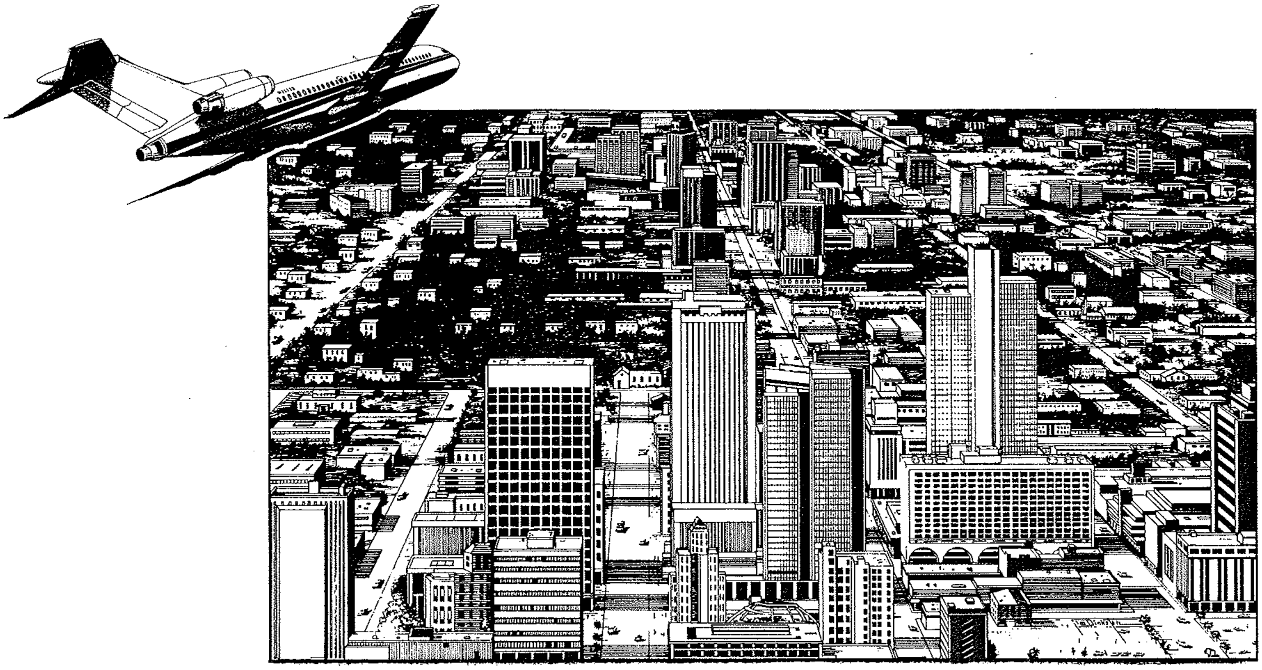
Chapter Five
NOISE ABATEMENT ALTERNATIVES



Chapter Five
NOISE ABATEMENT ALTERNATIVES

The responsibility for evaluating alternative noise abatement solutions and taking the necessary steps essential to minimizing the number of people adversely affected by noise does not rest with one individual, one government agency or one community. The authority and responsibility lie with a variety of federal, local, and private entities on a national as well as local level. The DOT/FAA Noise Abatement Policy of 1976 and the Airport Safety and Noise Act of 1979 have outlined a framework intended to assure coordination in tackling the difficult task of noise abatement. Responsibility for this effort rests with the airport users, aircraft manufacturers, airport proprietors, federal, state, and local governments, and residents in communities surrounding the airport. The following is a brief synopsis of each participant's unique role and responsibility in this effort.

- The Federal Government has the authority and responsibility to control aircraft noise sources, implement and enforce flight operational procedures, and manage the air traffic control system in ways that minimize noise impacts on urbanized areas.

- The aircraft manufacturers have the responsibility for incorporating **quiet engine** technology into the new aircraft designs in order to meet federal noise standards.

- Airport proprietors are responsible for planning and implementing airport development actions designed to reduce noise. Such actions include improvements in airport design and noise abatement ground procedures, in addition to evaluating and recommending restrictions on airport use that do not unjustly discriminate against any user, impede the federal interest in safety and management of the air navigation system, or unreasonably interfere with interstate commerce.

- Local government and planning agencies have the responsibility for providing land use planning, zoning, and housing regulation that will encourage development or redevelopment of land that is compatible with present and projected airport operations.

- The air carriers, all-cargo carriers, and commuter operators are responsible for scheduling and operating aircraft in ways that minimize the impact of noise on people.

- General aviation operators have the responsibility to use proper aircraft maintenance and good neighbor flying techniques to minimize their noise output.

- Air travelers and shippers generally should bear the cost of noise reduction, consistent with established federal economic and environmental policy which indicate that the adverse environmental consequences of a service or product should be reflected in its price.

- Residents and prospective residents in areas surrounding airports should seek to understand the aircraft noise problem and what steps can and cannot be taken to minimize its effect on people. Prospective residents of areas impacted by aircraft noise should be aware of the effect of noise on their "quality of life" and act accordingly.

The development of a noise abatement program has two primary objectives. The program elements selected for implementation should:

- Reduce the impacted population levels in the study area, within practical cost constraints.

- Enhance compatibility between existing and future area land uses and noise generated by aircraft using the airport.

In meeting these objectives, consideration must be given to the caveats presented by the legislation that the noise abatement program not impose an undue burden on interstate commerce or result in unjust discrimination against an airport user.

The achievement of these objectives can be accomplished only after a variety of realistic noise abatement alternatives have been evaluated independently and in combination with each other.

The current level of aircraft noise impacts at Phoenix Sky Harbor International Airport and the potential for growth of additional noise-sensitive residential areas in the airport vicinity demands that the greatest effort be made at this time to reduce off-airport noise, optimize the location of off-airport noise relative to residence-free corridors, and establish land use plans and controls which protect those corridors from future residential encroachment.

If the level of aircraft noise impacts in the airport vicinity is to be reduced, good-faith efforts are required from all responsible parties including airport management and air traffic control managers, owners and operators of aircraft, and land use regulatory agencies. While the next chapter reviews the alternative measures which the land use regulatory agencies may consider, this chapter and Appendix D are concerned with measures which would alter the use or configuration of air space, flight tracks, and airport facilities so as to reduce or shift the location of noise to more compatible areas.

EVALUATION CRITERIA

A variety of measures which provide noise abatement could be implemented at Sky Harbor International Airport. The extent to which these measures warrant inclusion in a noise compatibility program is dependent on such factors as the probable noise impact reduction resulting from their use, the extent to which the measures would likely compromise safety margins and the ability of the airport and its users to perform their intended functions, their environmental and financial cost, and their apparent implementability in light of necessary administrative and regulatory changes.

To assess the costs and benefits of the various techniques, a series of criteria are presented which, where applicable, are used to evaluate the individual noise abatement measures. The application of the criteria to 33 separate noise abatement measures is presented in Appendix D. When the measure could be computer modeled, the 1992 noise levels are calculated using the adjustment. The effectiveness of a measure on all of the noise pattern may often be implied by its effect in a single direction. Consequently, some measures were computer modeled in a single direction from the airport.

Noise Reduction Factors. The purpose of this study is to reduce aircraft noise impacts on people. The population impacts associated with a measure were determined, based on these primary comparative factors:

- Net change in residential population located within the 65 Ldn contours.
- Net change in level-weighted population (LWP).

Operational Factors. These factors consider the effects of the specified change on the operation of the airspace or airport and on aircraft using the airport.

- The type and general extent of conflicts or strain which the procedure will impose on the existing ATC system in the vicinity of the airport, and the means by which these could be resolved.
- Change in airport capacity resulting from the noise abatement procedure.
- Impacts on operating safety which would be associated with the noise abatement procedure.

Air Service Factors. These factors relate to a decline in the quality of airline or air transportation service which would be expected from adoption of an abatement measure. Such a decline may result from lowered capacity, rescheduling requirements, or restrictions on operations or aircraft types. The factors are:

- Effect on the level of service of air carrier passenger traffic and air cargo service.
- Effect on the level of general aviation and military service at the airport.

Environmental Factors. Environmental factors related to noise are of primary concern in a F.A.R. Part 150 analysis. The impacts, if any, of a noise abatement measure on other environmental issues such as air and water quality should be considered in the potential for its implementation. The factor is:

- Estimated effect on non-noise environmental factors.

Cost Factors. Cost factors include both the cost of operating aircraft to meet the noise abatement measure and the cost of construction or operation required for various noise abatement facilities. The factors are:

- The difference in flight time operating costs for the noise abatement procedures and for current operational procedures.

- Estimated capital costs of implementation of the noise abatement alternative, if known.

Upon completion of a review of each measure based on the above criteria, an assessment of the general feasibility of each measure and the strategies required for its implementation are presented in Appendix D.

NOISE ABATEMENT MEASURES

Noise abatement measures are those procedures or changes which have the potential to reduce the aircraft noise impact on persons living in the airport environs area. These measures fall into four general categories:

- Runway Use and Flight Routing Changes

- Airport Regulation Changes and Facility Restrictions

- Aircraft Operational Procedure Changes

- Airport Facility Changes

Measures falling within the first three categories occasionally may be implemented within a relatively short period of time, while those falling within the fourth category usually require a longer time to implement due to associated environmental assessment and construction activities.

RUNWAY USE AND FLIGHT ROUTING PROCEDURES

The pattern of land use around the airport provides guidance to the design of arrival and departure routes and runway use programs for noise abatement. By directing the traffic over the more compatibly used areas, noise impacts may often be significantly reduced. Generally, the present land use pattern would suggest noise abatement measures which concentrate as much noise as possible along the compatible Salt River channel. The nearby development of incompatible land uses to the west, northeast and southeast of the airport constrain the unlimited development of operational patterns for noise abatement. Measures within this category must be considered in the context of airport flight originations and destinations, as well as the efficient operation of the taxiway and runway system. The evaluation of several measures falling within this group is required by Part 150. Additional similar measures evolve from suggestions by the general public, the Planning Advisory Committee members, and consultant experience.

The responsibility for the implementation of any or all of the measures within this category will fall directly upon the Federal Aviation Administration's air traffic control function (either in the tower or at TRACON), the airport proprietor, and upon the operators of aircraft using the airport. Measures which fall within the runway use or flight route change category include:

1) Establish a rotational runway use system to equally distribute arrival and departure operations to both the east and west of the airport.

2) Establish a runway use program favoring the flow of traffic on Runways 8R/L (to the east).

3) Establish a runway use program favoring the flow of traffic on Runways 26R/L (to the west).

4) Require a 15 degree left turn, for jet aircraft departing Runways 26R/L, as soon as safe and practical.

5) Require a 15 degree left turn, for jet aircraft departing Runway 26L, as soon as safe and practical.

6) Replace the NDB instrument departure overflight procedure from Runways 8R/L with a procedure calling for flight along the 265 radial from the SRP VORTAC to a position 1 DME west of the navaid before turning on departure SID vectors.

7) Require Runway 8R/L IFR departures to fly runway heading until abeam the SRP VORTAC (crossing Price Road).

7A) Extend the 1 DME procedure (Measure 6) to overfly the SRP VORTAC.

8) Establish a SID flying northeast of the VORTAC and then over Williams MOA 1 for Stanfield, Mobie, and Buckeye departures from Runways 8R/L. This SID would be used only during low activity at Williams AFB.

9) Redefine the Buckeye SID from Runways 8R/L to turn northeast and then west to fly over more compatible uses or at higher altitudes over incompatible uses.

10) Extend by two miles the final approach segment of visual approaches to the east and west of the airport.

32) Establish flight corridors for helicopters using the airport.

Runway Use

A rotational runway use program which equalizes the traffic flow between east and west was the intent of an interim agreement between the mayors of Tempe and Phoenix. Full implementation of the program results in the day and night equalization of the noise pattern in each direction from the airport.

