

## Sound & Vibration 2.0: Design Guidelines for Health Care Facilities

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Springer Publishing, New York, Heidelberg, Dordrecht and London, (2010), 85 pp., softbound, 49.95 USD, ISBN 978-1-4614-4986-7

This book is a public review document, which incorporates an interpretation and expansion of the existing acoustical sections of the 2010 Edition of the Facilities Guidelines Institute (FGI) Guidelines for design and construction of Health Care Facilities. It was prepared at the request of FGI and the American Society for Healthcare Engineering (ASHE). In the photo border of page 5 is a statement that the book is the sole acoustical Reference Standard for FGI and ASHE for acoustic credits in the United States Green Building Council (USGBC) LEED certification (currently in draft form).

The intent of the book is “to provide constructive guidance on sound and vibration to the FGI and provide a reference standard for other groups such as the Green Guide for Healthcare and LEED.” The book includes the following:

- Corrections to the first public review document of versions 1.0 and 1.1,
- Table of contents,
- Introduction,
- Acknowledgements,
- Chronology of the FGI process sequence to prepare the book,
- Six chapters that correspond to the existing FGI Guidelines expanding and clarifying the existing content, and
- Glossary, Abbreviations list, and References list.

Although the intended audience is not stated, I believe that the book would provide general guidance to healthcare facility owners, architects, engineers, healthcare facility contractors and acoustical consultants.

The six chapters of the book include:

1. guidelines for site exterior noise,
2. acoustical finishes,
3. room noise levels,
4. sound isolation for partitions,
5. sound from alarm, communication and masking systems, and
6. building vibration.

Each chapter contains an overview section, a reference to applicable codes and regulations, a narrative

description of the Guidelines, and applicable tables with recommended criteria. The current guidelines are expanded by adding new tables, revising existing criteria and presenting methodology to determine the acoustic or vibration descriptors. Several sections of the 2.0 document also provide acoustic criteria options. The chapters are discussed in detail below.

Chapter 1 of the document provides design guidance for addressing **site exterior noise**. Exterior noise from non-facility-owned noise sources to the building interior and noise from facility equipment such as generators and cooling towers to the building interior are presented. Exterior noise from non-facility sources is categorized by day–night average sound levels (Ldn) in four different categories of environmental exposure with recommendations for wall/window composite construction in terms of STC ratings for different cases.

Examples of exterior wall STC ratings and composite construction methodology are given. A sub-section of this chapter and table specifies facility A-weighted sound level noise source limits in the four sound level categories dealing with noise impacts on the surrounding neighborhood. The tables for all exterior exposure do not indicate where the sound levels are to be measured for the facility equipment nor where sound measurements are to be taken outside of the facility property.

Chapter 2 covers recommended **acoustical finishes and details for room sound absorption**. The average absorption coefficient ( $\alpha$ ) at 500 Hz rating system is used to describe 6 categories of absorption from very “live” rooms to “dry” rooms, meaning that live rooms have many hard surfaces and are reverberant, and dry rooms are mildly absorptive with less reverberation. The six categories are cross-referenced to seven typical healthcare rooms by their subjective description. Not all types of healthcare rooms are listed. To provide additional qualification to the noise reduction “inside” a room, the editors use the acoustical descriptor A(R) that considers the room volume and average ( $\alpha$ ) coefficients.

The chapter concludes with ceiling finish recommendations for Neonatal Intensive Care Units (NICUs). No information is given regarding the NICU ceiling material composition for good absorption relative to its ability to be cleaned. The combination of sterile and cleanable ceiling surfaces with very high absorption coefficients (0.95) and concurrent high ceiling attenuation class (CAC), and wall surface treatments with absorptive coefficients of 0.65 for NICUs is not discussed. CAC is interjected into the narrative without proper explanation or visual descriptions of the “combined” effects of sound transmission and background sound between a NICU room and adjacent spaces.

Chapter 3 provides recommendations for **room noise levels**. The acoustic descriptors are Noise Criterion (NC) levels, neutral Room Criterion (RC(N)) levels, and equivalent dBA levels. Three different NC/RC(N) tables are specified, presumably to allow for public comment. The three tables are from ANSI S12.2 "Criteria for Evaluating Room Noise," 2003 ASHRAE Applications Handbook Chapter 47 "Sound and Vibration Control," and the FGI recommended noise criteria for noise in interior spaces. Twelve different room types are included in the ASHRAE and FGI criteria. ASHRAE does not include dBA levels. The book stated measurement is to be according to ANSI Standards, but no specific ANSI Standard is given. Room noise level is to be determined from HVAC sound sources, which are to be based on ASHRAE methodology. However, according to the contributor list provided in the document under "Acknowledgements," ASHRAE is not represented as a member of the "team" that prepared the book. ASHRAE is criticized for not providing "prediction" guidance with regard to low frequency noise below 63 Hz although the RC rating system developed by ASHRAE does establish low frequency noise criteria. Lack of prediction may be due to the absence of low frequency data for HVAC equipment and current laboratory room size limitations.

