New Sound Transmission Performance Requirements for Multi-Unit Residential Buildings in the 2015 National Building Code of Canada

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Special thanks to:
National Research Council of Canada (NRC)
Acoustics Laboratory
Sound Insulation Requirements in the 2015 NBCC

Topics covered in this presentation:
• Sound insulation requirements in the 2015 NBCC
• Paths to demonstrate compliance
• NRC projects to support the code change

Building Regulations in Canada

• Sound Insulation Requirements in Canada

• National Building Code of Canada is a “model” code
• NBCC is developed by the Canadian Commission on Building and Fire Codes, and adopted and enforced by the provincial and territorial authorities having jurisdiction
Sound Insulation Requirements: Change in the 2015 National Building Code of Canada

- No longer just Sound Transmission Class (STC) ratings
- Apparent Sound Transmission Class (ASTC) ratings now required

Images from National Research Council of Canada’s “Apparent Sound Transmission Class” leaflet.

Change in the 2015 National Building Code of Canada

- 2015 edition of the National Building Code of Canada: Change from building element to system performance
- 2010 NBCC: $\text{STC} \geq 50$ ($\text{STC} \approx R_w$)
- 2015 NBCC: $\text{ASTC} \geq 47$ ($\text{ASTC} \approx R'_w$)
Three Ways to Demonstrate Compliance:

- Field measurement
- Prescriptive procedure
- Design procedure

Images from National Research Council of Canada's "Apparent Sound Transmission Class" leaflet.

Three Ways to Demonstrate Compliance

- In-situ measurement according to ASTM E336
- Prescribed solutions that are deemed to comply
- Calculation method based on ISO 15712
Three Ways to Demonstrate Compliance

- **In-situ measurement according to ASTM E336**
  - Field measurement
  - Prescribed solutions that are deemed to comply
  - Calculation method based on ISO 15712

Compliance Path No. 1: In-situ Testing

- **In-situ measurement according to ASTM E336**
  - Yields accurate ASTC values
  - Only possible in finished building

Mathematical equation:

\[ ATL = L_s - L_R + 10 \log \frac{S}{AR} \]
Compliance Path No. 1: In-situ Testing

- Most reliable way to determine performance
- ASTM E336 defines several parameters:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Name</th>
<th>Type</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATL</td>
<td>Apparent transmission loss</td>
<td>Frequency bands</td>
<td>ATL = L_S – L_R + 10log(S/A)</td>
</tr>
<tr>
<td>ASTC</td>
<td>Apparent sound transmission class</td>
<td>Single number</td>
<td>Calculated from ATL</td>
</tr>
<tr>
<td>NR</td>
<td>Noise reduction</td>
<td>Frequency bands</td>
<td>NR = L_S – L_R</td>
</tr>
<tr>
<td>NIC</td>
<td>Noise isolation class</td>
<td>Single number</td>
<td>Calculated from NR</td>
</tr>
<tr>
<td>NNR</td>
<td>Normalized noise reduction</td>
<td>Frequency bands</td>
<td>NNR = NR + 10log(T_R/0.5)</td>
</tr>
<tr>
<td>NNIC</td>
<td>Normalized noise isolation class</td>
<td>Single number</td>
<td>Calculated from NNR</td>
</tr>
<tr>
<td>FTL</td>
<td>Field transmission loss</td>
<td>Frequency bands</td>
<td>Removed from E336. Do not use.</td>
</tr>
<tr>
<td>FSTC</td>
<td>Field sound transmission class</td>
<td>Single number</td>
<td>Removed from E336. Do not use.</td>
</tr>
</tbody>
</table>

Three Ways to Demonstrate Compliance

- In-situ measurement according to ASTM E336
- Prescribed solutions that are deemed to comply
- Calculation method based on ISO 15712
Compliance Path No. 2: Prescriptive Procedure

Prescribed solutions that are deemed to comply

+ Easy to use
- Does not yield ASTC values, only pass/fail mark

Summary of Prescriptive Procedure

Articles 5.8.1.1. & 9.11.1.1. - Required Protection

1. Dwelling units shall be separated from other spaces by:
   A. Separating assembly and adjoining constructions which together provide ASTC ≥ 47
   B. Separating assembly with STC ≥ 50 and adjoining constructions that conform to Article 9.11.1.4.

