



SUBURBAN O'HARE COMMISSION

**ANALYSIS OF THE CHICAGO O'HARE FLY QUIET
PROGRAM AND OPERATIONAL INITIATIVES TO
REDUCE NOISE IMPACTS**

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19 November 2015

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1. Background

The Suburban O'Hare Commission (SOC) has asked JDA Aviation Technology Solutions (JDA) to conduct an analysis of potential measures which could be used at Chicago's O'Hare Airport to reduce or ameliorate the impact of aircraft noise on the surrounding communities.

In response to SOC's request, JDA assembled a team of air traffic experts with significant experience – both at O'Hare and the FAA's Elgin Regional Air Traffic Center (TRACON) to conduct the analysis and provide recommendations as to potential remedial measures. The JDA team of air traffic experts consists of Rob Voss, Jim Krieger and Craig Burzych. Jim Krieger and Craig Burzych have over four decades of hands on operational experience in air traffic control at the O'Hare tower. Rob Voss has extensive experience with systems operations and the Air Traffic System Command Center and based at the FAA's Great Lakes Regional Office in Des Plaines, IL.

The JDA team's investigation included:

- An operational review of the City of Chicago's current "Fly Quiet" program at O'Hare.
- A review of the noise abatement programs at 15 major U.S. airports and several overseas airports for possible initiatives that might be used at O'Hare.
- Development of recommendations for operational changes at O'Hare that could provide potentially significant noise relief for O'Hare area communities – particularly at night.
- Preparation of four interim reports addressing visual approaches, crosswind/diagonal runway usage, the need for additional runways at O'Hare and intersection departures.

While nearly every airport with commercial activity advertises some form of Fly Quiet program, their scopes vary widely.

For the purpose of this analysis, detailed components of the many various noise abatement programs are not enumerated. However, airport, pilot and ATC procedural initiatives and strategies that appear effective or pertinent in making improvements to ORD's Fly Quiet Program are included. Constraints that limit or preclude potentially desirable changes, such as curfews, are also discussed.

Two major caveats must be included in the recommendations listed in this paper. While the recommendations offer promise of significant noise relief – particularly at night – these recommendations are conditioned on two fundamental conditions. First, all of these recommendations are conditioned on a paramount commitment to air safety and

operational efficiency. If weather conditions, air traffic load, or any other operational condition would make use of any of the recommended procedures adversely impact air safety, the goal of air safety should control.

Second, most of the recommended procedures in this paper are designed to reduce the impact of night-time noise. The JDA team recognizes that adverse weather conditions or other unforeseen scheduling problems may require the routing of additional flights into the so-called “shoulder” hours between 10:00 PM and Midnight. Under such circumstances it may not be possible or practicable to employ some or all of the operational procedures recommended here.

Though overall aircraft noise has improved over the past several decades through the development and use of quieter aircraft, noise issues continue to challenge airport operators across the globe, especially late at night. Airport noise mitigation programs often contain similar elements- collaboration and replication amongst airports appears common. Some of the most effective initiatives exist in Europe, where there appears to be a lower tolerance for the rights of aircraft operators and greater concern for airport neighbors than in the United States.

2. Summary of JDA Air Traffic Team Recommendations

(See Appendix 1 for responsibility and anticipated benefit):

- **JDA FQ-1:** The CDA should develop a more comprehensive, aggressive Fly Quiet program, with a strong mission statement demonstrating its commitment to the highest level of resources to establish and maintain the quietest environment practical for all nearby communities.
- **JDA FQ-2:** The CDA should leave a third runway open during Fly Quiet hours, including at least one diagonal runway, to disperse airport noise effects and to reduce flying distances over communities.
- **JDA FQ-3:** The FAA should encourage operational decision-making personnel to avoid terminating Fly Quiet departure procedures prematurely.
- **JDA FQ-4:** The CDA should continue encouraging ATC compliance with recommended procedures, through on-going recurrent controller education efforts, timely compliance reporting and follow-up activity.
- **JDA FQ-5:** A Continuous Descent Approach should be developed by the FAA for each arrival runway and used during Fly Quiet hours.
- **JDA FQ-6:** The CDA should conduct a review of Noise Abatement Departure Procedures (NADPs), revise as appropriate, coordinate with users and advertise the NADP policy within the Fly Quiet Program Manual.
- **JDA FQ-7:** The SOC, CDA and FAA coordinate to assess departure flight paths from ORD’s newest runways and preferred runway usage, to determine the best runway configurations and departure headings for noise abatement and include these within the Fly Quiet Program Manual.
- **JDA FQ-8:** All of the current recommended departure headings should be assessed to determine whether they are actually achieving the goal of directing flights over less-populated areas and revised as required to minimize population

impacted by noise on a rotating basis every evening to the extent practical. The CDA should utilize a computer driven model to best determine how to distribute flights over the region on an objective basis to minimize the impact on any particular community. Take-offs should be evenly disbursed over the entire population.

- **JDA FQ-9:** Enact a mechanism to facilitate the periodic review of the Fly Quiet Program Manual, to ensure that it is up-to-date and continues to reflect changes to the airfield and surrounding communities.
- **JDA FQ-10:** The FAA should reevaluate RNAV arrival and departure procedures to determine whether amendments or new procedures could be designed and implemented to provide additional noise benefits.
- **JDA FQ-11:** The areas in which over flights create the least disturbance should be specifically identified by the SOC and nearby communities by correlating noise complaint numbers with population density and flight track analysis. The SOC, CDA and FAA should then collaborate and review whether higher altitudes for initial turns, compound procedures or extended distances on initial headings will reduce noise impacts during Fly Quiet hours.
- **JDA FQ-12:** Throughout each day, during light traffic periods, or during weather events where departures are restricted to a single heading, controllers should use the published Fly Quiet noise headings as “default” departure headings, even outside of normal Fly Quiet hours.
- **JDA FQ-13:** The CDA should continue advocating the use of minimal reverse thrust and for pilots to avoid use of early runway exits during Fly Quiet hours, unless operationally necessary.
- **JDA FQ-14:** The CDA should encourage airlines to avoid using old generation aircraft such as the MD80 and DC10 during Fly Quiet hours.
- **JDA FQ-15:** The CDA should coordinate with other major airport operators to encourage airlines using A320 aircraft to retrofit their fleets with vortex generator modifications for reducing airframe noise.
- **JDA FQ-16:** The CDA should enhance the report card program to measure and publicly report on airlines and cargo operator’s noise mitigation performance metrics and the CDA, FAA and airlines collaborate to minimize scheduled operations during Fly Quiet hours.
- **JDA FQ-17:** Utilize two or more departure runways during Fly Quiet hours, along with a wider range of departure headings, allowing air traffic control to expedite traffic and draw overall aircraft operations per impacted area down to lower traffic levels more quickly in the busier shoulder hours.
- **JDA FQ-18:** The CDA should implement a Runway Rotation Plan to avoid concentrating flights over the same communities and equitably distribute noise during the Fly Quiet hours.
- **JDA FQ-19:** The FAA (O’Hare Tower) should refrain from using intersection departures during Fly Quiet hours.
- **JDA FQ-20:** FAA should consider eliminating visual approaches during fly quiet hours.

3. ORD Fly Quiet Program Overview

The O'Hare Fly Quiet Program¹ is primarily an outline of measures taken during the overnight hours, when air traffic volume is consistently lighter and procedures can be used that are mostly impractical during busier daytime hours. Review of the document from an operational perspective indicated that a more comprehensive and updated program paired with the development of several procedural initiatives might benefit communities which neighbor the airport. Ten pages in length, the manual is essentially comprised of five pages of policy and objectives, along with five airport maps, within six sections as follows:

1. Recommended Runway Configurations
2. Arrival and Departure Procedures
3. Ground Run-up Locations
4. Airport Layout Diagram
5. Land Use
6. Outreach

The content with the greatest potential for mitigation of noise includes:

1. Preferential runway configurations between 10pm and 7am, conditions allowing
2. Preferential departure headings for assignment by ATC between 10pm and 7am conditions allowing
3. Aircraft maintenance ground run-up procedures
4. Encouraging pilots to limit the use of reverse thrust
5. Outreach

Additional content includes:

1. Outreach: Automatic Terminal Information Service (ATIS)
2. Outreach: Noise Abatement Signage on the airfield

Additionally, ORD produces a quarterly noise report, reviewing data for nighttime runway usage, noise complaints, ground run-ups, noise monitors and Fly Quiet flight track deviation, by carrier.

Late-night engine run-ups are sometimes needed for the maintenance of aircraft. The ground run-up procedures outlined in the manual and reviewed in O'Hare's quarterly report appear to be effective. This includes encouraging and reporting on use of the enclosure, as well as using designated locations when simultaneous run-ups are needed.

¹<http://www.flychicago.com/SiteCollectionDocuments/OHare/AboutUs/Fly%20Quiet/FQ%20Manual%2006-08-15.pdf>

The CDA's efforts to address the resultant noise, along with support by the Tower, are positive enhancements for airport neighborhoods.

There are issues hindering the effectiveness of other potentially helpful measures, several of which are reviewed in this document. Specifically, the preferential runway configurations and recommended noise abatement headings are outdated. Also, the manual does not specify a preferential order for encouraging use of the most advantageous noise runways ("...in no particular order"). The list of preferred runways is obsolete. For example, it does not include departures from Runway 22L, which review of FAA traffic data² indicates was the third most heavily utilized departure runway during Fly Quiet hours (10pm to 7am) in 2014.

Outreach is difficult to objectively evaluate. There could be positive successes that are not readily measurable, such as influencing airlines to avoid schedule increases late at night. The CDA has been known to have meaningful follow-up with ATC to encourage best practices and program adherence.

The Fly Quiet Manual introduction states:

"In 1997, the City of Chicago announced that airlines operating at O'Hare International Airport had agreed to use designated noise abatement flight procedures in accordance with the Fly Quiet Program. The Fly Quiet Program was implemented in an effort to further reduce the impacts of aircraft noise on the surrounding neighborhoods."

Several other airports seem to indicate even a greater commitment to mitigating noise. For example, Minneapolis St. Paul (MSP) uses the following:

"The Airport should explore, develop and implement aggressive noise mitigation policies and procedures that will help to reduce the adverse impact of all airport operations, including future operations."

San Francisco International Airport (SFO) lies in close proximity to a number of affluent and environmentally sensitive communities. SFO is one of the nation's leaders in efforts to mitigate aircraft noise. The first of ten noise abatement measures (as outlined within its Fly Quiet Program and in its 14 CFR Part 150 Noise Exposure Map Report, November 2014) emphasizes:

"Establish noise as a priority function within the Director's office, including staff and resources to monitor the mitigation plan and recommend corrective actions...the overall goal of the Fly Quiet Program is to influence airlines to operate as quietly as possible...a successful Fly Quiet Program is expected to reduce both single event and total noise levels around the airport."

Another airport with an unusually high level of environmental focus is Portland (PDX). Their stated mitigation programs and proposals include several similar to those outlined

² FAA, Aviation System Performance Metrics

in this document. This includes careful development and refinement of departure headings and procedures over unpopulated areas, advocating the most advantageous Noise Abatement Departure Profiles, optimal climb rates, quietest engine run-ups, dedicated calm-wind preferential runway designations and optimized GPS approaches. Their stated mission is:

“To balance environmental concerns of the communities around the airport with the transportation needs of the region.”

It is our recommendation that the CDA should develop a more comprehensive, aggressive program, with a strong mission statement that demonstrates its commitment to the highest level of effort and resources toward maintaining the quietest environment practical for all nearby communities.

a. Fly Quiet and Air Traffic Control Compliance Efforts

For air traffic controllers, the Fly Quiet Program Manual provides guidance that affects their decision-making and the procedures that they will employ during the program hours, 10:00 PM to 07:00 AM. The decisions concern program implementation, runway selection, the use of recommended headings and altitudes, and program termination in the morning.

b. ATC Fly Quiet Implementation

On any typical day, the volume of flights arriving or waiting to depart O’Hare Airport at precisely 10:00 PM may be significant. This can often intensify with weather delaying flight operations at ORD or other parts of the country. In such cases, air traffic control may postpone implementing Fly Quiet procedures in part or in whole, until traffic decreases to more manageable levels. This is commonly between 10 to 30 minutes, but can be considerably longer on severe weather days.

