



TECHNICAL INFORMATION PAPER

Aircraft Noise and Land Use Compatibility Guidelines

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AIRCRAFT NOISE AND LAND USE COMPATIBILITY GUIDELINES



DNL accumulates the total noise occurring over a 24-hour period, with a 10 decibel penalty applied to noise occurring between 10:00 p.m. and 7:00 a.m.

In past years, noise has become a recognized factor in the land use planning process for cities, metropolitan planning organizations, counties, and states. Significant strides have been made in the reduction of noise at its source; however, noise cannot be entirely eliminated. Local, state, and federal agencies, in recognition of this fact, have developed guidelines and regulations to address noise within the land use planning process.

The fundamental variability in the way individuals react to noise makes it impossible to accurately predict how any one individual will respond to a given noise level. However, when one considers the community as a whole, trends emerge which relate noise to annoyance. This enables us to make reasonable evaluations of the average impacts of aircraft noise on a community.

According to scientific research, noise response is most readily correlated with noise as measured with cumulative noise metrics. A variety of cumulative noise exposure metrics have been used in research studies over the years. In the United States, the DNL (day-night noise level) metric has been widely used. DNL accumulates the total noise occurring over a 24-hour period, with a 10 decibel penalty applied to noise occurring between 10:00 p.m. and 7:00 a.m. DNL correlates well with average community response to





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noise. (For more information on noise measurement, see the TIP entitled, "The Measurement and Analysis of Sound.")

In California, the CNEL (community noise equivalent level) metric is used instead of the DNL metric. The two metrics are very similar. DNL accumulates the total noise occurring during a 24-hour period, with a 10 decibel penalty applied to noise occurring between 10:00 p.m. and 7:00 a.m. The CNEL metric is the same except that it also adds a 4.77 decibel penalty for noise occurring between 7:00 p.m. and 10:00 p.m. There is little actual difference between the two metrics in practice. Calculations of CNEL and DNL from the same data generally yield values with less than a 0.7 decibel difference (Caltrans 1983, p. 37).

The results of studies on community noise impacts show that the number of people expressing concerns with noise increases as the noise level increases. The level of concern increases along an S-shaped curve, as shown in **Exhibit A**. Research has shown that even at extremely high noise levels, there are at least some people, albeit a small percentage, who are not annoyed. Conversely, it also shows that at even very low noise levels, at least some people will be annoyed.

AMBIENT NOISE LEVEL AS A FACTOR OF ANNOYANCE LEVEL

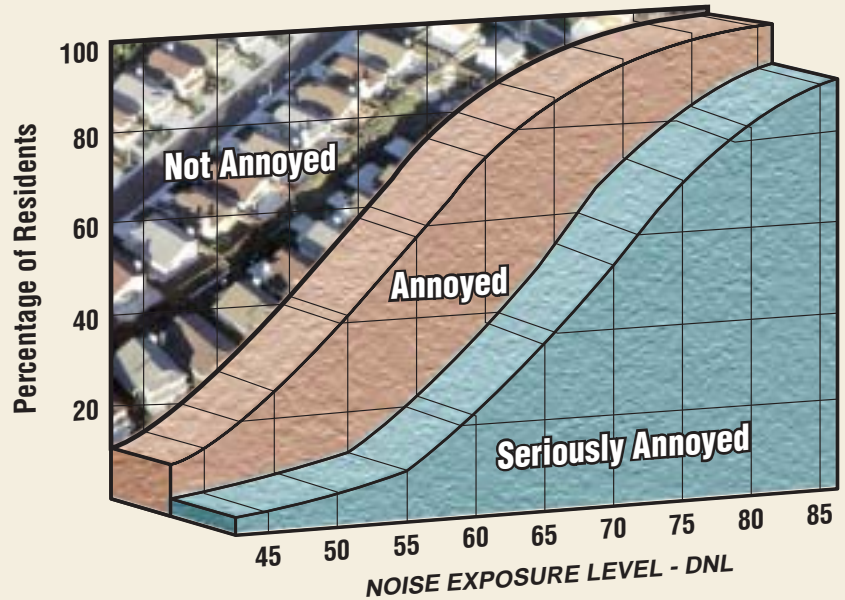
Noise analysts have speculated that the overall ambient noise level in an environment determines to what degree people will be annoyed by a given level of aircraft noise. That is, in a louder environment it takes a louder level of aircraft noise to generate complaints than it does in a quieter environment.

Kryter (1984, p. 582) reviewed some of the research on this question. He noted that the effects of laboratory tests and attitude surveys on this question are somewhat inconclusive. A laboratory test he reviewed found that recordings of aircraft noise were judged to be less intrusive as the background road traffic noise was increased. On the other hand, an attitude survey in the Toronto Airport area found that the effects of background noise were not significant.

ANNOYANCE CAUSED BY AIRCRAFT NOISE IN RESIDENTIAL AREAS

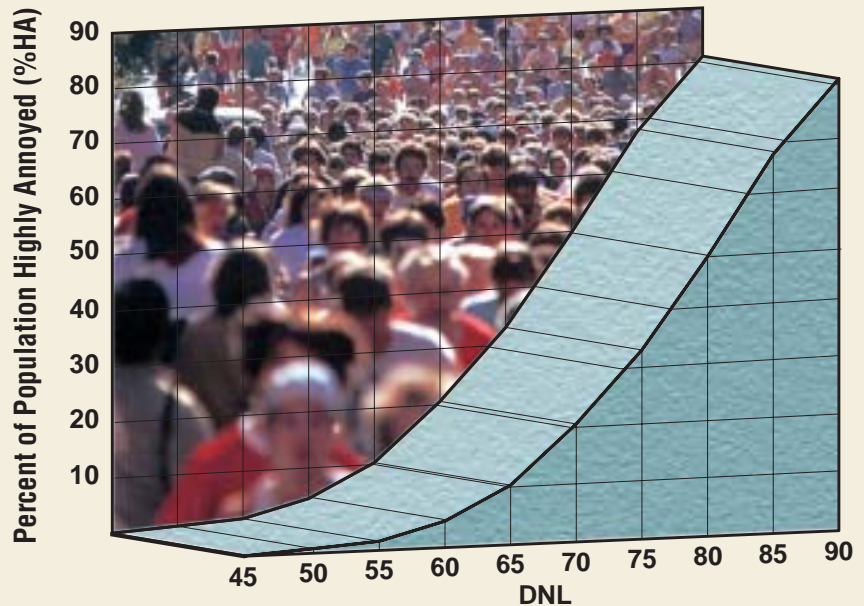


Noise analysts have speculated that the overall ambient noise level in an environment determines to what degree people will be annoyed by a given level of aircraft noise.



