

NOT FOR RELEASE

BOLT BERANEK AND NEWMAN INC



TECHNICAL MEMORANDUM

BBN Project 118602

n-96-01
II-A-939

A BUILDING CODE FOR EXTERIOR NOISE ISOLATION WITH RESPECT
TO AIRCRAFT NOISE

December 1974

Prepared for:

HQ USAF/PREFX
Washington, D.C. 20332

Contract No. F49642-74-31392

14 October 1974

A BUILDING CODE FOR EXTERIOR
NOISE ISOLATION WITH RESPECT
TO AIRCRAFT NOISE

Part I - General

ARTICLE I PURPOSE AND SCOPE

Section 1-1 Purpose

The purpose of this Ordinance is to provide for the health and welfare of the general public by establishing standards for land use and for building construction with respect to exterior noise produced by the legal and normal operations of the _____ airport. The Ordinance establishes noise zones of differing intensities on land adjacent to the _____ airport, establishes permitted land uses in the noise zones and establishes building construction requirements with respect to exterior noise isolation.

Section 1-2 Scope

It is not intended by this Ordinance to repeal, abrogate, annul or in any impair or interfere with existing provisions of other laws or Ordinances, or with private restriction placed upon property by covenant, deed, easement, or other private agreement. Where this Ordinance imposes a greater restriction upon land, buildings or structures than is imposed or required by other Ordinances, covenants or agreements, the provisions of these regulations shall govern. Where other Ordinances impose a greater restriction than is imposed herein, the provisions of such other Ordinances shall govern.

ARTICLE II DEFINITIONS

Section 2-1 Definitions

Words and phrases not defined in this Ordinance shall derive their meaning from nationally approved agencies, publications, common usage and court cases.

For the purpose of this Ordinance, certain terms or words found herein shall be interpreted and defined as follows:

A-Weighted Sound Levels: See Sound Level

Adjusted Sound Level Reduction (ASLR): (see Sound Level Reduction) Sound level reduction outside-to-inside a designated room that has been adjusted as if the room when furnished contained an amount of sound absorption equal to the floor area of the room.¹ The adjustment is accomplished by adding to a measured sound level reduction ten times the common logarithm off the ratio of the floor area of the room to the measured sound absorption of the room. No adjustment is added if the sound level reduction measurement is made in a room that is furnished for its intended usage.

¹In many living rooms the sound absorption therein is equal to the floor area, or 10 to 20 percent more, so the adjusted sound level reduction measured in an unfurnished room is expected to be nearly equal to the sound level reduction that will exist when the room is normally furnished.

Airport: The _____ airport.

ANSI Specifications: Specifications by the American National Standards Institute adopted by reference herein. Such references to decibels, frequency bands and others as referred to in such specifications are inclusive as definitions within the meaning of this Ordinance.

ASTM Specifications: Specifications by the American Society for Testing Materials adopted by reference herein. Such references to decibels, frequency bands and others as referred to in such specifications are inclusive as definitions within the meaning of this Ordinance.

City: The City of _____.

Decibel (dB): The physical unit commonly used to describe noise levels; the unit of level such as the sound pressure level. One decibel is the level of the squared sound pressure that is $10^{1/10} = 1.259$ times the squared reference sound pressure; also, one decibel is the level of the sound pressure that is $10^{1/20} = 1.122$ times the reference pressure.

Enforcing Officer: The person designated by properly constituted authority to enforce the regulations contained herein.

Frequency: Number of complete oscillation cycles per unit of time. The unit of frequency often used is the Hertz(Hz).

Frequency Band: Difference in Hertz between the upper and lower frequencies that delimit a band, or the interval in octaves between the two frequencies. The band is located frequency-wise by the geometric mean frequency between the two band-edge frequencies. Examples are: "an octave band centered at 500 Hz", or more simply, "the 500 Hz octave band".

Hertz: Unit of frequency equal to one cycle per second.

Noise Exposure Forecast (NEF): A calculated measure of noise exposure around Airports based upon consideration of the noise level and duration of noise events produced by aircraft (as measured in terms of the effective perceived noise level), the number of such events per day and the time of day (day or night), during which the events occurred. The NEF value is used to determine the relative impact of aircraft noise on land uses and human activities near airports.

Noise Level: Same as sound level, for airborne sound, unless specified otherwise.

Noise Reduction (NR): Reduction, in decibels, of the sound pressure levels between two designated locations or rooms, for a stated frequency or frequency band.

Noise Zone: An Area of the City subjected to a degree of exterior noise as specified in Part 2 of this Ordinance.

Occupied Rooms: Rooms within enclosed structures which are, or may reasonably be expected to be used for human activities which involve speech communication, sleeping, eating, listening to live, recorded or broadcast music or speech, or regular usage of telephones.

Person: Individual, firm, partnership, corporation, company, association, joint stock association, or body politic, includes the trustee, receiver, assignee, administrator, executor, guardian, or other representative.

Qualified Acoustical Consultant: A person who, by reason of his training and experience in the science and technology of acoustics and his knowledge of construction methods and materials, is considered qualified to pass judgment on acoustical design, materials, and methods of construction for the attenuation of noise, and who is acceptable to the Enforcing Officer.

Reverberation Time: Time that would be required for sound pressure level in a room to decay 60 decibels, after a sound source in the room is stopped.

Sound Absorption: Capacity of materials and furnishings in a room to absorb sound. For the purposes of this Ordinance, the sound absorption is equal to 0.05 times the room volume in cubic feet divided by the measured reverberation time in seconds determined with an octave band of noise centered at 500 Hertz.¹

Sound Level: In decibels, the quantity measured by an instrument satisfying requirements of American National Standard Specification for Sound Level Meters S1.4-1971, or the latest revision thereof. Unless explicitly described otherwise, the sound level shall be the frequency-weighted sound pressure level obtained with the frequency weighting A and the standardized dynamic characteristic SLOW.²

¹In many normally furnished rooms, the sound absorption is roughly equal, numerically, to the floor area of the room. Sound absorption measured in a room, either empty or furnished, can be obtained from measurements of the reverberation time and the volume of the room.

