspectors' appointment. The authority must establish and administer a fund to be known as the Victorian Building Authority Fund, which is to be divided into the building and plumbing funds and the Cladding Safety Victoria account for the building rectification works.

Division 5 – the role of Council to administer building provisions in its municipal district, and the crown and public authorities to promote better standards for building owned by the Crown or a public authority other than a Council are stated.

In this part (**part 12**), plumbing works conditions and requirements to regulate is carried out safely and competently is provided. Moreover, the conditions, restrictions, rectification of defective plumbing works, insurance coverages, and plumbing work provisions by licensed or registered plumbers are presented.

In part 13, the Minister's power concerning councils, Powers of inspection of the chief officer, and municipal building surveyor for the assessments of safety and emergency equipment, information gathering, entry powers, remedies and injunctions for the persons undertaking the duties, any building infringements and the associate penalties are stated.

Divisions 1 and 2– the powers of the Minister may, by order, direct the Council to carry out the function within a specified time or to cause the building surveyor to carry out the function within a specified time, and any other persons carrying out the building work. In division 2, the Minister's powers and any other persons gather information related to all elements of the building works, the equipment, and entry to the lands or building.

Divisions 3 and 4– the evidence of ownership or occupation of land in any legal proceedings is presented. Also, the offenses and associated penalties within a municipal district for different bodies carrying out the building work, or not vacating the land ordered by the authority, or building infringement for persons committed an offense.

In part 14, the improper use of information and information sharing are mentioned. It asserts that the authorities must not make improper use of information acquired under the person's position to gain directly or indirectly a pecuniary advantage for the person or any other person.

Appendix B - Building Regulations 2018, Version No. 013, S.R. No. 38/2018 - Summary

The building Regulation 2018 version 013 consists of 23 main parts and multiple divisions and sub-divisions for the building industry. The new Regulations also are designed to improve fire safety in multi-story residential buildings. In this new version, **ten critical areas** of regulatory change are described briefly below (www.legislation.vic.gov.au):

1. New forms and further requirements ensure that the permits, orders, and notices include the needed information.
2. The Regulations have been modernized for the electronic use of documents for permits.
3. Updated requirements for the chief officer, building surveyors and building practitioners about documenting performance solutions.
4. New building permit reporting requirements were commencing on 1 July 2019.
5. New obligations for the building surveyor to provide notice 30 days before a building permit lapsing to minimize lapsed permits.
6. Clear obligations on the building surveyor and the owner to inform the adjoining owner about protection work
7. They introduce a new mandatory notification stage and inspections if the building work includes fire and smoke resistant building elements, lightweight construction in multi-story residential buildings, and service penetrations in multi-story residential and healthcare buildings. The Regulations also clarify the prescribed mandatory notification stages for demolition work or the construction of a pool.
8. The Regulations clarify owners' obligations concerning essential safety measures (such as firefighting equipment) maintenance and encourage the uptake of maintenance schedules to simplify information for the owner. They also clarify the notification requirements concerning pool barriers.
9. As-of-right construction of a Class 10a building with a floor area not exceeding 10m2 on undeveloped land.
10. It formalizes the process for granting a determination to treat two or more allotments as a single allotment for a building permit application.

In part 1, the primary objectives, critical definitions of some terminologies employed in the regulations and rules, and the Act's commencement are described.

- ✓ These Regulations are made under sections 7, 9, 15A, 261 and 262 of, and Schedule 1 to, the **Building Act 1993**.
- ✓ These Regulations come into operation on **2 June 2018**.

The primary objectives of these regulations are;

a) to remake with amendments the regulations which control the design, construction and use of buildings and places of public entertainment,
b) to prescribe standards for the construction and demolition of buildings,
c) to prescribe standards of safety for places of public entertainment
d) to regulate matters relating to the use and maintenance of buildings and places of public entertainment
e) to prescribe requirements for the design and siting of single dwellings and associated buildings
f) to prescribe standards and matters relating to the maintenance of fire safety and safety measures
g) to prescribe requirements for swimming pools and spas
h) to provide for matters relating to the accreditation of building products, construction methods, designs, components, and systems connected with building work
i) to prescribe qualifications and provide for other matters relating to registration of building practitioners
j) to prescribe fees concerning matters before the Building Appeals Board, the Authority, and the Building Regulations Advisory Committee

In part 2, the building code of Australia (BCA) is stated. For the purposes of these Regulations, buildings must be classified as set out in the BCA. The relevant building surveyor must determine the classification of a building when performing a function under the 1993 Act or these Regulations.