Source: Richards and Ollerhead 1973, p.31

UPDATED SCHULTZ CURVE



$$\text{Equation for Curve: } \% \text{ HA} = \frac{100}{1 + e^{(11.13 - .14 \text{ Ldn})}}$$

Source: Finegold et al. 1992 and 1994.

The studies reviewed by Kryter were intended to evaluate whether or not background noise provided some degree of masking of aircraft noise. They did not, however, take into consideration the subjects' rating of the overall quality of the noise environment.

The U.S. Environmental Protection Agency (EPA) has provided guidelines to address the question of background noise and its relationship to aircraft noise.





The degree of annoyance which people suffer from aircraft noise varies depending on their activities at any given time.



The EPA has determined that complaints can be expected when the intruding DNL exceeds the background DNL by more than 5 decibels (U.S. EPA 1974). The California Department of Transportation (Caltrans 2000, pp. 7- 24 - 7-25) notes that the level of background (ambient) noise should be used in determining the suitable aircraft noise contour of significance. Specifically, adjustments have been made in areas with quiet background noise levels of 50 to 55 CNEL. In those cases, aircraft CNEL contours are prepared down to 55 or 60 CNEL, and land use compatibility criteria are adjusted to apply to those areas. The State of Oregon Department of Aviation (Oregon 2003) also requires the preparation of noise contours down to the 55 DNL level. This noise contour is used to establish the noise impact boundary for air carrier airports within the state.

The Federal Interagency Committee on Noise (FICON 1992, p. 2-6) examined the question of background noise and its relationship to perceptions of aircraft noise. It reviewed the research in this field, concluding that there was a basis for believing that, in addition to the magnitude of aircraft noise, the difference between background noise and aircraft noise was in some way related to human perceptions of noise disturbance. It noted, however, that there was insufficient scientific data to provide authoritative guidance on the consideration of these effects. FICON advocated further research in this area.

LAND USE COMPATIBILITY GUIDELINES

The degree of annoyance which people suffer from aircraft noise varies depending on their activities at any given time. People rarely are as disturbed by aircraft noise when they are shopping, working, or driving as when they are at home. Transient hotel and motel residents seldom express as much concern with aircraft noise as do permanent residents of an area. The concept of "land use compatibility" has arisen from this systematic variation in human tolerance to aircraft noise. Since the 1960s, many different sets of land use compatibility guidelines have been proposed and used. This section reviews some of the more well known guidelines.

FEDERAL LAND USE COMPATIBILITY GUIDELINES

FAA-DOD Guidelines

In 1964, the Federal Aviation Administration (FAA) and the U.S. Department of Defense (DOD) published similar documents setting forth guidelines to assist land use planners in areas subjected to aircraft noise from nearby airports. These guidelines, presented in **Table 1**, establish three zones and the expected responses to aircraft noise from residents of each zone. In Zone 1, areas exposed to noise below 65 DNL, essentially no complaints would be expected although noise could be an occasional annoyance. In Zone 2, areas exposed to noise between 65 and 80 DNL, individuals may complain, perhaps vigorously. In Zone 3, areas in excess of 80 DNL, vigorous complaints would be likely and concerted group action could be expected.

TABLE 1

CHART FOR ESTIMATING RESPONSE OF COMMUNITIES EXPOSED TO AIRCRAFT NOISE - 1964 FAA-DOD GUIDELINES

NOISE LEVEL	ZONE	DESCRIPTION OF EXPECTED RESPONSE
Less than 65 DNL	1	No complaints would be expected. The noise may, however, interfere occasionally with certain activities of the residents.
65 to 80 DNL	2	Individuals may complain, perhaps vigorously. Concerted group action is possible.
Greater than 80 DNL	3	Individual reactions would likely include repeated, vigorous complaints. Concerted group action might be expected.

Source: U.S. DOD 1964. Cited in Kryter 1984, p. 616.

HUD Guidelines

The U.S. Department of Housing and Urban Development (HUD) first published noise assessment requirements in 1971 for evaluating the acceptability of sites for housing assistance. These requirements contained standards for exterior noise levels along with policies for approving HUD-supported or assisted housing projects in high noise areas. In general, the requirements established three zones: an acceptable zone where all projects could be approved, a normally unacceptable zone where



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mitigation measures would be required and where each project would have to be individually evaluated for approval or denial, and an unacceptable zone in which projects would not, as a rule, be approved.

In 1979, HUD issued revised regulations which kept the same basic standards, but adopted new descriptor systems which were considered advanced over the old system. **Table 2** summarizes the revised HUD requirements.

TABLE 2

**SITE EXPOSURE TO AIRCRAFT NOISE
1979 HUD REQUIREMENTS**

ACCEPTABLE CATEGORY	DAY-NIGHT AVERAGE SOUND LEVEL	SPECIAL APPROVALS AND REQUIREMENTS
Acceptable	Not exceeding 65 dB	None
Normally Unacceptable	Above 65 dB but not exceeding 75 dB	Special approvals, environmental review, attenuation
Unacceptable	Above 75 dB	Special approvals, environmental review, attenuation

Source: U.S. HUD 1979

Veterans Administration Guidelines

The Veterans Administration has established policies and procedures for the appraisal and approval of VA loans relative to residential properties located near major civilian airports and military air bases. The agency's regulations, contained within M26-2, Change 15, state that "the VA must recognize the possible unsuitability for residential use of certain properties and the probable adverse effect on livability and/or value of homes in the vicinity of major airports and air bases. Such adverse effects may be due to a variety of factors including noise intensity." **Table 3** contains the VA's noise zones and associated development requirements and limitations.