²In this Ordinance, the sound level is to be understood to be the A-weighted sound level (meter response-slow). With the A-weighting, the sound-level meter is relatively less sensitive to low-frequency sound, somewhat in the way the ear is progressively less sensitive to sounds of frequency below 1000 Hertz (cycles per second).

Sound Level Reduction (SLR): Difference in decibels, between the sound level outside a building and the sound level inside a designated room in the building that was caused by exterior noise.

Sound Pressure Level: In decibels, 20 times the logarithm to base ten of the ratio of a sound pressure to the reference sound pressure. The reference pressure for airborne sound is 20 micronewtons per square meter (0.0002 microbar).

Sound Transmission Class (STC): A single-figure rating of the sound insulating properties of a partition as determined by methods described in "Determination of Sound Transmission Class", American Society of Testing and Materials Designation E#13-73.

Sound Transmission Loss: The noise reduction between two rooms, in a specified frequency band, plus ten times the common logarithm of the ratio of the area of the partition to the total sound absorption in the receiving room, as determined by methods described in "Measurement of Airborne Sound Insulation in Building", American Society of Testing and Materials Designation E90-70 or latest revision thereof.¹

¹A measure of the sound insulating properties of a wall/floor/ceiling/window/door, that are characteristics of the partition itself and not the room of which it is a part.

PART 2 - ZONING

ARTICLE III NOISE ZONES

Section 3-1 Establishment of Noise Zones

There are hereby created and established five land use noise zones (Zone C, Zone B-2, Zone B-1, Zone A-2 and Zone A-1). Such zones are shown on the Airport Noise Zoning Map of the City, which is attached and made part hereof.

The noise zones are based upon an evaluation of the current or expected future noise environment arising from aircraft flight operations at the Airport. The noise exposure shall be calculated by the Noise Exposure Forecast method or by any other system recommended by the Environmental Protection Agency of the Federal Government and adopted by the City.

Section 3-2 Definition of Noise Zone Boundaries

A. Zone C - a land use noise zone is hereby established and designated as Zone C, being that area commencing at the outermost boundary of the Airport and extending outward therefrom to a contour indicated on the Noise Zone Map at which an equal noise exposure of 40 has been calculated by the Noise Exposure Forecast rating method.

B. Zone B-2 - a land use noise zone is hereby established and designated as Zone B-2, being that area commencing at a contour indicated on the Noise Zone Map, at which an equal noise exposure of 40 has been calculated by the Noise Exposure Forecast rating method, and extending outward therefrom to a contour indicated on the Noise Zone Map, at which an equal noise exposure of 35 has been calculated by the Noise Exposure Forecast rating method.

C. Zone B-1 - a land use noise zone is hereby established and designated as Zone B-1, being that area commencing at a contour indicated on the Noise Zone Map, at which an equal noise exposure of 35 has been calculated by the Noise Exposure Forecast rating method, and extending outward therefrom to a contour indicated on the Noise Zone Map, at which an equal noise exposure of 30 has been calculated by the Noise Exposure Forecast rating method.

D. Zone A-2 - a land use noise zone is hereby established and designated as Zone A-2, being that area commencing at a contour indicated on the Noise Zone Map, at which an equal

noise exposure of 30 has been calculated by the Noise Exposure Forecast rating method, and extending outward therefrom to a contour indicated on the Noise Zone Map, at which an equal noise exposure of 25 has been calculated by the Noise Exposure Forecast rating method.

E. Zone A-1 - a land use noise zone is hereby established and designated as Zone A-1, being that area commencing at a contour indicated on the Noise Zone Map, at which an equal noise exposure of 25 has been calculated by the Noise Exposure Forecast rating method, and extending outward therefrom and encompassing all land with a lower noise exposure than that of the specified 25 NEF contour.

Section 3-3 Determination of Boundaries

In determining the location of zoning district boundaries on the map accompanying and made a part of these regulations, the following rules shall apply:

A. Where boundaries are shown to follow streets or alleys, the centerline of such streets or alleys, as they exist at the time of adoption of these regulations shall be the zoning boundary; or

B. Where boundaries are shown to enter or cross platted blocks, property lines of lots, as they exist at the time of adoption of these regulations, shall be the zoning boundary; or

C. Notwithstanding the above where boundaries are shown on any platted lot, provisions of the more restricted zones shall apply; or

D. Where boundaries are shown on unsubdivided property, less than 10 acres in area, provisions of the more restricted zone shall apply; or

E. Where boundaries are shown on unsubdivided property, 10 or more acres in area, the location shall be determined by scale shown on the map unless dimensions are given on the map.

Section 3-4 Revision of Noise Zone Boundaries

Following the adoption of this Ordinance, the noise zone boundaries established herein may from time to time be reviewed by the City and revised as necessary, taking into account the following, and such other factors as the City may deem desirable.

A. Forecasts of operations for the following five and ten year period provided by the Airport or the Federal Aviation Administration.

B. Noise exposure maps prepared with cooperation of the Airport.

C. Technological changes occurring since the previous review which are likely to result in changes in aircraft types, modes of operations or noise output from aircraft within the following five year period.

D. Measurements of the noise environment based upon information obtained by any noise monitoring system maintained or approved by the City.

Section 3-5 Adopted Specifications

The following specifications are hereby adopted and made a part of this Ordinance:

Sound level measuring instrument: ANSI S1.4-1971;

Sound transmission class: ASTM E413-70T or ASTM E413-73;
and

Sound transmission loss: ASTM E90-66T or ASTM E90-70.

Air infiltration test: ASTM E283-65T or latest revision thereof.

ARTICLE IV LAND USE RESTRICTIONS

Section 4-1 Activities Permitted and Restricted

No activities and/or land uses shall be permitted in the several noise zones except as provided in Table 4-1. Those activities and land uses not listed are permitted or restricted in the appropriate zones based on their similarity to noise tolerance as exhibited by the activities and land uses which are listed in Table 4-1.