In part 3, applications for certificates of consent for owner-builders, the information in a certificate of consent *are* described:

- ***Divisions 1 and 2*** relate to an application for a certificate of consent, associated information, and registration procedure to carry out domestic building work on the land in the form approved by the authority. The fees for an application for a certificate of consent, required knowledge, duties, and responsibilities for owner-builders are highlighted.

In part 4, the building permits regarding the applications for the permits, exemptions from building permits, reporting to the authorities, builder's insurance approved by the relevant building surveyor, duties of a building surveyor, duties of Council, time limits for building work, and permits are explained:

- ***Divisions 1 and 2*** relate to the conditions that permit the building works to be exempted. The application for building permits to construct or alter the building, demolish, or remove a building is also mentioned.
- ***Division 3*** specifies the reporting authorities (the chief officer, a relevant council, a relevant service authority, a relevant electricity supply authority). In this division, the prescribed time within which the relevant building surveyor must give a copy of an

application for a building permit to each reporting authority required to report on or consent to the application and maximum fees for report and consent is provided.

- ***Divisions 4 and 5*** explain how the relevant building surveyor may be satisfied with the builder's insurance details, conditions in which the building permit can be issued, and a copy of licenses by the relevant building surveyor. Also, any changes in the building work or the information should be submitted to the builder's building surveyor.

  In **division 5**, duties of the building of surveyor such as submitting documents to the Council, fees regarding lodging documents, details of all permits and certificates of final inspection issued by the relevant building surveyor during that month, whether any of the building work will be carried out in a designated **bushfire prone area** determined under section 192A of the Act and the applicable **bushfire attack** level determined for the site.

- ***Divisions 6 and 7*** specify the duties of the Council such as
  - the period that documents concerning building permits, applications for building permits, including documents relating to protection work must be kept,
  - any person may request the relevant Council to provide concerning any building or land details as to whether the building or land is
    - in an area that is liable to flooding,
    - in an area that is designated as an area in which buildings are likely to be subject to attack by termites,
    - in an area for which a bushfire attack level has been specified in a planning scheme,
    - in an area designated as likely to be subject to significant snowfalls.

  In **divisions 7 and 8**, the conditions that the building work must commence, the extension of building permits, and how combined allotments of lands can be considered a single allotment.

In part 5, the details and conditions on the fixing or building (siting) an existing building, construction of a single Class 1 building, and associated Class 10a buildings on an allotment are explained:

- ***Divisions 1 and 2*** focus on the application of siting related to the design in relation to a building on an allotment for siting matter. In division 2, the conditions related to constructing a single Class 1 building and associated Class 10a buildings on an allotment are provided. Different standards a Class 1 building should be taken into account:
  - Maximum street setback
  - Minimum street setbacks
  - Building height
  - Site coverage
  - Minimum garden area
  - Permeability of the surface
  - Side and rear setbacks

  - Car parking
  - Walls and carports on boundaries
  - Daylight to existing habitable room windows
  - Solar access to existing north-facing habitable room windows
  - Overlooking
  - Private open space
- ***Divisions 3 and 4*** explain the conditions concerning the siting of Class 10a buildings and Class 10b structures. This division applies to the construction of Class 10b structures on an allotment. A Class 10a building that is appurtenant to another class structure must be on the same allotment as the other class's building.
  - It specifies allotment requirements for Front fence height, Fence setbacks from side and rear boundaries, mast, pole, aerial, antenna, chimney, flue, or service pipe.

