

NICU's, or Neonatal Intensive Care Units, present a unique hospital noise control environment. Recent studies show that the average sound levels in a NICU range between 70 to 80 dB, but the American Academy of Pediatrics recommends a maximum safe noise level of 45 dB. The high sound levels of most NICU environments is due to equipment alarms, medical equipment processes, building equipment noise, occupational noise, and conversational sounds.

The first step in NICU noise control is to evaluate the sound levels that exist within the NICU with a sound level meter so that acoustical solutions can be determined. While the best solution is to implement noise control in the design process of the NICU, that is not an option for many existing NICUs. In these cases the acoustical solutions involve adding sound absorption materials and sound transmission barriers.



eNoise Control has experience in NICU noise level monitoring, sound reduction analysis, and NICU acoustical solutions. Please call or email with your NICU noise control questions.



NICU Standard 23: Acoustic Environment

Infant rooms (including airborne infection isolation rooms), staff work areas, family areas, and staff lounge and sleeping areas and the spaces opening onto them shall be designed to produce minimal background noise and to contain and absorb much of the transient noise that arises within them.

- In infant rooms and adult sleep areas, the combination of continuous background sound and operational sound shall not exceed an hourly Leq of 45 dB and an hourly L10 of 50 dB, both A-weighted slow response. Transient sounds or Lmax shall not exceed 65 dB, A-weighted, slow response in these rooms/areas.
- In staff work areas, family areas, and staff lounge areas, the combination of continuous background sound and operational sound shall not exceed an hourly Leq of 50 dB and an hourly L10 of 55 dB, both A-weighted slow response. Transient sounds or Lmax shall not exceed 70 dB, A-weighted, slow response in these areas.

To achieve the required noise levels in infant rooms and adult sleep rooms, building mechanical systems and permanent equipment in those areas shall conform to Noise Criteria (NC) -25 based on

manufacturers' noise ratings with allowance for other sound sources and adjustment for room loss if less than 10 dB. Areas in open communication with infant rooms and adult sleep rooms shall conform to NC-30. Building mechanical systems and permanent equipment in other areas specified in the Standard shall conform to a maximum of NC-35. Building mechanical systems include heating, ventilation, and air conditioning systems (HVAC) and other mechanical systems (e.g., plumbing, electrical, vacuum tube systems, and door mechanisms). Permanent equipment includes refrigerators, freezers, ice machines, storage/supply units, and other large non-medical equipment that is rarely replaced.

Where personal address speakers are located in sensitive areas, announcing systems shall have adjustable volume controls for the speakers in each room and for each microphone that sends signal through the system.

Speech privacy and freedom from intrusive sounds shall be provided by acoustic seals for doors and building to meet STC criteria (below) for demising partitions in infant rooms, on-call and sleep rooms, family transition rooms, and conference rooms or offices in which sensitive staff and family information is discussed. All other penetrations for conduits, inset boxes, pipes, ducts, and other elements in sound demising partitions shall be sealed airtight to prevent noise flanking (leakage) through gaps and openings.

Interpretation:

The acoustic environment is a function of both the facility (e.g. building mechanical systems and permanent equipment, the intrusion of exterior sounds, the sound containment afforded by doors and walls, and the sound absorption afforded by surface finishes) and operations (e.g. the activities of people and function of medical equipment and furnishings).

The acoustic conditions of the NICU should favor speech intelligibility, normal or relaxed vocal effort, speech privacy for staff and parents, and physiologic stability, uninterrupted sleep, and freedom from acoustic distraction for infants and adults(24). Such favorable conditions encompass more than the absence of noise and require specific planning for their achievement. Speech Intelligibility ratings in infant areas, parent areas, and staff work areas should be "good" to "excellent" as defined by the International Organization for Standardization ISO 9921:2003. Speech intelligibility for non-native but fluent speakers and listeners of a second language requires a 4 to 5 dBA improvement in signal-to-noise ratio for similar intelligibility with native speakers. The Leq, L10 and Lmax limits will safeguard this intelligibility and also protect infant sleep(25).