The primary reason for delayed implementation is to ensure safety. Loading significant numbers of flights onto only one arrival or departure runway is not the best option when two or more runways remain available. Also, doing so would delay the arrival and departure queues, resulting in more aircraft operating later into the late night or early morning hours.

Utilizing two or more departure runways and a range of departure headings (temporarily deferring Fly Quiet) allows air traffic control to expedite traffic and draw overall aircraft operations down to lower traffic levels more quickly, thus limiting exposure to surrounding communities during the most sensitive hours. **We recommend** the continued use of this practice during the busier shoulder hours as determined prudent by the ORD ATCT Operations Manager, Front Line Manager, or Controller-in-Charge.

c. ATC Fly Quiet Runway Selection

The Air Traffic Control handbook, JO7110.65V (paragraph 3-5-1), states that unless a “runway use” program is in effect, controllers should use the runway most nearly aligned with the wind (when 5 knots or more) or the “calm wind” runway (when less than 5 knots) unless use of another runway:

1. Will be operationally advantageous, or
2. Is requested by the pilot

Safety is the primary concern for runway selection decisions and strong winds, closures, snow or ice on the runways, pilot requests and traffic volume are just some of the reasons that the Fly Quiet preferential runways may not always be used. It is important to point out that the pilot in command (PIC) is the final authority on decisions affecting the safety of their aircraft and air traffic control will not attempt to discourage pilots from using runways requested for operational reasons.

In 2014, during the overnight hours, three runways were used 78% of the time (28R/10L, 28C/10C, 27L/9R, Figure 1). West flow operations accounted for 74% of nighttime operations- landing from the East (Lake Michigan area) and initially taking off toward the West or Southwest. During Fly Quiet hours in 2014, there was only light usage of Runway 32R, 04L, 09R, 10C and 28C for departures (Figure 3). Runway lengths are a consideration, as is weather and the inability to use Runway 27R/9L (or Runway 28L/10R once commissioned) because of ATC non-visibility, without additional staffing.

As detailed later in this document, **it is our recommendation** to keep three (versus two) runways open throughout Fly Quiet hours and to rotate the use of usable runways (see “Opening a Third Runway during Fly Quiet Hours”, section 6B).

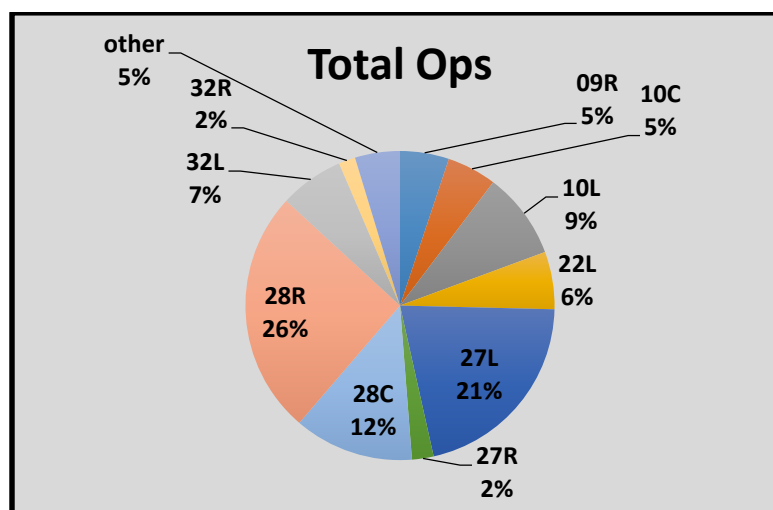


Figure 1. 2014 Total Operations Runway Usage during Fly Quiet Hours

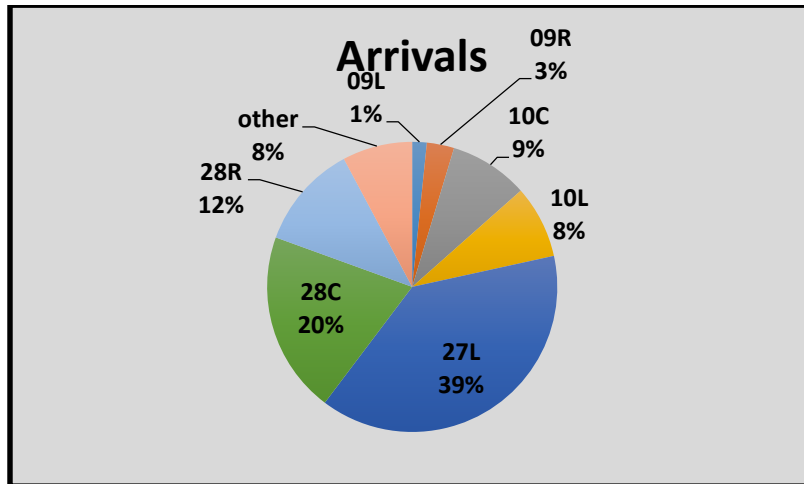


Figure 2. 2014 Arrival Runway Usage during Fly Quiet Hours

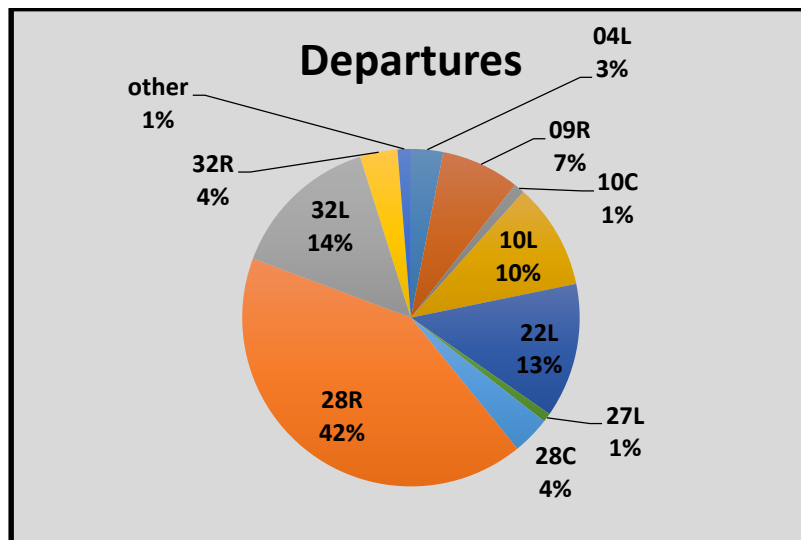


Figure 3. 2014 Departure Runway Usage during Fly Quiet Hours

d. ATC Use of Fly Quiet Recommended Departure Headings

When controllers make decisions about heading assignments for departing aircraft, they must consider many variables affecting flight safety, which may occasionally result in the use of headings different from those recommended in the Fly Quiet manual. These variables include strong winds pushing departures off course or toward other aircraft, thunderstorm cells near the airport and the presence of aircraft on opposite courses.

Strong winds cause aircraft to drift, possibly affecting aircraft separation. For example, with strong southerly winds, a runway 28R departure could drift far enough to the north to lose separation with traffic on approach to runway 14R. To compensate, a controller would use a heading more southerly (280 or 270) than the recommended 290-degree heading.

Thunderstorms pose a significant threat to flight operations and their presence may cause ATC to abandon noise headings altogether. As an example, a thunderstorm directly northwest of the airport could render the recommended runway heading off runway 32L unusable from a safety standpoint.

e. ATC Fly Quiet Termination Decisions

Like the decision about Fly Quiet implementation, ATC must consider similar factors when deciding when to terminate the program in the morning. In recent times, it is not unusual for a significant number of arrivals to be approaching O'Hare Airport long before the 07:00 AM desired termination time. In fact, ATC commonly has to utilize two arrival runways prior to 06:00 AM. This is done for safety reasons, as no-notice aircraft holding presents many issues with potential safety implications, including fuel management and diversions.

Similarly, the number of departing aircraft will dictate how long tower controllers can safely use the recommended headings. In most cases, they are able to do so at least into the shoulder hour. This means that most of the time, ATC will employ Fly Quiet departure procedures up until at least 06:00 AM and usually even later, while going to 2 arrival runways prior to 06:00 AM.

Some airports, such as SFO, rigidly adhere to Fly Quiet procedures and do not terminate it early to avoid increased workload or departure delays. Adopting such a policy at ORD is impractical because of the high traffic volume, congestion, workload and safety issues that would result. However, minor gains (of five or ten minutes) might occasionally be practical, during which the Tower or Approach Control could briefly delay terminating Fly Quiet in the morning. **We recommend** that the FAA (ORD ATCT and Chicago TRACON Air Traffic Managers) encourage operational decision-making personnel to make their best efforts to maximize the duration of Fly Quiet each morning, without impacting operational safety.

f. ATC and Fly Quiet Compliance

ATC compliance with recommended procedures is critically important to the success of the Fly Quiet Program. While it is recognized that controllers are sensitive to the needs of the surrounding communities, recurrent controller education efforts and compliance reporting that is timely enough to facilitate follow-up activity is helpful. As an example, in 2014, with the assistance of the CDA, O'Hare Tower adopted such activities and the rate of controller noncompliance dropped dramatically. We recommend that these types of efforts continue at O'Hare Tower to keep Fly Quiet compliance at the highest levels.

4. Air Traffic Procedural Initiatives

a. Fly Quiet Type Programs at Other Airports

The airfield layouts of major airports can differ considerably, with variations in runway orientations and lengths, traffic volume, fleet mix, airline operators, peak operating hours, proximity to densely populated areas and terrain. Many are close to natural features such as rivers, lakes, forests and open space, over which ATC (the FAA) is encouraged to concentrate flights to reduce impacts over non-compatible areas, especially late at night. In some low to moderate volume locations, such as Seattle (SEA), Portland (PDX) and Phoenix (PHX), restrictive initial noise abatement departure headings or procedures have been common, regardless of time of day or impact upon airport capacity, efficiency and delays. Some airports, such as San Francisco (SFO), Los Angeles (LAX) and Washington National (DCA), initiate more restrictive procedures for limited durations (i.e., 1am to 5am) within their lengthier fly quiet hours, even if delays will result.

A number of airports experience unusually heavy traffic volume overnight. Memphis (MEM), a major hub for FedEx and Louisville (SDF), a major hub for UPS, consistently handle more than 60% of their daily traffic between 10pm and 7am. Conversely, ORD and MDW, during the same hours typically operate slightly less than 15% of their daily traffic, though in ORD's case, this comprises 7,000 to 10,000 flights each month. Of ORD's operations during the 10pm to 7am Fly Quiet hours, approximately 50% of all operations occur during the "shoulder" hours, 10pm to 11pm and 6am to 7am. Arrivals are more common than departures during fly quiet hours, with ~15% more aircraft arriving than departing. The annual overnight traffic levels at ORD have been quite consistent since 2011.

There are other initiatives that can be considered during late night operations, since these hours consistently experience dramatically lower levels of traffic. With concentrated effort by the CDA and in aggregate, these might provide incremental relief and improvements to overall noise concerns. The following procedures are examples of such strategies in use at various airports both in the U.S. and abroad.

b. Continuous Descent Approach

The Continuous Descent Approach, also known as an Optimized Profile Descent (OPD), essentially produces a quieter, steeper aircraft approach. It involves the development, charting and use of a flight procedure to reduce aircraft noise, create fuel savings and reduce emissions³. Though not yet common in the United States, Continuous Descent Approaches are standard at many airports in Europe, particularly in the United Kingdom. The FAA's Optimization of Airspace and Procedures in the Metroplex (OAPM), is a national (NextGen) program used to refine procedures and maximize efficiencies for each major airport. Continuous Descent Approaches are often a part of an OAPM study, to streamline arrivals, reduce noise and fuel use. Figure 4 depicts a Continuous Descent Approach vs. a conventional arrival procedure.

