THE BCA 2004 – A PLAN FOR THE FUTURE

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Abstract

The Building Code of Australia 2004 (the "BCA 2004") came into effect on the 1st of May 2004. The new code was developed by the Australian Building Codes Board (the ABCB) in response to wide community complaints regarding the poor quality of noise control in new buildings, particularly multi-storey apartment buildings. Initial complaints received from new apartment owners about "noisy buildings" were variously attributed to poor construction and poor design. However, whilst this was true in a number of situations, it also became clear that the acoustic standards contained in the old code (the "BCA 1996") were simply not good enough even for low cost accommodation. The community expected the old code to protect them from poor quality buildings which regrettably it failed to do. There was also a misunderstanding in the community that the old code would provide good quality acoustics in the high end of the market. The changes in the BCA 2004 reflect an improvement in the minimum standards, however, to what extent these changes "fix the problem" is debatable. This paper examines how the BCA 2004 addresses the problem of poor quality noise control in buildings, recommends a methodology of implementation to ensure the intended end result is achieved and proposes a plan for future action where the code is found deficient or inconsistent.

Nomenclature

AAAC	Association of Australian Acoustical Consultants
ABCB	Australian Building Codes Board
BCA	Building Code of Australia
BRE	Building Research Establishment (UK)
C, C_{tr}	Spectrum Adaptation Terms
CEN	European Committee for Standardisation
C_I	Impact Spectrum Adaptation Term
CIEH	Chartered Institute of Environmental Health (UK)
$D_{nT,w}$	Weighted Standardized Level Difference
DTS	Deemed To Satisfy
EHCS	English House Condition Survey (UK)
IIC, FIIC	Impact Insulation Class, Field Impact Insulation Class
ISO	International Organisation for Standardisation
$L_{n,w}$, $L`_{nT,w}$	Weighted Normalized Impact Sound Pressure Level, Weighted Standardized Impact Sound Pressure Level
PCA	Principal Certifying Authority
RDL	Robust Details Limited (UK)
R_w, $R`_w$	Weighted Sound Reduction Index, Weighted Apparent Sound Reduction Index

Introduction

The ABCB produces and maintains the BCA, a regulatory framework standardising a minimum form of construction for buildings in Australia. The sound insulation provisions contained in the BCA have essentially remained unchanged since its first release in 1990. Since that time, there has been a dramatic increase in the number of people living in high-rise apartments and townhouses and a corresponding venting of displeasure about the poor quality of sound insulation being provided in them. Newspaper headings foretold the grim story – "High-rise crisis looming", "Board exodus adds to apartment tower woes" and "Towers of Trouble". Whilst some complaints can be traced to instances of unacceptable building construction practices, the overall impression is that the minimum requirements in the BCA are not relevant to today's standard of living and need to be upgraded.

In 1996, the City of Sydney took matters into its own hands and upgraded the sound insulation performance for buildings in its jurisdiction. The AAAC also wrote to the ABCB pleading for changes to the BCA. The ABCB recognised that Councils going their own way would result in a proliferation of sound insulation standards having the effect of undermining the intent of the BCA and (potentially) complicating regulation.

In the period January 2001 through to February 2002, the ABCB released three documents entitled "Proposal to Change the Sound Insulation Provisions of the Building Code of Australia" which incorporated recommendations and feedback from various stakeholders including the building industry, building products manufacturers, Councils, the AAAC, acoustic consultants and the Housing Industry Association. It was assumed that the last of these documents would form the regulatory framework for a new updated BCA.

However, the building industry and its suppliers were not supportive of the document and this prompted the ABCB to convene a special Forum on the 16th April 2002 to find out why. Forty nine people attended, representing the industry stakeholders. An "Outcomes Report" [1] was produced by the ABCB in December 2003 to provide the industry with lead-in time to prepare for the change.

Coincidentally, in April 2002, the NSW Parliament's Joint Select Committee on the Quality of Buildings was convened to examine amongst other issues, the poor sound insulation performance achieved in current day residential buildings.

The BCA 2004 came into effect on the 1st May 2004. The States of NT, Qld and WA, however, have not adopted it in total.

The Evidence for Change

The need for change was predicated in the ABCB's Regulatory Impact Statement as arising from an "extensive list of case studies and complaints from dissatisfied private individuals and acoustic specialists involved in litigation, stressing the need for a review of the BCA provisions" [2]. However, as far as the author is aware, there are no independent formal studies commissioned to define the cause and extent of the problem.