In part 6, the conditions on the projections of a building and the architectural features are explained:

- This part states that a building must not project beyond the street alignment based on the architectural design for different forms of streets (narrow, medium, wide). It also explains Windows and balconies' requirements, Verandahs, Sunblinds and awnings, Service pipes, rainwater heads and service installations, Window shutters, Signs, and Service cabinet doors.
- It should be noted that the report and consent of the relevant Council must be obtained to an application for a building permit to construct any of the parts above of a building if the part projects beyond the street alignment at a different height or distance to that specified in this part.

In part 7, the conditions of protecting an adjacent property, protection of the public, demolition of the building, excavations, and retaining walls are explained:

- ***Division 1***- The owner requires to perform work protection in respect of an adjoining property before or during the carrying out of building work for which a building permit is required must before commencing the building work.
  - The relevant building surveyor must determine whether protection work is required due to proposed building work when deciding an application for a building permit concerning that work.
  - The relevant building surveyor may at any time determine that protection work is required about building work.
  - Matters relevant building surveyor must consider when determining if protection work required
    - specifications that describe the materials and methods to be used in the proposed building work
    - any demolition required as part of the proposed building work, etc.

- ***Divisions 2, 3, and 4*** relate the Precautions that must be taken before and during building work to protect the public's safety if required by the relevant building surveyor, the operations related to Excavations and retaining walls, and demolition of the building if necessary.

In part 8, the regulations concerning the building work related to Methods of assessment of compliance and Special provisions are explained:

- ***Division 1*** explains the regulations of how the material should be tested. In terms of fire performance requirements, the relevant building surveyor must not determine that a performance solution complies with a fire performance requirement of the building code of Australia unless the relevant building surveyor:
  - holds a Graduate Certificate in Performance-Based Building & Fire Codes from Victoria University
  - holds a qualification that the Victorian Building Authority considers is equivalent to that Certificate
  - a report of the chief officer that that performance solution achieves a satisfactory degree of fire safety
  - certificate by a fire safety engineer, who did not design the building work that states that the performance solution complies with that performance requirement
  - certificate by a registered building surveyor, who did not design the building work, and who holds a qualification that states that the performance solution complies with that performance requirement
  - relies on a determination of the Building Appeals Board under section 160A of the 1993 Act that the performance solution complies with that performance requirement
  - relies on a certificate of accreditation issued by the Building Regulations Advisory Committee that states that the performance solution complies with that performance requirement
  - relies on a Certificate of Conformity issued by a person or body duly authorized by the Australian Building Codes Board that states that the performance solution complies with that performance requirement
- ***Division 2*** focuses on special provisions for the building work such as pile-driving, type of timber, septic tank systems, and requirements for permits involving fire safety matters such as:
  - fire hydrants, fire control centers or fire control rooms, fire precautions during construction
  - fire mains, control valves, booster assemblies, open space, and perimeter vehicular access to the extent it relates to emergency vehicles, fire indicator panels, fire services control in passenger lift cars.
- It should be noted that the report and consent of the chief officer must be obtained for an application for a building permit that involves any of the fire safety matters stated above.

In part 9, the fire safety requirements are explained:

- This regulation applies to a Class 1 or 3 building or a Class 4 part of a building or a sole-occupancy unit contained in a Class 2 building or a Class 9a building that is a residential care building that was constructed, or for which a building permit was granted. It specifies the conditions and requirements for installing automatic smoke detection and alarm systems, automated fire suppression systems for residential care, and shared accommodation buildings.
- This part also points out the safety and maintenance requirements and certification and for building swimming pools and spas. This part applies to the land where a swimming pool or spa is located in the swimming pool or spa. It specifies conditions for the barriers to restrict access to the part of the land on which the swimming pool or spa is located, doors and gates, and window in the wall.

In part 10, conditions and requirements concerning the mapping of designated particular areas, alteration to and creation of designated special areas, and risky areas are presented.

- A council must prepare maps for all designated special areas within its municipal district.
- A council may designate areas within its municipal district where buildings are likely to be subject to attack by termites.
- A council may designate areas in its municipal district that, in its opinion, are likely to be subject to significant snowfalls and flooding.
- The report and consent of the relevant Council must be obtained for an application for a building permit for the construction of a building on designated land or designated works.

In part 11, the conditions related to construction in designated bushfire prone areas for the buildings are stated.

