STUDY OF RUNWAY 12L AND 12R ARRIVAL OPERATIONS

September 2016

Environment Department, Noise Program Office

Metropolitan Airports Commission
6040 28th Avenue South, Minneapolis, MN 55450
MetroAirports.org
# Study of Runway 12L and 12R Arrival Operations

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Executive Summary

On May 18, 2016 the MSP Noise Oversight Committee directed MAC staff to conduct an analysis of MSP Runway 12L and 12R arrival activity over cities to the northwest of the airport. The direction was based on feedback provided from members of the public who attended the Second Quarter Public Input Meeting held in the City of St. Louis Park. At the meeting, residents who live near the arrival paths to Runways 12L and 12R all shared a consistent message that something has changed.

Collectively, a group of residents from St. Louis Park, Minnetonka, Minneapolis and MAC Noise Program Staff designed the objective and scope of the analysis to ensure the components would effectively incorporate observations and foundational noise concerns from the residents of these communities.

Airport data from 2004 – the peak year of aircraft operations at MSP – and 2013 through July 2016 was used to examine the following concerns identified by the residents:

1. Volume of arrival activity
2. Late-night and early-morning arrival activity
3. Arrival aircraft altitude trends
4. Frequency of arrival flights throughout the day
5. Arrival path changes

Consistent with the residents’ observations this report shows increased arrival activity to Runways 12L and 12R between 2013 and 2015; however, the number of arriving flights to these runways continues to be lower than the peak year of operations in 2004. Two primary factors are leading to the increase from 2013 – increased southerly winds and new separation standards for Converging Runway Operations. These factors are resulting in the Federal Aviation Administration Air Traffic Control configuring the airport in a southerly direction more often. This is also leading to more consecutive days spent in this configuration.

Although the overall use of these runways has increased since 2013, there are pronounced periods when the arrival demand slows down throughout the day, giving residents some break between high-frequency arrival periods. However, the peak hour of arrival activity occurs during evening hours for many people.

The study shows no substantial change to aircraft arrival altitudes. Extra care was taken to evaluate different aircraft sizes to determine if larger aircraft were flying lower to the ground as they arrive to the airport. Evaluation of aircraft altitudes by aircraft size does not support the notion that aircraft are flying lower, however it should be noted that individuals on the ground may experience an overflight by a larger aircraft differently than a smaller aircraft.

Lastly, a spatial analysis was conducted to determine if Area Navigation (RNAV) arrival procedures, which were implemented in March 2015, are leading to differences in aircraft arrival paths. The locations of the final approach paths, which are straight out extensions of the runway centerlines, have not changed. Although some of the arrivals are turning onto the final approach in the same area, the spread of flight tracks has shifted closer to the airport. Additionally, the downwind legs of the arrivals to Runways 12L and 12R, when arrivals are adjacent to the airport near 8,000 feet, are shifted slightly further away from the airport.
In summary, this report shows increased arrivals to Runways 12L and 12R from 2013 to 2015; however, the total number of arrivals to these runways is lower than 2004. The nighttime activity on these runways has also increased. Two factors leading to the increased use of these runways include increased southerly winds and new separation standards for Converging Runway Operations. Some variations exist with regard to the flight path locations for the downwind and turns onto final approach as a result of the implementation of RNAV arrival procedures. There was no substantial change to aircraft arrival altitudes throughout the study period.
1. Introduction

The Metropolitan Airports Commission (MAC) is a public corporation governed by a board of commissioners that reports to the Governor of Minnesota and the Minnesota State Legislature. The MAC is charged with managing a system of seven airports within the metropolitan area, including Minneapolis-St. Paul International Airport (MSP). In addition to the MAC, other air transportation entities play critical roles in the successful operation of an airport. The Federal Aviation Administration (FAA) regulates all aircraft activity. At MSP, the FAA’s Air Traffic Control (ATC) is solely responsible for directing aircraft on the ground and in the air. ATC’s highest priority is the safe and efficient movement of air traffic. Air transportation companies, such as airlines, provide transportation services for people and products. Figure 1.1 below outlines the primary air transportation units responsible for the successful operation of MSP.

**Figure 1.1 – Air Transportation Entities**

- **Airlines**
  - Transport people and products domestically and internationally
  - Determine number of flights, aircraft types and flight times based on customer travel preferences

- **Federal Aviation Administration**
  - Regulates Airports
  - Regulates Airlines
  - Operates Air Traffic Control (ATC) Facilities

- **Metropolitan Airports Commission**
  - Owns and Operates MSP and 6 Reliever Airports
  - Provides a Facility for Airlines to Conduct Air Commerce Activities
  - Does not determine where aircraft fly, runway use or pilot procedures

The MAC has designated the Noise Oversight Committee (NOC) as its primary advisory body regarding aircraft noise issues associated with operations at MSP. Based on feedback provided from members of the public who attended the Second Quarter Public Input Meeting, the NOC directed MAC staff to conduct an analysis of MSP Runway 12L and 12R arrival activity over cities to the northwest of the airport. A graphic of the MSP runway layout is provided in Appendix A.

