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NOISE CONTROL AND COMPATIBILITY PLANNING FOR AIRPORTS

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Advisory Circular

Subject:

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1. PURPOSE. This advisory circular provides guidance for Noise Control and Compatibility Planning for airports under Federal Aviation Regulation (FAR) Part 150 and the Aviation Safety and Noise Abatement Act of 1979 (ASNA) (P.L. 96-193). It is intended for use by airport operators, state/local planners and other officials, and interested citizens who may engage in noise control planning. Airport noise compatibility planning has the goals of reducing existing noncompatible land uses around airports and of preventing the introduction of additional noncompatible land uses through the cooperative efforts of all those involved. The Part 150 program is voluntary and airport operators are encouraged to participate.

2. BACKGROUND. FAR Part 150 implements portions of Title I of the Aviation Safety and Noise Abatement Act of 1979. It establishes a single system for the measurement of airport (and background) noise, a single system for determining the exposure of individuals to airport noise, and a standardized airport noise compatibility planning program. The planning program includes (1) provision for the development and submission to the FAA of Noise Exposure Maps and Noise Compatibility Programs by airport operators; (2) standard noise units, methods and analytical techniques for use in airport assessments; (3) identification of land uses which are normally considered compatible (or noncompatible) with various levels of noise around airports; and (4) procedures and criteria for FAA approval or disapproval of noise compatibility programs by the Administrator. The program includes consideration of alternative noise control that might be employed as well as appropriate land use

planning strategies. The goal of the overall program is for the airport proprietor, in consultation with state/local planners, local aviation groups and interested citizens, to develop a balanced and cost-effective program to minimize and/or mitigate the airport's noise impact on local communities.

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CHAPTER 1. GENERAL

SECTION 1. INTRODUCTION

1. PURPOSE. This advisory circular provides guidance for Noise Control and Compatibility Planning for airports under Federal Aviation Regulation (FAR). Part 150 and the Aviation Safety and Noise Abatement Act of 1979 (ASNA)as amended. It is intended for use by airport operators, state/local planners and other officials, and interested citizens who may engage in noise control planning. Airport noise compatibility planning has the goals of reducing existing noncompatible land uses around airports and of preventing the introduction of additional noncompatible land uses through the cooperative efforts of all those involved. The Part 150 program is voluntary and airport operators are encouraged to participate.

2. BACKGROUND. There are existing airport noise/land use compatibility problems at many airports in the United States. In addition, there is a potential for exacerbation of these noise problems and the possibility of problems arising at other airports as urban areas and use of air travel continue to grow. Through cooperative efforts on both the local and national levels, much has already been accomplished in limiting the growth and spread of noise compatibility problems. Actions have included limits upon noise emissions by new aircraft, provisions for the retirement or retrofit with quieter engines of the noisiest transport aircraft, and an environmental review process for airport development projects. Some of the major remaining obstacles for implementing successful noise compatibilty programs around airports have been the need for a single system for measuring airport noise, a single system for determining the exposure of individuals to airport noise, the identification of land uses that are normally compatible with the various levels of noise around airports, and a process for safety and economic evaluations of proposed actions. These remaining major obstacles have been addressed by recent regulatory actions detailed below.

a. Federal Aviation Regulation (FAR) Part 150 implements portions of Title I of the Aviation Safety and Noise Abatement Act. It specifically establishes a single system for the measurement of airport (and background) noise, a single system for determining the exposure of individuals to airport noise, and a standardized airport noise compatibility planning program. The planning program includes (1) provision for the development and submission to the FAA of Noise Exposure Maps and Noise Compatibility Programs by airport operators; (2) standard noise units, methods and analytical techniques for use in airport assessments; (3) identification of land uses that are normally compatible (or noncompatible) with various levels of noise around airports; and (4) procedures and criteria for FAA approval or disapproval of noise compatibility programs by the Administrator.

b. The Airport Noise Compatibility Planning Program includes land use planning and implementation programs necessary to carry out the ASNA Act. The Act does not in any way, however, interfere with established prerogatives of State and local governments concerning land use and related noise compatibility actions and responsibilities. Accordingly, approvals and disapprovals of programs submitted to the FAA under Part 150 do not constitute a Federal determination that the use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses remains with the local authorities.

3. BENEFITS OF NOISE COMPATIBILITY PLANNING - PROGRAMMING UNDER PART 150.

a. Noise is one of the greatest threats to aviation today. Projected growth in demand for air travel means that we will have larger aircraft and more operations in the future. The increase in air carrier traffic at large airports will generate more air carrier traffic at feeder airports and more traffic by sophisticated general aviation aircraft at these and many general aviation airports.

b. The costs of most forms of noise mitigation are rapidly increasing. These include soundproofing, land purchases, relocations, land use changes, by-passing of impacted land, and construction of alternative aviation facilities. People's perceptions of what is an acceptable level of urban noise is becoming more critical while their opportunity to voluntarily move away from such noise is becoming more limited. All of these are resulting in strong pressures upon airport operators to impose operational constraints, curfews, growth limitations, and other severe constraints upon their airports as easy, "one-shot" solutions to the noise problem.

c. Relief of these pressures on the airport operators and the preservation of a national system of airports requires that aviation become as compatible as possible with its neighbors. This requires that the airport operators work much more closely with local jurisdictions than has been generally feasible in the past, since they control most of the viable non aviation-constraining noise mitigation measures.

d. The Part 150 Airport Noise Compatibility Planning Program offers an ideal vehicle for noise planning and implementation in this contemporary context. It includes:

(1) A balanced approach producing realistic and practical solutions fair to both aviation and non aviation interests.

(2) Positive FAA technical guidance through regional and airports district offices.

(3) Federally identified land uses which are normally compatible with various exposures of individuals to noise.

(4) Consultations and interactions between the airport operator, airport users, airport neighbors, local land use control jurisdictions, and the FAA designed to achieve broad-based confidence in and acceptance of the program and the support essential for its implementation over the long term.

(5) Recognition of factors beyond the control of the airport operator which strongly influence local land use decisions.

(6) A viable framework for conducting efficient and constructive compatibility programs which achieve large benefits in noise reduction for the costs in aviation.

(7) Community and airport operator decisions that are made from a fully informed position in order to weigh the full costs and benefits of the alternatives.

(8) Federal financial assistance available to the airport operator under the Airport Improvement Program for noise compatibility planning and for implementation of that planning.

(9) Federal financial assistance also available to units of local government in the area surrounding the airport to carry out projects in accordance with FAA approved noise compatibility programs.

(10) Certain sanctions are available under Section 107 of the ASNA Act to protect the airport operator from land owner noise suits.

e. No two airport situations are alike, and each will likely require a unique combination of mitigation measures to achieve an acceptable solution. At a given airport, a full range of possible solutions is explored, then the best composition of solutions is chosen and carefully weighed before settling upon a final plan. The objective being to reduce the noise by the most efficient way and then balance this against the possible non-aviation solutions. A balance is sought between realistic environmental goals and the costs to the aviation system. When the proposed aviation constraints are significant, then the local needs and benefits are weighed and balanced against the needs and concerns of the rest of the nation.

4. FAA INFORMATION SOURCES. Users of this circular are strongly encouraged to contact their FAA Airports District Office or the Airports Division of their FAA regional office for additional information, guidance, and consultation prior to starting an Airport Noise Exposure Map or Airport Noise Compatibility Program. These offices are also prime sources for reference materials, such as other advisory circulars and citizen participation manuals.

5. DEFINITIONS. All terms used in this circular which are also used in Part 150 have the same meaning in this circular as they do in that Part.

a. A-Weighted Sound Level (L_A). The A-Weighted Sound Level is sound pressure level which has been filtered or weighted to reduce the influence of the low and high frequency noise (formerly dBA). It was designed to approximate the response of the human ear to sound. (See paragraph 203)

b. Average Day-Night Sound Level (L_{dn}). See Yearly Day-Night Average Sound Level.

c. Land Use. The present or planned utilization of a given parcel of land. Such land uses are normally indicated or delineated on a land use map. Land use maps may indicate usages for any given time period past, present, or future, and such period should always be indicated. (See paragraph 237)

d. Zoning. An exercise of the police powers of the State, as delegated to local governments, designating the uses permitted on each parcel of land within the zoning jurisdiction. (See paragraph 331)

e. Standard Land Use Coding Manual (SLUCM). A Standard System for identifying and coding land use activities. Published jointly in 1965 by Urban Renewal Administration, Housing and Home Finance Agency (both now Parts of HUD) and the Bureau of Public Roads (now the Federal Highway Administration). (See paragraph 237)

f. Noise Level Reduction (NLR). The amount of noise level reduction achieved through incorporation of noise attenuation (between outdoor and indoor levels) in the design and construction of a structure. (See paragraph 237)

g. Noise Exposure Map. A scaled, geographic, depiction of an airport, its noise contours, and surrounding area developed in accordance with Section A150.101 of Appendix A of FAR Part 150, including the accompanying documentation setting forth the required descriptions of projected aircraft operations at that airport during 1985 and if submitted after 1982, during the fifth calendar year beginning after submission of the map, together with the ways, if any those operations for each of those years will affect the map (including noise contours and the forecast land uses). See FAR Part 150 for legal definition.

h. Noise Contour. A continuous line on a map of the airport vicinity connecting all points of the same noise exposure level; for the purposes of this program usually the L_{dn} 65, 70, and 75 levels.

i. Airport Noise Compatibility Program. That program reflected in documents (and revised documents) developed in accordance with Appendix B of Part 150, including the measures proposed or taken by the airport operator to reduce existing noncompatible land uses and to prevent the introduction of additional noncompatible land uses within the area. See FAA Part 150 for legal definition.

j. NEPA. Acronym for the National Environmental Policy Act of 1969. (See paragraph 26)

k. Curfew. A restriction placed upon all or certain classes of aircraft by time of day for the purposes of reducing or controlling airport noise. (See paragraph 326)

l. Easement. The legal right of one party to use a portion of the total rights in real estate owned by another party. This may include the right of passage over, on, or below the property; certain air rights above the property, including view rights; and the rights to any specified form of development or activity, as well as any other legal rights in the property that may be specified in the easement document. (See paragraph 332)

m. Office of Management and Budget Circular No. A-95. A regulation requiring coordination of Federal and federally assisted programs and projects with each other and with State, areawide, and local plans and programs, utilizing a series of state and regional clearinghouses. (See paragraph 25)

n. Federal Aviation Regulation (FAR) Part 36. A regulation establishing noise certification standards for aircraft. (See paragraph 24)

o. Aviation Noise Abatement Policy (ANAP). Policy adopted jointly by the Secretary of Transportation and the FAA, on November 18, 1976, delineating the responsibilities of FAA, air carriers, airport operators, and local communities in achieving reductions in airport noise.

p. Airport Noise Control and Land Use Compatibility (ANCLUC) Program. A pilot program for airport noise compatibility planning established by the ANAP and funded under Section 13 of the Airport and Airway Development Act of 1970 as amended. It was a voluntary planning process initiated and led by airport proprietors with Federal funding and technical assistance. (See paragraph 21)

q. Yearly Day-Night Average Sound Levels (L_{dn}) or (DNL). The 24-hour average sound level, in decibels, for the period from midnight to midnight, obtained after the addition of ten decibels to sound levels for the periods between midnight and 7 a.m. and between 10 p.m. and midnight, local time, as averaged over a span of one year. It is the FAA standard metric for determining the cumulative exposure of individuals to noise. (See paragraph 221)

r. Equivalent Sound Level (L_{eq}). L_{eq} is the steady A-weighted sound level over any specified period (not necessarily 24 hours) that has the same acoustic energy as the fluctuating noise during that period (with no consideration of a nighttime weighting.) It is a measure of cumulative acoustical energy. Because the time interval may vary, it should always be specified by a subscript (such as L_{eq} 8) for an 8-hr exposure to workplace noise) or be clearly understood.

6.-19. RESERVED.

SECTION 2. RELATIONSHIP TO OTHER AIRPORT AND NOISE PLANNING ACTIONS

20. AIRPORT MASTER PLANS. An Airport Noise Exposure Map or an Airport Noise Compatiblity Program for an airport supplements but does not replace the Airport Master Plan (AMP) developed for that airport. The AMP may provide the base data for the noise exposure map. However, operational data for use in the Integrated Noise Model (INM) (or an FAA approved equivalent) and the land use and jurisdictional data for the map should be certifiable by the airport operator as current data. Similarly, the AMP may offer inputs to development of the noise compatibility program. Again, all of the alternatives, analyses, consultations, and public involvement required by Part 150 for the program should be certifiable by the airport operator as up-to-date and based upon current data. See also, Section A150.101(f) of Part 150.

21. AIRPORT NOISE CONTROL AND LAND USE COMPATIBILITY (ANCLUC) PLANNING STUDIES. A number of ANCLUC planning studies have been undertaken and/or completed. Although this was an interim program, much valuable noise and land use information was produced and much viable compatibility planning accomplished. Where these studies meet the requirements of Part 150, or an FAA approved equivalent under Part 150, and are otherwise appropriate, airport operators are encouraged to incorporate that work into Noise Compatibility Programs; see Section A150.101(f) of Part 150.

22. AIR INSTALLATION COMPATIBLE USE ZONES. Complimentary to ANCLUC, the U.S. Department of Defense developed the Air Installation Compatible Use Zones (AICUZ) Program for achieving noise/land use compatibility at military air installations. AICUZ studies have also been prepared for a number of joint civil-military use airports where there are a significant number of military operations. As in the case of ANCLUC's, information developed for an AICUZ study which is appropriate and certifiable as current by the airport operator may be used in developing an Airport Noise Exposure Map or Airport Noise Compatibility Program.

23. ENVIRONMENTAL ASSESSMENTS. Environmental Assessments (EA) are prepared for many types of airport development projects and/or airport operational changes under the requirements of the National Environmental Policy Act (NEPA), Regulations of the Council on Environmental Quality (CEQ), Department of Transportation Order 5610.1C (Procedures for Considering Environmental Impacts), FAA Order 1050.1C (Policies and Procedures for Considering Environmental Impacts), and FAA Order 5050.4 (Airport Environmental Handbook). Many EA's contain analyses of airport noise, compatible land use, social impacts, and induced socioeconomic impacts. An Airport Noise Compatibility Program may supplement, but is not intended to replace an EA in meeting required environmental analyses. Similarly, an EA may contain information that, provided it is current, can be valuable inputs to developing airport noise exposure maps and airport noise compatibility programs. To the extent the information in the EA is appropriate, such use of existing sources is encouraged. See also, paragraph 26 for applicability of NEPA to Part 150.

