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Average Annual Day Addendum to the Guidance for Noise Screening of Air Traffic Actions

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Abstract

The Federal Aviation Administration (FAA) Air Traffic Organization (ATO) established the noise screening process to help determine the need for detailed noise analyses of air traffic actions. The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) prepared the *Guidance for Noise Screening of Air Traffic Actions* [1] to assist the FAA and others involved in noise screening. An integral part of noise screening is the collection of average annual day (AAD) radar track data for noise modeling. This document proposes an objective method for determining the minimum subsample size of radar track data required and the sampling technique.

Acknowledgements

The authors acknowledge the contributions of Donna Warren and Terry English of the Federal Aviation Administration (FAA), and Angela Signore, Neal Westlund, and Fred Bankert of The MITRE Corporation's Center for Advanced Aviation System Development (CAASD).

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1 Introduction

This report documents an objective approach to determine the volume of radar track data that an analyst needs to collect to represent an average annual day (AAD) for the purposes of noise analyses, in particular noise screenings.

1.1 Synopsis

The proposed approach involves consideration of the volume of radar track data required and the sampling technique. The findings are generalized to airports in the National Airspace System (NAS). The results are grouped into four clusters of airports documented in Appendix D. For each cluster, a range is presented where the low number applies to airports with one runway and one/two dominant configurations, and the high number to all other airports. Cluster 1, composed of busy commercial airports similar to the Federal Aviation Administration (FAA) Core 30, would require anywhere from a random subsample (RS) of 30 to 60 days. Cluster 2, composed of moderately busy airports with a mix of commercial and general aviation traffic would also require a RS of 30 to 60 days. Cluster 3 composed of the busiest airports in the NAS would require a RS of 45 to 60 days. Finally, Cluster 4 composed mostly general aviation airports would require a RS of 30 to 45 days. In general, a minimum RS of 30 days would be required for all airports regardless of size and/or complexity.

1.2 Document Organization

This document is divided into five sections (including this introduction) and five appendices. Section 2, provides a brief overview of the need for an objective method for collecting radar track data. Section 3 outlines the overall methodology in terms of the amount of radar track data required, the sampling technique, and the generalization to most airports in the NAS. Section 4 documents the findings of the report. Section 5 provides references. Appendices A-D provide detailed information on the generalization approach, noise level calculations, statistical methods, and sample airports. Appendix E documents acronyms used in this report.

2 Background

The noise screening process is a solid and repeatable approach to identify extraordinary circumstances and/or the potential for significant noise impacts. The process leverages existing FAA tools and policies to identify the need for detailed noise analyses of proposed air traffic actions. Given the large number of air traffic proposals subject to review under the National Environmental Policy Act (NEPA) of 1969 [2] and its implementing regulations – Council on Environmental Quality (CEQ) Regulations [3] and FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures* [4] – noise screening streamlines the review process by providing an early indication of the potential for noise impacts of proposed air traffic actions. Several aspects of the noise screening process rely on AAD data.

The FAA Order 1050.1E states that noise exposure from aviation activities must be established in terms of a day-night average sound level (DNL) in decibels (dB). In addition, the FAA has established 65 dB DNL as the federal threshold of significance related to aircraft noise. AAD data is a key prerequisite of computing DNL and similar metrics; it is representative of long-term variations in airport operations such as runway configuration, fleet mix, number of operations, etc. Currently, AAD radar track data collection methods vary widely across the noise modeling community. This document proposes an objective method for determining the minimum sample size of radar track data required for noise screening (henceforth referred to as the subsample). The subsample would be expected to represent an AAD consistent with one year of radar track data (henceforth referred to as the sample).

3 Methodology

The methodology involves several steps with the goal of developing recommendations for airports in the NAS. The approach illustrated in Figure 3-1 includes the following steps:

1. Select sample airports – the sample airport studies are used as the basis for generalized findings applicable to airports in the NAS. Each group of airports represents a cluster with similar attributes.
2. Define study area – for each airport, a study area is defined for which the analysis is performed. The study area is further partitioned into multiple grid cells.
3. Compute daily noise levels – for each grid cell, daily noise levels are computed using radar track data and a simplified noise calculation. For each grid cell, 365 daily noise level data points are computed for the period of one year; this data forms the sample.
4. Select the subsample – a method is developed for selecting dates out of the sample to form the subsample. Using a specific sampling technique and an increment step, a subsample is selected and incremented until the daily noise levels for each grid cell are similar for the subsample and the sample.
5. Compare the daily noise levels for the subsample and sample – each increment of the subsample is compared to the sample using an objective statistical method, i.e., bootstrap resampling.
6. Complete the process if the subsample passes the criterion – Steps 4 through 6 are repeated iteratively until the difference between the subsample and sample are within a pre-established set of criteria.

The following sections discuss each step of the methodology in greater detail.

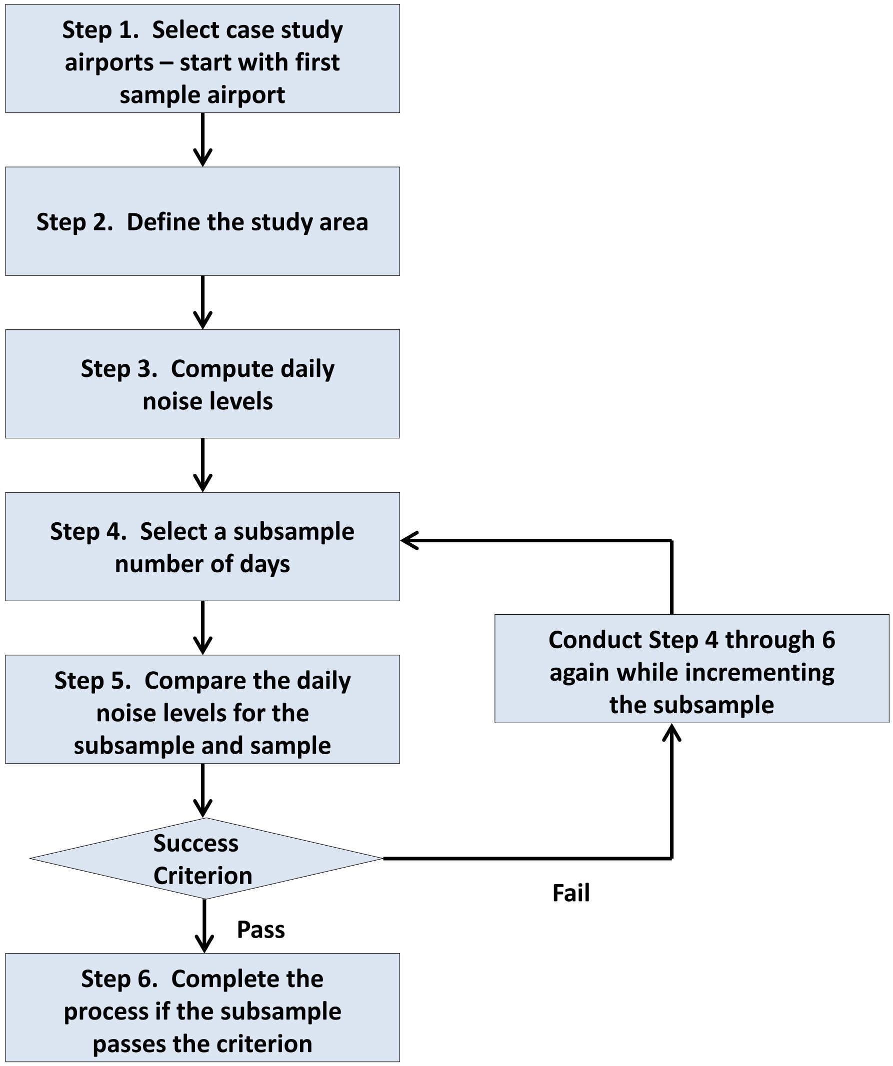

Figure 3-1. AAD Methodology

3.1 Select Sample Airports

Conducting this analysis for each of the hundreds of public-use airports in the NAS would require extensive resources that are neither justifiable nor available. As a result, the main objective of studying sample airports is to address a large mix such that the findings could be extrapolated to other airports in the NAS. In particular, two methods are used to select relevant airports: k mean clustering via principal component analysis (PCA) [5] to combine airports into clusters with similar attributes, and intra-cluster ranking to order airports within each group by the complexity of their operations. The ranking is used to select worst-case, average-case, and best-case scenarios for each cluster.

The first step in the selection of sample airports is the collection of data descriptive of flight operations. Overall, data for 396 airports in the National Flight Data Center (NFDC) database is used, including the number of instrument flight procedures (IFP), the number of runways, and the total number of Instrument Flight Rule (IFR) operations. The numbers of IFPs and the numbers of runways were derived from the Jeppesen flight procedure database [6]. The numbers of IFR operations were derived from the NFDC database as the sum of Commercial, Commuter and Air Taxi operations. The data was imported into the statistical package JMP for further analysis.

3.1.1 Principal Component Analysis

PCA is a mathematical technique that is used to transform a set of correlated variables into a set of linearly uncorrelated variables. The technique uses orthogonal transformations to derive Principal Components (PCs), the number of which may be less than or equal to the number of original variables. The technique is sensitive to the scale of the data and, therefore, the initial step was to standardize the following variables: numbers of runways, numbers of IFPs and numbers of IFR operations.

Standardizing variables helps to minimize differences in their magnitude. For example, the numbers of IFR operations is in the 1,000s whereas the numbers of IFP or runways are in the 10s. For each variable, the mean value is subtracted from the observed values and divided by the standard deviation. The resulting sets of observations have means and standard deviations of zero and one, respectively. For example, the mean number of procedures for all 396 airports is 12.64141 and the standard deviation 10.21653. As a result, an airport with 15 IFR procedures would have a standardized number of IFR procedures of 0.23086. Appendix A provides detailed information on the standardization process.

Next, using the standardized variables, pairwise correlation coefficients are computed for the three variables. The pairwise correlation coefficients indicate the linear relationship between two variables, for example, the number of IFR operations and the number of runways. Table 3-1 shows the results; for example, the number of IFR operations and the number of IFR procedures have a high positive correlation of 0.7756. Conversely, the number of runways and the number of IFR procedures have a weak positive correlation of 0.2924. Since the variables are standardized, the correlation matrix would equate to the covariance matrix.

Table 3-1. Correlation Coefficients

Variable	Number of IFR Procedures	Number of Runways	Number of IFR Operations
Number of IFR Procedures	1	0.2924	0.7756
Number of Runway	0.2924	1	0.3375
Number of IFR Operations	0.7756	0.3375	1

Using JMP's multivariate methods and principal components functions [7], the PCs of the covariance matrix were obtained from the Eigen-decomposition of the matrix to identify the principal directions in which the data varies. In practice, the technique is equivalent to finding the eigenvector with the largest Eigen value (the orthogonal direction of greatest variation), the eigenvector with the second largest eigenvalue (the orthogonal direction with the next highest variation), etc. Table 3-2 summarizes the top three PCs using the standardized variables as follows:

- $PC_1 = 0.64 \times Number\ of\ IFR\ Procedures + 0.41 \times Number\ of\ Runways + 0.65 \times Number\ of\ IFR\ Operations$ is the sum of all three variables with the number of runways carrying slightly less weight. PC_1 may be interpreted as the measure of total demand for an airport.
- $PC_2 = -0.33 \times Number\ of\ IFR\ Procedures + 0.91 \times Number\ of\ Runways - 0.26 \times Number\ of\ IFR\ Operations$ may be interpreted as the measure of the tradeoff between runway infrastructure and flight operations.
- $PC_3 = 0.7 \times Number\ of\ IFR\ Procedures + 0.05 \times Number\ of\ Runways - 0.72 \times Number\ of\ IFR\ Operations$ may be interpreted as the measure of the tradeoff between the number of procedures and the number of IFR operations.

Table 3-2. Principal Components Coefficients

PC	Number of IFR Procedures	Number of Runway	Number of IFR Operations
PC_1	.64	.41	0.65
PC_2	-.33	.91	-0.26
PC_3	.70	.05	-0.72

Using the above-defined three PCs and the standardized variables, PCs were computed for each observation and used as input to the k-mean clustering algorithm in JMP. This analysis helps to partition the 396 airports into an optimal number of clusters. Each airport belongs to a cluster based on a degree of membership measured by the least square distance to the cluster centroid. In general terms, the k-mean clustering algorithm can be described as follows:

1. Randomly select k initial centroids associated with k clusters; start with the lowest possible number of clusters.
2. Assign each airport to its closest cluster based on the minimum of least square distances between the PCs and the different cluster centroids.
3. Compute an objective function which is the sum of the minimum least square distances between all PCs and corresponding closest cluster.
4. Search for the locations of the cluster centroids that would minimize the objective function.
5. Repeat the process while adding additional clusters until there is no improvement in the objective function for the number of clusters or the locations of each centroid.

The analysis resulted in four clusters of 42, 37, 3, and 314 airports. Figure 3-2 illustrates the 95% confidence interval for the four clusters on two dimensions of PC_1 (measure of total demand) versus PC_2 (measure of infrastructure and flight operations tradeoff). Cluster 1 contained 42 major commercial airports similar to the FAA Core 30. The Core 30 is often described as the list of airports with significance to the NAS in terms of air traffic operations and enplanements. Next, Cluster 2 contained 37 moderately busy airports that support a mix of commercial and general aviation traffic. Cluster 3 contained 3 airports that have the highest numbers of IFR operations. Finally, Cluster 4 contained 314 airports that are mostly general aviation airports with relatively low numbers of operations. Appendix A provides more detail on the clustering analysis.

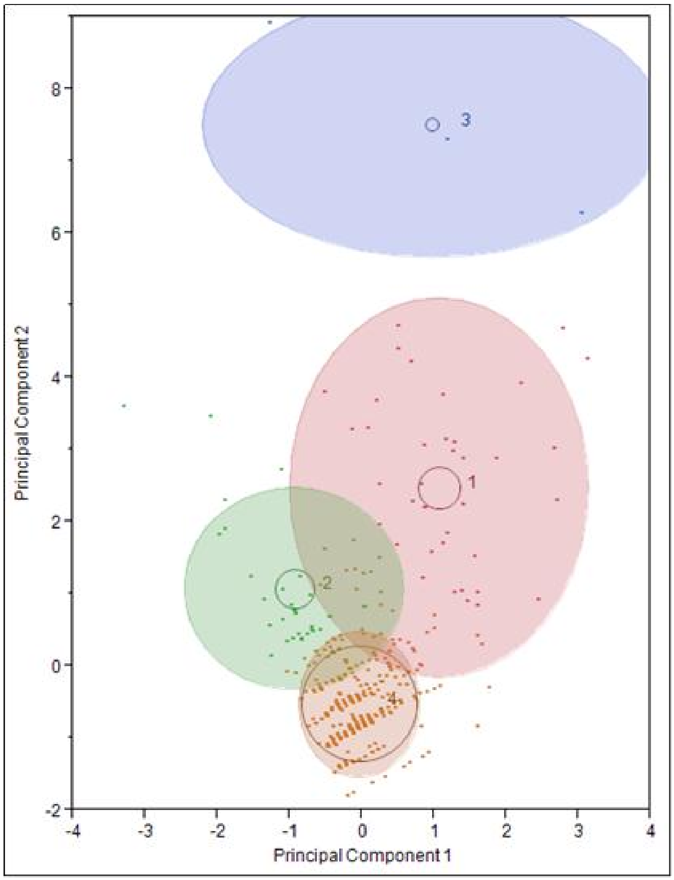

Figure 3-2. Illustration of Clusters

3.1.2 Intra-Cluster Ranking

For each cluster, the airports were ranked by complexity based on the number of IFR operations. The ranking allowed for selection of a worst-case, average-case and best-case studies for each cluster. This approach is intended to enable selection of largely different airports within each cluster. The selected airports are summarized in Table 3-3. For example, Cluster 1 airports include George Bush Intercontinental Airport (IAH) in Texas, Dulles International Airport (IAD) in Virginia, and Ellington International Airport (EFD) in Texas, ranked in order of decreasing complexity based on their number of IFR operations. The study was completed for each of the selected airports.

Table 3-3. Selected Airports

Group	Top-Ranked	Middle-Ranked	Last-Ranked
Cluster 1	George Bush Intercontinental Airport (Texas) - IAH	Dulles International Airport (Virginia) - IAD	Ellington International Airport (Texas) - EFD
Cluster 2	Austin-Bergstrom International Airport (Texas) - AUS	San Angelo Regional Airport (Texas) - SJT	Meridian Regional Airport (Mississipi) - MEI
Cluster 3	Chicago O'Hare International Airport (Illinois) - ORD	Dallas/Fort Worth International Airport (Texas) - DFW	Hartsfield-Jackson Atlanta International Airport (Georgia) - ATL
Cluster 4	Louisville International Airport (Kentucky) - SDF	Henderson Executive Airport (Nevada) - HND	Destin-Fort Walton Beach Airport - DTS

3.2 Define Study Area

For each sample airport, the study area was defined as a square grid centered on the airport (see illustration in Figure 3-3). For the purposes of this analysis, the study area extended 100 nautical miles (NM) north-south and east west. The area provides a distance of 50 NM north, south, east and west of the airport; this area is largely sufficient for noise impact purposes because arrivals and departures are typically well above 10,000 feet at this distance from the airport and their contribution to the noise environment on the ground is marginal. The study area was then partitioned into grid cells.

The grid cell is defined as a unit of area for which a sample of daily noise levels was developed. The size of each grid cell can affect the computed noise levels over the course of one year; a large grid cell encompasses more variability in noise levels encountered while a small grid cell is expected to have more homogeneous noise levels. As a result, a sensitivity analysis was performed to determine the effect of grid cell size on the minimum subsample size required for grid cell sizes of 1 NM, 2 NM, and 4 NM. The results documented in Appendix C show that a grid cell size of 2 NM is adequate in terms of the variability of the noise levels within the grid cell; further, it limits the number of grid cells to be analyzed thereby minimizing computational requirements.

