

## Study of Traffic Noise Levels at Various Heights of a 39-Story Building

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**ABSTRACT.**—Comparative measurements of exterior noise levels made at floors 3, 14, 26, and 37 of a high-rise apartment tower, when presented as a statistical distribution of percent exceedance vs. decibels, show the nature of the influence of local traffic at the low floors compared to the influence of an area source at the high floors. The open window penalty to interior noise levels was measured as well as the side street noise propagation along the building from avenue vehicular traffic sources alone.

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THE IMPOSITION OF NOISE-EXPOSURE limits on new urban multi-unit living quarters as a prerequisite to acceptability for government financial assistance has encouraged attention to this matter early in the design stage. The U. S. Department of Housing and Urban Development (HUD) criteria tend to discourage the construction of new dwelling units, including the rehabilitation of older dwellings, by withholding HUD financial assistance if there are, or are projected to be, unacceptable interior or exterior noise exposures.

HUD Circular 1390.2 specifies exposure standards in terms of categories termed broadly as; "Unacceptable", "Discretionary", and "Acceptable" as measured at appropriate locations along, and heights above, site boundaries. In New York City, local interpretation has extended the locations to the facades of the projected or existing buildings because most buildings do in fact start at the site line or very close to it. The external noise standards are fundamental to realizing an acceptable level of noise in the occupied or dwelling areas of the building, with specific emphasis on sleeping quarters. Performance standards limiting interior noise exposures as stipulated in Circular 1390.2 are predicated on "open windows unless other provision is made for adequate ventilation".

The sponsors of high-density housing, such as high-rise apartment buildings, are sensitive to the need to introduce measures to combat noise intrusion. This is particularly so because significant economies are realized when it can be established that, for a particular design, a majority of the living units meet the noise requirements without resorting to costly acoustic measures involving shifts in window exposures, insertion of high transmission loss window assemblies, installation of room or centralized comfort conditioning, etc. Just such a consideration precipitated the request for an evaluation of traffic noise exposure at various elevations on the avenue side of a 39-floor high-rise tower (figs. 1 and 2) and along the avenue side of a flanking L-section wing having 7 floors (figs. 3 and 4). The building is located in midtown Manhattan, fronting on a moderately used north-south avenue and between lightly used cross streets.

Before construction of the building, measurements at the site revealed that the external noise exposure at the avenue side of the tower and at the elevation of the projected lowest residential floor was "Discretionary—Normally Unacceptable" (fig. 5) since the distribution curve passed to the right of the stipulated transition point (X in fig. 5) between being normally unacceptable and normally acceptable. This was



Figure 1.—The 39-floor high-rise tower studied in New York is provided with room air-conditioner openings in the avenue exposure side of the building.



Figure 2.—The entrance and lower levels of the tower structure.