EPA Guidelines

The U.S. Environmental Protection Agency published a document in 1974 suggesting maximum noise exposure levels to protect public health with an adequate margin of safety. These are shown in **Table 4**. They note that the risk of hearing loss may become a concern with exposure



VETERANS ADMINISTRATION NOISE GUIDELINES NOVEMBER 23, 1992

NOISE ZONE	CNR (Composite Noise Rating)	NEF (Noise Exposure Forecasts)	DNL (Day/Night Average Sound Level)
1	Under 100	Under 30	Under 65
2	100-115	30-40	65-75
3	Over 115	Over 40	Over 75

Specific Limitations:

- (1) Proposed or existing properties located in zone 1 are generally acceptable as security for VA-guaranteed loans.
- (2) Proposed construction to be located in zone 2 will be acceptable provided:
 - (a) Sound attenuation features are built into the dwelling to bring the interior DNL of the living unit to 45 decibels or below.
 - (b) There is evidence of market acceptance of the subdivision.
 - (c) The veteran-purchaser signs a statement which indicates his/her awareness that (1) the property being purchased is located in an area adjacent to an airport, and (2) the aircraft noise may affect normal livability, value, and marketability of the property.
- (3) Proposed subdivisions located in zone 3 are not generally acceptable. The only exception is a situation in which VA has previously approved a subdivision, and the airport noise contours are subsequently changed to include the subdivision in zone 3. In such cases, VA will continue to process loan applications provided the requirements in the above subparagraphs (2) are met.
- (4) Existing dwellings in zones 2 and 3 are not to be rejected because of airport influence if there is evidence of acceptance by a fully informed veteran.

Source: Veterans Administration, M26-2, June 1992

TABLE 4

SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY - 1974 EPA GUIDELINES

EFFECT	LEVEL	AREA
Hearing loss	75 DNL and above	All areas
Outdoor activity interference and annoyance	55 DNL and above	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis of use.
	59 DNL and above	Outdoor areas where people spend limited amounts of time, such as school years, playgrounds, etc.
Indoor activity interference and annoyance	45 DNL and above	Indoor residential areas
	49 DNL and above	Other indoor areas with human activities such as schools, etc.

Note: All Leq values from EPA document were converted by FAA to DNL for ease of comparison. (DNL=Leq(24) + 4 dB).

Source: U.S. EPA 1974. Cited in FAA 1977a, p. 26.



LAND USE GUIDANCE CHART I: AIRPORT NOISE INTERPOLATION

LAND USE GUIDANCE ZONES (LUG)	NOISE EXPOSURE CLASS	INPUTS: AIRCRAFT NOISE ESTIMATING METHODOLOGIES				HUD NOISE ASSESSMENT GUIDELINES (1977)	SUGGESTED NOISE CONTROLS
		Ldn DAY-NIGHT AVERAGE SOUND LEVEL	NEF NOISE EXPOSURE FORECAST	CNR COMPOSITE NOISE RATING	CNEL COMMUNITY NOISE EQUIVALENT LEVEL		
A	MINIMAL EXPOSURE	0 TO 55	0 TO 20	0 TO 90	0 TO 55	"CLEARLY ACCEPTABLE"	NORMALLY REQUIRES NO SPECIAL CONSIDERATIONS
B	MODERATE EXPOSURE	55 TO 65	20 TO 30	90 TO 100	55 TO 65	"NORMALLY ACCEPTABLE"	LAND USE CONTROLS SHOULD BE CONSIDERED
C	SIGNIFICANT EXPOSURE	65 TO 75	30 TO 40	100 TO 115	65 TO 75	"NORMALLY UNACCEPTABLE"	NOISE EASEMENTS, LAND USE, AND OTHER COMPATIBILITY CONTROLS RECOMMENDED
D	SEVERE EXPOSURE	75 & HIGHER	40 & HIGHER	115 & HIGHER	75 & HIGHER	"CLEARLY UNACCEPTABLE"	CONTAINMENT WITHIN AIRPORT BOUNDARY OR USE OF POSITIVE COMPATIBILITY CONTROLS RECOMMENDED

Source: FAA 1977b, p. 12.

to noise above 74 DNL. Interference with outdoor activities may become a problem with noise levels above 55 DNL. Interference with indoor residential activities may become a problem with interior noise levels above 45 DNL. If we assume that standard construction attenuates noise by about 20 decibels, with doors and windows closed, this corresponds to an exterior noise level of 65 DNL.

FAA Land Use Guidance System

In 1977, FAA issued an advisory circular on airport land use compatibility planning (FAA 1977b). It describes land use guidance (LUG) zones corresponding to aircraft noise of varying levels as measured by four different noise metrics (**Exhibit B**). It also includes suggested land use noise sensitivity guidelines (**Exhibit C**).

In **Exhibit B**, LUG Chart I, four land use guidance zones are described, corresponding to DNL levels of 55 or less (A), 55 to 65 (B), 65 to 75 (C), and 75 and over (D). LUG Zone





In 1979, the Federal Interagency Committee on Urban Noise (FICUN), including representatives of the Environmental Protection Agency, the Department of Transportation, the Housing and Urban Development Department, the Department of Defense, and the Veterans Administration, was established to coordinate various federal programs relating to the promotion of noise-compatible development.



A is described as minimal exposure, normally requiring no special noise control considerations. LUG Zone B is described as moderate exposure where land use controls should be considered. LUG Zone C is subject to significant exposure, and various land use controls are recommended. In LUG Zone D, severe exposure, containment of the area within airport property, or other positive control measures, are suggested.

In LUG Chart II, **Exhibit C**, most noise-sensitive uses are suggested as appropriate only within LUG Zone A. These include single-family and two-family dwellings, mobile homes, cultural activities, places of public assembly, and resorts and group camps. Uses suggested for Zones A and B include multi-family dwellings and group quarters; financial, personal, business, governmental, and educational services; and manufacturing of precision instruments. In Zones C and D, various manufacturing, trade, service, resource production, and open space uses are suggested.