Residents of St. Louis Park, Minnetonka, Minneapolis and MAC Noise Program Staff collaboratively designed the objective and scope of the analysis to ensure the components would effectively incorporate observations and noise concerns from the residents of these communities. The study objective is provided below and the final scope developed in conjunction with the residents is provided in Appendix B.
Objective: By working with citizens to the northwest of the airport, the MAC Noise Program Office will identify their foundational concerns and compile a report using its extensive data-collection capabilities and bring insights into the trends that are observed in the data. MAC staff will update the NOC in September on the findings and facilitate a dialogue with the FAA on any potential variations in the analysis, help ascertain why these variations are occurring and identify any possible remedies for the future.

The time period evaluated in this report includes 2004 – the peak year of aircraft operations at MSP – and 2013, 2014, 2015 and January through July 2016 (year-to-date at the time of this report). The following provides a synopsis of the flight activity and milestones at MSP during the study period:

- 2004 – 540,727 annual operations (historical peak); prior to construction of Runway 17/35
- 2013 – 431,523 annual operations
- 2014 – 411,760 annual operations
- 2015 – 404,374 annual operations; implementation of Area Navigation (RNAV) arrival procedures in March; new flight rules for Converging Runway Operations for Runway 30L in July
- 2016 – 217,188 operations from January through July; new flight rules for Converging Runway Operations for Runway 30L and 30R in March

The nature of aircraft arrivals results in a concentrated and repeated flight path flown by all aircraft landing on a specific runway. Aircraft, especially fast-moving jets, need to be flying straight at the centerline of the runway with wings level and appropriate speed-reduction spoilers and landing gear deployed well in advance of touching down on the runway. This is especially critical during circumstances with low cloud levels and/or visibility because pilots will not have visual ground references. This is the arrival procedure at MSP and almost all airports around the world and has the effect of exposing those living under the arrival path of a runway to all of the aircraft landing on that runway. Therefore, even minor changes to the frequency and overall use of an arrival runway results in increased noise impacts and concerns from residents.

2. Runways 12L and 12R Arrival Trends

One of the foundational concerns expressed by residents to the northwest of the airport is the volume of arrival activity to Runways 12L and 12R. In 2004, the number and percent use of Runways 12L and 12R were fairly even with 59,720, or 22.6 percent of all arrivals on Runway 12L and 58,425, or 22.1 percent on Runway 12R. By 2013, the use of these runways were still fairly evenly split, with 18.8 percent on Runway 12L and 19.5 percent on Runway 12R. The number of arrivals to 12L and 12R

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continued to drop in 2014, however the percent of arrivals on the runways began to spread with Runway 12R taking on a higher percentage of arrivals than Runway 12L.

While the number of arrivals to these runways is significantly fewer than in 2004, they increased from 2014 to 2015. Additionally, the number of arrivals on Runway 12R is growing at a faster pace than those on Runway 12L. From 2014 to 2015, the number of arrivals on Runway 12L grew 17.7 percent and the number of arrivals on Runway 12R grew 22.6 percent. Figure 2.1 below shows the Runway 12L and 12R arrival usage for the study period. The dashed lines represent the percent of all arrival operations for each runway.

Figure 2.1

Runway 12L and 12R Arrival Usage

<table>
<thead>
<tr>
<th>Year</th>
<th>Runway 12L</th>
<th>Runway 12R</th>
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<tr>
<td>2004</td>
<td>59,720</td>
<td>58,425</td>
</tr>
<tr>
<td>2013</td>
<td>40,399</td>
<td>41,921</td>
</tr>
<tr>
<td>2014</td>
<td>41,496</td>
<td>41,496</td>
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<tr>
<td>2015</td>
<td>50,888</td>
<td>50,888</td>
</tr>
<tr>
<td>2016</td>
<td>27,790</td>
<td>32,056</td>
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*2016 numbers and percentages are for January through July 2016.
Source: MACNOMS

Flights during the late night and early morning hours have more effect on residents surrounding the airport. The airport never closes and there is no penalty for aircraft operations at night; however, the MAC tracks operations taking place between 10:30 P.M. to 6:00 A.M. to evaluate the trends in nighttime flights. Overall nighttime flights at MSP have increased during the study period, mostly driven by aircraft arriving to the airport. During the first six months in 2004, there were 7,474 nighttime arrivals. This increased to 7,845 in 2013 and by 2016, there were 10,571 flights arriving at night between January and July.

