ACOUSTIC DESIGN CONSIDERATIONS IN MODERN HEALTH CARE FACILITY DESIGN

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1 Introduction

Acoustic performance requirements are increasingly applied to all manner of new types of buildings. For health care facilities (HCFs), The Canadian standard CSA/CAN Z8000 – 11 (2011) includes acoustics in its broad range of considerations for Canadian HCFs. In the United States, the Facilities Guidelines Institute (FGI) Guideline for Design and Construction of HCFs (2010 and 2014) includes a substantial section on acoustic design. The 2014 version includes substantial changes from the 2010 version, a few of which are noted below. Work has started on the next version for 2018. The FGI requirements are now being applied to HCFs in Ontario and Nova Scotia.

The FGI Guideline for acoustics is more comprehensive in scope and much more detailed than the CSA Z8000 standard. The FGI guidance is reasonable and practical, and anticipates many of the concerns which will arise from its implementation. It is well thought-out and there are also several interesting points for acousticians to consider. It has now been adopted as part of the State Building Codes in 42 States.

The need for HCF design standards is clear, as the negative health effects of noise, particularly in hospitals is well documented. Additionally, requirements for speech privacy and confidentiality of patient information are increasing; noise and vibration levels from diagnostic imaging equipment, such as Lithotripters and MRIs are higher; and, the requirements for vibration-free floors for diagnostic equipment are becoming more stringent.

Vibration considerations are discussed in a companion paper, "Floor Vibration Considerations for Sensitive Equipment in Hospital, Medical, Pharma and Laboratory Facilities" (Paper 61).

2 Scope

Both the FGI (comprised of two documents) and CSA consider (a) the planning and design of HCFs, including hospitals, ambulatory care facilities and residential (i.e. long-term care) facilities, (b) environmental noise including the effect of the environment on the facility and vice-versa., (c) interior noise levels, (d) speech privacy and (e) vibration of the structure, particularly floors. Neither document addresses either speech intelligibility or any special requirements of the audiology department. While each document contains a special section on acoustics, there are acoustic requirements occasionally indicated in other sections. Seismic-induced vibration is dealt with in the structural section.

The acoustics section of the FGI document was developed by an ANSI committee and was first included in the 2010 version, which is repeated with substantial changes in the 2014 document.

	CSA Z8000	**FGI 2014**
SITE Enviro.	Reference nearby residential	Class A B C D L_{DN} <65 65-70 70-75 >75
SITE Noise allowed	----	Part Table 1.2-3 Mech 45 – 60 dBA at HCF (+ local / state code) B,C,D are special, ref. ANSI/ASA/12.9/2
SITE Outdoor	----	$L_{DN} \leq 50$
PARTITION / FLOOR	Part Table 12.1 STC Ad Off 40 Dr. Off 50 Inpatient 45 Inpatient / noisy 55 Labour / nursery 55 Mech.R 55+ Floors Floating floors	Part Table 1.2 – 6 STCC Consultation 50 Patient 45 Patient / services 60 Exam /Exam 50 Exam/Exam - Masking 40
ROOM NOISE	Room Noise (NC) Ref CAN/CSA Z317.2 Private Rm 25-35 Wards 30-40 Operat Rm 25-35 Elev Mech Rm 80dBA	Part Table 1.2-5 NC/RC(N) dBA Patient 40 45 NICU 30 35 Exam 40 45 Rm. Auditoria, Large Lecture 30 35
ROOM ACOUSTIC	Ceilings NRC ≥ 0.55 For Nursery, nurse station., offices Ceilings NRC ≥ 0.75 for special care nursery, open office Acoustic wall finishes for special areas	Part Table 1.2-4 Room absorption coefficient Patients, Physicians 0.15 Waiting areas 0.25 Atrium 0.1
SPEECH PRIVACY	Part of STC only	Part Table 1.2-7 Rooms SII SPC Normal .11-.25 52-59 Confidential 0.11 60-69 Open plan .11-.25 52-59
VIBRA-TION	References AISC Design Guide 11	References AISC Design Guide 11 (See companion Paper 61)

Table 1 Acoustic Comparison CSA/CAN Z8000-11 and FGI 2014

The FGI document history dates back to 1947 when it was developed in response to Federal legislation, and was developed by architects over many years before being incorporated in the FGI. The document is cross-referenced to ANSI standards for definitions and to ASHRAE for mechanical noise. It is a product of several standards committees working to produce a single harmonized document so as to avoid having competing documents.