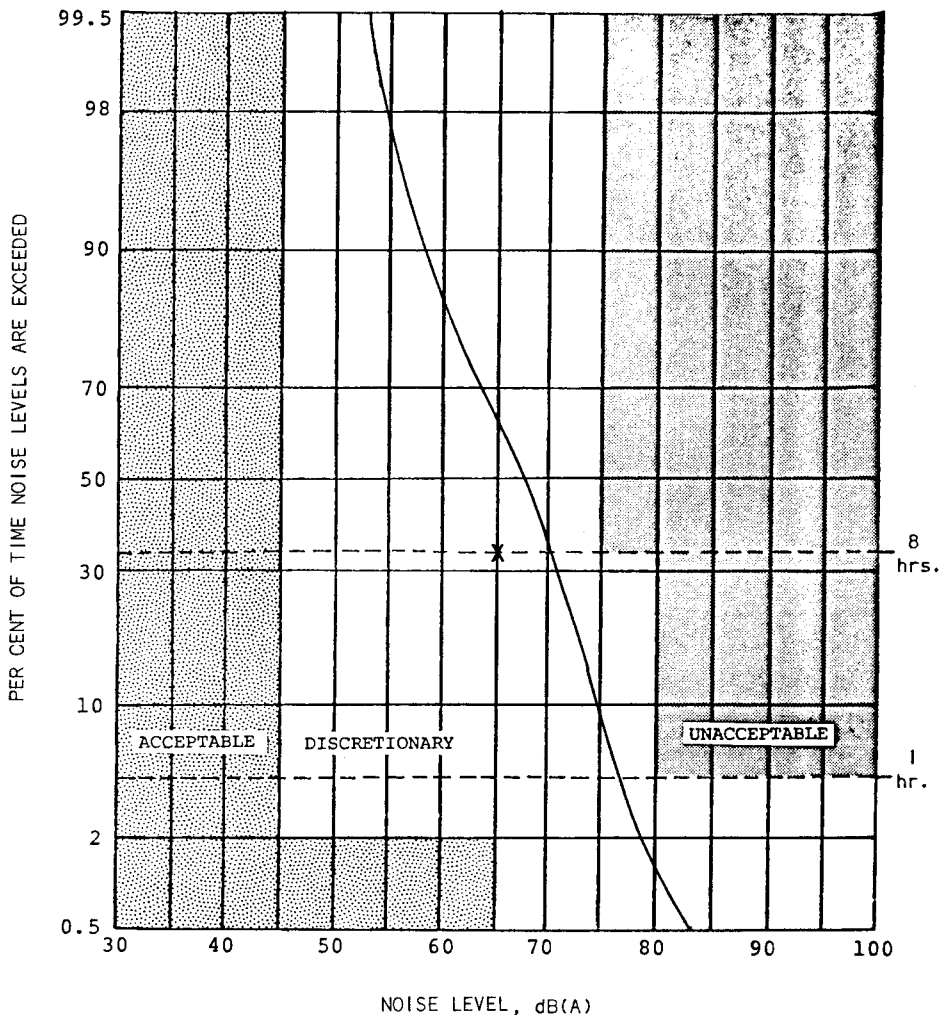
Figure 3.—The avenue side of the seven-floor L-section wing adjacent to the tower structure.



Figure 4.—A side-street view of the seven-floor L-section wing.



Figure 5.—Statistical exceedance distribution of recorded noise levels over a period of 24 hours at the building site before construction. Traffic in the area at the time of the tests was determined to be mid-week normal with no local street closures or disruptions. HUD Circular 1390.2 exterior criteria has been superimposed. Measurements were taken at the lowest projected bedroom elevation and at the building line.



based on a 24-hour midweek measurement showing the exterior noise level to exceed 65 dBA for more than 8 hours. Subsequent to this reporting, the building was erected and a repeat test was requested. Because of several important deterrents, the 24-hour test could not be repeated with any degree of reliability. Closing of a hazardous nearby highway caused a redistribution of avenue traf-

fic, and construction activity on nearby streets prompted this decision.

Accepting the premise that the normally unacceptable but discretionary exposure prevailed, and that measures must be taken to assure maintaining interior levels within criteria, a study was sponsored to determine the height at which the external noise standards would meet the discretionary but nor-

mally acceptable criteria. All apartments below this level would then be considered for mitigating measures by architectural and mechanical modification.

For exterior measurements at all selected locations, windscreen-fitted microphones attached to booms were extended out from the building facade to a distance of 1 meter and oriented for random incidence. Simultaneous A-weight recordings were made on tape recorders at several levels of the building tower; floors 3, 14, 26, and 37 were

selected for approximate equidistance. Since the readings were directly comparable, the level of traffic flow was essentially immaterial; however, to obtain a range of noise levels, testing was started early enough to include rush-hour traffic.

Graphic record comparisons were possible for recordings taken on the 3rd and 14th floors, but the smoother noise variations observed at the 26th and 37th floors made statistical analysis mandatory. Accordingly, analysis samplings of the simultaneously recorded data were

Figure 6.—Statistical exceedance distribution of simultaneously recorded noise levels over a 3-hour sampling period for four tower elevations.

