Chapter Four
NOISE ABATEMENT ALTERNATIVES

Noise Abatement Alternatives

The DOT/FAA Aviation Noise Abatement Policy of 1976, the Airport Safety and Noise Abatement Act of 1979, and *the Airport Noise and Capacity Act of 1990* outline the framework for a coordinated approach to noise abatement and the mitigation of noise impacts. Responsibilities are shared among federal, state, and local governments; aircraft manufacturers; airport proprietors; and residents of communities near the airport.

- The federal government has the authority and responsibility to control aircraft noise at the source, implement and enforce operational flight procedures, and manage the air traffic control system in ways that minimize noise impacts on populated areas.

- Aircraft manufacturers are responsible for incorporating quiet engine technology into new aircraft designs to meet federal noise standards.

- Airport proprietors are responsible for planning and implementing airport development actions designed to reduce noise. These include noise abatement ground procedures and improvements in airport design. Proprietors may also enact restrictions on airport uses that do not unjustly discriminate against any user, impede the federal interest in safety and management of the air navigation system, unreasonably interfere with interstate commerce, or otherwise conflict with federal law.

- Local governments are responsible for land use planning, zoning, and building regulations to encourage development that is compatible with present and projected airport noise levels.

- Air carriers, all-cargo carriers, and commuter operators are responsible for retirement, replacement, or retrofitting older aircraft to meet federal noise standards. They are also responsible for operating aircraft in ways that minimize the impact of noise on people.

- General aviation operators are responsible to use proper aircraft maintenance and flying techniques to minimize noise output.

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

- Residents of 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 affect of noise and make their locational decisions with that in mind.

An airport noise abatement program has three primary objectives:

1. To reduce the noise-impacted population in the study area, within practical cost and legal constraints by moving/reducing the noise contours.

2. To minimize, where practical, the exposure of the local population to very loud noise events. These loud single events can occur even outside the Day-Night-Level (DNL) contours. They can annoy airport neighbors and warrant attention.

3. To ensure maximum compatibility of existing and future noise-sensitive land uses with aircraft procedures and noise exposure in the airport vicinity.

This chapter discusses and analyzes measures which may potentially abate noise in the Lincoln Airport area. It begins by screening the full range of potential noise abatement measures for possible use at Lincoln Airport. The screening criteria includes the probable noise reduction over noise-sensitive areas, the potential for compromising safety margins, the ability of the airport to perform its intended function, and the potential for implementation considering the legal, political, and financial climate of the area. Measures which merit further consideration are analyzed in the following section where detailed noise analyses are presented.

POTENTIAL NOISE ABATEMENT MEASURES

A comprehensive list of potential noise abatement measures is shown on **Exhibit 4A**. F.A.R. Part 150 specifically requires most of these to be considered in noise compatibility studies for possible use at airports undertaking those studies. These techniques either (1) reduce the size of the noise contours or (2) move the noise to other areas where it is less disruptive.

To reduce the size of the noise contours, the total sound energy emitted by the aircraft must be reduced. This can be done by modifying aircraft operating procedures or restricting the number or type of aircraft allowed to operate at the airport. Measures which can be used to shift the location of noise include runway use programs, special flight routes, and airport facility development. In general, potential noise abatement measures can be assigned to the following four categories:

- Runway Use and Flight Routes
- Facilities Development
- Aircraft Operational Procedures
- Airport Restrictions and Regulations

RUNWAY USE AND FLIGHT ROUTES

The land use pattern around the airport provides clues to the design of arrival and departure corridors for noise abatement. By redirecting air traffic over compatible land uses, noise impacts may be reduced in noncompatible areas.

Lincoln Airport is surrounded by a mixture of commercial/industrial and residential uses. Additional residential and noise-sensitive development is proposed on all sides of the airport including in-fill development south of the airport.

Runway Use Programs

Runway use programs, the first noise abatement technique in the runway use and flight route category, refers to the use of selected runways by aircraft for noise abatement. There are two types of runway use programs: rotational and preferential. Rotational runway use is intended to distribute aircraft noise equally off all runway ends. Preferential runway use programs are intended to direct as much aircraft noise as possible in one direction.

Federal Aviation Administration (FAA) Order 8400.9 describes national safety and operational criteria for establishing runway use programs. It defines two classes of programs: formal and informal. A formal program must be defined and acknowledged in a Letter of

Understanding (LOU) between FAA's Flight Standards Division and Air Traffic Service, the airport proprietor, and the airport users. Once established, participation by aircraft operators is mandatory. Formal programs can be extremely difficult to establish, especially at airports with many different users.

An informal program is an approved runway use system which does not require the LOU. Informal programs are typically implemented through a Tower Order and publication of the procedure in the Airport/Facility Directory. Participation in the program is voluntary.

- EVALUATION

Currently, Lincoln Airport does not have a formal or informal preferential or rotational runway use program. Viable noise compatible corridors currently exist north, northwest, and south of the airport and are generally aligned with Runways 14, 17R, 32, 35L, and 35R. Runway 17L is the only runway that has noise-sensitive development along the extended centerline.

Wind conditions are a primary factor in runway use at Lincoln Airport. The winds in the Lincoln area are predominantly from the south-southeast making Runways 17L and 17R most often available to arriving and departing aircraft. Departures to the south from Runways 17L and 17R occur approximately 66 percent of the time and usually fly over a portion of the southern corridor.

Overflight impacts could potentially be reduced over the residential area off the extended centerline of Runway 17L during the nighttime hours (10:00 p.m. to 7:00a.m.) by shifting these operations to Runway 17R. This option will be analyzed in greater detail later in this chapter.

- CONCLUSION

Lincoln Airport has viable noise compatible corridors to the north, northwest, and south of the airport which are already used by departing aircraft. Shifting nighttime operations from Runway 17L to Runway 17R could potentially reduce overflight impacts over residential areas and will be assessed in greater detail at the end of this chapter.

Departure Turns

A common noise abatement technique is to route departing aircraft over noise-compatible areas immediately after takeoff. This is the second noise abatement technique in the runway use and flight route category. In order to be fully effective, the compatible corridor must be relatively wide and closely aligned with the runway so that turns over the area are practical.

- EVALUATION

As previously mentioned, viable noise-compatible corridors currently exist to the north, northwest, and south of Lincoln Airport. Runway 17L is the only runway that has noise-sensitive

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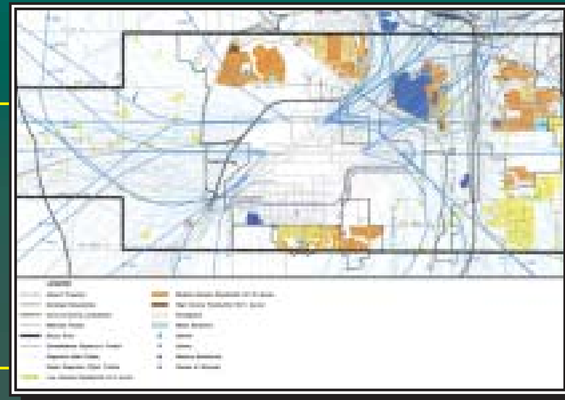
RUNWAY USE AND FLIGHT ROUTES

- Preferential Runway Use
- Rotational Runway Use
- Noise - Compatible Corridors
- Departure Turns
- Visual and Offset Instrument Approaches

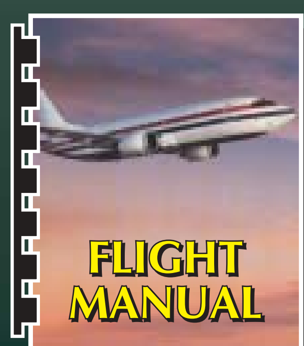


FACILITIES DEVELOPMENT

- Runway Lengthening
- New Runways
- Displaced / Relocated Thresholds
- Terminal Relocation
- Ground Activity Relocation
- Noise Barriers
- Navigational Aids

AIRCRAFT OPERATING PROCEDURES

- Reduced Thrust Takeoffs
- Thrust Cutback Departures
- Maximum Climb Departures
- Minimum Approach Altitude
- Approach Flap Adjustments
- Two-Stage Descents
- Raised Glide Slope Angle
- Limited Reverse Thrust
- Midfield Departures



AIRPORT RESTRICTIONS & REGULATIONS

- Nighttime Curfews
- Aircraft Type Restrictions Based On Noise Level
- Capacity Limitations
- Noise Budget
- Variable Landing Fees Based on Noise Level or Time of Day
- Ground Activity Restrictions
- Training Activity Restrictions

Lincoln Airport

Exhibit 4A
POSSIBLE NOISE ABATEMENT TECHNIQUES

development to the south off the extended centerline. Initiating a noise abatement departure turn to the east from Runway 17L would move aircraft further over the City of Lincoln and effectively shift noise from one residential group to another. A noise abatement departure to the west from Runway 17L is not possible because aircraft would be flying into the departure stream of Runway 17R.

- CONCLUSION

Compatible corridors currently exist straight off the extended centerlines of Runways 14, 17R, 32, 35L, and 35R. Runway 17L is the only runway that has noise-sensitive development along the extended centerline. Developing a departure turn that would avoid this noise-sensitive development would either shift noise to other noise-sensitive development or turn aircraft into the departure stream of Runway 17R. Therefore, departure turns will not be considered further.