The imbalance of 12L and 12R arrivals is more evident during the night. One factor driving this is that more nighttime arrivals originate from airports in the western portion of the country increasing the use of Runway 12R for arrivals by ATC, due to its closer proximity to these arrivals as they enter the airspace around MSP. Additionally, when demand is light during the nighttime, ATC has added flexibility to assign the arrival runway and will generally choose the runway closest to the parking location on the airport. This reduces the
need for aircraft to cross active runways, further promoting safety. Moreover, Runway 12R is longer than Runway 12L, so at times pilots request the longer runway as an added safety measure.

In 2004, 12.5 percent of all nighttime flights were on Runway 12L and 21.0 percent of all nighttime flights were on Runway 12R. By 2013, the percentage of arrivals on Runway 12L grew to 13.3 percent and Runway 12R grew to 28.0 percent. Growth continued in 2014 and 2015. By 2015, 17.6 percent of arrivals were on Runway 12L and 29.5 percent of arrivals were on Runway 12R. Figure 2.2 below shows the increases in the nighttime arrival usage for Runways 12L and 12R during the study period.

Nighttime flights have a significant effect on the annual noise contours because they are given a 10 decibel penalty. Increases in nighttime arrivals to Runway 12R have resulted in a larger annual noise contour under the arrival path, thereby extending the MAC’s Residential Noise Mitigation Program eligibility area.

Some of the same factors contributing to the imbalanced use of 12R versus 12L at nighttime described above is also leading to imbalanced use during all hours. These factors include: the origin airport; aircraft parking location on the airport; pilot requesting the longer runway (Runway 12R); and FAA’s use of Runway 12R as the primary arrival runway during southerly airport configurations to enhance airspace and airport efficiency. Further evaluation was conducted assessing airport of origin growth trends to better understand the degree they are driving the imbalance between the runways. It was found that similar levels of growth are occurring in origin airports that favor both runways, determining that origin airport is not a major driver in the imbalance of runway use.
FAA air traffic controllers rely on a combination of runways, or airport configurations, to efficiently and safely direct landing and departing aircraft. There are five primary configurations used at MSP. The MAC Noise Program Office has been tracking and reporting the increased occurrence of South Flow and Straight South Flow configurations since mid-2015. These two configurations are described below:

**South Flow**
Arrivals on Runways 12L and 12R over areas to the northwest of the airport with departures on Runways 12L, 12R and 17 over areas to the south and southeast of the airport. ATC will generally direct most of the departing flights to Runway 17 and 12L, allowing Runway 12R to become the primary arrival runway.

There are times when construction or weather conditions do not allow for departures on Runway 17 during a South Flow configuration. This results in all arrivals and departures occurring on Runways 12L and 12R, termed *Straight South Flow*.

When the airport is operated in one direction for multiple consecutive days, residents surrounding the airport voice concerns that the noise is not being shared equitably. As shown in Figure 2.3 below, the number of total days in South or Straight South Flow configurations increased, beginning in September 2015. In September and November 2015 and again in March and April 2016, 20 out of 30 days were spent in one of these configurations. In 2004, prior to Runway 17/35 opening, the airport averaged 13.9 days per month in a South or Straight South Flow. In 2013 and 2014, South Flows were only used an average of 12.0 and 13.1 days per month, respectively. In 2015 the average rose to 15.5 days per month – over half of each month. Between January and July 2016, that average has continued to grow to 16.6 days per month. Given normal seasonal wind conditions, this number is higher than projected for a full 2016 as the winter months produce more north winds and resultant North Flow days. When the airport is in a southerly configuration it is staying in it longer, as shown in the maximum number of consecutive days below. In September 2015, the airport spent 13 consecutive days in a South or Straight South Flow configuration. Since then, it has become a regular occurrence to have six or more days in a row in the same configuration. This has the effect of shortening the time period between successive days in a south flow.
In comparison to other major configurations at the airport, the South and Straight South Flow configurations have become the most dominant, overtaking North and Straight North Flow beginning in 2015. North Flow is when there are departures on Runways 30L and 30R with arrivals on Runways 30L, 30R and 35. Similar to Straight South Flow, there are times when Runway 35 is not used for arrivals resulting in arrivals and departures on Runways 30L and 30R. This is called Straight North Flow. The airport may also be in a mixed configuration with arrivals on Runways 30L and 30R and the majority of departures on Runway 17 with limited departure operations on Runways 30L and 30R. This occurs less often than the northerly and southerly configurations. Figure 2.4 below compares the number of days spent in these predominant configurations during the study period. South Flow and Straight South Flow is combined in this figure, as is North Flow and Straight North Flow.