Preferential runway use programs for noise abatement are intended to direct as much noise emission as possible over the least noise sensitive area beneath a flight corridor. Phoenix Sky Harbor International Airport has extensive residential development 1 1/2 miles to the west and compatible river bed to the east. At greater distance to the east, residential areas are impacted by noise above 65 Ldn. Computer analyses were conducted for preferential flow in each direction.

Flight Routes

The turning of departing aircraft to avoid populated areas is an accepted method of noise abatement which has been implemented in numerous areas. Presently turbojet and large propeller aircraft departing on Runway 26R/L climb on runway heading until 13 nautical miles west of the SRP VORTAC, at which point they turn to their initial enroute course. From Runways 8R/L, these aircraft currently turn to overfly the Rio Salado NDB before turning. As detailed in Appendix D, several other potential departure turns or routings for noise abatement were assessed. In each case, the departing aircraft would be directed to climb along a given heading or radial until reaching a preassigned location (typically defined by a DME location from the SRP VORTAC), where turns to enroute courses would take place.

A left turn by aircraft departing Runways 26R/L may shift noise from incompatible areas west of the airport to a more compatibly-used area of land along Salt River channel southwest of the airport. Such a turn could be implemented by requiring a turn at a specific altitude or location relative to a navigational aid.

A set of potential traffic routes from Runways 8R/L were evaluated which may redirect all or a portion of the traffic now overflying residential areas to corridors aligned with the more compatible Salt River channel northeast of the airport. A 1 DME departure procedure proposed for implementation during the summer of 1988, a left turn for departures to southern California, a procedure wrapping nighttime and weekend traffic around and east of Mesa and Tempe, and extensions of the 1 DME procedure farther to the east are presented in Appendix D. All will result in noise impact reduction or redistribution of overflights from one area to another. Each redefined turn causes aircraft to pass over areas of less dense development beyond the 65 Ldn contour.

A revision of the published visual approach routes was assessed. Virtually no adjustment to the contours would result from extending these routes further to the east or west, although areas overflown on base legs of the approach would be changed (but not necessarily to less impacted areas).

Finally, the development of standard routes for helicopter traffic using the airport or flying across its airspace is a method of rerouting those aircraft from noise-sensitive to compatible areas. Helicopter aircraft are not as confined to long straight and curved flight track segments as are fixed wing aircraft, and consequently may be routed to follow surface features. The routing of inbound and outbound traffic over noise compatible corridors along I-10 or Van Buren and 40th Street until reaching 400 to 800 AGL would reduce low flight complaints from throughout the area. The use of the roadways as flight corridors for through traffic would reduce overflights of noise-sensitive areas.

AIRPORT REGULATION CHANGES

Restrictions on airport use provide a second category of noise abatement procedures. These restrictions may be imposed by the airport proprietor at his option or implemented voluntarily, but an imposed restriction which would discriminate against a class of user or cause an undue burden on interstate commerce is prohibited by the legislation upon which F.A.R. Part 150 is based. There is no universal definition of what constitutes this undue burden, but formal restrictions such as an across-the-board nighttime curfew or the prohibition of specific aircraft types have not been generally viable elsewhere and have been challenged by either the FAA or by airport users. To provide a fair and comprehensive noise abatement evaluation, several regulatory measures have been considered for their utility at the airport. These include the following:

11) Establish a curfew on all nighttime operations.

12) Restrict jet nighttime departures to F.A.R. Part 36, Stage 3 aircraft.

13) Restrict jet nighttime departures and arrivals to F.A.R. Part 36, Stage 3 aircraft.

14) Restrict all jet operations to F.A.R. Part 36, Stage 3 aircraft, regardless of time of operation.

15) Establish a budget for the distribution of allowable noise generation to user air carriers.

16) Limit the total number of operations allowed at the airport.

17) Impose differential landing fees based on time of operation or aircraft noise level.

18) Expand restrictions on maintenance runup activity.

Time of Day Restrictions

The three nighttime restrictions listed above would apply during the 10:00 p.m. - 7:00 a.m. time period. In the first case, the airport would be closed to all arrivals and departures, while in the second case, it would be open for arrivals by any aircraft and departures by aircraft which meet specified maximum noise levels, as measured at critical locations off the airport; the third case would extend the noise restriction to include arrivals as well as departures. The fourth restriction (Number 14) would apply at all hours.

The implementation of any curfew would result in reductions of the aircraft LDN noise contours. Nighttime traffic comprises more than 10 percent of the scheduled operations at the airport, and the implementation of any restrictions on the availability of the airport during the nighttime hours could affect the commercial service users by requiring them to adjust national schedules to meet local limitations. The utility of the airport would be reduced to corporate general aviation users through a limitation on the hours of operation available for non-compliant aircraft. Other facilities are not locally available for the commercial service operators, but corporate users may be served at area reliever airports. The implementation of any across-the-board curfew which would seriously affect interstate commerce is not considered viable.

Based on the FAA's Area Equivalency ethod (AEM) of noise estimation, 95 percent of the 1987 noise exposure is contributed by air carrier and cargo jet aircraft which meet only the Stage 2 noise limits of F.A.R. Part 36. By the beginning of 1988, all air carrier and cargo jets certified to operate at more than 75,000 pounds GTW (gross takeoff weight) were to meet either Stage 2 or the more restrictive Stage 3 noise levels. One method to achieve significant reductions in both the size of the noise exposure contours and the noise levels produced by individual overflights is to require the use of Stage 3 aircraft such as the MD-80, A-300, L-1011, B-757, B-767, and B-737-300/400 during all or portions of the day and night. These aircraft are significantly quieter than their Stage 2 counterparts.

To comply with any of the three measures limiting the airport's use to Stage 3 aircraft, the affected carriers would have to divert these aircraft from other routes, abandon the flight, or accelerate the acquisition of replacement equipment. Most air carrier aircraft now using the airport (76%) do not meet the requirements of F.A.R. Part 36, Stage 3, and, under a policy banning the use of all but Stage 3 aircraft, would be unable to operate at the facility. There may not be enough Stage 3 aircraft of appropriate size owned by the carriers serving Phoenix to accommodate even a majority of the current schedule. This condition will however, change as older aircraft are replaced with Stage 3 equipment. Thus, a general restriction of the airport to aircraft meeting the Stage 3 noise limitations is considered infeasible at the present time.

At Phoenix, the limitation of operations based on aircraft noise levels appears to be feasible if limited to the more sensitive nighttime hours. Two of the regulatory measures investigated the effect on noise reduction of limiting jet operations at night to Stage 3 aircraft. It was found that a measure restricting departures to Stage 3 aircraft would require the rescheduling of twenty departures under 1987 baseline conditions or their replacement with quieter aircraft. If both departures and arrivals were restricted, approximately fifty operations would be impacted daily.

Noise Level Limitations

A restriction of aircraft based on noise levels can be effective in the correct circumstances. The restriction can be based on maximum permitted noise levels (L-Max) measured off the airport or based on compliance with F.A.R. 36. The selection of an L-Max level without regard to currently operating aircraft and/or the ability of the various users to meet the level within existing technologies may lead to a substantial reduction in the level and quality of air service available within the community. Noise limits based on Part 36 certification tests have the virtue of being fixed national standards, but they do not consider how quietly an aircraft can be flown in normal operations. On the other hand, noise limits based on SEL or maximum decibel readings are more specific to the airport and aircraft operator because they focus on noise produced in a particular situation.

A direct correlation between aircraft weight and noise exists. As weight increases, the level of energy to keep the aircraft aloft is increased. This means that a heavy aircraft climbs more slowly and creates more noise on departure than the same aircraft, but weighing less. Airport management cannot reasonably attempt to establish maximum weight restrictions for every aircraft using the airport. The benefits of close monitoring of excess weights would include reduced operating costs to the carrier and the reduction of single event levels in the surrounding community.

A noise budget is a technique designed to encourage the early conversion to quieter Stage 3 aircraft, the utilization of more effective noise abatement procedures, consolidation of flights, and operation during the less noise-sensitive hours. Under a budget, each carrier is allocated a designated amount of noise it may create per day, week, or year based on its prior performance, level of service, and the community's noise reduction goals. Over time, the level of noise allocated to each carrier and in total could be reduced to result in a declining amount of total noise exposure. Each carrier would retain the flexibility to develop scheduling at any time of the day with any aircraft type, so long as its total allocation is not exceeded. Quieter aircraft or operation during less noise-sensitive hours would result in increased flights per allocation.

While a noise budget can provide long term reductions in overall noise exposure contours for airports with a stable air service pattern, it is limited in allowing the entry of new carriers or rapid growth of existing carriers and requires extensive additional staff time on complex noise budget bookkeeping. Furthermore, it is extremely difficult to establish a reasonable, non-discriminatory initial allocation of allowable noise for each carrier which recognizes historical operations and previous efforts toward the abatement of noise. A carrier which has made a significant effort to convert to quiet aircraft could effectively be penalized by that effort if shares of the budget are based on recent historical portions of the total noise energy contributed by each carrier.

The methodology for determining aircraft budget equivalencies, as described in Appendix D, is but one of a number which might be used. The two best known noise budgets are for the air carrier airports in Minneapolis and Denver. The Minneapolis budget is based on the logarithmic addition of Part 36 certificated EPNdB noise levels for approach and departure by the various aircraft using the airport. The Denver budget is based on the logarithmic summation of average carrier-specific Leq values based on reference noise levels at two takeoff and one approach location. In each case, carriers are budgeted a portion of the overall noise level for the airport based on activity during a reference period within the past two years. At Minneapolis, an immediate reduction of 11 percent was incorporated into the budget, while at Denver the base level would be reduced only if a new airport is not completed by given future deadlines or if portions of noise certificates are transferred between carriers. It should be noted that in both cases, the use of a noise budget was made more acceptable by very localized circumstances. The specific methods used at those airports may not be applicable at Sky Harbor.

Capacity limits based on total operations are intended to control the total accumulated noise exposure. A cap based on raw numbers, (e.g., 1,000 air carrier operations on an average day) provides no incentive for conversion to quieter aircraft to handle naturally growing passenger loadings, but rather leads only to use of larger aircraft which may be louder. The goal of any noise abatement measure should be to reduce aircraft noise exposure, as measured by contour size and/or maximum single event noise levels.

The only adequate method for equitably distributing a set number of operations among numerous users is the allocation of operations among user groups and the subsequent auctioning or reservation of operating slots. This technique is used at some of the nation's largest and busiest airports, but is designed primarily to deal with meeting demands at an airport which has reached its capacity or has specific noise event limits.

Operational limits should be based on past history as well as projections about future operators and events. To allocate shares of a cap based solely on the past fails to adequately assure the free entry of new carriers, as required under airline deregulation.

Thus, the use of a capacity limitation may result in several adverse effects on the community and provide one positive effect. Positively, it limits the total number of noise events, while negatively, it limits the air service to a growing community, can encourage the delayed use of quieter aircraft at the airport, requires major administrative efforts, and does virtually nothing to reduce single event noise exposure levels.

Landing Fee Penalties

The initiation of differential landing fees based on either the noise level or the time of arrival have been proposed as incentives to use quieter aircraft or operate at less sensitive times. The first strategy bases all or part of the landing fee on the noisiness of the individual aircraft, thus apportioning the fees to the relative noise "cost" of the operation to the airport proprietor. The strategy encourages the use of quieter aircraft while producing additional revenue to offset noise-induced expenses.

To avoid discrimination, the fee should be based on standard single event noise ratings for each aircraft type, such as published in FAA Advisory Circular 36-1D, but additional penalties may be applied for the noise-sensitive hours.