The permissible noise criteria of an hourly Leq of 45 dB, A-weighted, slow response in infant rooms and adult sleep areas is more likely to be met in the fully operational NICU if building mechanical systems and permanent equipment in those areas and the areas in open communication with them conform to NC-25 or less. NC-25 translates to approximately 35 dBA of facility noise. A realistic addition of 10 dBA of operational noise above this background will result in an Leq of about 45 dBA. Limiting operational noise to only 10 dBA above the background will require conscientious effort.

Acoustically absorptive surfaces reduce reverberation and, therefore, sound levels at a distance from the sound source. When possible, two perpendicular walls should be covered with sound absorptive surface materials with an NRC of at least 0.65. Where this is not possible the upper portions of all four walls (above areas likely to be damaged by the movement of equipment) should be covered with such material. Glass should be limited to the area actually required for visualization in order to leave wall surface available for absorptive surface treatment. While a variety of flooring will limit impact noise somewhat, specialized carpeting offers the most protection.

Fire alarms in the infant area should be restricted to flashing lights without an audible signal. The audible alarm level in other occupied areas must be adjustable. Telephones audible from the infant area should have adjustable announcing signals.

The type of water supply and faucets in infant areas should be selected so as to minimize noise, and should provide instant warm water in order to minimize time "on".

Noise-generating activities (e.g., linen and supply carts, conference areas, clerk's areas, multiple-person work stations, and travel paths not essential to infant care), permanent equipment and office equipment should be acoustically isolated from the infant area. Vibration isolation pads are recommended under leveling feet of permanent equipment and appliances in noise-sensitive areas or areas in open or frequent communication with them.

Post-construction validation of specifications for the building mechanical systems and permanent equipment should include noise and vibration measurement, reporting, and remediation. Measurement of NC levels should be made at the location of the infant or adult bed or at the anticipated level of the adult head in other areas. Each bed space must conform to the Standard.

With space at a premium, many incompatible adjacencies are possible in NICU designs (e.g., break area, meeting room, or mechanical room sharing a wall with an infant room or adult sleep room). Specialized wall and floor/ceiling treatments will help to meet criteria in these non-optimal conditions.

The criteria below are for sound transmission loss (TL) or attenuation through horizontal barriers (e.g., walls, doors, windows) and vertical barriers (e.g., between floors). The Sound Transmission Class (STC) rating spans speech frequencies and is relevant for separation of spaces with conversational and other occupant-generated noise. The Noise Reduction (NR) rating, which covers a wider frequency span, is more relevant for mechanical noise dominated by low frequencies. The recommended criteria for TL below apply to barriers between adjacent spaces and infant areas or adult rest or sleep rooms.

Adjacent Spaces Pedestrian-only corridor STC 45 Equipment corridor STC 55 Infant area STC 40 Reception STC 55 Meeting room with amplified sound STC 55 Staff work area STC 55 Administrative office, conference STC 45 Non-related area STC 50 Mechanical area NR 60-65 Electrical area NR 50-55 (adapted from Evans JB, Philbin MK. Facility and operations planning for quiet hospital nurseries. *J Perinatol* 2000; 20(8):S105-12. Revised and reprinted with permission of Jack B. Evans, PE, M. Kathleen Philbin, RN, PhD, The Journal of Perinatology, and Nature Publishing Company).

Sound transmission from the exterior of the building should meet the NC criteria inside all spaces identified in the Standard.

It is advisable to enlist the services of an acoustical engineer from the onset of the project through post-construction validation. This specialty service is usually not covered by architectural fees and can assist in program and design development, design of mechanical systems, specification of equipment and building construction, and test and balance validation. Enlistment of acoustical services late in the design process often results in fewer and more costly options for meeting performance standards.