24. FEDERAL AVIATION REGULATIONS, PART 36. Federal Aviation Regulations, Part 36 contains noise certification standards for most airplane types, generally requiring newly designed and manufactured aircraft to be significantly quieter than older aircraft. However, as a certification standard, Part 36 has no provisions to control either the operations or numbers of operations at an airport in order to stabilize or reduce noise impacts. Part 150 works as a compliment to Part 36 by integrating the gains in reduced aircraft noise emissions into an overall noise compatibility program with controls on both aviation noise and land uses to assure full implementation and long term protection to both the airport and its environs.

25. OMB A-95 NOTIFICATION AND REVIEW. Office of Management and Budget (OMB) Circular No. A-95 established a process whereby state and local clearinghouses are notified of proposed Federal Grant-in-Aid projects and other assistance actions. Interested parties are provided the opportunity to review and evaluate the proposals in advance in terms of their potential impact on or conflict with statewide or areawide comprehensive planning or upon the plans and programs of local governments. The A-95 process (or its Federal or state successor) must (or should) be used to give notification and opportunity for comment when Federal assistance is involved. It does not, however, substitute for the consultative process as required by the ASNA Act. Note also that A-95 will be revised or replaced upon implementation of Executive Order 12372. See paragraphs 350-359 for guidance on Consultations.

26. NATIONAL ENVIRONMENTAL POLICY ACT. FAA compliance with the NEPA is controlled by FAA Order 1050.1C, Policies and Procedures for Considering Environmental Impacts. The FAA has determined that approval or disapproval of airport noise compatibility programs are "categorical exclusions" to the requirements for environmental assessment under Order 1050.1C. The ASNA Act requires an airport noise compatibility program to be either approved or disapproved within 180 days of receipt or it will be automatically approved. Development of a noise exposure map or noise compatibility program does not replace an environmental assessment but can be used in the preparation of such an assessment. Environmental assessment leading to a finding of no significant impact or to an environmental impact statement must still be conducted, where required by applicable procedures, prior to taking any Federal implementing action such as grant approvals or covered air traffic actions. Although the 180 day time constraint does not permit the normal federal Environmental Impact Assessment process, consideration of the potential impacts remains an integral part of the planning process. Airport operators should fully consider environmental as well as noise and land use consequences in developing an airport noise compatibility program.

27.-29. RESERVED.

SECTION 3. OVERVIEW

30. NOISE - ITS MEASUREMENT AND ASSESSMENT. It is assumed that users of this circular have a general technical background, but are not proficient in noise measurement, particularly aviation noise. Chapter 2 is devoted to a basic discussion of aviation noise and its measurement and assessment. Care has been taken to avoid technical language and the emphasis has been placed upon practical understanding. This should enable the typical user to understand what is involved; to estimate the size of the effort required; how to gather data for the Integrated Noise Model (or an FAA approved equivalent); how to interpret the noise contours; how to validate noise contours using noise measurements; and how to prepare an airport noise exposure map. FAA personnel are available to assist as necessary.

31. SENSITIVITY OF LAND USES TO NOISE. Different uses of land by people exhibit different sensitivities to noise. Schools, residences, churches, public health facilities, and concert halls often appear quite sensitive to noise. By contrast, factories, warehouses, storage yards, and open farmland are relatively insensitive to noise. Other uses, such as offices, shopping centers, recreation areas, or hotels, have intermediate levels of noise sensitivity. In order to assist the users in assessing noise compatibility/noncompatibility in the vicinity of their airports, a table of land uses and their compatibility/noncompatibility with various levels of noise is provided in Appendix 1. However, the designations in this table do not constitute a Federal determination that any use of land covered by this program is acceptable or unacceptable under Federal, state, or local law. The responsibility for determining the acceptable and permissible land uses remains 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.

32. NOISE EXPOSURE MAPS. FAR Part 150, in accordance with the ASNA Act, provides an opportunity for airport proprietors to submit Noise Exposure Maps to the FAA. Each such map is a scaled geographic depiction of an airport, its noise contours, and surrounding areas. Specifically, Part 150 requires that each noise exposure map shall depict continuous L_{dn} contours for levels of 65, 70, and 75. Within the 65 L_{dn} contour, the airport proprietor is required to identify land uses and to determine land use compatibility in accordance with the standards and procedures of Appendix A of FAR Part 150. Sections 150.21 and A150.101 contain other specific requirements on the form and contents of such maps.

33. NOISE COMPATIBILITY PROGRAMS. FAR Part 150 provides for the preparation and submission of Noise Compatibility Programs in addition to Noise Exposure Maps. The purpose of such a program is to seek optimal accommodation of both airport operations and community activities within acceptable safety, economic and environmental parameters. That may be accomplished by reducing existing noncompatible land uses in the vicinity of the airport and preventing the introduction of new noncompatible land uses in the future. To that end, the airport proprietor and other responsible officials should consider a wide range of feasible alternatives of noise control actions and land use patterns. A checklist for preparing Noise Compatibility Programs is contained in Appendix 2.

34. SUBMISSION TO THE FAA. Completed Airport Noise Exposure Maps and Airport Noise Compatibility Programs are submitted by the airport operator to the appropriate FAA Regional Director. They will be given Preliminary Review for acceptance for evaluation and then be given a full evaluation. Details of this procedure and of airport operator obligations following any change in the operation of the airport which might create any substantial incompatible land uses are described in Sections 150.23 through 150.35 of FAR Part 150.

35. WITHDRAWAL OR REVISION. At any time before approval or disapproval of a program, it may be withdrawn or revised. Such a termination stops the 180-day approval period. A new evaluation is begun upon receipt of a revised program and, unless the FAA finds that the revisions can be integrated without exceeding the original approval period, a new 180-day approval period is begun.

36. PERIODIC REVIEW AND UPDATING. Growth and transition in urban locations create pressures for changes to zoning and other controls established to achieve and protect compatibility. These stimuli are also likely to generate greater aviation activity and airport requirements with consequent changes in airport noise impacts. For these reasons, Part 150 requires the inclusion of a schedule for periodic review and updating of airport noise compatibility programs. Updating is also necessary to reflect increased operations and, with the map, continue the sanctions under Section 107 of the ASNA Act.

a. After the plan is adopted there is a need for the airport operator and the local planning agencies to continually evaluate its effectiveness and to identify those aspects of the plan which may need improvement. This includes evaluation to determine if proposed implementing actions are being carried out as scheduled. For instance, it should include review of land acquisition or soundproofing projects and ascertain whether they are effective, on schedule, or whether modifications are necessary. Also, operational procedures adopted as part of the noise control plan must be monitored to assure that they are being adhered to. The responsible organization, either the airport operator, the local planning authority, or both, should monitor all requests for changes in zoning, variances, or subdivision actions within the study area.

b. Periodic or formal reviews, at intervals of three to five years or when the noise exposure map or airport master plan is updated, should be scheduled and budgeted by the airport operator as an integral part of the program. Included within the formalized review should be consideration of those problems or deficiencies identified during the monitoring process and most notably those pertaining to the performance of the plan. The review will normally not be as extensive as the original effort but should establish whether the plan remains viable or what actions are necessary to correct existing or forecast deficiencies. The types of activities included in the review should be:

(1) A comparison of the current compatibility of the airport and its environs to that outlined in the program's goals and objectives.

(2) Appraisal of the rate of growth of both the community and airport to determine the current and future adequacy of the compatibility plan.

(3) Review of the airport noise exposure map in light of both current and forecast operations and the noise performance levels of aircraft.

(4) Review of the adequacy of current operational controls in maintaining aircraft noise within the designated noise impact areas.

(5) Review of the adequacy of the adopted development controls in protecting the designated noise impact areas from encroachment by noise sensitive uses.

(6) Review of the effectiveness of the corrective actions employed in resolving existing unprotected noise sensitive uses within the noise impact areas.

c. Revised Programs. Revised programs should be submitted to the Regional Director in the same manner as the original submission.

37.-199. RESERVED.

CHAPTER 2. NOISE MEASUREMENT AND ASSESSMENT

SECTION 1. NOISE FUNDAMENTALS

200. SOUND. This section provides a conceptual description of the acoustical metrics which comprise the FAA approved "system" for aircraft noise measurement. The sound experienced in our everyday lives is the result of objects or bodies being set into vibration. This vibration causes a motion in the surrounding air resulting in a minute variation in atmospheric pressure called "sound pressure." This sound pressure forms the basis to measure sound and is usually expressed as a sound pressure level in decibels which are dimensionless units expressing logarithmically the ratio of two values (i.e., a measured quantity and a referenced value). Another important characteristic of sound is its "frequency." The human ear is sensitive to frequencies ranging from 20 to 20,000 hertz (cycles per second). The simplest of all sounds are those composed of a single frequency. These sounds are called pure tones. However, the sounds to which people are usually exposed are much more complex, since they are composed of many frequencies, each occurring simultaneously at its own sound pressure level.

201. DECIBELS. Sound pressure level is a measure of the amplitude of the sound, while frequency relates to the sound's pitch. The range of sound pressures of interest is represented on the low end by the threshold of hearing of normal young people and on the upper end by the noise of gunfire at close range. Stated in physical terms, this sound pressure range is approximately from 0.00002 to 2,000 pascals. It is clear that this is a tremendous range of sound pressures. An analogous problem would be that of measuring lengths ranging from one inch to 1575 miles. Because acoustics deals with the effects of small changes near the threshold of hearing as well as the effects of small changes near the upper end of the scale, a proportional scale is more appropriate than a linear scale to handle this wide variation in sound pressure. The simplest mathematical scale available for this purpose is the logarithmic or decibel scale. A decibel (dB) is defined as ten times the logarithm (to the base 10) of a power or intensity ratio.

202. SOUND PRESSURE LEVELS. Sound pressure level is expressed as 10 log (P^2/Po^2), where P_o is the reference pressure and P is the differential pressure of a sound over that of ambient pressure. This is equivalent to twenty times the logarithm of the ratio of the pressures. It is also important to note that the reference pressure has been internationally standardized as 0.00002 pascals, which is approximately the threshold of human hearing. Because of the logarithmic nature of the decibel scale, a sound pressure level of 60 dB corresponds to a pressure, not 60 times the reference pressure, but 1000 times the reference pressure. Thus, 20 log (1000) = 20(3) = 60.

203. A-WEIGHTED SOUND PRESSURE LEVELS (L_A). Sound is a physical phenomenon that affects many things besides people. However, when sound is measured in order to relate to the reactions of people, it is necessary to use a measure which relates to the way human beings hear sound. It has been found that people are more sensitive to higher frequencies (treble) than lower frequencies (bass). That is, the human ear discriminates against lower frequencies. Naturally if we want to measure sound in a way which corresponds to the way people hear sound we want to duplicate the ear's discrimination. This is accomplished electrically using a device called a "weighting network." Because unweighted sound pressure level did not correlate well with human assessment of the loudness of sounds, weighting networks were added to sound level meters to attenuate low and high frequency noise to approximate the response of the human ear to sound. One of these weighting networks was designated "A" and was originally employed for sounds less than 55 dB in level. Now it is used for all levels. It is measured in decibels which are usually designated L_A (formerly dBA). A-Weighted Sound Level has been found to correlate well with people's subjective judgment. Its simplicity and superiority over unweighted sound pressure level in predicting people's response to noise have made it the most widely used metric for assessing the impact of aircraft noise and for comparing that noise with other community noise sources.

204. MEASUREMENT SYSTEM RESPONSE TIME. While the A-weighted sound level (L_A) is the basic unit for most Federal, State, and local noise standards, variations do exist in its method of measurement. Sound level meters and other noise measuring systems are capable of operating in several characteristic modes, such as "slow," "fast," "impulse," and "peak." Basically, these modes differ in the way in which the output value (indicated sound level reading) follows rapid changes in the input sound level. The higher speed responses are often useful in architectural, industrial and research acoustics. However, for most community and transportation noise sources the "slow" response is preferred since experience has shown that it provides the most repeatable data. Thus, in response to the ASNA Act requirements, the FAA uses a family of related noise units based on the slow response, A-weighted sound level (L_{AS}). FAR Part 150 incorporated by reference International Electrotechnical Commission Publication No. 179, entitled "Precision Sound Level Meters," dated 1973. This document specifies technical standards for both the system response and the A-weighting network.

205.-219. RESERVED.

SECTION 2. NOISE MEASUREMENTS

220. MEASURING SINGLE AIRCRAFT EVENTS. Part 150 specifies use of the slow response A-weighted sound level L_{AS} in decibels for measuring single events. Measurements of aircraft noise made in this unit can be directly related to sound levels of surface transportation noise sources since standards for the measurement of noise from these other sources also use L_{AS}. Many communities throughout the U.S. have local noise ordinances which use this unit. L_{AS} is also the metric used in FAA Advisory Circular 36-3B, Estimated Airplane Noise Levels in A-Weighted Decibels. Most U.S. and foreign airports with noise monitoring systems provide L_{AS} information. There is also a single event integrated A-weighted sound

level (L_{AE}) which is different from the maximum A-weighted sound level (L_{AS}) described in paragraphs 204 and 220. L_{AE} (sometimes also known as the Sound Exposure Level) is the level of an equivalent one-second duration reference signal. This metric quantifies the effect of both duration and magnitude for a single event measured above a specified threshold. The L_{AE} is sometimes best understood as the dose of noise associated with a single event. A survey program at an airport which provides average L_{AE} data for specific aircraft type categories can be used to compute L_{dn} values, one method of validating computer generated noise contours.

221. AIRPORT CUMULATIVE NOISE EXPOSURES. While people certainly respond to the noise of single events (particularly to the loudest single event in a series), the long-range effects of prolonged exposure to noise appear to best correlate with cumulative metrics. Such a unit provides a single number which is equivalent to the total noise exposure over a specified time period. Thus, cumulative noise units are based on both time and level. The day-night average sound level (L_{dn}) specified as the noise metric for cumulative exposure under Part 150 is such a unit. Specifically, the L_{dn} is the yearly average of the A-weighted sound level integrated over a 24-hour period. It also incorporates a 10 dB step function weighting to aircraft events between 10:00 p.m. and 7:00 a.m. to account for the increased annoyance to noise during the night hours.