The effectiveness of a landing fee in actually reducing the use of noisy aircraft depends on how expensive the fees are and how steeply the fee structure is graduated. There has been no known information published to date which correlates reduced noise impact with incremental landing fees for noisier aircraft. The development of a fee schedule must consider the aircraft in use at the airport and landing fee contracts and agreements now in force. It may be implemented as an across-the-board measure or enacted as a surcharge for landings which occur during special sensitive periods such as nighttime or weekends. The funds generated from the use of a differential landing fee should be used in noise abatement and mitigation programs.

The use of a fee penalty for late night arrivals provides a disincentive to the scheduling of arrival operations during highly sensitive hours. While not preventative, the measure could be subject to challenge as interference with interstate commerce, not only by cargo carriers, but also by air carriers.

Activity Restrictions

Engine runups are a necessary and critical portion of aircraft operation and maintenance, but they tend to last longer than an overflight and often are the subject of noise complaints. There are three typical approaches to abating runup noise. One is by restricting the times during which it can be conducted, another is by relocating it to a remote area, and the third is by the erection of a noise barrier (or similar structure) between the runup activity and the airport neighbors.

The first has been accomplished at Phoenix by implementation of an airport rule which requires maintenance runups to be conducted only between 0601 and 2100 hours. The second has been informally addressed by the designation of a runup site on the old crosswind runway south of Runway 8R-26L. Based on distances to established residential neighborhoods, it appears that the location now used should be retained for general use, but a location for America West's maintenance base on the new ramp is also feasible. A new location for America West should incorporate an aircraft heading of 120 or 300 degrees to direct noise over the most compatible areas.

The construction of noise barrier or berms does not appear to provide significant relief to area residents from runup noise. The distances between the maintenance runup locations and the nearest residential areas are so great as to negate the benefits associated with an interruptive structure. The attenuation associated with a barrier is greatest when the source and the receiver are adjacent to but on opposite sides of a barrier. As the distance is increased, the degree of attenuation is reduced to virtually zero at 2,000 feet separation.

A runup facility recently was constructed for use by the Arizona Air National Guard to lessen the effect of its runup noise. This approach is excellent when the aircraft types to use the facility are limited, but in the case of civil traffic, a number of facilities would be required to accommodate all users of the airport. If user aircraft types were limited, the utility of a runup facility or "hush house" may become more justifiable. For example, if America West, as part of its new maintenance operation, finds it necessary to schedule maintenance runups at night, these could be conducted in such a facility designed and built as part of the maintenance base. This would require a change in current policy prohibiting night runup activity. However, the general requirement that all runups be conducted in a hush house would require considerable area and cost for construction of multiple structures and does not appear to be economically justifiable.

Limitations on training operations can be effective in reducing noise when those operations are extremely noisy, unusually frequent, or occur at a very noise-sensitive time of day. Except for very limited operations, primary training activity is not conducted at the airport and its restriction would not be effective for noise abatement.

AIRCRAFT OPERATIONAL PROCEDURES

Within this category are various flight procedures which may decrease noise impacts on area population. They may apply to either departures or arrivals. Measures which fall within this category are normally the responsibility of the airport users to implement, although the procedures necessary for implementation will often need to be approved by the FAA prior to being put in place. Changes which have been investigated and which are presented in Appendix D are indicated below:

19) Request the use of thrust reduction after takeoff by all jet aircraft capable of using the procedure.

20) Request the use of maximum climb departures by all aircraft.

21) Request the minimum use of flaps during approaches.

22) Establish two-stage approach procedures.

23) Increase approach angles by raising glide slopes.

24) Limit use of reverse thrust on landing.

Departure Procedures

The use of thrust reduction after takeoff for jet aircraft is a procedure during which the pilot does not use the full thrust available for climb. Standardized thrust cutback departure procedures have been established by each airline because of system wide operating needs. Initially, the departure cutback procedures fell into two groups - the ATA and Northwest Airlines procedures. More recently, a number of airlines which had been using the ATA procedures have modified them for aircraft with low bypass ratio engines. Additionally, the FAA has developed a standard departure for noise abatement based on the ATA procedure. The major difference among these procedures is in the degree of thrust reduction after acceleration and clean-up. This reduction normally occurs above 1,000 feet AGL after the aircraft has been made aerodynamically clean (flaps and gear retracted) and a stabilized velocity has been reached. The amount of thrust reduction is dependent upon aircraft weight, temperature, and flap setting and can fall within a considerable range of settings, with the Northwest "quiet thrust" being at the lower limit. A significant, but safe, reduction in thrust can generate major reductions in the areas within the significant noise contours (65 Ldn).

Up to the present time, there has been a wide variety of views as to which procedure is best. It is generally agreed, however, that a single optimal procedure is desirable. On that basis, the FAA and a number of industry user groups are continually evaluating the full range of techniques and hope to arrive at a common procedure. However, since a new procedure has not yet been developed, the FAA's standard noise abatement departure procedure may be used to assess the general effectiveness of thrust cutback measures. The FAA's AC 91-53 noise abatement departure profile generally calls for a climb to 1,000 feet AGL at normal takeoff thrust, retraction of flaps to a clean configuration while accelerating to a stabilized velocity, reducing thrust to that required to maintain "engine-out climb gradient" (for low bypass ratio engines such as on 727's, 737's and DC-9's), or to normal climb power for aircraft with high by-pass ratio engines, while climbing to an altitude of 3,000 feet AGL where normal climb power is resumed. The "engine-out climb gradient" thrust level is dependent upon the flap setting carried through the climb segment. If the aircraft is aerodynamically clean (i.e., zero flaps) the resulting noise levels are as much as five decibels quieter than the same aircraft with a 15 degree flap setting. For the purpose of modeling aircraft noise reduction associated with thrust cutback departures, a thrust equivalent to a 1.7 engine pressure ratio for the 727, 737, and DC9 was selected for application. This thrust falls within the mid-range of the noise abatement thrust levels indicated by various air carriers.

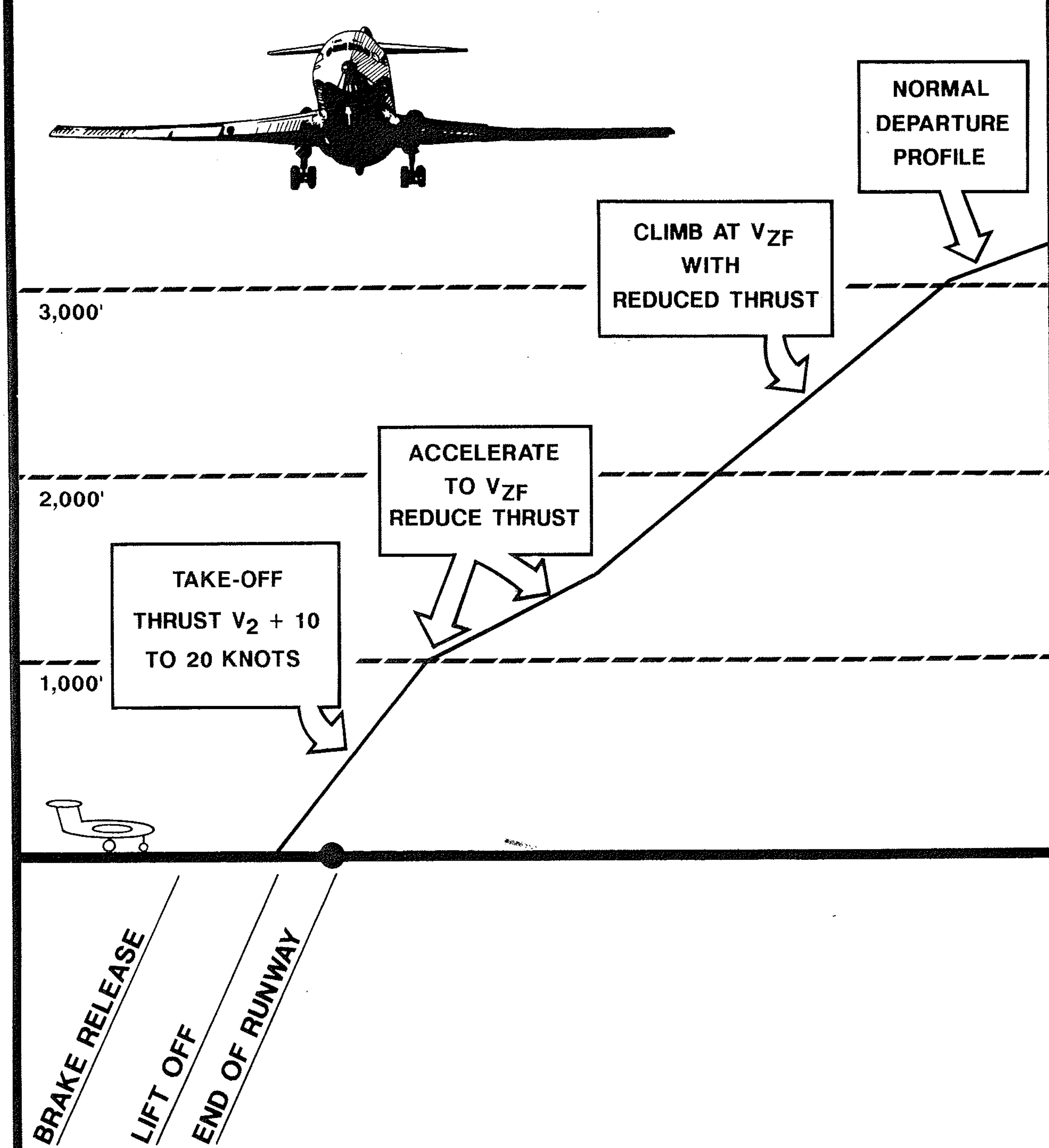
The use of a standardized thrust cutback procedure was investigated during the noise measurement program. It was found that the SEL noise levels measured in the field were generally representative of noise levels which would be attributable to aircraft flown at takeoff or climb thrust levels. Significant "quiet EPR" utilization was not concluded from the slant range vs. noise level determinations, although the aircraft climb gradients were similar to those anticipated by a cutback procedure. If all effected users agreed to restrict climb power to a standardized quiet EPR setting, except during extenuating circumstances, it is believed that substantive noise reduction could be achieved.

Exhibit 5A illustrates the FAA's standard AC 91-53 departure procedure. The use of this thrust cutback procedure must be tempered by the necessity of achieving safe flight attitudes, reaching minimum air traffic vectoring altitudes and the ability of the aircraft to climb in high temperatures.

As a service to the general aviation industry, the National Business Aircraft Association (NBAA) prepared a series of noise abatement takeoff and arrival procedures for its membership in 1967. This program has virtually become an industry standard for operators of business jet aircraft since that time. The departure procedures are of two types -- the **standard departure procedure** and the **close-in departure procedure.** The selection of the applicable noise abatement departure procedure is dependent on the proximity of the nearest noise sensitive area. In the case of departures at Phoenix, the use of the close-in procedure would appear to be more appropriate for Runways 26R/L departures since noise sensitive land uses are located near the end of the runway.