This is in marked contrast to the experience in the UK relating to the amendment of the building regulations in that country. On the 1st July 2003, the UK Government amended the Building Regulations 2000 "Approved Document E" relating to the provision of sound insulation in buildings in England and Wales [3]. The Regulations had not been amended since 1st June 1992.

According to the Regulatory Impact Statement (RIA) accompanying the Building Regulation 2000 [4], the extent of the problem in the UK was highlighted in the following reports;

1. The CIEH 1997/98 Report revealed that 148,006 complaints about domestic noise were reported and that in the period 1986 to 1996 the total number of domestic noise complaints trebled;
2. In 1996 the EHCS reported that 2.3 million households (12% of all households) experienced problems with noise due to neighbours. Of these, 80% were attributed to unreasonable behaviour and 20% to building defects;
3. A study undertaken by the BRE [5] between 1992 and 1994 investigated complaints about sound insulation between dwellings that appeared to comply with the relevant design guidance in the 1992 version of Approved Document E. The study found that, in the main, complainants lived in dwellings with sound insulation below the standard generally regarded as reasonable for Building Regulations purposes. Noise from amplified music, television, radio, domestic appliances (particularly washing machines, telephones, vacuum cleaners), footfalls, the slamming of doors and plumbing noises could all be heard in complainants' dwellings. The survey also found that some people were dissatisfied even when their home met current standards although these complaints were often concerned with banging doors and other noises not controlled by regulations.
4. The BRE estimates that, in new dwellings, as many as 40% of new separating floors and up to 25% of new separating walls may fail to meet the current standards. If this assessment is true, then it indicates the lack of enforcement effectiveness.
5. In 1995, the BRE report "Building Regulation and Health" [6] estimated the number of extremely severe health risks per year in UK homes due to noise at between one and ten, these being suicides or assaults attributed to noise from neighbours. The number of less severe problems (such as stress, migraines, etc) was estimated to be about 10,000 per year.
6. More recently, Grimwood and Tinsdeall [7] undertook a social survey and analysis of 200 converted and refurbished flats between 1993 and 1998 where the remedial treatment applied to the separating floor had followed the guidance contained in the 1992 Approved Document E. 50% of those surveyed reported poor or very poor sound insulation as opposed to 20% reporting good or very good sound insulation.

Accordingly, the RIA recommended the new standards be adopted estimating that those changes would produce a worthwhile positive benefit.

On the basis that the 1992 UK standard was a minimum $D_{nT,w}$ 48 whereas the BCA 1996 was a minimum Rw 45 (possibly equal to $D_{nT,w}$ 40), it is clear that the UK standard was more onerous than the Australian BCA 1996. It is not surprising, therefore, based on these studies that there was a need to review the BCA performance standards.

The lack of research studies in Australia is of concern. It is surprising that the ABCB contemplated modification of the BCA standards without commissioning formal scientific studies into the cause and extent of the problem in Australia.

The Legal Framework

The ABCB is at pains to point out that it is responsible only for producing the BCA not administering it. The ABCB takes the position that if there is a building quality issue then it alone cannot be held responsible and that the other components of the building regulation and certification process should also be brought to account.

In NSW the BCA is given legal status by the Environmental Planning & Assessment Act. The Act specifies roles for inspection and certification by the PCA who may be either a Council officer or a private certifier. At the completion of design, the PCA issues a Construction Certificate if satisfied that the design is *"not inconsistent with"* the Consent Conditions issued by Council. During the building works, inspections are carried out at the PCA's discretion to certify that the building works comply with the various provisions of the BCA and the Consent Conditions. Inspections of some structural and waterproofing works are mandatory whereas inspections of acoustic works are non-mandatory.

In Victoria the BCA is given legal status in the Building Regulations 1994 and private and Council certifiers are known as Private Building Surveyors and Municipal Building Surveyors respectively. The building surveyor issues a Building Permit if satisfied that the design is *"consistent with"* the Planning Permit.

In both States, the PCA or Building Surveyor must not be involved in preparing the design of the building. The intent of the legislation is to ensure that the certification and inspection process is performed by independent persons having no allegiance to any person associated with the building works. However, certifiers are likely to agree they lack detailed expertise in acoustics engineering and therefore invariably rely on inspections and reports produced by acoustic experts involved in the design to certify those works comply with the BCA. This is a clear conflict of interest and invariably makes a mockery of the intention of independent accountability.

In NSW there is scope to engage an independent Accredited Certifier (Acoustics) to issue a Compliance Certificate in relation to specific acoustic works, however, at the time of writing this has not occurred.