222. BASIC RECOMMENDED NOISE MEASUREMENT SYSTEM. A recommended basic noise measurement system and suggestions regarding its use and maintenance is included in Appendix 3.

223. VALIDATION OF NOISE CONTOURS. One of the primary objectives of many noise measurement programs is to validate computer generated noise contours. The understanding of a few important concepts (listed below) provides the basis for cumulative noise exposure estimation techniques.

a. Yearly average airport noise exposure contours are estimates of actual average airport noise exposure.

b. Actual airport noise exposure at any point on the ground may be approximated by the energy average (over a year's time) of the daily L_{dn} values for that point.

c. The actual daily L_{dn} value for any given location will vary from day to day. A large set of data acquired at Washington National Airport and Dulles International Airport (24 locations over 500 days) indicates that standard deviations in L_{dn} are generally 2 dB or less.

d. For daily L_{dn} standard deviations of 2 dB, it can be shown from simple statistical theory that a sample of 10 days (L_{dn}) will provide an estimate of the actual yearly L_{dn} accurate within 1 dB with 90 percent confidence. This "sample of 10" requirement involves the assumption that measurements are conducted on days when no bias exists in the airport operation. In order to assure "average" conditions over the 10 days, it is recommended that data be acquired for each direction of airport operation in proportion to the proper (annual) percent.

e. Thus one way to estimate the yearly L_{dn} value is to conduct 10 random (representative) 24 hour measurement surveys. Measurement equipment is available which, left unattended, can measure three consecutive daily L_{dn} values.

f. In lieu of conducting 24 hour continuous measurements in order to acquire a days L_{dn} data, it is possible to conduct a shorter sample and then estimate the L_{dn}. The method of extrapolation must be carefully documented and must demonstrate that the short sample is "representative" of the average operation during the day. The requirement of 10 representative days remains a requirement for estimating the yearly average L_{dn}. Two "shorter than 24 hour" sampling techniques are available. One involves measuring the noise during a period in which the mix of aircraft and the number of aircraft are representative of daily average values. Calculations are then needed for the nighttime weighting and to account for the present nighttime operations and curfew restrictions (if applicable) to arrive at an estimate of L_{dn} for the day. The second technique involves quantifying average single event L_{AE} values by aircraft type. The average L_{AE} data must reflect yearly average variability for the particular aircraft type. The yearly average L_{dn} is then computed from the mean L_{AE} data along with a knowledge of the airport mix and the daily operations schedule. This technique however, involves certain difficult to answer questions:

(1) How many measurements are needed for each aircraft type?

(2) How many measurements on any one day?

(3) How many total days of sampling?

Because of difficulty in identifying a statistical rationale, one may choose to use the first technique described in this subparagraph.

224. VALIDATION NOISE MEASUREMENTS VERSUS MICRO-SAMPLE SURVEY MEASUREMENTS. In any measurement program there is the tradeoff to be considered between the statistical confidence interval for the meaasured data and the available manpower and time. In survey work, the usual objective is to achieve a practical level of accuracy at many locations rather than highly accurate data at a few. When conducting a short survey which includes numerous measurement locations and a single measurement system, one implicitly

accepts the medium accuracy confidence level associated with the survey. These survey-measured levels accurately represent the acoustical environment at the time of the measurement. Short samples or surveys remain the most effective means (given limited time or resources) for quantifying the magnitude or environmental noise problems which affect large areas of a metropolis. If survey type measurements are utilized, it is important to identify them as such. In presenting single event survey data one should indicate means, standard deviations, and sample sizes. Care should be taken to avoid assigning statistical confidence limits to estimated daily L_{dn} values based on survey data unless the analytical and computational process is clearly set forth. This presentation is even more important when establishing an estimate of yearly average L_{dn} based on survey data alone.

225. AIRCRAFT NOISE EXPOSURE PREDICTION REFINEMENT PROCEDURE. The flow diagram shown in Figure 1 sets out the process by which FAA approved noise contours can be refined. Detailed modeling requirements are provided in Section 3 along with FAA approved procedures and standards. The key feature of this process is the "feedback loop" provided by L_{dn} data acquired either from continuous airport noise monitoring systems or from limited field measurement programs. This prediction refinement process (Figure 1) allows the contour analyst a chance to reevaluate the input assumptions and seek a reasonable explanation for differences (if any) between measured and predicted values. If suitable justifications can be provided, the analyst reruns the noise prediction model with new or modified inputs. Theoretically, several iterations could be run if justified on the basis of better input assumptions.

226. CONTINUOUS AIRPORT NOISE MONITORING SYSTEMS. There are several optional measures which may be undertaken as part of an airport noise compatibility program and which can enhance its effectiveness. Continuous airport noise monitoring systems fall into this category. Such systems can provide important input to the process of refining airport noise contours. (Contact AEE-120 for specific details). In brief, any FAA approved noise monitoring system would have the following minimum capabilities:

a. Provides continuous measurement of dBA at each site.

b. Provides hourly L_{eq} data.

c. Provides daily L_{dn} data.

d. Provides single event maximum A-weighted sound level data.

Desirable but nonessential capabilities include:

AIRCRAFT NOISE EXPOSURE PREDICTION

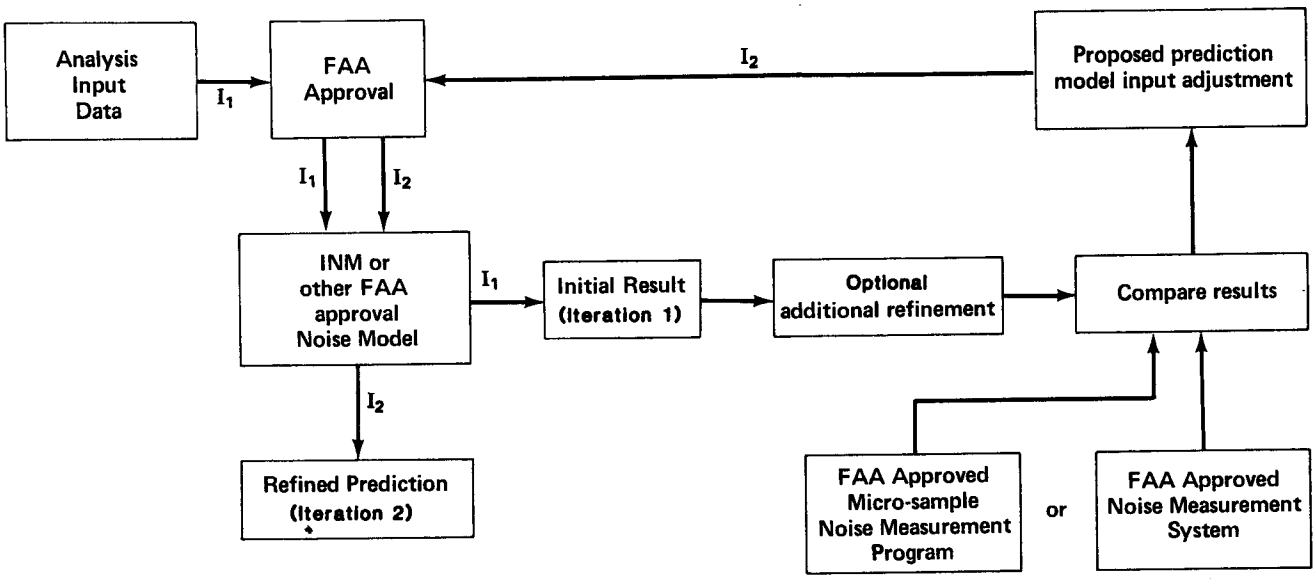

FIGURE 1

(1) Aircraft event discrimination ability.

(2) Single event L_{AE} data for each aircraft event.

(3) Differentiation between ambient and aircraft contributions to hourly Leq and L_{dn}.

(4) Monitoring data can be used to develop a statistical data base of noise levels for each aircraft type category.

227.-229. RESERVED.

SECTION 3. NOISE EXPOSURE PREDICTION

230. PREDICTION ANALYSIS TOOL. Only a computer-based mathematical model is capable of predicting the noise impact associated with the operation of a complex airport and projecting that impact to some future period. FAA approval of a model is conditional on the capability of that model to produce the required output and the public availability of the model to provide interested parties the opportunity to substantiate the results. Accuracy of a noise prediction model is measured by the statistical comparison of the noise exposure calculations derived from the data base and observations of the noise emitted during operations of similar aircraft types. Statistically adequate samples of observations are obtained over periods of a year or more.

231. INTEGRATED NOISE MODEL (INM). The FAA's Integrated Noise Model is the standard prediction analysis tool to which all computer-based airport noise exposure models are compared. The INM calculates the total impact of aircraft noise at or around airports. Although this noise exposure level can be presented in contours of equal noise exposure for any one of the following noise measures; Noise Exposure Forecast (NEF), Equivalent Sound Level (Leq), Day-Night Average Sound Level (L_{dn}), and Community Noise Equivalent Level (CNEL); only the L_{dn} is approved for use with Part 150. In January 1978, the FAA released Version 1 of INM to provide an analytical tool for the preparation of environmental impact studies. In September 1979, the FAA released Version 2, an improvement to the first version, with an expanded data base and additional input options. Version 3 reflects further enhancements in the method of determining noise impacts and in the data base of individual aircraft noise and performance. FAA has shipped magnetic tapes of the INM to government offices, consultants and various foreign countries. Tapes are also already in the possession of several commercial computer time-share vendors, thus offering broad accessibility on national and even international levels. Wider distribution is envisioned for later versions which will be more readily adaptable to a variety of large computers. In addition, the FAA has conducted an INM validation project to determine the accuracy of both the computational methods and data base of the model by comparing the model's noise exposure calculations with measured levels. The first phase of validation was an analysis of air carrier flights over the monitoring system at Washington National and Dulles International Airport. Information on the continuing validation project, availability of INM documents and tapes can be obtained through the Office of Environment and Energy (AEE-120).

232. INPUT REQUIREMENTS. The first step in running an airport case study is to gather the necessary data and organize it in the way which is recognized by the computer program. While the INM and similar models are accompanied with sets of aircraft noise and performance information, information on airport geometry and aircraft movements is also necessary.

The gathering of information is a time consuming process. Care must be taken in defining program input, especially in those situations in which a clearcut choice does not exist among similar items. There is also the problem of conflicting estimates of the airport operations from the airport manager, tower chief, airline operators and others. The following information needs to be obtained for input to INM computer program:

a. A map of the airport and its environs at an adequately detailed scale not less than 1 inch to 8,000 feet. It should indicate runway length, alignments, landing thresholds, takeoff start-of-roll points, and flight tracks out to at least 30,000 feet from the end of each runway. The locations of the nominal flight tracks are important. Exposure to aircraft noise is highest directly underneath the flight profile.

b. Airport activity levels and operational data which will indicate, on an annual average-daily-basis, the number of aircraft, by type, which utilize each flight track, in both the day time (7:00 a.m. to 10:00 p.m.) and nighttime (10 p.m. to 7 a.m.) periods for both landings and takeoffs. The INM offers a wide selection of aircraft types from which to choose. However, the model does not contain every combination of aircraft and engine types. Decisions on equivalent types must be carefully thought out with respect to possible ramifications to the calculation of exposure.

c. Landing glide slopes, glide slope intercept altitudes, and other pertinent information needed to establish approach profiles, along with the engine power setting for each aircraft type to fly that approach profile.

d. Takeoff flight profiles (the relationship of altitude to distance from start-of-roll and associated engine power settings for each aircraft type to fly that takeoff profile); these data must reflect the use of noise abatement departure procedures and, if applicable, the takeoff weight of the aircraft or some proxy for weight such as stage length. The INM data base contains a set of representative profiles for each aircraft type. The INM profiles conform to a widely used procedure. However, local conditions may preclude the use of these profiles in favor of a local standard procedure.

e. Any topographical or airspace restrictions which preclude the use of alternative flight tracks.

f. Government furnished data depicting aircraft noise characteristics. The standard data can be refined with on-site measurements by the procedure described in Section 234.

g. Airport elevation, wind conditions and average temperature.

233. ACCURACY. As is the case with any computer program or with any prediction method, the accuracy of the output of the Integrated Noise Model is directly dependent upon the appropriateness, completeness, and accuracy of the input data. Use as input of average flight tracks, flight procedures, aircraft types and mix, and the schedule of operations can

degrade the accuracy of the predicted contours. Further, the effects of local topography, weather, buildings, etc., cause variations from point to point along a contour. Accordingly, the accuracy of the INM computer noise prediction model in estimating the yearly average L_{dn} value at any specific geographical point has been estimated to be L_{dn} 75 contours $\pm$ 3 dB and L_{dn} 65 contours $\pm$ 5 dB with the average error over all points along the contour tending towards zero.

234. USE OF MEASUREMENTS IN REFINING/VALIDATING PREDICTIONS. On completion of a noise exposure map, one may find that the noise contours vary somewhat from measured conditions due to external influences that are not accounted for in the INM. This problem is not unexpected for a sophisticated model such as INM, since it is very difficult to compensate and model for all the variables that influence the noise environment. If a permanent and continuous noise monitoring system is in place, the airport operator may be able to calibrate the model specifically for that airport. The data acquisition will assist the airport operator in identifying specific problem areas based upon on-site measurements. A noise monitoring system may also allow the operator to fine tune or calibrate the output of the INM for specific conditions that cannot otherwise be accounted for. Thus the operator may be able to improve the noise compatibility program and the noise exposure map.

235. NOISE COMPATIBILITY PREDICTION. Different uses of the land have different sensitivities to noise. Individuals may each have different perceptions of what is an acceptable or an intruding level of noise. The background or residual noise against which a specific noise is perceived varies both by location and by time of day. Even the specific situation of the receiver, such as outdoor, indoor with windows open or closed, as well as one's activity of the moment affect the perception of a noise as intruding or not intruding. Regardless of the human activity, however, the associated noise sensitivity must be translated into a land use category for planning and regulatory purposes. The ASNA Act requires the FAA to identify land uses that are "normally compatible" or "noncompatible" with various levels of noise exposure by individuals. This was done in Part 150 and is used in developing and reviewing airport noise exposure maps and airport noise compatibility programs. It is important to recognize, however, that land use guidelines (even those adopted by regulation) are a planning tool and as such provide general indications as to whether particular land uses are appropriate for certain measured or calculated noise exposure levels.