The greater distance to noise-sensitive uses from Runway 8R/L would suggest the use of the standard departure procedure. The NBAA standard departure procedure calls for a thrust cutback at 1,500 feet altitude and a 1,000 feet per minute climb to 3,000 feet altitude during acceleration and clean-up. The major difference between this and the close-in procedure is the inclusion of a thrust cutback at 500 feet altitude during the close-in procedure. Each is illustrated on the Exhibit 5B. While both procedures are effective in reducing noise impacts on surrounding land uses, the locations of the reduction vary with each. The standard procedure will result in higher altitudes over down-range

AC 91-53 STANDARD NOISE ABATEMENT DEPARTURE PROFILE

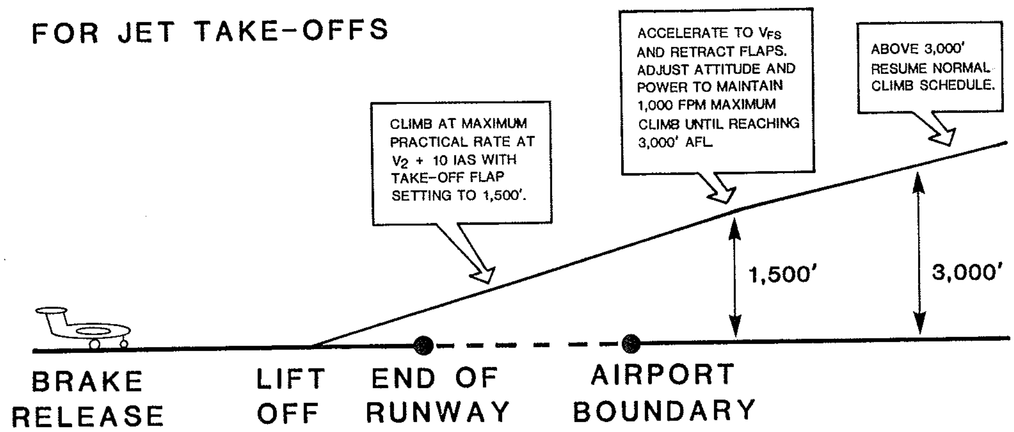


SOURCE: Federal Aviation Administration

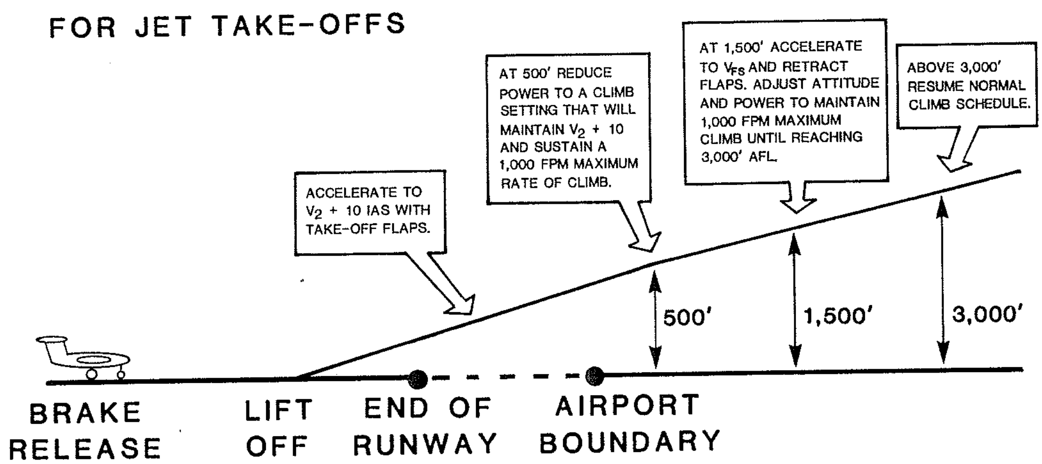
Exhibit 5A
FAA 91-53 DEPARTURE PROCEDURES

Sky Harbor INTERNATIONAL AIRPORT

NBAA STANDARD DEPARTURE PROCEDURE



NBAA CLOSE-IN DEPARTURE PROCEDURE



Notes applicable to the procedures are:

1) Consult your flight manual. Final Segement speed (V_{FS}) is usually found in the aircraft's flight manual and is generally equal to, but never less than, 1.25 Vs.

2) It is recognized that aircraft performance will differ with aircraft type and take-off conditions. Therefore, the business aircraft operator must have latitude to determine whether take-off thrust should be reduced prior to, during, or after flap retraction.

SOURCE: National Business Aircraft Association

Exhibit 5B
NBAA NOISE ABATEMENT
DEPARTURE PROCEDURES

Sky Harbor
INTERNATIONAL AIRPORT

locations, but the close-in procedure will result in lower noise levels near the airport. Neither NBAA procedure is intended to supplant a procedure recommended by the manufacturer, when one is included in the aircraft operating manual.

Standard thrust reduction procedures are generally not suitable for military or propeller-driven civil aircraft.

The use of maximum climb departure procedures is best applied to those areas where sideline noise impacts are low and heavily populated areas are located under the departure track at some distance from the airport. Maximum climb departures at Phoenix Sky Harbor International Airport would not be effective to the west, and did not prove to be beneficial to the east when computer modeled. Therefore, the procedure is not considered noise reducing and was dropped from further consideration.

Approach Procedures

Approach procedures to reduce noise impacts were attempted in the early days of noise abatement, but are no longer favorably received. These procedures entail the use of minimum flaps in order to reduce power settings and airframe noise, the use of increased approach angles, and two stage descent profiles. Follow-up studies have found that all of these techniques adversely impact operating safety because they are nonstandard and require aircraft to be operated outside of their optimal safe operating configurations. It should be stressed that, in the case of operations at Sky Harbor, none of the approach-specific operating procedures will have a substantive impact on the location of the Ldn contours.

The increase of an approach slope angle requires that the aircraft be landed at more than optimal approach speed. If faster approach and landing speeds are found acceptable because of long runway lengths, greater noise abatement benefits would be gained from clean flap configurations rather than steeper descent slopes. This is because the distance between the source and the receiver can rarely be increased enough to reduce noise levels by more than the reduction provided by a cleanly configured aircraft.

Additionally, some approach procedures were found to increase noise because additional power applications are required to arrest high sink rates. These higher sink rates and faster speeds associated with steeper descent approaches reduce pilot reaction time and result in raising decision heights on instrument approaches from 200 to approximately 300 feet. The limitation of reverse thrust has also been investigated, and given the length of the runway and aircraft types using the airport, limits on thrust reversal are considered possible, but not recommended. Since the contours at Phoenix are driven by the location of departure noise, there would be no reduction in noise-impacted area effected by application of approach operating procedures.

AIRPORT FACILITY CHANGES

The development of on-airport facilities to improve off-airport noise levels is an accepted technique of noise abatement. At Phoenix Sky Harbor International Airport, several facility-related alternatives were considered. These include:

25) Construct a new air carrier airport.

26) Encourage the use of reliever facilities by nonscheduled users.

27) Construct new Runway 8R/26L. Move west side arrivals and departures from current south to new south runway.

28) Construct new Runway 8R/26L. Move arrivals from the west and departures to the west from current south to new south runway. Conduct all east side nighttime operations to and from existing south runway.

29) Displace runway approach thresholds.

30) Install acoustical barriers and shielding.

31) Relocate Rio Salado NDB to mid-channel of Salt River.

Major Development

The transfer of large amounts of large aircraft traffic to another location may result in significant reductions in the noise levels surrounding Phoenix Sky Harbor International Airport. The feasibility for and location of a new air carrier airport, however, falls far beyond the scope of this Part 150 study. Until such time as a site is selected, if ever, for relocation of major facilities and that site is developed, it is impossible to determine the net benefit or cost in terms of noise abatement. Any reduction in noise levels at Sky Harbor would be offset to some degree by impacts at a new site. Such determinations are made in environmental assessments which directly address the need for and location of other facilities. If such facilities are ever developed, future noise studies for Sky Harbor should be conducted to reflect the operational conditions then in effect. The noise abatement program resulting from this Part 150 study cannot rely upon the development of a new airport as an integral part of its implementation actions.

To encourage the use of reliever facilities by non-scheduled traffic will have virtually no effect on the noise pattern at the airport, although it could result in more efficient operational conditions and fewer air traffic delays for those aircraft remaining at the airport. The number of single overflight events may also be reduced.

The use of two operational configurations were assessed in conjunction with a third parallel runway located as indicated on airport layout plans. The first configuration called for the use of a new south runway for takeoffs to and arrivals from the west to take greater advantage of the compatible land use along and south of Interstate 10. Operating conditions east of the airport were held constant. The second configuration assessed the effect of nighttime traffic east of the airport operating straight in to and out from the existing south parallel runway.

The first alternative resulted in decreased noise impacts west of the airport, with no change east of the airport, while the second alternative resulted in increased noise levels east of the airport. This increase was the result of higher sideline noise impacts on the south side of the river.

While the construction of a new parallel runway south of the current south parallel runway appears to have noise related benefits for areas west of the airport, the time required for its approval, design, assessment and construction are uncertain, but appears to be beyond the Part 150 five-year program. As the Part 150 program is updated and modified to better reflect existing conditions in future years, noise abatement measures associated with a new runway, if built, may be incorporated into the program. Such measures will depend upon the runway location, traffic levels and aircraft fleet mix, and the airspace technology in place at the date of construction. Consequently, definitive measures associated with the runway cannot be included in the five-year program.

Minor Development

To displace a threshold means that the touchdown zone for landing aircraft is moved to a location further down the runway. The determination of the amount of displacement must consider the runway lengths required for landing, as well as the amount of noise reduction associated with the displacement. For example, if the threshold of Runway 8R were displaced 1,000 feet to the east, the altitude of an aircraft along the approach path over areas west of the airport would be increased by only 52 feet. The single event noise levels associated with a 1,000 foot displaced threshold would decrease slightly along the flight track, but by no more than one decibel over the closest noise-sensitive uses areas under the approach track. To achieve a noticeable reduction in noise levels from a single approach, the thresholds would need to be displaced by at least 3,000 feet. A displacement of this length at Phoenix would reduce the available runway length to less than is required by the heaviest aircraft using the facility.

The second use of runway displacement to achieve noise abatement is to laterally increase the distance between the aircraft and the ground receiver when reverse thrust is applied after touchdown. Since the runways at Sky Harbor are not laterally adjacent to noncompatible areas, displacement does not appear to be an effective means of achieving significant noise reduction.

The geometry and acoustic characteristics of noise barriers have been touted for years as panaceas for the reduction of noise impacts at airports. In fact, they have very limited application in special situations, are most effective over relatively short distances, and their benefits are greatly influenced by surface topography and wind conditions. Furthermore, once an aircraft is in the air the barrier is no longer a factor of noise abatement. The degree of abatement is directly related to the distance of the noise source from the receiver and the distance of each from the barrier itself. Generally, the closer the barrier is to the noise source, the greater the areawide attenuation associated with it, but to abate noise over specific areas, location near the receiver can be as effective. The closest distance between an area of noise-sensitive land use and a location of high ground noise levels is the 1,600 feet between residences north of the airport and the taxiway on the north side of Runway 8L-26R. The installation of a twelve foot high barrier between these residences and the airfield would result in a noise level reduction of less than four decibels. Since the areas are exposed to much higher levels from flight operations, the potential benefits associated with a barrier are lost. No other areas potentially benefiting from barrier attenuation were identified.

In an earlier section, the development of a facility for aircraft runup activity was discussed. At the present time, runups are conducted at a location in the center of the airport, as remote from extensively developed noise-sensitive areas as is feasible. That location should be retained for the general runup activity at the airport. As was indicated, the development of a runup facility or hush house is most cost effective if there is a high associated demand level by a single type of aircraft. These facilities work well at airports which have aircraft manufacturers as tenants, at airports with airline maintenance bases, and at large military facilities. Airports which have general activity by a wide variety of users normally cannot justify the construction of large and expensive facilities to handle runups by many different aircraft types.

Occasionally, the installation of a navigational aid will assist the development of procedures for noise abatement. The interim agreement between the Mayors of Tempe and Phoenix called for the relocation of the Rio Salado NDB to the center of the Salt River channel. This measure was evaluated via computer modeling and found to increase the total number of persons within the 65 Ldn contour east of the airport. Consequently, the measure does not appear advisable for noise abatement. Furthermore, the implementation of the 1 DME departure procedures from Runway 8R/L, as discussed in an earlier section, preclude the use of the NDB for easterly departures.

The beacon could be removed and relocated to a different site to assist the development of procedures implementing other noise abatement measures. For example, it could be used in the implementation of a departure turn from Runway 26L to a 243 heading.

NOISE ABATEMENT SCENARIOS

Analysis of the noise abatement techniques, discussed briefly on the preceding pages and in detail in Appendix D has culminated in the selection of several measures for inclusion in one of three noise abatement scenarios.