In July 2002, a Joint Select Committee on the Quality of Buildings reported to the NSW Parliament into the quality of buildings, to determine whether there are enough checks and balances existing to ensure consumers are guaranteed that their new homes are safe, properly certified and built to satisfactory standards [8]. Regrettably, the report failed to identify the inherent deficiencies in the certification process.

In Victoria a similar conflict of interest arises. The Building Practitioners Board registers Building Surveyors and Building Practitioners. Acoustic Consultants must be registered as a Building Practitioner (usually in the category Engineer-Mechanical). The Building Surveyor again relies on inspections and reports produced by acoustic experts involved in the design to certify compliance with the BCA.

Similar difficulties also arise in the approval process related to certification of forms of construction in the BCA. According to Section A2.2 "Evidence of Suitability" in the BCA 2004 Volume One (a similar provision also applies in Volume Two) evidence of support that a form of construction complies with a Performance Requirement or DTS provision can be;

> *"…*
>
> *(iii) a certificate from a professional engineer or other appropriately qualified person which (A) certifies that a material, design or form of construction complies with the requirements of the BCA; and (B) sets out the basis on which it is given and the extent to which relevant specifications, rules, codes of practice or other publications have been relied upon, or*
>
> *…*
>
> *(vi) Any other form of documentary evidence that correctly describes the properties and performance of the material or form of construction and adequately demonstrates its suitability for use in the building."*

In the absence of a suitable definition for an *"appropriately qualified person"* and *"any other form of documentary evidence",* these requirements leave open the possibility of evidence being provided by someone with a passing interest in acoustics or a sales brochure.

A PCA or Building Surveyor may quite correctly interpret the requirements contained in Section A2.2 as being evidence of practically any kind with obvious dire consequences. This section needs a serious review.

Airborne Sound Insulation

International Standard ISO140 "Measurement of sound insulation in buildings and of building elements" forms the basis of the standards in the BCA 2004 and has been in existence for a long time. Its use, however, was not common amongst the various European nations. In 1988, the Construction Product Directive 89/106 EEC was adopted by the European Commission to facilitate trade in the Union through technical harmonisation of products.

In 1991, the CEN and the ISO agreed to formulate a set of comprehensive European standards relating to building acoustics (the Vienna Agreement). Some ISO standards were already suitable, however, some new standards had to be developed and others required modification [9].

Agreement was reached on the adoption of the ISO140 series (parts 1 to 13) relating to the measurement of airborne and impact sound insulation in test laboratories and *in situ*. The revision of ISO717 "Rating of sound insulation in buildings and of building elements – Part 1: Air-borne sound insulation; Part 2: Impact sound insulation", however, was the result of compromise after long discussions lasting several years. Whilst the Weighted Sound Reduction Index R_w was the adopted and preferred metric for sound insulation in the German speaking countries and in some Scandinavian countries, France and several other countries use R_A and $R_{A,tr}$.

R_w is the single sound insulation rating derived from the frequency dependent sound reduction indices R_i measured under ISO140. To determine R_w, the reference curve R_{i0} specified in ISO717 is shifted upwards in 1dB steps until the sum of unfavourable deviations at all frequencies *i*, $\sum(R_{i0} - R_i) \leq 32$. The value of the reference curve R_{i0} at 500Hz after shifting it according to the procedure above is the quoted R_w.

R_A is the A-weighted sound pressure level resulting from a pink noise spectrum L_i as the "loading noise" calculated according to the following equation;