In 2004, 2013 and 2014 the airport was predominantly in a northerly configuration. This configuration had the operational benefit of increasing arrival capacity by arriving aircraft onto three runways. In 2015, increased frequency of southerly winds, favoring south flow began occurring. Additionally, during this same time the FAA began enforcing new Converging Runway Operations (CRO) separation standards, which decreased the arrival rate in a northerly configuration from 90 arrivals per hour to 72-75 arrivals per hour. With the reduction of the arrival capacity and increased operational complexity in a northwest configuration and more prevalent southerly winds, the use of southerly configurations increased beginning in 2015.
In summary, since September 2015 the airport has had an increase in the number of total days and consecutive days in a South Flow or Straight South Flow configuration. This is leading to an increase in the number of arrivals on Runways 12L and 12R, with Runway 12R increasing at a faster rate than 12L. Arrival flights between 10:30 P.M. and 6:00 A.M. ("nighttime") have increased, contributing to increased arrivals on these runways at night. During the night, more aircraft arrive to Runway 12R than Runway 12L.

With more southerly winds beginning in late 2015, along with the reduction of arrival capacity and increased operational complexity in a northwest configuration due to new CRO separation standards, southerly configurations are being utilized more often. Contributing factors are further examined in Section 5.

3. Aircraft Arrival Altitude Trends

The next foundational concern expressed by residents to the northwest of the airport was about aircraft altitudes. Specifically, residents wanted to evaluate the trends in arrival altitudes over their communities, because they believe the aircraft are lower today than in the past.

Since this study covers a large geographic area, we focused this portion of the evaluation on four straight-line distances from each runway: two, four, six and eight miles. These areas are shown in Figure 3.1 below. Arrival flights within eight miles from MSP are typically lined up with their assigned arrival runway.
The average altitudes at these distances for Runway 12R arrivals are shown in Figure 3.2 and Runway 12L arrivals are shown in Figure 3.3. Altitude trends are consistent with historic altitudes throughout the study period. There are slight seasonal variations due to enhanced aircraft performance capabilities in colder weather, however arriving flights are less impacted by temperature changes than departing flights.

Fluctuations in the average altitudes decline the closer the aircraft is to the airport. At eight miles from Runway 12R, altitudes range from 2,000 to 2,300 feet – a difference of 300 feet. By the time the aircraft are two miles from the runway end, the altitudes are more uniform, ranging from 560 to 660 feet – a difference of 100 feet. This regularity in altitude closer in to the airport is a product of aircraft following a standard glide slope down to the runway end.

Beginning in late 2013, MAC staff made changes to its source of flight track data, which enhanced the integrity of the aircraft altitudes by eliminating variances from local atmospheric pressure changes. This results in slightly less variation between the winter and summer months in 2014 and later.
Figure 3.2

12R AVERAGE ARRIVAL ALTITUDE

Source: MACNOMS

Figure 3.3

12L AVERAGE ARRIVAL ALTITUDE

Source: MACNOMS
The aircraft arriving to Runway 12L tend to be smaller in size due to the runway’s proximity to the Regional Jet gates on Concourses A and B as well as the shorter runway length. During the study period, 52 percent of the arrivals on Runway 12L were in Regional Jets compared to 24 percent of the Runway 12R arrivals. Larger aircraft will typically arrive to Runway 12R because of the added runway length. During the study period, 64 percent of the arrivals on Runway 12R were in Wide-Body or Narrow-Body aircraft as compared to 38 percent of the arrivals on Runway 12L. Even with the mix of aircraft sizes on each runway, when contrasting the altitudes for Runways 12L and 12R at the same distances, there are no substantial differences. Although Runway 12R is used by larger aircraft than those on Runway 12L, the altitudes over the ground are not lower than aircraft arriving to Runway 12L.

To further explore the altitude variations in different aircraft sizes, Appendix C provides altitude charts specific to Regional Jets, Narrow-Body and Wide-Body aircraft for Runways 12L and 12R arrivals at each of these distances.

In summary, aircraft altitudes on arrival are no lower today than they were in the past. As aircraft get closer to the airport to land, the altitudes become more uniform, due to slope guidance for arriving aircraft. Additionally, there is little-to-no impact on aircraft arrival altitudes as MSP airlines continue to replace their small 50-seat Regional Jets with larger aircraft – known as “upgauging”. Moreover, the contrasting aircraft sizes using Runways 12L and 12R do not result in variations in aircraft altitudes. However, an individual on the ground under an arrival path may experience a larger aircraft overhead differently than a smaller one.

4. Frequency of Arrivals during a South Flow Day

Section 2 details the increased use of South and Straight South Flow configurations. Another fundamental concern from the residents was that there seemed to be fewer quiet periods during the days of southerly configurations. A common sentiment expressed by the residents was that, not only is the airport in a southerly configuration more often and for more days consecutively, but during those days the flights are occurring more frequently throughout the day.

To further examine this, Figures 4.1, 4.2 and 4.3 below show the average number of arrival operations during each hour for time spent in a southerly configuration during 2004, 2014 and year-to-date 2016, respectively. These charts show that there are peaks and valleys throughout the day and that the times of high arrival demand have shifted throughout the study period. These variations are the result of airline scheduling to meet passenger demand and are described in detail below.