The goal of scenario evaluation is to examine the combined effect of a variety of different noise abatement measures in reducing the extent of the 65 Ldn contour and its related noise impacts around the airport. Often, a single measure may have limited utility in reducing impacts, but if used in conjunction with another measure, may serve to improve the overall noise condition. For this reason, a series of three separate noise abatement scenarios have been designed for further evaluation at Sky Harbor International Airport. Only those measures which may be incorporated into an INM computer analysis are included in the scenarios.

The individual components of these scenarios are alternative measures which have been evaluated and tentatively found to have a degree of local implementability. Since some of the measures are controversial and complex, and may not ultimately be included in the program, the three scenarios are believed to represent different levels of difficulty of implementation. The most difficult to implement is the most complex and restrictive, while the scenarios which are less difficult to implement are believed to be less effective in overall noise abatement.

SCENARIO A - MAXIMUM IMPACT REDUCTION SCENARIO

The first scenario includes the assessment of a series of techniques which have been shown, via earlier evaluations, to potentially result in significant reductions in the overall numbers of persons falling within the 65 Ldn contour. The components of this scenario are:

- 1992 forecast traffic and fleet mix
- Runway 8R/L (east) preferential traffic flow
- 243 degree heading departure turn for jets from Runway 26R/L
- One DME departure for jets from Runway 8R/L during daytime
- Five DME departure for jets from Runway 8R/L during nighttime
- Restrict night jet arrivals and departures to aircraft meeting Stage 3 noise levels
- Departure thrust cutbacks

Several of the measures in this scenario are controversial and may not ultimately be acceptable to either the community or the users, but each was believed to be technically implementable. As such, this scenario is designed to demonstrate the maximum noise level reduction believed to be achievable without extensive disruption of the air traffic system and air service within the area.

The scenario makes direct application of east preferential flow, a one DME east departure during the day, nighttime Stage 3 noise level restriction and 100 percent use of departure thrust cutback by jets as discussed in earlier paragraphs. Additionally, revised applications of a 243 degree heading left turn for all west departures and a five DME east departure at night are incorporated.

The revision of the 243 degree heading departure turn assumes the presence of an additional crossfield taxiway so that all departures using the Payso and Cooper SIDs (north or northeast turning) may be departed from Runway 26R and all aircraft using the Stanfield, Mobie and Buckeye SIDs (south, southeast or west turning) may be routed from the south parallel runway. This change will eliminate the crossing of departure traffic from separate runways at a point 7 miles west of the airport.

The revision of the five DME departure route eliminates the 7 DME arc provision on the east side of the VORTAC and instead incorporates direct right turns to radials leading to the enroute navigational aids for aircraft using the Stanfield, Mobie and Buckeye SIDs on departure from Runway 8R/L. Since low activity periods at Williams AFB are between 9 p.m. and 6 a.m., Monday to Friday, this measure may be further revised to include its use on weekends, as well as at night, if selected for incorporation into the final noise compatibility program.

Noise Reduction Results

The noise contour results of the full implementation of the conditions of Scenario A are contrasted to the 1992 unabated contours on Exhibit 5C. Large areas of reduced noise exposure fall both east and west of the airport. The total population within the scenario contours is compared to the unabated forecast population in Table 5A.

TABLE 5A
Comparative Population Impacted
1992 Unabated Noise Vs. Scenario A

	1992 Unabated			Scenario A		
Ldn Noise Level	West	East	Total	West	East	Total
65-70	10,819	6,083	16,902	5,801	1,797	7,598
70-75	13,367	3,150	16,517	140	80	220
75+	1,668	0	1,668	0	0	0
Total	24,854	9,233	34,087	5,941	1,877	7,818
LWP	20,126	6,558	26,684	3,748	1,193	4,941

The population falling within the 65 Ldn contour of this scenario is 23 percent of the unabated condition. No persons would reside within the 75 Ldn contour and the reduction within the 70 Ldn contour would be nearly 99 percent. The area within the 65 Ldn contour is reduced from 13,997 acres for unabated conditions to 7,706 for the scenario.

The 75 Ldn contour remains over the airport or nonresidential areas to the immediate east and west of the runway ends. The sideline dispersion of the 75 Ldn contour does not pass beyond the bounds of the airport. The 70 Ldn contour extends over nonresidential areas of the Salt River channel to the east and over compatible land west of the runway ends. The population within the 70 Ldn contour is located in small residential areas between the Southern Pacific Railroad tracks and Washington Street north of the airport. The reduction of the area within the 70 and 75 Ldn contours are largely the result of a combination of the thrust cutback on takeoff and the limitation of nighttime activity to Part 36, Stage 3 noise level aircraft.

The 65 Ldn contour tapers to an end five miles east of the airport over the Salt River channel. West of the airport, the 65 Ldn contour reaches two points on the extended centerlines of the runways approximately three miles west of 24th Street. The 65 Ldn sideline noise levels near the airport reach points approximately 3,500 feet north and south of the nearest runway. The relatively long extensions of the 65 Ldn contour are the result of aircraft using very gradual climb gradients in the cutback mode of the departure procedure. The 60 Ldn contour east of the airport bends northeasterly to follow the relatively vacant areas over the Salt River Indian Reservation, largely as a result of the 5 DME routing which channels all nighttime traffic along that route. West of the airport, the contour bends to the southwest over industrially used properties and the river bed, reflecting the turns to a 243 degree heading from both runways. The great majority of the persons within the 65 Ldn contour reside in areas directly west of Runway 8R-26L or in apartment and single-family residential units near the intersection of Curry and Scottsdale Roads.

Sensitivity of Noise Exposure to Individual Measures

As indicated by the exhibit, the noise exposure resulting from the scenario conditions is generally several Ldn less than that of unabated conditions, and the extent of the decrease varies from area to area.

The most effective tool for noise abatement close to the airport appears to be the full utilization of a departure thrust reduction to "quiet EPR" levels for climbs to 3,000 feet AGL. Within one to two miles of the runway ends, the use of power settings less than normal climb power will cause the contours to retract significantly toward the airport. From that location to the point where the average departure reaches 3,000 feet AGL using a thrust cutback, the width of the noise contour is reduced by approximately 5 Ldn to each side, while along the direct route of flight, the length of the contour is reduced by 1 to 5 Ldn. Beyond the 65 Ldn contour, climb power is reapplied and noise levels may be extended for greater distances from the airport than under unabated conditions.

The use of a preferred east traffic flow in this scenario will, by itself, reduce noise levels by 2 to 3 Ldn west of the airport and increase levels by 1 to 2 Ldn east of the airport. The limitation of jet arrival and departure operations between 10:00 p.m. and 7:00 a.m. to aircraft having maximum noise levels in compliance with F.A.R. Part 36, Stage 3 will reduce the general noise levels by approximately 2 Ldn from baseline conditions.

Unfortunately, the reductions provided by the three general measures are not directly additive. Noise is summed logarithmically, and consequently, the benefits gained from a combination of measures will be greater than any single measure, but will not be as great as the arithmetic sum of the reductions gained from individual measures.

Noise reductions resulting from the three measures which prescribe specific routes of flight will be reflected only in the areas overflown. In general, they do not significantly decrease the size of the noise contour, but rather relocate it. These relocations are designed to move the noise to more compatible areas. A turn to a heading of 243 degrees by aircraft using SID departures from

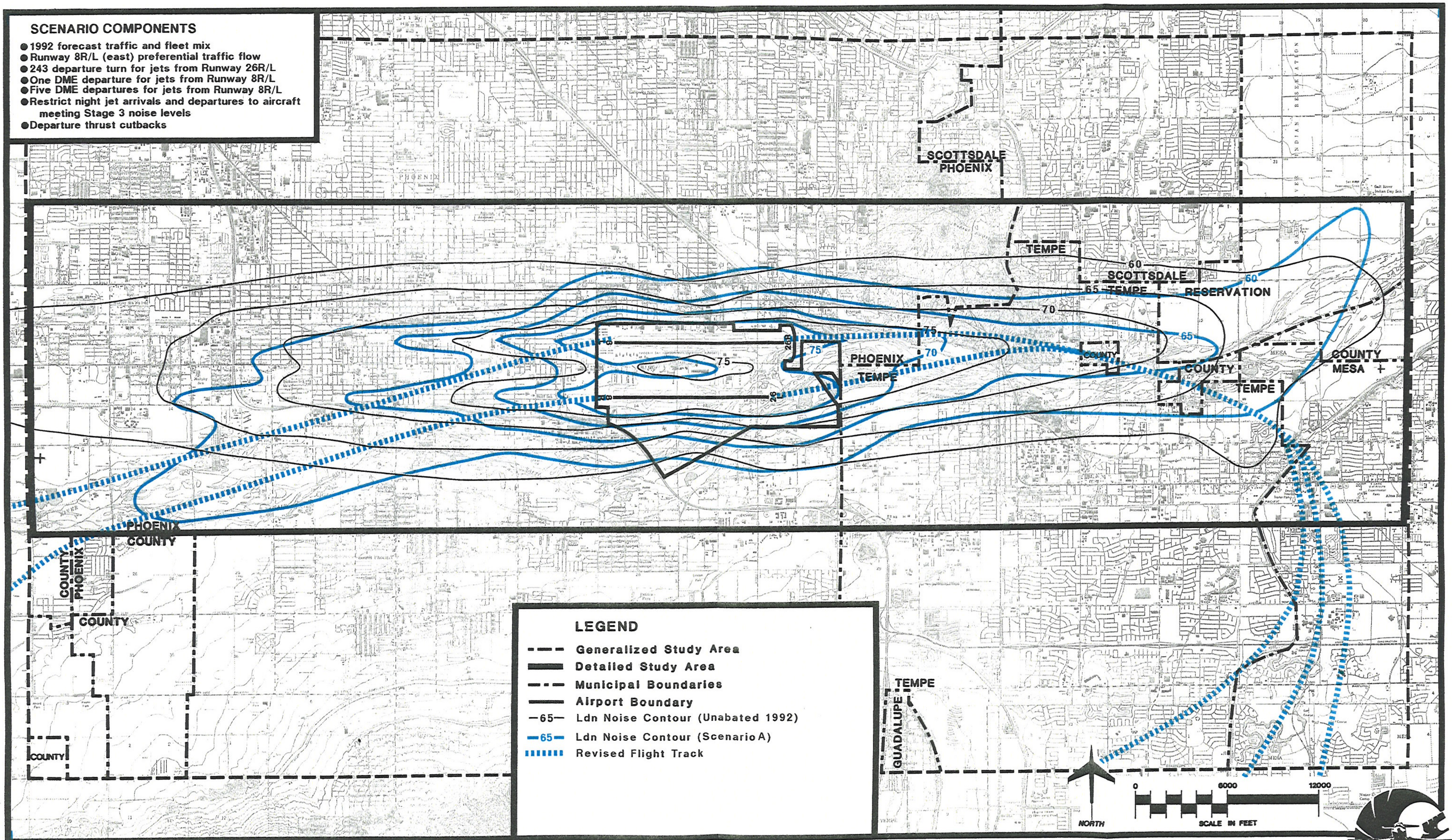


Exhibit 5C
SCENARIO A
NOISE EXPOSURE CONTOURS

Sky Harbor INTERNATIONAL AIRPORT

Runways 26R/L creates a southward bend of the contours west of the airport. As distance is increased from the airport, the amount of compatible land increases in comparison to the unabated contour.

To the east of the airport, the two measures associated with departure traffic routes from Runway 8R/L serve to extend the contour to the east, individually by as much as two Ldn. The redefinition of the tracks will shift the noise pattern to the southeast and to the northeast over more compatible areas, but the reduction in the extent of the contour is the result of other measures.