2. Construction separating dwelling units from elevator or refuse chute with STC ≥ 55
2015 NBC Division B Fire and Sound Resistance Tables

- after Section 9.37. (Objectives & Functional Statements)
- before Span Tables

**Article 9.11.1.4 – Walls**

- Rooms one above the other, separating floor STC ≥ 50

  a) $m'' \geq 200 \text{ kg/m}^2$

  b) Gypsum board ending or being interrupted
Article 9.11.1.4 – Ceilings

• Rooms side-by-side, separating wall STC ≥ 50

   a) \( m'' \geq 300 \text{ kg/m}^2 \)

   Wall STC \( \geq 50 \)

Article 9.11.1.4 – Ceilings

• Rooms side-by-side, separating wall STC ≥ 50

   b) Gypsum board ending or being interrupted
Article 9.11.1.4 – Floors

• Rooms side-by-side, separating wall STC ≥ 50

a) $m'' \geq 300 \text{ kg/m}^2$

b) Floor details:
   • Joists/trusses not continuous
   • topping from Table 9.11.1.4.
Article 9.11.1.4 – Floors – Table 9.11.1.4.

Table 9.11.1.4.
Floor Treatments for Flanking Wood-Framed Floor Assemblies in Horizontally Adjoining Spaces
Forming Part of Sentence 9.11.1.4(d)

<table>
<thead>
<tr>
<th>Type of Separating Wall Assembly with STC ≥ 50 from Table 9.11.1.4</th>
<th>Minimum Requirements for Floor Treatments Applied Over Subfloor of Wood-Framed Flanking Floor Assembly on Both Sides of Floor/Wall Junction</th>
</tr>
</thead>
</table>
| W5, W6, W10, W12 (staggered studs) | • wood strip flooring not less than 16 mm thick aligned parallel to separating wall, or  
one layer of OSB or plywood not less than 15.5 mm thick plus finished flooring, or  
one additional material layer plus finished flooring having a combined mass per area not less than 8 kg/m². |
| W4, W11 (staggered studs) | • one layer of OSB or plywood not less than 12.5 mm thick plus hardwood strip flooring not less than 18 mm thick aligned parallel to separating wall, or  
one additional material layer plus finished flooring having a combined mass per area not less than 16 kg/m². |
| W6, W9 (staggered studs) | • concrete or gypsum concrete topping not less than 19 mm thick bonded to the subfloor plus finished flooring, or  
one additional material layer plus finished flooring having a combined mass per area not less than 32 kg/m². |
| W13, W14, W15 (double stud walls) | • where a continuous substrate or other rigid material at the floor/wall junction provide structural connection between the two rows of studs in the separating wall:
  - Hardwood strip flooring not less than 16 mm thick aligned parallel to separating wall, or
  - one layer OSB or plywood not less than 15.5 mm thick plus finished flooring, or
  - one additional material layer plus finished flooring having a combined mass per area not less than 8 kg/m².  
  • any finished flooring where the subfloor and other rigid materials are not connected at the floor/wall junction and there are no structural connections between the two rows of studs in the separating wall. |
| B1 to B10 | • any finished flooring |

Notes to Table 9.11.1.4:
- See Note A to Table 9.11.1.4.

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Article 9.11.1.4 – Floors

• Rooms side-by-side, separating wall STC ≥ 50

b) Floor details:
- Joists/trusses not continuous
- Topping from Table 9.11.1.4.

Table 9.11.1.4. for walls W5, W6, W10, W12 with STC ≥ 50, specifies topping:
- Wood strip flooring not less than 16mm aligned parallel to separating wall, or
- One layer OSB or plywood not less than 15.5mm plus any finished flooring, or
- One additional material layer plus finished flooring having a combined mass per area not less than 8 kg/m².
Appendix A-9.11.1.4

Table A-9.11.1.4. Floor Treatments

<table>
<thead>
<tr>
<th>Floor Treatment Material</th>
<th>Thickness, mm</th>
<th>Density, kg/m³</th>
<th>Mass per Area, kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium-density fiberboard (MDF)</td>
<td>2.9–4.1</td>
<td>790–810</td>
<td>2.3–5.0</td>
</tr>
<tr>
<td>Plywood – generic softwood</td>
<td>12.5–13.3</td>
<td>400–600</td>
<td>5.6–6.6</td>
</tr>
<tr>
<td>Ceramic tile</td>
<td>8.4</td>
<td>150–1,000</td>
<td>5.8–8.4</td>
</tr>
</tbody>
</table>