Visual And Offset Instrument Approaches

The third noise abatement technique in the runway use and flight route category is visual and offset instrument approaches. These approaches involve turns relatively close to the airport that can sometimes be defined over noise-compatible corridors. These can be defined as either visual flight rule (VFR) approaches or non-precision instrument flight rule (IFR) approaches. A stabilized, straight-in final approach of at least one mile should be provided for small or medium-size aircraft. If large aircraft are involved, a longer straight-in final approach of two to three miles is needed. In some instances, to be effective for noise abatement, an offset or "side-step" approach must be used by the loudest aircraft, primarily business jets, using the airport.

- EVALUATION

At Lincoln Airport, compatible corridors currently exist straight off the extended centerlines of Runways 14, 17R, 17L, 32, and 35L. Runway 35R is the only runway that has noise-sensitive development along the approach path from the south. Even with the advent of advanced navigational technology, the relative closeness of incompatible land uses prevents the avoidance of this area on approach.

- CONCLUSION

Runways 14, 17R, 17L, 32, and 35L currently have compatible corridors along the approach path of each runway. Due to the close proximity of noise-sensitive development to the south of Runway 35R at Lincoln Airport, adjusted or approach procedures would not provide noise reduction benefits. Therefore, changes to the existing approaches for noise abatement are not viable and will not be considered further.

Midfield Departures

Midfield departures, the fourth noise abatement technique in the runway use and flight route category, refer to aircraft beginning their engine spool-up and takeoff role from a point, usually a taxiway intersection (intersection takeoffs), near midfield. While these operations are usually undertaken to reduce taxi time, such operations can help centralize departure spool-up noise on the airfield.

Since aircraft are not departing from the runway end, the usable length of the runway is reduced. This can present great safety and operational concerns given parameters such as aircraft performance, weight, outside air temperature, and airport altitude. Midfield departures would pose a serious safety concern given the limited runway length of Runway 17L-35R at Lincoln Airport. An additional concern is that by beginning the takeoff roll at a position farther down the runway, the aircraft will not have gained as much altitude prior to leaving the airport. This may increase the level of aircraft noise realized by residents living off the departure end of the runways.

- **EVALUATION**

Departures are currently allowed to start at the intersection of Taxiways E and J on Runway 17R. Aircraft starting there takeoff at this point on Runway 17R keeps the departure spool-up noise closer to the center of the airport while still providing over 9,000 feet of runway for take-off.

Midfield departures on Runways 17L-35R and 14-32 would inhibit aircraft from departing safely due to the short runway lengths (5,400 feet and 8,621 feet). These operations would further be jeopardized by the warm and humid weather experienced from late spring to early fall.

- **CONCLUSION**

Midfield takeoffs work well on Runway 17R due to the 12,901 feet available for takeoff. Allowing departures from Runway 17R to start at the intersection of Taxiway E and J keeps the majority departure spool-up noise on airport property. However, the shorter runway lengths of Runways 17L-35R and 14-32 would reduce the safety margins, especially during warm humid weather conditions.

AIRPORT FACILITIES DEVELOPMENT

The development of on-airport facilities to improve off-airport noise levels is an accepted technique in noise abatement. Airport facilities can be constructed or modified to reduce aircraft noise or shift it to compatible areas. Other facility changes that may offer some degree of noise abatement are displaced runway thresholds and acoustical barriers or shielding.

Runway Extensions And New Runways

Constructing a new runway or extending an existing runway is the first noise abatement technique in the airport facilities development category. New runways aligned with compatible land development or runway extensions shifting aircraft operations further away from residential areas are a proven means of noise abatement. New runways are most effective where there are large compatible areas near an airport, and existing runways are aligned with residential areas.

- EVALUATION/CONCLUSION

The runway system at Lincoln Airport is lined up with compatible land use corridors to the north, northwest, and south. Therefore, constructing a new runway for noise abatement would shift noise over noise-sensitive areas.

Runway extensions are usually beneficial where there is substantial residential development very close to one end of a runway and not the other. This is not the case at Lincoln Airport, as the runways are relatively free from close-in development. Therefore, extending runways to reduce noise impacts over noise-sensitive development is not practical.

Displaced And Relocated Thresholds

Displaced threshold, the second facilities development technique, involves the shifting of the touchdown zone for landings further down the runway. A relocated threshold involves shifting both the touchdown point and the takeoff initiation point. (In other words, the original runway end is completely relocated.) These techniques can promote noise abatement by effectively increasing the altitude of aircraft at any given point beneath the approach. The amount of noise reduction depends on the increase in altitude which, in turn, depends on the length of the displacement. Another potential noise abatement benefit of runway displacement may be the increased distance between the aircraft and noise-sensitive uses adjacent to the runway, from the point at which reverse thrust is applied after touchdown.

The determination of the amount of threshold displacement must consider the runway length required for landing in addition to the amount of noise reduction provided by the displacement. A considerable displacement is needed to produce a significant reduction in noise. (For example, if a runway threshold is displaced 1,000 feet, the altitude of an aircraft along the approach path would increase by only 50 feet.)

Unlike threshold displacement, threshold relocation increases noise off the runway end opposite the relocation because of the shift in the point of takeoff. Aircraft would be at lower altitudes at any given downrange location after takeoff than they would be without the relocation.

- EVALUATION

Parallel Runways 17R-35L and 17L-35R do not have displaced thresholds. Runway 14-32 has displaced thresholds located at each end of the runway. These are necessary to meet runway safety area and obstacle clearance requirements. Runway 17L-35R is the only runway that has noise-sensitive development off the extended centerline. However, Runway 17L-35R is only 5,400 feet long and reducing this runway's useful length would degrade the safety margins for little noise abatement benefit. Therefore, no rationale exists for displacing thresholds at Lincoln Airport.

- CONCLUSION

Threshold displacement and relocation generally offer only small noise reduction benefits. Any reductions in arrival noise caused by threshold relocations would be offset by increases in departure noise off the opposite runway end. Additionally, any measure that would reduce runway lengths would reduce safety margins of aircraft currently operating at Lincoln Airport. Threshold adjustment will not receive additional consideration for analysis at Lincoln Airport.

Acoustical Barriers

The third facilities development technique, acoustical barriers, such as noise walls or berms, are intended to shield areas from the noise of aircraft powering up for takeoff and rolling down the runway. It is also possible to use the orientation of buildings on the airport to provide a noise barrier to protect nearby residential areas from noise. Noise walls act best over relatively short distances, and their benefits are greatly affected by surface topography and wind conditions.

The effectiveness of a barrier is directly related to the distance of the noise source from the receiver, the distance from the barrier itself, as well as the angle between the ends of the berm and the receiver.

While noise walls and berms can attenuate noise, they are sometimes criticized by airport neighbors because they obstruct views. Another common complaint is that airport noise can become more alarming, particularly noise from unusual events, because people are unable to see the cause of the noise.

- EVALUATION

At Lincoln Airport, noise berms or walls would be largely ineffective for the attenuation of aircraft noise. Given the compatible development adjacent to the airport and the distance between area noise-sensitive development in the vicinity of the airport, there are no suitable areas for the effective placement of such a barrier.

- CONCLUSION

Since noise berms and walls do not offer noise reduction benefits to aircraft overflights or noise-sensitive areas not adjacent to the airport, these devices would offer no benefit and will not receive additional consideration.

Run-up Enclosures

An engine run-up enclosure, the final facilities development technique, is a special kind of noise barrier which can be appropriate at airports with aircraft engine maintenance operations. Engine run-ups are a necessary part of aircraft service and maintenance. They are necessary to diagnose problems and test the effectiveness of maintenance work. Run-up enclosures are designed so that aircraft can taxi or be towed into them. The structures are designed to absorb and deflect the noise from the run-up, thus reducing noise levels off the airport.

Run-up noise can be especially disturbing because it is so unpredictable. While the noise from takeoffs and landings is relatively brief and has a particular pattern to which a person can adjust, the noise from a run-up is completely unpredictable. The duration of the run-up can vary from 30 seconds to several minutes, and the listener has no way of knowing how long any given run-up will be. If the run-up is at or near full power, the noise level can be extremely high. Other important characteristics are the direction and frequency of run-up noise. Under full engine power, the noise levels toward the rear of the aircraft at angles of approximately 150 and 210 degrees are generally greater. The frequency characteristics of noise are also not equal in all directions.

The noise from the front of the aircraft is generally dominated by high-frequency fan and gear noise. The noise from the rear part of the aircraft is dominated by low-frequency combustion and turbulence mixing. Low-frequency noise attenuates more slowly than high-frequency noise. At distances greater than one mile from the aircraft, there is very little high-frequency noise and, essentially, all that remains at this distance is the low-frequency component of noise. Therefore, high-frequency noise from the front of the aircraft attenuates much quicker and noise generated from the rear of the aircraft attenuates much slower. This is important because low frequency noise is able to more easily penetrate the interior of building structures.

- EVALUATION

There are currently fixed-base operators (FBOs) that perform aircraft maintenance at Lincoln Airport on a regular basis. These operations involve both jet and propeller-driven aircraft, last up to 30 minutes, and range from partial to maximum power, several times per week.

The Lincoln Airport Authority contracted HWS Consulting Group, Inc. to prepare a run-up area study in March 2001. The purpose of the study was to investigate the potential for locating a new run-up area that would reduce the number of potential runway incursions by aircraft needing to cross active runways in order to perform run-ups. At the time this run-up area study was prepared, piston aircraft run-ups could be done on the east ramp but jet and turboprop aircraft run-ups were primarily done on the run-up pad located along Taxiway E adjacent to the west ramp. **Exhibit 4B** depicts the existing run-up pad location. A majority of the aircraft run-up activity is generated by fixed-base operators located in the general aviation area on the east side of the airport. These operators would have to cross all three runways to reach the run-up pad along Taxiway E, causing the potential for runway incursions.