Operational Considerations

Operationally, parts of Scenario A could be difficult to implement. Operational concerns are associated with the safety of the cutback procedure, the potential for airspace conflicts deriving from the left turns from Runways 26R/L or the 5 DME procedure, potential capacity constraints related to the 1 DME procedure, and increased flight times caused by the 5 DME measure.

Thrust cutback procedures for noise abatement are occasionally cited as unsafe. During extreme conditions of temperature or weather, such a procedure may be unsafe, but for the average annual condition, the cutback is believed to be advantageous for noise abatement if limited to levels previously approved as safe by the FAA. Several airlines have cited typical thrust cutback levels of 1.6 to 1.8 EPR for noise abatement. If all carriers would, in fact, operate within this range, the thrust cutback measure would be beneficial to noise abatement.

Left turns by all IFR aircraft departing from Runway 26R/L to a heading of 243 degrees would, according to ATC and TRACON, result in intolerable airspace conflicts west of the airport. These conflicts would occur even if traffic were separated between the runways based on the SID selected for departure. The variability of the initial turn location (by aircraft type and pilot) may result in aircraft flying essentially the same departure track southwest from the airport. This situation would result in costly delays to the operational efficiency of the airport and could be solved by the implementation of a designated initial turn location from each runway heading. The separation of traffic between the two runways would require the construction of a second cross-field taxiway or the acceptance of major delays to operation. The Airport Layout Plan indicates a second cross-field taxiway to be constructed at the east end of the runways as a part of the Terminal Four project. Two additional crossfield taxiways are indicated on the ALP for future construction, but the Master Plan is undergoing update and these may be revised in location or number.

The use of the 5 DME procedure which routes nighttime departures from Runways 8R/L to the northeast and then south and southwest near the Williams MOA 1 may potentially create airspace conflicts if Williams AFB is active. The measure is assumed as being in place only during periods of low activity at Williams. It is not intended to be assigned for departures from Sky Harbor when the airspace in the east end of the valley is saturated. Consequently, its period of use would rely on directives from TRACON during the low activity periods. When significant numbers of military operations occur in the area outside the normal high activity periods, the route should not be assigned.

It has been suggested that the 1 DME departure procedure from Runway 8R/L is capacity reducing. In that traffic from both runways will be flown along the same flight route prior to its dispersion, capacity will likely be reduced during peak periods. ATCT has indicated that current traffic levels can be accommodated by the measure.

If the 5 DME procedure were implemented as programmed in the scenario, the flight distances for each affected departure would increase from 11 to 18 miles. This will increase each effected flight time by approximately three to five minutes, and may require minor schedule adjustments to accommodate this difference.

The limitation of nighttime operations to those aircraft meeting Stage 3 noise levels may result in approach operations which are rushed to "beat the clock". Ten of the 28 nighttime arrivals by non-Stage 3 aircraft occur during the first 30 minutes of the penalty period.

Cost Considerations

Cost considerations are not the overriding concern in the development of noise abatement programs. However, if a measure is expensive relative to its benefits, as perceived by those who must bear the cost, the measure can meet opposition to its implementation. Each of the measures has an effect on the cost of operation for the users of the airport, or on the airport itself. All cost estimates are in increments over current operating costs and are presented in 1986 dollars for 1992 operational levels. They would need to be inflated to the time of implementation to indicate costs at that time.

A runway use program favoring easterly flows should have the least cost impact of the measures in this scenario. For each flight mile required by a departing aircraft, a commensurate flight mile is normally accrued by approaching aircraft. Only during the times when the circuitous 5 DME route is in effect would additional flight milage not be balanced by approaches. The aggregate annual estimated cost for nighttime utilization of the 5 DME measure is more than $960,000 based on the combination of the routing and the preferred east traffic flow. If the procedure were extended to the weekends, the aggregate annual operational cost would increase to more than $2,500,000.

The net cost of implementing the 1 DME departure route was estimated at $145,000 annually based on additional flight milage of less than one-half mile. The net additional cost of flight time from implementation of a 243 departure heading for aircraft departing Runway 26R/L is estimated at $420,000. In both cases aircraft using the Payso and Cooper SIDs would incur operating cost increases, while aircraft using the Stanfield and Mobie SIDs would receive slight cost decreases. In the first route, individual Buckeye SID departures would cost less, while in the second, the cost of a Buckeye SID operation would increase. Taxi costs will increase as aircraft taxi across the field to appropriate runway ends for the 243 degree departures.

An additional major cost associated with the 243 departure procedure is the provision of a second crossfield taxiway to allow ATC to separate aircraft by their departure SID. This facility is needed for the efficient use of Terminal Four. Under a current program, the taxiway will soon be under construction with completion expected late in 1989.

The cost of operation of an aircraft using noise abatement thrust cutback procedures, as opposed to normal climb power departures, is known to be somewhat less, owing to lower strains on engines and commensurately lower maintenance costs. Statistics are not available which delineate cost differentials between the two climb modes.

The major cost associated with Scenario A may be in the costs which it would impose on the users of the facility in assuring that nighttime operations are compliant with F.A.R. Part 36, Stage 3 noise levels. The operation of aircraft would cost no more or less, but the cost of rescheduling aircraft throughout each carrier's system could be prohibitive. Of the carriers now serving Phoenix with operations between 10:00 p.m. and 7:00 a.m., all but Midway and Braniff have Stage 3 aircraft in their fleets and most have additional Stage 3 aircraft on order. These two carriers each have one operation which falls in the nighttime period, both scheduled between 10:00 and 10:20 p.m. Based on the February 1988 Official Airline Guide, 48 operations would need to be rescheduled to meet Stage 3 requirements. Furthermore, several cargo arrivals and one cargo departure would require rescheduling out of the nighttime period or replacement of the aircraft with a noise-compliant type.

It is not anticipated that the measure would require acquisition of new aircraft above and beyond that now being accomplished, but the requirement for a Stage 3 nighttime fleet would limit the effective utilization of each carrier's equipment in the national system.

Feasibility of Implementation

Scenario A was examined as to its feasibility for implementation. This preliminary judgement is based on all comments received from members of the Planning Advisory committee, participants in both the aviation and land use technical conferences, and from assessment of the acceptability of various measures on a nationwide basis.

While effective for noise reduction, the preferential east flow contradicts the interim agreement between the Mayors of Tempe and Phoenix. Consequently, its implementation would be expected to be difficult if not impossible and therefore, is eleminated from further consideration.

A turn to a 243 degree heading for aircraft departing Runways 26R/L is likely not implementable owing to the potential for airspace conflicts between aircraft using the departure from the separate runways. It is more likely to be implemented if the traffic is separated between runways based on the SID that will be used.
The 1 DME departure procedure has been flight tested and its implementation is anticipated this year.

The 5 DME departure procedure runs the risk of conflicting with operations at Williams A.F.B. and Falcon Field. Therefore, its potential for implementation is not considered to be favorable.

There are two methods to restrict nighttime operations. The first is the imposition of a Stage 3 noise level restriction for arrival and departure traffic. It is considered to be one of the more difficult measures of this scenario to achieve. Similar noise level restrictions imposed at San Francisco International Airport were strongly opposed by the F.A.A., even though alternate facilities were available in that metropolitan area. A less restrictive approach to nighttime noise level restrictions would be the development of an agreement with the various effected carriers to voluntarily restrict nighttime operations to noise compliant aircraft or to reschedule to non-nighttime hours.

Several air carrier representatives have indicated that they use a noise abatement departure procedure which reduces thrust during the initial climbout from the airport. The range of this reduction varies among carriers and by local operating conditions. The general application of the measure by at least a portion of the carriers is likely, but across the board use in all conditions is not likely. This may be due to system-wide operating needs, as well as local operating limitations.

Preliminary Implementation Strategy and Schedule

The implementation of the various measures will require different strategies and times for completion. Some may be accomplished in the near term because they have been examined for some time, while others will require construction and/or agreement development by participating parties.

On request of the airport proprietor, the preferential east traffic flow could be implemented via an agreement between the ATCT, TRACON and the airport designating Runway 8R/L as the calm wind runway. A stronger measure could define specific directional utilization under predefined wind and weather conditions. This second agreement may be written to allow the various carriers serving the airport to become signatory parties. Generally, the more complex the measure, the more subject it is to negotiation and the longer it will take to bring to fruition, so no specific schedule can be estimated for implementation.

A turn to a 243 degree heading for all jet aircraft departing Runways 26R/L would likely not be implemented due to potential crossing traffic, but this could be resolved if traffic is separated by SID. While SIDs from Runways 26R and 26L were being revised, a new crossfield taxiway would need to be constructed. As this taxiway is a part of the Terminal Four construction project, its completion is anticipated by 1990. Its construction might be expedited to bring the aircraft/SID separations into being sooner.

The implementation of the 1 DME procedure requires the revision of the departure SIDs from Runways 8R/L, their publication, and the familiarization of users with the changes. This process is underway and implementation has been indicated for the summer of 1988.

Implementation of a 5 DME procedure, as described in this scenario, would require an airspace study and flight testing to be conducted by the FAA, the development of a low activity period SID by TRACON, and could include the preparation of formal use agreements between the airport, TRACON, and the air carriers. The process to implement the 1 DME procedure has taken nearly three years, and given the complexity of the 5 DME procedure, it is not likely it could be fully implemented for at least five years.

The nighttime prohibition of jet arrivals and departures which do not meet Part 36, Stage 3 noise levels is a legislative and administrative action which may be implemented by the City of Phoenix. Policy legislation regulating maximum allowable approach and departure noise levels at specific locations along the flight tracks would need to be developed and time should be allowed for those users which operate louder aircraft at night to reschedule quieter aircraft into the noise- sensitive hours. If not challenged and full cooperation were obtained, this measure could be implemented within a few months, but similar measures have almost always faced administrative or legal challenges before implementation. Such delays could last years.

The use of consistent thrust cutback procedures by all carriers would require that several rewrite their procedures to address a specific airport. Others have current procedures which fall within the parameters incorporated in this scenario. Communication and agreement with the air carriers for use of the noise abatement departure procedure may be accomplished on an individual basis. Communication of the use of NBAA noise abatement procedures to general aviation users may be accomplished via publication in the FAA's facility directory, the Airmen's Information Manual or in distribution material specific to the airport. Consequently, immediate or existing implementation may be expected of some carriers, while others may never fully participate in the measure.

SCENARIO B - MODERATE IMPACT REDUCTION SCENARIO 1

The second scenario is composed of a series of noise abatement measures believed to be less difficult to put in place than those of Scenario A. The scenario is less controversial, less costly, and would require fewer adjustments to existing operational schedules, runway use programs, and flight routings. The measures included in the second scenario are:

- 1992 forecast traffic and fleet mix
- Rotational runway use
- 243 degree heading departure turn for jets from Runway 26L
- One DME departure from Runway 8R/L
- Restrict night jet departures to aircraft meeting Stage 3 noise levels
- Departure thrust cutbacks

This second scenario tests the effects of continuing the equal distribution runway program now authorized, as well as the 1 DME departure procedure expected to soon be in place. Additionally, it includes the full utilization of departure thrust cutbacks and a restriction of nighttime departures to aircraft meeting Stage 3 noise limits.

The scenario also incorporates a revised 243 degree departure procedure for jet instrument departures from Runway 26L and a redistribution of all Runway 26R/L departure traffic among the two runways. Traffic using the Payso or Cooper SIDs are assigned to Runway 26R and traffic using the Buckeye, Mobie or Stanfield SIDs are assigned Runway 26L. These assignments would require the construction of a crossfield taxiway(s) to accommodate the movement of aircraft between gate positions and the appropriate runway. The separation of traffic between the two runways based on the SID selected for departure will assist ATCT in the separation and control of departure traffic to the west.

Noise Reduction Results

The projected noise contours resulting from full implementation of Scenario B are contrasted with the 1992 unabated contours on Exhibit 5D. The noise exposure is reduced significantly both east and west of the airport. The population within the scenario contours is compared to the unabated forecast population in Table 5B.