In conclusion, a grid area of 100 NM by 100 NM and a grid cell size of 2 NM were used, which yields 2,500 grid cells. For each one of the 2,500 grid cells, noise levels were computed for the sample 365 dates of Calendar Year (CY) 2012.

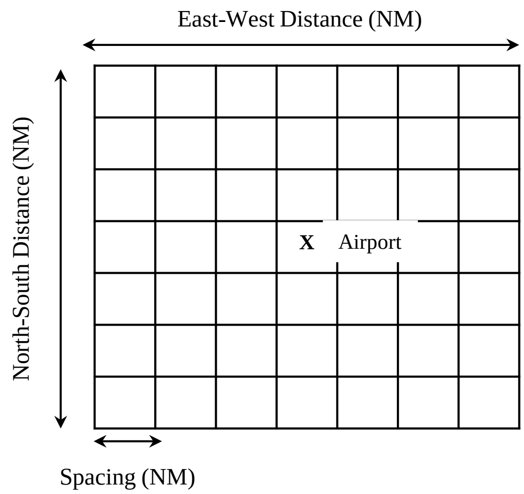

Figure 3-3. Illustration of Study Area

3.3 Compute Daily Noise Levels

The next step is to compute daily noise levels for each grid cell for the one-year sample. The noise level is intended to provide an acoustical measure that can be used to compare the subsample and the sample. The noise level estimates the acoustic value of a flight operation relative to a grid cell. The calculation accounts for individual aircraft types, types of operation, altitudes, speeds, and times of day. Computation of the daily noise levels follows these steps:

1. Query and collect one year of Threaded Track data for analysis [8]. Threaded Track is a CAASD trajectory data integration project which fuses a range of trajectory sources throughout the flight envelope into a single synthetic trajectory. These sources currently span the National Offload Program (NOP) data, the Airport Surface Detection Equipment, Model X (ASDE-X), and the Enhanced Traffic Management System (ETMS) data sources.
2. Extract the date, time, flight ID, International Civil Aviation Organization (ICAO) equipment code, the operation type, altitude, and speed for each intersection of a radar track and a grid cell. This step was accomplished by developing a Java-based routine as a part of CAASD's Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS) tool. This step yields up to $n \times m$ records where n is the number of grid cells and m is the number of flights in one year (number of radar tracks). Appendix B shows a sample of the detailed records from the process. To enable the next step, a mapping of ICAO equipment codes to the FAA Integrated Noise Model (INM) Version 7.0c aircraft types was developed as shown in Appendix B.

3. Using the information in Step 2, specifically the INM aircraft type and the operation type, the corresponding Sound Exposure Level (SEL) is determined based on the normalized Noise-Power-Distance (NPD) curve at 1,000 feet and 160 knots. The extracted SEL is then adjusted for altitude, speed, and the time of day using the equations listed below [9]:

$$L_{i,j,k} = L_{ref_{i,j}} + \Delta V + \Delta h + \Delta p$$

$$L_{i,j,k} = L_{ref_{i,j}} + 10 \times log\left[\left(\frac{V_{ref}}{V_{i,j,k}}\right) \times \left(\frac{h_{ref}}{h_{i,j,k}}\right)^2\right] + \Delta p$$

where $L_{i,j,k}$ is the SEL in dB for aircraft i , operation type j, and grid cell k

$L_{ref_{i,j}}$ is the reference SEL in dB for aircraft i and operation type j (this information is derived from a lookup table integrated in the Java-based routine)

ΔV is the duration adjustment based on the actual speed of the aircraft over a grid cell relative to the reference speed

Δh is the height adjustment based on the actual altitude of the aircraft over a grid cell relative to the reference altitude

Δp is a penalty for operations between 10:00 p.m. and 07:00 a.m. (10 dB) and, in California, an additional penalty for operations between 7:00 p.m. and 10:00 p.m. (5 dB)

V_{ref} is the referenced speed; the value is 160 knots

$V_{i,j,k}$ is the speed in knots for aircraft i , operation type j and grid cell k (based on the speed extracted from radar track)

h_{ref} is the referenced altitude; the value is 1,000 feet Above Ground Level (AGL)

$h_{i,j,k}$ is the altitude in feet AGL for aircraft i , operation type j and grid cell k (also based on the altitude extracted from radar track)

4. Step 3 yields the adjusted noise level for individual instances of a radar track intersecting a grid cell. The adjusted noise levels by event are averaged over the course of the day to derive the daily noise levels. It is important to note that there may be instances where the noise levels in given grid cell are found to be zero owing to the lack of flight operations in that cell. A background noise level of 50 dB is added to all grid cells beyond the noise level generated by flight operations to establish a common baseline for analysis. The TARGETS tool takes approximately 4-8 hours per airport to process one year of radar track data into a summary file containing noise levels by day and by grid cells. An example of the summary file is also shown in Appendix B.

3.4 Select a Subsample Number of Days

There are two aspects to finding a subsample number of days sufficient to represent an AAD: (1) the sampling technique is an important consideration for efficiently selecting a subsample that retains similar characteristics to the sample, and (2) the minimum number of days required is another important consideration. For the purposes of this effort, two sampling techniques were considered: random sampling and constrained sampling. In theory, the sampling technique could benefit from good knowledge of the sample, and therefore, the constrained subsample (CS) would be smaller than the RS. The effectiveness of each technique was evaluated by means of an analysis to determine the effect of the sampling method on the subsample size. The analysis documented in Appendix C shows no significant difference between the two sampling techniques. The random sampling method was retained because it performed slightly better than the constrained method and is widely used in different applications. The repeated sampling analysis in Appendix D also shows a high degree of variability for RSs less than 30 days; as a result, a minimum RS of 30 days would be most reliable in all cases and is suggested as the starting point for all airports.

3.4.1 Random Sampling

The random sampling technique assumes that each day of the sample has an equal probability of being selected. A pre-determined subsample size is selected at random from the sample with replacement (all dates have an equal probability of being selected for every RS). Table 3-4 shows an illustration of a subsample size of 15 days selected randomly out of 365 days. There are three days in December, two days each in February, June, August and November, and one day each in January, March, April and October. There are no days selected in May, July and September. The sequence of days could change in another trial. Many months are not represented in the subsample, demonstrating that a subsample size of 15 days may not represent long-term variations in airport operations such as runway configurations, fleet mix, number of operations etc. The subsample size may be increased incrementally by 15 days until the comparison confirms it is adequate.

Table 3-4. RS of Size 15 Days

1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1/1		2/1		3/1		4/1		5/1		6/1		7/1		8/1		9/1		10/1		11/1		12/1	
1/2		2/2		3/2		4/2		5/2		6/2		7/2		8/2		9/2		10/2		11/2		12/2	
1/3		2/3		3/3		4/3		5/3		6/3		7/3		8/3		9/3		10/3		11/3		12/3	
1/4		2/4		3/4	**3/4**	4/4	**4/4**	5/4		6/4		7/4		8/4		9/4		10/4		11/4		12/4	
1/5		2/5		3/5		4/5		5/5		6/5		7/5		8/5		9/5		10/5		11/5		12/5	
1/6		2/6		3/6		4/6		5/6		6/6		7/6		8/6		9/6		10/6		11/6		12/6	
1/7		2/7		3/7		4/7		5/7		6/7		7/7		8/7		9/7		10/7		11/7		12/7	
1/8		2/8	**2/8**	3/8		4/8		5/8		6/8		7/8		8/8	**8/8**	9/8		10/8	**10/8**	11/8	**11/8**	12/8	
1/9		2/9		3/9		4/9		5/9		6/9		7/9		8/9		9/9		10/9		11/9		12/9	
1/10		2/10		3/10		4/10		5/10		6/10		7/10		8/10		9/10		10/10		11/10		12/10	
1/11		2/11		3/11		4/11		5/11		6/11		7/11		8/11		9/11		10/11		11/11		12/11	
1/12		2/12		3/12		4/12		5/12		6/12		7/12		8/12		9/12		10/12		11/12		12/12	
1/13		2/13	**2/13**	3/13		4/13		5/13		6/13		7/13		8/13		9/13		10/13		11/13		12/13	
1/14		2/14		3/14		4/14		5/14		6/14		7/14		8/14		9/14		10/14		11/14		12/14	
1/15		2/15		3/15		4/15		5/15		6/15	**6/15**	7/15		8/15		9/15		10/15		11/15		12/15	**12/15**
1/16	**1/16**	2/16		3/16		4/16		5/16		6/16		7/16		8/16		9/16		10/16		11/16	**11/16**	12/16	
1/17		2/17		3/17		4/17		5/17		6/17		7/17		8/17		9/17		10/17		11/17		12/17	
1/18		2/18		3/18		4/18		5/18		6/18		7/18		8/18		9/18		10/18		11/18		12/18	
1/19		2/19		3/19		4/19		5/19		6/19		7/19		8/19		9/19		10/19		11/19		12/19	
1/20		2/20		3/20		4/20		5/20		6/20		7/20		8/20	**8/20**	9/20		10/20		11/20		12/20	**12/20**
1/21		2/21		3/21		4/21		5/21		6/21		7/21		8/21		9/21		10/21		11/21		12/21	
1/22		2/22		3/22		4/22		5/22		6/22	**6/22**	7/22		8/22		9/22		10/22		11/22		12/22	**12/22**
1/23		2/23		3/23		4/23		5/23		6/23		7/23		8/23		9/23		10/23		11/23		12/23	
1/24		2/24		3/24		4/24		5/24		6/24		7/24		8/24		9/24		10/24		11/24		12/24	
1/25		2/25		3/25		4/25		5/25		6/25		7/25		8/25		9/25		10/25		11/25		12/25	
1/26		2/26		3/26		4/26		5/26		6/26		7/26		8/26		9/26		10/26		11/26		12/26	
1/27		2/27		3/27		4/27		5/27		6/27		7/27		8/27		9/27		10/27		11/27		12/27	
1/28		2/28		3/28		4/28		5/28		6/28		7/28		8/28		9/28		10/28		11/28		12/28	
1/29				3/29		4/29		5/29		6/29		7/29		8/29		9/29		10/29		11/29		12/29	
1/30				3/30		4/30		5/30		6/30		7/30		8/30		9/30		10/30		11/30		12/30	
1/31				3/31				5/31				7/31		8/31				10/31				12/31	

1 - Sample, 2 - Subsample

3.4.2 Constrained Random Sampling

The constrained random sampling technique uses expert judgment to inform a random sampling process. In this case, the proposed technique is to sample randomly one day each month, including ten weekdays and two week-end days. This approach is intended to ensure that at least one day is sampled out of every month, therefore improving the odds of arriving quickly at a subsample size that is representative of the sample. Table 3-5 shows an illustration of a subsample size of 12 days selected out of 365 days using the constrained random sampling technique. There is one week-end day in January and September, and one weekday each month for the remaining months. Even with the constrained random sampling, a subsample size of 12 days may not be representative of long-term variations in airport operations such as runway configurations, fleet mix, number of operations etc. The subsample size may be increased incrementally by 12 days until the comparison to the sample confirms it is not adequate.

Table 3-5. CS of Size 12 Days

1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1/1		2/1		3/1		4/1		5/1		6/1		7/1		8/1		9/1		10/1		11/1		12/1	
1/2		2/2		3/2		4/2		5/2		6/2		7/2		8/2		9/2		10/2		11/2		12/2	
1/3		2/3		3/3		4/3		5/3		6/3		7/3		8/3		9/3		10/3		11/3		12/3	
1/4		2/4		3/4	**3/4**	4/4		5/4		6/4		7/4		8/4		9/4		10/4		11/4		12/4	
1/5		2/5		3/5		4/5		5/5		6/5		7/5		8/5		9/5		10/5		11/5		12/5	
1/6		2/6		3/6		4/6		5/6		6/6		7/6		8/6		9/6		10/6		11/6		12/6	
1/7		2/7		3/7		4/7		5/7		6/7		7/7		8/7		9/7		10/7		11/7		12/7	
1/8		2/8	**2/8**	3/8		4/8		5/8		6/8		7/8		8/8		9/8		10/8	**10/8**	11/8	**11/8**	12/8	
1/9		2/9		3/9		4/9		5/9		6/9		7/9		8/9		9/9		10/9		11/9		12/9	
1/10		2/10		3/10		4/10		5/10		6/10		7/10		8/10		9/10		10/10		11/10		12/10	
1/11		2/11		3/11		4/11		5/11		6/11		7/11		8/11	**8/11**	9/11		10/11		11/11		12/11	
1/12		2/12		3/12		4/12		5/12		6/12		7/12		8/12		9/12		10/12		11/12		12/12	
1/13		2/13		3/13		4/13		5/13	**5/13**	6/13		7/13		8/13		9/13		10/13		11/13		12/13	
1/14		2/14		3/14		4/14		5/14		6/14		7/14		8/14		9/14		10/14		11/14		12/14	
1/15		2/15		3/15		4/15		5/15		6/15		7/15		8/15		9/15		10/15		11/15		12/15	
1/16	**1/16**	2/16		3/16		4/16		5/16		6/16		7/16	**7/16**	8/16		9/16		10/16		11/16		12/16	
1/17		2/17		3/17		4/17		5/17		6/17		7/17		8/17		9/17		10/17		11/17		12/17	
1/18		2/18		3/18		4/18		5/18		6/18		7/18		8/18		9/18		10/18		11/18		12/18	
1/19		2/19		3/19		4/19		5/19		6/19		7/19		8/19		9/19		10/19		11/19		12/19	
1/20		2/20		3/20		4/20		5/20		6/20		7/20		8/20		9/20		10/20		11/20		12/20	
1/21		2/21		3/21		4/21		5/21		6/21		7/21		8/21		9/21		10/21		11/21		12/21	
1/22		2/22		3/22		4/22		5/22		6/22	**6/22**	7/22		8/22		9/22		10/22		11/22		12/22	**12/22**
1/23		2/23		3/23		4/23		5/23		6/23		7/23		8/23		9/23		10/23		11/23		12/23	
1/24		2/24		3/24		4/24		5/24		6/24		7/24		8/24		9/24		10/24		11/24		12/24	
1/25		2/25		3/25		4/25		5/25		6/25		7/25		8/25		9/25		10/25		11/25		12/25	
1/26		2/26		3/26		4/26	**4/26**	5/26		6/26		7/26		8/26		9/26	**9/26**	10/26		11/26		12/26	
1/27		2/27		3/27		4/27		5/27		6/27		7/27		8/27		9/27		10/27		11/27		12/27	
1/28		2/28		3/28		4/28		5/28		6/28		7/28		8/28		9/28		10/28		11/28		12/28	
1/29				3/29		4/29		5/29		6/29		7/29		8/29		9/29		10/29		11/29		12/29	
1/30				3/30		4/30		5/30		6/30		7/30		8/30		9/30		10/30		11/30		12/30	
1/31				3/31				5/31				7/31		8/31				10/31				12/31	

1 - Sample, 2 - Subsample

3.5 Compare the Daily Noise Levels for the Subsample and Sample

In this step, the selected subsample is compared to the sample to ensure it is sufficient. If the comparison fails, the subsample is incremented and the evaluation performed once again. The subsample and the sample are compared using the statistical technique known as bootstrap resampling.

Bootstrap resampling is used to estimate the sampling distribution of the subsample by sampling with replacement from it. Bootstrap resampling can be used to estimate medians and proportions, among other statistical measures [10]. In this analysis, it is used to determine the sampling distribution of the median noise level per grid cell for the subsample. For every grid cell, the subsample bootstrap median values are then compared with the sample median noise level to determine whether the subsample adequately represents the sample noise levels. A grid cell success rate is defined as the percentage of bootstrap median values that match the sample median value. Two thresholds are defined to declare the subsample representative of the AAD conditions reflected in the one-year sample. The first threshold at the grid cell level determines whether the subsample bootstrap median noise level matches the sample median noise level; a match is established when the bootstrap subsample median value is within a +/-15 percentile range of the sample median value. The second threshold sets a grid-level median success rate of 90% as the success criterion for the subsample, i.e., if 50% of all grid cells have a success rate of 90% or greater, the subsample passes the AAD test. An evaluation of grid cells with noise levels above 60 dB is completed to ensure the grid-level success rate is not biased by the size of the study area.

Bootstrap resampling is used iteratively to determine whether the subsample size passes the success criteria and the subsample size is increased if it fails the test. Figure 3-4 illustrates the process for a single grid cell recognizing that it is completed for all the grid cells defining the study area. The initial step is the computation of noise levels L_n for each day $n = 1, \ldots, 365$ of a one-year sample. Next, a random subsample of size 15 days is selected from the one-year sample without replacement. The bootstrap resampling consists of 1,000 random draws with replacement from the subsample; bootstrap median noise levels are computed for each of the 1,000 draws and compared with the sample's median noise level for the grid cell. A match is established when the bootstrap median value falls between the sample's 35th and the 65th percentile values. This corresponds to a threshold of a +/-15 percentile tolerance around the sample median (where the median is the 50th percentile). This median comparison is conducted for each of the 1,000 bootstrap median values for the grid cell and the cell success rate is computed. For instance, if for a given grid cell, 700 of the 1,000 bootstrap median values are found to be between the 35th and 65th sample percentile values, the success rate for that cell is 70%. This process is undertaken for all the 2,500 grid cells around an airport and success rates computed for each cell. Finally, the second threshold is set as a requirement that the median success rate at the airport including all grid cells is 90% or greater. In other words, this would imply an airport level success if 50% of grid cells (1,250 of 2,500) had a success rate of 90% or greater. If the subsample fails any of the criteria, the subsample size is increased by 15 days and the process repeated until all criteria is met.