The run-up area study identified four potential run-up pad locations on the east side of the airport. **Exhibit 4B** depicts the location of the run-up pad sites. Three criterion were used to evaluate each site: reducing the potential for runway incursions; potential of increasing noise to adjacent businesses, the Highlands residential area, and Highlands Golf Course; and pavement strength.

Sites A and B are limited because the run-ups would be moved closer to the Highlands residential area and golf course, and pavement load bearing capacity of the ramp in these areas. Site B would also limit future hangar development. Site C was found to be practical from the standpoint that the space was available and outside all the safety and object free zones. However, Site C was limited by the pavement load carrying capacity of Taxiway E and Runway 17L-35R would still need to be crossed to gain access to the site. Site D is limited because it is located in the runway visibility zone (RVZ) and Runway 17L-35R would still need to be crossed to gain access to the site.

The run-up area study concluded that it would be inappropriate to draw a final conclusion on siting a run-up area without assessing the noise impacts. In addition, if run-up noise is found to be a factor for all four sites, then the option of a run-up pen or hush house should be studied in detail for Sites B, C, and D.

Finally, the run-up area study suggested a short term trial of moving some run-up activity to the east ramp area.

A test was initiated in March 2001 allowing run-ups on the north end of east side general aviation ramp (Site A) from 7:00 a.m. to 7:00 p.m. Run-ups after 7:00 p.m. are to be done on the west side of the airport along Taxiway E. There have been no noise complaints on run-up activity at the airport since this test was initiated. However, aircraft congestion has been a concern on the north end of the east ramp and larger aircraft are now run-up at the run-up pad on the west side of the airport along Taxiway E.

- CONCLUSION

Based on the test of Site A, this site was found to be a suitable site for aircraft run-ups from 7:00 a.m. to 7:00 p.m. A noise analysis will be prepared for all four run-up area sites to provide a complete assessment of the run-up area options. In addition, a review of aircraft circulation at Site A will be done to try to eliminate congestion issues later in this chapter. A run-up enclosure analysis will also be prepared to access the potential to move all aircraft run-ups to the east side in order to reduce runway incursions.

AIRCRAFT OPERATIONAL PROCEDURES

Aircraft operating procedures which may reduce noise impacts include:

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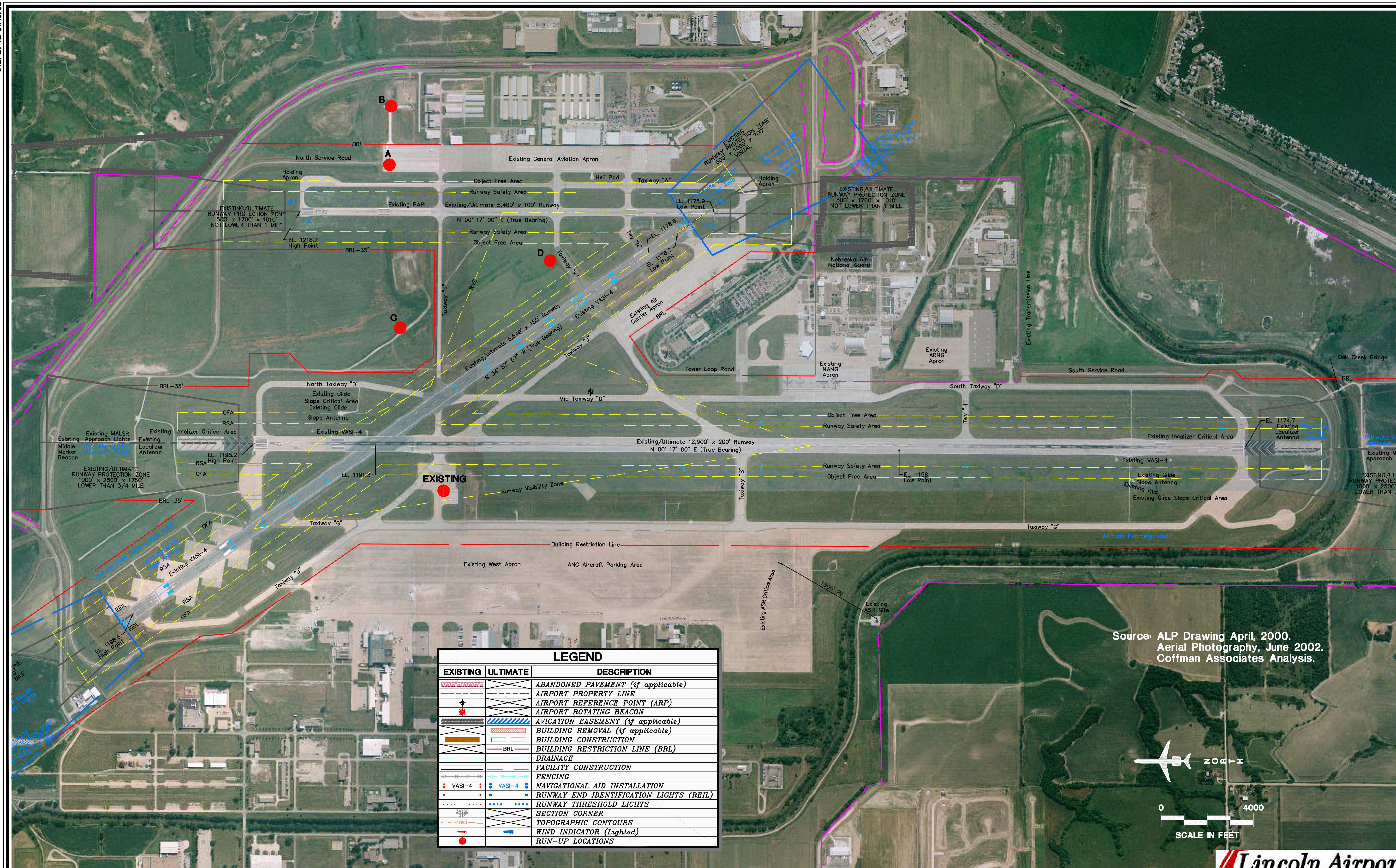

Lincoln Airport

Exhibit 4B

ALTERNATIVE RUN-UP LOCATIONS

- Reduced thrust takeoffs.
- Thrust cutbacks after takeoff.
- Maximum climb departures.
- Minimum approach altitudes.
- Use of minimum flaps during approaches.
- Steeper approach angles.
- Limitations on use of reverse thrust during landings.

Reduced Thrust Takeoffs

A reduced thrust takeoff for jet aircraft, the first operational procedure technique, involves takeoff with less than full thrust. A reduced power setting is used throughout both takeoff roll and climb. Use of the procedure depends on aircraft weight, weather and wind conditions, pavement conditions, and runway length. Since these conditions vary considerably, it is not possible to mandate safely the use of reduced thrust departures.

- EVALUATION

In practice, most airline and business jet operators at Lincoln Airport use reduced thrust departures to conserve fuel, reduce engine wear, and abate noise. Additional efforts to encourage the use of deeper reduced thrust takeoffs would reduce safety margins and are unlikely to yield noise abatement benefits.

- CONCLUSION

Because of the safety implications of these procedures, they are best left to the discretion of pilots and aircraft operators.

Thrust Cutbacks For Jets

The second operational technique is thrust cutbacks for jets. Standardized thrust cutback departure procedures have been established by each airline because of system wide operating needs and to promote noise abatement. While the procedures of each carrier differ somewhat, they all involve thrust reduction soon after takeoff and initial acceleration. This reduction normally occurs between 1,000 and 3,000 feet above the ground. The amount of thrust reduction depends on aircraft weight, temperature, and flap setting. A significant, but safe, reduction in thrust often can reduce noise within the 65 and 70 DNL noise contours but also can increase noise downrange from the airport.

For many years, the FAA has had an advisory circular describing recommended noise abatement departure procedures for large jets. In 1993, the FAA revised these guidelines and published them in Advisory Circular (AC) 91-53A. It provides for two standard thrust cutback procedures. One focuses on noise abatement near the airport (the close-in procedure), while the other abates noise further away from the airport (the distant procedure). The intent of the circular is to provide guidelines for aircraft operators to establish safe and effective procedures that can be used at all airports across the country. **Exhibit 4C** shows the version of the AC 91-53A distant departure procedure. The procedures flown by the other airlines are similar to that depicted in **Exhibit 4C**.

As a service to the general aviation industry, the National Business Aircraft Association (NBAA) prepared noise abatement takeoff and arrival procedures for business jets. 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 procedure and the close-in procedure. They are illustrated in **Exhibit 4D**.

The NBAA standard departure procedure calls for a thrust cutback at 1,000 feet above ground level (AGL) and at 1,000 feet per minute climb to 3,000 feet altitude during acceleration and flap retraction. The close-in procedure is similar except that it specifies a thrust cutback at 500 feet AGL. While both procedures are effective in reducing noise, the locations of the reduction vary with each. The standard procedure results in higher altitudes and lower noise levels over downrange locations, while the close-in procedure results in lower noise near the airport. Many aircraft manufacturers have developed their own thrust cutback procedures. Neither NBAA procedure is intended to supplant a procedure recommended by the manufacturer and published in the aircraft operating manual.