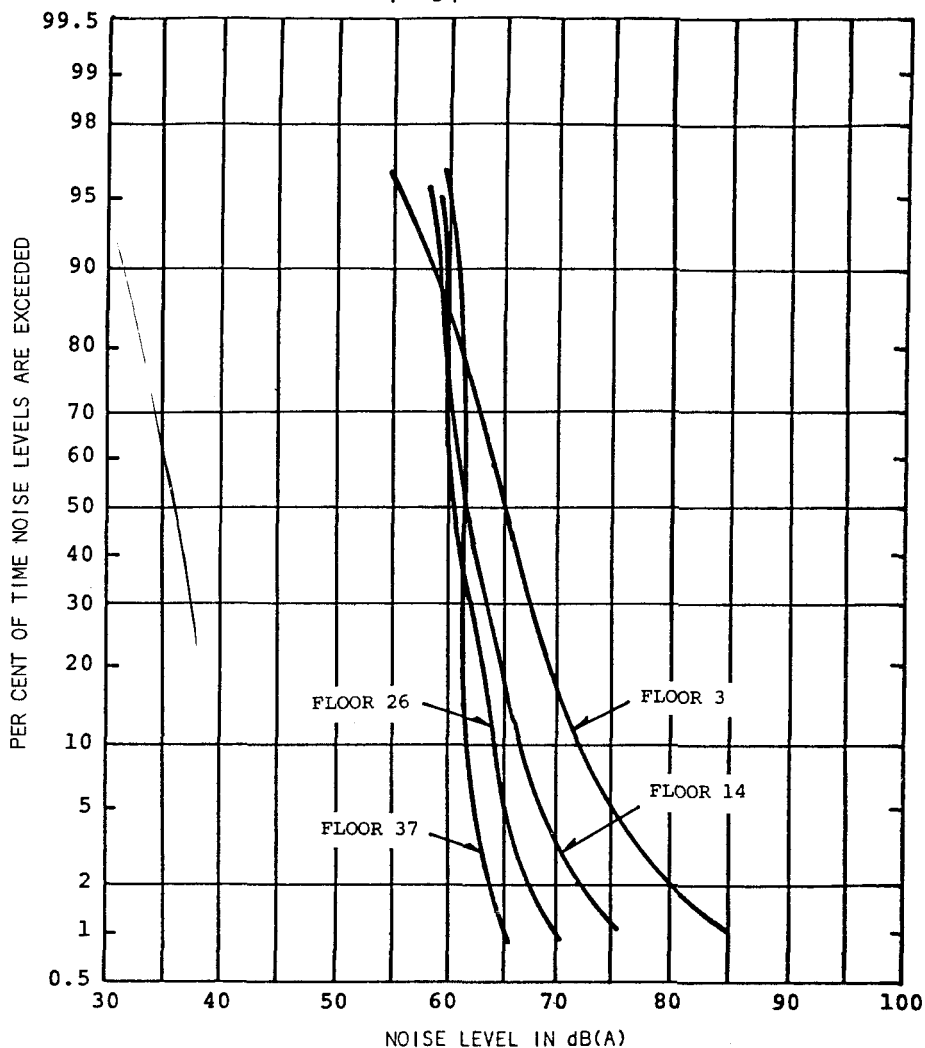
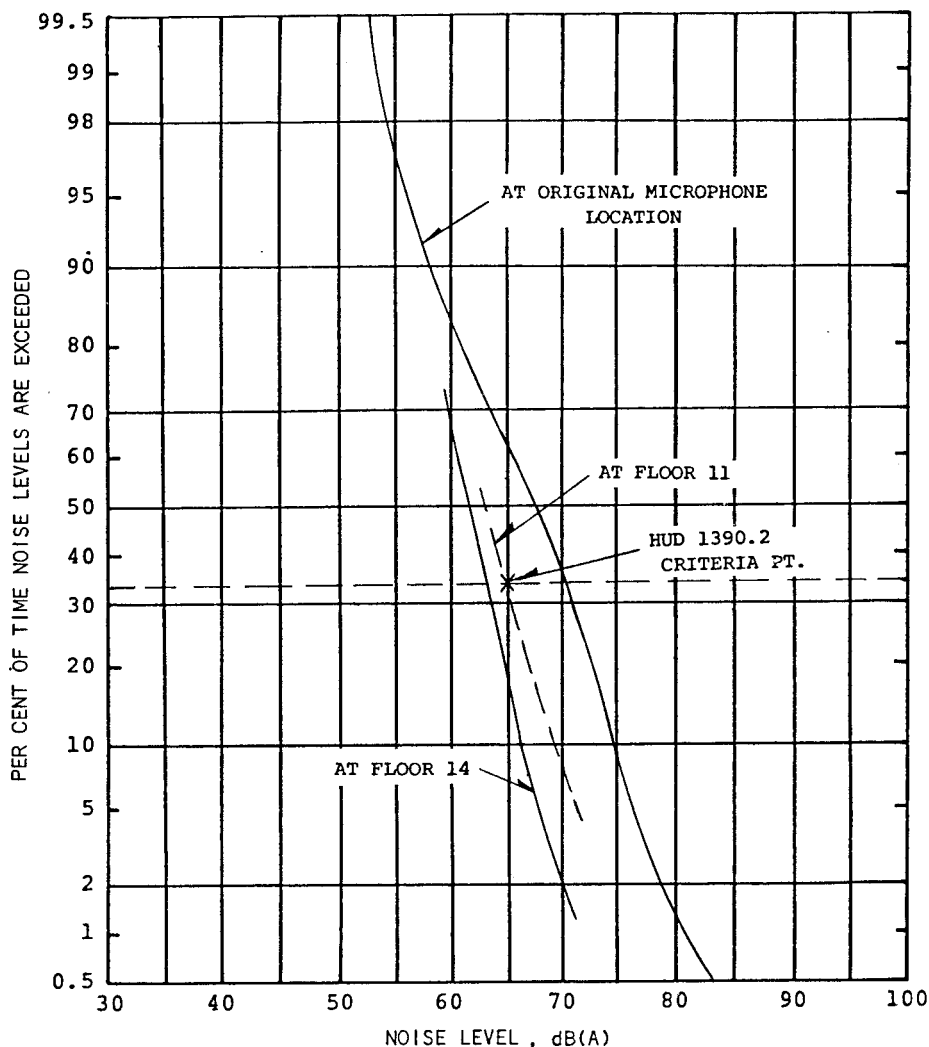