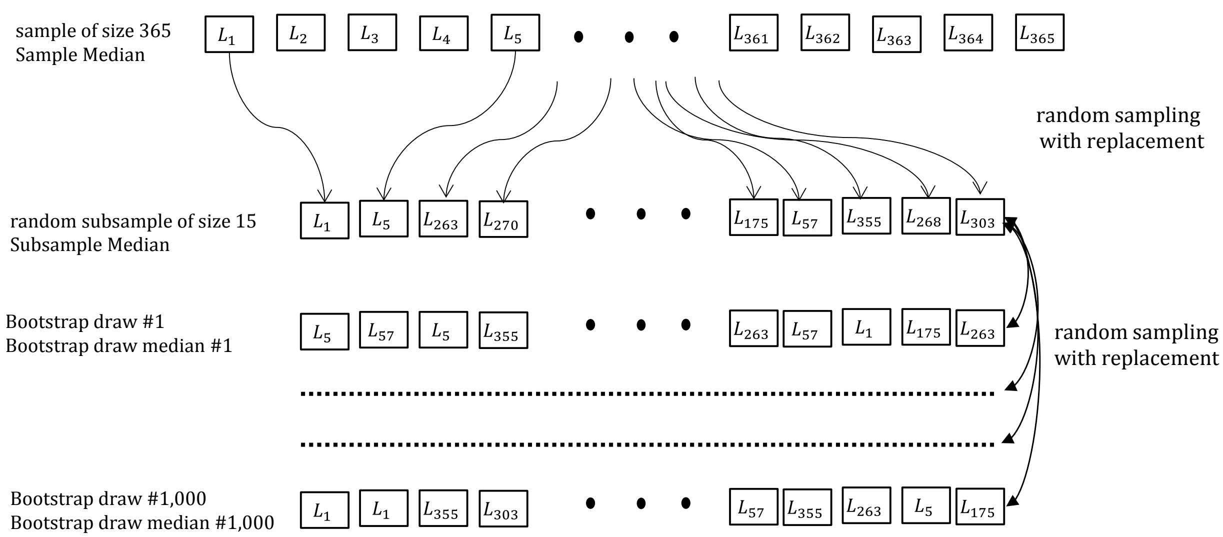

Figure 3-4. Illustration of Bootstrap Resampling for A Single Grid Cell

To conduct this analysis, the summary files containing noise levels by grid cell and by day are used as inputs to a MATLAB program designed to perform the bootstrap resampling. The results are displayed as a boxplot of the success rate which presents the median value, the interquartile range, as well as outliers. Appendix C provides additional details on the selection of the +/- 15 percentile tolerance, and on MATLAB specifications for this analysis.

3.6 Complete the Process if the Subsample Passes the Criterion

In this step, the analysis is complete if the subsample passes the bootstrap resampling test. Otherwise, the subsample is replaced with an incrementally larger one. For example, a random subsample of 15 days would be replaced by another random subsample of 30 days, etc. For illustration purposes, the process is discussed for the most complex airport in Cluster 1 (IAH) and the least complex airport in Cluster 4 (DTS). The results for all airports are documented in Appendix D of this report.

3.6.1 George Bush Intercontinental Airport (IAH)

The outputs of the multi-step process are summarized in boxplots for discussion purposes. The results for IAH illustrate the outcome for a major airport with multiple runways. Figures 3-5 and 3-6 are box plots showing the results for IAH. A subsample is considered to be adequate if it passes the success criteria for all grid cells. The performance of grid cells with noise levels above 60 dB is reviewed to ensure the success rate is not biased by a large number of grid cells with lower noise levels. The results show that a RS of 60 days would be sufficient to represent an AAD at IAH.

Figure 3-5 shows that for a RS of 15 days, the median success rate is slightly less than 70% as shown by the red line on the first boxplot. The interquartile range defined as the bottom and top edges of the blue box indicates the success rate of 25% and 75% of the grid cells, respectively. The interquartile range for a subsample size of 15 days ranges from approximately 40% to 78%. Figure 3-6 shows that the median success rate for grid cells with noise levels above 60 dB is about 40% as shown by the red line on the first boxplot. The interquartile range for a subsample size of 15 days ranges from approximately 40% to 60%. Based on the success criteria discussed in Section 3.5, a subsample size of 15 days would not be sufficient to represent an AAD. The same analysis was also completed for 30, 45, 60 and 90 days to illustrate the trend of the success rate for increasing RSs.

For 60 days, the median success rate improved significantly to almost 100% as shown by the red line on the fourth boxplot in Figure 3-5. The interquartile range for a subsample size of 60 days ranges from approximately 95% to 100%. Further, the median success rate for grid cells with noise levels above 60 dB is about 95% as shown by the red line on the fourth boxplot in Figure 3-6. The interquartile range for grid cells with noise levels above 60 dB ranges from approximately 95% to 100%. Based on the success criteria, a 60 day subsample would be sufficient to represent an AAD for IAH (the most complex airport in Cluster 1).

A feature of the boxplots for 30, 45, 60 and 90 days are the outliers shown as red crosses outside the whiskers. The outliers are artifacts of the random sampling process and have no practical significance for the results of this analysis. The outliers represent few grid cells with noise events observed on about half of the year. For those cells, the bootstrap median values are sensitive to the random sampling approach, i.e., there is a chance that the bootstrap median values would be significantly different from the sample median thus resulting in low success rates. The outliers are generally a marginal percentage of all grid cells.

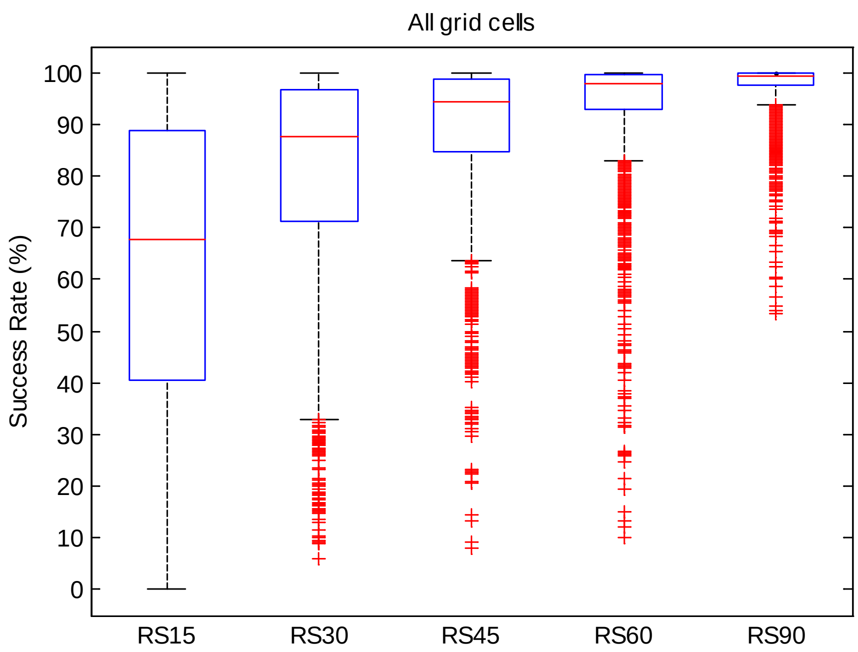

Figure 3-5. AAD Analysis for IAH – All Grid Cells

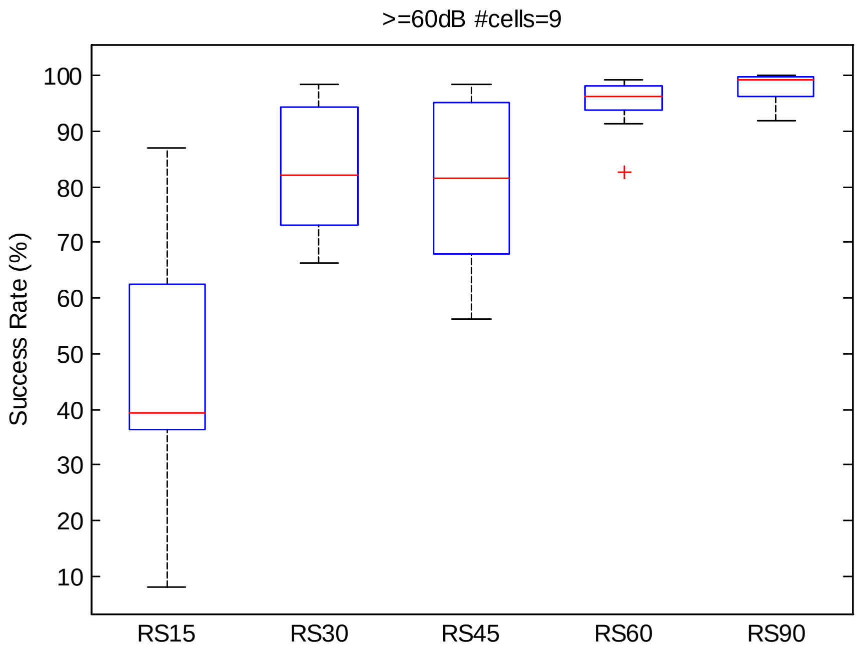

Figure 3-6. AAD Analysis for IAH – Grid Cells Greater than 60 Db

3.6.2 Destin Airport (DTS)

The results for DTS illustrate the outcome for a small, single-runway airport with two dominant runway configurations. DTS is located in the Florida Panhandle where winds are generally equally split from the south and the north [11]. For these kinds of airports, the computed noise levels rarely reached 60 dB, and therefore, the performance of grid cells with noise levels above 60 dB is not discussed. Figure 3-7 indicates that, for a RS of 15 days, the median success rate is slightly less than 100% as shown by the red line on the first boxplot. Further, the interquartile range for a subsample size of 15 days ranges from approximately 90% to 100%. While a RS of 15 days may be adequate based on the success criteria discussed in Section 3.5, a minimum RS of 30 days is suggested based on the repeated sampling evaluation detailed in Appendix D. Figure 3-7 also presents additional results for 30, 45, 60 and 90 days to illustrate the trend of the success rate for increasing RSs.

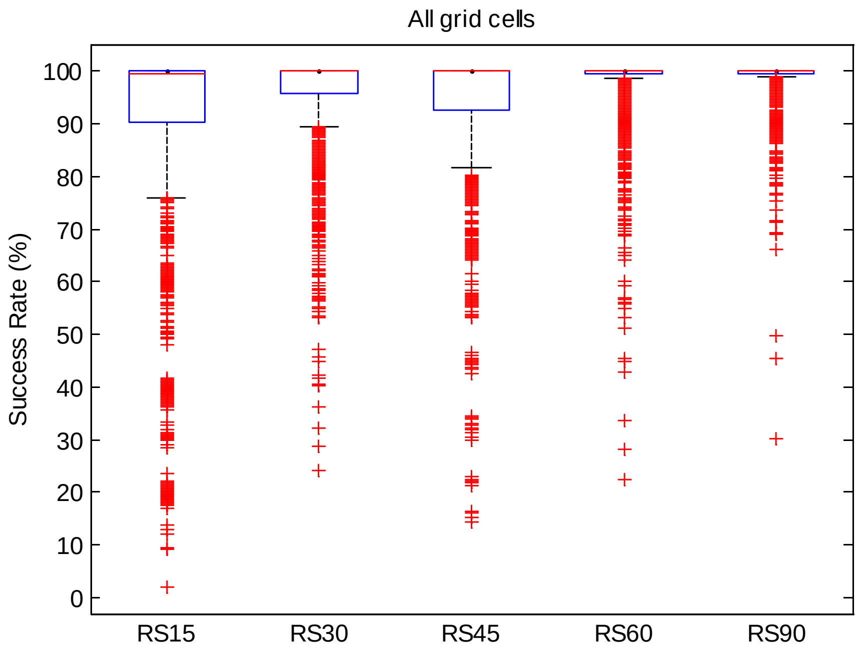

Figure 3-7. AAD Analysis for DTS – All Grid Cells

4 Summary

The multi-step process described in Section 3 was applied to all selected airports and the results are tabulated in Table 4-1. In general, Cluster 1 – busy commercial airports similar to the FAA Core 30 - would require anywhere from a RS of 30 to 60 days. Cluster 2 – moderately busy airports with a mix of commercial and general aviation traffic – would also require a RS of 30 to 60 days. Cluster 3 – busiest airports in the NAS – would require a RS of 45 to 60 days. Finally, Cluster 4 – mostly general aviation airports – would require a RS of 30 to 45 days. In general, the 30-day RS would apply to airports with one runway and one/two dominant configurations. That is the case, for example, for DTS where the airport has a single runway 14/32 and operates in one/two configuration the majority of the time. Table 4-1 summarizes the results for each cluster. Appendix D documents the minimum RS of radar track data required for airports within each cluster.

Table 4-1. Summary of Results

Group	Top-Ranked	Middle-Ranked	Last-Ranked
Cluster 1	IAH (60 days)	IAD (60 days)	EFD (30 days)
Cluster 2	AUS (60 days)	SJT (30 days)	MEI (30 days)
Cluster 3	ORD (60 days)	DFW (45 days)	ATL (45 days)
Cluster 4	SDF (45 days)	HND (45 days)	DTS (30 days)

The selection of radar track data dates could be done using the spreadsheet tool illustrated in Figure 4-1 and available as part of the FAA Noise Screening Guidance for Air Traffic Actions [1]. The tool provides a list of dates randomly sampled throughout a year inputted by the user. The tool lists 90 dates selected at random – the user could use the first 30, 45 or 60 dates as required by the airport of interest.

This Tool is intended to help randomly select 90 dates of radar track data throughout one year. Enter the first date of the year and the tool will list 90 dates selected at random	
FIRST DATE OF YEAR	1/1/2010
90 RANDOM DATES	
ID	**DATES**
1	**2/26/2010**
2	**2/8/2010**
3	**12/25/2010**
4	**6/1/2010**
5	**10/14/2010**
6	**5/23/2010**
7	**10/13/2010**
8	**10/3/2010**
9	**7/1/2010**
10	**7/25/2010**
11	**10/31/2010**

Figure 4-1. Random Dates Selection Tool

This document presents a methodology for determining the number of radar track data days required to represent an AAD for noise analysis. The report discusses the selection of sample airports, the comparison technique, and the criteria for deciding when a subsample is sufficient to represent the one-year sample.

5 List of References

[1] Amefia, A., December 2012, *Guidance for Noise Screening Air Traffic Actions Revision 1.1*, MP090164R1, The MITRE Corporation, McLean, VA.

[2] U.S. Congress, National Environmental Policy Act (NEPA) of 1969 Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b). 13 Sept 1982 (1969), Washington, D.C.

[3] Council on Environmental Quality (CEQ), Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (1978) 40 CFR Parts 1500-1508, Washington, D.C.

[4] FAA, March 2006, *Environmental Impacts: Policies and Procedures, Change 1, Order 1050.1E*, Washington, D.C.

[5] William Cochran, 1977, *Sampling Techniques, Third Edition*, John Wiley and Sons

[6] Jeppesen, 2012, *Flight Procedure Database - Published Procedures (jepp1207)*

[7] SAS Institute Inc., 2012, *JMP User Manual*

[8] The MITRE Corporation, April 2011, *Threaded Track Release Slides*, Mclean, VA

[9] Federal Aviation Administration (FAA), January 2008, *INM Technical Manual* Washington DC.

[10] Mathworks, 2012, Retrieved from http://www.mathworks.com/help/stats/bootstrp.html on 15 June

[11] Weatherunderground.com, 2012, Retrieved from http://www.wunderground.com/history/airport/KDTS/2012/1/1/CustomHistory.html?dayend=31&monthend=12&yearend=2012&req_city=NA&req_state=NA&req_statename=NA on June 15

Appendix A Select Sample Airports

This section provides detailed results of the clustering analysis in JMP, including the collected variables (number of procedures, number of runways and number of IFR operations), their principal components, the standardized variables, the standardized principal components, and finally the cluster IDs (see Table A-1).