Section 4-2 Nonconforming Uses

The regulations prescribed by this Ordinance shall not be construed to require the sound conditioning or other changes or alteration of any structure not conforming to the regulations as of the effective date of this Ordinance, or otherwise interfere with the continuance of any nonconforming use. Nothing herein contained shall require any change in the construction, alteration, or intended use of any structure, the construction or alteration of which was begun prior to the effective date of this Ordinance, and is diligently prosecuted.¹

¹This section should be compared with similar provisions in the comprehensive zoning Ordinance of the City to ascertain whether conformity therewith is desired.

TABLE 4-1 - PERMITTED ACTIVITIES AND/OR LAND USES AND MINIMUM SOUND LEVEL REDUCTION REQUIREMENTS FOR STRUCTURES

ACTIVITIES AND/OR LAND USES*	SLUCM CODE (1)	LAND USE NOISE ZONES				
		C	B-2	B-1	A-2	A-1
Residential (2)	11 x (10), 14	Not Allowed	Not Allowed	Permitted with SLR 25	Permitted	Permitted
Residential (3) , Educational and Institutional (4)	11 x, 12, 13, 19, 68, 7111, 651	Not Allowed	Permitted with SLR 30	Permitted with SLR 25	Permitted	Permitted
Auditoriums, Concert Halls	721 x	Not Allowed	Not Allowed	Permitted with SLR 35	Permitted with SLR 30	Permitted
Outdoor Amphitheatres, Music Shells	721 x	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Permitted
Offices, Personal, Business and Professional Services, Commercial-Retail, Movie Theaters, Restaurants (5)	61, 62, 63, 69, 65 (11)	Permitted with SLR 30	Permitted with SLR 25	Permitted	Permitted	Permitted
Transient Lodging-Hotels, Motels	15	Permitted with SLR 35	Permitted with SLR 30	Permitted with SLR 25	Permitted	Permitted
Sports Arenas, Outdoor Spectator Sports	722	Not Allowed	Not Allowed	Permitted	Permitted	Permitted
Playgrounds, Neighborhood Parks	761, 762	Not Allowed	Not Allowed	Permitted	Permitted	Permitted
Golf Courses, Driving Ranges, Water-Recreation, Cemeteries, (6)	741 x, 743 x, 744	Permitted	Permitted	Permitted	Permitted	Permitted
Commercial-Wholesale and Selected Retail, Industrial/ Manufacturing, Transportation Communication and Utilities (7)	2, 3, 4, 51, 52, 64	Permitted	Permitted	Permitted	Permitted	Permitted
Animal-related services (8)	82 x	Not Allowed	Permitted	Permitted	Permitted	Permitted
Agricultural (9)	81, 82 x	Permitted	Permitted	Permitted	Permitted	Permitted

*See accompanying notes for expanded list of activities and land uses.

TABLE 4-1, continued.

NOTES:

- (1) "Standard Land Use Coding Manual", Urban Renewal Administration Housing and Home Finance Agency and Bureau of Public Roads, Department of Commerce, First Edition, 1965.
- (2) Single family detached, duplex, mobile home parks.
- (3) Triplex, fourplex, apartment houses, multi-family dwellings, rooming houses, boarding houses, old persons homes, sorority and fraternity houses, dormitories, boarding schools, convalescent homes.
- (4) School classrooms, libraries, churches, hospitals.
- (5) Professional and financial offices, banks, savings and loan associations, mortgage bankers, insurance offices, real estate offices, architects, engineers, attorneys-at-law, decorators, medical and dental clinics and labs, funeral homes and mortuaries, retail stores, clothing stores, department stores, food and dairy markets, cafes, restaurants (enclosed and drive-in), cafeterias, barber shops, beauty shops, new and used car sales, country clubs.
- (6) Swimming pools, shooting ranges, miniature golf courses.
- (7) Auto salvage and wrecking yards, industrial metal and waste salvage yards, manufacturing facilities, gasoline service stations, ambulance services, automotive repair garages, public storage garages, taxi dispatch offices, automobile washing stations, lumber yards, warehousing, motor freight terminals, railway passenger and freight stations, airport services.
- (8) Animal grooming services, dog kennels, veterinarians and veterinarian hospitals.
- (9) Farms, orchards, nurseries, greenhouses.
- (10) "X" after SLUCM number means it represents a category broader or narrower than, but generally inclusive of, the category described.
- (11) Excluding hospitals.

PART 3 - REQUIREMENTS FOR BUILDINGS AND STRUCTURES

ARTICLE V APPLICATION

Section 5-1 Scope of Requirements

The provisions of this Ordinance shall apply to the construction, alteration, moving, demolition, repair, and use of any building or structure within the city, except work located primarily in a public way, public utility towers and poles, mechanical equipment not specifically regulated in this Ordinance, and hydraulic flood control structures.

Additions, alterations, repairs, and changes of use or occupancy in all buildings and structures shall comply with the provisions of this Ordinance, except as otherwise provided in Section 5-2.

Section 5-2 Application to Existing Buildings

A. General. Buildings or structures to which additions, alterations, or repairs are made shall comply with all the requirements of this Ordinance except as specifically provided in this Section.

B. Additions, Alterations, and Repairs: More than 50 percent. When additions, alterations, or repairs within any 12-month period exceed 50 percent of the value of an existing building or structure, such building or structure shall be made to conform to the requirements of this Ordinance.

C. Additions, Alterations, and Repairs: 25 to 50 percent. Additions, alterations, and repairs exceeding 25 percent but not exceeding 50 percent of the value of an existing building or structure and complying with the requirements of this Ordinance may be made to such building or structure within any 12-month period without making the entire building or structure comply. The new construction shall conform to the requirements of this Ordinance for a new building of like area, height, and occupancy.