- EVALUATION

While some airports have defined special thrust cutback departure procedures, this is frowned upon by the industry. The air carriers fear the consequences of a proliferation of airport-specific procedures. As the number of procedures increased, it would become more and more difficult for pilots to become proficient at all of them and still maintain comfortable safety margins. It would be like asking motorists to comply with a different set of braking and acceleration procedures at every intersection in the city. In any case, safety requires that the use of thrust cutbacks in any given situation must be left to the discretion of the pilot based on weather and the operational characteristics of the aircraft.

- CONCLUSION

Standard thrust cutback departure procedures are already used by virtually all air carriers and many business jet operators. The Airport Authority should continue to encourage the use of these procedures since they can produce important noise reductions. Efforts to mandate the use of these procedures, however, are not advised. As a critical flight operation, the use of thrust cutbacks in any given situation should be left to the discretion of the pilot to avoid eroding safety margins.

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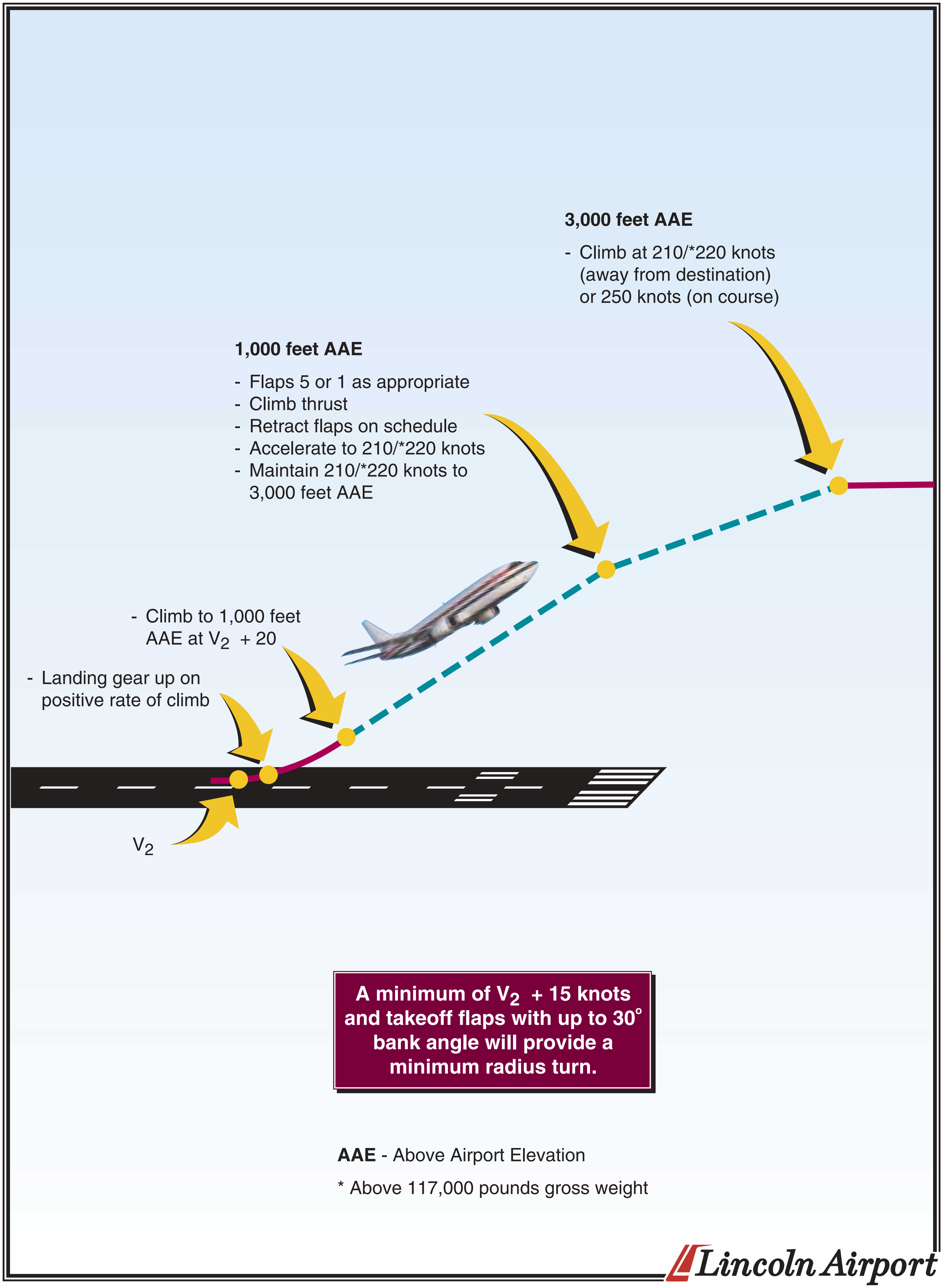

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Exhibit 4C
TYPICAL AIRLINE DISTANT NOISE ABATEMENT DEPARTURE PROCEDURE

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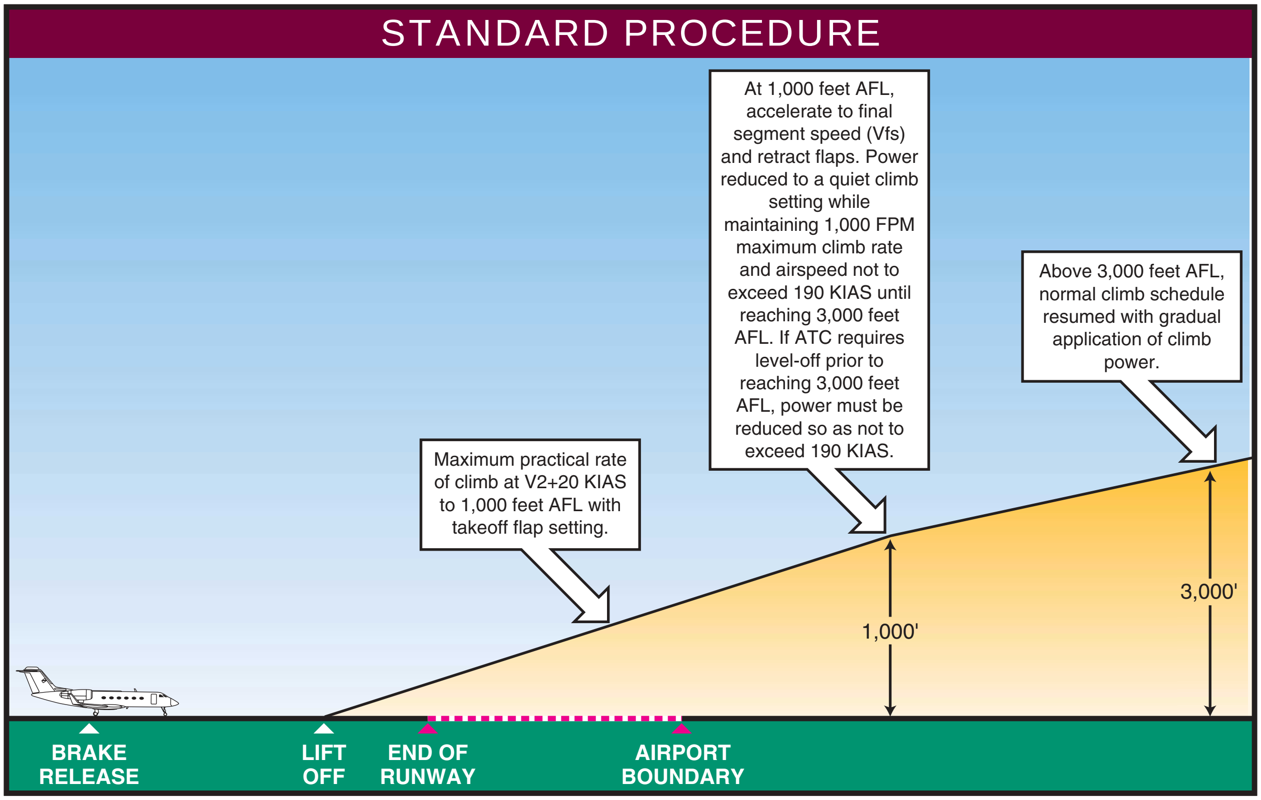