- Despite anything to the contrary in the building Act of Australia, if a building is to be constructed in a designated bushfire prone area and the bushfire attack level for the site is specified in a planning scheme applying to that site, the relevant building surveyor must accept that bushfire attack level to determine the construction requirements that apply to the building.
- Despite anything to the contrary in the building Act of Australia, if a building is to be constructed in a designated bushfire prone area and a planning permit is required for the construction of the building, and a site assessment to determine the bushfire attack level for the site has been considered as part of the application for the planning permit.
- Relevant building surveyor must accept bushfire attack level if
    - the building is to be constructed in a designated bushfire prone area
    - the bushfire attack level for the site is determined as LOW by the relevant building surveyor
- It should be noted that the building in this regulation means a Class 1, 2 or 3 building, or a Class 10a building that is associated with a Class 1, 2, or 3 building, or a deck that is associated with a Class 1, 2 or 3 building, or a specific use bushfire protected building.

In this part also the construction requirements for bushfire-protected buildings are stated. Notably, Specific use bushfire protected building means a Class 9a or 9c building, a building from which a school within the meaning of section 1.1.3(1) of the Education and Training Reform Act 2006 is operated, a building from which an early childhood center is operated.

In **division 2 of this part**, requirements for buildings replacing buildings destroyed in the 2009 bushfires for Class 1a buildings. It also states the conditions that a static water supply for firefighting purposes (the static water supply) must be provided on the allotment in accordance with this regulation.

Also, the driveway to the building must be designed to allow emergency vehicle access in accordance with this regulation, and the requirements concerning private bushfire shelters for a Class 10c building associated with a Class 1 building are explained.

In part 11, the conditions and requirements of emergency accommodation buildings (a building that is constructed or proposed to be constructed on land on which an existing Class 1a building has been destroyed or rendered unfit for occupation due to an emergency).

In parts 12 and 13- these parts state the requirements regarding the inspections and directions for mandatory notification stages for construction or alteration of the building, emergency orders, entry powers to the land or buildings, and finally occupancy permits and certificates for final inspections. In part 13, the time within which municipal building surveyor must decide application to accept or amend occupancy permit is also mentioned.

In parts 14 and 15, the conditions and maintenance for prescribed classes of buildings or places for public entertainment, temporary structures requirements, design, and associated safety measures are stated. Maintenance of exits and paths of travel relating to buildings or places of public entertainment and the annual safety assessment report requirements for public buildings are specified in these parts.

In parts 16 and 17, the conditions for any changes of use or any alternations of the existing buildings and associated paths or paths to exits, and application of requirements for persons with disabilities, and building products accreditation (includes construction method, design, component, or system connected with building work) are provided. In part 17, prescribed persons and bodies to accredit building products, accreditation fees, and associated procedures are explained.

In parts 18, 19, and 20, the conditions related to a registered building practitioner's appointment, and the penalties associated with an unregistered building practitioner's appointment, the conditions of suspension and disqualification for a building practitioner are stated. In part 19, the rights of building appeals boards for building and occupancy permits, fixing building works, temporary occupation, appointing private surveyors, work protection, building notices and orders, disputes about inspections, and application requirements for building works. Finally, in part 20, any building infringements and the associate penalties are

stated. In this part, the prescribed officers, penalties for the offenses are specified and classified.

In part 21, the exemptions related the building works such as Exemption for Class 10 buildings on farm land, Exemption from certain fees, etc. Finally, **in parts 22 and 23**, Transitional and savings provisions and Revocation of temporary fees are classified based on various regulations.