During 2004, the majority of the arrivals took place from 7:00 A.M. through 10:00 P.M. where the hourly arrivals stayed above 30 on average. The hours with the highest arrival demand (over 40 arrivals per hour) occurred from 9:00-11:00 A.M. then again from 12:00-6:00 P.M. and 7:00-9:00 P.M. The peak hour of arrivals in 2004 occurred from 5:00-6:00 P.M. with an average of 58.7 arrival flights. During the late night and early morning hours, the number of arrivals significantly dropped, beginning at 11:00 P.M. with 8.0 average arrivals until midnight. The morning arrivals began to increase by 5:00 A.M. with an average of 10.1 arrivals.
By 2014, the peaks and valleys in the arrival demand throughout the day grew more pronounced. Unlike 2004, there were periods in the middle of the day when the arrivals dropped below 30 per hour. This allowed residents some reprieve from the arrival activity. In 2014, the hours with the highest arrival demand (over 40 arrivals per hour) occurred from 8:00-9:00 A.M., from 1:00-2:00 P.M., from 4:00-5:00 P.M. and from 6:00-7:00 P.M. The peak hour of arrivals in 2014 occurred from 6:00-7:00 P.M. with an average of 54.5 arrival flights. During the late night and early morning hours, the number of arrivals stayed above 13 until midnight, when they dropped to an average of 4.4 average flights. A small bank of early morning arrivals occurred from 5:00-6:00 A.M. in 2014 with 10.0 average flights. The morning arrival activity was in full-swing by 7:00 A.M. with an average of 24.3 arrivals.
From January through July 2016, the peaks and valleys in the arrival demand continue to be more pronounced than 2004. In 2014, the hours with the highest arrival demand (over 40 arrivals per hour) occurred from 8:00-9:00 A.M., from 1:00-2:00 P.M., from 4:00-5:00 P.M. and lastly from 6:00-7:00 P.M. The peak hour of arrivals in 2016 occurred from 6:00-7:00 P.M. with an average of 59.1 arrival flights. As mentioned in the Section 2, 2016 has had an increase in nighttime arrivals. The number of arrivals decreased to an average of 12.1 flights per night from 10:00-11:00 P.M., but then increased to 17.1 arrivals from 11:00 P.M. to midnight. Like 2014, a small arrival push occurred between 5:00 and 6:00 A.M. with the majority of arriving aircraft beginning at 7:00 A.M.
In summary, there are more pronounced periods of time in 2014 and 2016 when the arrival demand slows down throughout the day when compared to 2004, giving residents some break between high-frequency arrival flights in southerly configurations. The peak hour of arrivals occurs during the same hour in 2016 as it did in the previous three years, however it has increased in 2016 by about 5 flights per day during that hour. The peak arrival hour, 6:00-7:00 P.M., is a popular time for evening meals with family and recreational activities, which are sensitive to noise intrusions. Additionally, added nighttime arrival flights, particularly between 11:00 P.M. and 5:00 A.M., contributes to added nuisance for the surrounding communities. Charts showing aircraft arrivals per 15-minute blocks are provided in Appendix D.

5. Contributing Factors

The factors that contribute to runway use and airport configuration decisions are dynamic, varying from day-to-day and season-to-season. Airport configuration and runway use decisions made by ATC are complex and continuous. Numerous factors are considered in making these decisions, including safety, efficiency, wind direction and speed (on the surface and aloft), aircraft weight, inbound and scheduled outbound flights, noise abatement and flight destinations and origins.

During the study period, there are some overarching trends in winds contributing to the increased use of Runways 12L and 12R for arrivals. Additionally, this period of study included the implementation of Area Navigation (RNAV) Standard Terminal Arrival Routes and new Converging Runway Operations regulations.

Figure 4.3
AVERAGE SOUTH FLOW ARRIVAL DAY IN 2016

*2016 numbers are for January through July 2016.
Source: MACNOMS
Each of these elements were evaluated individually to help deduce whether or not one or all are driving the increases in arrivals to Runways 12L and 12R.

**Wind**

Weather is an integral factor in airport operations, aircraft performance and the flight planning process. Aircraft land into the wind to slow to a speed capable of a controlled touch-down on the runway. Therefore, the wind direction and speed at an airport is the foundation for a host of operational decisions. As the wind changes, the runways in use change accordingly.

There are times when the wind direction and speed will dictate the configuration chosen at the airport. **Figure 5.1** shows a compass rose with a layout of the MSP runways to graphically represent wind conditions that would favor South and North Flows. For purposes of this section’s evaluation, South Flow and Straight South Flow will be combined, as will North Flow and Straight North Flow. The white sections show crosswind conditions, where the wind is blowing across the runways. During crosswind conditions, ATC would likely consider other factors, such as forecast wind direction, the current airport configuration and anticipated traffic demand to make a decision on how the airport should be configured for the maximum amount of safety and efficiency.