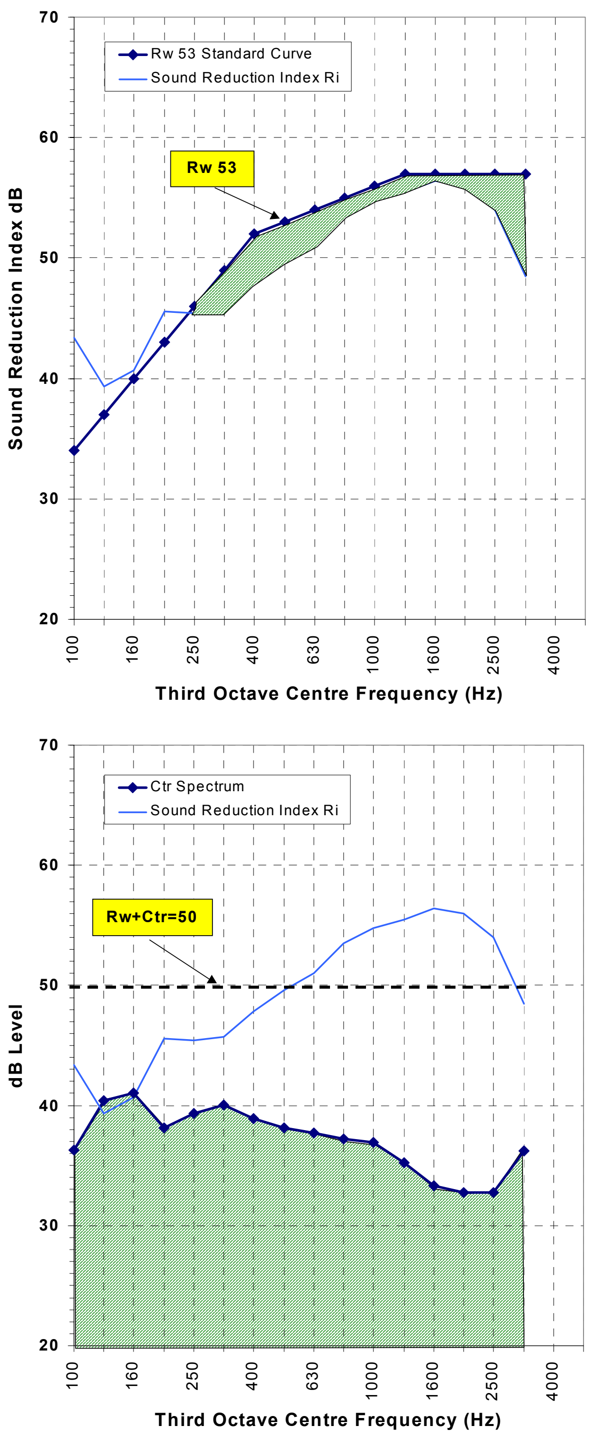

Figure 1: Comparison of R_w and R_w+C_{tr} for a hypothetical construction

$$R_A = 10 \log \{\Sigma 10^{L_i/10} / \Sigma 10^{(L_i-R_i)/10}\} \qquad (1)$$

Similarly, $R_{A,tr}$ is the A-weighted sound pressure level resulting from a traffic noise spectrum $L_{i\ tr}$ as the “loading noise” calculated according to Equation (1) above but with $L_{i\ tr}$ replacing L_i. The traffic noise spectrum is A-weighted and is of Swedish origin [10].

The agreed compromise was to calculate and report new quantities C and C_{tr} denoted as Spectrum Adaptation terms. The values (R_w+C) and (R_w+C_{tr}) are equal to R_A and R_{Atr} respectively and are not reported to avoid misinterpretation of three quantities that would be similar in magnitude. The difference between R_w and R_w+C_{tr} for a hypothetical form of construction can be gleaned from Figure 1.

The top graph of Figure 1 shows the selected R_w 53 curve for this hypothetical example is based on deficiencies in the high frequencies. On the other hand, the bottom graph of Figure 1 demonstrates that it is the low frequency performance of the partition that mostly contributes to the A-weighted sound pressure level R_w+C_{tr} 50 derived from Equation (1) above. In this case, the value of C_{tr} is –3. A value of C_{tr} close to zero is typical of constructions with good low frequency performance whereas a high negative value of C_{tr} is indicative of poor low frequency performance.

For most constructions the value of C_{tr} is in the range –4 to -11dB (within a 10-90% band) as demonstrated in Figure 2, the results of 157 laboratory and *in-situ* floor and wall sound insulation measurements for a wide range of building constructions.

In general terms, the R_w sets a lower limit on the partition performance at individual frequencies whereas R_w+C_{tr} is a limit on the total A-weighted sound pressure level transmitted through the partition.

The hypothetical example in Figure 1 serves to illustrate that a metric based on R_w+C_{tr} can be quite insensitive to partitions having a reduced high frequency sound insulation performance. In practice, the high frequency range is an important one because it is characterised by typical household sounds (such as pans clanking, voice, telephone rings and television). If an otherwise acceptable wall is constructed poorly then the high frequencies are the first to deteriorate and, as stated above, this defect would not necessarily be identified by the R_w+C_{tr} metric.

From a practical viewpoint, if it is desirable to increase sound insulation at low frequencies this could equally be achieved by increasing the R_w. However, those promoting R_w+C_{tr} would possibly argue that it is the A-weighted sound pressure level on the transmitted side of the partition that is important.