³ http://www.caa.co.uk/docs/68/Basic_Principles_CDA.pdf

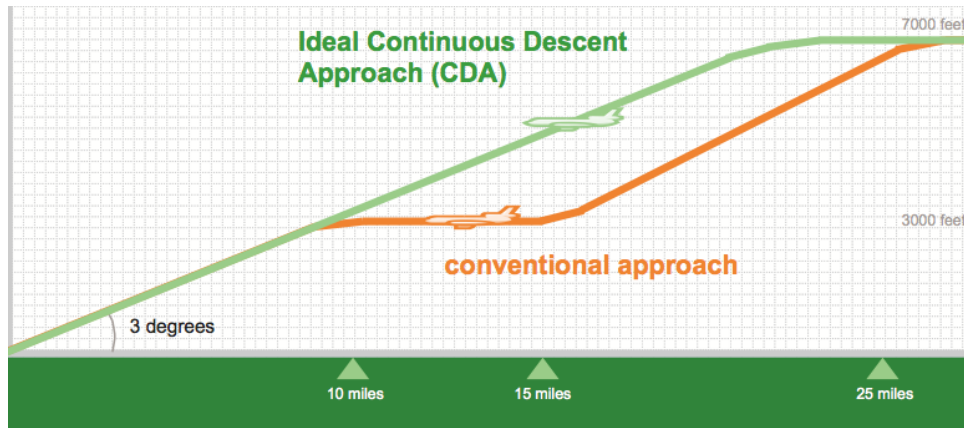


Figure 4. Comparison between a Continuous Descent and Conventional Approach⁴

This procedure eliminates a level off that is a standard component of instrument approaches. Without Continuous Descent Approaches, ATC vectors aircraft toward the final approach course (runway ILS localizer, or extended runway centerline). Aircraft are typically given an altitude at which to level off, until the pilot approaches the localizer and turns onto final approach. The aircraft travels several miles or more, most commonly at 4,000' to 6,000' for aircraft arriving into ORD. This segment contributes to noise experienced on the ground before the aircraft turns final approach, typically in areas to the side of the extended arrival runway centerlines and 10 to 20 miles from the runway. During west flow, this may be over Lake Michigan. A Continuous Descent Approach flown from 10,000 feet can reduce noise by as much as 5 dB within certain areas under the approach, save 220.5 lbs. of fuel per aircraft and 661.4 lbs. of emissions.⁵

Due to its slightly steeper trajectory, this type of procedure is not recommended with certain airport conditions (i.e., contaminated runway, strong crosswinds or low visibility)⁶. It does not reduce noise close-in to the airport or in the areas beneath and near the arrival runway ILS localizer signals (extended centerline).

A Continuous Descent Approach (or OPD) was proposed by the Chicago OAPM workgroup in 2013 but was considered impractical by the local FAA air traffic facilities. This was due to the high volume of traffic using Chicago airspace. Variations in aircraft performance can make spacing and sequencing aircraft using this procedure difficult, as well as increasing pilot workload. However, using a Continuous Descent Approach only during Fly Quiet hours may not have been considered. **We recommend** that FAA (Air Traffic) develop Continuous Descent Approaches to each runway for use during Fly Quiet hours.

c. Noise Abatement Departure Procedure (NADP)

⁴ http://www.caa.co.uk/docs/68/Basic_Principles_CDA.pdf

⁵ <http://www.greenaironline.com/news.php?viewStory=923>

⁶ <http://www.caac.gov.cn/dev/fbs/xjsyy/201305/P020130503515528554654.pdf>

There are several variations in how turbojet aircraft can be flown immediately after takeoff. In 1993, the FAA published Advisory Circular AC 91-53A, *Noise Abatement Departure Profiles*.⁷ The document describes aircraft speed, thrust and airplane configurations for two departure profiles known as “Close-in” (NADP 1) and “Distant” (NADP 2). Airport operators were to specify to air carriers which profile should be flown from each runway, dependent upon the proximity of noise sensitive areas. The Close-in NADP was designed to benefit areas within 3.5 nautical miles from the start of takeoff. The distant NADP was designed for use when noise sensitive areas are further from the airport⁸.

Roughly, the NADP 1 provides a steeper initial climb to 3,000’, after which the flight crew reduces power, “cleans up” the aircraft (i.e., flaps) and accelerates. The NADP 2 provides a shallower climb to 3,000’, with the pilots reducing power, cleaning up the aircraft and accelerating after just 800’. There are fuel considerations as well. Reduced thrust takeoffs can be used with either procedure, which can create a quieter climb out, but with a slower ascent to altitude.

NADPs are not mentioned within the O’Hare Fly Quiet Manual. It is unclear what analysis was conducted at ORD per the Advisory Circular, when the CDA coordinated with airlines to specify which NADPs are used. Some airports have documented extensive effort to identify and coordinate the most beneficial NADPs for their situation. At MSP, this included extensive cost benefit and parcel compatibility analysis.

We recommend the CDA conduct a careful review of the NADPs, including flight tests from each runway with noise measurements of several aircraft types in various metrological conditions. The NADPs should be revised as appropriate, the CDA coordinate with airlines and prominently advertise their policy within the Fly Quiet Manual.

d. Flight Track Variability

During the period between 10:00 PM and 07:00 AM, the Fly Quiet manual recommends the use of departure headings specific to certain runways that were designed to direct aircraft over less-populated areas. For example, for an aircraft using runway 28R for departure, a heading of 290 degrees is recommended. For clarification, runway numbers are generally assigned based on the rounded magnetic heading of the runway in degrees. For example, a runway with a magnetic heading of 276 degrees would generally be assigned the number 28, for 280 degrees.

When issuing the takeoff clearance, air traffic controllers assign these headings and when airborne, pilots turn the aircraft at their discretion, typically 400 feet above the departure end of the runway, to the assigned heading⁹.

While the intent to direct aircraft over less-populated areas is an admirable one, in practice there are subtle flaws in this concept. First, a heading flown by the pilot is subject to drift

⁷ http://www.faa.gov/documentLibrary/media/Advisory_Circular/ac91-53.pdf

⁸ <http://www.boeing.com/resources/boeingdotcom/commercial/noise/minneapolis.html>

⁹ FAA *Instrument Procedures Handbook*, FAA-H-8083-16, page 1-14

caused by the wind, meaning that the actual track of the aircraft over the ground can vary. The amount of variation depends upon the direction and strength of the wind, and the size of the aircraft. For example, a strong wind from the south would push a runway 28R departure flying a 290-degree heading to the north. Conversely, a strong north wind would have the opposite effect. The total amount of drift would also be increased for smaller, lighter weight aircraft.

Considering ever-changing combinations of winds, aircraft types, loading, and pilot preferences, this means that even consecutive departures off the same runway are likely to have slightly different ground tracks and overfly areas somewhat different from those intended by the Fly Quiet Program.

Second, since many aircraft climb at different rates before reaching 400 feet above ground level before beginning their turns, the headings can begin at different points, thus adding even more variability to the resultant flight tracks.

Third, to be effective, the headings need to be assessed frequently to determine whether they are achieving the intended effect. New runways must also be added to the program upon commissioning so that aircraft departing from them are directed over less-populated areas.

Two new runways have been commissioned at O'Hare Airport and yet they have not been assigned recommended departure headings in the Fly Quiet Manual. For example, runway 10C-28C opened in October 2013 and the Manual contains no recommended nighttime departure headings for that runway. By default, this means that aircraft departing that runway will be assigned the runway heading which may actually take them over more densely populated areas. This is significant given that when other runways are closed, runway 10C-28C is frequently used for nighttime departures. **We recommend** that these runways, and another to be commissioned in October 2015, are assessed to determine the best possible departure headings for noise abatement purposes.

In addition, the Fly Quiet Manual contains misleading information about the preferred runway use configurations. Runway 14R is listed as a preferred departure runway even though departures on that runway are extremely rare due to obstacle clearance issues on the taxiways just south of that runway. Departures could use runway 14R, but that would be the exception rather than the normal operating practice.

We recommend updating the *Fly Quiet Program Manual* (Arrivals and Departures Section) to address missing nighttime runway heading recommendations for certain runways and runway usage inaccuracies. All of the current recommended headings should be assessed to determine whether they are actually achieving the goal of directing flights over less-populated areas. **We also recommend** enacting a requirement for a periodic review of the Fly Quiet Manual to ensure that it is up-to-date and that it continues to reflect current and recent changes to the airfield and surrounding communities.

e. Area Navigation Standard Instrument Departures (RNAV SID)

The most effective method to ensure routes that will consistently direct aircraft over less-populated areas is to employ Area Navigation (RNAV). RNAV is a means of aircraft navigation that can be utilized to repeatedly place aircraft on any desired route, like those over less-populated areas. The advent of Global Navigation Satellite Systems (GNSS), mainly in the form of Global Positioning System (GPS) navigation hardware, has brought a new level of precision to aircraft navigation that improves constantly.

In practice, the terms RNAV and GPS are frequently used almost interchangeably. To avoid confusion, think of RNAV as the overall navigation method and GPS being the equipment used to accomplish that method. It is important to note that most, if not all aircraft today have some level of GPS capability, especially those operating at ORD. Today, GPS is accurate to within 40 feet or better¹⁰ and GPS accuracy can be enhanced further through wide area or ground based augmentation systems.

f. Using RNAV SID to Enhance Fly Quiet Departure Tracks

Using RNAV/GPS departure procedures at O'Hare, designed to direct aircraft over less-populated areas would add much more accuracy to the current intent of the Fly Quiet manual departure procedures regardless of wind conditions and departing aircraft type.

Controllers would assign the procedure to pilots, who subsequently would climb to 400 feet above ground level before turning to intercept the designated route. Note that this will cause some variability in the initial flight tracks as aircraft climb at different rates but this variability is a factor today with turns to the Fly Quiet headings. An examination of existing flight tracks would show the point where a preponderance of current departures reach 400 feet and start their turn (in other words, turn away from the runway heading). This typically would be a logical point for placement of the first waypoint of the SID and where the turned portion of the route commences. After reaching 400 feet, aircraft could precisely follow GPS waypoints along a predetermined route until turning on course at a specified altitude.

Implementing RNAV SIDs can involve extensive design and procedural review by the FAA ORD Air Traffic Control Tower, FAA Chicago TRACON (C90, Elgin, IL) and FAA Chicago Air Route Traffic Control Center (ZAU, Aurora, IL). Additional review would involve airport operators (airlines), FAA Flight Standards for "fly ability", and FAA Airports Division and CDA for environmental review. In 2013, the FAA attempted to implement RNAV SIDS for ORD departures. That project was postponed indefinitely after one operator asserted that some of its fleet could not comply with crossing restrictions required by the new procedures.

¹⁰ FAA online, *Satellite Navigation - GPS - Policy - Selective Availability*, http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/gps/policy/availability/

RNAV SIDs have been implemented throughout the country with mixed results. They have been implemented successfully at several major airports, including Denver (DEN), and have encountered significant community objection at other airports, notably Phoenix (PHX) and Minneapolis (MSP). At PHX, close-in neighborhoods vigorously objected after revised low altitude routes commenced, even though the procedures had passed Environmental Review. Those procedures are still in use and the concerns appear to be mostly unresolved. In 2014 at MSP, RNAV SIDs were postponed indefinitely after property owners beneath the narrowly defined RNAV departure tracks led the FAA to abandon its plans for RNAV SIDs at the request of the airport authority. **We recommend** that the FAA reevaluate RNAV departure procedures to determine whether new procedures could be designed and implemented to provide additional noise benefits during fly quiet hours.

RNAV arrival procedures, already in use at O'Hare for initial descent segments, should also be reviewed to determine whether amendments could be made to provide additional Fly Quiet benefits. However, because of the high volume of traffic operating at ORD and the complexity of its airspace, it is unlikely that close-in RNAV arrival procedures would be used other than during periods of light traffic.

g. Fly Quiet Altitudes

The O'Hare Fly Quiet Manual requires tower controllers to assign noise headings to all aircraft departing O'Hare airport during FLY Quiet hours. The noise headings are designed to generally direct O'Hare departures over less densely populated areas. Controllers are discouraged from turning departing aircraft from the tower assigned Fly Quiet noise headings until reaching 3000' MSL¹¹, or just less than 2,400' above ground level. The altitude restriction is intended to keep departures from flying over more populated areas until at a higher altitude, where noise impacts are reduced.