It must be noted that there are times when the airport is configured in a manner inconsistent to the graphic below due to various circumstances (i.e. winds aloft, differing forecasted winds, area storm cells). Ultimately decisions about airport configuration belong to ATC and they will make the decision that is the safest and most efficient at the time. When ATC makes a decision to change configurations, it takes time for arriving aircraft, already flying one configuration to land before the airport can be fully reconfigured.
One of the questions resulting from residents’ concerns about increased use of Runways 12L and 12R is whether or not it is being driven by increased southerly winds. To investigate the trends in prevailing wind conditions at the airport, data from the Iowa State University of Science and Technology, which logs environmental data – including wind speed and direction – from the sensors at MSP, is used.

MAC staff categorized the data using the compass rose in Figure 5.1 to answer whether or not winds favoring South Flow are occurring more today than they have in the past. Table 5.1 below shows the percentage of time the winds favored North and South flows, when calm winds existed and when crosswind conditions existed. Prior to 2015, winds favoring South Flow remained consistent. This changed in 2015, when it increased by 3.8 percentage points. This increase is likely driving some of the increases in Runway 12L and 12R usage for aircraft arrivals experienced in 2015. With the exception of 2014, winds favoring North Flow during the study period remained within two percentage points. In 2014, there was an increase of 3.7 percentage points from the previous year. Since 2013, calm wind conditions did not vary significantly. Crosswind conditions took a small dip in 2014, then rebounded in 2015.

Table 5.1

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<td>Crosswind</td>
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<td>8.0</td>
<td>6.4</td>
<td>7.8</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Another component that is important to evaluate with regard to wind conditions is the actual airport configuration when winds favor certain conditions. This is particularly important for crosswind conditions and during calm and light wind conditions, which allow ATC more discretion to make airport configuration decisions based on other factors.

Figure 5.2 below examines the actual percent of time spent in each airport configuration during the study period when the wind conditions favored South Flow. This portion of the study does not include 2004, since this was prior to the construction of Runway 17/35, therefore the runway configurations would be dissimilar to the rest of the study period. On an annual basis, when the winds were greater than 7 kts and anywhere from 50 to 190 degrees, the airport was in a South Flow almost 100 percent of the time.
Further examining time periods when the wind conditions favor North Flow, Figure 5.3 shows the actual percent of time spent in each configuration. In 2013 and 2014, the percentage of time in a North Flow was around 95 percent. By 2015, the use of North Flow decreased to near 90 percent and a corresponding increase occurs in Mixed Flow use. Mixed Flow, which increased by about 5 percent beginning in 2015, is North Flow but instead of arrival operations on Runway 35, departures are occurring on that runway in the opposite direction on Runway 17.
Figure 5.4 below provides a view of airport configurations during crosswind conditions. As mentioned above, crosswind conditions do not necessarily favor North or South flows and, depending on the speed of the wind, may dictate an irregular airport configuration, for example use of Runway 4/22 for strong southwesterly or northeasterly winds. This study only evaluates time spent in either North, South or Mixed flows.

A steady increase has been occurring for the past three years in the use of South Flow during crosswind conditions. In 2013, 26.8 percent of the time was spent in South Flow and by 2015 the use of South Flow was 52.0 percent, overtaking the use of North Flow. During crosswind conditions in 2013, 55.0 percent of the time was spent in North Flow. For the next two years this decreased and by 2015, only 28.3 percent of the time was spent in North Flow. Year-to-date 2016 rebounded slightly back up to 36.9 percent, however there may be some skewing since 2016 is not reflective of an entire year.

Figure 5.4

RUNWAY CONFIGURATION DURING CROSSWINDS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SOUTH FLOW</th>
<th>NORTH FLOW</th>
<th>MIXED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>20%</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>2014</td>
<td>35%</td>
<td>25%</td>
<td>40%</td>
</tr>
<tr>
<td>2015</td>
<td>50%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>2016</td>
<td>45%</td>
<td>25%</td>
<td>30%</td>
</tr>
</tbody>
</table>

*2016 percentages are for January through July 2016.
Source: MACNOMS

The most discretion on runway use and airport configuration occurs when winds are light or calm. During these occasions, ATC has more flexibility in how the airport is configured and will likely look to other factors to make runway decisions. Figure 5.5 shows the runway configurations during calm and light (7 kts or less) wind conditions. Similar to the case of crosswind conditions, use of North Flow configurations was dominant in 2013 and 2014. In 2015, South Flow use increased and became used the most at 46.0 percent. This increased further in 2016 to 50.1 percent. During light and calm wind conditions today, half of the time the airport is in a South Flow, the other half is spent in either North Flow or Mixed Flow. This is different from what was occurring two years ago, when half of the time was spent in North Flow and the other half was divided between Mixed and South Flow.
In summary, winds favoring arrivals to Runways 12L and 12R began occurring slightly more often beginning in 2015. In fact, MAC staff released a web news article on the macnoise.com website in November 2015, detailing the increase in southerly winds. The article referenced September 2015 as the warmest September on record for Minnesota and Wisconsin since records were kept back to 1895. The unseasonably warm temperatures were brought about by southerly winds.

