

THE CASE FOR MINIMUM IMPACT NOISE REQUIREMENTS IN THE NATIONAL BUILDING CODE OF CANADA

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1 Introduction

Unlike the residential building codes of most developed and all other Organization for Economic Cooperation and Development (OECD) countries, the National Building Code of Canada (NBCC) does not contain any mandatory, minimum impact noise performance requirements for multi-family dwellings. This is despite a stated objective of the Code to provide “noise protection” to building occupants (Code Objective OH3). As of the latest 2015 Edition, the NBCC continues to only “recommend” that bare floors should achieve a minimum impact insulation class (IIC) of IIC 55. [1]

In Early 2016, the lead author submitted a Code Change Request (CCR) for the NBCC to make impact noise insulation a requirement in the 2020 code [1, 2]. The CCR, (CCR 1017), was modelled on the new airborne sound insulation requirements that were included in the 2015 code [2]. A new mandatory impact noise requirement was proposed in terms of the Apparent Impact Insulation Class (AIIC) metric, as well a suggested minimum criterion of \leq AIIC 47 to both mirror current airborne requirements and reduce resistance to the CCR. It is noted that the submitted CCR was proposed to Codes Canada as a urgently required placeholder, in the knowledge that to truly address occupant health risks it is very likely that it may be necessary to modify the language, and possibly the metric and minimum level of protection required. The justification for the CCR is presented in Sections 2 through 4.

2 The Nature and Health Risks of Impact Noise in Dwellings

Typical sources of residential impact noise transmitted between dwellings include footfall (walking, running, jumping) noise; furniture being moved; objects being dropped; vacuum cleaners and appliances; doors or cupboards closing; and plugs going into or out of sockets. A study by Park et al. determined that approximately 80% of all measurable noise events (airborne and impact) recorded between dwellings separated by concrete floor partitions were either footsteps, movement of furniture, or dropping of small items [3]. Even with floating floors and suspended ceilings, many impact sources exceeded 45 dBA (LAmax), occurring throughout the day and night [3].

Canadian and International studies concerning occupant perceptions have shown that impact noise in multi-family dwellings is a major cause of complaint; accounting for up

to 50% of all residential noise complaints [4], with footfall noise being the most annoying for occupants [5] and coming 2nd only to stereo music for noise generating moderate-to-high levels of concern [6]. The National Research Council of Canada (NRCC) observes that impact noise is the “Number one source of complaint by building occupants” [7].

Occupant exposure to impact noise in dwellings also carries significant short and long-term health risks, mostly indirect physiological and psychological consequences associated with persistent sleep disruption (including but not limited to stress, fatigue, behavioural problems in children, hypertension, cardiovascular disease, colorectal cancer, and increased mortality), and mental health consequences associated with annoyance (including but not limited to increased stress, depression, and decreased social well-being and intra-family relations) [8–12]. An expanded summary of the health risks associated with sleep disruption and annoyance, as well as the references for such studies, can be found in the authors previously published paper. [13]

3 2015 National Building Code of Canada Requirements

3.1 NBCC 2015 Code Objectives

The NBCC presents the technical provisions for the design and construction of new buildings, including multi-family dwellings [1]. Health Code Objective OH3, Noise Protection, has a stated objective to “limit the probability” that, as a result of the design or construction of the building, a person in the building will be exposed to an unacceptable risk of illness due to high levels of sound originating in adjacent spaces in the building [1]. A sub-clause, OH3.1, specifically restricts this exposure only to airborne sound transmitted through separating assemblies [1]. Based on the physical and mental health risks previously discussed concerning sleep disturbance and annoyance, to adequately meet the current code objective OH3 to protect occupants from noise-induced illness, it is necessary to require protection against all relevant sources of noise, including impact noise.

3.2 NBCC 2015 Current Provisions for Impact Sound Insulation

In Appendix A-9.11.1.4.- Sound Transmission, the NBCC 2015 confirms that there is no requirement for the appropriate control of impact noise, and yet confirms that: “Footstep and other impacts can cause severe annoyance in multi-family residences” [1]. The Section then continues that “Builders concerned about quality and reducing occupant complaints will ensure that floors are designed to minimize impact trans-

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mission. A recommended criterion is that bare floors (tested without a carpet) should achieve an impact insulation class (IIC) of 55" [1].

Despite the NBCC containing no subsequent guidance for the user on how to achieve this criterion (as no floors in the example floor tables provided meet this level), IIC 55 is comparable to international peers (See next section). However references such as [14] cite studies showing that for the equivalent of AIIC 55, 47% of occupants found children on the floor above to be annoying, but for a lightweight floor also equivalent to AIIC 55, the annoyance rate was 80% [14]. They also cited another study showing a 60% occupant annoyance rate for walking noise when the separating floor was the equivalent of AIIC 52 [14]. Additionally, because there is no prescribed mandatory requirement for impact noise, dwellings are currently being built, tested, and lived in that have an AIIC in the low 30's, but because the ASTC is above 50, this is deemed acceptable (although clearly not to the occupants).