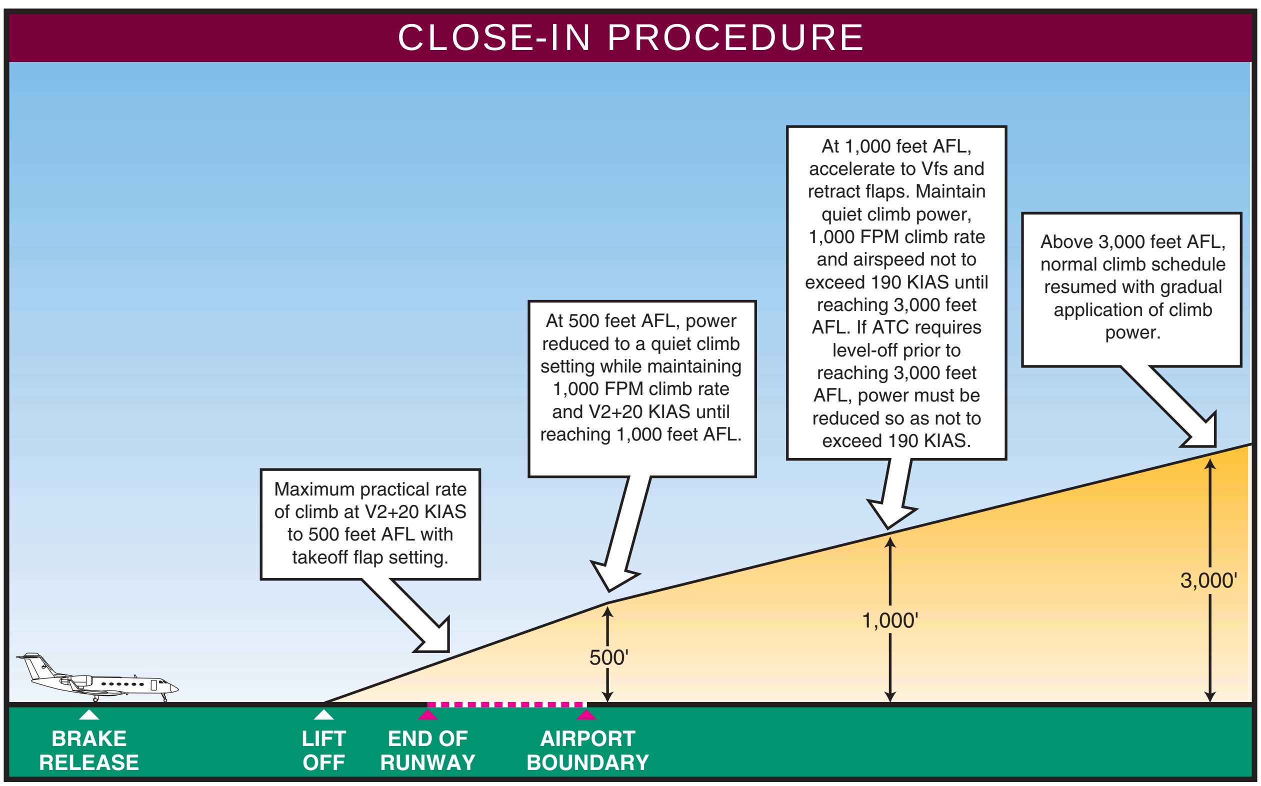

KEY

AFL - Above field elevation
ATC - Air traffic control
FPM - Feet per minute
KIAS - Knots, indicated airspeed

Note: It is recognized that aircraft performance will differ with aircraft type and takeoff conditions; therefore, the business aircraft operator must have the latitude to determine whether takeoff thrust should be reduced prior to, during, or after flap retraction.

Source: National Business Aircraft Association (NBAA), "NBAA Noise Abatement Program," January 1, 1993.

Lincoln Airport

Exhibit 4D
NBAA NOISE ABATEMENT DEPARTURE PROCEDURES

Maximum Climb Departures

Maximum climb departures, the third operational procedure, can help reduce noise exposure over populated areas some distance from an airport. The procedure requires the use of maximum thrust with no cutback on departure. Consequently, the potential noise reductions in the outlying areas are at the expense of significant noise increases closer to the airport.

- EVALUATION

While there are fewer residential areas close to Lincoln Airport than there are further out, this type of procedure would, in effect, be raising the noise levels considerably on those fewer people who are already exposed to higher noise levels than their outlying counterparts. These increases would be the cost for only marginal noise reduction on areas that are already receiving lower noise levels.

This type of procedure can also be very costly to operators at Lincoln Airport. The use of maximum thrust procedures would increase fuel usage and wear and tear on engines and equipment. Given today's economic climate, these types of costs can be critical to aircraft operators.

- CONCLUSION

Maximum climb departures at Lincoln Airport would, at best, slightly reduce noise impacts in the lower noise exposure areas while increasing noise close-in to the airport dramatically. The costs of this questionable benefit are also very high for operators and airlines at Lincoln Airport. Therefore, the procedure is not considered effective and has been dropped from further consideration.

Minimum Approach Altitudes

Minimum approach altitudes is the fourth operational procedure in this category. A minimum approach altitude procedure would entail an air traffic control requirement that all positively-controlled aircraft approaches be conducted at a specified minimum altitude until the aircraft must begin its descent to land. This would affect only aircraft quite some distance from the airport as well as outside the noise exposure contours. Since aircraft on approach are using little power, they tend to be relatively quiet. Accordingly, increases in approach altitudes result in only very small reductions in single event noise.

- EVALUATION

Currently, the pattern altitude at Lincoln Airport is 2,219 feet MSL (1,000 feet AGL) for small aircraft and 3,000 MSL (1,781 feet AGL) for military jets. Minimum altitudes would apply to aircraft some distance from the airport, well outside the noise exposure contour area. Increases in approach altitude can yield only small reductions in noise. Even doubling the altitude of aircraft within the traffic pattern or circling approach would achieve only a noise reduction of four to six decibels. Additionally, raising the pattern altitude would enlarge the pattern as aircraft would have to extend each leg of the traffic pattern to climb to, or descend from, the increased altitude.

- CONCLUSION

Raising approach altitudes into Lincoln Airport would produce only very small noise reductions well outside the 60 DNL noise contour. In addition, raising the traffic pattern altitude would potentially expose additional individuals to overflight noise due to an elongated traffic pattern. Therefore, these measures do not merit further consideration.

Minimum Flap And Steeper Approach Angles

The fifth and sixth operational procedures evaluated are minimum flap settings and steeper approach angles. Approach procedures to reduce noise impacts were attempted in the early days of noise abatement, but are no longer favorably received. The procedures include the minimal use of flaps in order to reduce power settings and airframe noise, the use of increased approach angles, and two-stage descent profiles.

- EVALUATION

All of these techniques raise safety concerns because they are non-standard and require an aircraft to be operated outside of its optimal safe operating configuration. Increased approach slope angles require aircraft to be landed at more than optimal approach speeds. The higher sink rates and faster speeds reduce pilot reaction time and erode safety margins. They also increase stopping distances on the runway and are especially inadvisable on relatively short runways, such as those at Lincoln Airport. Some of these procedures have actually been found to increase noise because of power applications needed to arrest high sink rates.

- CONCLUSION

Because these procedures erode safety margins and are of little practical noise abatement benefit, they do not deserve further consideration at Lincoln Airport.

Reverse Thrust Restrictions

The final aircraft operational procedure evaluated is reverse thrust restrictions. Thrust reversal is routinely used to slow jet aircraft immediately after touchdown. This is an important safety procedure which has the added benefit of reducing brake wear. Limits on the use of thrust reversal can reduce noise impacts off the sides of the runways, although they would not significantly reduce the size of the noise contours. Enforced restrictions on the use of reverse thrust, however, are not considered fully safe.

- EVALUATION

Given the location of noise-sensitive uses in the Lincoln Airport vicinity, a restriction on thrust reversal would not produce significant benefits. Reverse thrust restrictions tend to erode landing safety margins, increase runway occupancy time, and increase brake wear on aircraft.

- CONCLUSION

Mandated limitations on the use of reverse thrust are inadvisable at Lincoln Airport because of the reduced safety margins and the likelihood for only small benefits. As an operational flight procedure with a direct effect on safety, decisions about whether to use reverse thrust should be left to the discretion of pilots.

AIRPORT REGULATIONS

F.A.R. Part 150 requires that, in developing Noise Compatibility Programs, airports study the possible implementation of airport use restrictions to abate aircraft noise. (See F.A.R. Part 150, B150.7[b][5].) The courts have recognized the rights of airport proprietors to reduce their liability for aircraft noise by imposing restrictions which are reasonable and do not violate contractual agreements with the FAA conditioning the receipt of federal aid. (These are known as "grant assurances.") In addition, constitutional prohibitions on unjust discrimination and the imposition of undue burdens on interstate commerce must be respected. The restrictions must also be crafted to avoid infringing on regulatory areas preempted by the federal government. Finally, the regulations must be evaluated under the requirements of F.A.R. Part 161.

Airport noise and access restrictions may be proposed by an airport operator in its F.A.R. Part 150 Noise Compatibility Program. The FAA has made it clear that the approval of a restriction in an F.A.R. Part 150 document would depend on the noise abatement benefit of the restriction at noise levels of 65 DNL or higher. Even if the FAA should accept a noise restriction as part of an F.A.R. Part 150 Noise Compatibility Program, the requirements of Part 161 would still need to be met before the measure could be implemented.

F.A.R. Part 161

In the *Airport Noise and Capacity Act* (ANCA) of 1990, Congress not only established a national phase-out policy for Stage 2 aircraft above 75,000 pounds (see Part 91 and 161 discussion on page 1-5 of the *Noise Exposure Maps* document), but it also established analytical and procedural requirements for airports desiring to establish noise or access restrictions on Stage 2 or Stage 3 aircraft. Regulations implementing these requirements are published in F.A.R. Part 161.

F.A.R. Part 161 requires the following actions to establish a local restriction on Stage 2 aircraft:

- An analysis of the costs and benefits of the proposed restriction and alternative measures.

- Publication of a notice of the proposed restriction in the Federal Register and an opportunity for comment on the analysis.

While implementation of a Stage 2 aircraft operating restriction does not require FAA approval, the FAA does determine whether adequate analysis has been done and all notification procedures have been followed.

For restrictions on Stage 3 aircraft, Part 161 requires a much more rigorous analysis as well as final FAA approval of the restriction. Before approving a local Stage 3 noise or access restriction, the FAA must make the following findings:

- The restriction is reasonable, non-arbitrary, and non-discriminatory.
- The restriction does not create an undue burden on interstate or foreign commerce.
- The restriction maintains safe and efficient use of navigable airspace.
- The restriction does not conflict with any existing federal statute or regulation.
- The applicant has provided adequate opportunity for public comment on the proposed restriction.
- The restriction does not create an undue burden on the national aviation system.