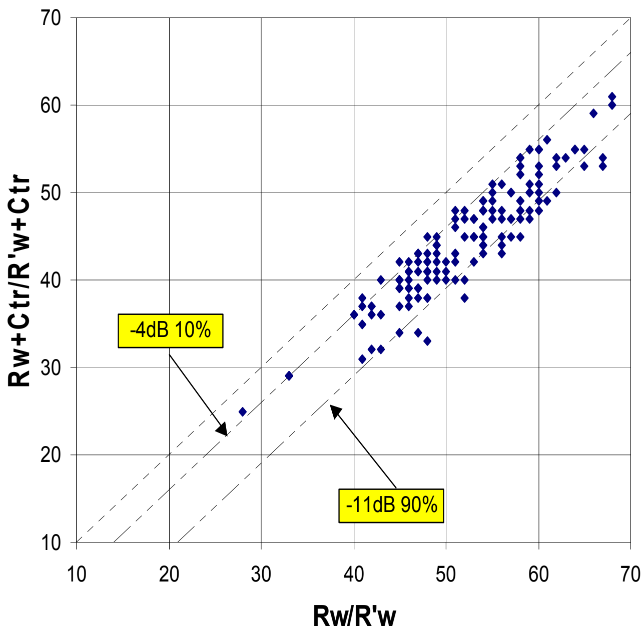

Figure 2: Comparison of Rw/R\`$_w$ and $R_w$+$C_{tr}$/R\`$_w$+C_{tr} laboratory/*in-situ* wall and floor air-borne sound insulation ratings (source Renzo Tonin & Associates Pty Ltd)

Floor Impact Sound Insulation

The new floor impact standard in the BCA 2004 is a laboratory $L_{n,w}+C_I$ 62 or an *in-situ* verification of L\`$_{nT,w}+C_I$ 62. The verification standard is less stringent than that adopted in the UK Building Regulation 2000 Approved Document E of L\`$_{nT,w}$ 62 because C_I is generally (but not always) negative. It is calculated according to the following Equation;

$$C_I = 10 \log \{\Sigma 10^{L`_{nT}/10}\} - 15 - L`_{nT,w} \qquad (2)$$

However, the metric has not until now been used in Australia. The more common floor impact sound insulation measure has been the IIC and FIIC [11].

Most engineers would probably agree that a rating below IIC 50 (measured in a laboratory) is generally inadequate in residential buildings. An FIIC *in-situ* standard is adopted as a minimum, for example, in the Sydney City Council's Development Control Plan 1996 and the Hornsby Town Centre Development Control Plan 2002. An IIC 65 would probably be rated a superior standard and a rating exceeding IIC 70 is typical of the performance of a good quality carpet and underlay on a concrete floor.

The measures $L_{n,w}+C_I$ and IIC can only be measured in a laboratory whereas the L\`$_{nT,w}+C_I$ and FIIC are measured *in-situ*. In order to derive an understanding of this new measure, a comparison was made of 115 *in-situ* floor impact measurements of L\`$_{nT,w}+C_I$ and FIIC for a variety of carpeted and hard floor systems both with underlay treatment and without. The results are shown in Figure 3.

On the basis of this data, the following approximation is derived,

$$\{L`_{nT,w}+C_I\} + \text{FIIC} = 100 \qquad (3)$$

however, as obvious from Figure 3, individual values can differ.

The first important conclusion to be drawn from Figure 3 is that not one of the 115 floors tested failed to comply with the new standard. On the understanding the tests involved a variety of treated and untreated floor systems of various kinds, this would raise the suspicion of an inappropriately low standard.

On the basis that the new verification standard is L\`$_{nT,w}+C_I$ 62, this equates to FIIC 38 which most acoustic engineers would recognize as only marginally better than the performance of a bare concrete slab which by any measure is unacceptable. The new verification standard is therefore likely to result in a raft of problems as apartment owners expecting a reasonable standard of impact noise insulation find that their reliance on a new BCA is again thwarted.

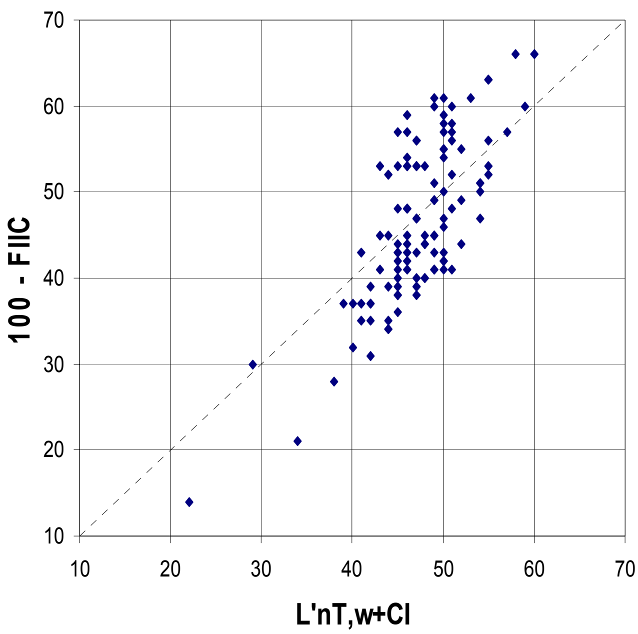

Figure 3: Comparison of *in-situ* measurement of floor impact sound insulation ratings (source Renzo Tonin & Associates Pty Ltd)