Table A-1. Results of the K-Mean Clustering via PCA

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
ABQ	15	4	99764	0.50	0.08	-0.09	0.23	0.28	0.37	0.50	0.08	-0.09	4
ACK	11	3	91622	0.02	-0.18	-0.33	-0.16	-0.17	0.30	0.02	-0.18	-0.33	4
ACV	9	2	11830	-0.71	-0.36	-0.03	-0.36	-0.62	-0.35	-0.71	-0.36	-0.03	4
ADS	18	2	10955	-0.15	-0.64	0.59	0.52	-0.62	-0.36	-0.15	-0.64	0.59	4
ADW	20	2	0	-0.09	-0.69	0.79	0.72	-0.62	-0.44	-0.09	-0.69	0.79	4
AFW	17	2	12325	-0.21	-0.61	0.51	0.43	-0.62	-0.34	-0.21	-0.61	0.51	4
AGS	15	2	13749	-0.33	-0.55	0.37	0.23	-0.62	-0.33	-0.33	-0.55	0.37	4
ANE	19	2	2500	-0.13	-0.66	0.71	0.62	-0.62	-0.42	-0.13	-0.66	0.71	4
APA	16	3	31308	0.02	-0.22	0.36	0.33	-0.17	-0.19	0.02	-0.22	0.36	4
APC	9	3	5101	-0.56	0.06	0.03	-0.36	-0.17	-0.40	-0.56	0.06	0.03	4
APF	9	3	7507	-0.55	0.06	0.02	-0.36	-0.17	-0.38	-0.55	0.06	0.02	4
ASE	5	6	18346	-0.18	1.39	-0.25	-0.75	1.17	-0.30	-0.18	1.39	-0.25	2
ATL	58	8	947847	8.39	-1.45	-2.00	4.44	2.07	7.25	8.39	-1.45	-2.00	3
AUS	20	7	112785	1.44	1.11	0.24	0.72	1.62	0.47	1.44	1.11	0.24	2
BDL	17	3	85743	0.36	-0.36	0.11	0.43	-0.17	0.25	0.36	-0.36	0.11	4
BFI	12	2	70945	-0.21	-0.58	-0.17	-0.06	-0.62	0.13	-0.21	-0.58	-0.17	4
BFL	7	3	12872	-0.64	0.11	-0.15	-0.55	-0.17	-0.34	-0.64	0.11	-0.15	4
BGR	9	2	15733	-0.69	-0.36	-0.05	-0.36	-0.62	-0.32	-0.69	-0.36	-0.05	4
BJC	20	3	4606	0.12	-0.29	0.78	0.72	-0.17	-0.41	0.12	-0.29	0.78	4
BKL	10	2	14275	-0.63	-0.39	0.02	-0.26	-0.62	-0.33	-0.63	-0.39	0.02	4
BLI	5	2	19892	-0.92	-0.24	-0.35	-0.75	-0.62	-0.28	-0.92	-0.24	-0.35	4
BOI	17	2	52174	0.00	-0.70	0.28	0.43	-0.62	-0.02	0.00	-0.70	0.28	4
BOS	35	6	341539	3.39	-0.25	-0.09	2.19	1.17	2.33	3.39	-0.25	-0.09	1
BUF	9	3	81786	-0.16	-0.10	-0.41	-0.36	-0.17	0.22	-0.16	-0.10	-0.41	4
BUR	12	2	73735	-0.20	-0.58	-0.18	-0.06	-0.62	0.15	-0.20	-0.58	-0.18	4
BWI	31	5	253165	2.49	-0.35	0.13	1.80	0.72	1.61	2.49	-0.35	0.13	1
BZN	10	3	17241	-0.43	0.01	0.03	-0.26	-0.17	-0.30	-0.43	0.01	0.03	4
CHS	29	2	48892	0.73	-1.08	1.12	1.60	-0.62	-0.05	0.73	-1.08	1.12	4
CLE	22	5	184909	1.57	0.08	-0.08	0.92	0.72	1.06	1.57	0.08	-0.08	1
CLT	51	4	520517	4.96	-1.96	-0.08	3.75	0.28	3.78	4.96	-1.96	-0.08	1
COS	16	3	47718	0.10	-0.25	0.26	0.33	-0.17	-0.06	0.10	-0.25	0.26	4
CPR	10	2	11746	-0.65	-0.39	0.04	-0.26	-0.62	-0.35	-0.65	-0.39	0.04	4
CPS	11	3	14309	-0.39	-0.02	0.11	-0.16	-0.17	-0.33	-0.39	-0.02	0.11	4
CVG	48	4	165226	2.90	-1.12	1.78	3.46	0.28	0.90	2.90	-1.12	1.78	1
DAB	10	4	6661	-0.30	0.44	0.11	-0.26	0.28	-0.39	-0.30	0.44	0.11	4

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
DAL	32	3	115391	1.46	-0.91	0.96	1.89	-0.17	0.49	1.46	-0.91	0.96	1
DCA	18	4	269342	1.58	-0.37	-0.87	0.52	0.28	1.74	1.58	-0.37	-0.87	1
DEN	38	6	630965	5.10	-0.96	-1.56	2.48	1.17	4.68	5.10	-0.96	-1.56	1
DFW	70	7	645682	7.37	-1.61	0.55	5.61	1.62	4.80	7.37	-1.61	0.55	3
DLF	9	3	0	-0.59	0.08	0.06	-0.36	-0.17	-0.44	-0.59	0.08	0.06	4
DOV	11	4	0	-0.28	0.42	0.22	-0.16	0.28	-0.44	-0.28	0.42	0.22	4
DTO	16	1	1000	-0.52	-0.97	0.49	0.33	-1.07	-0.44	-0.52	-0.97	0.49	4
DTW	32	7	442907	3.92	0.04	-0.86	1.89	1.62	3.15	3.92	0.04	-0.86	1
DVT	7	2	284	-0.90	-0.27	-0.10	-0.55	-0.62	-0.44	-0.90	-0.27	-0.10	4
DWH	29	3	2552	0.68	-0.57	1.41	1.60	-0.17	-0.42	0.68	-0.57	1.41	4
EFD	39	3	9748	1.34	-0.91	2.05	2.58	-0.17	-0.37	1.34	-0.91	2.05	1
EGE	6	3	11005	-0.72	0.15	-0.21	-0.65	-0.17	-0.35	-0.72	0.15	-0.21	4
ELP	19	5	58874	0.72	0.44	0.44	0.62	0.72	0.03	0.72	0.44	0.44	4
END	20	4	0	0.29	0.13	0.83	0.72	0.28	-0.44	0.29	0.13	0.83	4
EUG	15	2	18370	-0.30	-0.56	0.34	0.23	-0.62	-0.30	-0.30	-0.56	0.34	4
EWR	32	4	399190	3.14	-1.09	-0.67	1.89	0.28	2.80	3.14	-1.09	-0.67	1
FAT	11	4	36152	-0.09	0.34	0.01	-0.16	0.28	-0.15	-0.09	0.34	0.01	4
FAY	11	7	27530	0.43	1.58	0.13	-0.16	1.62	-0.22	0.43	1.58	0.13	2
FCM	17	6	1246	0.48	1.04	0.67	0.43	1.17	-0.43	0.48	1.04	0.67	2
FLL	26	3	228748	1.68	-0.95	-0.11	1.31	-0.17	1.41	1.68	-0.95	-0.11	1
FMN	11	4	17249	-0.19	0.38	0.12	-0.16	0.28	-0.30	-0.19	0.38	0.12	4
FMY	10	6	4322	0.05	1.25	0.17	-0.26	1.17	-0.41	0.05	1.25	0.17	2
FRG	14	3	14851	-0.20	-0.12	0.32	0.13	-0.17	-0.32	-0.20	-0.12	0.32	4
FTW	16	12	6577	1.55	3.50	0.70	0.33	3.86	-0.39	1.55	3.50	0.70	2
GEG	16	8	50998	1.05	1.78	0.35	0.33	2.07	-0.03	1.05	1.78	0.35	2
GJT	9	2	16918	-0.68	-0.37	-0.06	-0.36	-0.62	-0.31	-0.68	-0.37	-0.06	4
GPI	6	2	9837	-0.91	-0.26	-0.22	-0.65	-0.62	-0.36	-0.91	-0.26	-0.22	4
GRK	8	4	12022	-0.40	0.49	-0.05	-0.45	0.28	-0.35	-0.40	0.49	-0.05	4
GSB	5	1	0	-1.21	-0.61	-0.25	-0.75	-1.07	-0.44	-1.21	-0.61	-0.25	4
GSO	20	3	50246	0.36	-0.38	0.52	0.72	-0.17	-0.04	0.36	-0.38	0.52	4
GTU	9	4	873	-0.40	0.48	0.08	-0.36	0.28	-0.44	-0.40	0.48	0.08	4
HEF	8	2	1458	-0.83	-0.30	-0.04	-0.45	-0.62	-0.43	-0.83	-0.30	-0.04	4
HIO	10	2	9561	-0.66	-0.38	0.05	-0.26	-0.62	-0.37	-0.66	-0.38	0.05	4
HLN	11	15	8013	1.81	4.88	0.41	-0.16	5.20	-0.38	1.81	4.88	0.41	2
HND	15	2	9644	-0.35	-0.54	0.39	0.23	-0.62	-0.37	-0.35	-0.54	0.39	4
HOU	41	10	132096	3.41	1.62	1.63	2.78	2.96	0.63	3.41	1.62	1.63	1
HPN	12	5	35516	0.16	0.72	0.10	-0.06	0.72	-0.16	0.16	0.72	0.10	4
IAD	36	4	288048	2.80	-0.99	0.25	2.29	0.28	1.89	2.80	-0.99	0.25	1

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
IAH	60	5	527790	5.75	-1.85	0.51	4.64	0.72	3.84	5.75	-1.85	0.51	1
IND	29	3	147527	1.44	-0.88	0.57	1.60	-0.17	0.75	1.44	-0.88	0.57	1
INT	10	3	2502	-0.51	0.04	0.12	-0.26	-0.17	-0.42	-0.51	0.04	0.12	4
IWA	14	3	16958	-0.19	-0.12	0.30	0.13	-0.17	-0.31	-0.19	-0.12	0.30	4
IXD	13	2	2300	-0.51	-0.46	0.30	0.04	-0.62	-0.43	-0.51	-0.46	0.30	4
JAC	12	2	12067	-0.52	-0.45	0.17	-0.06	-0.62	-0.35	-0.52	-0.45	0.17	4
JAX	17	2	77786	0.14	-0.75	0.13	0.43	-0.62	0.19	0.14	-0.75	0.13	4
JFK	39	8	421908	4.44	0.26	-0.24	2.58	2.07	2.98	4.44	0.26	-0.24	1
JQF	9	1	2865	-0.94	-0.74	0.00	-0.36	-1.07	-0.42	-0.94	-0.74	0.00	4
JZI	11	5	2000	-0.08	0.82	0.23	-0.16	0.72	-0.43	-0.08	0.82	0.23	4
LAS	27	6	484194	3.64	-0.29	-1.46	1.41	1.17	3.49	3.64	-0.29	-1.46	1
LAX	61	5	415980	5.22	-1.65	1.23	4.73	0.72	2.93	5.22	-1.65	1.23	1
LCK	13	2	17429	-0.43	-0.50	0.21	0.04	-0.62	-0.30	-0.43	-0.50	0.21	4
LGA	24	4	352200	2.39	-0.74	-0.94	1.11	0.28	2.41	2.39	-0.74	-0.94	1
LGB	11	5	36968	0.10	0.75	0.03	-0.16	0.72	-0.14	0.10	0.75	0.03	4
LMT	8	4	3895	-0.44	0.51	-0.01	-0.45	0.28	-0.41	-0.44	0.51	-0.01	4
LTS	18	3	0	-0.02	-0.21	0.67	0.52	-0.17	-0.44	-0.02	-0.21	0.67	4
LUK	12	3	12466	-0.33	-0.05	0.19	-0.06	-0.17	-0.34	-0.33	-0.05	0.19	4
MCI	30	3	138527	1.45	-0.89	0.69	1.70	-0.17	0.68	1.45	-0.89	0.69	1
MCO	40	11	296965	4.40	1.71	0.62	2.68	3.41	1.97	4.40	1.71	0.62	1
MDW	17	5	199913	1.34	0.21	-0.51	0.43	0.72	1.18	1.34	0.21	-0.51	1
MEM	51	4	306948	3.84	-1.51	1.16	3.75	0.28	2.05	3.84	-1.51	1.16	1
MFR	9	1	18240	-0.86	-0.78	-0.09	-0.36	-1.07	-0.30	-0.86	-0.78	-0.09	4
MHT	14	2	51168	-0.19	-0.60	0.08	0.13	-0.62	-0.03	-0.19	-0.60	0.08	4
MIA	43	4	360093	3.62	-1.36	0.31	2.97	0.28	2.48	3.62	-1.36	0.31	1
MKC	20	6	17831	0.75	0.90	0.77	0.72	1.17	-0.30	0.75	0.90	0.77	2
MMU	7	2	10685	-0.84	-0.29	-0.16	-0.55	-0.62	-0.36	-0.84	-0.29	-0.16	4
MRY	10	2	18013	-0.62	-0.40	0.00	-0.26	-0.62	-0.30	-0.62	-0.40	0.00	4
MSO	8	2	13851	-0.76	-0.33	-0.11	-0.45	-0.62	-0.33	-0.76	-0.33	-0.11	4
MSP	39	4	408366	3.62	-1.34	-0.25	2.58	0.28	2.87	3.62	-1.34	-0.25	1
MTJ	10	4	5054	-0.31	0.44	0.12	-0.26	0.28	-0.40	-0.31	0.44	0.12	4
NCA	9	5	0	-0.22	0.89	0.11	-0.36	0.72	-0.44	-0.22	0.89	0.11	4
NFW	17	6	0	0.47	1.04	0.67	0.43	1.17	-0.44	0.47	1.04	0.67	2
NGP	23	4	0	0.47	0.03	1.04	1.01	0.28	-0.44	0.47	0.03	1.04	4
NGU	8	1	0	-1.02	-0.71	-0.05	-0.45	-1.07	-0.44	-1.02	-0.71	-0.05	4
NKX	10	2	0	-0.71	-0.36	0.11	-0.26	-0.62	-0.44	-0.71	-0.36	0.11	4
NUW	8	7	0	0.09	1.73	0.08	-0.45	1.62	-0.44	0.09	1.73	0.08	2
NYL	12	6	24442	0.29	1.15	0.19	-0.06	1.17	-0.25	0.29	1.15	0.19	2

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NZY	6	2	0	-0.96	-0.23	-0.16	-0.65	-0.62	-0.44	-0.96	-0.23	-0.16	4
OAK	31	5	135944	1.87	-0.10	0.81	1.80	0.72	0.66	1.87	-0.10	0.81	1
OMA	24	3	80776	0.78	-0.58	0.61	1.11	-0.17	0.21	0.78	-0.58	0.61	4
ONT	19	2	74426	0.24	-0.81	0.29	0.62	-0.62	0.16	0.24	-0.81	0.29	4
ORF	16	4	65490	0.38	0.12	0.18	0.33	0.28	0.09	0.38	0.12	0.18	4
OWD	4	2	22000	-0.97	-0.22	-0.43	-0.85	-0.62	-0.27	-0.97	-0.22	-0.43	4
PBI	20	6	82063	1.09	0.77	0.40	0.72	1.17	0.22	1.09	0.77	0.40	2
PDX	25	5	194018	1.81	-0.03	0.07	1.21	0.72	1.13	1.81	-0.03	0.07	1
PHL	29	4	621837	4.12	-1.46	-2.17	1.60	0.28	4.60	4.12	-1.46	-2.17	1
PHX	38	4	439570	3.72	-1.37	-0.50	2.48	0.28	3.12	3.72	-1.37	-0.50	1
PIE	15	4	14308	0.05	0.26	0.41	0.23	0.28	-0.33	0.05	0.26	0.41	4
PIT	29	5	129314	1.71	-0.02	0.72	1.60	0.72	0.61	1.71	-0.02	0.72	1
PSM	8	1	1465	-1.01	-0.71	-0.06	-0.45	-1.07	-0.43	-1.01	-0.71	-0.06	4
PSP	8	5	30194	-0.12	0.86	-0.14	-0.45	0.72	-0.20	-0.12	0.86	-0.14	4
PTK	16	3	7819	-0.11	-0.17	0.49	0.33	-0.17	-0.38	-0.11	-0.17	0.49	4
PWM	9	2	35820	-0.58	-0.41	-0.17	-0.36	-0.62	-0.15	-0.58	-0.41	-0.17	4
RDD	8	2	28608	-0.68	-0.36	-0.19	-0.45	-0.62	-0.21	-0.68	-0.36	-0.19	4
RDU	31	3	82382	1.22	-0.80	1.08	1.80	-0.17	0.22	1.22	-0.80	1.08	1
RIC	16	3	69442	0.22	-0.29	0.13	0.33	-0.17	0.12	0.22	-0.29	0.13	4
RNO	34	5	56884	1.65	-0.03	1.48	2.09	0.72	0.02	1.65	-0.03	1.48	1
ROA	8	2	23495	-0.71	-0.35	-0.17	-0.45	-0.62	-0.25	-0.71	-0.35	-0.17	4
ROC	11	3	52659	-0.18	-0.10	-0.11	-0.16	-0.17	-0.02	-0.18	-0.10	-0.11	4
RSW	10	1	82728	-0.46	-0.94	-0.40	-0.26	-1.07	0.23	-0.46	-0.94	-0.40	4
SAF	10	3	5934	-0.49	0.03	0.10	-0.26	-0.17	-0.40	-0.49	0.03	0.10	4
SAN	14	1	190208	0.36	-1.30	-0.75	0.13	-1.07	1.10	0.36	-1.30	-0.75	4
SAT	25	3	116006	1.02	-0.68	0.48	1.21	-0.17	0.50	1.02	-0.68	0.48	4
SBA	6	5	26797	-0.26	0.93	-0.25	-0.65	0.72	-0.23	-0.26	0.93	-0.25	4
SBP	7	2	12620	-0.83	-0.29	-0.17	-0.55	-0.62	-0.34	-0.83	-0.29	-0.17	4
SDL	10	3	11218	-0.47	0.02	0.06	-0.26	-0.17	-0.35	-0.47	0.02	0.06	4
SEA	32	3	311090	2.49	-1.31	-0.18	1.89	-0.17	2.08	2.49	-1.31	-0.18	1
SFB	14	4	9752	-0.04	0.30	0.37	0.13	0.28	-0.37	-0.04	0.30	0.37	4
SFO	38	5	404801	3.73	-0.89	-0.27	2.48	0.72	2.84	3.73	-0.89	-0.27	1
SGR	27	1	5692	0.20	-1.33	1.21	1.41	-1.07	-0.40	0.20	-1.33	1.21	4
SJC	30	3	106557	1.29	-0.82	0.87	1.70	-0.17	0.42	1.29	-0.82	0.87	1
SLC	39	6	304739	3.45	-0.31	0.40	2.58	1.17	2.03	3.45	-0.31	0.40	1
SMF	15	2	101948	0.14	-0.74	-0.14	0.23	-0.62	0.38	0.14	-0.74	-0.14	4
SMO	4	2	11766	-1.02	-0.20	-0.37	-0.85	-0.62	-0.35	-1.02	-0.20	-0.37	4
SMX	5	2	11941	-0.96	-0.23	-0.30	-0.75	-0.62	-0.35	-0.96	-0.23	-0.30	4