Federal Interagency Committee on Urban Noise

In 1979, the Federal Interagency Committee on Urban Noise (FICUN), including representatives of the Environmental Protection Agency, the Department of Transportation, the Housing and Urban Development Department, the Department of Defense, and the Veterans Administration, was established to coordinate various federal programs relating to the promotion of noise-compatible development. In 1980, the Committee published a report which contained detailed land use compatibility guidelines for varying DNL noise levels (FICUN 1980). The work of the Interagency Committee was very important as it brought together for the first time all federal agencies with a direct involvement in noise compatibility issues and forged a general consensus on land use compatibility for noise analysis on federal projects.

The Interagency guidelines describe the 65 DNL contour as the threshold of significant impact for residential land uses and a variety of noise-sensitive institutions (such as hospitals, nursing homes, schools, cultural activities, auditoriums, and outdoor music shells). Within the 55 to 65 DNL contour range, the guidelines note that cost and

**LAND USE GUIDANCE CHART II:
LAND USE NOISE SENSITIVITY INTERPOLATION**

LAND USE			LUG ZONE ¹	LAND USE			LUG ZONE ¹	
SLUCM No.	Name	Suggested	SLUCM No.	Name	Suggested	SLUCM No.	Name	Suggested
10 Residential			A-B	50 Trade⁴				
11	Household units.		51	Wholesale trade.	C-D			
11,11	Single units - detached.	A	52	Retail trade-building materials, hardware, and farm equipment.	C			
11,12	Single units - semi attached.	A	53	Retail trade-general merchandise.	C			
11,13	Single units - attached row.	B	54	Retail trade-food.	C			
11,21	Two units - side-by-side.	A	55	Retail trade-automotive, marine craft, aircraft and accessories.	C			
11,22	Two units - one above the other.	A	56	Retail trade-apparel and accessories.	C			
11,31	Apartments - walk up.	B	57	Retail trade-furniture, home furnishings, and equipment.	C			
11,32	Apartments - elevator.	B-C	59	Retail trade-eating and drinking. Other retail trade.	C-D			
12	Group quarters.	A-B	60 Services⁴					
13	Residential hotels.	B	61	Financial, insurance, and real estate services.	B			
14	Mobile home parks or courts.	A	62	Personal services.	B			
15	Transient lodgings.	C	63	Business services.	B			
19	Other residential.	A-C	64	Repair services.	C			
20 Manufacturing²			C-D	65	Professional services.	B-C		
21	Food and kindred products-manufacturing.		66	Contract construction services.	C			
22	Textile mill products-manufacturing.	C-D	67	Governmental services.	B			
23	Apparel and other finished products made from fabrics, leather, and similar materials-manufacturing.	C-D	68	Educational services.	A-B			
24	Lumber and wood products (except furniture)-manufacturing.	C-D	69	Miscellaneous services.	A-C			
25	Furniture and fixtures-manufacturing.	C-D	70 Cultural, entertainment, and recreational					
26	Paper and allied products-manufacturing.	C-D	71	Cultural activities and nature exhibitions.	A			
27	Printing, publishing, and allied industries.	C-D	72	Public assembly.	A			
28	Chemicals and allied products-manufacturing.	C-D	73	Amusements.	C			
29	Petroleum refining and related industries. ³	C-D	74	Recreational activities. ⁵	B-C			
30 Manufacturing²				75	Resorts and group camps.	A		
31	Rubber and miscellaneous plastic products-manufacturing.	C-D	76	Parks.	A-C			
32	Stone, clay, and glass products-manufacturing.	C-D	79	Other cultural, entertainment, and recreational. ⁵	A-B			
33	Primary metal industries.	D	80 Resource production and extraction					
34	Fabricated metal products-manufacturing.	D	81	Agriculture.	C-D			
35	Professional, scientific, and controlling instruments: photographic and optical goods; watches and clocks-manufacturing.	B	82	Agricultural related activities.	C-D			
39	Miscellaneous manufacturing.	C-D	83	Forestry activities and related services.	D			
40 Transportation, communications, and utilities				84	Fishing activities and related services.	D		
41	Railroad, rapid rail transit, and street railway transportation.	D	85	Mining activities and related services.	D			
42	Motor vehicle transportation.	D	89	Other resource production and extraction.	C-D			
43	Aircraft transportation.	D	90 Undeveloped land and water areas					
44	Marine craft transportation.	D	91	Undeveloped and unused land area (excluding noncommercial forest development).	D			
45	Highway and street right-of-way.	D	92	Noncommercial forest development.	D			
46	Automobile parking.	D	93	Water areas.	A-D			
47	Communication.	A-D	94	Vacant floor area.	A-D			
48	Utilities.	D	95	Under construction.	A-D			
49	Other transportation communications and utilities.	A-D	99	Other undeveloped land and water areas.	A-D			

¹ Refer to Land Use Guidance Chart I, Exhibit C-1.
² Zone "C" suggested maximum except where exceeded by self generated noise.
³ Zone "D" for noise purposes; observe normal hazard precautions.
⁴ If activity is not in substantial, air-conditioned building, go to next higher zone.
⁵ Requirements likely to vary - individual appraisal recommended.

SLUCM: *Standard Land Use Coding Manual*, U.S. Urban Renewal Administration and Bureau of Public Roads, 1965.



The ANSI standard acknowledges the potential for noise effects below the 65 DNL level, describing several uses as "marginally compatible" with noise below 65 DNL.



feasibility factors were considered in defining residential development and several of the institutions as compatible. In other words, the guidelines are not based solely on the effects of noise. They also consider the cost and feasibility of noise control.

ANSI Guidelines

In 1980, the American National Standards Institute (ANSI) published recommendations for land use compatibility with respect to noise (ANSI 1980). Kryter (1984, p. 621) notes that no supporting data for the recommended standard is provided.