There is no clear reason why 3,000' was chosen as the minimum altitude before an aircraft can be turned off the Fly Quiet noise heading. For separation purposes, the O'Hare SID restricts departures to an altitude of 5000'. Using a higher minimum altitude for the Fly Quiet turning altitude would keep departures on the noise heading and possibly over less populated areas, for a longer time period. Using a higher Fly Quiet altitude would still be in compliance with air traffic procedural restrictions specified within the O'Hare SID.

We recommend that the SOC, along with other interested airport communities, carefully evaluate the area's most desirable for departure over flights during fly quiet hours. This should include the review of existing geographic objectives within approximately two to ten miles of each runway end. Findings should be shared with the

¹¹ MSL, or "Mean Sea Level"; *O'Hare Fly Quiet Program Manual*, <http://www.flychicago.com/SiteCollectionDocuments/OHare/AboutUs/Fly%20Quiet/FQ%20Manual%2006-08-15.pdf>

CDA and the FAA (Chicago TRACON) to consider whether using a higher altitude for initial turns from a Fly Quiet noise heading would be beneficial.

h. Departure Procedures with Multiple Segments

The headings within ORD's departure procedures consist of an initial departure heading. After reaching a specified altitude (i.e., 3,000'), ATC (FAA Chicago TRACON) turns departures on course, as traffic allows. A single heading might not be the most advantageous procedure for noise mitigation. While the Fly Quiet manual recommends headings and discusses following various tollways, pilots are given little latitude, if any, to ever do so.

Due to workload and other factors, ATC rarely gives aircraft multiple vectors or heading changes to follow tollways, ground reference points or to overfly less populated areas as the aircraft gain altitude. Other than the initial heading and general flight tracks to the altitude at which aircraft can be turned, the result becomes random flight tracks as controllers turn departures on course. This also varies based upon wind, aircraft/pilot performance and controller preference.

The intent is not to significantly detour aircraft. Some airports, such as Las Vegas (LAS) and St. Louis (STL) require a minimum distance departures must fly before starting a turn, as specified by ATC radar and aircraft distance measuring equipment (DME) or GPS (RNAV). Other airports address this through the development of compound departure procedures with multiple segments. This may consist of procedures using either RNAV or conventional procedures. For example, San Francisco (SFO) utilizes the "Quiet Seven" departure procedure (see Appendix 2) from 10pm to 7am, designed to keep departures over the San Francisco Bay. Initially the aircraft depart straight-out. If they continued straight out or were turned on course shortly thereafter, aircraft would overfly densely populated residential areas. A procedure was designed where pilots navigate straight-out four miles, and then turn thirty degrees left to climb over water for another 15 miles, before being turned on course.

Such procedures are allowable under the Airport Noise and Capacity Act (ANCA) ANCA and can greatly enhance noise mitigation, but can be inefficient during busier traffic. Determining whether a similar departure procedure might benefit the communities surrounding ORD would require careful analysis of areas that would be subject to the over flights and potential airspace constraints.

It is our recommendation that the areas in which over flights create the least disturbance be validated by the SOC. The FAA (Chicago TRACON) should then review whether a compound procedure or extended distance on initial heading could be developed to reduce noise impacts during Fly Quiet hours.

5. Use of Fly Quiet Headings *Outside* of Fly Quiet Hours

Noise headings specified for use during the Fly Quiet hours are intended to provide relief for communities surrounding O'Hare. Air Traffic Controllers are not required to use noise headings outside of the Fly Quiet hours (after 7am or before 10pm).

Departures from O'Hare are assigned a specific route to their destination. When the tower controller clears an aircraft for takeoff, he or she assigns a heading which puts the aircraft on its general direction of flight. For example, an aircraft departing west bound to Phoenix might be assigned any heading between 220 to 320 degrees. During periods of busier traffic and to avoid delaying aircraft, controllers use multiple headings for a single direction of flight. When using multiple headings controllers must have a minimum of 15 degrees separation between successive departures¹².

For example, during a period of heavy west bound departures, a controller might assign the first departure a 250 degree heading, the next a 270 degree heading and the third a heading of 300 degrees. Using multiple headings for departures is referred to as "fanning". Fanning departures is the most efficient and expeditious way of moving airplanes, as it allows spacing aircraft as little as one nautical mile apart, instead of three miles or more. Fanning is not necessary during Fly Quiet hours due to lighter traffic volume and minor inconvenience to the operations. During Fly Quiet hours departures are restricted to flying the single, designated headings that are published in the Fly Quiet Program Manual and using multiple headings would not be in compliance.

Throughout the day, outside of Fly Quiet hours, there are occasional periods of light to moderate traffic. During these slower periods, fanning departures is sometimes not needed to efficiently manage the traffic. There are also weather situations, a line of thunderstorms for instance, which can block departure routes and slow down the traffic flow. In these cases controllers are sometimes restricted to using a single heading. When multiple headings are not needed, individual controllers determine what headings they assign to individual aircraft. Some controllers will use the cardinal headings¹³ as their "default" heading when single headings are used. Other controllers assign headings aiming the aircraft most closely toward its eventual flight plan route. Controllers do not normally consider noise headings when working outside of the Fly Quiet hours.

It is understood that an air traffic controller's number one priority is the safe and efficient flow of air traffic. In most cases outside of the Fly Quiet hours, the use of multiple headings is required to keep the air traffic operation safe and efficient. Occasionally there are situations when multiple headings, or fanning, may not be needed to keep up with traffic flow. During these slow periods, or during weather events where departures are restricted to a single heading, controllers may have opportunities to assign the

¹² FAA JO 7110.65 Controller Handbook

¹³ Cardinal headings are the four magnetic headings which correspond to the four cardinal directions of north (360), south (180), east (090) and west (270).

published noise headings. **We recommend** that as opportunities arise, controllers should consider using the published noise headings as the “default” departure headings when working outside of normal Fly Quiet hours.¹⁴

a. Pilot Use of Reverse Thrust

The ORD Fly Quiet Manual, “*Arrival and Departure Procedures*”, advises pilots to limit the use of reverse thrust. Reverse thrust is often used on the ground, just after landing, as a form of braking. After touchdown in a jet aircraft, the flight crew can initiate engine reversal, creating a forceful forward jet thrust to help decelerate. How reverse thrust is used is left to pilot discretion. Aircraft performance and landing distances are calculated with the expectation that reverse thrust will be activated. In practice, its use varies by type aircraft, runway length and runway remaining, winds, speed, runway contamination, runway exit locations, and pilot’s desire or ATC’s need to expedite the slowing of their aircraft and clearing of the runway for other traffic. Using less reverse thrust can increase the amount of runway used, increase the need for wheel braking and associated mechanical wear. Using more reverse thrust reduces the need for braking, shortens stopping distance as well as creating additional engine noise, audible for several miles.

Pilots typically use the minimum reverse thrust consistent with safety for the runway conditions and available length. The exception is when they desire to exit the runway at first opportunity because later exits may increase taxi time to their parking areas. **Our recommendation is** that the CDA continue to recommend to pilots to use minimal reverse thrust needed during Fly Quiet hours. Using outreach, the CDA should also emphasize with cargo operators, ATC and airlines with flights during Fly Quiet hours to avoid use of early runway exits, unless operationally necessary.

b. Aircraft Fleets

In 2000, large Stage 2 turbojet aircraft were prohibited from operating within the United States. There were several variations of aircraft that were unaffected, but barely conformed to Stage 3 requirements. These included the McDonnell Douglas MD80 and DC10, amongst others. While the operators of many of these aircraft have indicated they intend to phase-out or retire these older aircraft, there is no requirement to do so. Fleet improvements can be affected by business plan and economic changes.

Unfortunately, the aircraft noise levels for these aircraft, some 35 years old, are noticeably higher than more modern aircraft. Noise levels are published within the FAA’s Aircraft

¹⁴ The O’Hare Tower –Chicago Approach Control Letter of agreement requires some airplanes (based on direction of flight) to fly headings that put them adjacent to the protected arrival area airspace. This recommendation only refers to possibilities where using a noise heading does not conflict with any LOA or other type of agreement.

Noise Levels database¹⁵ as well as within Advisory Circular AC 36-1H.¹⁶ Measurements are provided for takeoff, sideline and approach configurations. The loudest aircraft currently operating appears to be the DC10. While airlines no longer carry passengers on these aircraft, the DC10 is commonly used for cargo operations, most often in the late night and early morning hours.

As of May 2015, FedEx was still operating 47 DC10 aircraft configured for cargo operations¹⁷ (models DC-10-10 and DC10-30). American Airlines still operates 108 MD80 style aircraft (51 MD-82, 57 MD-83). Delta Airlines operates 180 MD80 variants, though their fleet is slightly newer and quieter than American's (116 MD-88, 64 MD-90).¹⁸

While ANCA precludes sanctions against these operators for using noisier aircraft, aggressive outreach could help. For instance, operators can be encouraged to give high priority or even accelerate disposing of these aircraft. Meanwhile, the same operators can be encouraged to use them on alternate routes and discouraged from operating these aircraft to or from ORD during Fly Quiet hours. This can be another metric included in a report-card type program that uses the media to inform the public on the success and sincerity of each carrier's efforts to minimize their noise impacts. This may in turn motivate airlines to make positive changes to enhance their local image.

The Los Angeles International Airport (LAWA)/Community Noise Roundtable 2014-2015 Work Program details 22 objectives to reduce local aircraft noise.¹⁹ Item A12 of the document describes an effective method²⁰ to reduce noise exposure from the Airbus A320 family of aircraft that has similar application at ORD:

"Researchers in Europe have identified a high-pitched noise from the older A320 family of aircraft as the aircraft descends for landing, caused by air flowing across open cavities under the wing. The noise can be heard several miles from the runway before the deployment of landing gear. Researchers have developed a simple solution called the Vortex Generator that solves this particular problem. The Vortex Generator is a small metal device placed in front of the open cavities that changes the air flow and reduces the noise by 2 dB to 6 dB. Airbus is already placing vortex generators on newly manufactured aircraft and Lufthansa and Air France are retrofitting their existing aircraft that operate in Europe."

Airlines that operate A320s at ORD have the following fleet compositions:²¹

- United Airlines: 97 A320 (of 714 aircraft)
- American Airlines: 55 A320 (of 963 aircraft)

¹⁵https://www.faa.gov/about/office_org/headquarters_offices/apl/noise_emissions/aircraft_noise_levels/

¹⁶ http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%2036-1H.pdf

¹⁷ [http://www.planespotters.net/Airline/Federal-Express-\(FedEx\)](http://www.planespotters.net/Airline/Federal-Express-(FedEx))

¹⁸ <http://www.airfleets.net/flottecie/American%20Airlines.htm>

¹⁹<https://www.lawa.org/uploadedFiles/LAX/pdf/Roundtable%20Work%20Program.pdf>

²⁰ <http://www.euractiv.com/sections/aviation/small-beautiful-how-tiny-device-cuts-aircraft-noise-303505>

²¹ <http://www.airfleets.net/flottecie/United%20Airlines.htm>

- Delta Airlines: 69 A320 (of 803 aircraft)
- Jet Blue Airlines: 130 A320 (of 210 aircraft)
- Spirit Airlines: 42 A320 (of 75 aircraft)
- Frontier Airlines: 22 A320 (of 56 aircraft)
- Virgin America Airlines: 45 A320 (of 55 aircraft)

July 2015 statistics indicated that approximately 7.0% of ORD's fleet composition were A320 aircraft. LAWA has an objective to reach out to other airport's noise programs to develop support for encouraging airlines to retrofit these aircraft as described. **It is our recommendation** that the CDA and the impacted O'Hare communities and interested public officials coordinate with LAWA and other interested airport operators to best accomplish this.

c. Curfews

The concept of curfew occasionally arises in discussion of noise mitigation. A number of larger airports within the United States do have curfews on jets. These are mostly in the west and include Orange County, CA (SNA), San Jose, CA (SJC) and San Diego (SAN). SNA's curfew runs between 11pm and 7am; SNA also established a set of 10 noise stations that monitor aircraft noise and can lead to sanctions for violations. SJC's curfew runs between 11:30pm and 6:30am. SAN has a curfew during those same hours for departures only. Washington National (DCA) has a nighttime noise rule which limits louder aircraft types, as well as requiring use of operationally challenging arrival flight procedures. Overnight curfews are common in Europe, while night quota periods are established for the three major airports serving London (ELHR, EGKK and EGSS).