Appendix C - Additional Key Fire and Life Safety Provisions

C.1.1 E - Services and Equipment

E1 Firefighting equipment

C.1.1.1 *Objectives:*

EO1 - The Objective of this Part is to:

a. *safeguard occupants from illness or injury while evacuating during a fire; and*
b. *provide facilities for occupants and the fire brigade to undertake firefighting operations; and*
c. *prevent the spread of fire between buildings.*

C.1.1.2 *Functional Statements*

EF1.1 - A building is to be provided with firefighting equipment to safeguard against fire spread:

a. *to allow occupants time to evacuate safely without being overcome by the effects of fire; and*
b. *so that occupants may undertake initial attack on a fire; and*
c. *so that the fire brigade have the necessary equipment to undertake search, rescue, and firefighting operations; and*
d. *to other parts of the building; and*
e. *between buildings.*

C.1.1.3 *Performance Requirements*

a. *EP1.1 Fire hose reels: A fire hose reel system must be installed to the degree necessary to allow occupants to safely undertake initial attack on a fire.*
b. *EP1.2 Fire extinguishers: Fire extinguishers must be installed to the degree necessary to allow occupants to undertake initial attack on a fire.*
c. *EP1.3 Fire hydrants: A fire hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade.*
d. *EP1.4 Automatic fire suppression systems (NSW EP1.4): An automatic fire suppression system must be installed to the degree necessary to control the development and spread of fire.*
e. *EP1.5 Firefighting services in buildings under construction: Suitable means of firefighting must be installed to the degree necessary in a building under construction to allow initial fire attack by construction workers and for the fire brigade to undertake attack on the fire.*
f. *EP1.6 Fire control centres: Suitable facilities must be provided to the degree necessary in a building to co-ordinate fire brigade intervention during an emergency.*

C.1.1.4 *Verification Methods*

a. *EV1.1 Fire Safety Verification Method: Compliance with EP1.1, EP1.2, EP1.3, EP1.4 and EP1.6 is verified when a building is designed in accordance with Schedule 7.*

E2 Smoke hazard management

C.1.1.5 *Objectives:*

EO2 - The Objective of this Part is to:

a. *safeguard occupants from illness or injury by warning them of a fire so that they may safely evacuate; and*
b. *safeguard occupants from illness or injury while evacuating during a fire.*

C.1.1.6 *Functional Statements*

EF2.1 - A building is to be provided with safeguards so that:

a. *occupants are warned of a fire in the building so that they may safely evacuate; and*
c. *occupants have time to safely evacuate before the environment in any evacuation route becomes untenable from the effects of fire.*

C.1.1.7 *Performance Requirements*

a. *EP2.1 Automatic warning for sleeping occupants: In a building providing sleeping accommodation, occupants must be provided with automatic warning on the detection of smoke so they may evacuate in the event of a fire to a safe place.*
b. *EP2.2 Safe evacuation routes:*
   i) *In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building.*
   ii) *The period of time occupants take to evacuate referred to in (i) must be appropriate.*

C.1.1.8 *Verification Methods*

a. *EV2.1 Fire Safety Verification Method: Compliance with EP2.1 and EP2.2 is verified when a building is designed in accordance with Schedule 7.*

E3 Lift installations

C.1.1.9 *Objectives:*

EO3 - The Objective of this Part is to:

a. *facilitate the safe movement of occupants; and*
b. *facilitate access for emergency services personnel to carry out emergency procedures and assist in the evacuation of occupants.*

C.1.1.10 *Functional Statements*

EF3.1 - Where a passenger lift is provided, it is to facilitate safe and easy:

a. *movement for occupants with a disability; and*

b. *evacuation of occupants, who due to illness or injury need stretcher assistance.*

EF3.2 - A building is to be provided with one or more passenger lifts to facilitate:

a. *the safe access for emergency services personnel; and*
b. *safe and easy evacuation of occupants who due to illness, injury or disability cannot use stairways in the event of an emergency.*

EF3.3 - A building having a passenger lift is to be provided with measures to alert occupants about the use of the lift in an emergency.

C.1.1.11 *Performance Requirements*

a. *EP3.1 Stretcher facilities: Stretcher facilities must be provided, to the degree necessary:*
   i) *in at least one emergency lift required by EP3.2; or*
   ii) *where an emergency lift is not required and a passenger lift is provided, in at least one lift, to serve each floor in the building served by the passenger lift.*
b. *EP3.2 Emergency lifts: One or more passenger lifts fitted as emergency lifts to serve each floor served by the lifts in a building must be installed to facilitate the activities of the fire brigade and other emergency services personnel.*
c. *EP3.3 Emergency alerts: Signs or other means must be provided to alert occupants about the use of a lift during an emergency.*
d. *EP3.4 Lift access for people with a disability: When a passenger lift is provided in a building required to be accessible, it must be suitable for use by people with a disability.*