236. BASIS FOR NOISE COMPATIBILITY. The adverse effects of noise exposure on people can be grouped into three general categories: degradation of health, attitudinal reactions, and activity interference. The first category, which includes hearing loss, is not normally encountered from aircraft sources at any point outside the airport boundary. However, the noise levels defining the thresholds of interference with noise-sensitive human activities, such as sleep and speech thresholds, are lower and airport noise can affect compatibility or noncompatibility.

a. Interference with human activity. These may generally be grouped as sleep interference; speech interference; interference with study, concentration, or critical tasks; interference with the performing arts; interference with outdoor activities; and interference with warning sounds.

(1) Sleep Interference. Interference with sleep activity is critical in hospitals, nursing homes, and certain other health facilities, and is important in individual homes. The zero interference threshold inside such health facilities is 40 dBA (Report No. DOT-FAA-AEQ-77-9, Study of Soundproofing Public Buildings Near Airports, April 1977). Tests have shown that about 10 percent of people sleeping in a laboratory environment who were exposed to a noise level of 50 dBA were awakened. Most residences have ambient noise levels that are higher than might be expected in a laboratory. Due to this higher background noise level, fewer than 10 percent of those exposed to 50-55 dBA of interior noise from aircraft would be expected to be awakened (Metropolitan Washington Airport Policy, Supplement to the August 1980 Environmental Impact Statement, Final, September 1981).

(2) Speech Interference. Interference with speech is most critical in learning environments such as classrooms. It has been determined to be somewhat less critical in other activities where speech communications are important. At sound levels greater than 45 dBA speech interference can begin to occur (at distances of about 25 to 30 feet) in a classroom. (Study of Soundproofing Public Buildings, et. al).

(3) Study, Concentration, and Critical Tasks. These thresholds are more difficult to identify than are those for sleep or speech interference and are even more subjective. To a considerable degree, these thresholds are dependent upon the individual recipient, the task at hand, the background noise through which the specific noise intrudes, and the impulse characteristics of the noise. The absence of recognized standards should not, however, prevent adequate consideration being given to these sensitive tasks whenever it is appropriate.

b. Relationship to Self-Generated Noise. Part 150 directs that no use or activity should be considered to be noncompatible as a result of airport noise if its own self-generated noise equals or exceeds the airport noise.

c. Relationship to Background Noise. Steady state background (ambient) noise which equals or exceeds the maximum noise resulting from individual aircraft events effectively masks uses in the immediate locale from aircraft noise impact. Hence, Part 150 directs that no uses in such an area should be considered to be incompatible. However, such cases can be determined only by analyzing the average 24 hour pattern of ambient noise and comparing it with the time of day distribution of aircraft events.

d. Noise Attenuation. Attenuation of noise, or outdoor to indoor Noise Level Reduction (NLR) through blocking of noise paths or soundproofing measures can reduce the intrusive impacts of noise. Where appropriate, NLR may be taken into account in determining the compatibility of indoor uses or activities. Inasmuch as this implies that windows and doors must be closed and that air conditioning or artificial ventilation must be used, due consideration should be given to the living environment and quality of life before using NLR to place individual residences or schools into a "compatible" designation. Consideration should also be given to the possible impacts upon outdoor and indoor-outdoor living and activities.

237. LAND USE COMPATIBILITY TABLE. FAR Part 150 contains a table, Land Use Compatibility With Yearly Day-night Average Sound Levels, identifying land uses that are "normally compatible" or "noncompatible" with various levels of noise exposure. Appendix 1 contains that table, but expands the list of uses under most categories in order to be more useful. The expanded land use descriptions are based upon the Standard Land Use Coding Manual (SLUCM) published by the Federal Highway Administration and the Department of Housing and Urban Development in 1965. The levels of noise exposure, in yearly day-night average sound levels (L_{dn}) correspond to the contours required to be shown on Airport Noise Exposure Maps. The table indicates compatibility of the land uses with the outdoor noise environment. By comparing the predicted or measured yearly L_{dn} level at a particular site with the values given in the table the range of compatible uses may be determined. In using the land use compatibility table, the following cautions should be observed:

a. L_{dn} contours indicate the boundaries lines between areas of acceptable or unacceptable noise exposures for the various land uses in Appendix I. The contours do indicate the trend in relative noise levels. However, vegetation, land contours, and the position of buildings or walls may often affect the impact of noise on the human users at a specific site.

b. L_{dn} levels may vary somewhat above or below the predicted levels for a particular location, depending upon local topography and vegetation, and upon final aircraft loadings and operations.

c. Although all land uses may be considered as normally compatible with noise levels less than 65 L_{dn}, local needs and values may dictate further delineation based on specific local requirements or determinations as well as low ambient levels.

d. When appropriate, noise level reduction may be achieved through incorporation of sound attenuation into the design and construction of a structure to achieve compatibility. However, more specific noise measurement and analysis is generally advisable prior to incurring the expense of such sound treatment. The cautions mentioned in paragraph 236d should be observed when applying Noise Level Reduction (NLR) to residential uses or other uses where indoor-outdoor activities are important.

e. Other local noise sources may often contribute as much as or more than aircraft to the total noise exposure at a specific location.

f. Compatibility designations in the table generally refer to the major use of the site. If other uses with greater sensitivity to noise are permitted at a site, the compatibility determination is based upon the use which is most adversely affected by noise.

g. Designations contained in the table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptability and permissible land uses remains with the local authorities.

h. Although Table 2 of FAR Part 150 defines the compatibility or noncompatibility of various land uses for the purposes of Federal aid, programs, or sanctions under the ASNA Act, adjustments or modifications of the descriptions of the land use categories may be desirable after consideration of specific local conditions.

238. INTERPRETATION OF NOISE EXPOSURE MAPS. Note that it is possible that the process of plotting noise contours onto locally generated land use maps may introduce a degree of charting imprecision, especially relative to property lines on the land use map. For the purpose of Section 107 of the ASNA Act, as amended, questions may arise concerning the precise relationship of specific properties to noise exposure contours depicted on a noise exposure map submitted under Section 103 of that Act. The FAA is not involved in any way in determining the relative locations of specific properties with regard to the depicted noise contours, or in interpreting the noise exposure map to resolve questions concerning which properties should be covered by the provisions of Section 107. These functions are inseparable from the ultimate land use control and planning responsibilities of local government. Therefore, the responsibility for the detailed overlaying of noise exposure contours onto the map of subjacent properties on the surface rests exclusively with the airport operator which submitted those maps, and/or with those public agencies and planning agencies with which consultation is required under Section 103 of the Act. In its decisions to accept noise exposure maps, the FAA relies on the certifications, by the airport operator that this statutorily required consultation has been accomplished.

239.-299. RESERVED.

CHAPTER 3. AIRPORT NOISE COMPATIBILITY PLANNING

SECTION 1. ELEMENTS OF AIRPORT NOISE PLANNING

300. GENERAL. This chapter discusses the airport noise compatibility planning process and forms the primary background for preparing airport noise compatibility programs under FAR Part 150. In addition, noise control and noise impact abatement actions available to both airport operator and neighboring communities are discussed. Equal emphasis is placed upon urban planning and airport operational solutions. Throughout the chapter, emphasis will be placed upon reduction of airport noise (present and future) to the practical minimum; long-term protection of the agreed-upon noise impact areas from development with noncompatible uses; and actions to reduce the noncompatibilities remaining within those noise impact areas to acceptable levels.

301. NOISE COMPATIBILITY PLANNING. Airport Noise Compatibility Planning is a joint planning effort which examines and weighs both aviation and urban planning strategies in seeking long-term solutions to existing and or future noise conflicts around an airport. Local consultation and citizen participation are key elements of the process. This includes the participation of airport users, affected local governments and airport neighbors, as well as the airport's operator. Section 103 of the ASNA Act requires that noise exposure maps be prepared in consultation with public agencies and planning agencies in areas surrounding the airport. FAR Part 150 requires consultation with the users and the agencies with land use control jurisdiction or planning responsibilities lying within the airport's 65 L_{dn} contour. Citizen participation in the planning and decisionmaking processes which affect their lives and property is now recognized as a cornerstone of planning and should be integrated into that process. See FAA Advisory Circular 150/5050-4, Citizen Participation in Airport Planning, and Report No. FAA-EE-79-06, Community Involvement Manual, for more detail on this subject.

302. SCOPE OF THE PLANNING EFFORT. The scope of the planning effort will, of course, vary considerably, depending upon the extent and complexity of the noise problems at a given airport. However, the planning effort should be sufficient to identify the most viable alternative of those which might be proposed, to demonstrate that it is equitable to those affected, and that is fully implementable. This planning should be integrated into the existing or ongoing comprehensive planning for the region involved and should be realistic in its regard for monetary costs and its ability to generate the local planning and land use control actions necessary for its implementation and longevity. FAA does not regulate or direct the consultative process of local governments, but will rely on the certification by the airport operator, under Section 150.21 of Part 150, concerning such consultation.

303. THE CONTEXT OF AIRPORT NOISE PLANS. The Airport Noise Compatibility Planning Program should be viewed as a more detailed segment of the overall comprehensive planning for the area. It should first determine the extent of existing problems (if any) and the effects of airport and air traffic growth trends, and then determine the needs and values of both the airport users and those impacted by the airport. The planning program must explore with equal vigor both aviation and urban planning solutions to the problems. Each viable solution or combination of solutions is then tested against the realities of the social, economic, and environmental needs of the community(s) served and of the State and the Nation. It should also be recalled that aviation growth is not only a function of community growth but also the per capita usage of aviation.

304. THE OBJECTIVES OF PART 150 PLANNING. The objective of the planning effort is to find reasonable solutions to the noise problems and to present solutions that can be implemented. Although FAA environmental assessment of the compatibility program is not required prior to FAA approval or disapproval within the 180 day review period, each element or combination of elements going into the program should be capable of passing such a test prior to implementation. Failure to do so may seriously delay FAA funding of projects to carry out approved programs if, through the sponsor's failure to adequately assess those impacts, the FAA is forced to deal with these impacts without adequate environmental data at the funding stage. FAR Part 150 also requires that adequate provision be included for periodic review and updating of the compatibility program to account for changes in airport operations.

305. USE OF LOCAL OR STATE STANDARDS. The land use compatibility chart (Appendix 1) is derived from FAR Part 150 and contains land uses that have been identified as "normally compatible" with various levels of noise. The values for residential uses are based upon studies of noise-induced annoyance. For other land uses, the values are based primarily upon noise-induced interference with speech communication or upon interference with the critical activity associated with the use. However, in applying the table, it should be kept in mind that no two communities are likely to have situations or value systems that are identical. Adjustments to the land-use categories and noise levels may be necessary in considering specific local conditions. These decisions should be made early in the compatibility planning process. Citizen participation in this key element of the planning is advisable.

306. DEVELOPMENT OF ALTERNATIVES AND IMPLEMENTATION STRATEGIES. Development of reasonable alternatives is the nucleus of the compatibility planning process. The objective is to explore a wide range of feasible options and alternative compostions of land use patterns, noise control actions, and noise impact patterns, seeking optimum accommodation of both airport users and airport neighbors within acceptable safety, economic, and environmental parameters. Consideration of alternatives should address both physical planning and the implementation aspects of proposed solutions. It is, however, unlikely that any single option, by itself, will be capable of totally solving the problem(s) without having objectional impacts of its own. Some of the options may have little or no value in the situation,

especially if used alone. Realistic alternatives, then, will normally consist of combinations of the various options in ways which offer more complete solutions with more acceptable impacts or costs. Each alternative considered should: have the potential of resolving the problem(s); be implementable within acceptable economic, environmental, and social costs; and be legally implementable within existing State/Federal legislation and/or regulation. Brief summations or estimates indicating how these criteria are to be met should be prepared for each alternative. A sufficiently wide range of alternatives should be developed to assure that all reasonable routes to the ultimate solution have been explored and that there is a sufficiently broad range of choices available to give credibility to the studies. The matrix of noise control actions shown in Figure 2 on the following page, while not necessarily exhaustive, illustrates an array of options or possible solutions to a cross section of noise compatibility problems.

307.-319. RESERVED.

SECTION 2. AIRPORT PROPRIETOR OPTIONS

320. DENIAL OF USE TO AIRCRAFT NOT MEETING FEDERAL NOISE STANDARDS. This strategy may be implemented by limiting access to the airport to aircraft that conform with certain FAR Part 36 standards. Most turbojets and other large aircraft produced after 1974 already meet those standards; so do most propeller-driven light airplanes. In addition, older turbojets over 75,000 lbs. maximum gross weight must (under FAR Part 91) be either retrofitted with quiet engines or be replaced by certain specific dates. The ASNA Act also directs that certain classes of aircraft be exempt from compliance with FAA noise standards until certain dates. Denial of the use of an airport to such aircraft prior to the Part 91 or ASNA Act prescribed retirement dates might force some owners to retrofit or replace the aircraft to meet Part 36 standards in order to continue to operate at the airport during the interim period. To this extent, such local rules are in conflict with the Federal scheme and should be avoided.

321. CAPACITY LIMITS BASED ON NOISE. Airport use restrictions are sometimes based upon noise limits. However, such restrictions often have uneven economic consequences and should be employed only after careful consideration of other alternatives and after thorough consultation with the affected parties. Some of the forms that such restrictions might take are as follows:

a. Restrictions based on cumulative impact. Under this strategy, a maximum cumulative impact (such as the total area within the L_{dn} 75 contour) is established and then the airport's operations are adjusted or limited so as to not exceed that maximum. This is done through "capacity limitations," e.g., limiting either the aircraft types based upon their noisiness, or the numbers and mix of aircraft so as to respect the established cumulative noise exposure restriction.