The ANSI guidelines are shown in **Exhibit D**. While generally similar to the Federal Interagency guidelines, there are some important differences. First, ANSI's land use classification system is less detailed. Second, the ANSI standard acknowledges the potential for noise effects below the 65 DNL level, describing several uses as "marginally compatible" with noise below 65 DNL. These include single-family residential (from 55 to 65 DNL), multi-family residential, schools, hospitals, and auditoriums (60 to 65 DNL), and outdoor music shells (50 to 65 DNL). Other outdoor activities, such as parks, playgrounds, cemeteries, and sports arenas, are described as marginally compatible with noise levels as low as 55 or 60 DNL.

F.A.R. Part 150 Guidelines

The FAA adopted a revised and simplified version of the Federal Interagency guidelines when it promulgated F.A.R. Part 150 in the early 1980s. (The Interim Rule was adopted on January 19, 1981. The final rule was adopted on December 13, 1984, published in the Federal Register on December 18, and became effective on January 18, 1985.) Among the changes made by FAA include the use of a coarser land use classification system and the deletion of any reference to any potential for noise impacts below the 65 DNL level.

The determination of the compatibility of various land uses with various noise levels, however, is very similar to the Interagency determinations.

LAND USE COMPATIBILITY WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVEL AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED

LAND USE	Yearly Day-Night Average Sound Level (DNL) in Decibels			
	50-60	60-70	70-80	80-90
Residential - Single Family, Extensive Outdoor Use	Compatible	with Insulation	Marginally Compatible	Incompatible
Residential - Multiple Family, Moderate Outdoor Use	Compatible	with Insulation	Marginally Compatible	Incompatible
Residential - Multi-Story, Limited Outdoor Use	Compatible	with Insulation	Marginally Compatible	Incompatible
Transient Lodging	Compatible	with Insulation	Marginally Compatible	Incompatible
School Classrooms, Libraries, Religious Facilities	Compatible	with Insulation	Marginally Compatible	Incompatible
Hospitals, Clinics, Nursing Homes, Health-Related Facilities	Compatible	with Insulation	Marginally Compatible	Incompatible
Auditoriums, Concert Halls	Compatible	with Insulation	Marginally Compatible	Incompatible
Music Shells	with Insulation	with Insulation	Marginally Compatible	Incompatible
Sports Arenas, Outdoor Spectator Sports	Compatible	with Insulation	Marginally Compatible	Incompatible
Neighborhood Parks	Compatible	with Insulation	Marginally Compatible	Incompatible
Playgrounds, Golf Courses, Riding Stables, Water Rec., Cemeteries	Compatible	with Insulation	Marginally Compatible	Incompatible
Office Buildings, Personal Services, Business and Professional	Compatible	with Insulation	Marginally Compatible	Incompatible
Commercial - Retail, Movie Theaters, Restaurants	Compatible	with Insulation	Marginally Compatible	Incompatible
Commercial - Wholesale, Some Retail, Ind., Mfg., Utilities	Compatible	with Insulation	Marginally Compatible	Incompatible
Livestock Farming, Animal Breeding	Compatible	with Insulation	Marginally Compatible	Incompatible
Agriculture (Except Livestock)	Compatible	with Insulation	Marginally Compatible	Incompatible
Extensive Natural Wildlife and Recreation Areas	Compatible	with Insulation	Marginally Compatible	Incompatible

LEGEND

Compatible
 with Insulation
 Marginally Compatible
 Incompatible

Source: ANSI 1980. Cited in Kryter 1984, p. 624.



Exhibit E lists the F.A.R. Part 150 land use compatibility guidelines. These are only guidelines. Part 150 explicitly states that determinations of noise compatibility and regulation of land uses are purely local responsibilities.

F.A.R. PART 150 LAND USE COMPATIBILITY GUIDELINES

LAND USE	Yearly Day-Night Average Sound Level (DNL) in Decibels					
	Below 65	65-70	70-75	75-80	80-85	Over 85
RESIDENTIAL						
Residential, other than mobile homes and transient lodgings	Y	N ¹	N ¹	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N ¹	N ¹	N ¹	N	N
PUBLIC USE						
Schools	Y	N ¹	N ¹	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y ²	Y ³	Y ⁴	Y ⁴
Parking	Y	Y	Y ²	Y ³	Y ⁴	N
COMMERCIAL USE						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail-building materials, hardware and farm equipment	Y	Y	Y ²	Y ³	Y ⁴	N
Retail trade-general	Y	Y	25	30	N	N
Utilities	Y	Y	Y ²	Y ³	Y ⁴	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, general	Y	Y	Y ²	Y ³	Y ⁴	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y ⁶	Y ⁷	Y ⁸	Y ⁸	Y ⁸
Livestock farming and breeding	Y	Y ⁶	Y ⁷	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y ⁵	Y ⁵	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N



The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally-determined land uses for those determined to be appropriate by local authorities in response to locally-determined needs and values in achieving noise compatible land uses.

See other side for notes and key to table.

F.A.R. PART 150 LAND USE COMPATIBILITY GUIDELINES**KEY**

Y (Yes)	Land Use and related structures compatible without restrictions.
N (No)	Land Use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (outdoor-to-indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25, 30, 35	Land Use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

NOTES

- 1 Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB, respectively, should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB; thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.
- 2 Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
- 3 Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
- 4 Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
- 5 Land use compatible provided special sound reinforcement systems are installed.
- 6 Residential buildings require a NLR of 25.
- 7 Residential buildings require a NLR of 30.
- 8 Residential buildings not permitted.

Source: *F.A.R. Part 150*,
Appendix A, Table 1.

**SELECTED STATE LAND USE
COMPATIBILITY GUIDELINES****State of Oregon**

The State of Oregon's Airport Planning Rule (APR) establishes a series of local government requirements and rules which pertain to aviation facility planning. These requirements are intended to promote land use compatibility around airports as well as promote a convenient and economic system of airports in the state. To assist local governments and airports in meeting the requirements of the APR, the Oregon Department of Aviation published the *Airport Land Use Compatibility Guidebook* in January 2003.





The State of Oregon recognizes that, in some instances, land use controls and restrictions that apply to the 65 DNL may be appropriate for applications to areas impacted by noise levels above 55 DNL.