TABLE 5B
Comparative Population Impacted
1992 Unabated Noise Vs. Scenario B

	1992 Unabated			Scenario B		
Ldn Noise Level	West	East	Total	West	East	Total
65-70	10,819	6,083	16,902	5,574	1,052	6,626
70-75	13,367	3,150	16,517	114	50	164
75+	1,668	0	1,558	0	0	0
Total	24,854	9,233	34,087	5,688	1,102	6,790
LWP	20,126	6,558	26,684	3,584	701	4,285

The population falling within the 65 Ldn contour resulting from full implementation of this scenario is less than that associated with Scenario A. No persons would reside within the 75 Ldn contour and the reduction within the 70 Ldn contour would be more than 99 percent. The area within the 65 Ldn contour is reduced from 13,997 acres for unabated conditions to 6,893 for the scenario. Again, the total area is less than that included within the contours of Scenario A. The primary reason the population and contour area are smaller than those of Scenario A is that the preferential east flow and 5 DME procedures have been dropped in Scenario B. These two measures concentrated departing traffic along a single flight corridor east of the airport rather than dispersing its noise.

As under Scenario A, the 70 and 75 Ldn contour remains over the airport or nonresidential areas to the immediate east and west of the runway ends. The sideline dispersion of the 75 Ldn contour does not pass beyond the airport. The population within the 70 Ldn contour is located in small residential pockets north of the airport. The reduction of the area within the 70 and 75 Ldn contours are largely the result of a combination of the thrust cutback on takeoff and the limitation of nighttime departures to Part 36, Stage 3 noise level aircraft.

East of the airport the 65 Ldn contour ends over north Tempe. West of the airport, the 65 Ldn contour extends approximately 3 1/2 miles west of the west end of Runway 26R and 2 3/4 miles west of the west end of Runway 26L. The 65 Ldn sideline noise levels near the airport reach as far as 3,000 feet north and south of the runway. The 60 Ldn contour west of the airport splits to form two fingers, each related to a departure route from the Runway 26 pair. The finger associated with Runway 26R is larger because it reflects not only departure noise from that runway, but also includes approach noise from both Runways 8R and 8L. The southern finger reflects that noise associated with departures from Runway 26L following the 243 degree heading procedure. As under the previous scenario, the majority of persons residing within the 65 Ldn contour are located near the intersection of Curry and Scottsdale Roads in north Tempe or along the extended centerlines of both runways west of the airport.

Sensitivity of Noise Exposure to Individual Measures

The general measures of this scenario are subject to similar sensitivities as in Scenario A. The complete elimination of the noise abatement departure procedure would result in noise increases of 1 to 5 Ldn, dependent upon the area under consideration. The elimination of the nighttime departure restriction would result in increased levels of approximately 2 Ldn. There is virtually no difference between the departure restriction and the total restriction to aircraft having Stage 3 noise levels.

Dropping the 243 departure procedure from Runway 26L would likely result in the joining of the 65 Ldn contours from both runways west of the airport and the inclusion of significantly more persons within the contour (estimated as approximately 12,000). The population within the 70 Ldn contour would also increase (by an estimated 600 to 700 persons) as a result of extending the contour west of Runway 26L.

The elimination of the 1 DME procedure would shift the noise pattern to the north over less compatible areas and would slightly increase the population within the 65 Ldn contour.

Elimination of the rotational runway use program would result in greater noise levels to the east as a result of greater wind frequency from that direction, especially during the nighttime hours. This adjustment would increase east side noise levels by 1 to 2 Ldn east of the airport and decrease them by 1 to 2 Ldn west of the airport.

Operational Considerations

This scenario should be less difficult to implement than Scenario A. Concerns remain relative to the safety of the cutback procedure and capacity constraints related to the 1 DME procedure. The earlier concerns for airspace conflicts on the 243 departure heading are alleviated by the enhanced separation of traffic via both runway selection by SID used and departure heading. It will be necessary to redefine VFR general aviation departure

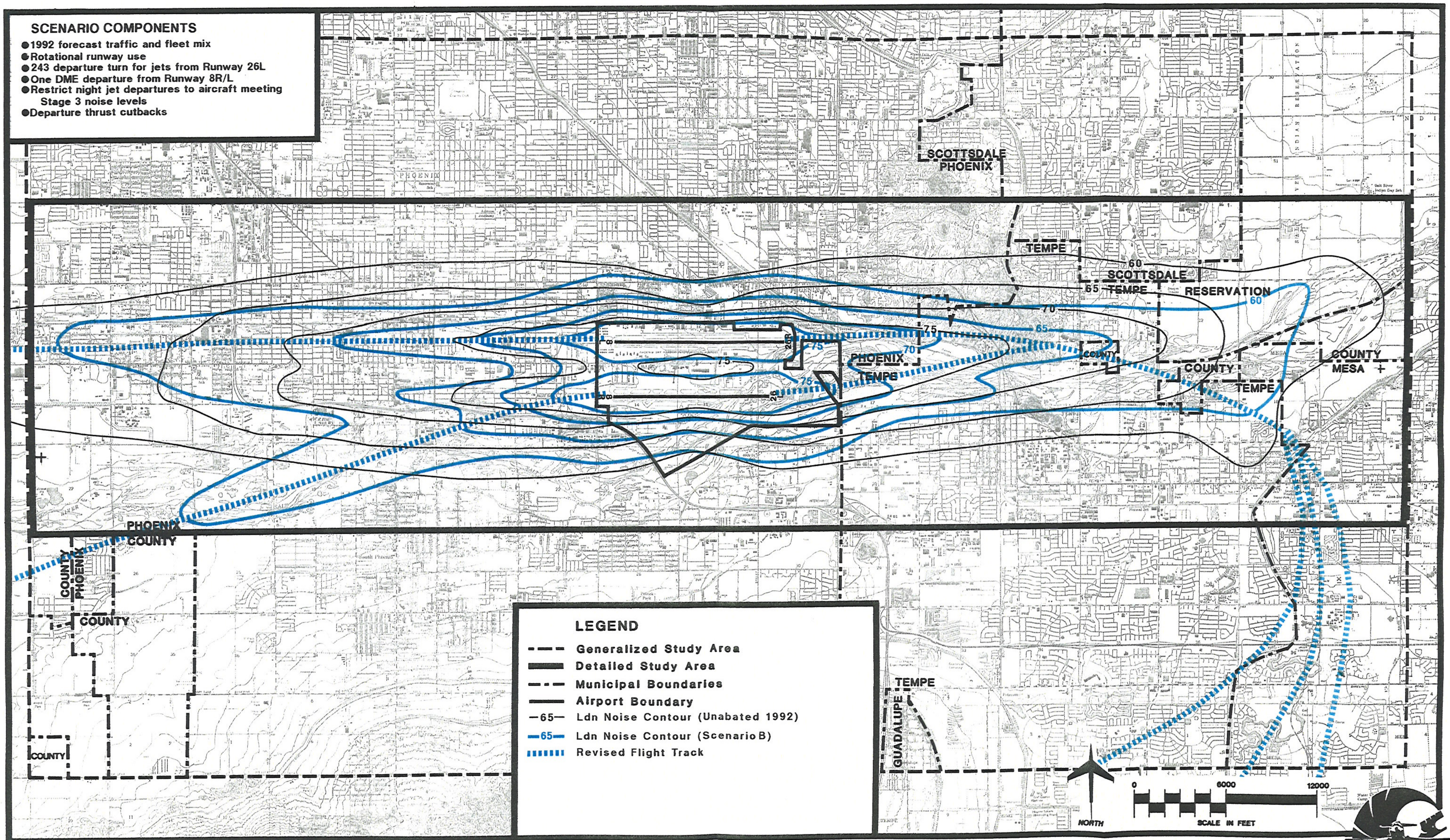


Exhibit 5D
SCENARIO B
NOISE EXPOSURE CONTOURS

Sky Harbor INTERNATIONAL AIRPORT

and arrival routes south of the airport to fully implement the 243 procedure.

As was indicated earlier, the 1 DME departure procedure from Runway 8R/L may reduce capacity. The degree of any reduction is, however, less under this scenario than under Scenario A because a smaller number of departures are programmed to the east. ATCT has indicated that normal traffic levels can be accommodated by the measure.

Formalization of the rotational runway use program may occasionally require operation in directions which are less than optimal. During periods of low activity, pilots will often request the use of Runway 8R or 8L for departure if the winds are favorable and the destination is to the east of Phoenix.

Under proper circumstances, aircraft may operate with tailwinds of up to seven knots, allowing greater latitude in runway assignment, but the selection of a runway for use is often based in the aircraft's location on the field, its destination, and the time required to exit the local airspace. A pilot will often opt for the most convenient runway available if conditions are not unfavorable. This can result in an imbalancing of the rotational use program during off-peak hours.

Cost Considerations

A rotational runway use program calling for equalized directional flows should have little cost impact. Milage flown to and from the exit and entry points to the local airspace are essentially equal and consequently will balance cost effects.

The net cost of implementing the 1 DME departure route was estimated at $94,000 annually based on additional flight milage of less than one-half mile. The savings of flight time from implementation of a 243 departure heading for aircraft departing Runway 26L and using a south turning SID is estimated at $180,000. Flight costs for aircraft using the Payso and Cooper SIDs would not change, while aircraft using the Stanfield and Mobie SIDs would benefit from cost reductions and costs for those using the Buckeye SID would be slightly greater. Taxi costs may be expected to increase as aircraft taxi across the airfield to appropriate runway ends. As was indicated under Scenario A, the additional crossfield taxiway required to implement the 243 heading procedure may, although included as part of the Terminal Four plan, be partially attributed to noise abatement needs.

The cost of operation of an aircraft using noise abatement thrust cutback procedures as opposed to normal climb power departures was discussed under Scenario A.

Again, a major cost associated with this scenario is the same as under Scenario A. The users would incur costs in rescheduling or acquiring aircraft to meet a requirement for nighttime departure operations to be compliant with F.A.R. Part 36, Stage 3 noise levels. The operation of individual aircraft would cost no more or less, but the cost of rescheduling other aircraft throughout each carriers system could be significant. Of the ten carriers now departing Phoenix between 10:00 p.m. and 7:00 a.m., all but Braniff have Stage 3 aircraft in their fleets and most have additional Stage 3 aircraft on order. Based on the February, 1988 Official Airline Guide, 20 departures (51 percent) would need to be rescheduled to meet Stage 3 noise level requirements. Furthermore, one cargo departure (6:00 a.m., five days weekly) would require either rescheduling out of the nighttime period or that a different aircraft be assigned to the run.

Feasibility of Implementation

The rotational runway use program (flow equalization) agrees with the interim agreement between the Mayors of Tempe and Phoenix. Consequently, it is considered acceptable, but its continuing and full implementation may be difficult to achieve without a formalized agreement between the airport, TRACON, the ATCT and the users.

A turn to a 243 degree heading for aircraft departing Runways 26L appears to be implementable if traffic is assigned to runways based on the SID used. This judgment of implementability assumes that appropriate steps will be taken to relocate the VFR departure routing and general aviation arrival routes south of the airport.

The 1 DME departure procedure has been flight tested and its implementation is considered likely.

The imposition of a Stage 3 noise level restriction for departing is considered to be more implementable than a total restriction, but remains very difficult to implement. Similar restrictions at other airports have been strongly opposed by the F.A.A. and users. A voluntary agreement is considered more likely to be acceptable to the users.

Several air carriers have indicated that they use a noise abatement departure procedure which reduces thrust during the initial climbout from the airport. The range of this reduction varies among carriers and by local operating conditions. The general application of the measure by at least a portion of the carriers is likely, but across the board use in all conditions is not likely. This may be due to system-wide operating needs, as well as local operating conditions.