The Airport Noise and Capacity Act (ANCA) of 1990 restricts the development of new curfews or access restrictions. However ANCA does not prevent curfews or similar noise abatement measures which can be adopted and implemented without requiring FAA approval if the airlines using the airport reach agreement with the airport proprietor as to such restrictions ²²

²² ANCA's prohibition on any Stage 3 measures without FAA approval does not bar such measures if both the proprietor and the airline agree. See 49 U.S.C. Section 47524 (c); **"Stage 3 aircraft.--(1)** Except as provided in subsection (d) of this section, an airport noise or access restriction on the operation of stage 3 aircraft not in effect on October 1, 1990, may become effective only if the restriction has been agreed to by the airport proprietor and all aircraft operators..." (emphasis added). The upcoming renegotiation of the Airport Master Lease (which expires in 2018) between Chicago and the O'Hare airlines creates an opportunity for various options for curfews or other noise abatement restrictions to be negotiated between Chicago and the O'Hare airlines.

One factor which may prevent the consideration of a curfew or late night restrictions has been ORD's accommodation and continued infrastructure development for cargo operations. Unfortunately, this encourages a heavy concentration of nighttime activity. In addition, there are various foreign flag carrier operations operating to and from overseas airports during fly quiet hours, many to comply with their own curfews. Domestic passenger airlines have sought to increase profitability through greater aircraft utilization and have increasingly scheduled operations during Fly Quiet shoulder hours- such as between 5am and 7am, as well as 9pm to 11pm. Thus, there are potentially significant noise remedies that may raise objections because of Chicago and airline business considerations.

These potential conflicts should not prevent the development of voluntary restrictions w. Minneapolis, for example, has advocated since 2007 for airlines to "put forth their best efforts" to avoid scheduling operations between the nighttime hours of 10:30pm and 6:00 am. Our analysis shows, however, that effort has had limited success. In 2014, MSP averaged 400 air carrier operations per evening between 23:00 and 06:00²³. Austin, TX (AUS) has a similar voluntary curfew (12:00am to 6:00am); compliance has also been disappointing.

Pairing such a policy request with a *Report-Card* type program could encourage greater compliance. O'Hare already uses a report card, by airline, in their analysis of late night flight tracks. Including and publicizing a monthly report of airlines with higher volumes of flights scheduled during Fly Quiet hours could encourage them to avoid adding flights during these sensitive hours each day. San Francisco (SFO) utilizes a monthly noise report card, publicly recognizing carrier's performance with six local noise reduction metrics (see Appendix 3). **We recommend** that the CDA enhance its report card program and that the CDA, FAA and the airlines collaborate to minimize operations during the Fly Quiet hours.

6. Modifying Runway Usage Configuration during Fly Quiet Hours

a. Current Fly Quiet Operations

During Fly Quiet hours (2200-0700) the City of Chicago Department of Aviation (CDA) closes all but two runways on the airport. The intent is to leave one runway open for arrivals and another for departures. Approximately 9% of the aircraft that fly over night are wide body aircraft referred to as "heavy jets"²⁴. These heavy aircraft are capable of weighing over 300,000 pounds and many times operate at two or three times that weight. Aircraft such as these normally require runways that are 10,000 feet or longer for both landing and takeoff. Runway 28R/10L is 13,000' long and is almost always left open to

²³ FAA, Aviation System Performance Metrics

²⁴ ASPM traffic count number for July 2015

accommodate these aircraft. The second runway left open is a shorter runway and most often Runway 27L. CDA closes the remaining runways for convenience. According to the 2015 1st Quarter Fly Quiet Report, runway 27L received 46% of all arrivals during Fly Quiet hours. Runway 28 C (19%) and 28R (8%) were also used frequently. Together, these three runways carry 73% of the arrival noise impact during Fly Quiet hours.

During Fly Quiet hours the CDA performs maintenance on the runways and taxiways. In most cases this work requires the maintenance vehicles to drive on or cross active runways. The FAA requires all vehicles to obtain an air traffic control (ATC) clearance before they can enter any part of an active runway. If a runway is closed, or inactive, an ATC clearance is not necessary and vehicles can proceed on runways without coordination. Closing the runways also helps the ATC operation. Numerous requests from maintenance vehicles to operate on runways can increase controller workload, create frequency congestion and distract controllers from other duties.

b. Opening a Third Runway during Fly Quiet Hours

One option to spread aircraft noise during Fly Quiet hours is to leave a third runway open. It's important that the third runway be one of the diagonals and not another east west runway. Using another east west runway would keep the noise on the east and west sides of the airport. Using a diagonal runway allows aircraft noise to be spread over a wider area. A third runway could also benefit arrivals by saving flying distance, time and fuel. An example is an aircraft arriving from the west might land on Runway 14R instead of flying five or ten miles past the airport and getting vectored in from the east to Runway 27L (Figure 5). A third runway would provide flexibility to the FAA approach control (Chicago TRACON). Controllers could assign arrivals to both runways based on where they are arriving from, rather than directing all arrivals to a single runway. This would benefit arrivals by saving flying distance, time, fuel and overflying a wider expanse of populated areas.



Figure 5. Flight Tracks with Arrivals on 14 R and 27L

The ASPM traffic count numbers for the month of July 2015 show there were 7068 arrivals and departures at O'Hare between 2300-0600²⁵. Of these operations 91% were smaller than a 757. These smaller aircraft are usually able to land on the shorter runways at O'Hare. A third runway could also spread noise generated by departing traffic. O'Hare Tower could use two runways for departures instead of sending all departing aircraft to a single runway. Using more than one departure runway would save time and fuel by shortening taxi routes. It's important to note that although a third runway could provide noise benefits, this could vary, depending on how individual controllers made use of the extra runway.

c. Fly Quiet Options Using Three Runways

West Winds

Arrivals can be rotated between 22R, 27L, 28R and 28C.

Departures can be rotated between runways 32L, 28R, 28C or 22L.

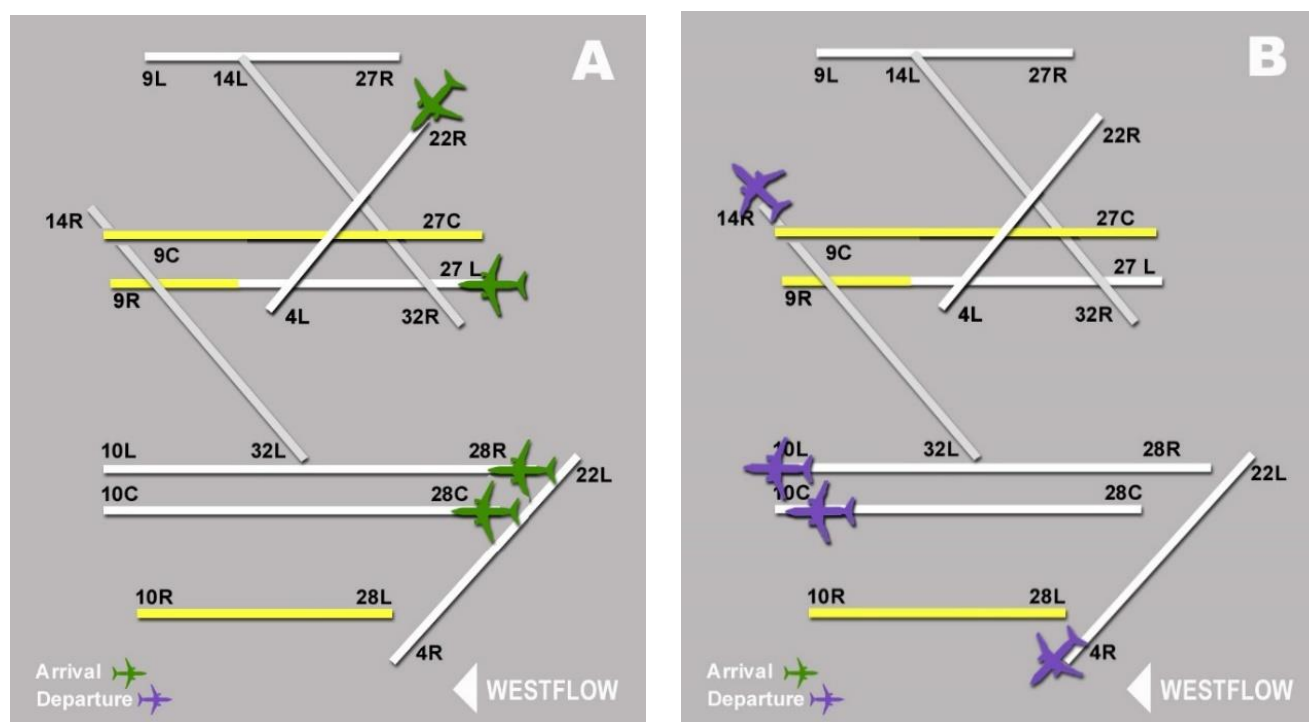


Figure 6. West Flow Arrival and Departure Options

²⁵ Operations during the “shoulder hours” of Fly Quiet were not included because those hours often have a full operation in progress that includes three arrival runways.

East Winds

Arrivals can be rotated between 14R, 9R, 10L, 10C and 4R.
Departures can be rotated between 10L, 10C, 9R and 4L.

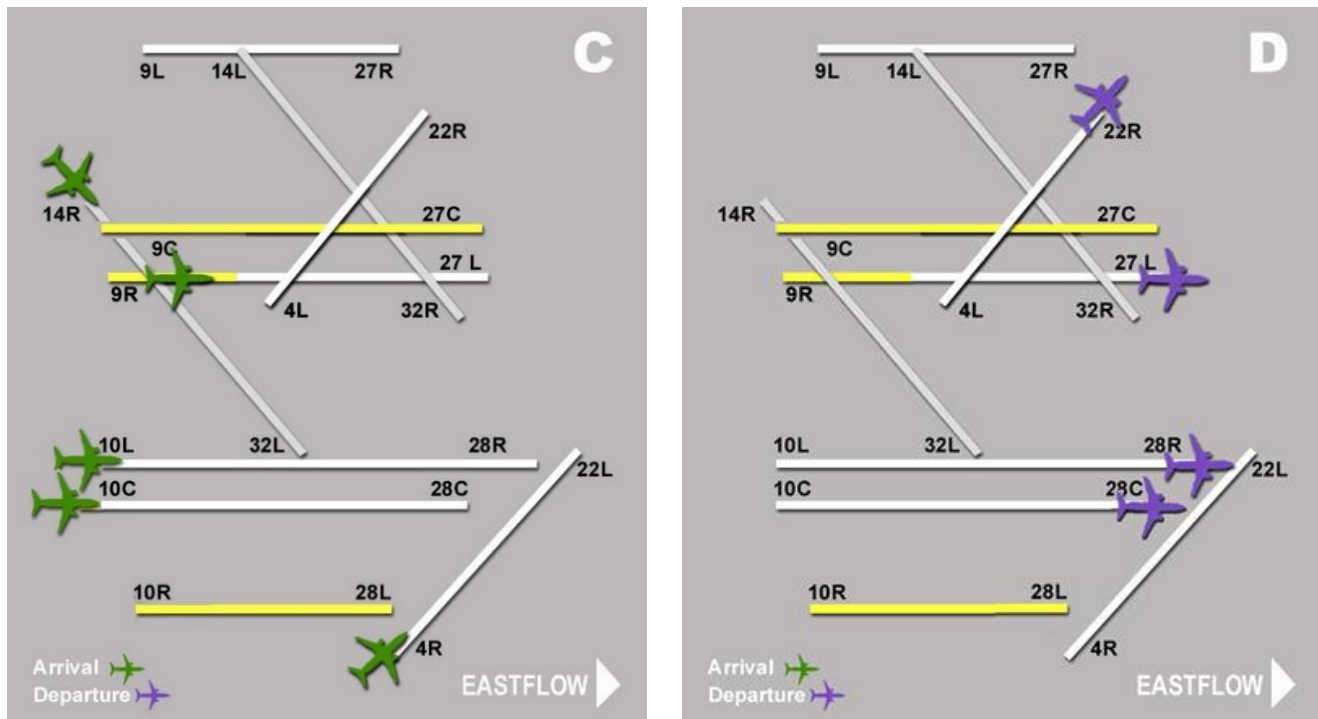


Figure 7. East Flow Arrival and Departure Options

d. O'Hare Modernization Project (OMP) Changes

Runway 14L/32R recently was closed. Current OMP plans to eventually close the other northwest diagonal runway (14R/32L). With the northwest diagonals closed, the southwest diagonals (22R/4L and 22L/4R) would still provide benefits for spreading noise. Runways available without the northwest diagonals are:

West Winds

Arrivals can be rotated between 28C, 28R, 27L and 22R.