The Oregon guidelines contained within the guidebook, as they relate to land use compatibility around airports, are based on administrative regulations of the Department of Environmental Quality, adopted by the Oregon Environmental Quality Commission in 1979 (Oregon Administrative Rules, Chapter 340, Division 35, Section 45). Although the FAA regards the 65 DNL contours and above as significant, the State of Oregon considers the 55 and 60 DNL contours as significant. The state recognizes that, in some instances, land use controls and restrictions that apply to the 65 DNL may be appropriate for applications to areas impacted by noise levels above 55 DNL. For example, a rural area exposed to 55 to 65 DNL noise levels may be more affected by these levels than an urban area. This is because there is typically a higher level of background noise associated with an urban area (Oregon 2003). Air carrier airports are required to do studies defining the airport impact boundary, corresponding to the 55 DNL contour. Where any noise-sensitive property occurs within the noise impact boundary, the airport must develop a noise abatement program.

An Oregon airport noise abatement program may include many different recommendations for promoting land use compatibility. These include changes in land use planning, zoning, and building codes within the 55 DNL contour. In addition, disclosure of potential noise impacts may be required and purchase of land for non-noise sensitive public uses may be permitted within the 55 DNL contour.

Within the 65 DNL contour, purchase assurance, voluntary relocation, soundproofing, and purchase of land is permitted.

State of California

California law sets the standard for the acceptable level of aircraft noise for persons residing near airports at 65 CNEL (California Code of Regulations, Title 21, Division 2.5, Chapter 6). The 65 CNEL criterion was chosen for urban residential areas where houses are of typical construction with windows partially open. Four types of land uses are defined as incompatible with noise above 65 CNEL: residences, schools, hospitals and convalescent





The guidelines contained within the California Airport Land Use Planning Handbook suggest that no new residential uses should be permitted within the 65 CNEL noise contour.



homes, and places of worship. These land uses are regarded as compatible if they have been insulated to assure an interior sound level, from aircraft noise, of 45 CNEL. They are also to be considered compatible if an aviation easement over the property has been obtained by the airport operator.

California noise insulation standards apply to new hotels, motels, apartment buildings, and other dwellings, not including detached single-family homes. They require that "interior noise levels attributable to outdoor sources shall not exceed 45 decibels (based on the DNL or CNEL metric) in any habitable room." In addition, any of these residential structures proposed within a 60 CNEL noise contour requires an acoustical analysis to show that the proposed design will meet the allowable interior noise level standard. (California Code of Regulations, Title 24, Part 2, Appendix Chapter 35.)

In the *California Airport Land Use Planning Handbook* (Caltrans 2002), land use compatibility guidelines are suggested for use in the preparation of comprehensive airport land use plans. The guidelines suggest that no new residential uses should be permitted within the 65 CNEL noise contour. In quiet communities, it is recommended that the 60 CNEL should be used as the maximum permissible noise level for residential uses. At rural airports, it is noted that 55 CNEL may be suitable for use as a maximum permissible noise level for residential uses.

These guidelines are similar to those proposed in earlier editions of the *Airport Land Use Planning Handbook*. However, the 2003 handbook provides much more definitive guidance for compatible land use planning around airports.

State of Florida

In 1990, the State of Florida passed legislation which created the Airport Safety and Land Use Compatibility Study Commission. The charge to this commission was to assure that airports in Florida will have the capacity to accommodate future growth without jeopardizing public health, safety, and welfare. One of the Commissions' recommendations was to require the Florida Department



Within the State of Florida's Airport Compatible Land Use Guidance for Florida Communities, it was requested that each local government prohibit new residential development and other noise-sensitive uses for areas within the 65 DNL contour. Where practical, new residential development should be limited in areas down to the 55 DNL contour.



of Transportation (FDOT) to establish guidelines regarding compatible land use around airports. In 1994, FDOT responded to this recommendation by publishing a guidance document entitled *Airport Compatible Land Use Guidance for Florida Communities*.

As part of this document's conclusions, it was recommended that all commercial service airports, or airports with significant numbers of general aviation operations, establish a noise compatibility planning program in accordance with the provisions of F.A.R. Part 150. All communities within the airport environs should participate in the preparation of this program. It was requested that each local government prohibit new residential development and other noise-sensitive uses for areas within the 65 DNL contour. Where practical, new residential development should be limited in areas down to the 55 DNL contour.

State of Wisconsin

Wisconsin State Law 114.136 was established to give local governments the authority to regulate land uses within three miles of the airport boundary. These land use controls supercede any other applicable zoning limits by other jurisdictions that may apply to the area surrounding the airport. To assist airports with the development of land use controls, the Wisconsin Department of Transportation (WisDOT) published a document titled *Land Use Planning Around Airports in Wisconsin* in 2001. Various land use tools such as aviation easements, noise overlay zones, height and hazard zoning, and subdivision regulations are presented within the land use planning guide. WisDOT has recognized that the types of airport compatible land uses depend on the location and size of the airport as well as the type and volume of aircraft using the facility. The 65 DNL contour should be used as a starting point for land use regulations, but lesser contours should be considered if deemed necessary.

The 1985 Wisconsin Act 136 takes State Law 114.136 one step further by requiring counties and municipalities to depict airport locations and areas affected by aircraft operations on official maps. The law also requires the zoning authority to notify the airport owner of any proposed zoning changes within the airport environs.



Within the Airports and Compatible Land Use document, jurisdictions are encouraged to work with airports to ensure that airport noise is factored into land use decisions for the protection of the health, safety, and welfare of its residents.

State of Washington

In 1996, Washington State Senate Bill 6442 was passed. This bill requires that every city, town, and county, having a general aviation airport in its jurisdiction, discourage the siting of land uses that are incompatible with airport operations. Policies protecting airport facilities must be implemented within the comprehensive plan and development regulations. Formal consultation with the aviation community is required and all plans must be filed with the Washington State Department of Transportation Aviation Division (WADOT). To assist jurisdictions with establishing appropriate land use planning tools and regulations, WADOT published a revised *Airports and Compatible Land Use* document in February 1999. Within this planning document, jurisdictions are encouraged to work with airports to ensure that airport noise is factored into land use decisions for the protection of the health, safety, and welfare of its residents.