Preliminary Implementation Strategy and Schedule

The rotational runway use program has been implemented voluntarily, but could be strengthened by an agreement between the airport, ATCT, TRACON and the users. Development of a formal agreement will require an unknown amount of time for its negotiation and acceptance by all parties.

A turn to a 243 degree heading will require the revision of the Stanfield, Mobie and Buckeye SIDs from Runways 26L and the construction of a new crossfield taxiway. Construction of this taxiway is anticipated by 1990. Its construction might be expedited to hasten the aircraft/SID separations.

The implementation strategy and schedule for the 1 DME procedure is discussed under Scenario A.

The methodology and schedule considerations for implementation of the nighttime prohibition of jet departures which do not meet Part 36, Stage 3 noise levels is virtually the same as that discussed for the similar measure under Scenario A. Restrictions would be limited to departure noise levels.

The methodology necessary to implement the use of thrust cutback procedures and the timing of implementation are the same as discussed under Scenario A.

SCENARIO C - MODERATE IMPACT REDUCTION SCENARIO 2

The third scenario selected for evaluation is the least controversial of the three and requires fewer changes to current operating conditions. The measures incorporated in the scenario are:

- 1992 forecast traffic and fleet mix
- Rotational runway use
- 243 degree heading departure turn for jets from Runway 26L
- One DME departure from Runway 8R/L
- Departure thrust cutbacks

Of the measures included in this scenario, the equal distribution runway use program and the one DME departure procedure have already been authorized. Departure thrust cutbacks are used by several of the carriers and may be extended to all users. The revised 243 degree departure turn from Runway 26L considers the assignment of north turning traffic to Runway 26R and south turning traffic to Runway 26L to avoid crossing patterns beyond the 13 DME location.

Noise Reduction Results

The noise contours derived from a computer analysis of Scenario C are contrasted to the 1992 unabated contours on Exhibit 5E. The noise exposure is reduced both east and west of the airport. The population within the scenario contours is compared to the unabated forecast population in Table 5C.

TABLE 5C
Comparative Population Impacted
1992 Unabated Noise Vs. Scenario C

	1992 Unabated			Scenario C		
Ldn Noise Level	West	East	Total	West	East	Total
65-70	10,819	6,083	16,902	9,616	1,670	11,286
70-75	13,367	3,150	16,517	320	117	437
75+	1,668	0	1,668	0	0	0
Total	24,854	9,233	34,087	9,936	1,787	11,723
LWP	20,126	6,558	26,684	6,290	1,146	7,436

The population falling within the 65 Ldn contour resulting from full implementation of this scenario is several thousand more than that of the earlier scenarios. As under both earlier scenarios, no persons would reside within the 75 Ldn contour. The reduction of impacted population within the 70 Ldn contour would be more than 97 percent. The area within the 65 Ldn contour is reduced from 13,997 acres for unabated conditions to 9,030 acres for the scenario.

The 75 Ldn contour remains over the airport or nonresidential areas to the immediate east and west of the runway ends. The 70 Ldn contour just reaches the east end of Nuestro Barrio west of Runway 26L, but the majority of the population within the 70 Ldn contour resides north of the airport. The reduction of the area within the 70 and 75 Ldn contours are largely the result of the full use of the thrust cutback on takeoff.

East of the airport the 65 Ldn contour extends to Price Road, but remains over compatible areas except where it falls over residential areas near Curry and Scottsdale Roads. West of the airport, the 65 Ldn contour extends approximately 4 1/4 miles west of the west end of Runway 26R and 2 3/4 miles west of the west end of Runway 26L. Aside from small residential areas north and south of the airport, the impacted residential areas within 65 Ldn fall along or adjacent to the extended runway centerlines. The 60 Ldn contour west of the airport splits to form two large extensions, each related to the departure routes from the Runway 26R and 26L. To the east, the 60 Ldn contour bulges to reflect turns to enroute courses from the initial departure route.

Sensitivity of Noise Exposure to Individual Measures

The sensitivity of the rotational runway use program discussed under Scenario B applies equally to Scenario C, as does the sensitivity relationship of the 1 DME departure procedure. Much of the improvement indicated by this scenario reflects the full utilization of the noise abatement departure procedure. This procedure results in noise decreases of 2 to 6 Ldn from unabated conditions, dependent upon the area under consideration.

Dropping the 243 departure procedure from Runway 26L would likely result in the joining of the 65 Ldn contours from both runways west of the airport and the inclusion of significantly more persons within the contour (estimated as approximately 14,000). The population within the 70 Ldn contour would also increase (by an estimated 1,000 persons) as a result of extending the contour west of Runway 26L.

Operational Considerations

This scenario should be less difficult to implement than either of the earlier scenarios. The operational considerations of rotational runway use, the thrust cutback procedure, and the 1 DME and 243 heading departure procedures were discussed under Scenario B and remain applicable here.

Cost Considerations

The operational and capital cost considerations of the measures comprising this scenario are identical to those of Scenario B. The costs of rescheduling or aircraft acquisition required there are not included here. The net operational cost for flight time associated with this scenario is estimated to be approximately $86,000 less than under unabated conditions, although additional costs will be incurred for taxi time to implement the separations necessary under the 243 departure.

Feasibility of Implementation

The feasibility of implementation of each of the component measures was discussed under Scenario B and applies equally to Scenario C. Implementation of the components appears feasible.

Preliminary Implementation Strategy and Schedule

The strategies and schedules of implementation for the components of this scenario were discussed under Scenario A or Scenario B.

ADDITIONAL RETAINED MEASURES

In addition to the techniques incorporated into the three scenarios, those measures now in place and suggested for retention at Phoenix Sky Harbor International Airport are:

1) Prohibition of maintenance runups between 2100 and 0600 hours.
2) Continue noise monitoring program.
3) Continue funding of noise compatibility staff.
4) Continue noise abatement committee.
5) Continue community education program.

Furthermore, although the following measures are not included in the scenarios, they remain as potential alternatives for noise abatement and management. They are available at local option and may be incorporated into the noise compatibility program.

- Encouraged use of general aviation reliever facilities.
- Development of preferred helicopter flight routes.

SUMMARY

A variety of noise abatement measures have been addressed in this chapter and Appendix D. After preliminary evaluation, a number of measures were selected for inclusion in three operational scenarios. The scenarios were presented in order of perceived difficulty of implementation. Of the components included, only the preferential east flow and rotational runway use program are mutually exclusive.

It should again be restated that the evaluations conducted in this chapter and in Appendix D are tentative. The components of each scenario may be independent of each other and the invalidation of any one measure does not necessarily invalidate the remaining measures. Furthermore, as the final program is developed, measures not incorporated into these scenarios may be reinstated. Also, components tested under one scenario may be combined with components tested under another scenario in the preparation of the final program.

The assessments presented here are subject to review by the Planning Advisory Committee, community officials, the project sponsors, the FAA and the general public. The final program will evolve from input provided by each of these groups. It will incorporate not only a recommended program of noise abatement measures, but also a methodology for their implementation, their monitoring, their scheduling, and their financing. Additionally, the associated land use management techniques discussed in the next chapter may play a major role in the utility and effectiveness of each selected measure.

With the exception of the left turn from Runway 26R to a 243 heading by aircraft using any SID, each measure incorporated in the three scenarios appears to be implementable from a safety and airspace perspective. Furthermore, the measures which are listed as additional retained measures may be incorporated in the final noise compatibility program if considered warranted.

Nonetheless, the measures which may be feasible and appear to provide optimal noise abatement are:

- Continued use of rotational runway use program.
- Implement 1 DME SID procedures from Runway 8R/L.
- Implement 243 degree jet departure heading from Runway 26L.
- Separate Runway 26R/L jet departures by SID selected.
- Continued and enhanced use of noise abatement cutback procedures by all jet aircraft.
- Nighttime restriction of jet departures to Part 36, Stage 3 noise levels.
- Develop optimal helicopter routes to and from, as well as across the local airspace.
- Continued restriction of maintenance runup times.
- Continue noise monitoring, staff, committee and public education programs.
- Encourage continued development of general aviation reliever facilities.

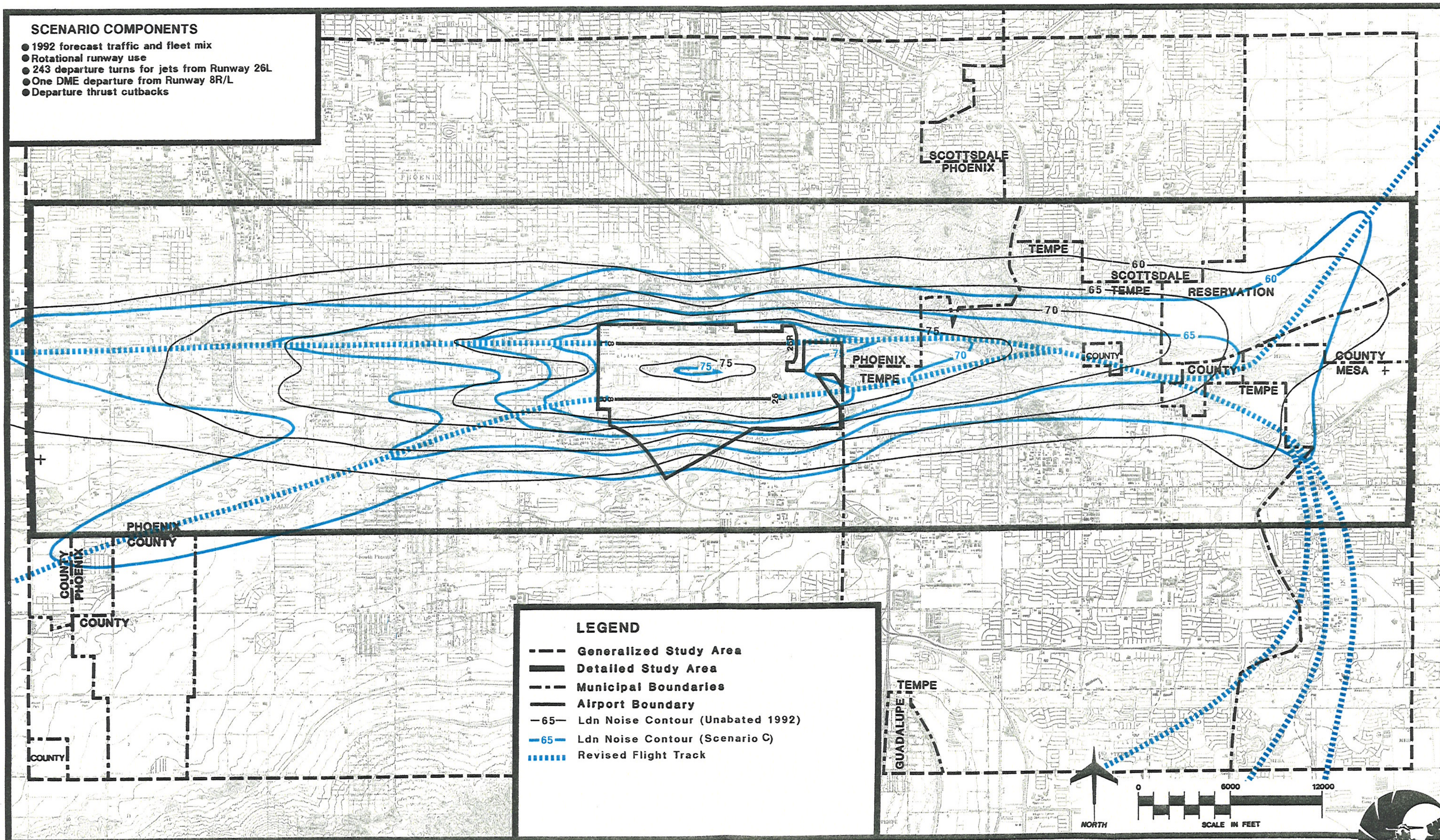


Exhibit 5E
SCENARIO C
NOISE EXPOSURE CONTOURS