4 International Comparisons

All other OECD countries have already recognized the need for an impact noise insulation requirement as part of their respective building codes. In some European countries, impact noise requirements have been part of the national building regulations since the 1940s. In terms of minimum criterion; Austria, Finland and Germany are the most restrictive at approximately AIIC 62, whereas most Nordic and Baltic countries generally set the minimum around AIIC 55-60, and other European nations around AIIC 50-55 [11]. Closer to Canada, the International Building Code used in the U.S. specifies a mandatory minimum requirement for impact insulation (IIC ≤ 50 , NISR ≤ 45), whilst the International Code Council G2 2010 Guideline for Acoustics recommends \leq IIC 55 as an acceptable performance grade, whilst IIC 60 would be the preferred grade [15]. Due to the widespread use of impact insulation requirements, there is considerable knowledge and data regarding cost-effective solutions to achieve satisfactory impact insulation performance.

The Canadian Mortgage and Housing Corporation propose a minimum AIIC 55 as acceptable for most multi-family dwelling rooms with hard floors, with AIIC 50 was suggested for ceramic floors [16]. The NRCC also promotes IIC 55 as a best practice criterion [17], with IIC/AIIC 50 deemed the minimum rating for occupant satisfaction [18]. Again, these are only recommendations, not requirements.

5 CCR proposed Additions

Based on the aforementioned issues, there is a clear need to address the omission of minimum impact noise criteria from the NBCC, hence the submitted CCR. The homebuilding industry should be assured that this would be implemented in a considerate and sensitive manner that takes account of existing practices with only incremental changes. The proposed minimum requirement in the CCR is deliberately set rather low compared to most other members of the OECD (AIIC ≤ 47), so as to allow Canadian industry to adjust to the new requirement and to align with building code regulations in the

U.S. Note however that most people will not find this level satisfactory for subjective impact sound insulation. The IIC ratings for the most common floor construction designs have already been measured in the past and are readily available in datasheets or publications (for example by the NRCC). Overall, it is expected that the enforcement implications for this code change will be minimal; compliance can be demonstrated through field testing, prescriptive procedures using the Tables, or the Calculation procedure in the same manner and at the same time as is currently performed for ASTC/STC. The following changes to the NBCC were submitted as part of the CCR [2]:

1. Add new Code Sub-Objective OH3.2, "Exposure to impact sound transmitted through assemblies separating dwelling units from adjacent spaces in the building".
2. Add new Sections 5.8.2 and 9.11.2 "Protection from Impact Noise"; this essentially contains the same requirements as the airborne noise sections, but with all references to "airborne noise" and the associated standards replaced by "impact noise" and the associated standards.

6 Current Status of the CCR

Since the NBCC is an objective-based building code, the core objectives must be expanded. The process to change the objectives is detailed in Appendix L of the Policies and Procedures of the Canadian Commission on Building and Fire Codes (CCBFC) [19]. Through this process OH3 will be expanded or modified to include impact noise. The CCBFC sets the work plan for the Standing Committees (SC), and have assigned the CCR 1017 to the Standing Committee on Environmental Separation (SC-ES) as the lead committee joint with the Standing Committee on Housing and Small Buildings (SC-HSB) [20]. Once that process is complete the SC-ES and SC-HSB can begin the work of changing the NBCC through the code change request following the procedures in Appendix F Policies and Procedures of the CCBFC.

In a recently published meeting agenda, the Joint Task Group on Impact Sound (JTG-IS) published an Agenda Item Summary Sheet [21]. Both the SC-ES and SC-HSB have given this task a high priority for completion in the next Code Cycle. To their credit, this joint task force has identified the issue well. They state that; Failure to address impact noise will (i) put the burden of addressing sound insulation performance on professionals/designers with no (or little) harmony in approaches and level of performances across the country; (ii) support design approaches that may result in investment in the wrong elements and most importantly may fail to address the system function that establishes a minimum acceptable performance necessary to satisfy the Objective OH3-Noise Protection; (iii) Leave Canada lagging most industrialized countries; and (iv) Leave Canadians at risk for adverse health effects (increased stress, compromised immune systems and depression) as recognized by the WHO.