The final discussion paragraph of the section does indicate that the RC rating system is to be used primarily for quality assessment, and not as a design tool. For health care facilities, except for NICU rooms, no guidance is provided for owners to control operational sound from facility-owned instrumentation and equipment in other types of patient rooms. A special section is provided for NICU rooms that establishes lower background sound levels. No statement is provided on how these lower sound levels would combine with overall privacy needed with wall/window/door construction, and room absorption in surrounding rooms/corridors.

Chapter 4 specifies **sound isolation performance of constructions**. The sound transmission class (STC) rating system based on ASTM E90 and ASTM E413 is used to describe sound transmission for indoor sound from room-to-room. STC recommendations for 16 combinations of room-to-room cases are provided in tabular form. Several qualifications are made including an increase in STC values for cases where wall construction does not extend from floor-to-floor, making composite STC calculations where a door or window is part of the wall construction (STCc), and for NICU spaces. No methodology is given to calculate STCc where more than two surfaces such as a door and window and wall are combined to calculate the STCc rating. Where walls extend from floor-to-floor no consideration is given to sound passing from one

room through the ceiling(s) and the portion of the wall that extends from the ceiling up to structure in a plenum space.

In order to address **speech privacy** from room-to-room the transmission loss (STC) of a typical wall must be considered in combination with the room absorption of the source and receiving rooms, and the background sound of the receiving room. Guidelines have been provided to achieve speech privacy using four possible acoustic criteria: the articulation index (AI), privacy index (PI), speech transmission index (STI), and speech intelligibility index (SII). Guidelines have also been provided for open-plan spaces, which are typical of office areas. However, open plan offices are rare, if ever designed, in hospitals and medical office buildings. Qualification of speech privacy concerns with patient health needs to be defined.

Chapter 5 provides guidance for sounds that are required for patient safety such as **paging and call systems, clinical alarms, and fire alarms**. A sub-section is also provided for consideration of **masking systems**. Design Guidelines provide recommended sound levels above the background sound levels for communication systems. Paging sound level recommendations are based on the speech transmission index (STI) and common intelligibility scale (CIS). NFPA 72 is referenced for fire alarms. Sound masking is presented as a useful tool inside patient rooms. However, since staff communication is **critical** for patient safety, masking systems may not be appropriate for patient occupied areas. Typical masking system sound levels are also contrary to the book's Chapter 3 **design criteria for room noise levels**, and needs to be qualified.

Chapter 6 provides recommendations for **building vibration** limits in patient rooms, operating rooms, administrative areas, and public circulation areas, due to people walking on floors (footfalls). The limits are specified in units of peak velocity vibration (micro-inches per second). Narrative guidance is provided for other types of vibration sources such as mechanical equipment, and exterior ground traffic. Limits for vibration sensitive hospital equipment such as magnetic resonance imaging instrumentation are referenced to the vendor's specifications or AISC Design Guide 11.

The stated purpose of the book is to provide constructive guidance on sound and vibration to the FGI and provide a reference standard for other groups such as the Green Guide for Healthcare and LEED. This statement needs to be clarified in the Introduction section of the book, and the intended audience needs to be indicated. The general nature of the book's contents does provide adequate constructive guidance to its readers. However, the book does not hold up on a detailed technical basis as a reference standard.

LEED requirements in particular are very strict and need to be specific in addressing compliance. This book lacks that type of specificity. To achieve the high level of technical detail as a reference standard, the authors will need to weed out the generalities of each section. A definitive statement is needed to indicate that Codes and Regulations take **precedence** over the book's guidelines. Allowing multiple acoustic descriptors also weakens the effort to meet reference standard quality. The words "shall" and "must" are used throughout the book. These words would indicate that compliance is mandatory, but the generalities and stated goal only as "guidance" are in conflict. This book stands alone as the only available healthcare reference book

for noise and vibration criteria. Based on my review I believe the book is useful and would recommend this book only as a **guidance** document in its present form to healthcare owners, architects, engineers and acoustical consultants. As the book evolves with public comment, it could eventually be edited sufficiently with the specificity required to meet the reference standard level of qualification.

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