FIGURE 2

MATRIX OF NOISE CONTROL ACTIONS

CONSIDER THESE ACTIONS ▼	IF YOU HAVE THIS PROBLEM ➤		NOISE FROM: TAXIING	DEPARTURE	APPROACH	LANDING ROLL	TRAINING FLIGHTS	MAINTENANCE	GROUND EQUIPMENT
AIRPORT PLAN	Changes in Runway Location, Length or Strength	1	●	●	●	●	●		
	Displaced Thresholds	2			●		●		
	High-Speed Exit Taxiways	3	●			●			
	Relocated Terminals	4	●					●	●
	Isolating Maintenance Runups or Use of Test Stand Noise Suppressors and Barriers	5	●					●	●
AIRPORT AND AIRSPACE USE	Preferential or Rotational Runway Use *	6	●	●	●	●	●		
	Preferential Flight Track Use or Modification to Approach and Departure Procedures *	7		●	●		●		
	Restrictions on Ground Movement of Aircraft *	8	●						
	Restrictions on Engine Runups or Use of Ground Equipment	9						●	●
	Limitations on Number or Types of Operations or Types of Aircraft	10	●	●	●	●	●	●	●
	Use Restrictions Rescheduling Move Flights to Another Airport	11	●	●	●	●	●	●	●
	Raise Glide Slope Angle or Intercept *	12			●		●		
AIRCRAFT OPERATION	Power and Flap Management *	13		●	●		●		
	Limited Use of Reverse Thrust *	14				●			
LAND USE	Land or Easement Acquisition	15	●	●	●	●	●	●	●
	Joint Development of Airport Property	16	●	●	●	●	●	●	●
	Compatible Use Zoning	17	●	●	●	●	●	●	●
	Building Code Provisions and Sound Insulation of Buildings	18	●	●	●	●	●	●	●
	Real Property Noise Notices	19		●	●	●	●	●	●
	Purchase Assurance	20		●	●	●	●	●	●
NOISE PROGRAM MANAGEMENT	Noise-Related Landing Fees	21	●	●	●	●	●		
	Noise Monitoring	22		●	●		●	●	
	Establish Citizen Complaint Mechanism Establish Community Participation Program	23	●	●	●	●	●	●	●

* These are examples of restrictions that involve FAA's responsibility for safe implementation. They should not be accomplished unilaterly by the airport operator.

b. Restrictions based upon certificated noise levels. Most aircraft types in general service today have been certificated for noise by the FAA. Consequently, it possible to devise limitations based upon those certificated data. Such limitations might take the form of threshold noise levels for the airport or different levels for day and night at the airport.

c. Restrictions based upon estimated single event noise levels. Since aircraft noise levels vary widely with changes in operational procedures, it may be possible to set limits on estimated single event noise levels. However, it should be noted that this does not mean that the airport operator or community can set up a microphone and a noise level limit and challenge the pilots to "beat the box." The FAA considers this to be unsafe and has never approved such a scheme. Instead, a target noise level limit or threshold is discussed in advance with the FAA and the aircraft operators and an appropriate level is selected, balancing the needs of aviation and the noise impacts on the community. FAA Advisory Circular 36-3B, Estimated Airplane Noise Levels in A-Weighted Decibels is useful with this option.

322. NOISE ABATEMENT TAKEOFF OR APPROACH PROCEDURES. A basic noise mitigation strategy is the use of noise abatement takeoff and landing procedures. There are a number of alternatives within this strategy, including runway selection, takeoff and landing profiles and power settings, and approach or departure paths. Runway selection has an obvious relationship with wind vectors, runway lengths, aircraft peformance and tolerance for crosswinds, and safety. Within these parameters, however, there is often a significant range of acceptable options. Some of these options may well offer significant relief to the airport's noise impact problems, especially when linked with appropriate landing and takeoff profiles and approach-departure paths. Takeoff and landing profiles and their attendent power and flap settings can be adjusted so as to offer relief to either close-in or more distant noise sensitive areas. These options are covered in more detail in other FAA documents such as Advisory Circular 91-53. Similarly, there are also often a number of viable choices for approach and departure paths. Some of these options may only be

323. LANDING FEES BASED ON NOISE. This strategy bases all or a portion of the landing fee upon the noisiness of the individual aircraft, thus apportioning the fees to the relative noise "cost" of the operation to the airport's proprietor. The strategy encourages the use of quieter aircraft while producing additional revenue to offset noise induced expenses. For maximum benefit, noise fees should be used in concert with other noise abateement strategies. A steeply sloped-noise fee curve would offer additional disincentive to continued use of the noisiest aircraft. Noise fees could also be used differentially to help shift noisier aircraft from a close-in, urban impacted airport to an outlying airport with greater noise capacity. To avoid discrimination the noise fee for each aircraft should be based upon standard single event noise ratings for the aircraft, such as those published by the FAA in Advisory Circular 36-3B (subject to the limitations contained in its preamble). The reverse strategy can also be applied. Instead of assessing a fee, an airport operator can reward air carriers who go to extra lengths to reduce noise generated by their aircraft by providing a discount or a reduction in landing fees. This might also act as an incentive for air carriers to use one airport over another in special circumstances.

324. NOISE BARRIERS (SHIELDING). Ground-level noise sources on an airport include run-up and maintenance areas, taxiways and freight warehouse areas. Because the noise is generated on the ground, the impact is usually confined to those areas immediately adjacent to the source. An effective method of mitigating this type of noise impact is through use of sound barriers or berms. "Hush houses" may be appropriate in engine maintenance areas. Strategic placement of new hangar or terminal structures on the airport may also be used. These wil shield adjacent neighborhoods by absorbing and third method is the movement of run-up and maintenance operations to an area of the airport away from the community. One common misconception is that trees or bushes will provide substantial attenuation of sound. This is not true except when bands several hundred feet wide are used and when they are planted thickly with both trees and underbrush.

325. ACQUISITION OF LAND AND INTEREST THEREIN. Purchase of sufficient land area to totally contain the significant noise impacts of an airport is usually impractical. Not only is it very costly, but it removes too much potentially valuable land from local tax rolls. However, certain land areas are often much more critical to achieving or maintaining an airport's noise compatibility than are others. Purchase of full or partial interest in such lands may be the only way the airport can be assured of long-term protection. Acquisition by the airport of development rights for all but noise tolerant development via easement in these critical areas may often be accomplished at much less cost than purchase in fee-simple. Compatible development under such restrictions should enhance the airport as well as the local tax rolls.

326. COMPLETE OR PARTIAL CURFEWS. Curfews are an effective though costly method of controlling noise intrusion into areas adjacent or in proximity to an airport. They should be reserved as a strategy of last resort, however, when all other options have been shown to be clearly inadequate, because of their drastic negative impacts upon both aviation and the community's benefit from aviation. They can take various forms, from restrictions upon some or all flights during certain periods of the day through restrictions based upon noise threshold and certificated aircraft noise levels (see AC 36-3B). Since unwanted noise intrusions are most pronounced in the late evening or early morning hours, curfews are usually implemented to restrict operations that occur during those periods. The period of 2200 hours to 0700 hours is when most people are resting and are most sensitive to noise intrusions. However, it should be pointed out that curfews have economic impacts upon airport users, upon those providing airport-related services, and upon the community as a whole. Other communities may also be impacted through curtailment of service. Thus undue burden on interstate or foreign commerce is a specific concern of the ASNA Act. Therefore, curfews should only be considered after careful consideration of other alternatives and after thorough consultation with the affected parties.

327.-329. RESERVED.

SECTION 3. STATE/LOCAL GOVERNMENT OPTIONS (STRATEGIES TO PREVENT NEW NONCOMPATIBLE DEVELOPMENT)

330. DEVELOPMENT CONTROL. Land use and development controls based upon a well worked out compatible land use plan is among the most potent and affordable of all the compatibility strategies. This is particularly so in still developing areas. The exercise of these land use and development controls is usually within the authority of local or county governments rather than in the airport operator. Even when the airport is operated by the same governmental body which exercises these controls there is often little recognition or action based on the needs in these critical areas. This emphasizes the need for a comprehensive approach to developing an airport noise compatibility program. A number of different controls are normally available to local governments and/or to airport operators to prevent intrusion of noncompatible development. The controls which are generally most useful for mitigating noise intrusions or achieving compatible land use within proximity to the airport are: zoning, easements, transfer of development rights, land purchase (for compatible public use), and capital improvements. In addition, local governments can consider establishing minimum acoustical insulation standards, expressed as Sound Transmission Coefficients (STC) for new residential dwellings within high noise impact contours. Approrpiate expertise should be consulted in developing such a code.

331. ZONING. The most common land use control is zoning. Zoning is an exercise of the police powers of a state or local government which enables that government to designate the uses that are permitted for each parcel of land. It normally consists of a zoning ordinance which specifies land development and use constraints. One of the primary advantages of zoning is that it may be used to promote land use compatibility while leaving the land in private ownership, on the tax rolls, and economically productive. Although most cities and larger towns have zoning authority, it should be remembered that rural areas often are not subject to this remedy, since in many states counties have only limited (or no) zoning authority.

a. Use of Zoning. In order for zoning to work effectively it should be based upon a comprehensive plan. This plan must consider the total needs of the community along with the specific needs of the airport. A comprehensive plan defines the goals and objectives of a community and zoning is one of the tools available to the community for implementing that plan. Zoning can and should be used constructively to increase the value and productivity of the affected land. For zoning to be viable, there should be a reasonable present or future need for each designated use. Within its limitations, zoning is a preferred method of controlling land use in noise impacted areas.

b. Limitations of Zoning. Zoning has a number of limitations which must be considered when using it as a compatibility implementation tool:

(1) Zoning is not necessarily permanent. In most jurisdictions, the current legislative body is not bound by prior zoning actions and it may change that zoning. Consequently, zoning which achieves compatibility is subject to continual pressure for change from both urban expansion and those

who might profit from such changes. Also, from time to time the entire zoning ordinance for a jurisdiction will be updated to accommodate increased growth or incorporate new land use concepts.

(2) Cumulative zoning can permit noncompatible development. A number of communities still have "cumulative" type zoning districts which permit all "higher" uses (such as residential) in "lower" use districts (such as commercial or industrial), thus permitting development that may be incompatible. In these instances it would be necessary to prepare and adopt new or additional zoning use districts of the "exclusive" type which clearly specify the uses permitted and exclude all other uses.

(3) Zoning is usually not retroactive. Changing zoning primarily for the purpose of prohibiting a use which is already in existence is normally not possible. In some jurisdictions, any zoning or rezoning that affects current land uses may not pass state constitutional tests. However, if such zoning is permissable and is accomplished, the use may be permitted to remain as a "nonconforming" use until such time as it is changed voluntarily to a conforming use or until the owner has had ample opportunity to recoup his/her investment.

(4) Zoning controls are normally applicable to those areas within the boundaries of the zoning jurisdiction. Noise impacts with airport operation, however, often span more than one such jurisdiction. Therefore, effective zoning requires the coordinated efforts of all the involved jurisdictions. Zoning which implements a land use compatibility plan will often be a composition of existing and new zoning districts within each of the jurisdictions covered by the plan. Often, each jurisdiction will have a different zoning ordinance with districts having different applicability for implementing the compatibility plan.

332. EASEMENTS. An easement is a right held by one person to make use of the land of another for a limited purpose. In the context of airport noise compatibility planning, two general types of easements are possible: positive easements to allow someone to make noise over the land and negative easements to prevent the creation or continuation of unprotected noise sensitive uses on the property. Easements can be an effective strategy for assuring compatible development around airports. A major advantage of easements for controlling land use around airports is that they can be permanent, whereas zoning may be easily changed. Additionally, easements often may be acquired for a fraction of the total value of the land and thus be less expensive than outright purchase. Acquisition of easements does not reduce the noise impacts on people or by and of itself change noncompatible land uses to compatible uses. However, the purchase of price can and should be dedicated to the soundproofing and or use change necessary to achieve compatibility. The most important advantage of easements over full acquisition is that the land is left on the tax rolls and remains free for compatible development by its owner(s).

a. Obtaining Easements. Easements may be obtained in a number of ways including purchase, condemnation, and dedication. For each easement acquired, consideration may be given to including a legal description of the noise that may be created over the property, describing classes of uses which may be established or maintained with and without soundproofing, and, where applicable, granting an avigation easement.

b. Purchase. Easements may be purchased via negotiation with the price based upon the value to the owner of the rights surrendered. Timing can have a significant effect upon the price paid; once the subject land has gotten into the arena of speculation, prices tend to rise quickly.

c. Condemnation. Easements, may also be obtained by condemnation, in a manner similiar to full rights condemnation. The cost, while still likely to be less than that of outright acquisition (fee simple) of the land, is likely to be significantly higher than similar rights obtained via negotiation because of the time and court costs involved. Also, the cost of any ill will generated by a condemnation action, while difficult to measure, can be significant.

d. Dedication. Dedication is another way to obtain easements. Subdivision regulations governing the development of land for industrial or other purposes can include provision for dedicating private land or easements upon private land for public purposes. When easements for airport-environs compatibility are considered necessary and when they are determined to be compatible with the intended use of the land, the need for such easements may be required by local agencies in the approval of subdivision dedications.

333. TRANSFER OF DEVELOPMENT RIGHTS (TDR). TDR involves separate ownership and use of the various "rights" associated with a parcel of real estate. Under the TDR concept, some of the property's development rights are transferred to a remote location where they may be used to intensify allowable development. With TDR, for example, lands within an airport's noise impact area could be kept in open space or agricultural uses and their development rights for residential uses transferred to locations outside the area. Landowners could be compensated for the transferred rights by their sale at the new locations or the rights could be purchased by the airport. Depending upon market conditions and/or legal requirements, the airport could either hold or resell the rights. The TDR approach must be fully coordinated with the community's planning and zoning. It may be necessary for the zoning ordinance to be amended in order to permit TDR's. Also, such transfers must usually be contained within single zoning jurisdictions.

334. PURCHASE. There are often locations or circumstances within the noise impact areas which leave little choice other than direct acquisition of full or partial interest in the impacted land by either the airport sponsor or, perhaps, by state or local levels of government. Purchase of noise impacted land is the most direct (and usually the most expensive) of all forms of land use control. However, when combined with either resale for compatible

purposes can considerably enhance compatibility. Provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) are applicable whenever Federal or federally-assisted programs are involved in such purchases.

335.-339. RESERVED.