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SNA	17	3	83159	0.35	-0.36	0.12	0.43	-0.17	0.23	0.35	-0.36	0.12	4
SRQ	14	2	21368	-0.35	-0.54	0.26	0.13	-0.62	-0.27	-0.35	-0.54	0.26	4
STL	31	6	175840	2.27	0.22	0.60	1.80	1.17	0.98	2.27	0.22	0.60	1
STP	18	3	5314	0.00	-0.23	0.64	0.52	-0.17	-0.40	0.00	-0.23	0.64	4
STS	8	2	8938	-0.79	-0.32	-0.08	-0.45	-0.62	-0.37	-0.79	-0.32	-0.08	4
SUA	5	8	4460	0.11	2.23	-0.13	-0.75	2.07	-0.41	0.11	2.23	-0.13	2
SUN	3	5	19702	-0.49	1.04	-0.42	-0.94	0.72	-0.28	-0.49	1.04	-0.42	4
SUS	15	2	12358	-0.33	-0.55	0.38	0.23	-0.62	-0.34	-0.33	-0.55	0.38	4
SUU	10	2	0	-0.71	-0.36	0.11	-0.26	-0.62	-0.44	-0.71	-0.36	0.11	4
SWF	10	3	11188	-0.47	0.02	0.06	-0.26	-0.17	-0.35	-0.47	0.02	0.06	4
TEB	13	2	52152	-0.25	-0.57	0.01	0.04	-0.62	-0.02	-0.25	-0.57	0.01	4
TPA	26	5	698934	4.53	-1.12	-2.80	1.31	0.72	5.23	4.53	-1.12	-2.80	1
TUS	20	3	58271	0.41	-0.40	0.47	0.72	-0.17	0.03	0.41	-0.40	0.47	4
TWF	7	2	7651	-0.86	-0.28	-0.14	-0.55	-0.62	-0.38	-0.86	-0.28	-0.14	4
VGT	10	3	10403	-0.47	0.02	0.07	-0.26	-0.17	-0.36	-0.47	0.02	0.07	4
VNY	6	2	16408	-0.87	-0.27	-0.26	-0.65	-0.62	-0.31	-0.87	-0.27	-0.26	4
WRI	21	2	0	-0.02	-0.72	0.86	0.82	-0.62	-0.44	-0.02	-0.72	0.86	4
XNA	9	2	31636	-0.61	-0.40	-0.14	-0.36	-0.62	-0.19	-0.61	-0.40	-0.14	4
YIP	18	4	18921	0.26	0.15	0.59	0.52	0.28	-0.29	0.26	0.15	0.59	4
YKM	10	5	7186	-0.12	0.84	0.13	-0.26	0.72	-0.39	-0.12	0.84	0.13	4
AED	8	0	0	-1.21	-1.11	-0.07	-0.45	-1.51	-0.44	-1.21	-1.11	-0.07	4
AFA	12	0	0	-0.96	-1.24	0.20	-0.06	-1.51	-0.44	-0.96	-1.24	0.20	4
ANC	20	3	185955	1.08	-0.67	-0.27	0.72	-0.17	1.07	1.08	-0.67	-0.27	4
HKO	14	0	0	-0.83	-1.31	0.34	0.13	-1.51	-0.44	-0.83	-1.31	0.34	4
HLI	11	0	0	-1.02	-1.21	0.13	-0.16	-1.51	-0.44	-1.02	-1.21	0.13	4
HMK	2	0	0	-1.58	-0.92	-0.48	-1.04	-1.51	-0.44	-1.58	-0.92	-0.48	4
HNL	30	6	206430	2.37	0.19	0.36	1.70	1.17	1.23	2.37	0.19	0.36	1
HOG	15	0	0	-0.77	-1.34	0.40	0.23	-1.51	-0.44	-0.77	-1.34	0.40	4
HTO	7	3	15110	-0.63	0.11	-0.16	-0.55	-0.17	-0.32	-0.63	0.11	-0.16	4
IST	3	0	0	-1.52	-0.95	-0.41	-0.94	-1.51	-0.44	-1.52	-0.95	-0.41	4
JSJ	23	0	0	-0.27	-1.60	0.95	1.01	-1.51	-0.44	-0.27	-1.60	0.95	4
AGC	6	3	18547	-0.68	0.13	-0.25	-0.65	-0.17	-0.29	-0.68	0.13	-0.25	4
BCT	5	1	5289	-1.18	-0.62	-0.29	-0.75	-1.07	-0.40	-1.18	-0.62	-0.29	4
BED	9	2	18422	-0.68	-0.37	-0.07	-0.36	-0.62	-0.29	-0.68	-0.37	-0.07	4
BNA	27	8	142247	2.21	1.23	0.57	1.41	2.07	0.71	2.21	1.23	0.57	1
CMH	18	3	109567	0.55	-0.44	0.04	0.52	-0.17	0.45	0.55	-0.44	0.04	4
CNO	5	3	307	-0.84	0.20	-0.21	-0.75	-0.17	-0.44	-0.84	0.20	-0.21	4
CRG	8	2	7601	-0.79	-0.32	-0.07	-0.45	-0.62	-0.38	-0.79	-0.32	-0.07	4

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CRQ	4	1	7772	-1.23	-0.59	-0.37	-0.85	-1.07	-0.38	-1.23	-0.59	-0.37	4
DAY	13	3	67146	0.02	-0.19	-0.06	0.04	-0.17	0.10	0.02	-0.19	-0.06	4
FTY	10	3	0	-0.52	0.04	0.13	-0.26	-0.17	-0.44	-0.52	0.04	0.13	4
FXE	12	2	12414	-0.52	-0.45	0.17	-0.06	-0.62	-0.34	-0.52	-0.45	0.17	4
GMU	6	6	19957	-0.11	1.35	-0.19	-0.65	1.17	-0.28	-0.11	1.35	-0.19	2
GSP	6	2	37626	-0.76	-0.31	-0.38	-0.65	-0.62	-0.14	-0.76	-0.31	-0.38	4
HWD	6	4	1766	-0.58	0.57	-0.13	-0.65	0.28	-0.43	-0.58	0.57	-0.13	4
ILG	11	3	3464	-0.44	0.00	0.18	-0.16	-0.17	-0.42	-0.44	0.00	0.18	4
ISM	12	2	2330	-0.57	-0.43	0.23	-0.06	-0.62	-0.43	-0.57	-0.43	0.23	4
ISP	9	6	23040	0.09	1.25	-0.01	-0.36	1.17	-0.26	0.09	1.25	-0.01	2
JWN	8	1	21524	-0.91	-0.75	-0.18	-0.45	-1.07	-0.27	-0.91	-0.75	-0.18	4
JYO	7	1	1024	-1.08	-0.68	-0.12	-0.55	-1.07	-0.44	-1.08	-0.68	-0.12	4
LAL	9	2	1309	-0.77	-0.33	0.03	-0.36	-0.62	-0.43	-0.77	-0.33	0.03	4
LEX	7	3	31520	-0.55	0.07	-0.26	-0.55	-0.17	-0.19	-0.55	0.07	-0.26	4
LZU	10	1	439	-0.89	-0.77	0.08	-0.26	-1.07	-0.44	-0.89	-0.77	0.08	4
MHR	6	4	19445	-0.49	0.54	-0.23	-0.65	0.28	-0.29	-0.49	0.54	-0.23	4
MKE	19	5	167486	1.29	0.22	-0.19	0.62	0.72	0.92	1.29	0.22	-0.19	1
MLB	10	4	6088	-0.31	0.44	0.12	-0.26	0.28	-0.39	-0.31	0.44	0.12	4
MQY	10	3	1129	-0.52	0.04	0.12	-0.26	-0.17	-0.44	-0.52	0.04	0.12	4
MSY	19	3	100117	0.56	-0.46	0.16	0.62	-0.17	0.37	0.56	-0.46	0.16	4
MTN	7	2	1741	-0.89	-0.27	-0.11	-0.55	-0.62	-0.43	-0.89	-0.27	-0.11	4
NEW	8	3	2772	-0.63	0.10	-0.02	-0.45	-0.17	-0.42	-0.63	0.10	-0.02	4
NIP	7	2	0	-0.90	-0.27	-0.10	-0.55	-0.62	-0.44	-0.90	-0.27	-0.10	4
OKC	17	4	62123	0.43	0.09	0.27	0.43	0.28	0.06	0.43	0.09	0.27	4
OPF	20	3	4173	0.12	-0.29	0.79	0.72	-0.17	-0.41	0.12	-0.29	0.79	4
ORD	44	16	877871	8.63	2.40	-2.37	3.07	5.65	6.68	8.63	2.40	-2.37	3
ORL	14	2	5890	-0.43	-0.50	0.35	0.13	-0.62	-0.40	-0.43	-0.50	0.35	4
OSU	7	5	2955	-0.33	0.95	-0.05	-0.55	0.72	-0.42	-0.33	0.95	-0.05	4
PDK	10	5	0	-0.15	0.86	0.17	-0.26	0.72	-0.44	-0.15	0.86	0.17	4
PHF	12	2	23026	-0.46	-0.48	0.11	-0.06	-0.62	-0.26	-0.46	-0.48	0.11	4
PNE	13	2	0	-0.52	-0.46	0.31	0.04	-0.62	-0.44	-0.52	-0.46	0.31	4
PVD	16	2	60128	-0.02	-0.68	0.17	0.33	-0.62	0.04	-0.02	-0.68	0.17	4
PWA	7	3	3128	-0.70	0.13	-0.09	-0.55	-0.17	-0.42	-0.70	0.13	-0.09	4
RND	17	2	0	-0.27	-0.59	0.58	0.43	-0.62	-0.44	-0.27	-0.59	0.58	4
RVS	4	3	1024	-0.89	0.23	-0.29	-0.85	-0.17	-0.44	-0.89	0.23	-0.29	4
RYY	9	1	0	-0.96	-0.74	0.02	-0.36	-1.07	-0.44	-0.96	-0.74	0.02	4
SDF	17	5	138508	1.01	0.34	-0.15	0.43	0.72	0.68	1.01	0.34	-0.15	4
SKF	9	1	0	-0.96	-0.74	0.02	-0.36	-1.07	-0.44	-0.96	-0.74	0.02	4

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
TIK	9	2	0	-0.77	-0.33	0.04	-0.36	-0.62	-0.44	-0.77	-0.33	0.04	4
TMB	15	4	1857	-0.02	0.29	0.48	0.23	0.28	-0.43	-0.02	0.29	0.48	4
TRM	5	2	500	-1.02	-0.20	-0.24	-0.75	-0.62	-0.44	-1.02	-0.20	-0.24	4
TTN	10	5	2595	-0.14	0.85	0.16	-0.26	0.72	-0.42	-0.14	0.85	0.16	4
TUL	16	3	57637	0.15	-0.27	0.20	0.33	-0.17	0.02	0.15	-0.27	0.20	4
UDD	4	1	8000	-1.23	-0.59	-0.37	-0.85	-1.07	-0.38	-1.23	-0.59	-0.37	4
UGN	4	5	3732	-0.51	1.04	-0.26	-0.85	0.72	-0.41	-0.51	1.04	-0.26	4
AAO	3	2	1300	-1.14	-0.14	-0.38	-0.94	-0.62	-0.43	-1.14	-0.14	-0.38	4
ABE	12	2	24029	-0.46	-0.48	0.10	-0.06	-0.62	-0.25	-0.46	-0.48	0.10	4
ABI	5	3	10371	-0.78	0.18	-0.27	-0.75	-0.17	-0.36	-0.78	0.18	-0.27	4
ABY	8	2	2884	-0.82	-0.31	-0.05	-0.45	-0.62	-0.42	-0.82	-0.31	-0.05	4
ACT	7	12	6346	0.99	3.79	0.09	-0.55	3.86	-0.39	0.99	3.79	0.09	2
ACY	12	2	18566	-0.49	-0.47	0.14	-0.06	-0.62	-0.29	-0.49	-0.47	0.14	4
AEX	7	2	10835	-0.84	-0.29	-0.16	-0.55	-0.62	-0.36	-0.84	-0.29	-0.16	4
ALB	11	3	121274	0.18	-0.24	-0.51	-0.16	-0.17	0.54	0.18	-0.24	-0.51	4
AMA	15	2	21971	-0.28	-0.57	0.32	0.23	-0.62	-0.27	-0.28	-0.57	0.32	4
ATW	8	2	15713	-0.75	-0.33	-0.12	-0.45	-0.62	-0.32	-0.75	-0.33	-0.12	4
AVL	4	2	17600	-0.99	-0.21	-0.40	-0.85	-0.62	-0.30	-0.99	-0.21	-0.40	4
AVP	4	4	15552	-0.63	0.61	-0.35	-0.85	0.28	-0.32	-0.63	0.61	-0.35	4
AZO	7	3	10060	-0.66	0.12	-0.13	-0.55	-0.17	-0.36	-0.66	0.12	-0.13	4
BAD	6	1	0	-1.15	-0.64	-0.19	-0.65	-1.07	-0.44	-1.15	-0.64	-0.19	4
BFM	9	6	7939	0.01	1.28	0.08	-0.36	1.17	-0.38	0.01	1.28	0.08	2
BHM	11	3	63089	-0.13	-0.12	-0.17	-0.16	-0.17	0.07	-0.13	-0.12	-0.17	4
BIL	10	5	35147	0.03	0.78	-0.03	-0.26	0.72	-0.16	0.03	0.78	-0.03	4
BIS	6	3	11984	-0.71	0.15	-0.21	-0.65	-0.17	-0.35	-0.71	0.15	-0.21	4
BMI	9	3	10134	-0.53	0.05	0.00	-0.36	-0.17	-0.36	-0.53	0.05	0.00	4
BRO	5	4	5659	-0.62	0.60	-0.22	-0.75	0.28	-0.40	-0.62	0.60	-0.22	4
BTR	9	3	24355	-0.46	0.02	-0.08	-0.36	-0.17	-0.25	-0.46	0.02	-0.08	4
BTV	7	2	29087	-0.74	-0.33	-0.27	-0.55	-0.62	-0.21	-0.74	-0.33	-0.27	4
CAE	8	3	38729	-0.45	0.03	-0.23	-0.45	-0.17	-0.13	-0.45	0.03	-0.23	4
CAK	12	3	29490	-0.24	-0.08	0.09	-0.06	-0.17	-0.20	-0.24	-0.08	0.09	4
CBM	13	3	700	-0.33	-0.05	0.33	0.04	-0.17	-0.44	-0.33	-0.05	0.33	4
CHA	8	3	18720	-0.55	0.07	-0.12	-0.45	-0.17	-0.29	-0.55	0.07	-0.12	4
CHO	3	1	15650	-1.25	-0.58	-0.48	-0.94	-1.07	-0.32	-1.25	-0.58	-0.48	4
CID	9	2	23853	-0.65	-0.38	-0.10	-0.36	-0.62	-0.25	-0.65	-0.38	-0.10	4
CLL	9	3	6410	-0.55	0.06	0.02	-0.36	-0.17	-0.39	-0.55	0.06	0.02	4
CMA	3	1	3959	-1.31	-0.55	-0.41	-0.94	-1.07	-0.41	-1.31	-0.55	-0.41	4
CMI	12	5	24012	0.10	0.74	0.17	-0.06	0.72	-0.25	0.10	0.74	0.17	4

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
CRE	5	1	1070	-1.20	-0.61	-0.26	-0.75	-1.07	-0.44	-1.20	-0.61	-0.26	4
CRP	14	2	20168	-0.35	-0.53	0.26	0.13	-0.62	-0.28	-0.35	-0.53	0.26	4
CRW	4	1	73308	-0.88	-0.73	-0.75	-0.85	-1.07	0.15	-0.88	-0.73	-0.75	4
CSG	3	2	4228	-1.12	-0.15	-0.39	-0.94	-0.62	-0.41	-1.12	-0.15	-0.39	4
CWA	7	2	12339	-0.83	-0.29	-0.17	-0.55	-0.62	-0.34	-0.83	-0.29	-0.17	4
CWF	4	1	3607	-1.25	-0.58	-0.34	-0.85	-1.07	-0.41	-1.25	-0.58	-0.34	4
CYS	6	4	5958	-0.56	0.57	-0.16	-0.65	0.28	-0.40	-0.56	0.57	-0.16	4
DBQ	9	2	3221	-0.76	-0.34	0.02	-0.36	-0.62	-0.42	-0.76	-0.34	0.02	4
DDC	5	2	5301	-0.99	-0.21	-0.26	-0.75	-0.62	-0.40	-0.99	-0.21	-0.26	4
DHN	8	7	3037	0.11	1.73	0.06	-0.45	1.62	-0.42	0.11	1.73	0.06	2
DLH	11	2	10074	-0.59	-0.42	0.12	-0.16	-0.62	-0.36	-0.59	-0.42	0.12	4
DMA	3	3	0	-0.96	0.27	-0.35	-0.94	-0.17	-0.44	-0.96	0.27	-0.35	4
DPA	7	4	11672	-0.46	0.52	-0.12	-0.55	0.28	-0.35	-0.46	0.52	-0.12	4
DRO	3	1	8520	-1.29	-0.56	-0.44	-0.94	-1.07	-0.38	-1.29	-0.56	-0.44	4
DSM	8	3	47034	-0.40	0.01	-0.28	-0.45	-0.17	-0.06	-0.40	0.01	-0.28	4
DTN	3	2	310	-1.15	-0.14	-0.37	-0.94	-0.62	-0.44	-1.15	-0.14	-0.37	4
DTS	2	1	600	-1.39	-0.51	-0.46	-1.04	-1.07	-0.44	-1.39	-0.51	-0.46	4
EAU	5	4	5347	-0.62	0.60	-0.22	-0.75	0.28	-0.40	-0.62	0.60	-0.22	4
ECP	4	1	17016	-1.18	-0.61	-0.42	-0.85	-1.07	-0.31	-1.18	-0.61	-0.42	4
ELM	6	4	10212	-0.53	0.56	-0.18	-0.65	0.28	-0.36	-0.53	0.56	-0.18	4
ERI	9	2	9401	-0.72	-0.35	-0.02	-0.36	-0.62	-0.37	-0.72	-0.35	-0.02	4
EVV	8	3	13390	-0.58	0.08	-0.08	-0.45	-0.17	-0.34	-0.58	0.08	-0.08	4
EWN	5	3	8404	-0.79	0.19	-0.26	-0.75	-0.17	-0.38	-0.79	0.19	-0.26	4
EYW	2	2	20608	-1.10	-0.15	-0.56	-1.04	-0.62	-0.28	-1.10	-0.15	-0.56	4
FAR	10	5	23012	-0.03	0.81	0.04	-0.26	0.72	-0.26	-0.03	0.81	0.04	4
FLG	4	1	8916	-1.22	-0.60	-0.37	-0.85	-1.07	-0.37	-1.22	-0.60	-0.37	4
FLO	5	3	4826	-0.81	0.19	-0.24	-0.75	-0.17	-0.41	-0.81	0.19	-0.24	4
FNT	10	2	20196	-0.60	-0.41	-0.01	-0.26	-0.62	-0.28	-0.60	-0.41	-0.01	4
FPR	7	6	0	-0.16	1.36	-0.01	-0.55	1.17	-0.44	-0.16	1.36	-0.01	2
FSD	11	5	38244	0.11	0.74	0.02	-0.16	0.72	-0.13	0.11	0.74	0.02	4
FSM	10	2	6448	-0.68	-0.38	0.07	-0.26	-0.62	-0.39	-0.68	-0.38	0.07	4
FWA	13	3	18900	-0.24	-0.09	0.22	0.04	-0.17	-0.29	-0.24	-0.09	0.22	4
GAI	3	2	8350	-1.10	-0.16	-0.42	-0.94	-0.62	-0.38	-1.10	-0.16	-0.42	4
GCC	5	11	7224	0.69	3.44	-0.08	-0.75	3.41	-0.39	0.69	3.44	-0.08	2
GCK	10	2	5409	-0.68	-0.37	0.08	-0.26	-0.62	-0.40	-0.68	-0.37	0.08	4
GFK	8	6	107449	0.47	1.10	-0.57	-0.45	1.17	0.43	0.47	1.10	-0.57	2
GGG	10	2	2643	-0.70	-0.37	0.09	-0.26	-0.62	-0.42	-0.70	-0.37	0.09	4
GNV	9	3	9516	-0.54	0.06	0.01	-0.36	-0.17	-0.37	-0.54	0.06	0.01	4