TRENDS IN LAND USE COMPATIBILITY GUIDELINES

In recent years, citizen activists, anti-noise groups, and environmental organizations have become concerned that the current methods of assessing aircraft noise are not sufficient. Among the concerns is that 65 DNL does not adequately represent the true threshold of significant noise impact. It has been argued that the impact threshold should be lowered to 60 or even 55 DNL, especially in areas of quiet background noise and in areas impacted by large increases in noise (ANR, V. 4, N. 12, p. 91; V. 5, No. 3, p. 21; V. 5, N. 11, p. 82). The purpose of this section is to provide a time line of events which, taken together, indicate a distinct movement toward the consideration of airport noise impacts below the 65 DNL level.

Y E A R

1992



In the 1992 session of Congress, a bill was introduced to lower the threshold for non-compatible land uses from 65 to 55 DNL (ANR, V. 4, N. 11, p. 83). The bill, however, was not passed. In 1995, a bill (HR 1971) was introduced in the House of Representatives to require the Department of Transportation to develop a plan to reduce the number of people residing within the 60 DNL contours around airports by 75 percent by January 1, 2001 (ANR, V. 7, N.

13, p. 101). This bill was not passed either. Nevertheless, these developments indicate concerns about aircraft noise below 65 DNL are coalescing into specific proposals to address the situation.

Also in 1992, an important arbitration proceeding between Raleigh-Durham International Airport and airport neighbors was concluded. Residents residing between the 55 and 65 DNL contours were awarded compensation for noise damages. This was apparently the first time damages had been awarded beyond the 65 DNL contour at any domestic airport (ANR V. 4, No. 14, p. 107). While, strictly speaking, this case sets no legal precedent, it provides further evidence that a change in the definition of the threshold of significant noise impact may be gathering momentum.

After the arbitration was concluded, the Raleigh-Durham Airport Authority developed a model noise ordinance that would require new housing between the 55 and 60 DNL contours to be sound-insulated to achieve an outdoor-to-indoor noise level reduction of 30 dB. Between the 60 and 65 DNL contours, a 35 dB reduction would be required. The model ordinance was proposed for use by local governments exercising land use control. (See ANR, V. 6, N. 3, p. 17.)

In August 1992, the Federal Interagency Committee on Noise (FICON 1992) issued its final report. FICON included representatives of the Departments of Transportation, Defense, Justice, Veterans Affairs, Housing and Urban Development; the Environmental Protection Agency; and the Council on Environmental Quality. FICON was formed to review federal policies for the assessment of aircraft noise in environmental studies. The Committee advocated the continued use of the DNL metric as the principal means of assessing long-term aircraft noise exposure. It further reinforced the designation of 65 DNL as the threshold of significant impact on non-compatible land use. FICON recognized, however, the potential for noise impacts down to the 60 DNL level, providing guidance for analyzing noise between 60 and 65 DNL in reports prepared under the National Environmental Policy Act (NEPA). This includes environmental assessments and environmental impact statements. (It does not include F.A.R. Part 150 studies.) FICON offered this explanation for this action (FICON 1992, p. 3-5).



1992 (cont.)

There are a number of reasons for moving in this direction at this time. First, the Schultz Curve [see the bottom panel in **Exhibit A**] recognizes that some people will be highly annoyed at relatively low levels of noise. This is further evidenced from numerous public response forums that some people living in areas exposed to DNL values less than 65 dB believe they are substantially impacted (U.S. EPA 1991). Secondly, the FICON Technical Subgroup has shown clearly that large changes in levels of noise exposure (on the order of 3 dB or more) below DNL 65 dB can be perceived by people as a degradation of their noise environment. Finally, there now exist computational techniques that allow for cost-effective calculation of noise exposure and impact data in the range below DNL 65 dB.

The specific FICON recommendation was as follows (FICON 1992, p. 3-5):

If screening analysis shows that noise-sensitive areas will be at or above DNL 65 dB and will have an increase of DNL 1.5 dB or more, further analysis should be conducted of noise-sensitive areas between DNL 60-65 dB having an increase of DNL 3 dB or more due to the proposed airport noise exposure.

FICON further recommended that if any noise-sensitive areas between 60 and 65 DNL are projected to have an increase of 3 DNL or more as a result of the proposed airport noise exposure, mitigation actions should be included for those areas (FICON 1992, p. 3-7). The FICON recommendations represent the first uniform guidelines issued by the federal government for the consideration of aircraft noise impacts below the 65 DNL level. At this time, these remain recommendations and are not official policy.

1995



The Federal Transit Administration (FTA) released a guidance document entitled *Transit Noise and Vibration Impact Assessment*. Within this document, FTA cites the EPA recommendation of 55 DNL to develop their curve of impact. Further, FTA states that they use the FAA criteria of 65 DNL to define their curve of severe impact.

1996

The American National Standards Institute (ANSI) recommends 55 DNL as the criterion level for housing and similar noise-sensitive land uses within their report *ANSI Quantities and Procedures for Description and Measurement of Environmental Sounds - Part 3: Short-Term Measurements with an Observer Present*.

The International Organization for Economic Cooperation and Development suggests the following environmentally sustainable transport noise levels: 55 DNL in urban areas and 50 DNL in rural areas.

1998

Within the Federal Railroad Administration's (FRA) *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, the same criteria used by the FTA is used to assess impacts of new, high-speed trains.

In this same year, the Surface Transportation Board (STB) utilizes 55 DNL as a threshold of impact within the Draft Environmental Impact Statement for the proposed Conrail acquisition by Norfolk Southern Railway Company.

The World Bank Group (WBG) set noise limits for general industrial projects to ensure that projects they fund, such as iron and steel manufacturing and thermal power plants, do not negatively impact noise-sensitive development. The WBG set their threshold of impact at 55 DNL.

1999

The Federal Energy Regulatory Commission adopts a revision to their regulations (Part 157) which states "the noise attributable to any new compressor stations, compression added to an existing station, or any modification, upgrade, or update of an existing station, must not exceed a day-night level (Ldn) of 55 dBA at any pre-existing noise-sensitive area."

