A working acoustician's guide to compliance and the NCC(BCA)

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ABSTRACT

The Building Code of Australia [BCA] presents a one-size-fits-all approach to the provision of adequate acoustic amenity for new construction. To quote from the document, "The BCA is a uniform set of technical provisions for the design and construction of buildings and other structures". Acousticians must constantly interpret the provisions and perhaps the intent, of the Code for our clients; often in conflict with margin-poor constructors doing "it" the way they have always done. The BCA is given legal effect by building regulatory legislation in each State and Territory and while the various pieces of legislation differ, they all give the BCA the force of law. In our increasingly risk adverse construction environment there is a need to adhere more carefully to due process as we provide our recommendations and expert opinions. This paper gives an acoustician's understanding of the process whereby the Code provisions are presented and the process by which acoustic "certification" should be documented. Further, it presents a path by which variations to Code deemed-to-satisfy provisions ("performance solutions") can be introduced in a manner such as to limit unintended consequences and allow others to "tick-the-boxes" on the path to certification.

1. INTRODUCTION

The National Construction Code (NCC) is an initiative of the Council of Australian Governments (COAG) developed to incorporate all on-site building and plumbing requirements into a single code. The introduction to the document (BCA, 2016) states:

> *The NCC is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia, which allows for variations in climate and geological or geographic conditions.*

The NCC is published in three volumes. Volumes One and Two of the NCC comprise the Building Code of Australia (BCA); the Plumbing Code of Australia (PCA) comprises Volume Three. As acousticians, our professional interest is limited to Volumes One and Two, hence we have the confusion of knowing the document as both the NCC and the BCA. For the remainder of the paper the Code is referred to as the BCA.

With the many codes, policies, guidelines and City Plans that we need to deal with, the BCA may seem to be "off to one side" and "of lesser importance" than, say, the requirements of a Transport Authority or the Development conditions imposed by a local council. However, lest we get complacent, the BCA is "the law" and is invoked by legislation in each state.

> *The BCA is given legal effect by building regulatory legislation in each State and Territory. This legislation consists of an Act of Parliament and subordinate legislation which empowers the regulation of certain aspects of buildings and structures, and contains the administrative provisions necessary to give effect to the legislation. (BCA, 2016).*

The NCC is structured into three volumes:

BCA Volume 1 contains:

- *(a) all Class 2 to 9 buildings; and*
- *(b) access requirements for people with a disability in Class 1b and 10a buildings; and*
- *(c) certain Class 10b structures including access requirements for people with a disability in Class 10b swimming pools.*

BCA Volume 2 contains:

- *(a) Class 1 and 10a buildings (other than access requirements for people with a disability in Class 1b and 10a buildings); and*
- *(b) certain Class 10b structures (other than access requirements for people with a disability in Class 10b swimming pools); and*
- *(c) Class 10c private bushfire shelters.*

NCC Volume 3 contains the requirements for plumbing and drainage associated with all classes of buildings.

BCA Volume 1 acoustic provisions, are provided in Section F "Health and Amenity" and Part 5 "Sound transmission and insulation". Those for Volume 2 are contained in Part 2.4 and Part 3.8.6 "Sound Insulation". For the remainder of this paper, reference will be to Volume 1.

2. THE ISSUE

Within a typical workload as acousticians working in the built environment, we are often called on to certify compliance with BCA requirements. The provision of such certification, in a manner that is rigorous and traceable[1] is a matter of professional competence: failure may raise issues of professional liability. The call for acoustic certification may be as a result of a vigilant Building Certifier or simply as a result of our warning to a builder early in project construction, that there will be an issue with certification. There are also instances, where, while we are not called to certify, common sense would suggest we should be.

This paper aims to raise awareness of where certification is required, by whom and the detail required. A driver for my concern, is a Queensland situation, where a certifier offered his services to building owners/developers to ensure that the BCA processes were being rigorously, complied with, particularly in relation of provisions concerning fire resistance. A number of actual and procedural failings were uncovered in the resulting investigations, which has led to a greater focus on compliance in all areas. Recent failings in building cladding components and fire sealing in Melbourne high-rise constructions (Anon., n.d.) indicates that such failings are not simply a Queensland matter.

In reading the BCA I have yet to find a section that ranks compliance in merit order, i.e. structural trumps fire, water proofing, trumps acoustic amenity etc. Among other things this calls to mind, the very common practice of installing fire rated apartment doors with no acoustic ratings (the Code requirement is R_w30).[2]

3. THE PROCESS

With the release of the BCA 2016 the pathway from performance requirements to achieving compliance solutions was streamlined compared to previous versions.