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
GPT	11	2	16403	-0.56	-0.43	0.08	-0.16	-0.62	-0.31	-0.56	-0.43	0.08	4
GRB	9	2	22097	-0.66	-0.38	-0.09	-0.36	-0.62	-0.26	-0.66	-0.38	-0.09	4
GRR	11	4	46884	-0.03	0.32	-0.05	-0.16	0.28	-0.06	-0.03	0.32	-0.05	4
GTF	9	6	15384	0.05	1.26	0.04	-0.36	1.17	-0.32	0.05	1.26	0.04	2
HDN	4	1	5273	-1.24	-0.59	-0.35	-0.85	-1.07	-0.40	-1.24	-0.59	-0.35	4
HRL	11	4	13803	-0.20	0.39	0.14	-0.16	0.28	-0.33	-0.20	0.39	0.14	4
HSV	8	2	33396	-0.66	-0.37	-0.22	-0.45	-0.62	-0.17	-0.66	-0.37	-0.22	4
HXD	3	1	8584	-1.29	-0.56	-0.44	-0.94	-1.07	-0.37	-1.29	-0.56	-0.44	4
HYA	7	2	76832	-0.49	-0.43	-0.54	-0.55	-0.62	0.18	-0.49	-0.43	-0.54	4
ICT	16	3	42288	0.07	-0.24	0.29	0.33	-0.17	-0.10	0.07	-0.24	0.29	4
IDA	9	4	9182	-0.35	0.46	0.03	-0.36	0.28	-0.37	-0.35	0.46	0.03	4
ILM	7	2	21398	-0.78	-0.31	-0.22	-0.55	-0.62	-0.27	-0.78	-0.31	-0.22	4
ITH	5	3	9553	-0.79	0.18	-0.27	-0.75	-0.17	-0.37	-0.79	0.18	-0.27	4
JAN	10	2	29416	-0.56	-0.43	-0.06	-0.26	-0.62	-0.21	-0.56	-0.43	-0.06	4
JKA	3	2	0	-1.15	-0.14	-0.37	-0.94	-0.62	-0.44	-1.15	-0.14	-0.37	4
LAN	9	3	17693	-0.49	0.04	-0.04	-0.36	-0.17	-0.30	-0.49	0.04	-0.04	4
LBB	11	3	33206	-0.29	-0.06	0.00	-0.16	-0.17	-0.17	-0.29	-0.06	0.00	4
LCH	6	2	13023	-0.89	-0.26	-0.24	-0.65	-0.62	-0.34	-0.89	-0.26	-0.24	4
LFT	6	4	31394	-0.42	0.51	-0.30	-0.65	0.28	-0.19	-0.42	0.51	-0.30	4
LIT	13	7	39652	0.61	1.49	0.19	0.04	1.62	-0.12	0.61	1.49	0.19	2
LNK	12	4	16120	-0.13	0.35	0.19	-0.06	0.28	-0.31	-0.13	0.35	0.19	4
LRD	13	4	14502	-0.08	0.32	0.27	0.04	0.28	-0.33	-0.08	0.32	0.27	4
LRF	4	2	0	-1.08	-0.17	-0.30	-0.85	-0.62	-0.44	-1.08	-0.17	-0.30	4
LSE	11	3	8708	-0.42	-0.01	0.15	-0.16	-0.17	-0.37	-0.42	-0.01	0.15	4
LYH	5	2	5869	-0.99	-0.21	-0.27	-0.75	-0.62	-0.40	-0.99	-0.21	-0.27	4
MAF	12	6	23248	0.28	1.15	0.20	-0.06	1.17	-0.26	0.28	1.15	0.20	2
MBS	10	2	10786	-0.65	-0.39	0.05	-0.26	-0.62	-0.36	-0.65	-0.39	0.05	4
MDT	5	1	37749	-1.01	-0.69	-0.47	-0.75	-1.07	-0.14	-1.01	-0.69	-0.47	4
MEI	6	7	1410	-0.02	1.80	-0.06	-0.65	1.62	-0.43	-0.02	1.80	-0.06	2
MFE	6	2	10552	-0.90	-0.26	-0.23	-0.65	-0.62	-0.36	-0.90	-0.26	-0.23	4
MGM	6	2	12710	-0.89	-0.26	-0.24	-0.65	-0.62	-0.34	-0.89	-0.26	-0.24	4
MLI	7	3	23640	-0.59	0.09	-0.21	-0.55	-0.17	-0.25	-0.59	0.09	-0.21	4
MLU	8	3	9953	-0.60	0.09	-0.06	-0.45	-0.17	-0.36	-0.60	0.09	-0.06	4
MOB	7	3	16060	-0.63	0.11	-0.17	-0.55	-0.17	-0.31	-0.63	0.11	-0.17	4
MOT	10	3	10736	-0.47	0.02	0.07	-0.26	-0.17	-0.36	-0.47	0.02	0.07	4
MSN	17	3	32172	0.08	-0.25	0.42	0.43	-0.17	-0.18	0.08	-0.25	0.42	4
MTH	2	1	3958	-1.37	-0.52	-0.48	-1.04	-1.07	-0.41	-1.37	-0.52	-0.48	4
MWH	15	5	8556	0.20	0.68	0.46	0.23	0.72	-0.37	0.20	0.68	0.46	4

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
MYF	2	6	3232	-0.45	1.51	-0.37	-1.04	1.17	-0.42	-0.45	1.51	-0.37	2
MYR	4	1	72641	-0.89	-0.73	-0.75	-0.85	-1.07	0.15	-0.89	-0.73	-0.75	4
NDZ	1	17	0	1.51	6.03	-0.18	-1.14	6.09	-0.44	1.51	6.03	-0.18	2
NKT	6	4	0	-0.59	0.58	-0.12	-0.65	0.28	-0.44	-0.59	0.58	-0.12	4
NLC	7	2	0	-0.90	-0.27	-0.10	-0.55	-0.62	-0.44	-0.90	-0.27	-0.10	4
NMM	3	3	0	-0.96	0.27	-0.35	-0.94	-0.17	-0.44	-0.96	0.27	-0.35	4
NPA	12	3	0	-0.40	-0.02	0.27	-0.06	-0.17	-0.44	-0.40	-0.02	0.27	4
NQI	4	5	0	-0.53	1.05	-0.24	-0.85	0.72	-0.44	-0.53	1.05	-0.24	4
NQX	10	3	0	-0.52	0.04	0.13	-0.26	-0.17	-0.44	-0.52	0.04	0.13	4
NSE	6	2	0	-0.96	-0.23	-0.16	-0.65	-0.62	-0.44	-0.96	-0.23	-0.16	4
OAJ	5	3	10640	-0.78	0.18	-0.27	-0.75	-0.17	-0.36	-0.78	0.18	-0.27	4
OCF	4	11	458	0.59	3.49	-0.11	-0.85	3.41	-0.44	0.59	3.49	-0.11	2
PAE	4	7	5697	-0.13	1.85	-0.22	-0.85	1.62	-0.40	-0.13	1.85	-0.22	2
PGD	6	5	3005	-0.39	0.98	-0.12	-0.65	0.72	-0.42	-0.39	0.98	-0.12	4
PIA	12	3	15388	-0.32	-0.05	0.18	-0.06	-0.17	-0.32	-0.32	-0.05	0.18	4
PMD	4	3	2523	-0.89	0.23	-0.29	-0.85	-0.17	-0.42	-0.89	0.23	-0.29	4
PNS	8	5	30826	-0.12	0.86	-0.14	-0.45	0.72	-0.19	-0.12	0.86	-0.14	4
POB	4	2	0	-1.08	-0.17	-0.30	-0.85	-0.62	-0.44	-1.08	-0.17	-0.30	4
PSC	11	8	13093	0.53	2.02	0.23	-0.16	2.07	-0.34	0.53	2.02	0.23	2
PUB	8	8	5472	0.31	2.13	0.07	-0.45	2.07	-0.40	0.31	2.13	0.07	2
PWK	3	3	13897	-0.89	0.24	-0.43	-0.94	-0.17	-0.33	-0.89	0.24	-0.43	4
RAP	7	2	16230	-0.81	-0.30	-0.19	-0.55	-0.62	-0.31	-0.81	-0.30	-0.19	4
RDM	8	5	13818	-0.21	0.89	-0.04	-0.45	0.72	-0.33	-0.21	0.89	-0.04	4
RFD	8	2	13075	-0.77	-0.33	-0.10	-0.45	-0.62	-0.34	-0.77	-0.33	-0.10	4
RKS	5	3	2048	-0.83	0.20	-0.22	-0.75	-0.17	-0.43	-0.83	0.20	-0.22	4
ROG	6	2	2000	-0.95	-0.24	-0.18	-0.65	-0.62	-0.43	-0.95	-0.24	-0.18	4
ROW	6	2	6756	-0.92	-0.25	-0.20	-0.65	-0.62	-0.39	-0.92	-0.25	-0.20	4
RST	8	2	13056	-0.77	-0.33	-0.10	-0.45	-0.62	-0.34	-0.77	-0.33	-0.10	4
SAC	3	4	4715	-0.75	0.67	-0.35	-0.94	0.28	-0.41	-0.75	0.67	-0.35	4
SAV	11	4	38867	-0.07	0.34	-0.01	-0.16	0.28	-0.13	-0.07	0.34	-0.01	4
SBN	9	3	20026	-0.48	0.03	-0.05	-0.36	-0.17	-0.28	-0.48	0.03	-0.05	4
SGF	10	2	21491	-0.60	-0.41	-0.02	-0.26	-0.62	-0.27	-0.60	-0.41	-0.02	4
SGJ	5	9	5831	0.31	2.63	-0.11	-0.75	2.51	-0.40	0.31	2.63	-0.11	2
SHV	7	3	22255	-0.59	0.09	-0.20	-0.55	-0.17	-0.26	-0.59	0.09	-0.20	4
SJT	8	7	10949	0.15	1.71	0.02	-0.45	1.62	-0.36	0.15	1.71	0.02	2
SLN	7	6	20166	-0.05	1.32	-0.13	-0.55	1.17	-0.28	-0.05	1.32	-0.13	2
SPI	11	5	7225	-0.05	0.81	0.20	-0.16	0.72	-0.39	-0.05	0.81	0.20	4
SPS	9	4	2973	-0.39	0.48	0.07	-0.36	0.28	-0.42	-0.39	0.48	0.07	4

Airport Code	Number of Procedures	Number of Runways	Total Number of IFR Operations	Principal Component 1	Principal Component 2	Principal Component 3	Standardized Number of Procedures	Standardized Number of Runways	Standardized Total Number of IFR Operations	Standardized Principal Component 1	Standardized Principal Component 2	Standardized Principal Component 3	Cluster ID
SSC	4	2	0	-1.08	-0.17	-0.30	-0.85	-0.62	-0.44	-1.08	-0.17	-0.30	4
SSI	3	2	0	-1.15	-0.14	-0.37	-0.94	-0.62	-0.44	-1.15	-0.14	-0.37	4
SYR	8	2	49520	-0.57	-0.40	-0.32	-0.45	-0.62	-0.04	-0.57	-0.40	-0.32	4
TCL	9	2	1366	-0.77	-0.33	0.03	-0.36	-0.62	-0.43	-0.77	-0.33	0.03	4
TEX	2	3	1760	-1.01	0.30	-0.43	-1.04	-0.17	-0.43	-1.01	0.30	-0.43	4
TLH	9	5	21028	-0.11	0.84	-0.02	-0.36	0.72	-0.27	-0.11	0.84	-0.02	4
TOL	7	2	12865	-0.83	-0.29	-0.17	-0.55	-0.62	-0.34	-0.83	-0.29	-0.17	4
TRI	7	2	13218	-0.83	-0.29	-0.17	-0.55	-0.62	-0.34	-0.83	-0.29	-0.17	4
TVC	5	4	10645	-0.60	0.59	-0.25	-0.75	0.28	-0.36	-0.60	0.59	-0.25	4
TXK	7	6	4754	-0.13	1.35	-0.04	-0.55	1.17	-0.41	-0.13	1.35	-0.04	2
TYR	8	6	8006	-0.05	1.31	0.01	-0.45	1.17	-0.38	-0.05	1.31	0.01	2
TYS	8	2	40140	-0.62	-0.38	-0.26	-0.45	-0.62	-0.12	-0.62	-0.38	-0.26	4
UNV	4	1	16180	-1.19	-0.61	-0.42	-0.85	-1.07	-0.31	-1.19	-0.61	-0.42	4
VIS	4	2	7000	-1.05	-0.19	-0.34	-0.85	-0.62	-0.39	-1.05	-0.19	-0.34	4
VPS	5	2	17742	-0.93	-0.24	-0.34	-0.75	-0.62	-0.30	-0.93	-0.24	-0.34	4
VRB	6	4	2797	-0.57	0.57	-0.14	-0.65	0.28	-0.42	-0.57	0.57	-0.14	4
AEN	6	0	0	-1.33	-1.05	-0.21	-0.65	-1.51	-0.44	-1.33	-1.05	-0.21	4
GSN	5	2	47051	-0.77	-0.30	-0.51	-0.75	-0.62	-0.06	-0.77	-0.30	-0.51	4
GUM	15	4	25798	0.11	0.24	0.34	0.23	0.28	-0.23	0.11	0.24	0.34	4

Appendix B Noise Level Computation

This section documents the outputs of the Java-based routine developed as a part of CAASD's TARGETS tool. Table B-1 presents a sample from the detailed report which includes for each flight ID and aircraft type the grid cells crossed, and the hour, altitude and speed when crossing the grid. Table B-2 presents a sample from the summary report which includes the grid cell ID, the day of the year and the daily noise level. Finally, Table B-3 presents the mapping from radar track aircraft ID to the FAA INM aircraft ID.

Table B-1. Sample Detailed Grid Cell Records

Grid Cell ID	Date	Hour	Flight ID	Aircraft Type	Altitude (AGL)	Speed (Knots)
0.0 0.0	2011.01.23	18	CJC7802D	SF34	11764.9	231
0.0 0.0	2011.01.10	6	CJC7811A	SF34	8654.9	281
0.0 0.0	2011.01.21	13	UAL217D	B752	25425.9	368
0.0 0.0	2011.01.03	19	FLG4192D	CRJ2	25713.9	343
0.0 0.0	2011.02.01	14	CPZ5824D	E170	27478.9	355
0.0 0.0	2011.01.11	13	PJC79D	C25B	13639.9	328
0.0 0.0	2011.01.19	10	COM266D	CRJ1	21515.9	355
0.0 0.0	2011.01.27	22	N793PD	BE9L	11860.9	228
0.0 0.0	2011.01.11	17	N75SJD	C680	21713.9	371
0.0 0.0	2011.01.07	17	CJC7808D	SF34	11821.9	194
0.0 0.0	2011.01.12	0	CJC7820D	SF34	10781.9	248
0.0 0.0	2011.01.18	17	OPT448D	BE40	30772.9	361
0.0 0.0	2011.01.20	16	VNR156D	P180	13715.9	282
0.0 0.0	2011.01.14	16	CJC7856A	SF34	10662.9	300
0.0 0.0	2011.01.21	23	SWQ802D	B734	31035.9	367
0.0 0.0	2011.01.14	20	LXJ524D	CL30	30589.9	335
0.0 0.0	2011.01.02	17	CJC7821D	SF34	13697.9	249
0.0 0.0	2011.01.22	14	N440KFA	BE9L	10673.9	226
0.0 0.0	2011.01.19	9	N600BWD	C560	27321.9	343
0.0 0.0	2011.01.17	18	N618WFD	GLEX	27212.9	393
0.0 0.0	2011.01.14	16	LJY889D	C550	13693.9	248
0.0 0.0	2011.01.13	12	N521FPD	C750	25462.9	430

Table B-2. Sample Summary Grid Cell Records

Grid Cell	Date	Noise Level
27.0 27.0	2010.12.31	50
27.0 27.0	2011.01.01	51
27.0 27.0	2011.01.02	68
27.0 27.0	2011.01.03	67
27.0 27.0	2011.01.04	59
27.0 27.0	2011.01.05	72
27.0 27.0	2011.01.06	56
27.0 27.0	2011.01.07	66
27.0 27.0	2011.01.08	64
27.0 27.0	2011.01.09	58
27.0 27.0	2011.01.10	60
27.0 27.0	2011.01.11	66
27.0 27.0	2011.01.12	67
27.0 27.0	2011.01.13	69
27.0 27.0	2011.01.14	73
27.0 27.0	2011.01.15	51
27.0 27.0	2011.01.16	55
27.0 27.0	2011.01.17	55
27.0 27.0	2011.01.18	50