Departures can be rotated between 28R, 28C and 22L.

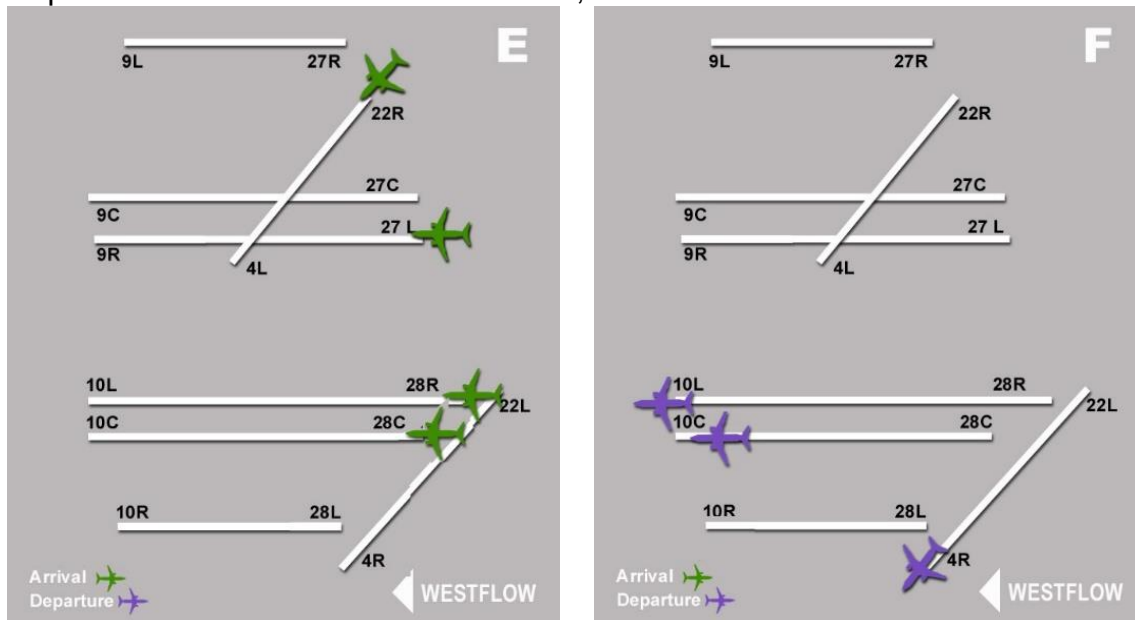


Figure 8. OMP West Flow Arrival and Departure Options

East Winds

Arrivals can be rotated between 9R, 10L, 10C and 4R.

Departures can be rotated between 4L, 9R, 10L and 10C.

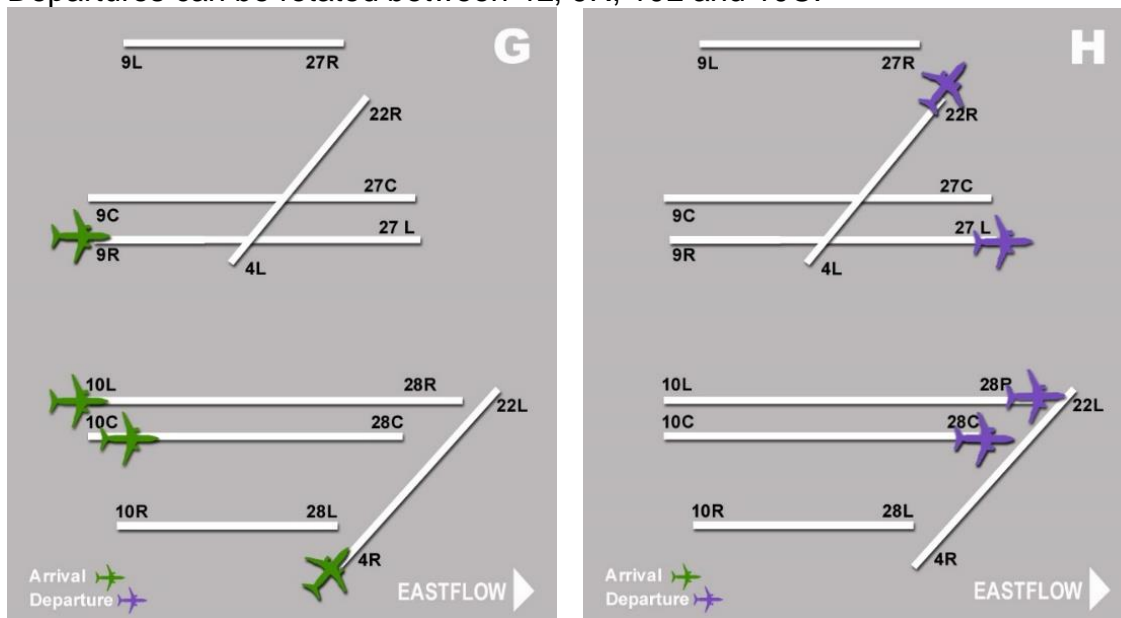


Figure 9. OMP East Flow Arrival and Departure Options

e. Runway Rotation Plan

Another option to address noise is a Runway Rotation Plan (RRP). A RRP provides different noise benefits by specifying which runways are to be used for arrivals and departures on a given day. The runways can be alternated on a nightly basis. The RRP would track runway use, with the intent being that no single arrival runway is used on consecutive days²⁶. An RRP would move aircraft noise to an entirely different area, rather than spreading the noise over a wider area. We have identified the runways that would be available for use in a RRP. Those runways are 10C/28C, 9R, 14R, 22R, 27L, 28C/28R and Runway 4R.

Referring to the current O'Hare runway layout and assuming east winds, four options would exist for rotating runways. Runways 10L/10C, 9R, 14R and 4R would all be usable with winds out of the east. For a west wind situation, arrivals could similarly be rotated between Runways 28R/28C, 27L and 22R. Departure runways can be rotated as well. During east winds Runways 10C/10L, 9R and 4L would be available for departures²⁷. During west winds Runways 28C/28R, 22L, 27L and Runway 32L would be options for departures.

There are three runways that likely cannot be used in a runway rotation plan. Portions of Runway 9L/27R along with portions of the new Runway 10R/28L (opening October 2015) are not visible from the center tower. Air traffic controllers must have a full view of runways and taxiways. Because of the restricted visibility, operations on these runways are managed by controllers working in the two smaller, remote towers. Due to limited equipment in the smaller towers along with other logistical issues, the ATC operation during Fly Quiet hours takes place from the center tower. Controllers working in the remote towers have the reverse situation regarding restricted visibility. This would likely prevent Runway 9L/27R and Runway 10R/28L from being used in a rotation plan.

Runway 22L is not used as an arrival runway in this report. Aircraft landing Runway 22L would have a lengthy taxi route back to the terminals. The taxi route would require aircraft to cross two other runways, which could be active depending on the runways being used that night. This type of operation could be considered inefficient as well as create potential for runway incursions. Runway incursions are a safety concern. Any proposal submitted to the FAA has to be considered safe and efficient, or otherwise will likely be rejected.

f. Effects of Strong Winds or Other Weather

When winds are strong (i.e., greater than ten knots) aircraft must land and depart into the wind. A runway rotation plan could be limited for extended periods because of wind or

²⁶ There may be times where rotating runways is not possible. Examples include weather issues, runway maintenance or closures, or any other situation that impacts the air traffic control operation.

²⁷ Runway 14R was not included. ATC rarely uses Runway 14R for departures because of runway obstacle and clear zone requirements off of the departure end.

other weather conditions. For instance, during a long period of strong west winds (days or weeks) the rotation plan could be limited to only those runways aligned with the wind. During snowstorms, some runways may not be available because of snow removal. Thunderstorms can block the final approach of a runway and prevent it from being used. A runway rotation plan has to be flexible because it is dependent on daily weather conditions. A plan that designates runways in advance without concern for weather will likely not be successful.

g. Periods of Calm or Light Winds

According to the National Climatic Center (NOAA) records, and using 15 years of data at O'Hare (2000-2014), steady winds at O'Hare with an intensity equal or less than 10 knots from any direction comprised 68% of the total operations over that period. When the wind velocity is less than 10 knots there is minimal effect on aircraft performance. Pilots often accept tailwind conditions if winds are light. If winds are not a factor, runways can be rotated even further. Nine of O'Hare's runways have been identified as usable in a RRP. With light winds it's conceivable to have nine consecutive days where no single runway is used more than once.

h. Future Runways

The rotation plan can be expanded further to include the any new or extended runways that open in the future.

i. Considerations with the Current O'Hare Runway Layout (August 2015)

The current runway layout includes only two runways that are over 10,000 feet long. If a runway rotation plan was implemented today many of the heavier aircraft may not be able to land on the shorter runways. Any aircraft rejecting a shorter runway would have to be accommodated on one of the longer runways. For this reason either Runway 28R/10L or 28C/10C would have to be open every night. This means that some communities around O'Hare might be subject to noise even though it's "their turn" to have noise distributed to another area. If the OMP project is built to final phase, this situation could improve as new and longer runways open. It should be noted that Runway 32R (recently decommissioned by Chicago) has sufficient length to accommodate flights requiring long runways and could serve as an alternative departure runway for heavy aircraft departures during nighttime Fly Quiet hours. This could provide short term more immediate relief for those communities impacted by departures off 28R/10L or 28C/10C. The limited number of nighttime departures for heavy aircraft departing 32R would not raise safety issues of conflicting runways (e.g. "hot spots") since those potentially conflicting runways would not be active when 32R departures were taking place.

For the purpose of spreading noise, Runway 10C/28C and Runway 10L/28R are not considered as separate runways, because they are only 1400' apart and would result in minimal noise benefit in a rotation plan. If Runway 9C/27C is built in the future, it will be

close to Runway 9R/27L, resulting in the same situation and the same minimal noise benefit (Figure 10).

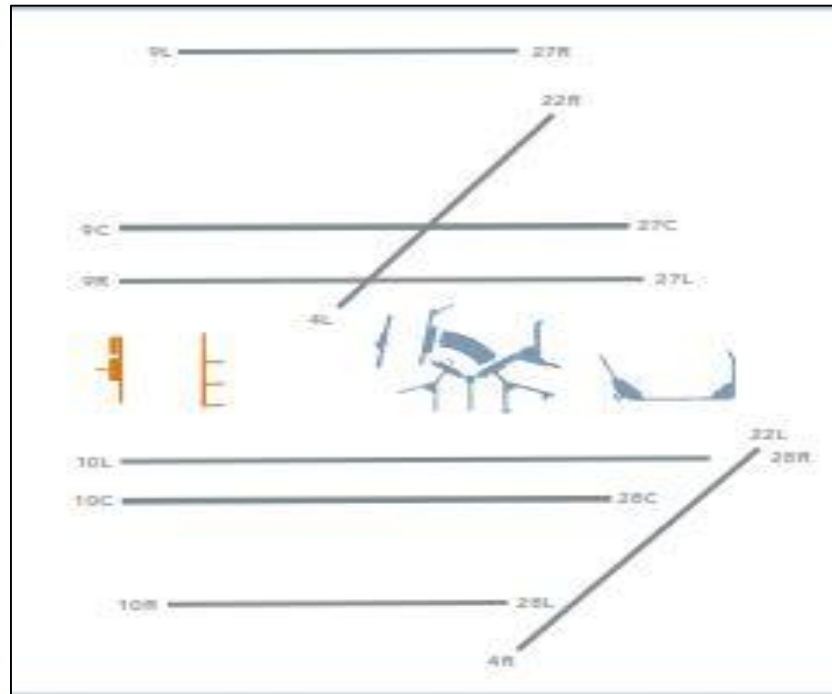


Figure 10. Runway Spacing 28R and 28C

j. Implementation and Community Agreement

It is unlikely that the FAA will commit to anything more than an approximation of runway usage targets (i.e., “equitable rotation”), based upon operational priorities and issues with similar agreements at other airfields, such as at Phoenix Sky Harbor (PHX). While collecting and reporting on usage trends can be useful, the FAA (or the CDA) is unlikely to agree to be held strictly accountable for aberrations. The rotation plan would need to be in compliance with all applicable safety and environmental requirements.

