The National Institutes of Health | Division of Technical Resources | Office of Research Facilities

Design Requirements Manual **News to Use**

December 2020

Vol. 02, No. 48

The formulae $\frac{\partial \rho \bar{U}_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho \bar{U}_i \bar{U}_j)=-\frac{\partial \bar{P}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu \frac{\partial \bar{U}_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ *for building* $\frac{\partial}{\partial x_j}(\rho \bar{U}_i \bar{U}_j)=-\frac{\partial \bar{P}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu \frac{\partial \bar{U}_i}{\partial x_j}-\rho \overline{u_i' u_j'}\right)+g_i(\rho-\rho_0)$ *state of the art* $\frac{\partial}{\partial x_i}(\rho \bar{U}_i \bar{H})=\frac{\partial}{\partial x_i}\left(\lambda \frac{\partial \bar{T}}{\partial x_i}-\rho \overline{u_i' h'}\right)$ *biomedical research facilities.*

Acoustical Door Design

Speech privacy and sound control are important factors when designing for healthcare environments and research laboratories. Ramifications linked to poor acoustical design include sleep deprivation, patient privacy, and doctor-patient confidentiality breaches, all of which are addressed in the Health Insurance Portability and Accountability Act (HIPAA). Sound can also impact research animals adversely as animal sensitivity to noise has been linked to changes in breeding and behavior as well as physiological effects.[1]

Basis of Design

The criteria for sound control should be clearly identified in the program requirements and scope of work. The Sound Transmission Class (STC) rating specifies how well a door or wall assembly prevents sound from passing through. Demising partitions separating occupied areas from public corridors and construction separating enclosed rooms and non-public corridors must be designed to achieve minimum STC and Noise Isolation Class (NIC) ratings, per the DRM. Components that will improve the STC rating of a wall assembly include slab-to-slab staggered or double metal studs, resilient channels, acoustical insulation, layered gypsum board, and the use of acoustical sealants at gaps and penetrations. Since sound transmission increases at wall openings, greater consideration should be given at door locations. Successful acoustical door integration is dependent on a complete wall assembly design and proper installation of its components.

Acoustical Door Assemblies

Sound control door assemblies include the door frame, leaf, threshold, perimeter seals, gasketing, astragal, door sweeps or automatic door bottoms, and hinges and may also include vision panels for increased visibility. Door seals and gaskets create a continuous airtight seal and are compressed against the leaf and frame. Door sweeps seal the gap between the bottom of the door and the threshold. The sweep can be made of neoprene, silicone, or a nylon brush. Automatic door bottoms are adjustable and are used when a higher degree of sound control is required. When the door is closed, the seal automatically drops and closes the gap at the bottom of the door. Cam lift hinges are specially designed for sound control doors. The door is lifted and lowered during travel, improving the seal along the door perimeter and creating a positive seal at the closed position.

Acoustical Door Design Considerations

High STC ratings can impact the design by requiring heavier steel doors, wider door frames, and specific framing requirements at the door jamb that cannot be easily addressed mid- or post-construction. Heavier doors may not only require additional detailing at the door jamb, such as double metal studs, specialty hinges, or added bracing, but can also trigger ABA/ADA requirements for automatic doors due to the force required to operate the door leaf. Design features such as view windows and material finishes can be aesthetically limited due to the STC rating as well as the cost and lead time associated with acoustical metal and wood doors. Additionally, glazing should be specified to match the STC rating of the door in order to maintain the acoustical characteristics of the door assembly.

Warranty & Testing

A variety of warranty and testing factors must be considered prior to construction. For instance, in order to meet manufacturer warranty requirements, field conditions may need to incorporate certain elements present in lab testing conditions, such as door frames that are infilled with grout or insulation. When specifying sound control requirements, it is important to set an acceptable STC range for field testing between two adjoining areas to account for the fact that ratings can differ when door assemblies are tested in the field. Acoustical assembly components such as seals, gaskets, and bottoms may also be required to be single sourced and installed by a certified installer. Hospital stops modify the door frame such that the stop terminates above the floor to prevent corners from collecting debris and obstructing wheeled equipment and are therefore not recommended where a desired STC assembly is to be tested or warranted.

Additional Resources & References

1. Role of Noise & Music as Anxiety Modulators, Applied Animal Behavior Science Volume 152, March 2014.

News to Use article *Laboratory Door Design Considerations* dated November 2020 and *Sound Design Metrics* dated September 2019 and *Vision Panels in Laboratory Doors* dated December 2017 for additional lab door design considerations.

FGI Guidelines for Design and Construction of Hospitals, 2018 for additional acoustical hospital design requirements.

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Further details on this month's topic are available on the DRM website DRM Section 4.2, Doors
https://www.orf.od.nih.gov/TechnicalResources/Pages/DesignRequirementsManual2016.aspx