Table B-3. Mapping of ICAO Code to INM Aircraft Types

ICAO Code	Description	INM Aircraft Type
A002	N/A	B212
A10	Fairchild A-10 Thunderbolt 2	A10A
A109	Agusta/AgustaWestland A-109	A109
A119	Agusta/AgustaWestland A-119 Koala	B212
A122	Uirapuru, AEROTEC (1)	GASEPV
A124	Antonow/Antonov An-124 Ruslan	707320
A129	Agusta/AgustaWestland A-129 Mangusta	B212
A139	Agusta/AgustaWestland AB139/AW139	B212
A140	Antonow/Antonov An-140	707320
A148	Antonow/Antonov An-148	737700
A149	AW-149, AGUSTA	B212
A16	A-16 Sport Falcon, AVIADESIGN	GASEPV
A19	A-19, AEROPRACT	GASEPV
A205	MAI-205, OSKBES-MAI	B212
A21	Solo, AEROPRACT	GASEPV
A3	Douglas A-3 Skywarrior	A3
A306	Airbus A300B4-600 /C4-600/F4-600	A300-622R
A30B	Airbus A300B2/B4/C4/F4	A300-622R
A310	Airbus A310/CC-150 Polaris	A310-304
A318	Airbus A318	A319-131
A319	Airbus A319	A319-131
A320	Airbus A320	A320-211
A321	Airbus A321	A321-232
A332	Airbus A330-200	A330-301
A333	Airbus A330-300	A330-301
A342	Airbus A340-200	A340-211
A343	Airbus A340-300	A340-211
A345	Airbus A340-500	A340-211
A346	Airbus A340-600	A340-642
A388	Airbus A380-800	A380-841
A3ST	Airbus A300-600ST Beluga	A300B4-203

ICAO Code	Description	INM Aircraft Type
A4	Douglas A-4 Skyhawk	A4C
A6	Grumman EA-6 Prowler	A6A
A7	Chance-Vought A-7 Corsair 2	A7D
A743	Antonow/Antonov An-74-300	DC930
A748	AVRO 748	HS748
AC50	Aero Commander 500 Commander 500	BEC58P
AC52	N/A	BEC58P
AC56	Aero Commander 560 Commander 560	BEC58P
AC68	Aero Commander 680F Commander 680F	BEC58P
AC6L	Aero Commander 680FL Grand Commander	BEC58P
AC72	Aero Commander Alti Cruiser	BEC58P
AC80	Aero Commander 680T/680V Turbo Commander	BEC58P
AC90	American 690 Jetprop Commander 840/900	DHC6
AC95	American 695 Jetprop Commander 1000	CNA441
AEST	Piper PA-60 Aerostar	BEC58P
AN12	Antonow/Antonov An-12	707320
AN24	Antonow/Antonov An-24	DHC8
AN26	Antonow/Antonov An-26	DHC8
AN28	Antonow/Antonov An-28	DHC6
AN30	Antonow/Antonov An-30	DHC8
AN32	Antonow/Antonov An-32	DHC8
AN72	Antonow/Antonov An-72	DC930
ARVA	IAI Arava	DHC6
ASTR	IAI 1125 Astra	IA1125
AT3	AIDC AT-3 Tzu-Chung	DHC8
AT43	ATR ATR 42-200/42-300	DHC8
AT44	ATR ATR-42-400	DHC8
AT45	ATR ATR-42-500	DHC8
AT5T	Air Tractor AT-502/AT-503	GASEPV
AT6T	Air Tractor AT-602	GASEPV
AT72	ATR ATR 72	HS748A
AT8T	Air Tractor AT-802	GASEPV

ICAO Code	Description	INM Aircraft Type
ATP	BAe ATP	HS748A
B06	Agusta/AgustaWestland AB-206 JetRanger/LongRanger	B206L
B1	Rockwell B-1 Lancer	B1
B105	MBB BO-105	BO105
B190	Beech 1900	1900D
B2	Northrop B-2 Spirit	B2A
B350	Beech 300 (B300) Super King Air 350	DHC6
B36T	Beech 36 Bonanza (turbine)	GASEPV
B407	Bell Helicopter 407	B407
B461	BAe BAe-146-100	BAE146
B462	BAe BAe-146-200	BAE146
B463	BAe BAe-146-300	BAE146
B52	Boeing B-52 Stratofortress	B52G
B701	Boeing 707-100	707120
B703	Boeing 707-300	707
B712	Boeing 717-200	717200
B720	Boeing 720	720B
B721	Boeing C-22	720
B722	Boeing 727-200	727200
B731	Boeing 737-100	737
B732	Boeing 737-200	737
B733	Boeing 737-300	737300
B734	Boeing 737-400	737400
B735	Boeing 737-500	737500
B736	Boeing 737-600	737700
B737	Boeing C-40 Clipper	737700
B738	Boeing 737-800	737800
B739	Boeing 737-900	737700
B741	Boeing 747-100	747100
B742	Boeing E-4/VC-25	747200
B743	Boeing 747-300	747200
B744	Boeing 747-400	747400

ICAO Code	Description	INM Aircraft Type
B74R	Boeing 747SR	74720A
B74S	Boeing 747SP	747SP
B752	Boeing C-32	757PW
B753	Boeing 757-300	757300
B762	Boeing 767-200	767300
B763	Boeing 767-300	767300
B764	Boeing 767-400	767400
B772	Boeing 777-200	777200
B773	Boeing 777-300	777300
B77L	Boeing 777-200LR	777200
B77W	Boeing 777-300ER	777300
BA11	BAC 111 One-Eleven	BAC111
BE10	Beech 100 King Air	DHC6
BE17	Beech 17 Staggerwing	CNA172
BE18	Beech 18	DHC6
BE20	Beech 200 Super King Air	C12
BE30	Beech 300 Super King Air	DHC6
BE36	Beech 36 Bonanza	GASEPV
BE40	Beech 400 Beechjet	LEAR25
BE55	Beech 55 Baron	BEC58P
BE58	Beech 58 Baron	BEC58P
BE60	Beech 60 Duke	BEC58P
BE99	Beech 99 Airliner	DHC6
BE9L	Beech 90 King Air	DHC6
BE9T	Beech 90 (F90) King Air	DHC6
BELF	Shorts SC-5 Belfast	SD330
BN2T	Britten Norman BN-2T Defender 4000/Turbine Islander	BEC58P
C101	CASA C-101 Aviojet	LEAR25
C10T	Cessna P210 (turbine)	GASEPV
C130	Lockheed C-130 Hercules	C-130E
C135	Boeing C-135 Stratolifter	B52BDE
C141	Lockheed C-141 Starlifter	C141A

ICAO Code	Description	INM Aircraft Type
C14T	Cessna 414 (turbine)	BEC58P
C150	Cessna A150 Aerobat	GASEPF
C160	Transport Allianz C-160	HS748A
C17	Boeing C-17 Globemaster 3	C17
C172	Cessna 172	CNA172
C182	Cessna 182	CNA182
C206	Cessna T206 Turbo Stationair	CNA206
C208	Cessna 208 Caravan 1	PA42
C210	Cessna 210 Centurion	GASEPV
C212	CASA C-212 Aviocar	DHC6
C25A	Cessna 525A Citation CJ2	CNA500
C25B	Cessna 525B Citation CJ3	CNA500
C295	CASA C-295	DHC8
C310	Cessna 310	BEC58P
C337	Cessna 337 Super Skymaster	BEC58P
C340	Cessna 340	BEC58P
C402	Cessna 401	BEC58P
C404	Cessna 404 Titan	BEC58P
C414	Cessna 414	BEC58P
C421	Cessna 421 Golden Eagle	BEC58P
C425	Cessna 425 Corsair	CNA441
C441	Cessna 441 Conquest 2	CNA441
C5	Lockheed C-5 Galaxy	C5A
C500	Cessna 500 Citation 1	CNA500
C501	Cessna 501 Citation 1SP	CNA500
C510	Cessna 510 Citation Mustang	CNA510
C525	Cessna 525 Citation CJ1	CNA500
C526	Cessna 526 CitationJet	CNA500
C550	Cessna 550 Citation Bravo	CNA55B
C551	Cessna 551 Citation 2SP	CNA55B
C560	Cessna 560 Citation 5 Ultra Encore	CNA55B
C56X	Cessna 560XL Citation Excel	CNA55B

ICAO Code	Description	INM Aircraft Type
C650	Cessna 650 Citation 7	CIT3
C680	Cessna 680 Citation Sovereign	CIT3
C750	Cessna 750 Citation X	CNA750
CD2	N/A	DHC6
CL2P	Canadair CL-215	DHC6
CL2T	Canadair CL-415	DHC6
CL30	Bombardier BD-100 Challenger 300	CL600
CL60	Canadair CL-600 Challenger 600	CL600
CN35	Airtech CN-235	SF340
COUR	Helio Courier	GASEPV
CRER	N/A	CNA172
CRJ1	Canadair CL-600 Regional Jet CRJ-100	CRJ9-ER
CRJ2	Canadair CL-600 Regional Jet CRJ-200	CRJ9-ER
CRJ7	Canadair CL-600 Regional Jet CRJ-700	CRJ9-ER
CRJ9	Canadair CL-600 Regional Jet CRJ-900	CRJ9-ER
CRJX	N/A	CRJ9-ER
CVLP	Convair CV-340 Convairliner	DHC8
CVLT	Canadair CV-580	CVR580
D11	Jodel D-11	DC1010
D228	Dornier 228	DHC6
D28D	Dornier Do-28D Skyservant	DHC6
D328	Dornier 328	CNA750
DC10	McDonnell Douglas KC-10 Extender	DC1010
DC3	Douglas DC-3	DC3
DC3T	Basler BT-67 Turbo 67	DC3
DC6	Douglas DC-6	C118
DC85	Douglas DC-8-50	DC850
DC86	Douglas DC-8-60	DC820
DC87	Douglas DC-8-70	DC870
DC91	Douglas DC-9-10	DC910
DC92	Douglas DC-9-20	DC910
DC93	Douglas DC-9-30	C9A

ICAO Code	Description	INM Aircraft Type
DC94	Douglas DC-9-40	DC93LW
DC95	Douglas DC-9-50	DC950
DH2T	De Havilland Canada DHC-2 Mk3 Turbo Beaver	DC95HW
DH3T	De Havilland Canada DHC-3 Turbo Otter	C7A
DH8A	De Havilland Canada DHC-8-100 Dash 8	DHC8
DH8B	De Havilland Canada DHC-8-200 Dash 8	DHC8
DH8C	De Havilland Canada DHC-8-300 Dash 8	DHC8
DH8D	De Havilland Canada DHC-8-400 Dash 8	DHC8
DHC3	De Havilland Canada DHC-3 Otter	C7A
DHC6	De Havilland Canada DHC-6 Twin Otter	DHC6
DHC7	De Havilland Canada DHC-7 Dash 7	DHC7
DR40	N/A	GASEPF
E110	EMBRAER EMB-110 Bandeirante	DHC6
E120	EMBRAER EMB-120 Brasilia	EMB120
E135	EMBRAER EMB-135/ERJ-135	EMB145
E145	EMBRAER EMB-145/ERJ-145	EMB145
E170	EMBRAER EMB-170/EMB-175/ERJ-170/ERJ-175	CL601
E190	EMBRAER EMB-190/EMB-195/ERJ-190/ERJ-195	717200
E2	Grumman E-2 Hawkeye	C130
E45X	EMBRAER EMB-145XR/ERJ-145XR	EMB14L
EA50	Eclipse Eclipse 500	ECLIPSE500
F100	Fokker 100	F10062
F111	General Dynamics F-111	F-111F
F117	Lockheed F-117 Nighthawk	F117A
F14	Grumman F-14 Tomcat	A5C
F15	Boeing F-15 Eagle	F15A
F16	General Dynamics F-16 Fighting Falcon	F100D
F18	Boeing FA-18 Hornet	F-18
F27	Fairchild-Hiller FH-227	HS748A
F28	Fokker F-28 Fellowship	F10062
F2TH	Dassault Falcon 2000	CNA750
F4	McDonnell F-4 Phantom 2	CANBER

ICAO Code	Description	INM Aircraft Type
F406	Cessna F406 Caravan 2	DHC6
F5	AIDC F-5 Chung-Cheng	BAE146
F50	Fokker 50	HS748A
F60	Fokker 60	HS748A
F600	SIAI-Marchetti SF-600 Canguro	DHC6
F70	Fokker 70	F10062
F8	Chance-Vought F8 Crusader	F8
F900	Dassault Mystère 900	COMJET
FA10	Dassault Mystère 10	727EM2
FA20	Dassault Mystère 20	CNA750
FA50	Dassault Mystère 50	COMJET
FA7X	Dassault Falcon 7X	CNA750
G150	IAI Gulfstream G150	IA1125
G159	Grumman G-159 Gulfstream 1	HS748A
G21	Grumman G-21A Goose	DHC6
G21T	N/A	DHC6
G73	Grumman G-73 Mallard	DC3
G73T	Grumman G-73T Turbo Mallard	DC3
G96	Grumman G-96 Trader	DHC6
GALX	IAI 1126 Galaxy	GII
GL5T	Bombardier BD-700 Global 5000	F10062
GLEX	Bombardier BD-700 Global Express	F10062
GLF2	Grumman G-1159 Gulfstream 2	GII
GLF3	Gulfstream G-1159A Gulfstream 3	C-20
GLF4	Gulfstream G-4 Gulfstream G400	GIV
GLF5	Gulfstream G-5 Gulfstream 5	GV
H2	Kaman SH-2 Seasprite	SA330J
H25A	De Havilland DH-125	DOMIN
H25B	BAe BAe-125-700	FAL20
H25C	BAe BAe-125-1000	LEAR35
H46	Boeing Vertol HH-46 Sea Knight	CH47D
H500	Hughes 369	H500D

ICAO Code	Description	INM Aircraft Type
H53	Sikorsky CH-53	S65
H53S	Sikorsky CH-53E Super Stallion	S65
H60	Mitsubishi S-70 Seahawk	S70
HA4T	Hawker-Beechcraft Hawker 4000	CNA750
HAR	BAe Harrier	AV8A
HUCO	Bell Helicopter 209 HueyCobra	B212
HUNT	Hawker Hunter	F4C
HUSK	Aviat A-1 Husky	CNA172
I114	Ilyushin Il-114	DHC8
IA63	FMA IA-63 Pampa	F4C
IL18	Ilyushin Il-20	C130
IL62	Ilyushin Il-62	707320
IL76	Ilyushin Il-82	A300B4-203
IL86	Ilyushin Il-86	DC870
IL96	Ilyushin Il-96	747200
J328	Fairchild-Dornier 328JET	CNA750
JCOM	Aero Commander 1121 Jet Commander	IA1125
JS1	Handley Page HP-137 Jetstream 1	1900D
JS20	Handley Page Jetstream 200	1900D
JS31	BAe BAe-3100 Jetstream 31	DHC6
JS32	BAe BAe-3200 Jetstream Super 31	DHC6
JS41	BAe BAe-4100 Jetstream 41	SF340
K35R	Boeing KC-135R/T Stratotanker	B52BDE
L10	Lockheed L-10 Electra	L1011
L101	Lockheed L-1011 TriStar	L1011
L11	Luscombe 11A Sedan	L1011
L15	N/A	L1011
L188	Lockheed L-188 Electra	L188
L29A	Lockheed L-1329 Jetstar 6/8	LEAR25
L29B	Lockheed L-1329 Jetstar 2	C140
L410	LET L-420 Turbolet	DHC6
LJ23	Learjet 23	LEAR25

ICAO Code	Description	INM Aircraft Type
LJ24	Learjet 24	LEAR25
LJ25	Learjet 25	LEAR25
LJ28	N/A	LEAR25
LJ31	Learjet 31	LEAR35
LJ35	Learjet 35	C21A
LJ40	Learjet 40	LEAR35
LJ45	Learjet 45	LEAR35
LJ55	Learjet 55	LEAR35
LJ60	Learjet 60	LEAR35
LNC2	N/A	CNA172
M20T	Mooney M-20K 252TSE/M-20M	GASEPV
M28	PZL Mielec M-28 Skytruck	DHC6
M7	N/A	GASEPV
MD11	McDonnell Douglas MD-11	DC1010
MD81	McDonnell Douglas MD-81	MD81
MD82	McDonnell Douglas MD-82	MD82
MD83	McDonnell Douglas MD-83	MD83
MD87	McDonnell Douglas MD-87	MD81
MD88	McDonnell Douglas MD-88	MD83
MD90	McDonnell Douglas MD-90	MD9025
MU2	Mitsubishi MU-2	DHC6
MU30	Mitsubishi MU-300 Diamond	MU3001
N262	Aerospatiale/SNIAS N-262 Frégate	SD330
NAVI	North American Navion	GASEPV
NIM	BAe Nimrod	BAE146
NOMA	GAF Nomad	DHC6
P180	Piaggio P-180 Avanti	DHC6
P28A	EMBRAER Carioquinha	GASEPF
P3	Kawasaki P-3 Orion	C130
P32R	EMBRAER EMB-721 Sertanejo	GASEPV
P46T	Piper PA-46-500TP Malibu Meridian	GASEPF
P66P	Piaggio P-166	DHC6