D. Additions, Alterations, and Repairs: 25 percent or less. Structural additions, alterations, and repairs to any portion of an existing building or structure, within any 12-month period, not exceeding 25 percent of the value of the building or structure shall comply with all of the requirements of this Ordinance, except that minor structural additions, alterations, or repairs, when approved by the Enforcing Officer may be made with the same material of which the building or structure is constructed.

E. Nonstructural Alterations and Repairs: 25 percent or less. Alterations or repairs, not exceeding 25 percent of the value of an existing building or structure, and which are nonstructural, may be made with the same materials of which the building or structure is constructed.

F. Repairs: Roof covering. Not more than 25 percent of the roof covering of any building or structure shall be replaced in any 12-month period unless the new roof covering is made to conform to the requirements of this Ordinance.

G. Existing Occupancy. Buildings in existence at the time of the passage of this Ordinance may have their existing use or occupancy continued if such use or occupancy was legal at the time of the passage of this Ordinance, provided such continued use is not dangerous to life.

Section 5-3 Moved Buildings

Buildings or structures moved into or within the city shall comply with applicable provisions of this Ordinance.

Section 5-4 Alternate Materials and Methods of Construction

The provisions of this Ordinance are not intended to prevent the use of any material or method of construction not specifically prescribed by this Ordinance, provided any such alternate has been approved.

The Enforcing Officer may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the provisions of this Ordinance, and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed in this Ordinance in quality, strength, effectiveness, fire resistance, durability, and safety.

The Enforcing Officer shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use.

ARTICLE VI SLR DESIGN REQUIREMENTS

Section 6-1 General Requirements

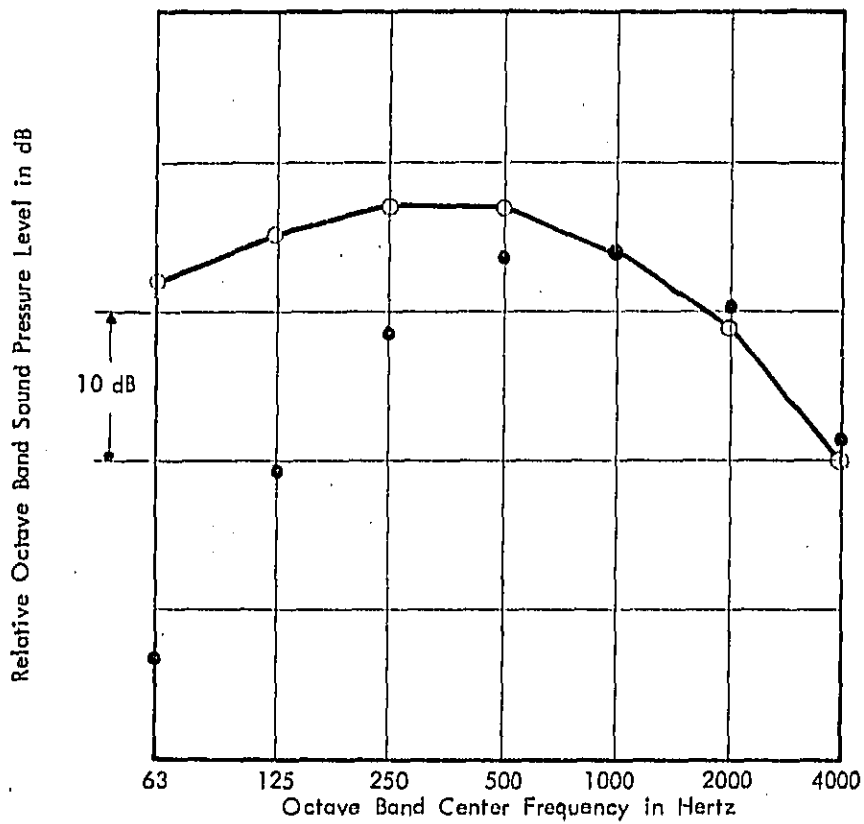
The SLR requirements of Table 4-1 may be achieved by any suitable combination of building design, choice of building materials and execution of construction details in accordance with established architectural and acoustical principles. The SLR requirements shall apply to all occupied rooms having one or more exterior walls or ceiling, when furnished in accordance with the intended final usage of the rooms.

Section 6-2 Meeting SLR Requirements

No building or structure, for which an SLR 25, SLR 30 or SLR 35 is required by Table 4-1 of this Ordinance may be constructed, altered, moved, demolished, or repaired unless and until a building permit therefore has been issued by the Enforcing Officer. No such permit shall be issued unless and until conformance with the requirements contained in Part 3 of this Ordinance is indicated, by plans and specifications for the building or structure, or if such plans and specifications do not indicate conformance, by a supplementary written statement from a Qualified Acoustical Consultant certifying that the construction of the building as indicated in the plans and specifications will result in a Sound Level Reduction for the applicable room(s) at least as great as the SLR Value specified in Table 4-1 for the particular usage involved.

Section 6-3 SLR Design Information

For calculations undertaken for purposes of meeting the requirements of Sections 6-2 and 6-3, the Qualified Acoustical Consultant may use the assumed outside noise spectrum shown in Figure 6-4, attached and made part of this Ordinance. Such calculations shall take into account the area of exposed room surfaces, the sound transmission loss characteristics of exposed room surfaces and the amount



Note: Closed Circles show the corresponding relative A-Weighted octave band sound pressure levels.

FIGURE 6-4. OCTAVE BAND NOISE SPECTRUM TO BE USED FOR CALCULATION OF NOISE LEVEL REDUCTION

of sound absorption in the room. For rooms in residential structures, it can be assumed that the ratio of the sound absorption in each room to the room floor area is as follows:

<u>Octave Frequency</u> <u>Band, Hz</u>	<u>Sound Absorption</u> <u>Floor Area</u>
63	0.30
125	0.50
250	0.75
500 and higher	1.0

In the calculations, allowance shall be made for a decrement of at least two decibels for sound leaks and flanking sound transmission paths.

