FGI GUIDELINES FOR HEALTHCARE ACOUSTIC DESIGN

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1 Introduction

The Facility Guidelines Institute is responsible for the production of their industry-standard document focused on the design and construction of health care facilities in the United States. This once-singular document has been divided into two separate volumes since the latest (2014) revision cycle : *Guidelines for the Design and Construction of Hospitals and Outpatient Facilities*, and *Guidelines for the Design and Construction of Residential Health, Care, and Support Facilities* (hereafter referred to as FGI 2014). Currently, 42 U.S. states use at least one edition of the *Guidelines* in some form into their building codes and they have been read in 60 countries [1].

The *Guidelines* have been available in the United States in multiple iterations beginning in 1947 as the *General Standards* [2]. Today, the *Guidelines* are edited and re-issued every four years by a a multi-disciplinary group of experts related to healthcare facilities. Due to such issues as patient privacy and evidence linking hospital acoustics and patient recovery, acoustical criteria for healthcare facilities was formally introduced into the 2010 cycle. They are included in both volumes of the *Guidelines* and cover six categories, which will be explained in detail in the following sections of this paper :

1. Site exterior noise
2. Acoustic surfaces
3. Room noise levels
4. Interior wall and floor/ceiling constructions
5. Speech privacy
6. Building vibration

2 FGI Guidelines Acoustical Criteria [3, 4]

2.1 Site Exterior Noise

FGI 2014 requires that the sound isolation provided by the exterior shell (including the exterior wall/window assemblies, penetrations, etc.) of health care facilities be designed to result in appropriate interior noise levels. Exterior noise transmitted into the building and noise produced by the facility reaching nearby receptors (neighbors) are considered.

This section classifies exterior site noise into one of four categories based on the site exposure and provides prescriptive building envelope Outdoor-Indoor Transmission Class (OITC) ratings. The noise exposure categories are determined by the day-night average sound level (L_{dn}, dB) and the average hourly maximum sound level (L_{01}, dBA). A separate, non-prescriptive, resource is also given to approximate the site noise exposure by the distance to nearby transportation noise sources.

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2.2 Acoustic Surfaces

In order to foster a pleasing acoustical environment for patients and staff, the FGI 2014 sets minimum average room absorption coefficients for multiple types of healthcare facility spaces based on their use. Any material used must also satisfy all infection control/cleaning requirements as defined by the facility.

Rather than requiring specific finishes to be used, FGI 2014 defines acoustical performance based upon the average sound absorption coefficient, which is calculated as the sum of all boundary areas in the room first multiplied by the sound absorbing performance of each material in the room and divided by the sum of the boundary areas.

2.3 Room Noise Levels

Noise from building mechanical systems is an important aspect of the acoustical environment and contributes to the overall comfort of both patients and facility staff. Since several metrics exist to define noise levels in a room, FGI 2014 presents the maximum criteria for noise in interior occupied spaces based on functionality in terms of NC, RC (Neutral), RNC, and dBA. FGI 2014 also clarifies that the criteria outlined refer only to maximum building mechanical system noise rather than overall interior noise levels due to occupant and/or medical equipment noise. The presentation of maximum noise criteria, rather than the minimum-maximum criteria presented in FGI 2010 is new to FGI 2014.

2.4 Interior wall and floor/ceiling constructions

Interior wall and floor/ceiling constructions must provide adequate sound isolation for patient and staff comfort as well as to meet patient privacy requirements. FGI 2014 sets forth minimum required composite sound transmission class (STC_C) performance based upon the function of adjacent spaces.

Since the 2010 cycle, the FGI 2014 requires the STC_C for patient, consultation and exam rooms adjacent to a corridor (including the door) to be 35, excluding the door, rather than being STC_C 35 with a closed door. This implies that the performance objective is now assigned to the partition itself. FGI 2014 also states that doors are not required to be sound sealed and the use of higher performing doors, full-perimeter gasketing, and bottom seals will be left to the discretion of the facility. These changes were made in response to concerns that the composite rating including doors required door hardware that may not be compatible with infection control and cleaning requirements.