The UK Experience

The revision of the UK Building Regulations 2000 occurred at about the same time as the BCA 2004. As the BCA 2004 verification standards for airborne sound insulation of walls and floors are numerically the same, the UK experience is relevant.

The Building Regulations 2000 "Approved Document E" relating to the provision of sound insulation in buildings in England and Wales was adopted on the 1st July 2003. The old and revised standards are as follows for dwelling houses and flats;

Table 1: Performance Standards for Separating Walls and Floors for Purpose Built Dwelling-Houses and Flats – UK Approved Document E 2003

Partition Type	1992	2003
Walls Airborne (minimum values)	$D_{nT,w}$ 49	$D_{nT,w}+C_{tr}$ 45
Floors Airborne (minimum values)	$D_{nT,w}$ 48	$D_{nT,w}+C_{tr}$ 45
Floors Impact (maximum values)	$L`_{nT,w}$ 65	$L`_{nT,w}$ 62

The regulations require pre-completion testing of all new residential and hostel buildings as part of the approvals certification process. However, the implementation of pre-completion testing was delayed. From the 1st July 2003, dwelling conversions and hostels were subject to pre-completion testing followed by new dwellings from 1st July 2004. The reasons given for a gradual roll-out include a) the lack of availability of testers, b) house layouts that only have small rooms adjacent to the party wall, c) non approved testers being used, d) testing not always being enforced and e) uncertainty involved in the testing of timber floors having a carpet and soft underlay [12].

As outlined in the RIA, support for adopting the new $D_{nT,w}+C_{tr}$ rating came from a subjective listening experiment carried out by Wright and Fothergill under controlled laboratory conditions [13]. The tests simulated the situation of a flat above a pub or bar playing amplified music and allowed the effect of typical floor constructions and low frequency insulation performance to be investigated. Subjects were asked to provide ratings of acceptability of the level of a series of amplified music stimuli. Use of the proposed $D_{nT,w}+C_{tr}$ rating markedly improved the correlation between subjective acceptability and the insulation rating. An increase in 3dB in the new rating was associated with a clear reported improvement in acceptability.

Curiously, the RIA makes the following statement (para 78);

> *"It has to be noted that the proposed standard is not intended to provide protection from unreasonable levels of noise. However, there is also some acceptance that the current standards are set close to a threshold of noise audibility where certain everyday sounds such as that from normal conversation and listening to the TV or radio at a reasonable level are only just audible. The proposed improvements to sound insulation will help to ensure that many of these reasonable everyday sounds that might currently just be heard will become inaudible."*

This statement is quite surprising given the poor acceptability rating of the 1992 standards.

According to the RIA, the new standard for $D_{nT,w}+C_{tr}$ was derived by the following process. In response to complaints about poor sound insulation, the target standard for walls was raised 3dB from $D_{nT,w}$ 49 to 52 and then reduced by 5dB because $D_{nT,w}+C_{tr}$ is typically about 5dB less than $D_{nT,w}$. A further reduction of 2dB was allowed for measurement accuracy resulting in the new target of $D_{nT,w}+C_{tr}$ 45.

In other words, the new standard improves on the old standard by 1dB which is insignificant. It is therefore difficult to understand how the complaints referred to above could be resolved. As the Australian BCA adopts the same standard for verification, on the basis of the UK experience, the BCA verification standard is likely to be unacceptable.

The RIA contemplates a pre-completion testing regime that will generate an extensive database of sound insulation performance data to be fed back to the industry (both developers and enforcement bodies). Ultimately, it is anticipated that the database would allow poorly performing constructions to be identified and removed from the Approved Document, as well as providing a route whereby new and innovative constructions can prove their field performance and be added to future revisions of the Approved Document.

However, this process inevitably transfers the risk to the end user (the building owner) who is most vulnerable and who it is assumed the Building Regulation was intended to protect.