The World Health Organization's *Guidelines for Community Noise* recommends a "criteria of annoyance" daytime threshold of 55 DNL and nighttime threshold of 50 DNL for residential areas.





Early in 2003, the FAA announced the establishment of the Center of Excellence for Aircraft Noise Mitigation. This research center is a partnership between academia, industry, and government. Part of the center's focus will be on what level of noise is significant as well as other noise metrics that can be used to assess the impact of aircraft noise on individuals.



RECENT DEVELOPMENTS AT THE FAA

In the late 1990s, the Naples Airport Authority determined that the short-term viability of the airport was in jeopardy due to the noise impacts at the airport. An F.A.R. Part 150 Study determined that the majority of the noise complaints were from individuals which reside outside the 65 DNL noise contour and were, therefore, not eligible for federal mitigation funding.

For several decades, the airport authority had led efforts to balance the competing needs of airport users with those of the surrounding community and had adopted numerous measures to control noise and limit incompatible land uses surrounding the facility. The surrounding jurisdictions had gone as far as to adopt the 60 DNL noise contour as the threshold of significant impact and had limited development within this contour.

Naples adopted a ban on Stage 2 aircraft under 75,000 pounds in June 2000 pursuant to the Noise Act and its implementing regulations, commonly referred to as Part 161. The restriction at Naples is important not only because it was the first, but also because it was, and is, the subject of several challenges, the results of which may prove precedential for other airport operators' efforts to address local noise issues.

Early in 2003, the FAA announced the establishment of the Center of Excellence for Aircraft Noise Mitigation. This research center is a partnership between academia, industry, and government. Part of the center's focus will be on what level of noise is significant as well as other noise metrics that can be used to assess the impact of aircraft noise on individuals.

On March 10, 2003, the FAA ruled that the ban on Stage 2 business jet operations imposed by Naples Airport Authority violates federal grant assurance obligations. This ruling came after years of research and debate regarding the restriction at Naples Airport.

CONCLUSIONS

This technical information paper has presented information on land use compatibility guidelines with



There is a strong and long-lasting consensus among various government agencies that 65 DNL represents an appropriate threshold for defining significant impacts on non-compatible land use. Nonetheless, both research and empirical evidence suggest that noise at levels below 65 DNL is often a concern.



respect to noise. It is intended to serve as a reference for the development of policy guidelines for F.A.R. Part 150 Noise Compatibility Studies.

There is a strong and long-lasting consensus among various government agencies that 65 DNL represents an appropriate threshold for defining significant impacts on non-compatible land use. Nonetheless, both research and empirical evidence suggest that noise at levels below 65 DNL is often a concern. Increased concern about these lower levels of noise has been registered in public forums across the country. Official responses by public agencies indicate at least a partial acknowledgment of these concerns. Indeed, according to many agencies and organizations as well as in the states of Oregon, Florida, Wisconsin, and California, airport noise analysis and compatibility planning below the 65 DNL level is strongly advised or required.

In urbanized areas with relatively high background noise levels, 65 DNL continues to be a reasonable threshold for defining airport noise impacts. In suburban and rural locations, lower noise thresholds deserve consideration. Given emerging national trends and the experience at many airports, it can be important to assess aircraft noise below 65 DNL, especially in areas with significant amounts of undeveloped land where land use compatibility planning is still possible. Future planning in undeveloped areas around airports should recognize that the definition of critical noise thresholds is undergoing transition. In setting a prudent course for future land use near airports, planners and policy-makers should try to anticipate these changes.

REFERENCES

ANR (Airport Noise Report), selected issues, Ashburn, VA.

ANSI 1980. *Sound Level Descriptors for Determination of Compatible Land Use*. American National Standards Institute, ANSI S3.23 - 1980 (ASA 22-1980).

Caltrans 1983. *Airport Land Use Planning Handbook - A Reference and Guide for Local Agencies*. Prepared for California Department of Transportation, Division of Aeronautics by the Metropolitan Transportation



Commission and the Association of Bay Area Governments, July 1983.

Caltrans 1993. *Airport Land Use Planning Handbook*. Prepared for California Department of Transportation, Division of Aeronautics by Hodges & Shutt, Santa Rosa, California, in association with Flight Safety Institute; Chris Hunter & Associates; and University of California, Berkeley, Institute of Transportation Studies, December 1993.

FAA 1977a. Impact of Noise on People. U.S. Department of Transportation, Federal Aviation Administration, May 1977.

FAA 1977b. Airport Land Use Compatibility Planning, AC 150/5050-6. U.S. Department of Transportation, Federal Aviation Administration, Washington, D.C.

FICON 1992. Federal Agency Review of Selected Airport Noise Analysis Issues. Federal Interagency Committee on Noise, Washington, D.C.

FICUN 1980. Guidelines for Considering Noise in Land Use Planning and Control. Federal Interagency Committee on Urban Noise, Washington, D.C.

Finegold, L.S. et al. 1992. "Applied Acoustical Report: Criteria for Assessment of Noise Impacts on People" Submitted to Journal of Acoustical Society of America. June 1992. Cited in FICON 1992.

Kryter, K.D. 1984. Physiological, Psychological, and Social Effects of Noise, NASA Reference Publication 1115.

ODOT 1981. Airport Compatibility Guidelines, Oregon Aviation System Plan, Volume VI, Oregon Department of Transportation, Aeronautics Division, Salem.

Richards, E.J. and J.B. Ollerhead, 1973. "Noise Burden Factor - A New Way of Rating Noise, Sound and Vibration," Vol. 7, No. 12, December.

Schultz, T.J. and McMahon, N.M. 1971. HUD Noise Assessment Guidelines. Report No. HUD TE/NA 171, August 1971. (Available from NTIS as PB 210 590.)





U.S. DOD 1964. Land Use Planning with Respect to Aircraft Noise. AFM 86-5, TM 5-365, NAVDOCKS P-98, U.S. Department of Defense, October 1, 1964. (Available from DTIC as AD 615 015.)

U.S. EPA 1974. Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety. U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., March 1974.

U.S. EPA 1991. A Review of Recent Public Comments on the Application of Aircraft Noise Descriptors. U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C. Cited in FICON 1992.