There could be dissent from communities that benefit from existing Fly Quiet runway usage patterns. Certain neighborhoods could resist the use of a rotation system that shifts noise and impacts to their areas in order to provide relief to others.

The six parallel runways in the OMP plan forces all arrivals and departures to approach and depart the airport from the east or west. The same is true during Fly Quiet hours. A Runway Rotation Plan appears to be a viable alternative for distributing and relocating noise to other runways and areas during the overnight hours. An RRP can provide immediately relief for those areas mostly affected by noise. An RRP requires no additional infrastructure or training for controllers and pilots. If the SOC and the other surrounding airport communities concur, **we recommend** that the CDA consider a Runway Rotation Plan to spread noise during the Fly Quiet hours.

7. Intersection Departures during Fly Quiet

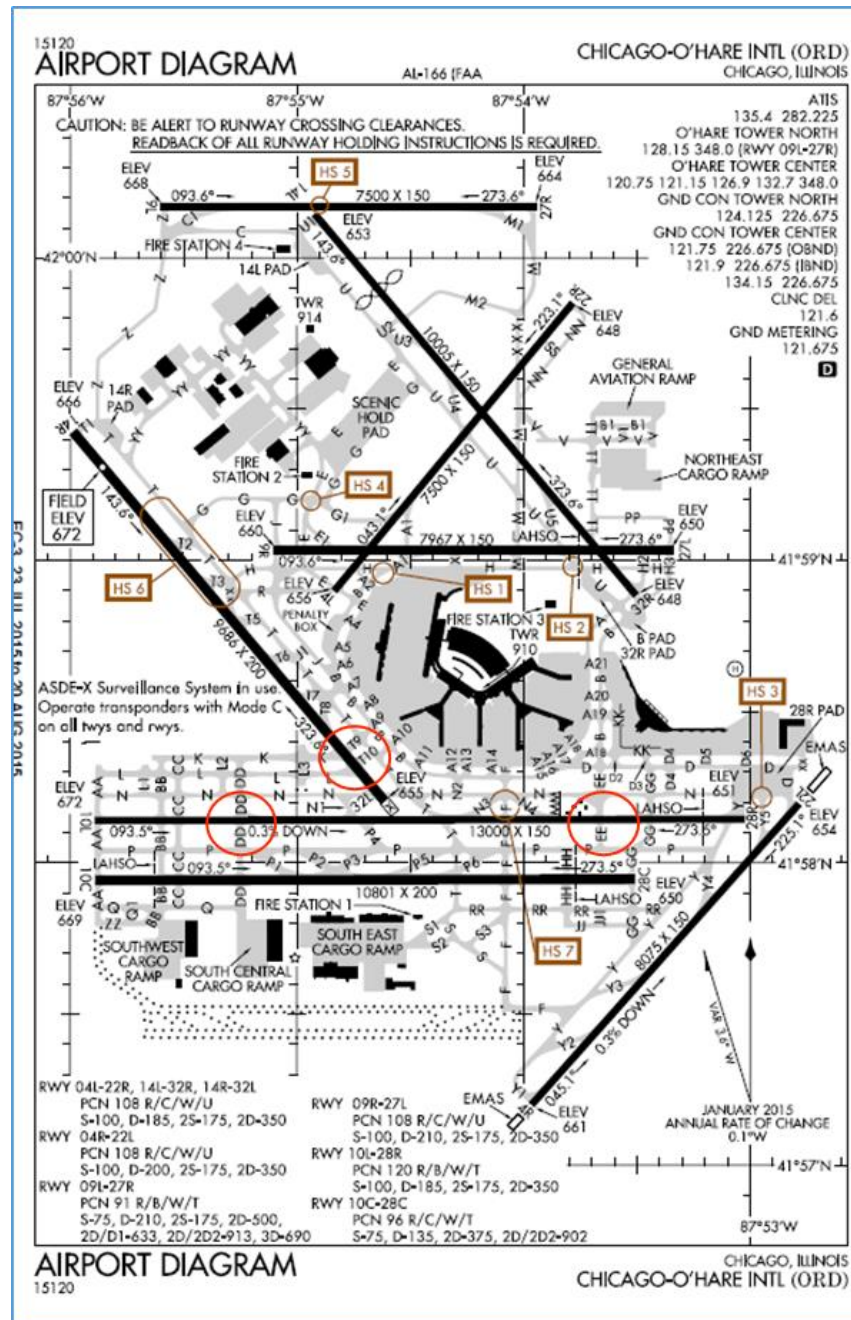


Figure 11. Chicago O'Hare Intersection Departure Locations

O'Hare Tower air traffic control (ATC) has historically used intersection takeoffs (taxiways that intersect with the runway) as the departing point for aircraft instead of the full-length of the runway (Figure 11). Intersection departures not only improve the efficiency of the

operation but also can reduce runway incursions and eliminate controller workload. The use of intersection takeoffs will continue with the new runway layout being built under the O'Hare Modernization Project (OMP).

a. Safety Issues with the OMP Runway Design

If OMP is completed as planned O'Hare airport will have six parallel runways. The four runways that are closest to the terminal area (inboard runways) are all 11,000 to 13,000 feet long. These long runways (along with the associated clear zones at the runway ends) extend from the east to the west boundary of the field. This leaves no room to route taxiing aircraft around the ends of the inboard runways as they move to and from the outboard runways. This creates a situation where any aircraft taxiing to or from an outboard runway has to cross at least one active runway along its route.

Routing taxiing aircraft across active runways is not recommended and strongly discouraged by the FAA. Doing so creates the potential for runway incursions. A runway incursion is "Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for landing and takeoff of aircraft". Runway incursions are one of the top safety issues within the FAA.

b. Continued Use of Intersection Takeoffs on the New Runways

When OMP was unveiled the original thought was to build End-Around Taxiways (EAT) that would route aircraft around the ends of the inboard runways. As mentioned earlier, the length of the runways along with protected areas (clear zones) off the ends of the runways eliminated this option. A typical EAT would have to be offset 2,500 feet from the end of the runway to allow an aircraft such as a Boeing 747-400 to taxi around without interfering with takeoff procedures on the runway. Without EAT taxiways, all aircraft taxiing to and from the terminal would have to stop short of the inboard runways until cleared to cross by ATC. Controllers must stop the departing aircraft when they clear a taxiing aircraft to cross the runway. This frequent stop-and-go operation creates extensive delays for both the taxiing and departing aircraft. This operation also creates the potential for runway incursions.

To eliminate this problem, O'Hare tower came up with a unique procedure. Instead of clearing aircraft for takeoff from the full length of the runway, they use a taxiway intersection several thousand feet from the approach end of the runway as the departing point. On runway 28R, for example, ATC taxis departures to the intersection of the EE taxiway as the departing point. This leaves 10,108 feet of runway for departures, which is more than adequate for most aircraft. Ground control then routes the taxiing airplanes to cross the runway behind this departure point. This type of operation eliminates the safety issue as well as the efficiency problem when crossing active runways with taxiing aircraft. The potential for a serious runway incursion is eliminated as well as the need for ground traffic to stop short of runways while waiting to cross. In addition there is no need to stop departures while aircraft taxi across which allows for maximum efficiency.

c. Intersection Takeoffs and Noise

An aircraft departing the full length of a runway will get airborne earlier and will be at higher altitude as it leaves the airport boundary than an airplane departing from an intersection. Takeoff distances and climb rates can vary greatly depending on the type of aircraft, aircraft weight and weather conditions. Based on average climb rates and speeds the altitude of an aircraft departing the full length of the runway can be several hundred feet higher or more as it leaves the airport boundary than the same airplane executing an intersection departure. The higher the airplane the less noise for residents close to the airport. Preliminary analysis using Boeing 737-800 data indicates that an intersection departure could generate 1.3 dB above the noise level produced by a full-length departure using the same aircraft and the same takeoff thrust settings.



Figure 12. Intersection and Full Length Departure Path Areas

Use of a full-length takeoff rather than starting at an intersection leaves more room for an aircraft to turn onto an assigned heading before reaching the airport boundary. Figure 12 shows how an earlier turn could shift noise away from residential areas west of the airport. The orange and yellow area shows the existing pattern when the aircraft departs from the intersection. The green and yellow area shows the pattern with the takeoff starting from the full length of the runway, or 2000 feet further east. This change could benefit some areas by as much as four decibels as indicated by the orange oval. This is in addition to the reduction in noise afforded by the increased altitude of an aircraft departing from the full length of the runway.

d. Using the Full length of the Runway at O'Hare

O'Hare Tower uses intersection takeoffs to keep the ATC operation safe and efficient. Eliminating this procedure outside of the Fly Quiet hours (0700 -2200) is not practical without impacting the operation and jeopardizing safety. During Fly Quiet hours the traffic

volume is low and averages 133 nighttime departure operations for the entire shift (source is the CDA ANMS data). Controller workload during these hours is normally lower than other times of the day. The low volume of traffic itself eliminates much of the potential for a runway incursion to occur. The “trickle in, trickle out” pace of midnight operations means there is rarely a line of aircraft waiting to depart or a steady stream of arrivals that would get delayed waiting to cross the active runway.

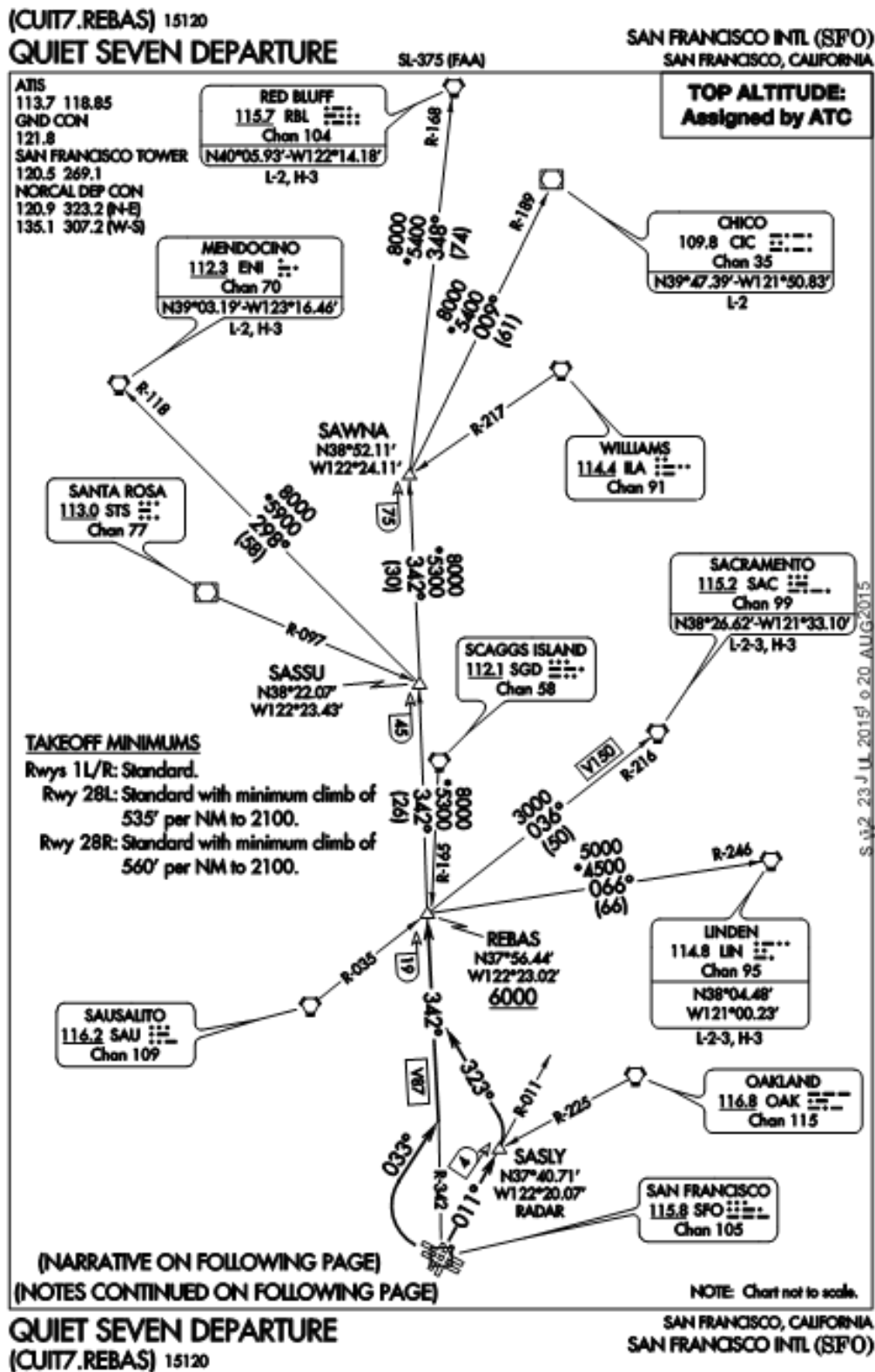
We recommend as long as operational requirements permit, O'Hare Tower should consider refraining from using intersection departures during Fly Quiet hours. Any aircraft departing the airport should be assigned the full length of the runway. The exception is what's referred to as “shoulder hour” operations. Shoulder hour operations are defined as the first and last hour of the Fly Quiet time period where traffic volume, at times, can be much heavier than normal midnight traffic.