SECTION 4. STATE/LOCAL GOVERNMENT OPTIONS (ACTIONS TO REDUCE EXISTING NONCOMPATIBLE USES)

340. REMEDIAL ACTIONS. In cases where there are already existing conflicts between land-use and airport noise, remedial or corrective actions may be appropriate. The degree of remedial action will be dependent upon the degree of urbanization around the airport. Where the noise impacts fall on predominately rural land or, where a new airport is built in an undeveloped area, there may be only a few scattered noncompatible uses to be resolved. In urbanized areas, however, remedial actions are complex and may be difficult to implement. Change to noise compatible usages, soundproofing, and acquisition of full or partial interest in the land are examples of possible actions that can be used to mitigate noise impacts. Changes in the use of noise impacted land or changes in occupancy to uses or occupations less sensitive to noise are obvious and practical strategies for resolving conflicts.

341. ENCOURAGEMENT OF EXISTING FAVORABLE TRENDS. Land use in urban areas is in a continual state of change and transition. Many of these changes tend to favor a turnover in land use from noncompatible to compatible. A typical example would be the transition of older residential areas into retail, commercial, or office uses. Encouragement and promotion of these trends can be through the implementation of public policy and local planning processes.

342. CONSTRUCTIVE USE OF PLANNING AND ZONING. Detailed planning of land within noise impact areas by local authorities and constructive uses of zoning changes can often improve both compatibility and land values. Noise sensitive uses cannot normally be forced to move by simply changing their zoning to a use district that is compatible. The existing uses must be permitted to continue under the new zoning as "Legal Nonconforming Uses" as long as the use is continuous and unchanged or until the owner has had an opportunity to receive a fair value from the use. This strategy then finds productive and compatible uses for the land which will give the present land owner a fair return on his investment in addition to covering his relocation expenses. The land should then be rezoned accordingly.

343. CONSTRUCTIVE USE OF PUBLIC CAPITAL IMPROVEMENT PROJECTS. Locating and programming of public works projects can exert strong influences over land use trends and demands. These include road construction and widenings, transit service, schools, parks or recreation facilities, water and sewer lines, and flood control projects. Exercised judiciously as an implementation tool for promoting compatible land use such capital improvements can be a powerful tool.

344. PURCHASE ASSURANCE PROGRAMS. Purchase guarantees can be applied to residential properties within lightly or short-term noise impacted areas to help assure their saleability. Such sales should then be to individuals not as sensitive to the noise impacts or who have trade off values for residing in these particular areas. Sales agreements should assure that all future purchasers are cognizant of the noise levels and sign appropriate releases or easements. The advantages of this strategy are its relatively low costs and its retention of otherwise viable residential areas.

345. SOUNDPROOFING. Soundproofing consists of increasing the exterior to interior sound transmission losses of a building by identifying those structural elements providing transmission paths and applying appropriate modifications to improve noise attenuation.

a. Metrics. The airport cumulative noise metric (L_{dn}) is useful as an indicator that soundproofing may be required in a particular area. However, when considering any specific building site within a cumulative noise exposure contour (representing significant noise impact) it is recommended that additional analysis via single event maximum sound level and/or sound pressure level versus frequency data be used to determine the necessity (and/or eligibility) for soundproofing. While L_{AS} is utilized to assess eligibility, the sound pressure levels in each of the one-third octave bands are required to design and implement soundproofing measures. The A-weighted sound level is more utilitarian than other single event metrics in establishing the need for soundproofing as many of the sleep, speech and activity interference criteria have been developed using L_{AS} levels.

b. Sealing Existing Leaks. In soundproofing most structures, the first five decibels of additional sound insulation usually can be obtained by sealing existing leaks. A very small gap or imperfect seal in an otherwise massive wall can result in only moderate sound attenuation.

c. Retrofit of Existing Buildings. For rehabilitation of existing buildings, soundproofing modifications include: replacement of existing windows with windows of greater sound transmission coefficient (STC) rating, or adding a second layer of glass; upgrading doors and seals; acoustic baffling of vents; adding insulation to walls and attic spaces; adding another layer of wall material to existing walls, in effect creating a two-panel wall; eliminating windows and filling the space to match exterior walls (only recommended to achieve noise reduction commensurate with the

potential capability of the wall). Some very effective soundproofing techniques, such as staggered studs or fiberboard under paneling are not suitable for retrofit because they would involve virtual demolition of the existing structure and construction of a new wall.

d. New Construction. For new sound-insulated construction, design considerations often include: using brick or concrete masonry walls, using staggered studs, insulation and fiberboard under interior and exterior finish materials; installing attic space insulation; properly baffling vents avoiding single joint roof constructions where interior and exterior materials are attached to the same rafters; avoiding exposed rafter ceilings with any roof material other than thick concrete and with no interior finish ceilings; installation of air conditioning; mortar should be free of pinholes; and all joints should be well sealed.

e. Energy Savings from Soundproofing. The soundproofing of buildings has two direct energy effects - increased energy consumption by air conditioning equipment due to the elimination of natural ventilation and reduction in heat loss due to the sealing of walls, windows and other openings. Energy savings realized by reduction of heat loss, will in the long run outstrip the increased energy consumption of air conditioning. One caution is in order however; a reduction in thermal energy transmission does not always accompany a reduction in sound transmission (e.g., concrete wall).

f. Cost/Benefit of Soundproofing. While soundproofing is both a feasible and practicable means of alleviating the impact of external noise, the analysis should be made on a case by case basis in concert with both acoustical and architectural expertise. The general condition, age and repair of a structure normally dictate the degree of soundproofing application. Also, the building's location and noise exposure levels must be quantified to identify the target "reduction in noise level." Before a soundproofing program is initiated, tradeoffs in costs and benefits should be carefully examined. If some form of cost sharing arrangement between the airport operator or a governmental agency and the property owner should be utilized, suitable agreements or easements for current and future aircraft noise should also be obtained.

346. ACQUISITION OF IMPACTED LAND. In some circumstances, there may be locations or circumstances within the noise impact areas which leave little choice other than direct acquisition of full or partial interest in the impacted land by either the airport sponsor or, perhaps, by state or local levels of government. As described in paragraph 343, constructive use of land purchases for other public purposes can also enhance compatibility.

Land or interest in land (easement) may be acquired by negotiation, through a voluntary program, or via condemnation. In any case, the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) are applicable whenever Federal or federally assisted programs are involved.

a. Land for Other Public Uses. Noise impacted land can be acquired by a public or semi-public agency either to implement the compatibility plan or in cooperation with the plan while fulfilling another public purpose. Typical uses may include sites for equipment maintenance or storage yards, water or sewer works, and floodways or reservoirs. Other possibilities include selected park, recreation, and open space uses which are noise tolerant (golf courses, skeet ranges, nature areas, etc.). All uses should respect the height and hazard requirements of the airport and be tolerant of future airport growth.

b. Land for Compatible Resale. Occasionally, state or local governments are willing to acquire land which is then resold with covenants or easements retained to assure long-term compatibility. In some cases, it may be feasible to change such land to compatible uses within existing or remodeled buildings. In other cases, it would be desirable to clear and redevelop the land before making it available for sale. In either case, the changes should be in compliance with the land use plan and be supported by appropriate zoning. Appropriate covenants or easements should be retained to assure long-term compatibility. Since this strategy approaches the complexity of urban renewal, appropriate expertise should be consulted.

347.-349. RESERVED.

SECTION 5. CONSULTATIONS

350. CONSULTATIONS UNDER PART 150. In developing a noise exposure map and identifying noncompatible land uses the airport proprietor should identify the geographic areas of jurisdiction of each public agency and planning agency which are either wholly or partially contained within the 65 L_{dn} contour and meet with the appropriate officials to discuss means of reducing the noise impact as required by Part 150. Methods for mitigating and/or reducing the effects of noise that are available to local authorities after consulting with the airport proprietor are discussed in sections 3 and 4 of this chapter. Part 150 requires that consultation must include any air carriers and to the extent practicable, other aircraft operators using the airport. Prior to submission of the noise exposure map or noise compatibility program, the airport operator is required by Part 150 to allow interested persons adequate opportunity to submit their views, data, and comments concerning the correctness and adequacy of the map or program and projection of aircraft operations. FAA will not inject itself into the essentially local responsibility for consultation imposed directly on the airport operator by the ASNA Act, but will rely upon the airport operator's certification under penalty of 18 U.S.C. § 1001, that such consultation has occurred (See § 150.21).

351. RESERVED.

352. CONSULTATION WITH AVIATION GROUPS. Part 150 requires consultation with aviation groups. For air carrier airports, this consultation includes all air carriers and, to the extent practicable, other aircraft operators using the airport. For other than air carrier airports, consultations should include those aircraft operators that do use the airport. Thus, "operators" may include some or all of the following groups: airlines; commuter airlines; air taxi; and commercial; flight training and instruction; based aircraft operators (business, private, public); and fixed; base operators. These consultations should take place as early as possible in the planning process in order that the view and perspectives obtained may be fully integrated into the study effort. Additional consultations, as may be appropriate, should be conducted throughout the progress of the study. If proposed aircraft operational changes are not coordinated with the appropriate parties until the end of the study, there is potential for real problems to develop.

353. PUBLIC AND COMMUNITY INVOLVEMENT.

a. The airport and the community have a number of important influences upon each other, including economic, social, and environmental considerations. The airport acts as an entry point for air traveling vacationers and business persons and freight movement. Since the airport can act as a major focal point for growth, it should be integrated in the comprehensive planning process for the community and region. Therefore, it is essential to receive public response to any new proposed actions for airport development that would influence the public.

b. Community involvement and public participation are often determining factors in successfully assessing the compatibility/noncompatibility of various land uses for individual communities. The goals, values and developmental needs of the communities should always be considered from the early (planning) stages of land use evaluation. See FAA Advisory Circular 150/5050-4, Citizen Participation in Airport Planning, for guidance in developing citizen participation and community involvement programs.

c. When organizing a community involvement program, it is first necessary to identify the issues and to determine:

(1) What information must be communicated to the public;
(2) Which groups must receive this information;
(3) What information must be received from the public;
(4) From which groups this information can be obtained.

d. Specific community involvement techniques can then be evaluated and a sequence of activities developed, including formulation of alternatives, analysis and evaluation of alternatives, and the final decisionmaking process. Additional guidance that may be useful on aviation issues may be found in Federal Aviation Administration's Community Involvement Manual. This may be obtained from the Office of Environment and Energy, Noise Abatement Division, AEE-100, Washington, D.C., 20591.

354. DOCUMENTATION. In accordance with Part 150, the airport operator is to provide documentation summarizing the public procedure and input to the program. In addition, the operator is to provide documentation of consultation with officials of public agencies, planning agencies, FAA required, and other Federal officials which may be affected by the proposed action. This documentation may consist of summaries of communications between the organizations indicating the issues and depth of review or it may consist of a summary of comments and replies to the plan or letters of approval adopting the proposed action.

355.-359. RESERVED.

SECTION 6. ANALYSIS OF COSTS AND BENEFITS AND SELECTION OF AN ALTERNATIVE

360. GENERAL. The costs and benefits of each reasonable alternative should be identified and assessed in order to form a logical basis for decisionmaking. Detailed alternatives most closely approaching an optimum solution to the noise compatibility problems of the particular airport should be identified. Costs may be generally grouped as possible constraints upon interstate or foreign commerce, or as environmental, economic, and social impacts. Obviously, solutions (alternatives) will not only differ in their costs and benefits; costs and benefits may also accrue to different groups, industries, geographical areas, or persons.

361. CONSTRAINTS UPON INTERSTATE AND FOREIGN COMMERCE. A stipulation of the ASNA Act and of FAR Part 150 is that an approved airport noise compatibility program not create an undue burden on interstate or foreign commerce. Such an undue burden is often difficult to identify and is based upon a number of trade-offs, which go beyond the responsibilities of the local airport operator. For example, a restriction upon the operations of aircraft exceeding a given noise level between 10 p.m. and 7 a.m. could create too small a "window" for connection with another airport 2,000 miles away. Full consultation with the FAA, the air carrier users of the airport, and with other users will identify constraints in this area and help generate mutually acceptable compromises.

362. ENVIRONMENTAL COSTS. Each action proposed by an airport noise compatibility program may have environmental costs and/or benefits to be traded off against its economic and social costs and benefits. The environmental impacts may also have to be assessed under Federal or state guidelines prior to implementing the action. The analysis at this preliminary stage should be sufficient to reasonably assure that future implementation will be both possible and within the constraints of economic and social costs. If a particular action is critical to the success of the alternative, then a more thorough analysis may be in order. FAA Orders 1050.1C, Policies and Procedures for Considering Environmental Impacts, and 5050.4, Airport Environmental Handbook, give detailed instructions for conducting environmental analyses when an environmental assessment is required for Federal approval of certain actions. Although FAA acceptance of noise exposure maps and approval of noise compatibility programs are both categorical exclusions, any application for Federal funding of any portion of noise compatibility program may involve the need for an environmental assessment before such funding decisions can be made.

363. ECONOMIC COSTS. The economic costs or benefits of a noise compatibility alternative may be both direct and indirect. It is the total of these costs which should be assessed and considered against social and environmental costs. The direct costs are usually obvious and easily quantifiable. They include such things as construction costs, acquisition costs, the cost of extra fuel used in noise abatement operations, and the costs of aircraft idled by noise curfews. Benefits may include the increase in value of noncompatible uses after the critical noise environment is removed. Indirect costs and benefits can be more difficult to identify and quantify. They can include induced development resulting from airport construction or from the introduction of noise tolerant industrial uses into the area. They may also include lost opportunities for development when there are more acres of noise impacted land than will be needed for noise compatible uses. Also, housing removed from noise impacted areas must be replaced with new housing in another location. Other costs and benefits may be more subtle but just as real as are these.

364. SOCIAL COSTS. Evaluation of the social costs and benefits of the alternatives is of equal importance with those of economics and the environment. Social costs can include such impacts as the disruption of established neighborhoods or school districts through removal of noise impacted housing, altered surface transporation patterns, disruption of orderly planned development, or the creation of appreciable changes in employment. The often improved sense of safety with the diminishment of aircraft noise may also be a significant benefit. If preparation of an environmental assessment becomes necessary prior to approval of Federal funding for a program element, social costs are one of the prime impacts which must be assessed.