ARTICLE VII BUILDING REQUIREMENTS FOR A MINIMUM
SOUND LEVEL REDUCTION OF 25 dB

Section 7-1 Compliance

Compliance with the following standards shall be deemed to meet the requirements of the various noise zones of this Ordinance in which an SLR 25 is specified.

Section 7-2 General

- A. Brick veneer, masonry blocks or stucco exterior walls shall be constructed airtight. All joints shall be grouted or caulked airtight.
- B. At the penetration of exterior walls by pipes, ducts, or conduits the space between the wall and pipes, ducts or conduits shall be caulked or filled with mortar.
- C. Window and/or through-the-wall ventilation units shall not be used.
- D. Through-the-wall/door mail boxes shall not be used.

Section 7-3 Exterior Walls

- A. Exterior walls other than as described in this section shall have a laboratory sound transmission class rating of at least STC-34.
- B. Masonry walls having a surface weight of at least 25 pounds per square foot do not require a furred (stud) interior wall. At least one surface of concrete block walls shall be plastered or painted with heavy "bridging" paint.
- C. Stud walls shall be at least 4" in nominal depth and shall be finished on the outside with siding-on-sheathing, stucco, or brick veneer.
 - 1. Interior surface of the exterior walls shall be of gypsum board or plaster at least 1/2" thick, installed on the studs.

2. Continuous composition board, plywood or gypsum board sheathing at least $\frac{1}{2}$ " thick shall cover the exterior side of the wall studs behind wood, or metal siding. Asphaltic or wood shake shingles are acceptable in lieu of siding.

3. Sheathing panels shall be butted tightly and covered on the exterior with overlapping building paper. The top and bottom edges of the sheathing shall be sealed.

4. Insulation material at least 2" thick shall be installed continuously throughout the cavity space behind the exterior sheathing and between wall studs. Insulation shall be glass fiber or mineral wool.

Section 7-4 Windows

A. Windows other than as described in this section shall have a laboratory sound transmission class rating of at least STC-28.

B. Glass shall be at least $\frac{3}{16}$ " thick.

C. All operable windows shall be weatherstripped and airtight when closed so as to conform to an air infiltration test not to exceed 0.5 cubic foot per minute per foot of crack length in accordance with ASTM E-283-65-T.

D. Glass of fixed-sash windows shall be sealed in an airtight manner with a non-hardening sealant, or a soft elastomer gasket or glazing tape.

E. The perimeter of window frames shall be sealed airtight to the exterior wall construction with a sealant conforming to one of the following Federal Specifications: TT-S-00227, TT-S-00230, or TT-S-00153.

F. The total area of glass in both windows and doors in sleeping spaces shall not exceed 20% of the floor area.

Section 7-5 Doors

- A. Doors, other than as described in this section shall have a laboratory sound transmission class rating of at least STC-28.
- B. All exterior side-hinged doors shall be solid-core wood or insulated hollow metal at least 1-3/4" thick and shall be fully weatherstripped.
- C. Exterior sliding doors shall be weatherstripped with an efficient airtight gasket system with performance as specified in Section 7-4.C. The glass in the sliding doors shall be at least 3/16" thick.
- D. Glass in doors shall be sealed in an airtight non-hardening sealant, or in a soft elastomer gasket or glazing tape.
- E. The perimeter of door frames shall be sealed airtight to the exterior wall construction as described in Section 7-4.E.

Section 7-6 Roofs

- A. Combined roof and ceiling construction other than described in this section and Section 7-7 shall have a laboratory sound transmission class rating of at least STC-34.
- B. With an attic or rafter space at least 6" deep, and with a ceiling below, the roof shall consist of closely butted 1/2" composition board, plywood or gypsum board sheathing topped by roofing as required.
- C. If the underside of the roof is exposed, or if the attic or rafter spacing is less than 6", the roof construction shall have a surface weight of at least 25 pounds per square foot. Rafters, joists or other framing may not be included in the surface weight calculation.

D. Window or dome skylights shall have a laboratory sound transmission class rating of at least STC-28.

Section 7-7 Ceilings

A. Gypsum board or plaster ceilings at least $\frac{1}{2}$ " thick shall be provided where required by Paragraph 7-6.B above. Ceilings shall be substantially airtight, with a minimum number of penetrations.

B. Glass fiber or mineral wool insulation at least 2" thick shall be provided above the ceiling between joists.

Section 7-8 Floors

A. Openings to any crawl spaces below the floor of the lowest occupied rooms shall not exceed 2% of the floor area of the occupied rooms.

Section 7-9 Ventilation

A. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in _____, without the need to open any windows, doors, or other openings to the exterior.

B. Gravity vent openings in attic shall not exceed code minimum in number and size.

C. If a fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel, which shall be lined with 1" thick coated glass fiber, and shall be at least 5 ft. long with one 90° bend.

D. All vent ducts connecting the interior space to the outdoors, excepting domestic range exhaust ducts, shall contain at least a 5 ft. length of internal sound absorbing duct lining. Each duct shall be provided with a bend in

the duct such that there is no direct line of sight through the duct from the venting cross section to the room-opening cross section.

E. Duct lining shall be coated glass fiber duct liner at least 1" thick.

F. Domestic range exhaust ducts connecting the interior space to the outdoors shall contain a baffle plate across the exterior termination which allows proper ventilation. The dimensions of the baffle plate should extend at least one diameter beyond the line of sight into the vent duct. The baffle plate shall be of the same material and thickness as the vent duct material.

G. Fireplaces shall be provided with well-fitted dampers.

ARTICLE VIII BUILDING REQUIREMENTS FOR A MINIMUM
SOUND LEVEL REDUCTION OF 30 dB

Section 8-1 Compliance

Compliance with the following standards shall be deemed to meet the requirements of the various Noise Zones of this Ordinance in which an SLR 30 is specified.