Based on FAA's interpretations of Part 161, the regulations do not apply to restrictions proposed only for aircraft under 12,500 pounds. Because these light aircraft, which include small, single-engine aircraft, are not classified under Part 36 as Stage 2 or 3, the FAA has concluded that the 1990 *Airport Noise and Capacity Act* was not intended to apply to them. (See "Airport Noise Report," Vol. 6, No. 18, September 26, 1994, p. 142.)

Very few Part 161 studies have been undertaken since the enactment of ANCA. **Table 4A** summarizes the studies that have been done to date.

There are essentially three types of curfews or nighttime operating restrictions: (1) closure of the airport to all arrivals and departures (a full curfew); (2) closure to departures only; and (3) closure to arrivals and departures by aircraft exceeding specified noise levels.

- EVALUATION

The time during which nighttime restrictions could be applied varies. The DNL metric applies a 10-decibel penalty to noise occurring between 10:00 p.m. and 7:00 a.m. That period could be defined as a curfew period. A shorter period, corresponding to the very late night hours, midnight to 6:00 a.m., could also be specified.

Full Curfews: While full curfews can totally resolve concerns about nighttime aircraft noise, they can be indiscriminately harsh. Not only would the loudest operations be prohibited, but quiet operations by light aircraft would also be banned by a full curfew. Full curfews also deprive the community of the services of some potentially important nighttime airport users.

TABLE 4A
Summary of F.A.R. Part 161 Studies

Airport	Year Started	Year Ended	Cost	Proposal, Status
Aspen-Pitkin County Airport, Aspen, Colorado	N.A.	N.A.	N.A.	The study has not yet been submitted to FAA.
Kahului Airport, Kahului, Maui, Hawaii	1991	1994	$50,000 (est.)	Proposed nighttime prohibition of Stage 2 aircraft pursuant to court stipulation. Cost-benefit and statewide impact analysis found to be deficient by FAA. Airport never submitted a complete Part 161 Study. Suspended consideration of restriction.
Minneapolis-St. Paul International Airport, Minneapolis, Minnesota	1992	1992	N.A.	Proposed nighttime prohibition of Stage 2 aircraft. Cost-benefit analysis was deficient. Never submitted complete Part 161 study. Suspended consideration of restriction and entered into negotiations with carriers for voluntary cooperation.
Pease International Tradeport, Portsmouth, New Hampshire	1995	N.A.	N.A.	Have not yet submitted Part 161 study for FAA review.
San Francisco International Airport, San Francisco, California	1998	1999	$200,000	Proposing extension of nighttime curfew on Stage 2 aircraft over 75,000 pounds. Started study in May 1998. Submitted to FAA in early 1999 and subsequently withdrawn.
San Jose International Airport, San Jose, California	1994	1997	Phase 1 - $400,000 Phase 2 - $5 to $10 million (est.)	Study undertaken as part of a legal settlement agreement. Studied a Stage 2 restriction. Suspended study after Phase 1 report showed costs to airlines at San Jose greater than benefits in San Jose. Never undertook Phase 2, systemwide analysis. Never submitted study for FAA review.
Burbank-Glendale-Pasadena Airport	2000	Ongoing	Phase 1 - $1 million (est.)	Proposed curfew restricting all aircraft operations from 10:00 p.m. to 7 a.m. Started Phase 2 in 2003.
Naples Municipal Airport Naples, Florida	2000	2000	Currently $730,000 Expect an additional cost of $1.5 to $3.0 million in legal fees due to litigation.	Enactment of a total ban on Stage 2 general aviation jet aircraft under 75,000 pounds. Naples is currently in litigation and may also have to repay all previous federal funding received for airport projects.

N.A. - Not available.

Sources: Telephone interviews with Federal Aviation Administration officials and staffs of various airports.

Important economic reasons drive nighttime airport activity. Early morning departures are often attractive for business travelers who wish to reach their destinations with a large part of the workday ahead of them. Not only is this a personal convenience, but it can result in a significant savings in the cost of travel by reducing the need for overnight stays. Accordingly, early morning departures are often very popular. Similarly, late night arrivals are important in allowing travelers to return home without incurring the costs of another night away.

Different, but equally compelling, reasons encourage cargo carriers and courier companies to operate in the evening and at night. Cargo is collected during the business day. It is shipped to a hub facility in the evening or at night where it is sorted and, in the case of package express service, delivered to its destination the next business day. Bulk cargo companies work essentially the same way, although, where speed is not of paramount importance, the collection and delivery functions may involve more use of surface transportation. Modern air cargo service cannot operate without nighttime access to airports.

Prohibition of Nighttime Departures: The prohibition of nighttime departures would allow aircraft to return home but would prohibit departures, which are generally louder than arrivals. Although somewhat less restrictive, this would have similar impacts at Lincoln Airport as a full curfew. It would interfere with corporations in their attempts to schedule early morning departures for the business travel market.

As with a full curfew, a nighttime prohibition on departures would restrict access to the airport by Stage 3 aircraft. This would require a full Part 161 analysis and FAA approval of the restriction before it could be implemented.

Nighttime Restrictions Based on Aircraft Noise Levels: Nighttime operating restrictions can be designed to apply to only those aircraft which exceed specified noise levels. If it is to be effective in reducing the size of the DNL noise contours, the restricted noise level would have to be set to restrict the loudest, most commonly used aircraft at the airport. These restrictions would be subject to the special analysis procedures of F.A.R. Part 161. Any restrictions affecting Stage 3 aircraft would have to receive FAA approval.

- CONCLUSION

Curfews and nighttime operating restrictions can be an effective way to reduce the size of DNL noise contours around an airport. Because of the extra 10-decibel weight assigned to nighttime noise, removing a single nighttime operation is equivalent to eliminating 10 daytime operations. The effect on the noise contours can be significant.

A particularly troubling aspect of curfews and nighttime operating restrictions is their potential adverse effects on local air service and the region's economy. Additionally, implementation of nighttime restrictions can be costly, problematic, and require the completion, and subsequent FAA approval, of a Part 161 Study. Given the likelihood of FAA disapproval, due to the limited impacts within the 65 DNL contour, curfews need not be considered further.

Noise-Based Landing Fees

Noise-based landing fees is the second airport regulation option. Commercial airports like Lincoln Airport typically levy landing fees on aircraft to raise revenue for airport operations and maintenance. Fees are typically based on aircraft gross weight. Landing fees can also be based on aircraft noise levels and the time of day of landings. Thus, arrivals at night by loud aircraft would be charged the highest fees, while arrivals during the day by quiet aircraft would be charged the smallest fees.

If noise-based landing fees are set high enough, they might encourage airlines to bring quieter aircraft into the airport. Noise-based landing fees set high enough to affect air carrier behavior would almost certainly be subject to legal challenge. The system could be vulnerable to attack as an undue burden on interstate commerce. The fee structure could also possibly be attacked as discriminatory if its effect was to single out one, or a few, carriers for especially strict treatment. In practice, however, landing fees are such a small part of the total operating costs of an airline that increases in fees or noise-based surcharges may become merely an irritant to the carrier.

Before the adoption of ANCA, noise-based landing fees were often considered a way to encourage air carriers to convert to Stage 3 aircraft. Under ANCA, full conversion of aircraft over 75,000 pounds to Stage 3 standards was mandated by the year 2000, so the traditional objective of noise-based landing fees is no longer relevant. Of course, different kinds of Stage 3 aircraft produce different levels of noise. B-727s and DC-9s equipped with Stage 3 hush kits, for example, are louder than B-737-300s and A-320s. In theory, a system of noise-based landing fees could be used to attempt to encourage carriers to convert to the quietest Stage 3 aircraft. It is questionable how effective this could be in practice. An air carrier's fleet composition is dictated by many variables, including aircraft purchase, financing, and leasing costs; operating and maintenance costs; air and maintenance crew training requirements; manufacturer support; and marketing strategy. Whether one airport can exert enough leverage through noise-based landing fees to influence aircraft acquisition and route assignment decisions is questionable.

- EVALUATION

Noise-based landing fees are considered airport noise restrictions under F.A.R. Part 161. A Part 161 analysis would be required before such a fee system could be implemented. Any fee structure that would place a noise surcharge on Stage 3 aircraft would require FAA approval prior to implementation.

- CONCLUSION

A noise-based landing fee system intended to provide strong incentives for carriers to convert their fleets to quieter aircraft is not practical and is vulnerable to legal challenges. A noise-based landing fee surcharge intended to raise revenue for noise mitigation activities is not considered necessary. FAA disapproval is also likely due to the limited impacts within the 65 DNL contour. Therefore, noise-based landing fees will not receive additional consideration.

Capacity Limitations

Capacity limits, the third airport regulation option, has been used by some severely impacted airports to control cumulative noise exposure. This kind of restriction would impose a cap on the number of scheduled operations. This is only an imprecise way to control aircraft noise. For one thing, unscheduled operations would not be subject to the limit. In addition, the limit on scheduled operations actually provides no incentive for conversion to quieter aircraft. Rather, if passenger demand is increasing, it would encourage airlines to convert to larger aircraft, which often (but not always) tend to be noisier than smaller aircraft in the same Part 36 stage classification.

- EVALUATION

A cap on operations would not necessarily provide noise benefits. The forecast noise contours presented in Chapter Two provide an example. A comparison of the noise contours for forecast 2002 conditions and 2007 conditions (Table 2D on page 2-11 of the Noise Exposure Maps document) shows a slight decrease in the size of the 60, 65, 70, and 75 DNL noise contours from 2002 to 2007 (See Table 2G on page 2-17). During that period, however, the number of annual aircraft operations is projected to increase from 102,286 to 127,840.