2.5 Speech Privacy

United States law through the Health Insurance Portability and Acountability Act (HIPAA) requires facilities to safeguard patients' private information [5]. FGI 2014 requires that spaces be designed to meet speech privacy goals using one of four speech privacy metrics : PI, AI, SPC and SII. By not specifying exact design criteria to meet speech privacy needs, greater flexibility in the design is allowed based upon the needs and expectations of the specific facility.

2.6 Building Vibration

Mechanical, Electrical and Plumbing Equipment Vibration

Most building mechanical equipment generates vibrations that can be transmitted to the building structure. To avoid structure-borne transmitted sound, and to minimize impact on human comfort or sensitive equipment, FGI 2014 states that all rotating and vibrating components of the building systems should be isolated as recommended in the most current Applications Handbook of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).

Structural Vibration

FGI 2014 requires that the building structure must be designed so as to avoid footfall vibration levels in excess of specific values. In addition, because hospitals and healthcare facilities are likely to have sensitive equipment (i.e. MRI, microscope), the building must be designed so that structural vibrations do not exceed the limits recommended by the equipment supplier.

Structure-borne Sound

FGI 2014 requires that structurally transmitted sound may not exceed the airborne room noise levels discussed in the section, "Room Noise Levels" and also requires vibration isolators to be used on sources of structurally borne sound when necessary.

3 Continual Improvement Process

In order to stay current with the latest research and changes in healthcare laws, the *Guidelines* are edited and re-issued every four years following an open, formal, Continual Improvement Process. This work is done by the FGI's Health Guidelines Revision Committee (HGRC), which is composed of a multidisciplinary group of experts related to healthcare facilities.

The acoustical content is the responsibility of the FGI Acoustics Working Group, of which the author holds membership (as co-chair of education). This group authors and edits the *Sound & Vibration Design Guidelines for Health Care Facilities* which serves as the sole acoustical reference for the *Guidelines*.

The revision cycle begins shortly after publication of the current edition of the *Guidelines* with a period for public submission of proposed changes. Then, the HGRC considers the public proposals and proposals prepared by HGRC members and subcommittees, and votes on whether to accept, accept with modification reject, or reject them.

The result of this committee work is a draft manuscript for the next edition of the *Guidelines* which is posted on the Internet for public review and comment. After this review period the HGRC meets again to consider the comments on the draft document, and finalizes the content for the next edition. After this meeting, a final draft is reviewed by the Steering Committee and then submitted to the HGRC for final approval by ballot. Subsequently, the next edition of the *Guidelines* is published.

4 Conclusions

Both the *Guidelines for the Design and Construction of Hospitals and Outpatient Facilities*, and *Guidelines for the Design and Construction of Residential Health, Care, and Support Facilities* serve as an industry standard documents for the design and construction of health care facilities in the United States. Their acoustical criteria, brought on by both patient privacy laws and evidence of detrimental effects of hospital noise on patients and staff, help enforce the importance of proper acoustical design in healthcare facilities. As evidence of the benefit of proper acoustical treatment in healthcare facilities grows, it is expected that incorporation of the latest acoustical issues will be incorporated into future editions of the *Guidelines*.

References

[1] The Facility Guidelines Institute. Frequently asked questions about the Guidelines.

[2] The Facility Guidelines Institute. The history of the FGI.

[3] The Facility Guidelines Institute. *Guidelines for Design and Construction of Hospitals and Outpatient Facilities*. American Society for Healthcare Engineering of the American Hospital Association, Illinois, USA, 2014.

[4] The Facility Guidelines Institute. *Guidelines for Design and Construction of Residential Health, Care, and Support Facilities*. American Society for Healthcare Engineering of the American Hospital Association, Illinois, USA, 2014.

[5] U.S. Congress House of Representatives. Health insurance portability and accountability act of 1996. *Public Law*, 104 :191, 1996.