Section 8-2 General

A. Brick veneer, masonry blocks or stucco exterior walls shall be constructed airtight. All joints shall be grouted or caulked airtight.

B. At the penetration of exterior walls by pipes, ducts or conduits, the space between the wall and pipes, ducts or conduits shall be caulked or filled with mortar.

C. Window and/or through-the-wall ventilation units shall not be used.

D. Operational vented fireplaces shall not be used.

A. E. All sleeping spaces shall be provided with either a sound-absorbing ceiling or a carpeted floor.

F. Through-the-wall/door mailboxes shall not be used.

Section 8-3 Exterior Walls

A. Exterior walls other than as described below shall have a laboratory sound transmission class rating of at least STC-39.

B. Masonry walls having a surface weight of at least 40 pounds per square foot do not require a furred (stud) interior wall. At least one surface of concrete block walls shall be plastered or painted with heavy "bridging" paint.

C. Stud walls shall be at least 4" in nominal depth and shall be finished on the outside with siding-on-sheathing, stucco, or brick veneer.

1. Interior surface of the exterior walls shall be of gypsum board or plaster at least $\frac{1}{2}$ " thick, installed on the studs. The gypsum board or plaster may be fastened rigidly to the studs if the exterior is brick veneer or stucco. If the exterior is siding-on-sheathing, the interior gypsum board or plaster must be fastened resiliently to the studs.

2. Continuous composition board, plywood or gypsum board sheathing shall cover the exterior side of the wall studs behind wood, or metal siding. The sheathing and facing shall weigh at least 4 pounds per square foot.

3. Sheathing panels shall be butted tightly and covered on the exterior with overlapping building paper. The top and bottom edges of the sheathing shall be sealed.

4. Insulation material at least 2" thick shall be installed continuously throughout the cavity space behind the exterior sheathing and between wall studs. Insulation shall be glass fiber or mineral wool.

Section 8-4 Windows

A. Windows other than as described in this section shall have a laboratory sound transmission class rating of at least STC-33.

B. Glass of double-glazed windows shall be at least $\frac{1}{8}$ " thick. Panes of glass shall be separated by a minimum 3" air space.

C. Double-glazed windows shall employ fixed sash or efficiently weatherstripped operable sash. The sash shall be

rigid and weatherstripped with material that is compressed airtight when the window is closed so as to conform to an infiltration test not to exceed 0.5 cubic foot per minute per foot of crack length in accordance with ASTM E-283-65-T.

D. Glass of fixed-sash windows shall be sealed in an airtight manner with a non-hardening sealant, or a soft elastomer gasket or glazing tape.

E. The perimeter of window frames shall be sealed airtight to the exterior wall construction with a sealant conforming to one of the following Federal Specifications: TT-S-00227, TT-S-00230, or TT-S-00153.

F. The total area of glass of both windows and exterior doors in sleeping spaces shall not exceed 20% of the floor area.

Section 8-5 Doors

A. Doors, other than as described in this section shall have a laboratory sound transmission class rating of at least STC-33.

B. Double door construction is required for all door openings to the exterior. Openings fitted with side-hinged doors shall have one solid-core wood or insulated hollow metal core door at least 1-3/4" thick separated by an airspace of at least 4" from another door, which can be a storm door. Both doors shall be tightly fitted and weatherstripped.

C. The glass of double-glazed sliding doors shall be separated by a minimum 4" airspace. Each sliding frame shall be provided with an efficiently airtight weatherstripping material as specified in Section 8-4.C.

D. Glass of all doors shall be at least 3/16" thick. Glass of double sliding doors shall not be equal in thickness.

E. The perimeter of door frames shall be sealed airtight to the exterior wall construction as indicated in Section 8-4.E.

F. Glass of doors shall be set and sealed in an airtight non-hardening sealant, or a soft elastomer gasket or glazing tape.

Section 8-6 Roofs

A. Combined roof and ceiling construction other than described in this section and Section 8-7 shall have a laboratory sound transmission class rating of at least STC-44.

B. With an attic or rafter space at least 6" deep, and with a ceiling below, the roof shall consist of closely butted 1/2" composition board, plywood or gypsum board sheathing topped by roofing as required.

C. If the underside of the roof is exposed, or if the attic or rafter spacing is less than 6", the roof construction shall have a surface weight of at least 40 pounds per square foot. Rafters, joists or other framing may not be included in the surface weight calculation.

D. Window or dome skylights shall have a laboratory sound transmission class rating of at least STC-33.

Section 8-7 Ceilings

A. Gypsum board or plaster ceilings at least 1/2" thick shall be provided where required by Paragraph 8-6.B above. Ceilings shall be substantially airtight, with a minimum number of penetrations.

B. Glass fiber or mineral wool insulation at least 2" thick shall be provided above the ceiling between joists.

Section 8-8 Floors

The floor of the lowest occupied rooms shall be slab on fill, below grade, or over a fully enclosed basement. All door and window openings in the fully enclosed basement shall be tightly fitted.

Section 8-9 Ventilation

A. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms as specified in _____, without the need to open any windows, doors, or other openings to the exterior.

B. Gravity vent openings in attic shall not exceed code minimum in number and size. The openings shall be fitted with transfer ducts at least 3 ft. in length containing internal sound absorbing duct lining. Each duct shall have a lined 90° bend in the duct such that there is no direct line of sight from the exterior through the duct into the attic.

C. If a fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel, which shall be lined with 1" thick coated glass fiber, and shall be at least 5 ft. long with one 90° bend.

D. All vent ducts connecting the interior space to the outdoors, excepting domestic range exhaust ducts, shall contain at least a 10 ft. length of internal sound absorbing duct lining. Each duct shall be provided with a lined 90° bend in the duct such that there is no direct line of sight through the duct from the venting cross section to the room-opening cross section.

E. Duct lining shall be coated glass fiber duct liner at least 1" thick.

F. Domestic range exhaust ducts connecting the interior space to the outdoors shall contain a baffle plate across the exterior termination which allows proper ventilation. The dimensions of the baffle plate should extend at least one diameter beyond the line of sight into the vent duct. The baffle plate shall be of the same material and thickness as the vent duct material.