Materials Typically Having a Mass per Area Less Than 6 kg/m²

| Particleboard          | 11.3–19.2      | 716–756         | 8.1–14.5            |
| MDF                     | 13.9–21.1      | 640–755         | 8.9–15.9            |
| Oriented strandboard (OSB) | 14.3–15.8   | 600–680         | 8.6–10.7            |
| Plywood – generic softwood | 17.3–18.8   | 600–680         | 10.4–12.8           |

Materials Typically Having a Mass per Area Greater Than 8 kg/m² but Less Than 16 kg/m²

| Concrete                | 65.0–80.0      | 2.016–2.380     | 80.6–119.0          |
| Typical concrete        | 24.0          | 1.846–1.970     | 46.1–48.7           |

Materials Typically Having a Mass per Area Greater Than 16 kg/m² but Less Than 32 kg/m²

Materials Typically Having a Mass per Area Greater Than 32 kg/m²

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Side-by-side spaces (horizontally adjoining)

- Details for floor and floor/wall junction
- Details for ceiling and ceiling/wall junction
- Details for side walls and wall/wall junctions
- Separating walls W4, W5, W6, etc.

Sample diagrams:
- Side view of one separating wall with floor and ceiling junctions
- Plan view of separating wall with flanking walls on one end

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Appendix A-9.11.1.4
Appendix A-9.11.1.4

Table A-9.11.1.4.-B:
- Additional options for separating wall systems in Table A-9.11.1.4.-A
- Further improve the sound insulation performance achieved

Side-by-side spaces (horizontally adjoining)

Spaces one over another (vertically adjoining)

Details for loadbearing and non-loadbearing wall junctions

Sample diagrams:
- Side view of one separating floor with flanking loadbearing junctions
- Side view of one separating floor with flanking non-loadbearing wall
Appendix A-9.11.1.4

Spaces one over another
(vertically adjoining)

Table A-9.11.1.4-D:
• Additional options for separating floor systems in Table A-9.11.1.4.-C
• Further improve the sound insulation performance achieved

Three Ways to Demonstrate Compliance

In-situ measurement according to ASTM E336
Prescribed solutions that are deemed to comply
Calculation method based on ISO 15712
Summary of Calculation Procedure

**Articles 5.8.1.1. & 9.11.1.1. - Required Protection**

1. Dwelling units shall be separated from other spaces by:
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   B. Separating assembly with STC ≥ 50 and adjoining constructions that conform to Article 9.11.1.4.

2. Construction separating dwelling units from elevator or refuse chute with STC ≥ 55

Compliance Path No. 3: Design Procedure

**Calculation method based on ISO 15712**
- Allows design of a variety of buildings
- Requires laboratory test data
Calculation Procedure for ASTC

<table>
<thead>
<tr>
<th>Direct</th>
<th>Floor</th>
<th>Ceiling</th>
<th>Left Wall</th>
<th>Right Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Direct" /></td>
<td><img src="image" alt="Floor" /></td>
<td><img src="image" alt="Ceiling" /></td>
<td><img src="image" alt="Left Wall" /></td>
<td><img src="image" alt="Right Wall" /></td>
</tr>
</tbody>
</table>

**Detailed Method:**

\[ ATL = -10 \log_{10} \left( 10^{-0.1 T_{Ld,k}} + \sum_{k=1}^{4} \left( 10^{-0.1 T_{Ld,k}} + 10^{-0.1 T_{Ld,k}} + 10^{-0.1 T_{Ld,k}} \right) \right) \]

**Simplified Method:**

\[ ASTC = -10 \log_{10} \left( 10^{-0.1 T_{C,k}} + \sum_{k=1}^{4} \left( 10^{-0.1 T_{C,k}} + 10^{-0.1 T_{C,k}} + 10^{-0.1 T_{C,k}} \right) \right) \]

ASTC ≥ 47

Summary of Design Procedure

Two options for design procedure:

- **Detailed Method**
  - uses lab test data for set of standard frequency bands
  - can be used to identify weakest paths for design optimization
  - uses multiple spreadsheets/formulas

- **Simplified Method**
  - uses the summary ratings (such as STC)
  - is easy (simple spreadsheet/calculator)
  - tends to be more conservative (lower ASTC)
NRC Projects to Support the Code Change

NRC Special Interest Group (SIG) on ASTC:

- Currently on Phase III (2016/17-2018/19)
- Development of tools for designers/acoustical experts
- Partnering with industry groups and companies
  - Canadian Concrete and Masonry Producers Association (CCMPA)
  - Canadian Institute for Steel Construction (CISC)
  - Canadian Precast Prestressed Concrete Institute (CPPCI)
  - Canadian Ready Mix Concrete Association (CRMCA)
  - Canadian Wood Council (CWC)
  - Gypsum Association
  - Owens Corning Canada
  - ROXUL

RR-331:
Guide to Calculating Airborne Sound Transmission

• Referenced in the National Building Code:

A-5.8.1.4. Methods of Calculating ASTC. The technical concepts, terminology and calculation procedures relating to the detailed and simplified ASTC calculation methods are discussed in detail, with numerous worked examples, in the NRC publication entitled “Guide to Calculating Airborne Sound Transmission in Buildings.” This Guide includes references to readily-available sources of pertinent data.

For many common constructions, the calculations required by Article 5.8.1.4 can be performed using software tools, such as soundPATH5, which is available on NRC’s Web site.

The simplified calculation method may not always identify the prominent flanking paths. Furthermore, it corresponds more closely with the results of the detailed calculation method where the separating assembly and the flanking constructions are both constructed according to the same method, i.e. either lightweight construction (steel or wood framing) or both are heavyweight construction (masonry or concrete).

• Intended mainly for acoustical experts
• Available online from NRC’s website:
  • www.nrc-cnrc.gc.ca
  • http://doi.org/10.4224/23002279

NRC Publications Archive Online
http://nparc.cisti-icist.nrc-cnrc.gc.ca/eng/home/
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NRC Projects to Support the Code Change


2. Collecting data and providing examples for industry:

   **Apparent Sound Insulation in…**
   - *Concrete Block Buildings*, RR-334 (2015)
   - *Cold-Formed Steel-Framed Buildings*, RR-337 (2017)

RR-335: *Apparent Sound Insulation in CLT Buildings*

- Explains ASTC calculation procedures for CLT
- Provides laboratory data for junction attenuation and improvements due to liners
NRC Projects to Support the Code Change


2. Collecting data and providing examples for industry:
   **Apparent Sound Insulation in…**
   - Concrete Buildings, RR-333 (2018)
   - Concrete Block Buildings, RR-334 (2015)
   - Cold-Formed Steel-Framed Buildings, RR-337 (2017)

3. Online application for ASTC calculation – *soundPATHS*

**soundPATHS** –
A web application to predict the apparent sound insulation between rooms
Online Tool: soundPATHS

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A-5.8.1.4. Methods of Calculating STC. The technical concepts, terminology, and calculation procedures relating to the detailed and simplified STC calculation methods are discussed in detail, with numerous worked examples, in the NRC publication entitled “Guide to Calculating Airborne Sound Transmission in Buildings.” This Guide includes references to readily-available sources of pertinent data.

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- Intended for builders and architects
- Available online on NRC’s website:
  - www.nrc-cnrc.gc.ca

Online Tool: soundPATHS 1.0
Online Tool: soundPATHS 2.0

• Developed 2016/2017
• Sponsored by NRC and SIG ASTC
• Compatible with most common browsers:
  Chrome, Firefox, Edge, Safari, newer versions of IE
• Also works on mobile devices (preferably tablets)
• Supports English and French
• Supports both detailed and simplified method
• Supports varying room dimensions
• Freely available to the public
• No registration necessary
Online Tool: soundPATHS 2.0

- Data in soundPATHS 2.0:
  - Concrete walls and floors
  - Masonry walls
  - Hollowcore concrete floors
  - CLT walls and floors
  - Wood-framed walls and floors
  - CFS-framed walls and floors
  - Large number of linings for masonry walls and CLT assemblies
- More data will be added as it becomes available

NRC Projects to Support the Code Change

2. Collecting data and providing examples for industry:
   - Apparent Sound Insulation in...
     - Concrete Buildings, RR-333 (2018)
     - Concrete Block Buildings, RR-334 (2015)
     - Cold-Formed Steel-Framed, RR-337 (2017)
3. Online application for ASTC calculation – soundPATHS
4. Training courses

Three Ways to Demonstrate Compliance

- In-situ measurement according to ASTM E336
  - Yields accurate ASTC values
  - Only possible in finished building

- Prescribed solutions that are deemed to comply
  - Easy to use
  - Does not yield ASTC values, only pass/fail mark

- Calculation method based on ISO 15712
  - Allows design of a variety of buildings
  - Requires laboratory test data
Thank You