In addition to the increased occurrence of winds favoring South Flow, there is also a difference in the airport configuration trends during crosswind and light wind conditions. When there are crosswinds, the airport is increasingly configured in a South Flow, resulting in arrivals over Minnetonka, St. Louis Park and Minneapolis. This observation is similar during light wind conditions. It is apparent through this evaluation that the decision process taken by ATC to determine the airport configuration during wind conditions that do not dictate a single configuration may be different today.

A driving component of this is the FAA’s implementation of new rules governing Converging Runway Operations, which only impacts North Flow. This adds increased complexity for ATC to operate the airport in this configuration. ATC is still in the evaluation state of implementing these new rules, however at this time it appears it is reducing the time the airport spends in a North Flow while increasing the time the airport spends in a South Flow, and to a lesser degree, Mixed Flow.

**Area Navigation (RNAV) Arrival Procedures**

Area Navigation (RNAV) Standard Terminal Arrival procedures (STARS) at MSP begin as far out as 270 miles when the aircraft first begins its descent from cruise altitude and end when the aircraft reaches 8,000 feet, after which the pilot is either directed by ATC with headings and altitude instructions or follows a Required Navigation Performance (RNP) procedure down to the runway. Currently, the majority of arrivals are instructed by ATC because either the aircraft and/or pilots are not certified to fly an RNP procedure.
RNAV STAR procedures were designed to keep aircraft separated from all arrivals and departures at MSP and the other airports in the area. They also bring significant reductions in carbon emissions, because aircraft are flying fewer track miles within the MSP airspace and they are descending at a continuous descent, rather than the step-down approach method of conventional approaches. These efficiency benefits are the primary reason why the MSP Noise Oversight Committee and the MAC board supported implementation of the procedures.

Some residents to the northwest of the airport raised concerns that the increased arrival activity and associated noise from arrivals on Runways 12L and 12R was the result of the Area Navigation (RNAV) arrival procedures. This section examines the aircraft arrival paths for Runways 12L and 12R before and after the implementation of RNAV Standard Terminal Arrival Routes (STARs) in March 2015.

In order to make a dependable comparison, a flight track density analysis was conducted using two days that met the following criteria:

- The airport was in a southerly configuration the entire day
- Week days around the same time of year
- Pilots were operating under Visual Meteorological Conditions the entire day
- There were no adverse weather conditions
- One day was prior to RNAV STAR implementation and one day post-RNAV implementation

Using the criteria above, June 27, 2014 was chosen to show a representative arrival track density pre-RNAV implementation, shown in Figure 5.6. June 2, 2015 was chosen to show a representative arrival track density post-RNAV implementation, shown in Figure 5.7.

The RNAV STAR procedures did not change the location of the final approach paths to Runways 12L and 12R. These are the segments of the approach that aircraft will be at the lowest altitude. Residents under the final approach paths pre-RNAV continue to live under them in today’s post-RNAV environment. Once on the final approach path, RNAV arrivals are intercepting the glide slope and descending down to the runway in the same manner they did prior to RNAV implementation. Therefore, the RNAV procedures did not change the altitudes of aircraft arrivals on the final approach paths. Under the RNAV arrival procedures, the same three-mile spacing between successive arrivals still needs to be maintained, as was the case prior to RNAV procedure implementation.

The downwind segments move slightly outward from the airport and become more concentrated post RNAV implementation. Residents living under these downwind paths may notice this concentration and slight shift outward, however aircraft are still at high altitudes at that point, producing less noise on the ground. Aircraft arrivals on the downwind segments are at 8,000 feet mean sea level (MSL) when abeam the airport.

Although some of the arrivals are turning onto the final approach in the same area, the spread of flight tracks has shifted closer to the airport. The RNAV procedures allow more aircraft to make the turn closer to the airport, rather than following an extended downwind leg before making a turn toward the airport. This represents the intent of the FAA to design the procedures to be more efficient, cutting down on carbon emissions.
Additional analysis was conducted using the same criteria for a representative flight track day in 2016 to evaluate if the new Converging Runway Operations (CRO) rules implemented in March 2016 impact the arrival flight paths. Figure 5.8 below shows the Runways 12L and 12R arrival density from June 17, 2016. There are no discernable differences in the spatial flight tracks from CRO implementation.