Table 1 above provides excerpts, briefly stated, comparing the provisions of the two documents. The FGI document is both broader in its scope and more detailed. For example, FGI has four different classes of exterior environmental noise and recommends special attention for the three noisier environments. The classes are defined in terms of day-night outdoor sound levels, L_{DN}, distances from highways, railways and slant distance from aircraft. It specifies the amount of noise allowable from the HCF's own equipment on itself, particularly for nighttime, the design goals being quite low, ranging from 45 to 60 dBA.

Examining the STC requirements, the documents are similar, however, FGI specifies the composite STC, anticipating the presence of door side lights, clerestory windows and doors. Interestingly, there is a lower STC requirement between examination rooms if sound masking is present, which is limited to 48 dBA. The Z8000 document specifically references floating floors for mechanical rooms, while the FGI does not.

The two Guidelines differ significantly on the treatment of room acoustics: where Z8000 requires ceilings of various NRC values for different spaces, FGI requires an average room absorption coefficient, with a large majority of rooms requiring an average coefficient of 0.15. The FGI deals with speech privacy specifying values of PI, AI, SII and SPC for both closed and open offices and for three levels of speech privacy. CSA Z8000 deals with speech privacy only as part of an STC requirement. Neither document considers speech intelligibility for areas such as lecture halls or auditoria, though the FGI refers to Speech Transmission Index (STI) and provides specifications relating to paging and call systems.

The FGI document provides limits for floor vibration caused by footfalls, and requires use of the AISC Design Guide 11. This is the subject of the companion paper. The CSA standard provides only reference to the AISC Guide.

3 Discussion of the FGI HCF Guideline

In the FGI Guidelines, references to acoustic requirements, including specific references to the acoustic section, appear at many locations as requirements for many types of rooms. This forces designers to consider acoustics and helps avoid locking-in an architectural design early in the design process which fails to meet the acoustic requirements.

Concern for the acoustic environment outside the hospital and the effect of the environment on the HCF appears throughout the document, and is very thorough, covering items such as future noise sources and outdoor patient areas – limited to L_{DN} of 50 dBA and an extensive section on Heliports. Other areas of consideration include construction activities, normal materials management activities such as trash removal, and truck backup signals.

Specific advice is given to "Enlist the services of an acoustic engineer ..." and also warns: "Enlistment of acoustic services late in the design process often results in fewer and more costly options for meeting the performance standards". The document looks forward, thinking of patient health and comfort noting "…. Patients should be able to have some control of their acoustic environment. Noisy equipment and systems should be controllable at bedside wherever possible…." The FGI further adds that "Patients and staff should be able to activate sound-masking technology to help mask unwanted sounds ….".

Neonatal intensive care units (NICUs) are dealt with separately and extensively as they have many "incompatible adjacencies" and contain many noise sources including the infants themselves.

Anticipating compliance STC difficulties, the document requires use of composite STC. For example, the exam room / corridor requirement of STCc 35, door closed, resolves a common design problem

The FGI notes when selecting assemblies based on their tested STC ratings, the general accuracy is $\pm$ 2 STC points. Thus, an assembly with an STC rating as low as 2 points below the stated minimum may be considered acceptable; which implies a field testing tolerance of 2 points also which is more strict than the usual tolerance.

Surprisngly, FGI 2014 has higher allowable background noise levels (NC, dBA) than the 2010 version and these are significantly higher than CSA Z8000. In FGI a private patient room is specified a maximum of NC 40 and 45 dBA which is higher than the Z8000 values of NC 25-35. The minimum patient room STC is 45, which is five points less than Z8000. This is consistent with the same speech privacy, but comes at the expense of a noisier patient room. This seems at odds with the desire for quiet spaces, particularly patient rooms, and the goal of giving the patient a degree of control over the acoustics of the space, such as through use of patient controllable sound masking.

4 Conclusions

The acoustic sections of Health Care Facility design guides CSA/CAN Z8000-11 and the US FGI 2014 have been reviewed and compared. The FGI document represents years of determined effort and is both very comprehensive and very detailed and seems to anticipate the difficulties of implementation. It first appeared in 2010 and was re-issued in 2014 with significant changes and refinements. However, background noise levels from HVAC have been significantly increased, marking a significant difference between the two documents. The FGI document is important in Canada because it is being used as part of specifications of requirements for new HCF facilities both in Ontario and Nova Scotia.

5 References

1. Facilities Guidelines Institute, Guidelines for Design and Construction of Hospitals and Outpatient Facilities, 2014 Edition.

2. CSA/CAN Standard Z8000-11, Canadian Health Care Facilities, 2011.

3. CSA Standard Z317.2-10, Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Health Care Facilities.