A0.1 Compliance with the NCC

Compliance with the NCC is achieved by satisfying the Performance Requirements

A0.2 Meeting the Performance Requirements

The Performance Requirements can only be satisfied by a—

- *(a) Performance Solution; or*
- *(b) Deemed-to-Satisfy Solution; or*
- *(c) combination of (a) and (b).*

In the above "performance solution" has the same meaning as the term "alternate solution" used in previous versions of the Code.

The compliance structure is illustrated in Figure 1. The most significant change introduced with BCA 2016, with respect to previous versions is, from the point of view of acoustical compliance, the removal of the need to identify the Deemed-to-Satisfy Solution (DtS) as a part of the documentation of a performance (alternative) solution.

From Sections A.03 "Performance Solutions" and A.04 "Deemed to Satisfy Solutions" we learn that both avenues to a compliance solution are to be assessed as meeting the Performance Requirements by the same pathway:

A.05 Assessment methods

- *(a) Evidence to support that the use of a material or product, form of construction or design meets a performance Requirement or a Deemed-to-Satisfy Provision as described in A2.2.*
- *(b) Verification Methods such as—*
  - *(i) the Verification Methods in the NCC; or*
  - *(ii) such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.*
- *(c) Expert Judgement.*
- *(d) Comparison with the Deemed-to-Satisfy Provisions.*

[1] BCA Introduction "*documentation of decisions*" for a recommended documentation schedule

[2] BCA Contents and Features Introduction, Section A1.5 *"Compliance with all Performance Requirements"*

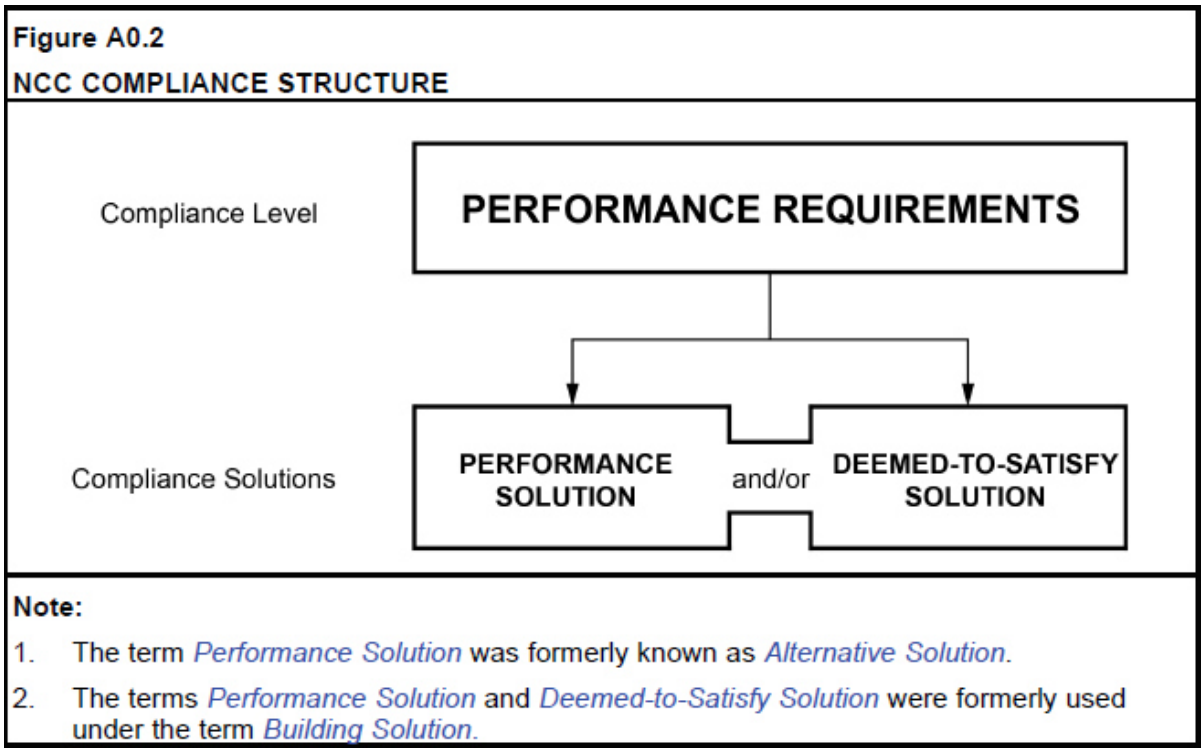


Figure 1: BCA 2016 - Compliance Structure

4. THE DEEMED TO SATISFY PATHWAY

For a builder, the process of BCA compliance for an inter-tenancy party wall, for instance, may be as simple as choosing from the multiplicity of solutions available from such plasterboard supplier's publications as, the Red Book (CSR Gyprock, 2012), Green Book (USG Boral, 2014), Knauf Book (Knauf Plasterboard Pty Ltd, 2014), etc. Further options are provided in the "*Acceptable forms of construction"* provided in Table 2 of Specification F5.2 (BCA, 2016).