365. SELECTION OF AN ALTERNATIVE. The selection of one or a combination of the alternatives explored is the focal point of the whole planning and evaluation process. It is also a common point of failure of the process, either immediately or later, during the implementation stages. Although the final decision must remain with the duly elected or appointed decisionmaker(s), an appropriate degree of involvement by those affected by that ultimate decision during the deliberations and eliminations leading up to a final recommendation is likely to produce more workable and satisfying results. It is suggested that prior to this point in the planning process a logical and fair decisionmaking process be agreed upon and established. Such a process might take the following form:

a. A decision tree indicating the decisions to be made, who is to make them, and their sequence and timing.

b. A matrix which displays the costs and benefits of each alternative and arrays them against the costs and benefits of the other alternatives.

c. An outline of the possible decision combinations (some decisions automatically preclude other decisions or combinations).

d. A draft of a logical and probable scenario of future events based upon each decision combination.

e. Review and discussion of the issues in each of the alternatives by the reviewers and/or decisionmakers, following the sequences and format noted above, to make the evaluations and trade-offs leading to recommendations or decisions. A two-step selection process may be appropriate for multiple or complex alternatives.

366. DEVELOPMENT OF THE SELECTED ALTERNATIVE INTO A DRAFT COMPATIBILITY PROGRAM. Once an alternative has been selected, it should be fully developed into a complete airport noise compatibility program. This consists, essentially, of treating the alternative as an accepted preliminary scheme, then making the more vigorous investigations into its viability and developing the details of the plan and its implementation. The recommended steps include:

a. Stringent investigation of the alternative's assets and liabilities to assure that it will stand the tests of reality.

b. Detailed development of the plan, giving particular attention to fully coordinating it with existing local planning, community growth trends and the local agencies which will be responsible for its implementation.

c. Development of the specific implementation actions necessary to fully implement the plan.

d. Assign to and get written agreement from the agencies (or officials) who will be responsible for each of the implementing actions.

e. Development of the implementation schedules and any documents required for adoption and full implementation. these could include resoltuions for adoption as well as new or revised zoning districts designed to be added to existing local zoning ordinances.

367.-399. RESERVED.

APPENDIX 1. TABLE OF LAND USES NORMALLY COMPATIBLE WITH VARIOUS NOISE LEVELS.

1. LAND USE COMPATIBILITY TABLE. FAR Part 150 contains a table, Land Use Compatibility With Yearly Day-night Average Sound Levels, identifying land uses that are "normally compatible" or "noncompatible" with various levels of noise exposure. This appendix contains that table, but expands the list of uses under most categories in order to be more useful. The expanded land use descriptions are based upon the Standard Land Use Coding Manual (SLUCM) published by the Federal Highway Administration and the Department of Housing and Urban Development in 1965. The levels of noise exposure, in yearly day-night average sound levels (L_{dn}) correspond to the contours required to be shown on Airport Noise Exposure Maps. The table indicates compatibility of the land uses with the outdoor noise environment. By comparing the predicted or measured yearly L_{dn} level at a particular site with the values given in the table the range of compatible uses may be determined. In using the land use compatibility table, the following cautions should be observed:

a. L_{dn} contours indicate the boundaries lines between areas of acceptable or unacceptable noise exposures for the various land uses in Appendix I. The contours do indicate the trend in relative noise levels. However, vegetation, land contours, and the position of buildings or walls may often affect the impact of noise on the human users at a specific site.

b. L_{dn} levels may vary somewhat above or below the predicted levels for a particular location, depending upon local topography and vegetation, and upon final aircraft loadings and operations.

c. Although all land uses may be considered as normally compatible with noise levels less than 65 L_{dn}, local needs and values may dictate further delineation based on specific local requirements or determinations as well as low ambient levels.

d. When appropriate, noise level reduction may be achieved through incorporation of sound attenuation into the design and construction of a structure to achieve compatibility. However, more specific noise measurement and analysis is generally advisable prior to incurring the expense of such sound treatment. The cautions mentioned in paragraph 236d should be observed when applying Noise Level Reduction (NLR) to residential uses or other uses where indoor-outdoor activities are important.

e. Other local noise sources may often contribute as much as or more than aircraft to the total noise exposure at a specific location.

f. Compatibility designations in the table generally refer to the major use of the site. If other uses with greater sensitivity to noise are permitted at a site, the compatibility determination is based upon the use which is most adversely affected by noise.

LAND USES NORMALLY COMPATIBLE WITH VARIOUS NOISE LEVELS

Land Uses	Yearly Day-Night Average Sound Level (L_{dn}) 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
Household units. (11)						
Single units - detached (11.11)						
Single units - semidetached (11.12)						
Single units - attached row (11.13)						
Two units - side-by-side (11.21)						
Two units -one above the other (11.22)						
Apartments - walk up (11.31)						
Apartments - elevator (11.32)						
Group quarters (12)						
Residential hotels (13)						
Other residential (19)						
Mobile home parks (14)	Y	N	N	N	N	N
Transient lodgings (15)	Y	N[1]	N[1]	N[1]	N	N
PUBLIC USE:						
Schools, hospitals, and nursing homes	Y	25	30	N	N	N
Educational services (68)						
Hospitals, nursing homes (65.13 ,65.16)						
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Cultural activities (including churches) (71)						
Auditoriums, concert halls (72.1)						
Governmental services (67)	Y	Y	25	30	N	N
Transportation	Y	Y	Y[2]	Y[3]	Y[4]	Y[4]
Railroad, rapid rail transit and street railway transportation (41)						
Motor vehicle transportation (42)						
Aircraft transportation (43)						
Marine craft transport (44)						
Highway and street right-of-way (45)						
Parking (46)	Y	Y	Y[2]	Y[3]	Y[4]	N
COMMERCIAL USE						
Offices, business, and professional	Y	Y	25	30	N	N
Finance, insurance and real estate services (61)						
Personal services (62)						
Business services (63)						
Professional services (65)						
Other medical facilities (65.1)						
Miscellaneous services (69)						
Wholesale and retail - building materials, hardware and farm equipment	Y	Y	Y[2]	Y[3]	Y[4]	N
Wholesale trade (51)						
Retail trade - building materials, hardware and farm equipment (52)						
Repair services (64)						
Contract construction services (66)						
Retail Trade - general	Y	Y	25	30	N	N
Retail trade - general merchandise (53)						
Retail trade - food (54)						
Retail trade - automotive, marine craft, aircraft and accessories (55)						
Retail trade - apparel and accessories (56)						
Retail trade - furniture, home furnishings and equipment (57)						
Retail trade - eating and drinking establishments (58)						
Other retail trade (59)						
Utilities (48)	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication (47	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, general	Y	Y	Y[2]	Y[3]	Y[4]	N
Food and kindred products - manufacturing (21)						
Textile mill products - manufacturing (22)						
Apparel and other finished products made from fabrics, leather, and similar materials - manufacturing (23)						
Lumber and wood products (except furniture) - manufacturing (24)						
Furniture and fixtures - manufacturing (25)						
Paper and allied products - manufacturing (26)						
Printing, publishing, and allied industries (27)						
Chemicals and allied products - manufacturing (28)						
Petroleum refining and related industries (29)						
Rubber and misc. plastic products - manufacturing (31)						
Stone, clay and glass products - manufacturing (32)						
Primary metal industries (33)						
Fabricated metal products - manufacturing (34)						
Miscellaneous manufacturing (39)						
Photographic and optical	Y	Y	25	30	N	N
Professional, scientific, and controlling instruments, photographic and optical goods; watches and clocks - manufacturing (35)						
Agriculture (except livestock) and forestry	Y	Y[6]	Y[7]	Y[8]	Y[8]	Y[8]
Agriculture (except livestock) (81)						
Agricultural related activities (82)						
Forestry activities and related services (83)						
Livestock farming and breeding (81.5 to 81.7)	Y	Y[6]	Y[7]	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Fishing activities and related services (84)						
Mining activities and related services (85)						
Other resource production and extraction (89)						
RECREATIONAL						
Outdoor sports arenas and spectator sports (72.2)	Y	Y[5]	Y[5]	N	N	N
Outdoor music shells, amphitheaters (72.11)	Y	N	N	N	N	N
Nature exhibits and zoos (71.2)	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Amusements (73)						
Parks (76)						
Public assembly (72)						
Resorts and group camps (75)						
Other cultural, entertainment and recreation (79)						
Golf courses, riding stables and water recreation (74)	Y	Y	25	30	N	N

Numbers in parentheses refer to Standard Land Use Coding Manual (SLUCM)

*The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses remains 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.

KEY TO TABLE

Number in ( )	Standard Land Use Coding Manual (SLUCM).
Y (Yes)	Land Use and related structures compatible without restrictions.
N (No)	Land Use and related structures are not compatible and should be prohibited.
25, 30, or 35	Land use and related structures generally compatible; measures to achieve Noise Level Reduction (NLR), outdoor to indoor, of 25, 30, or 35 must be incorporated into design and construction of structure.

NOTES FOR TABLE

1. Where the community determines that residential uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal 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. Compatible where measures to achieve NLR of 25 are 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. Compatible where measures to achieve NLR of 30 are 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. Compatible where measures to achieve NLR of 35 are 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. Prime use only, any residential buildings require an NLR of 25 to be compatible.

7. Prime use only any residential buildings require an NLR of 30 to be compatible.

8. Prime use only, NLR for residential buildings not normally feasible, and such uses should be prohibited.

g. Designations contained in the table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptability and permissible land uses remains with the local authorities.

h. Although Table 2 of FAR Part 150 defines the compatibility or noncompatibility of various land uses for the purposes of Federal aid, programs, or sanctions under the ASNA Act, adjustments or modifications of the descriptions of the land use categories may be desirable after consideration of specific local conditions.

2. INTERPRETATION OF NOISE EXPOSURE MAPS. Note that it is possible that the process of plotting noise contours onto locally generated land use maps may introduce a degree of charting imprecision, especially relative to property lines on the land use map. For the purpose of Section 107 of the ASNA Act, as amended, questions may arise concerning the precise relationship of specific properties to noise exposure contours depicted on a noise exposure map submitted under Section 103 of that Act. The FAA is not involved in any way in determining the relative locations of specific properties with regard to the depicted noise contours, or in interpreting the noise exposure map to resolve questions concerning which properties should be covered by the provisions of Section 107. These functions are inseparable from the ultimate land use control and planning responsibilities of local government. Therefore, the responsibility for the detailed overlaying of noise exposure contours onto the map of subjacent properties on the surface rests exclusively with the airport operator which submitted those maps, and/or with those public agencies and planning agencies with which consultation is required under Section 103 of the Act. In its decisions to accept noise exposure maps, the FAA relies on the certifications, by the airport operator that this statutorily required consultation has been accomplished.

APPENDIX 2. CHECKLISTS FOR NOISE EXPOSURE MAPS AND NOISE COMPATIBILITY PROGRAMS.

The two checklists included in this appendix are intended as an aid to both developing and reviewing noise exposure maps and noise compatibility programs. They should not, however, be considered as definitive or as replacing in any way the requirements of FAR Part 150. Responsibility for compliance with the provisions of Part 150 remains with the preparers and reviewers.

Airport: _____

CHECKLIST FOR NOISE EXPOSURE MAPS

	REFERENCE	YES	NO
1. Base Map developed using INM or approved equivalent.	A150.103(a)	___	___
a. Land uses identified.	A150.101(a)	___	___
b. Scale not less than 1 inch = 8000 feet.	A150.103(b)(1)	___	___
c. Runway Locations and alignments.	A150.101(e) & A150.103(b)(1)	___	___
d. Airport boundaries.	A150.101(e)	___	___
e. Flight tracks.	A150.101(e)	___	___
2. Continuous noise for L_{dn} 65, 70, and 75.	A150.101(a&e)	___	___
a. Estimates of numbers of people residing within each contour.	A150.101(e)	___	___
b. Depicted on land use map of sufficient detail and quality to discern streets and other identifiable geographical features.	A150.101(e)	___	___
3. Depiction and identification of each public and/or planning agency having jurisdiction within the L_{dn} 65 contour.	A150.105(a)	___	___
4. Brief analysis of the types of land use controls available to the identified agencies.	A150.105(b)	___	___
5. Noncompatible land uses identified within the L_{dn} 65 contours using Table 2 of Part 150 and based on self generated noise (ambient)	A150.101(a&b)	___	___
6. Location of noise sensitive public buildings (schools, hospitals, etc.).	A150.101(e)	___	___
7. Locations of any noise monitoring sites.	A150.101(e)	___	___
8. Projected aircraft operations for submission date and for fifth calendar year after submission date.	150.21(a)	___	___
9. Consultations with public, users, and other agencies	150.21(b)	___	___
10. Certified as true and complete	150.21(e)	___	___

Airport _____

CHECKLIST FOR NOISE COMPATIBILITY PROGRAMS

	REFERENCE	YES	NO
1. Current FAA accepted noise exposure map included.	150.23(e)(1)	___	___
2. Consultations with public and/or planning agencies within L_{dn} 65.	150.23(c)	___	___
3. Consultations with air carriers and other airport users.	150.23.(c)	___	___
4. Opportunity afforded public to submit views, data and comments.	150.23(d)	___	___
5. Description (summary) of the consultations conducted.	150.23(e)(1,4,&8)	___	___
6. Alternatives considered and presented according to these categories:			
a. Those within airport operator's implementation authority.	B150.7(a)(1)	___	___
b. Those within authority of another local agency or state/local governing body.	B150.7(a)(2)	___	___
c. Those under Federal authority.	B150.7(a)(3)	___	___
7. At a minimum have these alternatives been considered:			
a. Preferential runway system.	B150.7(b)(3)	___	___
b. Restrictions on use of airport based on noise:	B150.7(b)(5)	___	___
(1) Restrictions on aircraft not meeting FAA noise standard.	B150.7(b)(5)	___	___
(2) Capacity limitations based on relative noisiness.	B150.7(b)(5)	___	___
(3) Required use of noise abatement takeoff/approach procedures.	B150.7(b)(5)	___	___
(4) Landing fees based on noise or on time of arrival.	B150.7(b)(5)	___	___
(5) Other actions recommended for FAA analysis.	B150.7(b)(5)	___	___