![Figure 5.8](image)

6. Summary of Findings

Consistent with concerns from residents to the northwest of the airport regarding increased arrival activity this report shows increased arrivals to Runways 12L and 12R from 2013 to 2015 with a higher growth rate for arrivals to Runway 12R, particularly during the nighttime period from 10:30 P.M. to 6:00 A.M. The level of arrivals to these runways is lower than 2004, the peak year of MSP airport operations.

Two primary factors are leading to the increased use of these runways for arrivals – increased southerly winds and new separation standards for Converging Runway Operations. These factors are resulting in the FAA Air Traffic Control configuring the airport in a southerly direction more often and once in this configuration, they are staying in it for more consecutive days. Prior to 2015, ATC’s desired configuration was to operate with departures to the northwest because it was the most efficient use of the airspace and airport surfaces. This appears to have transitioned to more of a southerly configuration beginning late-summer 2015 as evidenced by airport configuration data during times when wind was not driving the configuration, allowing ATC more discretion in determining the airport configuration. The northerly configuration at the airport is now layered with added complexity from the CRO rules, appearing to make it
less frequently used. Moreover, winds favoring arrivals to Runways 12L and 12R began occurring slightly more often beginning in 2015.

Although the overall use of these runways has increased, there continues to be pronounced periods when the arrival demand slows down throughout the day, giving residents some break between high-frequency arrival periods. The peak hour of arrival activity falls generally around the time many people are getting home from work or sitting down for an evening meal.

There was no substantial change to aircraft arrival altitudes throughout the study period. Extra care was taken to evaluate different aircraft sizes to determine if larger aircraft were flying lower to the ground as they arrive to the airport. Evaluation of aircraft altitudes by aircraft size does not support this notion, however it should be noted that individuals on the ground may experience a larger aircraft differently than a smaller aircraft.

Lastly, a spatial analysis was conducted to determine if RNAV arrival procedures are leading to differences in aircraft arrival paths. The locations of the final approach paths, which are straight out extensions of the runway centerlines, have not changed. Although some of the arrivals are turning onto the final approach in the same area, the spread of flight tracks has shifted closer to the airport. Additionally, there is a shift outward from the airport for the two downwind legs to Runways 12L and 12R.
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<td>E. List of Abbreviations</td>
<td>A-10</td>
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Appendix A - MSP Runway Layout
Appendix B – Study Scope

Objective:

By working with citizens to the northwest of the airport, the MAC Noise Program Office will identify their foundational concerns and compile a report using its extensive data-collection capabilities and bring insights into the trends that are observed in the data. MAC staff will update the NOC in September on the findings and facilitate a dialogue with the FAA on any potential variations in the analysis, help ascertain why these variations are occurring and identify any possible remedies for the future.

Work Plan Description:

Complete an analysis of MSP Runway 12L and 12R arrival activity over cities to the northwest of the airport.

Scope:

  - Including an assessment of how many successive days the airport was in a south-flow configuration.

- Examine average altitudes of RJ, narrow-body and wide-body aircraft arrivals on Runway 12L and 12R at 2, 4, 6 and 8 miles from runway end for 2004, 2013, 2014, 2015 and 2016 YTD.

  - Investigate where the predominant turn onto final approach is taking place. Has it changed? If so, is it causing more frequent arrivals following the extended runway centerline over residents in St. Louis Park and more arrivals turning onto final over residents in Minnetonka?


- Study origin airport mix for 2004, 2013, 2014, 2015 and 2016 YTD. Are differing origin airports impacting the runway use?

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3 Originally scoped to examine altitudes at 3, 6, 9 and 12 miles from runway end, however due to the lack of sufficient flight track sampling straight out from the runways at 12 miles, MAC staff adjusted the distances.

2 MACNOMS data did not record origin airport prior to 2008


- Study trends in airport configuration during calm or light wind conditions and compare to 2004, 2013, 2014, 2015 and 2016 YTD.

MAC Noise Program Staff will present the study and findings to the group of residents that helped with scoping the study prior to publishing the report and sharing with the NOC.
Appendix C – Average Arrival Altitude Charts

NARROWBODY AIRCRAFT

AVERAGE ALTITUDE (FEET ABOVE MSP)


WIDEBODY AIRCRAFT

A small use of widebody aircraft in Jan-Feb 2013 and Jan-Feb and Oct-Nov 2014 lead to outliers in altitude data.
Appendix D – 15-Minute Arrival Block Charts

2004

2013

RUNWAY 12L
RUNWAY 12R
2016*

RUNWAY 12L/R ARRIVALS BY HOUR

*January 1 – July 31, 2016
Appendix E – List of Abbreviations

ATC – Air Traffic Control

CRO – Converging Runway Operations

FAA – Federal Aviation Administration

Kts – wind speed in knots

MAC – Metropolitan Airports Commission

MSP – Minneapolis-St. Paul International Airport

NOC – Noise Oversight Committee