G. Building heating units with flues or combustion air vents shall be located in a closet or room closed off from the occupied space by doors.

H. Doors between occupied space and mechanical equipment areas shall be solid core wood or 20 gauge steel hollow metal at least 1-3/4" thick and shall be fully weather-stripped.

ARTICLE IX BUILDING REQUIREMENTS FOR A MINIMUM
SOUND LEVEL REDUCTION OF 35 dB

Section 9-1 Compliance

Compliance with the following standards shall be deemed to meet the requirements of the various Noise Zones of this Ordinance in which an SLR 35 is specified.

Section 9-2 General

- A. Brick veneer, masonry blocks or stucco exterior walls shall be constructed airtight. All joints shall be grouted or caulked airtight.
- B. At the penetration of exterior walls by pipes, ducts or conduits the space between the wall and pipes, ducts or conduits shall be caulked or filled with mortar.
- C. Window and/or through-the-wall ventilation units shall not be used.
- D. Operational vented fireplaces shall not be used.
- E. All sleeping spaces shall be provided with either a sound absorbing ceiling or a carpeted floor.
- F. Through-the-wall/door mailboxes shall not be used.
- G. No glass or plastic skylight shall be used.

Section 9-3 Exterior Walls

- A. Exterior walls other than as described below shall have a laboratory sound transmission class rating of at least STC-49.
- B. Masonry walls having a surface weight of at least 75 pounds per square foot do not require a furred (stud)

interior wall. At least one surface of concrete block walls shall be plastered or painted with heavy "bridging" paint.

C. Stud walls shall be at least 4" in nominal depth and shall be finished on the outside with siding-on-sheathing, stucco, or brick veneer.

1. Interior surface of the exterior walls shall be of gypsum board or plaster at least $\frac{1}{2}$ " thick, installed on studs. The gypsum board or plaster may be fastened rigidly to the studs if the exterior is brick veneer. If the exterior is stucco or siding-on-sheathing, the interior gypsum board or plaster must be fastened resiliently to the studs.

2. Continuous composition board, plywood or gypsum board sheathing shall cover the exterior side of the wall studs behind wood, or metal siding. The sheathing and facing shall weigh at least 4 pounds per square foot.

3. Sheathing panels shall be butted tightly and covered on the exterior with overlapping building paper. The top and bottom edges of the sheathing shall be sealed.

4. Insulation material at least $3\frac{1}{2}$ " thick shall be installed continuously throughout the cavity space behind the exterior sheathing and between wall studs. Insulation shall be glass fiber or mineral wool.

Section 9-4 Windows

A. Windows other than as described in this section shall have a laboratory sound transmission class rating of at least STC-38.

B. Double-glazed windows shall employ fixed sash. Glass of double-glazed windows shall be at least $\frac{1}{8}$ " thick. Panes of glass shall be separated by a minimum 3" air space and shall not be equal in thickness.

C. Glass of windows shall be sealed in an airtight manner with a non-hardening sealant, or a soft elastomer gasket or glazing tape.

D. The perimeter of window frames shall be sealed airtight to the exterior wall construction with a sealant conforming to one of the following Federal Specifications: TT-S-00227, TT-S-00230, or TT-S-00153.

E. The total area of glass of both windows and exterior doors in sleeping spaces shall not exceed 20% of the floor area.

Section 9-5 Doors

A. Doors, other than as described in this section shall have a laboratory sound transmission class rating of at least STC-38.

B. Double door construction is required for all door openings to the exterior. The door shall be side-hinged and shall be solid-core wood or insulated hollow metal, at least 1-3/4" thick, separated by a vestibule at least 3 ft. in length. Both doors shall be tightly fitted and weather-stripped.

C. The perimeter of door frames shall be sealed airtight to the exterior wall construction as specified in Section 9-4.D.

Section 9-6 Roofs

A. Combined roof and ceiling construction other than described in this section and Section 9-7 shall have a laboratory sound transmission class rating of at least STC-49.

B. With an attic or rafter space at least 6" deep, and with a ceiling below, the roof shall consist of closely

butted $\frac{1}{2}$ " composition board, plywood or gypsum board sheathing topped by roofing as required.

C. If the underside of the roof is exposed, or if the attic or rafter spacing is less than 6", the roof construction shall have a surface weight of at least 75 pounds per square foot. Rafters, joists or other framing may not be included in the surface weight calculation.

Section 9-7 Ceilings

A. Gypsum board or plaster ceilings at least $\frac{1}{2}$ " thick shall be provided where required by Paragraph 9-6.B above. Ceilings shall be substantially airtight, with a minimum number of penetrations. The ceiling panels shall be mounted on resilient clips or channels. A non-hardening sealant shall be used to seal gaps between the ceiling and walls around the ceiling perimeter.

B. Glass fiber or mineral wool insulation at least $3\frac{1}{2}$ " thick shall be provided above the ceiling between joists.

Section 9-8 Floors

The floors of the lowest occupied rooms shall be slab on fill or below grade.

Section 9-9 Ventilation

A. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in _____, without need to open any windows, doors, or other openings to the exterior.

B. Gravity vent openings in attic shall not exceed code minimum in number and size. The openings shall be fitted with transfer ducts at least 6 ft. in length containing internal sound absorbing duct lining. Each duct shall have

a lined 90° bend in the duct such that there is no direct line of sight from the exterior through the duct into the attic.

C. If a fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel, which shall be lined with 1" thick coated glass fiber, and shall be at least 10 ft. long with one 90° bend.

D. All vent ducts connecting the interior space to the outdoors excepting domestic range exhaust ducts, shall contain at least a 10 ft. length of internal sound absorbing duct lining. Each duct shall be provided with a lined 90° bend in the duct such that there is no direct line of sight through the duct from the venting cross section to the room-opening cross section.