Figure 7.—Interpolation between exceedance curves for the tower floors establishes the approximate floor just meeting the Discretionary-Normally Acceptable criteria.



taken every half-second of the recording period and accumulated in 5-dB steps (pentads). The results, normalized to remove minor variations (fig. 6), showed a distinct convergence of the exceedance curves. For the 37th floor, the curve indicated a relatively uniform noise level approaching an  $L_{90}$ , A-weight, residual value of approximately 61 dBA. At floor 3, the full impact of local avenue traffic was experienced, with wider excursions of noise level. The

intermediate floors, 14 and 26, indicated a relatively lower influence of immediately local traffic noise.

Transposition of the elevation adjustment to the original normal traffic noise base permitted an interpolation approximating the tower floor that would have an exceedance curve (fig. 7) to the right of the discretionary transition point. This was computed to be floor 11. Mitigating measures were indicated as recommended for residential floors 2

through 11 on the avenue side of the tower and all six residential floors of the avenue side of the building wing.

Sutherland (1975) has reported a recorded A-weight residual level ranging from 69 dBA to 73 dBA from ground level to 20 floors above ground level at another high-rise apartment site in New York City. For the particular study made by Sutherland, his  $L_{90}$  residual levels were materially higher than those recorded during this investigation since the nature of the local and distributed sources of noise were different. However, a similar flat  $L_{90}$  relationship was found when the  $L_{90}$  A-weight levels were plotted as a function of the various floor heights above ground.