This JTG-IS has also clearly identified their mandate to: Identify and review documents related to impact sound; Review

codes and regulations from other jurisdictions; Review recent research findings; Review Provincial/Territorial and International requirements in terms of construction, design, operation, use, etc., where applicable; Report to the parent standing committees if no changes to the current requirements are required; Identify areas where additional information is needed and report to the parent standing committees if changes to the current requirements are warranted but there is insufficient information to support requests for changes; Recommend changes to the parent standing committees where changes to the current requirements are considered appropriate and there is sufficient information to support requests for changes; and coordinate between parent standing committees to maintain harmonization between the National Model Code provisions. Unfortunately, the JTG-IS estimated that the work to include impact noise into the NBCC will not be completed until September 2022. This means that impact noise will not be addressed in the 2020 NBCC, but would "likely" be included in the 2025 NBCC, provided that they find that (i) changes are required, and (ii) sufficient information has been gathered. However this offers no guarantee that the changes will happen by 2025, only that there is a willingness to see the changes made. Even then, at best most residential buildings will not see any impact noise requirements enacted until 2032 at the earliest.

7 What you can do to help

There are a few things that the acoustical community can do to help. The first is to join the observers page for the NBCC. Then you can help collect the information that the JTG-IS will need to complete their work. Additional work that is encouraged to make the case includes quantifying the scale of the problem by asking acoustical consultants and large condo boards for anonymous failure rates found in new-build constructions. Repeating the studies of Park *et al.* to determine the apparent sound level (LA_{max}) that results from different objects being dropped, furniture moving, and footfall on different floor assemblies typically built in Canada would be of use in comparing against LA_{max} criteria for the protection of sleep. Finally, you can help raise public awareness to prevalence of impact noise in the general public; more articles and discussions in general publications about the pervasive issue of inadequate impact sound insulation protection will help document the need for these code changes. This may give encouragement to the Standing Committees to complete the work on time so as to include the code change in the 2025 NBCC.

It is also noted that historically the Canadian Acoustical Association (CAA-ACA) was active in passing motions at their AGMs in the 1980s calling for Code Changes to bring airborne sound insulation requirements to STC 50. We would encourage the CAA to again pass such a motion on the need for impact noise requirements, and proactively lobby for such as change on behalf of Canadians.

Acknowledgments

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References

- [1] Canadian Commission on Building and Fire Codes National Research Council Canada. National building code of Canada, 2015.
- [2] M. Golden. Building code of Canada code change request (ccr1017), March 2016.
- [3] Lee P-J, Lee B-K, Park, S-H. Levels and sources of neighbour noise in heavyweight residential buildings in Korea. *Applied Acoustics*, 120:148–157, 2017.
- [4] Building Performance Centre. The development and production of a guide for noise control from laminated and wooden flooring - a research study conducted for UK Department for Environment, Food and Rural Affairs, 2005.
- [5] Bard D.-Waye K.P. Vardaxis, N-G. Review of acoustic comfort evaluation in dwellings—part I: Associations of acoustic field data to subjective responses from building surveys. *Building Acoustics*, 25(2):151–170, 2018.
- [6] K. Bryson and N Allen. Defining medium-density housing, 2017.
- [7] NEWBuildS. *Acoustical performance of buildings: Current practice, research, and code requirements*, 2011.
- [8] World Health Organisation. Burden of disease from environmental noise, 2011.
- [9] D. Halperin. Environmental noise and sleep disturbances: A threat to health? *Sleep Science*, 7:209–212, 2014.
- [10] Wille M, Hemels M.E.H, Medic, G. Short- and long-term health consequences of sleep disruption. *Nature and Science of Sleep*, 2017.
- [11] Nordic Acoustics Association (NAA). *Building acoustic regulations in Europe – Brief history and actual situation*, 2018.
- [12] Niemann H, Maschke, C. Health effects of annoyance induced by neighbour noise. *Noise Control Eng. J.*, 55:348–356, 2007.
- [13] International Institute of Acoustics and Vibration (IIAV). *The Case for Minimum Impact Noise Requirements in the National Building Code of Canada*, 2019.
- [14] R. Pierrard W. Schonback, J. Lang. Sound insulation in construction, July 2006.
- [15] Icc g2-2010 guideline for acoustics, 2010.
- [16] Qualification of the degree of acoustic comfort provided by multi-family buildings - phase II, 2003.
- [17] Quirt J.D, Warnock, A.C.C. and Lio. M. Fire and sound control in wood-frame multi-family buildings, 2002.
- [18] A.C.C. Warnock. Specifying acoustical criteria for buildings, 2001.
- [19] Policies and procedures of the Canadian Commission on Building and Fire Codes, 2016.
- [20] Agenda for the 2015-15 meeting of the standing committee on fire protection.
- [21] Agenda for the 2015-06 meeting of the standing committee on environmental separation.