Following the announcement of the new Part E, the House Builders Federation lobbied the Minister to implement an alternative scheme called "robust details". This involves the use of approved constructions in lieu of pre-completion testing similar to the BCA DTS forms of constructions. Thirteen robust details were selected which met the required performance criteria and in January 2004, the Minister approved the proposal. An organisation called RDL was formed comprising representatives of the Association of Noise Consultants, Building Performance Centre (Napier University), the House Builders Federation and other building, certification and building insurance stakeholders.

RDL certifies new proposals submitted by trade industry for inclusion in the approved robust details. Any new construction must submit 30 *in-situ* test results demonstrating compliance with Part E.

Outcome of the ABCB Sound Insulation Issues Forum

As outlined in the introduction, a Sound Insulation Issues Forum was convened on the 16th April 2002 comprising representatives of the principal stakeholders.

The Forum's consensus was primarily that the proposed BCA regulations would not achieve its intended goal of "eliminating the complaints".

The reasons advanced were many (some justified some not) such as - the proposed new metrics for sound insulation R_w+C_{tr} and for floor impact $L_{n,w}+C_I$ were too complicated, the deemed to comply constructions were untested and unproven, what was being achieved in the laboratory was not being achieved in field tests, the cost impacts are understated, floors would need to be too thick to achieve the ratings, it would "wipe out the brickies", the proposals were aimed at the luxury end of the market and they would incur unnecessary cost at the consumer end.

At the conclusion of a vigorous discussion process, the Forum identified that the following actions should be taken by the ABCB;

1. **Performance Standards**. It was ultimately agreed that the proposed new metrics represented a sufficiently high standard for the new BCA and should prevail despite their complexity. However, the standards for waste and water supply pipe noise could be simplified.
2. **DTS Constructions**. The proposed constructions should work in the field not just in the laboratory and should be economically sensible solutions. It was proposed that these solutions should be submitted by industry/manufacturers/associations. A regime was proposed for acceptance of DTS Constructions including laboratory testing, demonstrated field performance and a detailed construction specification to enable the system to be built in the same manner consistently.
3. **Code of Practice for Administration**. The Forum recognised that "eliminating the complaints" cannot be accomplished by the BCA alone. Certification of building works is a necessary component of the building cycle to ensure that what is specified is ultimately built.
   However, in respect of sound insulation, there is no satisfactory standard of certification. It was therefore recommended that the industry set up a code of practice for the administration of the BCA with ultimate endorsement by the ABCB. The code will be given legal status if the Councils and regulatory authorities include it as a Consent Condition in their Development Application or Building Permit.
4. **Community and Industry Education.** It was recommended that the following documents – "Guidelines for Designers", "Guidelines for Builders" and "Guidelines for Purchasers" - should be prepared to ensure that all stakeholders involved in the building process are adequately informed of their respective roles. For designers, good practice guidelines: for builders, what to look out for: for purchasers, how to make quality judgements, what to expect and how to do inspections.
5. **Cost Analysis.** It was considered that the indicative costs of the new regulation prepared by the ABCB were not realistic and should be reviewed.
6. **Identify All Noise Issues**. The BCA's perspective was considered to be a narrow one and should embrace all noise issues in multi-dwelling living including wall and floor sound and impact transmission, waste plumbing, reticulation water noise, storm-water noise, lifts and plantrooms and external noise intrusion. The ABCB responded that these issues were on its future agenda.

Of particular interest is recommendation 2 involving an industry sponsored DTS approvals process predating the "robust details" scheme adopted in the UK. The DTS constructions specified in the BCA are relied upon as *"tried and true solutions used over previous years"* [14]. However, the DTS solutions remain uncertified and unverified *in-situ* despite assurances by the ABCB that this situation will be rectified prior to BCA 2004 being published [15].

However, other than commissioning a document likely to be known as an "Acoustic Guide to the BCA", the ABCB appears to have ignored the Forum's contribution.

Risk and Risk Taking Culture

According to Australian Standard 4360 "Risk Management", risk is defined as *"the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood"* [16].

Risk culture is the inherent or established behaviour of those involved in the building process (developers, builders, suppliers, designers, certifiers, government authorities and owners) in dealing with risk. It is common knowledge that there is a risk taking culture in the building industry presumably created by the slim profit margins involved. However, the risk matrix extends far beyond the builder – it permeates to all levels of the building process as identified in Table 2 below.

All stakeholders involved in the building industry should develop risk management techniques in accordance with AS4360 and apply those principles at an early stage in the design and construction process to develop methods of treating those risks and avoiding undue consequences.