An additional series of tests were performed at each of the test floors. A bedroom window on each test floor was opened so that the open area was 5 percent of the floor area of the room, es-

entially complying with the New York City building code minimum requirement for adequate ventilation. Microphones were set up in the center of the rooms and directly outside on the 1-meter booms. In each case, when the window was open, the room level was 12 dBA greater than when it was shut. The windows were conventional Alwin-seal double hung sash with DSB ( $1\frac{1}{8}$ -inch) glass.

On the side street, along the L-wing of the building, the effect of avenue noise was determined by locating microphones exterior to rooms e, f, and g (fig. 8) located on the 5th floor of the wing. Simultaneous recordings were made only during intervals when no traffic moved on the side street and with active traffic motion on the avenue. The noise level distribution at the test locations in terms of statistically accumulated pentad samples (fig. 9) shows a con-

Figure 8.—Section view through tower and L-wing showing apartment and room locations and the designation of measurement rooms (a, b, c, d, e, f, g).

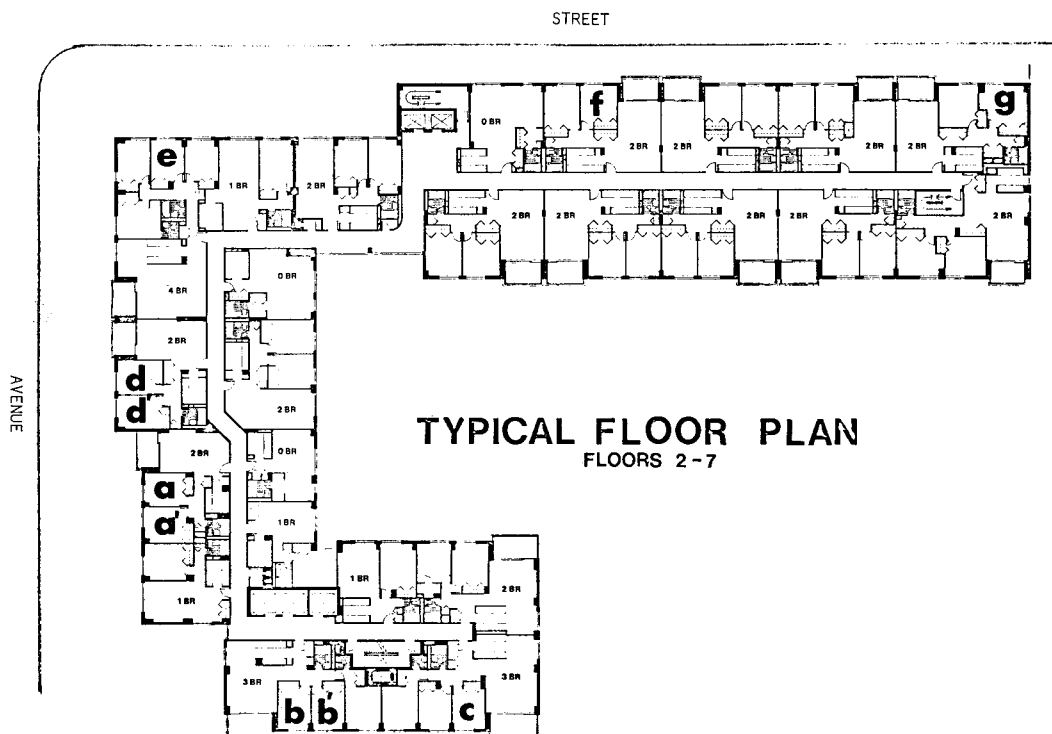
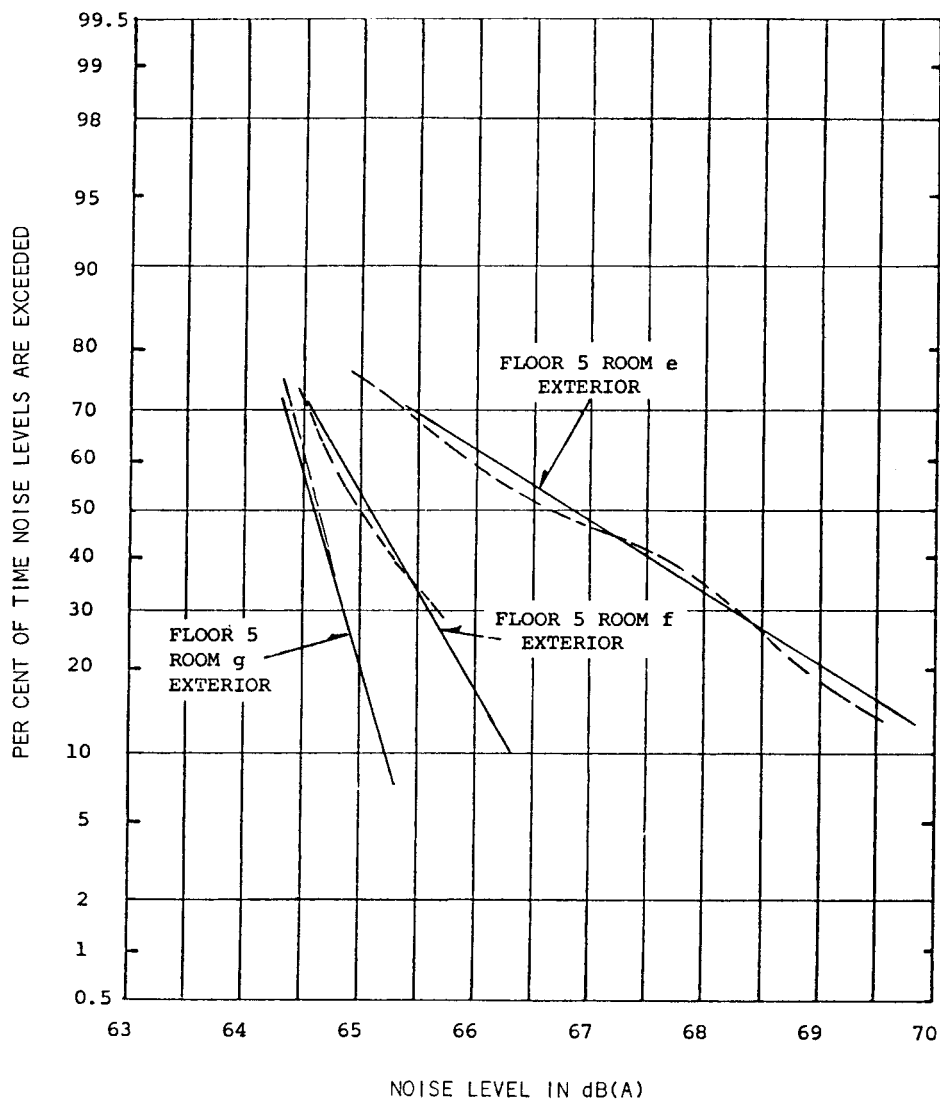


Figure 9.—Statistical exceedance distribution of recorded exterior noise levels along the street side of the L-wing at three widely separated locations. Noise is primarily from avenue traffic, with no moving traffic on fronting street.



verging pattern, the remote location exhibiting the lowest and smoothest characteristic.

Much work remains to define in depth the effect of vehicular traffic noise on high-rise structures with respect to local and distributed sources as an aid for planning and architectural design.

#### LITERATURE REFERENCE

- Sutherland, Louis C.  
1975. AMBIENT NOISE LEVEL ABOVE PLANE WITH CONTINUOUS DISTRIBUTION OF RANDOM SOURCES. J. Acoust. Soc. Am. 57 (6, part II): 1540-1542.