- CONCLUSION

Airport capacity limitations intended to control noise are too imprecise to guarantee effectiveness and are unlikely to achieve significant noise reductions. They can also limit air service to the community, interfering with the needs of the local economy. They can be difficult and expensive to administer. Since they inevitably would restrict access to the airport by Stage 3 aircraft, capacity limitations would be subject to Part 161 analysis and approval by the FAA. Airport capacity restrictions, therefore, do not merit additional analysis.

Noise Budgets

Noise budgets is the fourth airport regulation option. In the late 1980s, noise budgets gained attention as a potential noise abatement tool. After the enactment of ANCA, mandating the retirement of Stage 2 aircraft over 75,000 pounds, interest in noise budgets waned. Noise budgets are designed to limit airport noise and allocate noise among airport users. The intent is to encourage aircraft operators to convert to quieter aircraft or to shift operations to less noise-sensitive hours. Before ANCA, the intent was to encourage conversion to Stage 3 aircraft and to discourage the use of Stage 2 aircraft.

While noise budgets can be designed in many different ways, six basic steps are involved. First, the airport must set a target level of cumulative noise exposure, usually expressed in DNL, which it intends to achieve by a certain date. Second, it must determine how to express that overall noise level in a way that would permit allocation among airport users. Third, it must design the allocation system. Fourth is the design of a monitoring system to ensure that airport users are complying with the allocations. Fifth is the establishment of sanctions for carriers that fail to operate within their allocations. Sixth, the system should be fine-tuned based on actual experience. The only simple step in this process is the first, setting a goal. From that point, it becomes increasingly complex.

- EVALUATION

Different approaches can be used to define noise in a way which permits allocation. It is possible to use the DNL metric, or a variant, for this purpose. This has some advantages in that the FAA's Integrated Noise Model (INM) can be easily used to derive DNL levels attributable to the average daily operations of the various airport operators. The INM database can be used to establish a basis for noise allocations based on aircraft type. An alternative is to use the effective perceived noise level (EPNL) metric. This is the metric used to certify aircraft noise levels for compliance with F.A.R. Part 36. Noise levels of various aircraft expressed in EPNL are published in FAA Advisory Circulars 36-1E and 36-2C. EPNL values for the aircraft used by each operator on an average day could be summed to define the total noise attributable to the operator.

The third step, the design of the allocation system, is the most difficult and the least subject to fair and objective definition. The allocations can be handled in different ways. They could be auctioned, but without careful controls this could cause serious problems. It could give the financially stronger carriers the opportunity to buy extra noise allocations for purposes of speculation or restraint of competition. Another way to allocate the noise would be through a lottery. A drawback with both of these methods is that they would not recognize past operating histories. It is also important that any allocation system include provisions for the entry of new carriers in order to have any chance of being legally permissible.

An allocation system based on the recent operating histories of each airline would probably be the fairest approach, but it would not be problem-free. To be as fair as theoretically possible, the allocation should be based on each carrier's contribution to existing noise levels at the airport and its past performance in helping to reduce that noise. If the allocation system is based only on current noise contribution, the carriers that have made significant investments in converting their fleets will be penalized in comparison with those which have not. The noisier airline, for example, could conceivably be given a competitive advantage because, if they were willing to convert to quieter aircraft, they would be able to increase their number of flights while still reducing their overall noise output. Carriers can also argue that their corporate aircraft operating procedures result in less noise than the operating procedures of their competitors and that this should be recognized in the noise allocation system.

After establishing the initial allocation system, it would be necessary to develop a schedule of declining noise allocations to each carrier in order to reach the overall noise reduction goals of the program. Each carrier would have the flexibility to develop scheduling at any time of the day with any aircraft type, so long as its allocation is not exceeded. The use of quieter aircraft or operations during less noise-sensitive hours would result in increased flights per allocation.

The fourth step involves monitoring compliance with the noise allocations. Any monitoring system will require extensive bookkeeping. The simplest method would involve the monitoring of aircraft schedules. Total noise contribution by carrier would be summed for the reporting period based on the activity during the reporting period. Noise levels for each flight would be based on the certificated noise level, or the INM data base noise level, for each aircraft. While this system would require large amounts of staff time to administer, it would be relatively simple to computerize and would have the advantage of enabling carriers to plan their activities with a clear understanding of the noise implications of their decisions.

A theoretically more precise method of compliance monitoring, but a more expensive and complex method, would be to monitor actual aircraft noise levels. Actual noise from each aircraft operation would be recorded for each operator. The advantage of this approach is that it would be based on actual experience. A significant disadvantage, however, is that it could be quite difficult for carriers to make predictions about the noise impact of their scheduling decisions. Many variables influence the noise occurring from any particular aircraft operation, including the weather, pilot technique, and air traffic control instructions. In addition, the Airport Authority would have to purchase a monitoring and flight tracking system.

The fifth step is to establish a system of fines or other sanctions to levy against carriers which fail to operate within their assigned noise allocations. To be effective, the sanctions should be severe enough to provide a strong incentive to cooperate with the program.

In an era where all aircraft weighing more than 75,000 pounds are Stage 3, it is difficult to imagine how a noise budget could promote significant noise reduction without reducing air service in the community. While some Stage 3 aircraft are louder than others, some carriers operate with fleets almost completely composed of among the quietest Stage 3 aircraft. Depending on the noise allocation and the reduction target assigned to such a carrier, they might be able to meet the target only by eliminating flights.

- CONCLUSION

Noise budgets are complex methods of promoting airport noise reduction. They are particularly vulnerable to attack on grounds of discrimination and interference with interstate commerce.

Noise budgets are extremely difficult to design in a way that will be seen as fair by all airport users and are likely to be quite expensive to develop. Negotiations on noise budget design and noise allocations are likely to be long and contentious and would require the assistance of noise consultants and attorneys. The costs of administering the system also would be substantial. The bookkeeping requirements are complex and additional administrative staff would definitely be required.

At Lincoln Airport, a noise budget does not appear to be a practical option. The process would be long, expensive, and contentious. Its potential for delivering real and substantial improvements in the local airport noise environment is questionable and will not be discussed further.

Restrictions Based On Aircraft Noise Levels

Restrictions based on aircraft noise levels is the fifth airport regulation option. Outright restrictions on the use of aircraft exceeding certain noise levels can reduce cumulative noise exposure at an airport. Aircraft producing noise above certain thresholds, as defined in F.A.R. Part 36, could be prohibited from operating at the airport at all or certain times of the day. A variation is to impose a non-addition rule, prohibiting the addition of new flights by aircraft exceeding the threshold level at all or certain times of the day. These restrictions would be subject to the special analysis procedures of F.A.R. Part 161. Any restrictions affecting Stage 3 aircraft would have to receive FAA approval.

Noise limits based on F.A.R. Part 36 certification levels have the virtue of being fixed national standards which are understood by all in the industry. They are average values, however, and do not consider variations in noise levels based on different methods of operating the aircraft. As an alternative, restrictions could be based on measured noise levels at the airport. This has the advantage of focusing on noise produced in a given situation and, in theory, gives aircraft operators increased flexibility to comply with the restrictions by designing special approach and departure procedures to minimize noise. It has the disadvantage of requiring extra administrative effort to design testing procedures, monitor tests, interpret monitoring data, and design the restrictions.

- EVALUATION

Whether threshold noise levels are based on F.A.R. Part 36 or measured results, care must be taken to ensure that the restriction does not fall with undue harshness on any particular operator. The feasibility of complying with the restriction, given existing technologies and equipment, must also be considered. Such a restriction would be subject to legal challenges and rejection by FAA as unjust discrimination and potentially burdensome to interstate commerce.

- CONCLUSION

Restrictions based on noise levels could be viewed as discriminatory and, therefore, be subject to litigation and possible rejection by the FAA. In addition, the requirements of a costly F.A.R. Part 161 Study would have to be met before any restriction on Stage 2 business jets under 75,000 pounds or Stage 3 aircraft could be implemented.

Touch-and-Go Restrictions

Restrictions on touch-and-go or multiple approach operations, the sixth airport regulation option, can be effective in reducing noise when those operations are extremely noisy, unusually frequent, or occur at very noise-sensitive times of the day. At many airports, touch-and-go's are associated with primary pilot training, although this type of operation is also done by licensed pilots practicing approaches.

Touch-and-go's and multiple approaches are frequently done at Lincoln Airport. In 2001, there were 22,490 local general aviation operations (generally involving multiple approaches or touch-and-go's). The general aviation touch-and-go operations were done mainly by light, single-engine aircraft. In the same year, there were 5,923 local operations by military aircraft. These operations were done mainly by KC and RC-135 aircraft and are a source of noise complaint in the Lincoln Airport area.

- EVALUATION

There are four primary noise abatement options for touch-and-go operations: raise the pattern altitude; move the touch-and-go pattern; restrict the time of day that touch-and-go operations can occur; and restrict touch-and-go's altogether. Currently, the pattern altitude at Lincoln Airport is 2,219 feet MSL (1,000 feet AGL) for small aircraft and 3,000 MSL (1,781 feet AGL) for military jets. Raising the current touch-and-go pattern would increase the noise exposure on runway centerline because of the longer climb and descent from pattern altitude. Therefore, raising the touch-and-go pattern at Lincoln Airport would not be an effective noise abatement option.