Table 2: Risk Identification, Analysis and Treatment

Stakeholder	Identify Risk	Analyse Risk	Treat Risk
ABCB	BCA incorporates DTS options	DTS options not properly specified, not tested and validated	Risk passed on to designer and builder
	BCA specifies *in-situ* validation option	Methodology untested, specification value too low	Risk passed on to designer, builder and owner
Designer (Acoustic Consultant or Architect)	Selects BCA DTS option as a form of construction or a modified form with evidence of suitability under A2.2	Selected DTS option not properly specified in the BCA, not tested and validated and may be challenged by certifier or his consultant. Consequences are time & cost delays and legal proceedings instigated.	a) Recommend testing prior to construction; b) Pass risk onto builder
	Relies on untested opinions in trade literature as evidence of compliance with BCA performance requirements	Form of construction not tested and validated and may be challenged by certifier or his consultant. Consequences are time & cost delays and legal proceedings instigated.	a) Recommend testing prior to construction; b) Pass risk onto builder
	Selects BCA validation option	Option fails test. Consequences are time & cost delays and legal proceedings instigated.	a) Recommend *in-situ* testing early on in construction program; b) Develop add-on options if tests fail and warn of cost and time consequences; c) Pass risk onto builder
Builder	Selects BCA DTS option as a form of construction	Selected DTS option not properly specified in the BCA, not tested and validated and may be challenged by certifier or his consultant. Consequences are time & cost delays and legal proceedings instigated.	a) Recommend testing prior to construction; b) Ensure rigorous inspection regime
	Relies on untested opinions in trade literature as evidence of compliance with BCA performance requirements	Form of construction not tested and validated and may be challenged by certifier or his consultant. Consequences are time & cost delays and legal proceedings instigated.	a) Recommend testing prior to construction; b) Ensure rigorous inspection regime; c) Bring suit against trade supplier
	Relies on acoustics advice or acoustic specification document prepared by the Designer	Design options fail test or are challenged leading to time & cost delays and legal proceedings instigated.	a) Ensure sufficient time is allocated to pre-testing programs; b) Budget for the cost of option failures; c) Budget for add-on options; d) Bring suit against designer
Trade Supplier	Manufactures, tests and prepares specifications and site instructions for use of components or forms of constructions	Components or forms of constructions not properly tested or specified leading to failure when tested	a) Implement quality control; b) Ensure adequate testing regime both in laboratory and *in-situ*; c) Provide detailed specifications and site instructions
Certifier	Relies on inspections and test reports provided by himself or a secondary consultant	Inspections and test reports are challenged by a third party. Occupation certificate may be challenged. Consequences are time & cost delays and legal proceedings instigated.	a) Obtain advice only from accredited consultants (in NSW from an Accredited Certifier); b) Bring suit against testing consultant
Owner	Purchases building or apartment in full reliance upon it complying with statutory codes and "fit for purpose"	Building has defects and not fit for purpose. Owner suffers reduction in amenity whilst problem persists and ongoing stress	a) Obtain copies of test certificates relating to sound insulation testing and get independent advice; b) Institute proceedings against the builder

Conclusion

The BCA 2004 is the ABCB's response to concerns expressed by professionals and the public relating to the poor sound insulation performance achieved in residential buildings. The ABCB appears to have ignored the advice of the Forum it convened with industry stakeholders creating an impression of a single minded attitude.The lack of research studies in Australia relating to building issues is an unacceptable situation. The ABCB should plan and budget for appropriate research studies in Australia to better understand the social and technical issues arising from the everyday implementation of the BCA. A review is recommended of Section A2.2 of the BCA pertaining to the qualifications of persons able to provide Evidence of Suitability of forms of construction.

The process of acoustic certification of buildings needs immediate review. It is inappropriate for certifiers to rely upon designers for certification documentation. The intended independence of this process is seriously eroded. Furthermore, inspections of acoustic works should be made mandatory.

As evidenced from experience in the UK, the *in-situ* verification performance standard of $D_{nT,w}+C_{tr}$ 45 is inadequate and unacceptable as a minimum standard.

The new floor impact standard of $L_{n,w}+C_I$ 62 or an *in-situ* verification of $L`_{nT,w}+C_I$ 62 is hopelessly inadequate and the consequence is that buildings built to this standard will require no floor impact insulation treatment to comply. This will undoubtedly cause significant footfall impact noise problems as buildings come on stream.

All stakeholders involved in the building industry should develop risk management techniques in accordance with Australian Standard 4360 "Risk Management" and apply those principles at an early stage in the design and construction process to develop methods of treating those risks and avoiding undue consequences.

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