The wall will be built and the documentation provided to the certifier to show that the supplier's system specification was complied with. The certifier will, typically, accept the construction as compliant.

This process follows the above route A.05 (d). As an example, presented in Figure 2 & Table 1; consider a party wall in a Class 2 structure and trace backwards from a typical solution to the underlying performance requirement. Our starting point is a Laboratory Measurement, as documented in a supplier's literature. It is worth noting that few of the many solutions presented in the literature are tested (as indicated as **Bold** in the results table).

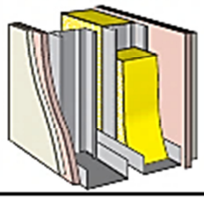
SYSTEM N°	WALL LININGS	STUD DEPTH mm	64	76	92	150
		MINIMUM CAVITY WIDTH mm	148	172	204	320
		CAVITY INFILL (Refer to Bradford)	R_w / R_w+C_{tr}			
CSR 206 Plus 	*Both Sides (Any Order)* • 1 x 10mm Gyprock Plus plasterboard. • 1 x 16mm Gyprock Fyrchek plasterboard.	(a) Nil	49/43	49/43	50/44	52/46
		(b) 50 GW Acoustigard 11kg	57/48	57/48	58/49	60/**51**
		(c) 75 GW Acoustigard 11kg	60/**51**	59/**50**	60/**51**	62/**53**
		(d) MSB3 Polyester	53/46	53/46	54/47	56/49
		(e) 60NG SoundScreen 1.7	60/49	60/49	61/**50**	63/**52**
		WALL THICKNESS mm	200	224	256	372

Figure 2: Extract from CSR data (CSR Gyprock, 2015)

Table 1: Deemed-to Satisfy [DTS] Solution Tree

The Performance requirement	FP5.5 Walls separating sole-occupancy units, or a sole-occupancy unit from a kitchen, bathroom, sanitary compartment (not being an associated ensuite), laundry, plant room or utilities room, must provide insulation against the transmission of— (a) airborne sound (b) … Sufficient to prevent illness or loss of amenity to the occupants;
The DTS Provisions	F5.5 A wall in a Class 2 building must have an Rw + Ctr (airborne) not less than 50, if it separates sole-occupancy units
	F5.2 A form of construction required to have an airborne sound insulation rating must— (a) have the required value for weighted sound reduction index (Rw) or weighted sound reduction index with spectrum adaptation term (Rw + Ctr) determined in accordance with AS/NZS 1276.1 or ISO 717.1 using results from laboratory measurements
	F5.0 Deemed-to-Satisfy Provisions (a) Where a Deemed-to-Satisfy Solution is proposed, Performance Requirements FP5.1 to FP5.6 are satisfied by complying with F5.1 to F5.7
The complying solution	CSR Red book complying structure Rw + Ctr 51 – Laboratory Measurement (CSR275 – (e))
Got there	☺

4.1 Typical variations

From Figure 2, we can note that the wall system illustrated provides for a number of variations some being tested and others not. From our site experience, we note a further range of variations:

- Substitution of plasterboard;
- Substitution of insulation;
- Variation of cavity width.

For the tested solutions, the path to certification presented above, i.e. via "results from laboratory measurements", holds true, however when faced with a situation where a substitution has been made a different path for certification needs to be chosen and documented. Within Figure 2 there are a number of options that are not tested and are therefore, strictly, a performance solution (refer A0.5 (c)) relying on expert judgements and comparison to a tested solution (refer A0.5 (d)) and should be documented as such.

Methodologies of assessing proposals against the performance requirements are presented below.

4.2 Verification testing

Verification testing is provided as a path to meeting a performance requirement within the DTS pathway (refer A0.5(b) and as a stand-alone path within Part 5 for floors and walls, BCA sections FV5.1 and FV5.2 respectively. A test certificate showing complying performance, referenced to Section 5.0, is a straightforward path to certification that sidesteps many issues, however it is still a performance solution and should be documented as such.