Large residential areas to the east of the airport make movement of the touch-and-go pattern to this area impractical. Moving the pattern to the east of the airport also creates an unsafe crossing pattern for aircraft using 17L-35R. Moving the pattern further west will impact rural residential areas.

Restricting the time of day that touch-and-go's can occur is not feasible because the National Guard unit has to be available after regular working hours for reserve pilots with other jobs. In addition, nighttime training is also required to maintain proficiency ratings.

Restriction of touch-and-go operations altogether at Lincoln Airport would have legal ramifications as it would conflict with a condition of the grant assurances the Airport Authority signed when it accepted a Federal grant for airport improvements. Section C- 27 Sponsor Certification states: "It will make available all of the facilities of the airport developed with Federal financial assistance and all those usable for landing and takeoff of aircraft to the United States for use by Government aircraft in common with other aircraft at all times..."

The local Guard unit and Offutt Air Force personnel have worked to reduce the impact of their training operations. These efforts have resulted in the establishment of touch-and-go procedures for the local Guard unit and aircraft from Offutt Air Force Base.

The local Guard unit developed a noise abatement procedure that requires the use of CAT (Category) E minimums for practice circling approaches and trying to avoid direct overflight of residential areas west of the airport. The use of CAT E minimums places the aircraft at an altitude of 800 feet AGL versus the typical 500-foot AGL.

In a memo dated August 16, 1996, a number of noise procedures for aircraft arriving from the Offutt Air Force Base (AFB) are outlined. These procedures were developed with input from the airport, airport traffic control tower (ATCT), and Offutt AFB representatives, and are solely recommendations, as no specific formal or informal procedures have been adopted. The procedures are summarized as follows.

- Circling approaches by Offutt AFB aircraft will only be conducted between the hours of 0800 and 1600 local time (8:00 a.m. to 4:00 p.m.).
- Offutt AFB pilots will be asked to fly their VFR patterns downwind, just west of the Airpark.
- Lincoln Airport Authority will permit Offutt AFB aircraft to transition at the airport between 2200 and 2400 local time (10:00 p.m. to 12:00 a.m.). The following procedures are to be used by Offutt AFB pilots during this time frame:
  - Upon completion of the approach, the aircraft are issued standard corridor headings (i.e., 300 or 210).
  - The aircraft are assigned an altitude of 4,000 feet.
  - Crosswind turns should be started no sooner than two miles from the departure end of the runway to which the approach had been conducted, no lower than 3,000 feet.
  - Downwind turns should be commenced four to six miles from the airport.
  - Descent from 4,000 feet will be issued on the base turn.

Other transient military aircraft are not aware of the touch-and-go procedures and are frequently operated without the same sensitivity to local noise-sensitive areas as the local Guard unit. This could be remedied by publishing the Guard unit's touch-and-go procedures in the *United States IFR Supplement* put out by the Defense Mapping Agency Aerospace Center which disseminates this type of information to military units nationwide.

- CONCLUSION

The normal touch-and-go activity at Lincoln Airport is considered a source of noise complaint. A review of the potential adjustments and restrictions to the touch-and-go procedures revealed that changing location and elevation of the touch-and-go pattern would shift noise from one residential area to another. In addition, due to the limited impacts within the 65 DNL contour and conflicts with deed transferring the airport, FAA would probably not approve such a restriction. Therefore, this option will not receive further consideration.

Consideration should be given to publishing the local Guard unit's touch-and-go procedures in the IFR Supplement. This would provide transient military aircraft information on the noise-sensitive areas around Lincoln Airport and provide the proper procedures for doing touch-and-go's at the airport.

Engine Run-up Restrictions

The final airport regulation option is engine run-up restrictions. As previously discussed, engine run-ups are a necessary and critical part of aircraft operation and maintenance. Run-ups are required for various aircraft maintenance operations. Engine maintenance run-ups may be restricted by airport operators. These restrictions, when they apply to run-ups as a separate function from the takeoff and landing of the aircraft, do not appear to need special FAA review or approval under F.A.R. Part 161. (See *Airport Noise Report*, Vol. 6, No. 18, September 26, 1994, p. 142.) They are, nevertheless, subject to other legal and constitutional limitations on unjust discrimination, undue interference with interstate commerce, or conflict with FAA grant assurances. As previously discussed, noise impacts due to aircraft maintenance run-up operations occur on residential areas to the northeast and could be mitigated through the installation of a relocated run-up pad or enclosure.

- EVALUATION

Lincoln Airport currently requests that aircraft maintenance run-ups be performed on the north end of the east ramp (between the daytime hours of 7:00 a.m. and 7:00 p.m.). The Lincoln Airport has requested that the FBOs located on the east side of the airport perform run-up operations between the evening and nighttime hours of 7:00 p.m. and 7:00 a.m. on the run-up mat located on Taxiway E between Runway 17R-35L and the west apron.

- CONCLUSION

Aircraft operational and maintenance run-ups are a necessary part of operations at Lincoln Airport. The airport has established policies limiting run-up operations on the northern portion of the east ramp between 7:00 a.m. and 7:00 p.m. The implementation of additional restrictions that would significantly curtail aircraft run-ups would hinder airport operators, safety, and would likely facilitate litigation. The additional mitigation of run-up noise would best be addressed through the adjusting of current run-up locations or utilization of a run-up enclosure such as a hush-house or run-up pen.

SELECTION OF MEASURES FOR DETAILED EVALUATION

Preliminary screening of the complete list of noise abatement techniques indicated that some measures may be potentially effective in the Lincoln Airport area. These are evaluated in detail in this section.

EVALUATION CRITERIA

One operational alternative and four run-up locations have been selected for detailed analysis in addition to the possible effects of a run-up enclosure. The noise analysis for each alternative was based on the 2007 baseline analysis presented in Chapter Three, "Aviation Noise Impacts." The 2007 baseline was chosen to offer a common base of comparison for all alternatives. This time frame allows time for FAA review and approval of the final Noise Compatibility Program (NCP) and any environmental assessments which may be required prior to implementation of the procedures. The alternatives are evaluated using the following criteria.

Noise Effects. The purpose of this evaluation is to reduce aircraft noise on people. A reduction in noise impacts, if any, over noise-sensitive areas is assessed.

Operational Issues. The effects of the alternative on the operation of aircraft, the airport, and local airspace are considered. Potential airspace conflicts and air traffic control (ATC) constraints are discussed, and the means by which they could be resolved are evaluated. Potential impacts on operating safety are also addressed. FAA regulations and procedures will not permit aircraft operation and pilot workload to be handled other than in a safe manner, but within this limitation differences in safety margins occur. A significant reduction in safety margins will render an abatement procedure unacceptable.

Air Service Factors. These factors relate to a decline in the quality of air transportation service which would be expected from adoption of an abatement measure. Declines could possibly result from lowered capacity or rescheduling requirements.

Costs. Both the cost of operating aircraft to comply with the noise abatement measure and the cost of construction or operation of noise abatement facilities are considered. Estimated capital costs of implementing the noise abatement alternative, where relevant, are also presented.

Environmental Issues. Environmental factors related to noise are of primary concern in an F.A.R. Part 150 Update analysis. Procedures that involve a change in air traffic control procedures or increase noise over residential areas may require separate environmental evaluation and possible National Environmental Policy Act (NEPA) documentation.

Implementation Factors. The agency responsible for implementing the noise abatement procedure is identified. Any difficulties in implementing the procedure are discussed. This is based on the extent to which it departs from accepted standard operating procedures; the need for changes in FAA procedures, regulations, or criteria; the need for changes in airport administrative procedures; and the likelihood of community acceptance.

Upon completion of a review of each measure based on the above criteria, an assessment of the feasibility of each measure and the strategies required for its implementation are presented. At the end of the section, a summary comparison of the noise impacts of each alternative is presented. Recommendations as to alternatives which deserve additional consideration are presented.

ALTERNATIVE 1 - TEST THE EFFECTIVENESS OF UTILIZING RUNWAY 17R-35L FOR NIGHTTIME OPERATIONS

Goals

This alternative seeks to test the effectiveness of utilizing Runway 17R-35L during nighttime hours (10:00 p.m. to 7:00 a.m.). The goal of this procedure would be to take advantage of the existing noise compatible corridor off the departure end of Runway 17R. By removing some nighttime departures and arrivals from Runway 17L-35R, noise impacts and aircraft overflights could be reduced southeast of the airport.

Procedure

Approximately 11 percent of the total annual operations at Lincoln Airport occur during nighttime hours (10:00 p.m. and 7:00 a.m.). To test the nighttime preferential Runway 17R-35L use program, a 50 percent compliance rate was assumed. For noise modeling purposes, the 2007 baseline input was modified to reflect the use of the nighttime runway use program described above.

Noise Effects

The noise contours presented in **Exhibit 4E** illustrate the effects of this procedure. The shape of the alternative noise contours is very similar to the 2007 baseline contours. The 60 DNL noise contour to the southeast is approximately 100 feet closer to the airport than the 2007 baseline noise contour. The 65 DNL noise contour to the southeast is also closer to the airport, however, this alteration is more pronounced. The 70 and 75 DNL noise contours are also slightly smaller along Runway 17L-35R. The procedure has a slight effect on the noise contours to the south of the airport along the extended centerline of Runway 17R-35L. There is a minimal effect on the noise contours north of the airport.

Table 4B presents the population impacts for this alternative. This alternative results in an overall decrease to the existing 2007 baseline population impacts. However, one additional person was added to the 65-70 DNL noise exposure contour. Future potential population impacts also increase slightly by 24 persons within the 60 DNL noise exposure contours.