E. Duct lining shall be coated glass fiber duct liner at least 1" thick.

F. Domestic range exhaust ducts connecting the interior space to the outdoors shall contain a baffle plate across the exterior termination which allows proper ventilation. The dimensions of the baffle plate should extend at least one diameter beyond the line of sight into the vent duct. The baffle plate shall be of the same material and thickness as the vent duct material.

G. Building heating units with flues or combustion air vents shall be located in a closet or room closed off from the occupied space by doors.

H. Doors between occupied space and mechanical equipment areas shall be solid core wood or 20 gauge steel hollow metal at least 1-3/4" thick and shall be fully weather-stripped.

PART 4 - ADMINISTRATION AND ENFORCEMENT

ARTICLE X ADMINISTRATION AND ENFORCEMENT

Section 10-1 General Responsibilities

The Enforcing Officer shall administer and enforce the regulations prescribed herein. Application for permits and variances shall be made to the Enforcing Officer upon the forms furnished.

Section 10-2 Verification of Building Noise Level Reduction

The Enforcing Officer may, prior to granting final approval of the finished building construction, require at the expense of the owner, field tests by a Qualified Acoustical Consultant to verify the sound level reduction (SLR) of the building. The Enforcing Officer may require such verification whenever it appears that variations from sound-isolation features in the approved plan, poor sealing methods, or defective workmanship may have been employed. The report of verification shall be filed with the Enforcing Officer which shall include a description of the verification method, measurement instrumentation and the results of the noise level reduction-measurements.

The noise level reduction requirements of Section 4-1 must be satisfied for each occupied room. For the purposes of verification, it will suffice to test only in those occupied rooms in which exterior noise is most likely to penetrate.

Section 10-3 Verification Test Procedure

For the purpose of verifying compliance with the noise level reduction requirements in a completed building, aircraft noise prevailing outside the building may be used as the sound source.

Using the noise signal generated by an individual aircraft operation (flyover event), outside and inside noise levels shall be measured simultaneously. The difference between the maximum noise levels measured outside and inside the room for the

flyover event shall be taken as the measured SLR for the flyover event, provided that the maximum inside noise level exceeds by at least seven decibels the background noise level in the absence of the flyover.

The SLR shall be determined for at least four flyover events for each room tested. The resulting SLR value assigned to the room shall be the arithmetic average of the individual flyover event SLR values.

For occupied rooms in residential structures, the inside noise level shall be measured with a single microphone four feet above the floor near the center of the room. For other than residential structures, the inside noise level shall be measured with a single microphone five feet above the floor, either near the center of the room, or eight feet into the room from the center of the exterior wall most directly exposed to the aircraft noise, whichever distance from the most directly exposed wall is smaller.

The outside noise level shall be measured at an unobstructed location approximately five feet above the level of the floor of the room under test and eight feet outside the exterior wall most directly exposed to the aircraft noise source, near the center of the wall.

For structures in which several rooms are to be evaluated, the tests need be conducted only for those rooms whose exterior walls are most directly exposed to the noise source. If noise level reduction requirements are met for these rooms, the tests need not be repeated for rooms of similar construction which are not as directly exposed to the flyover event.

For structures where a number of rooms receive nearly-equal exposure to aircraft noise, tests need be conducted in only two of the near-identical rooms.

For residential units, it will usually be sufficient to conduct tests in two rooms. One of the rooms to be tested shall be the

bedroom most directly exposed to aircraft noise. The other room to be tested shall be either the living room, dining room or family room, whichever is most directly exposed to the aircraft noise source.

When the sound level reduction is measured in an unfurnished room or a room furnished less than normally, the adjusted sound level reduction shall be computed by adding ten times the logarithm to the base ten of the ratio of the floor area of the room to the sound absorption in the unfurnished room, but in any event, such correction shall not exceed two decibels. The adjusted noise level reduction value shall be used in determining compliance with the NLR requirements. If the noise level reduction is measured in a furnished room, no adjustment in the noise level reduction shall be made.

The noise levels measured outside and inside the room under test may be observed directly by simultaneously reading the maximum noise levels on two sound level meters. Alternatively, the outside and inside flyover event noise signals shall be recorded on magnetic tape with noise level reduction determined by analysis of the recorded signals. In either case, the two measuring systems used for outside and inside noise measurements must each satisfy the requirements for a Type 2 sound level meter according to ANSI S1.4-1971 and be operated in the manner designated by ANSI S1.13-1971 (or latest revisions thereof). Further, the two systems are to be calibrated prior to and following the flyover events so that they indicate the same sound level, within one decibel, for the same noise, using suitable calibration procedures as specified by the sound level meter manufacturer.

Section 10-4. Appeals

An appeal from any interpretation of administrative decision of the Enforcing Officer may be taken, and requests for variance or exception may be made to the Board of Adjustment as provided in the Comprehensive Zoning Ordinance of the City.

Section 10-5 Future Uses

No change shall be made in the use of land and no structure shall be erected, altered or otherwise established in any zone hereby created except in accordance with this Ordinance.

Section 10-6 Variances

A variance may be granted by the _____¹ where, owing to conditions peculiar to the property and not the result of the actions of the applicant, a literal enforcement of the regulations would result in unnecessary and undue hardship and would prevent the substantial enjoyment of property rights as shared by nearby properties which do conform to these regulations.

Section 10-7 Violations and Penalties

Any person, firm or corporation who violates any of the provisions of these regulations shall be guilty of a misdemeanor, and upon conviction in the Municipal Court, shall be subject to a fine of not more than the maximum established by state law for each offense. Each day that a violation is permitted to exist shall constitute a separate offense.

Section 10-8 Severability

If any section, provision, or part thereof in these regulations shall be adjudged invalid or unconstitutional by a court of competent jurisdiction, such adjudication shall not affect the validity of the regulations as a whole, or any section, provision or part thereof not adjudged invalid or unconstitutional.

¹ Board of Adjustment or other appropriate body.