I would contend that where a concrete floor is required to have an impact rating, apart from the "*Acceptable forms of construction"* provided in Table 2 of Specification F5.2, verification testing is the only path to compliance with the performance requirement. This contention is based largely upon testing laboratories utilizing a 150 mm slab thickness for tests and typical floor slabs in Queensland varying between 180 and 220mm (Hsin-Huang, 2014). Any comparison to laboratory testing is further complicated by the (typically) unknown concrete density and reinforcing methodology encountered in the field.

4.3 Comparison with DTS

A situation for the use of this method would be a statement that a proposed or utilised solution is equivalent to a laboratory tested solution. This was used extensively in the preparation of the Red Book, (see Figure 2) and other manufacturer's data by persons who by virtue of their involvement with laboratory testing could be considered expert. For the rest of us, stating that a substitution of one manufacturer's plasterboard with another has no detrimental effect is perhaps the most that we can/should do. However, again from experience, this is not always a safe path.

For example, a wall specified to achieve a performance of Rw + Ctr >50 was constructed in accordance with a manufacturer's tested system, except that, the studs were spaced at 300mm, rather than 600mm. This was done apparently to suit wind loading and wall length restrictions. The modification was considered by the builder to be a "safe bet". The wall failed acoustical testing and remediation was expensive and disruptive. Similarly, with a wall using studs formed from 1 mm steel rather than the more common 0.55 mm. The increased stud stiffness, significantly lowered the walls acoustic performance. Thus, verification testing should be the preferred approach to certification of a non-laboratory certified construction.

Comparison with DTS can also be used to support decisions where an element is not cater for by a specific DTS clause – e.g. the acoustic performance of doors separating interconnected single occupancy units in a hotel (there is no DTS clause, explicitly addressing their acoustic performance).

5. THE PERFORMANCE SOLUTION

For many years, the BCA has stated Performance Requirements for the insulation of floors and walls that would seem to allow wide interpretation, e.g.

> *Floors separating sole-occupancy units must provide insulation against the transmission of airborne and impact generated sound sufficient to prevent illness or loss of amenity to the occupants.*

However, pre BCA 2016, the method of arriving at a performance solution narrowed the possible interpretation; thus, BCA 2015 A0.10 (removed in BCA 2016):

> *Identify the relevant Deemed-to-Satisfy Provision of each Section or Part that is to be the subject of the Alternative Solution".*

From 2016 a performance solution must be referenced to the "Relevant Performance Requirement*".*

Even though a wide interpretation is apparently now permitted, many current (as of 2016) high rise buildings will be assessed under prior versions of the BCA and performance solutions will need to reference the DTS performance statements (Section 37 of the QLD building act permits assessment against the legislative requirements in force at commencement of design). However, in other states this may not apply: for example in NSW assessment is to be made against the legislation in force at the date of lodging for construction approval. The DTS provisions mean that numerical criteria remain for the foreseeable future however, amongst other possibilities, reference to the Australian Association of Acoustical Consultants guide, *Acoustical Star Ratings For Apartments and Townhouses* (AAAC, 2009) offers a peer reviewed reference for performance parameters.

5.1 Documentation

The following is an extract from the "Record of Approved Alternative Solutions" tabulated by the Building Certifier. It relates to Alternative Solutions to fire system DTS provisions. It is indicative of the information that is required to be provided with any performance solution and also the level of documentation to be undertaken by a certifier.

Alternative Solution #2 – *Travel distance at Residential Levels*

- *Performance Requirement – BCA Clause DP5 & EP2.2*
- *Associated Deemed to Satisfy Clause (DTS) – BCA Clause D1.4*
- *Alternative Solution basic description – Travel distance at residential levels of 8m to a single exit in lieu of 6m.*
- *Refer xxxxx (Fire engineer's solution report)*
- *Method of Assessment – A0.9(c)*

Alternative Solution #3 – *Fire Isolated Stair Discharge*

- *Performance Requirement – BCA Clause DP5 & EP2.2*
- *Associated Deemed to Satisfy Clause (DTS) – BCA Clause D1.4*
- *Alternative Solution basic description – Fire Isolated stair discharge to internal lobby space*
- *Refer xxxxx (Fire engineer's solution report)*
- *Method of Assessment – A0.9(b)(ii).*

The following example relates to an acoustical issue which follows from the requirements of the Queensland Development Code (which is given regulatory effect by provisions of the Queensland Building Act) and mirrors the "Documentation" requirements of the BCA.