Appendix 1: Summary of Recommendations, Action Authority, Benefits

Recommendation	Description	Responsibility	Likely Benefit *
JDA-FQ-1	Revise Mission and Resources	CDA	Moderate
JDA-FQ-2	Second Departure Runway to Start FQ	CDA, FAA	Moderate
JDA-FQ-3	Daily FQ Termination	FAA	Minor
JDA-FQ-4	ATC Compliance/Education	CDA, FAA	Moderate
JDA-FQ-5	Continuous Descent Arrivals	FAA	Moderate
JDA-FQ-6	NADP Update	CDA	Minor
JDA-FQ-7	Add Noise Headings for New Runways	SOC/CDA/FAA	Significant
JDA-FQ-8	Review Existing Noise Headings	SOC/CDA/FAA	Significant
JDA-FQ-9	Periodic Fly Quiet Review	CDA	Moderate
JDA-FQ-10	RNAV Procedures	FAA	Significant
JDA-FQ-11	Geographic Review	SOC/FAA	Moderate
JDA-FQ-12	Fly Quiet Headings in Light Traffic 24/7	FAA	Moderate
JDA-FQ-13	Reverse Thrust	CDA/FAA	Minor
JDA-FQ-14	Old Aircraft	CDA	Moderate
JDA-FQ-15	Advocate A320 Modification	CDA	Moderate
JDA-FQ-16	Report Card Program	CDA	Minor
JDA-FQ-17	Three Runways in FQ	CDA, FAA	Significant
JDA-FQ-18	Runway Rotation Plan	CDA, FAA	Significant
JDA-FQ-19	Reduce Intersection Departures	FAA	Moderate
JDA-FQ-20	Eliminate Visual Approaches During FQ.	FAA	Minor

** Subjective noise mitigation benefit based upon estimated effects and probability of success*
































Appendix 2: SFO Quiet Seven Departure



Appendix 3: SFO Monthly Noise Report Card

Airline Fly Quiet Summary Report - 1st Quarter 2015

January 1 to March 31, 2015

Airline	Fleet Noise Density	Noise Exceedance	Nighttime Banway Use	Departure Shoreline Gap	Arrival Foster City	Final Score	Airline Fly Quiet Rating
 ASH	10.00	9.89	-	-	7.64	6.13	8.42
	9.07	9.84	-	87.5	4.92		8.11
 FFI						9.29	
 ABX	4.80	9.48	-	10.00	6.14	7.21	7.52
 ACA	5.52	9.98	5.56	9.21	5.94	8.46	7.41
 ANZ	6.61	9.96	-	-	5.55	-	7.31
 FDX	3.42	9.22	10.00	10.00	4.38	6.63	7.21
 EIN	4.05	10.00	-	10.00	4.72	-	7.15
 SWA	5.72	9.92	3.33	10.00	6.00	8.14	7.11
 SWR	8.17	9.94	-	-	3.39	-	7.11
 AFR	5.77	10.00	-	50.0	7.67	-	7.11
 GTI	4.72	8.69	-	-	7.03	7.00	6.80
 AAL	5.64	9.90	3.89	9.34	3.22	8.96	6.80
 JBU	4.81	9.90	3.33	8.82	5.27	8.40	6.70
 AWE	4.75	9.86	4.44	7.37	6.06	7.39	6.60
 DAL	6.55	9.94	4.59	8.19	2.22	8.33	6.60
 NCA	9.81	7.95	-	-	2.50	6.22	6.60
 CES	4.08	9.97	-	-	5.57	-	6.54
 KLM	4.02	9.97	-	80.0	3.64	-	6.41
							6.31
 VIR	3.51	9.77	-	-	5.58	-	6.29
 UAL	5.81	9.84	3.64	8.01	3.06	7.24	6.21
 HAL	4.05	9.46	-	-	6.43	5.00	6.21
 ASA	5.16	9.93	3.33	9.91	4.06	5.00	6.21
 CSN	10.00	10.00	0.00	-	4.68	-	6.11
 AMX	5.82	9.66	3.24	-	4.63	5.99	5.80
 SAS	8.17	9.97	-	00.0	4.96	-	5.71
 UAE	10.00	9.97	-	00.0	3.05	-	5.70
 TAI	4.93	9.29	3.15	-	4.00	6.64	5.61
 ETD	7.15	9.39	-	25.0	2.82	-	5.41
 JAL	7.15	7.90	0.98	-	5.79	-	5.41
 CPA	7.15	7.80	0.00	-	6.42	5.00	5.21
 BAW	3.48	9.50	-	-	2.82	-	5.21

San Francisco International Airport
Fly Quiet Program

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SFO Aircraft Noise Abatement Office

Appendix 4: THE JDA TEAM

Authors:

Rob Voss Senior Air Traffic Operations Subject Matter Expert, is a JDA associated consultant and former career FAA Air Traffic Control Specialist, Operations Supervisor, Quality Assurance and Training Specialist, Plans and Procedures Specialist, Air Traffic Manager, Integration and Efficiency Specialist and finished his FAA career as a System Operations Senior Advisor. Rob spent more than 26 years with the FAA including assignments at Chicago Midway (MDW), San Francisco (SFO), Santa Rosa (STS), Scottsdale (SDL), San Carlos (SQL) and the Midwest Tactical Operations office. While working for several years outside of the FAA, Rob was an Air Traffic Consultant to the Deputy Airport Director (Noise Abatement) at SFO, where he provided analysis, advice and education involving aircraft noise and air traffic procedures and was the Project Manager for a FAR Part 150 noise exposure map update. He has also served as a contractor and Air Traffic Analyst at NASA-Ames Future Flight Central research and simulation facility.

Craig Burzych is an Air Traffic Operations Specialist, a JDA associated consultant and former career FAA Air Traffic Control Specialist. He spent 24 years working at the O'Hare Control Tower and 4 years working in the Chicago Midway Tower. He was detailed annually to lead the FAA Air Traffic Control support for the annual EAA Oshkosh "fly In" the single largest aviation show and exhibit held in the U.S. Craig served as President of the National Air Traffic Control Association (NATCA) (Chicago ORD) 9 years and also was a NATCA Aviation Safety Inspector and a member of the FAA Runway Safety Action team for the Great Lakes Region.

Jim Krieger Senior Air Traffic Subject Matter Expert, has over 33 years of experience with the FAA, mostly in the Chicago area, working primarily at O'Hare Tower (ORD) as an air traffic controller, Area Supervisor, Area Manager, Staff Manager, Support Manager for Quality Assurance and finally, as the Air Traffic Manager. He was named Assistant Air Traffic Manager at Chicago Terminal Radar Approach Control (TRACON) in 2003 until 2008. Jim has FAA Headquarters experience too. In 2010, he was named the Chairman of the Airport Construction Advisory Council (ACAC), a panel of safety experts that was tasked with ensuring safety during airport construction projects. Jim served as the FAA's Group Manager for Runway Safety as well and used that experience as a tremendous opportunity to influence positive change nationwide and to move Runway Safety to the next level. Jim pioneered the conceptual procedure of the arrival-departure window tool to assist controllers with converging runway operations. He analyzed major airport construction projects across the National Airspace System to document and identify best practices during construction for air traffic managers and airport operators. Served as subject matter expert on many airport surface safety forums including "Navigating the Risks on the Airport Surface" for the Airline Pilots Association (ALPA) 59th Safety Forum. Mr. Krieger retired from the FAA in July 2015 as the Air Traffic Manager of O'Hare Tower.

Contributing:

Dr. Antonio A. Trani, is a JDA associated consultant and Professor with the Department of Civil and Environmental Engineering at Virginia Tech University and is Co-Director of the National Center of Excellence for Aviation Operations Research (NEXTOR). He has been the Principal or Co-Principal Investigator on 68 research projects sponsored by the National Science Foundation, Federal Aviation Administration, National Aeronautics and Space Administration, National Consortium for Aviation Mobility, Federal Highway Administration, and the Center for Naval Analyses. Dr. Trani has provided noise, capacity and safety consulting services to the Norman Manley International Airport, Punta Cana International, National Institute for Aerospace (NIA), Xcelar, Quanta Technologies, Los Angeles World Airport, Charles Rivers Associates, Boeing Phantom Works, Civil Aviation Administration of China (CAAC), British Airports Authority (BAA), SEATAC Airport Authority, Louisville International Airport, Delta Airport Consultants, Celanese, and the MITRE Corporation.

Dr. Sanford Fidell, is a JDA associated consultant and owner and President of Fidell Associates which provides consulting and research services and litigation assistance in environmental acoustics, transportation noise, and effects of noise on individuals and communities. He is the U.S. Representative to International Standards Organization (ISO) Technical Advisory Group on Community Response Questionnaire Standardization and to ISO Working Group 45 on Community Response to Noise. Dr. Fidell is member of the Acoustical Society of America and the Technical Committee on Noise. He was on the Design Review Group for the FAA's Integrated Noise Model software. Dr. Fidell has provided consulting services to community, airport and government agencies involved in aircraft noise controversies and assessments and disclosures of aircraft noise impacts and has consulted on land use planning related to aircraft noise regulation. He is active in international standardization efforts for prediction of aircraft, rail and road noise impacts.

Dr. David Dubbink, is a JDA associated consultant and an Environmental Planning and Noise Management Specialist. He holds a PHD from UCLA in Urban Planning and Environmental Management. He is the designer and developer of ISIS (the Interactive Sound Information System). Dr. Dubbink is a member of the Acoustical Society of America, Institute of Noise Control Engineering, International Association for Impact Assessment and the Transportation Research Board, Committee A1F04, Transportation Related Noise and Vibration. He has provided training and consulting services on noise management to over 80 organizations worldwide.

Joe Del Balzo, JDA Founder and President, served as the highest-ranking career professional (Acting Administrator) in the Federal Aviation Administration (FAA). Both in his long career with FAA (where he also served as FAA's Executive Director of System Operations, Executive Director for System Development, Director of the Eastern Region and Director of the FAA Technical Center) and in his subsequent private role as an

aviation consultant, he has earned wide respect for his expertise in a wide range of aviation issues.

Cynthia Schultz PE, AAE is JDA's Vice President of Airports where she manages the airport line of business including, airport Safety Management System services, airport sustainability, airport strategic planning, airport security, facilitating new technology/products for airports, training for airports and airlines, airline negotiation and development of support services. Before joining JDA Cynthia was the Airport Director of Great Falls International Airport where she directed and led all airport operations, maintenance, administration, finances, security and support services including project management of engineering, architectural and construction, negotiation and administration of leases and concessions, safety, certification, design, construction and funding issues.