C.1.1.12 *Verification Methods*

a. *EV3.1 Fire Safety Verification Method: Compliance with EP3.2 is verified when a building is designed in accordance with Schedule 7.*
b. *EV3.2 Emergency alerts on the use of lifts: (a) Compliance with Performance Requirement EP3.3 is verified when building occupants are provided with automatic warning that lifts must not be used during a fire emergency.*

E4 Visibility in an emergency, exit signs and warning systems

C.1.1.13 *Objectives:*

EO4 - The Objective of this Part is, in an emergency, to safeguard occupants from injury by:

a. *having adequate visibility; and*
b. *having adequate identification of exits and paths of travel to exits; and*
c. *being made aware of the emergency.*

C.1.1.14 *Functional Statements*

EF4.1 - A building is to be provided with:

a. *adequate visibility upon failure of normal artificial lighting during an emergency; and*
b. *adequate means:*
   i) *of warning occupants to evacuate; and*

ii) to manage the evacuation process; and
iii) to identify exits and paths of travel to an exit.

C.1.1.15 *Performance Requirements*

a. *EP4.1 Visibility in an emergency: To facilitate safe evacuation in an emergency, a building must be provided with a system.*
b. *EP4.2 Identification of exits: To facilitate evacuation, suitable signs or other means of identification must be provided, to the degree necessary.*
c. *EP4.3 Emergency warning and intercom systems: To warn occupants of an emergency and assist evacuation of a building, an emergency warning and intercom system must be provided, to the degree necessary.*

C.1.1.16 *Verification Methods*

a. *EV4.1 Emergency Lighting: Compliance with EP4.1 is verified for the level of visibility for safe evacuation in an emergency and instantaneous activation.*
b. *EV4.2 Fire Safety Verification Method: Compliance with EP4.1, EP4.2 and EP4.3 is verified when a building is designed in accordance with Schedule 7.*

C.1.2 G - Ancillary Provisions

G2 Boilers, pressure vessels, heating appliances, fireplaces, chimneys and flues

C.1.2.1 *Objectives:*

GO2 - The Objective of this Part is to:

a. *safeguard occupants from illness or injury caused by:*
   i) fire from combustion appliances installed within a building; and
   ii) malfunction of a boiler or pressure vessel installed within a building; and
b. *protect a building from damage caused by the malfunction of a boiler or pressure vessel installed within.*

C.1.2.2 *Functional Statements*

GF2.1 - Combustion appliances using controlled combustion located in a building are to be installed in a way which reduces the likelihood of fire spreading beyond the appliance.

C.1.2.3 *Performance Requirements*

a. *GP2.1 Combustion heating appliances: Where provided in a building, a combustion appliance and its associated components, including an open fire-place, chimney, flue, chute, hopper or the like, must be installed adequately*

C.1.2.4 *Verification Methods*

a. *GV2 Combustion appliances: Compliance with GP2.1 is verified.*

G5 Construction in bushfire prone areas

C.1.2.5 *Objective*

GO5 - The Objective of this Part is to:

a. *safeguard occupants from injury; and*
b. *protect buildings,*

from the effects of a bushfire.

C.1.2.6 *Functional Statements*

GF5.1 - A building constructed in a designated bushfire prone area is to provide a resistance to bushfires in order to reduce the danger to life and minimise the risk of the loss of the building.

C.1.2.7 *Performance Requirements*

a. *GP5.1 Bushfire resistance: A building that is constructed in a designated bushfire prone area must, to the degree necessary, be designed and constructed to reduce the risk of ignition from a bushfire.*

C.1.2.8 *Verification Methods*

a. *GV5 Buildings in bushfire prone areas:*
   i) *Compliance with Performance Requirement GP5.1 is verified if the ignition probability for a building exposed to a design bushfire does not exceed 10%.*
   ii) *Bushfire design actions must be determined in consideration of the annual probability of a design bushfire.*
   iii) *A building or structure's importance level must be identified.*