<table>
<tr><th>DtS Clause</th><th>Issue</th><th>Performance Requirements</th></tr>
<tr><td>QDC MP 4.4 A1</td><td>Façade treatments for the building to meet the requirements of the transport noise corridor provisions have been calculated on a noise reduction basis, rather than meeting the acceptable solutions of QDC MP 4.4 - A1.</td><td>P1</td></tr>
<tr><td colspan="3">Discussion</td></tr>
<tr><td>Background</td><td colspan="2">The site is approximately 17 metres from the running edge of the gazetted transport noise corridor of XXXXX, XXXXX. Accordingly, the project, specifically including Building 4, is subject to the provisions of the QDC Mandatory Part 4.4, owing to the proximity of the gazetted transport noise corridor.

The development site is identified as being in Noise Categories 1 – 3 as per the SPP Interactive Mapping System.

The project acoustic engineer proposes that the required façade element acoustic performance, i.e. Rw value, be calculated in accordance with Australian Standard AS3671 1989 Road Traffic Noise Intrusion – Building Siting and Construction (as referenced in QDC MP 4.4). Objective internal levels will be as per the "recommended" levels from Table 1 of Australian Standard AS 2107 – 2000 Acoustics – Recommended design sound levels and reverberation times for building interiors in lieu of meeting the reduction levels in QDC MP 4.4.

The proposed design levels are:

<table>
<tr><th>Area</th><th>Objective Design Level</th></tr>
<tr><td>Living areas:</td><td>40 dB(A) LAeq</td></tr>
<tr><td>Sleeping areas:</td><td>35 dB(A) LAeq</td></tr>
<tr><td>Work areas, i.e. remaining habitable spaces:</td><td>40 dB(A) LAeq</td></tr>
</table>
</td></tr>
<tr><td>Assessment Method</td><td colspan="2">Combination of expert judgment and comparison to the DtS acceptable solution under QDC.</td></tr>
<tr><td>Conclusion</td><td colspan="2">The acoustic engineer has confirmed that the performance requirement of QDC MP 4.4 has been met in the specification and as an expert in the field (RPEQ) we concur with the assessment.</td></tr>
</table>

6. WHO IS EXPERT

The issue of expert qualifications is a vexing one as those practicing as "Acousticians" come from a diversity of backgrounds, often with little formal training in their craft and certainly without a common, recognised qualification. Developers, councils, noise complainants and certifiers thus tend to assess competence based on little more than word-of-mouth and perhaps familiarity with submitted works. In Queensland, those of us who are engineers, wonder if what we do is appropriately described as engineering and therefore required, under the Professional Engineer's Act 2002, to be performed by registered, professional engineers. in Queensland, there is a process for determining a "competent person" spelt out at part 5 of the Building Regulation but I understand that

this is not necessarily spelt out in other states. It seems be prudent to raise this issue with the certifying authority early in the design and documentation process to ensure understandings of a "competent person" coincide.

7. OTHER CONSIDERATIONS

As a further example, we consider the application of the Queensland Development Code Mandatory provisions MP 4.4 *Buildings in a Transport Noise Corridor.* This code has Performance Requirements and Accepted Solutions, analogous to BCA Deemed to Satisfy (see above – Para 6). As with the BCA, MP4.4, is invoked by the Queensland Building Act and under that Act, alternative solutions are possible. In two noise reports the alternative solution was introduced and documented as:

> *In accordance with MP4.4 the materials of construction are defined for the subject site or, alternatively, a noise report can be prepared which relates specifically to site based traffic noise level measurements and the calculation of minimum Rw values based on these noise level measurements, DTMR traffic volumes and the actual design of the residential units. For this development a site specific noise report has been prepared.*

and

> *This letter outlines the road traffic noise attenuation requirements for the proposed dwelling at xxxx for predicted compliance with the requirements of Schedule 3 of the Queensland Development Code MP4.4 Buildings in a Transport Noise Corridor.*

In the first case the council ignored the conclusions of the report and required construction to MP4.4, in the second, the report conclusions appear to have been accepted by the certifier. Both represent a failure to comply with any reasonable process of defining the problem and then dimensioning the solution. Both reports place the project at risk of having to be reassessed or in the worst case, with the requirement for remediation of a sub-standard result.

8. FINAL REMARKS

Within the period of the preparation of this paper, there have been several instances where my colleagues and I have been asked to attend site and resolve issues where there was no clear DTS solution. We have been heartened by an increased willingness to resolve problems early before the multiplication factor of multi-level apartment buildings makes any change difficult. However, the documentation required by the project certifiers has varied from just a site note documenting our advice to a fully supported, Performance Solution proposal.

I contend that as a profession, we need to do better. A starting point is certainly to develop a better working relationship with certifiers to both raise awareness of the need for better consideration of acoustical issues and then to "get it right" when issues are addressed. I further note the potential to formulate a wider range of Performance solutions by addressing the Performance Requirements directly.

ACKNOWLEDGEMENTS

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