	REFERENCE	YES	NO
c. Noise barriers and/or acoustical shielding.	B150.7(b)(2)	___	___
d. Soundproofing of public buildings.	B150.7(b)(2)	___	___
e. Modified flight procedures and/or flight tracks.	B150.7(b)(4)	___	___
f. Land purchases, air rights, easements and/or development rights.	B150.7(b)(1)	___	___
g. Other actions or combinations of actions having beneficial impact on noise.	B150.7(b)(6)	___	___
8. Description of alternatives considered and the reasons why any alternatives were rejected.	150.23(e)(2)	___	___
9. Specific alternative program measures (actions) proposed and the relative contribution of each to program effectiveness.	150.23(e)(3)	___	___
10. Statement of the actual or anticipated effect of the program on reducing noise to individuals and noncompatible uses.	150.23(e)(5)	___	___
11. Documentation of feasibility of each proposed measure, including:			
a. Essential governmental actions.	150.23(e)(8)	___	___
b. Anticipated funding sources.	150.23(e)(8)	___	___
12. Relationship of proposals to existing FAA approved airport layout plan, master plan, and system plan.	150.23(e)(6)	___	___
13. Summary of the comments and materials received via public comment and disposition.	150.23(e)(7)	___	___
14. Time period covered by the program.	150.23(e)(8)	___	___
15. Schedule for implementation of the program.	150.23(e)(8)	___	___
16. Persons responsible for implementation of each program measure.	150.23(e)(8) & B150.7(c)	___	___
17. Schedule for periodic review and updating.	150.23(e)(9)	___	___

APPENDIX 3

RECOMMENDED BASIC NOISE MEASUREMENT SYSTEM

Noise monitoring may be utilized by airport operators for data acquisition and data refinement, but is not required by Part 150, for the development of noise exposure maps or airport noise compatibility programs. This Appendix describes a basic noise measurement system. First a few words about the purchase and maintenance of noise measurement equipment. There are at least four or five companies in the U.S. which carry special product lines of noise measurement equipment. The FAA Office of Environment and Energy, Noise Abatement Division, Noise Technology Branch, (AEE-120) will furnish a list of vendors upon request. At the time of purchase, two very important related needs must be considered, (1) periodic maintenance and (2) periodic re-calibration of equipment traceable to the National Bureau of Standards. If possible, try to minimize future difficulties, by assuring that local service is available. One should also seriously consider the advantages of establishing a maintenance service contract. This is especially recommended if long delays and extensive paperwork are required for each individual maintenance purchase order. The following list details the principle components of a mobile noise measurement system. The word "system" is underlined to indicate that much more than a sound level meter is required to be able to conduct an efficient multi-purpose noise measurement survey.

ITEM	COMMENT
Microphone Windscreens	Purchase several for each microphone. Windscreens have a habit of disappearing, blowing away, becoming misplaced etc.
Microphones	Purchase at least 2 per system. Microphones are easily damaged making one spare per system essential.
"Dummy Microphone"	This device simulates the microphone impedence and is used to determine the system electrical noise floor and as an aid in troubleshooting. One "dummy mike" per system is recommended.
Calibrators	At least one calibrator per system is recommended. Multi-frequency calibrators are very useful for checking the "A-weighting" filter characteristic, as well as for demonstrating the variation in human hearing response with frequency.
Calibrator Inserts	It is often advantageous to use a single calibrator type on different types and sizes of microphones. Plastic inserts are recommended as their low thermal conductivity avoids thermally shocking the microphone in cold weather, a problem encountered with metal inserts. One set is needed for each calibrator.
Tripod(s)	One tripod per system is necessary to remove the microphone 50 to 100 feet from the observer and any vertical reflective surface.
Microphone extension cable	Purchase at least one per system. The extension cable permits the microphone to be separated from the meter, as mentioned above. Caution: When ordering extension cable be sure the meter (with built in preamp) has enough power to handle the cable length.

ITEM (Cont'd)	COMMENT
Precision Integrating Sound Level Meter (PISLM)	The PISLM is a highly versitile instrument, part sound level meter-part computer, capable of providing single event metrics L_{AS}, and L_{AE} as well as a cumulative metric. This meter can be used both for assessment of airport use restrictions as well as for noise contour validation. Some PISLMs can also provide octave band analysis capabilities. The PISLM "DC output" can be input to a graphic level recorder providing A-weighted time histories.
Sound Level Meter (SLM)	Most SLMs can provide maximum L_{AS} as well as a continuous readout. The "DC output" of most SLM's can also be input into graphic level recorders providing A-weighted time histories. The typical SLM can be used to assess airport use restrictions but is difficult to use in evaluating airport noise contours. Many SLM's also have the capability of assessing octave band sound pressure levels, useful in analyzing stationary noise source problems.
Graphic Level Recorder (GLR)	The GLR is a highly recommended system component. Many situations arise in which a grpahic time history "pictorial" is more understandable than tabulated decibels. Caution: The GLR must accept a DC signal within a voltage range corresponding to the SLM or PISLM output voltage. An AC signal GLR cannot be used in a manner which will provide an accurate dBA, slow response time history. The power supply of the GLR can be either AC or DC however a DC power option is highly recommended for field operational flexibility.

ITEM (Cont'd)	COMMENT
Portable Aviation Frequency Radio	The portable aviation frequency radio, preferably with rechargable batteries, is a vital system component. Monitoring the Advisory Terminal Information System (ATIS) frequengy provides airport wind and barometric pressure readings. Monitoring tower, approach and departure frequencies provides aircraft identification and most importantly warning that an aircraft overflight is imminent.
Walkie-Talkies	Communication between noise measurement teams is often a requirement both for aircraft identification as well as redeploying teams in response to a chage in airport operational runways. Walkie-talkies can also be useful in estimating aircraft speed between two observation points.
Camera	A camera is useful for photo-scaling aircraft altitudes. It is usually not necessary to acquire aircraft altitude data, however, special programs do arise in which altitude is required. The camera is also used to document the test site environs, equipment set ups, and microphone locations to resolve post test questions.
Portable sling psychrometer	The sling psychrometer provides dry-bulb and wet-bulb temperature for computing relative humidity. Sound attenuation varies significantly with temperature and relative humidity and the measurement of those parameters is often necessary.
100 Ft. Tape Measure	Useful in siting microphone position relative to landmarks as well as microphone height.
Four-foot long rope (1.2m)	Convenient way to verify microphone height when a tape measure is not available.

2. RECOMMENDED MEASUREMENT PRACTICES. The following list of recommended measurement practices are key elements in providing a traceable record of a noise monitoring program.

a. Conduct measurement with the microphone(s) at a height of 4 feet (1.2m) above the ground.

b. Orient the microphone properly, according to manufacturer's specifications.

c. Avoid measuring aircraft noise in close proximity to vertical reflective surfaces (at least 25 feet whenever possible).

d. Avoid overhead obstructions in the vicinity of the microphone. Ideally, a cone of free space, with a half angle of 75 degrees from vertical should exist above the microphone.

e. Avoid the use of two-way radios in the immediate vicinity of microphone cables and SLM's while recording data. The transmission of electromagnetic energy often can be picked up through the noise measurement system.

f. Calibrate all instrumentation at least once an hour as well as at the beginning and the end of each measurement period. Take special care with calibrators. If a calibrator is dropped it must be checked against another calibrator known to be accurate. For this reason it is a good idea to keep a "laboratory standard" calibrator in the office.

g. Use a windscreen at all times. Avoid measurements under windy conditions; if unavoidable, document the wind-induced sound level. If maximum sound levels of aircraft or other events exceed the wind noise by more than 10 dB, the sound level measurement error will be less than 0.5 dB.

h. Check battery energy levels at least once every thirty minutes. Instruments, using nickel-cadmium batteries may require more frequent checking.

i. Maintain accurate thorough data logs during a measurement program including: day, data, time(s), calibration levels, noise floor levels, battery checks and the selector and gain settings for every component in the measurement system. Noise event data sheets should also include aircraft type, carrier, elevation anagle above the horizon, time, aircraft operaltion (takeoff or landing), and a space for comments. All intrusive noise events during data recording should be noted. When the time comes to write a report on the measurement survey, all of the little details noted during the test will prove most valuable.

j. As further documentary record it is always good to draw a schematic diagram of the measurement setup showing equipment, orientation, priximity to obstructions, roadways, etc. Photos of each measurement site are also very useful in going back and addressing questions concerning field procedure or the neighborhood characteristics.

k. During data acquisition for any desired event avoid conversation in the vicinity of the microphone(s). Keep voice levels low at all times. This may seem obvious but is one of the most frequent errors in procedure made by inexperienced persons and observers.

l. The list shown below identifies certain essential items easily overlooked in preparing to go out and measure noise:

(1) properly sized calibration screwdriver(s);

(2) calibrated watch, clock, or other "time-piece";

(3) extra graphic level recorder pens and paper;

(4) spare batteries;

(5) maps;

(6) data sheets, and clipboard.

m. Two of the "easiest errors to make" in sound level measurement are:

(1) Meter Response Time set incorrectly on fast rather than SLOW.

(2) Meter weighting network on some other setting than A.

n. The single biggest category of problems encountered with noise measurement equipment involves connections and cables. Time spent in checking and caring for these items will minimize the chance of wasting a day in the field. Avoid pulling cords anywhere but at the connector, avoid kinks in wiring (especially in cold weather) and frequently test cables for continuity. If a cable becomes crimped or damaged in any way, remove it from service until repaired.

APPENDIX 4. BIBLIOGRAPHY

NOISE MEASUREMENT, ESTIMATION, AND FORECASTING

Bishop, D.E. and Anthony P. Hayes. Handbook for Developing Noise Exposure Contours for General Aviation Airports, 1975. Federal Aviation Administration.

International Electrotechnical Commission. Publication No. 179: Precision Sound Level Meters. 1973.

May, Daryl. Handbook of Noise Assessment. Van Nostrand Reinhold, 1978.

U.S. Department of Transportation, Federal Aviation Administration. FAA Integrated Noise Model, Basic User's Guide, Version 2, 1979.

U.S. Department of Transportation, Federal Aviation Administration. Estimated Noise Levels in A-Weighted Decibels. Advisory Circular 36-3A, June 11, 1980.

U.S. Department of Transportation, Federal Aviation Administration. Terminal Area Forecasts, Fiscal Years 1980-1991, 1979.

CONSULTATION AND COMMUNITY PARTICIPATION

Pennsylvania Department of Transportation. A Manual for Achieving Effective Community Participation in Transportation Planning.

Stein-Hudson, Kathleen. An Introduction to Community Involvement in the Transportation Planning Process. Federal Highway Administration, 1976.

U.S. Department of Transportation, Federal Aviation Administration. Community Involvement Manual. Report No. FAA-EE-79-06.

U. S. Department of Transportation, Federal Aviation Administration. Citizen Participation in Airport Planning. Washington, D.C.: Advisory Circular 150/5050-4, September 26, 1975.

Zelco, Harold P., Successful Conference and Discussion Techniques. McGraw-Hill Book Company, Inc., 1957.

NOISE ABATEMENT AIRPORT/AIRCRAFT OPERATIONS

Bolt, Beranek and Newman, Inc. A Guidance Document on Airport Noise Control. U.S. Department of Transportation, Federal Aviation Administration, Report No. FAA-EE-80-37, August 1980.

U.S. Department of Transportation, Office of The Secretary and the Federal Aviation Administration. Aviation Noise Abatement Policy. November 18, 1976.

LAND USE PLANNING AND CONTROLS

Bair, Frederick H., Jr. Planning Cities. American Planning Association (Formerly ASPO), 1970.

Chapin, F. Stuart, Jr., and Edward J. Kaiser. Urban Land Use Planning. University of Illinois Press, 1979.

Haar, Charles M. Land Use Planning: A Casebook on the Use, Misuse and Re-Use of Urban Land. Little, Brown and Co., 1977, plus the 1980 Supplement.

Hagman, Donald G., and Dean J. Misczynski. Windfalls for Wipeouts: Land Value Capture and Compensation. American Planning Association, 1978.

Institute for Contemporary Studies. No Land Is An Island. 1975.

Listokin, David. Land Use Controls: Present Problems and Future Reform. Center for Urban Policy Research, 1974.

Mandelker, Daniel R. Environmental and Land Controls Legislation. The Bobbs-Merrill Co., Inc., 1977.

McHarg, Ian L. Design with Nature. Natural History Press, 1971.

Siegan, Bernard H., Planning Without Prices Lexington Books, D.C. Heath and Co., 1977.

So, Frank S., et. al. Practice of Local Government Planning, Vol. 1., International City Manager's Association, 1979.

U.S. Department of Transportation, Federal Highway Administration Reprint. The Standard Land Use Coding Manual. January 1965.

NOISE LEVEL REDUCTION, SOUNDPROOFING/TREATMENT AND SITE PLANNING/TREATMENT

Bishop, Dwight E. A Building Code for Exterior Noise Isolation with Respect to Aircraft Noise. HQ USAF/PREVX, Contract No. F49642-74-31392, U.S. Department of Defense, U.S. Air Force, June 1975.

Cleary, Gottlieb, Steen and Hamilton. Certain Legal Aspects of Required Soundproofing in High Noise Areas. Technical supplement to the report JFK International Airport in New York. HUD-H-1091 (Tri-State Transportation Commission). February 1970.

Close, Paul D. Sound Control and Thermal Insulation of Buildings. Van Nostrdad Reinhold Co., 1966.

Harris, Cyril M. Handbook of Noise Control. McGraw Hill, 1979.

Magrab, Edward B. Environmental Noise Control. Wiley-Interscience, 1975.

Moore, J. E. Design for Good Acoustics and Noise Control. Scholium Intl., 1979.

Ramsey, C. G. and H. R. Sleeper. Architectural Graphic Standards. Wiley-Interscience, 7th Edition, 1980.

U.S. Department of Commerce, National Bureau of Standards. Design Guide for Reducing Transportation Noise In and Around Buildings. NBS Building Science Series 84. U.S. Government Printing Office, April 1978.

U.S. Department of Commerce, National Bureau of Standards. Highway Noise Criteria Study: Outdoor/Indoor Noise Isolation. NBS Technical Note 1113-2. U.S. Government Printing Office, August 1980.

U.S. Department of Transportation, Federal Highway Administration. The Audible Landscape: A Manual for Highway Noise and Land Use. November 1974, Reprinted August 1976.

U.S. Department of Transportation, Federal Highway Administration. Insulation of Buildings Against Highway Noise. FHWA-TS-77-202.