ICAO Code	Description	INM Aircraft Type
P68	Partenavia P-68 Observer	PA30
PA23	Piper PA-23 Apache	BEC58P
PA24	Piper PA-24 Comanche	GASEPV
PA27	Piper PA-23-250 Turbo Aztec	BEC58P
PA30	Piper PA-30 Twin Comanche	PA30
PA31	EMBRAER EMB-820 Navajo	BEC58P
PA32	EMBRAER EMB-720 Minuano	GASEPV
PA34	EMBRAER EMB-810 Seneca	BEC58P
PAT4	Piper PA-31T3-500 T-1040	DHC6
PAY1	Piper PA-31T1-500 Cheyenne 1	BEC58P
PAY2	Piper PA-31T-620 Cheyenne 2	BEC58P
PAY3	N/A	CNA441
PAY4	Piper PA-42-1000 Cheyenne 400	PA42
PC12	Pilatus PC-12	GASEPF
PC6P	Pilatus PC-6 Porter	DHC6
PC9	Pilatus PC-9	GASEPF
PL2	N/A	GASEPF
PRM1	Hawker-Beechcraft 390 Premier 1	CNA55B
PT22	Ryan PT-22 Recruit	GASEPV
R200	Alpha R-2160 Alpha 160	GASEPF
R22	N/A	H500D
R300	Robin/Apex R-3120	GASEPF
R44	N/A	R44
R722	Boeing 727-200RE Super 27	727EM2
RC70	Fuji FA-300	BEC58P
RJ1H	BAe RJ-100	BAE146
RJ70	BAe Avro RJ-70	BAE146
RJ85	BAe RJ-85	BAE146
S10	Stinson 10 Voyager	DC910
S12	N/A	GASEPV
S210	Aerospatiale/SNIAS SE-210 Caravelle	DC910
S2P	De Havilland Canada S-2 Tracker	DHC6

ICAO Code	Description	INM Aircraft Type
S2T	Grumman S-2 Turbo Tracker	DHC6
S3	Lockheed S-3 Viking	F4C
S601	Aerospatiale/SNIAS SN-601 Corvette	CNA55B
S61	Agusta/AgustaWestland SH-3	S61
S76	Sikorsky S-76	S76
SB20	Saab 2000	HS748A
SBR1	North American Sabreliner	LEAR25
SBR2	North American Rockwell NA-265 Sabre 75	LEAR25
SC7	Shorts SC-7 Skyvan	DHC6
SF34	Saab 340	SF340
SGUP	N/A	C130
SH33	Shorts 330	SD330
SH36	Shorts 360	C23
SR20	Cirrus SR-20	COMSEP
SR22	Cirrus SR-22	COMSEP
SS2T	Ayres Turbo Thrush (S-2R-G/T except T660)	DHC6
ST75	Boeing PT-18 Kaydet	GASEPV
STAR	Beech 2000 Starship	DHC6
SUCO	Bell Helicopter SuperCobra	SA365N
SW2	Swearingen SA-26 Merlin 2	DHC6
SW3	Fairchild Merlin 3	DHC6
SW4	Fairchild Merlin 23	DHC6
T134	Tupolev Tu-134	DC930
T154	Tupolev Tu-154	727D17
T2	North American T-2 Buckeye	T-2C
T204	Tupolev Tu-224	757300
T334	Tupolev Tu-334	F10065
T37	Cessna 318/T-37	A37
T38	Northrop T-38 Talon	T-38A
TAMP	SOCATA TB-9 Tampico	GASEPF
TBM7	SOCATA TBM-700	GASEPV
TBM8	SOCATA TBM-850	CNA441

ICAO Code	Description	INM Aircraft Type
TOBA	SOCATA TB-10 Tobago	GASEPV
TRIN	SOCATA TB-20 Trinidad	GASEPV
TRIS	Britten Norman BN-2A Mk3 Trislander	BEC58P
TUCA	EMBRAER T-27 Tucano	DHC6
UH1	Bell Helicopter UH-1 Iroquois	B212
V10	North American OV-10 Bronco	OV10A
VF14	VFW VFW-614	CL600
VISC	Vickers Viscount	CVR580
WB57	N/A	B57E
WW23	IAI 1123 Westwind	IA1125
WW24	IAI 1124 Westwind	HS748A
Y12	HAMC/Harbin Y-12	DHC6
YK40	Yakovlev/Jakovlev Yak-40	DHC6
YK42	Yakovlev/Jakovlev Yak-42	727100
YS11	NAMC YS-11	HS748A

Appendix C Bootstrap Resampling

This section presents additional information on the selection of the sampling technique, the tolerance for the bootstrap resampling, and finally the definition of the boxplot features.

C.1 Sampling Technique

The sampling technique is an important consideration for selecting a subsample that retains similar characteristics to the sample. Two sampling techniques were considered: random sampling and constrained sampling which leverages some expert judgment, and therefore, would be expected to be more efficient. The two sampling techniques are described in greater detail in Section 3.4. A test was performed to assess the sensitivity of the process to both sampling methods using IAD data. Figures C-1 and C-2 presents the results for all grid cells and grid cells with noise levels above 60 dB, respectively. Figure C-1 shows a median success rate between 80%-90% for a RS of 15/30 days (first two boxplots), and a median success rate between 65%-85% for a CS of 12/24 days (last two boxplots). For grid cells with noise levels above 60 dB, Figure C-2 shows a median success rate between 65%-75% for a RS of 15/30 days (first two boxplots), and a median success rate between 60%-75% for a CS of 12/24 days (last two boxplots). There is no significant difference in success rate between the two sampling techniques. As a result, the random sampling method was used as it is simpler and widely used for statistical analyses of sample distributions, hypothesis testing, and sample size determinations.

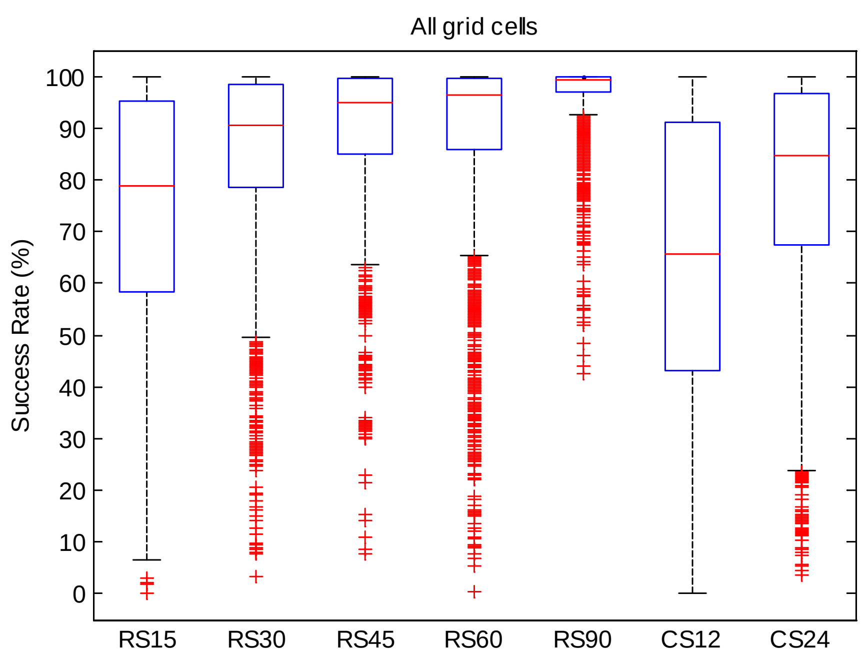

Figure C-1. RS versus CS (All Grid Cells)

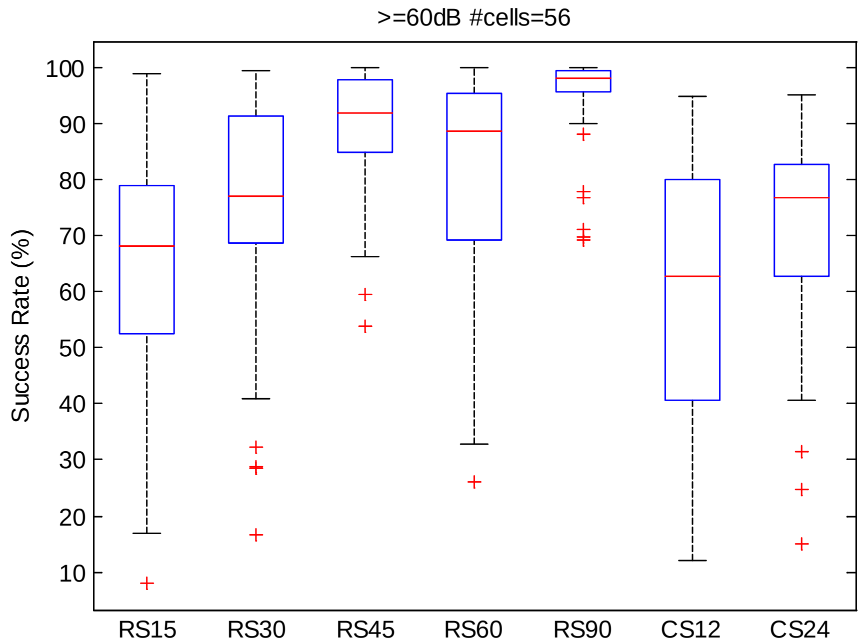

Figure C-2. RS versus CS (Grid Cells Greater than 60 dB)

C.2 Bootstrap Tolerance

As discussed in Section 3.5, the bootstrap resampling consists of 1,000 random draws with replacement from the subsample; bootstrap median noise levels are computed for each of the 1,000 draws and compared with the sample's median noise level for the grid cell. A match is established when the bootstrap median value falls between the sample's 35th and the 65th percentile values which corresponds to a threshold of a +/-15 percentile tolerance around the sample median (where the median is the 50th percentile). The accuracy of this match is acceptable only to the degree that it is within the known uncertainties of noise modeling inputs and tools. For example, FAA recognizes the limitations of the FAA INM tool in *FAA Aviation Noise Effects, Section 13*: "… Because INM is not a detailed acoustical model, differences between predicted and measured values can and do sometimes occur because important local acoustical variables are not averaged, or because complicated physical phenomena are not explicitly modeled." The Society of Automotive Engineers A-21 Aircraft Noise Committee also acknowledges: "Analytical models often have a 95% confidence interval of +/- 3 dB to +/- 5 dB. Therefore, a difference of 3 dB between an estimate from measurements and one from an analytical model may not be significant. Neither estimate can be presumed to be the absolute: each has errors in the estimate it represents." Several other stakeholders provided various judgments as to the required accuracy of noise modeling.

In order to select the tolerance for matching the bootstrap median values to the sample median, the effective tolerances in dB were computed for +/-10 percentile, +/-15 percentile and +/-20 percentile values. The distributions of errors in dB are summarized in Figures C-3, C-4 and C-5 for grid cells with noise levels greater than 60 dB. Figure C-3 shows that, for a +/-10 percentile tolerance, the match to the sample median is achieved within 1-2 dB; further, 50% of the matches are within 1-1.3 dB. Figure C-4 shows that, for a +/-15 percentile tolerance, the match to the sample median is achieved within 1-3 dB, and 50% of the matches are within 1-2.1 dB. Figure C-5 shows that, for a +/-20 percentile tolerance, the match to the sample median is achieved within 2-4 dB, and 50% of the matches are within 2-3 dB. The +/- 15 percentile tolerance was selected because it was less stringent (compared to the +/- 10 percentile tolerance) but did not result in significantly larger errors.

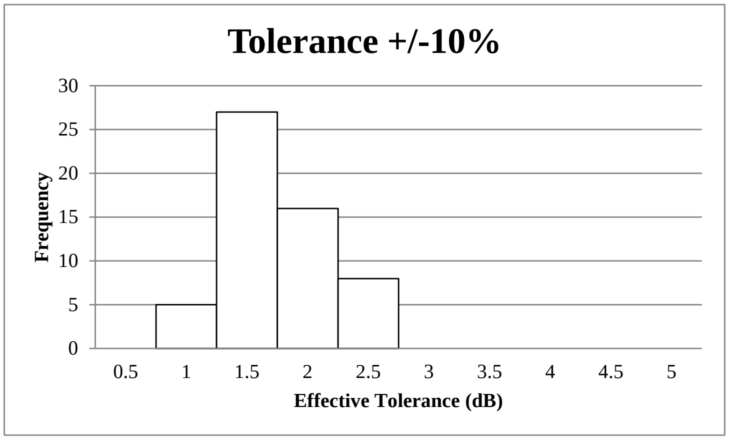

Figure C-3. Distribution of Errors for +/- 10 Percentile Tolerance

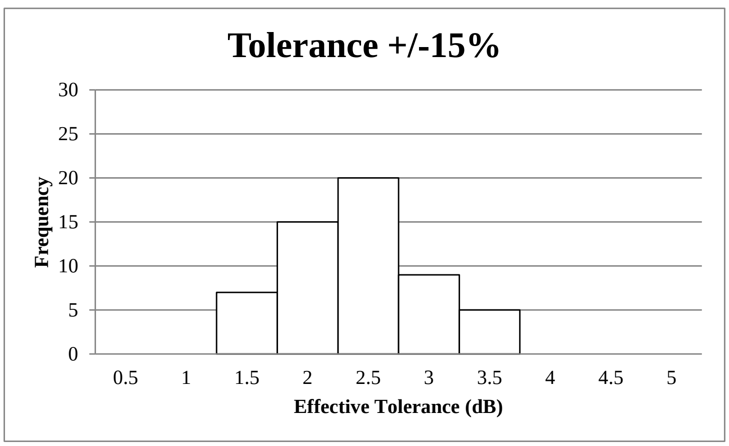

Figure C-4. Distribution of Errors for +/- 15 Percentile Tolerance

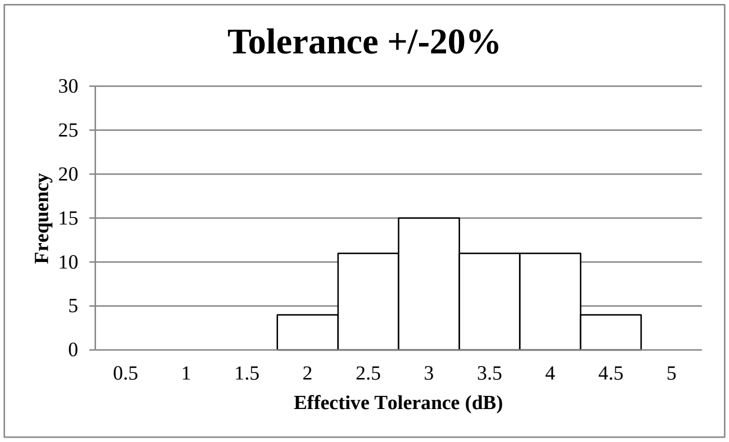

Figure C-5. Distribution of Errors for +/- 20 Percentile Tolerance

C.3 Grid Size Sensitivities

A sensitivity analysis is intended to measure the impact of grid size on the outcome of the AAD analysis. In this case, grid sizes of 1 NM, 2 NM and 4 NM were assessed with respect to the success criteria defined in Section 3.5. This example was completed for IAD and other parameters such as the sampling technique (RS) and the bootstrap tolerance (15%) remained constant.

Figures C-6 through C-8 presents the results of the sensitivity analysis. The success rates are similar with respect to the RS size for all grid sizes. For a RS of 60 days, the grid size of 2 NM tends to perform slightly worse, indicating a lower degree of homogeneity compared to both the 1 NM and 4 NM grid sizes. The level of variability within the grid cell increases as the grid size increases up to a certain point, then decreases; therefore, the most conservative outcome would result from a grid size that is neither too fine nor too coarse.

Another consideration is the number of grid cells to be analyzed. For grid sizes of 1 NM, 2 NM and 4 NM, the numbers of grid cells are 10,000, 2,500 and 625 grid cells, respectively. As a result, the grid size of 2 NM was selected for this analysis as the most stringent in terms of the variability of the noise levels captured within the cells; it is also advantageous in terms of the number of grid cells to be analyzed by minimizing computational requirements.

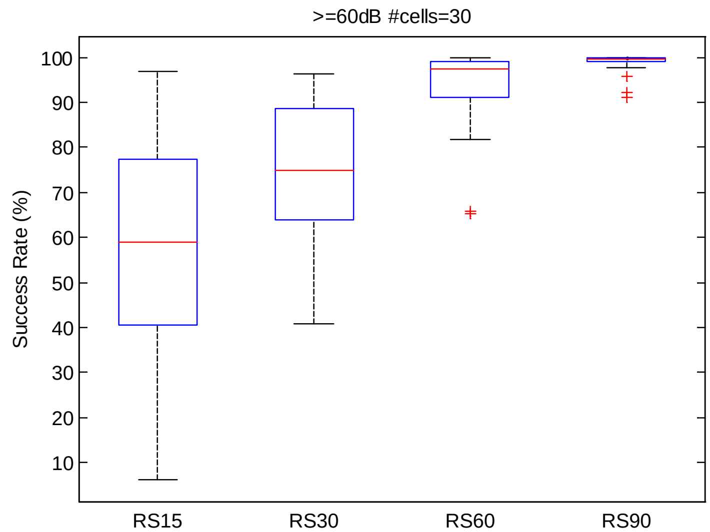

Figure C-6. Success Rate with Grid Size of 1 NM

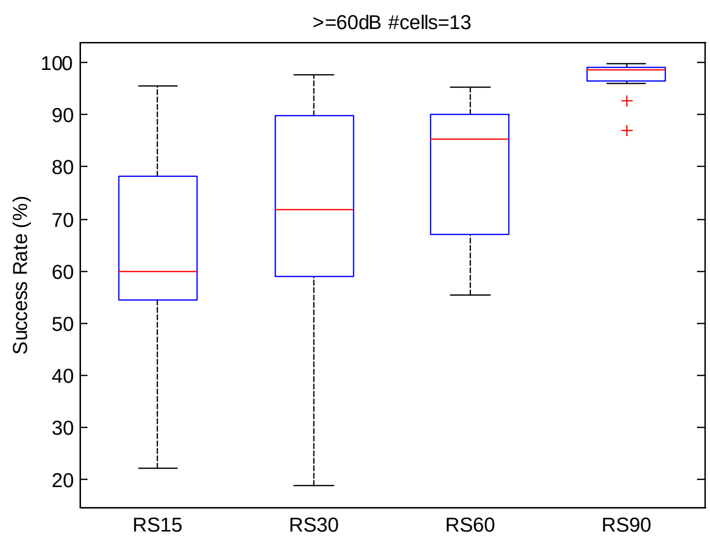

Figure C-7. Success Rate with Grid Size of 2 NM

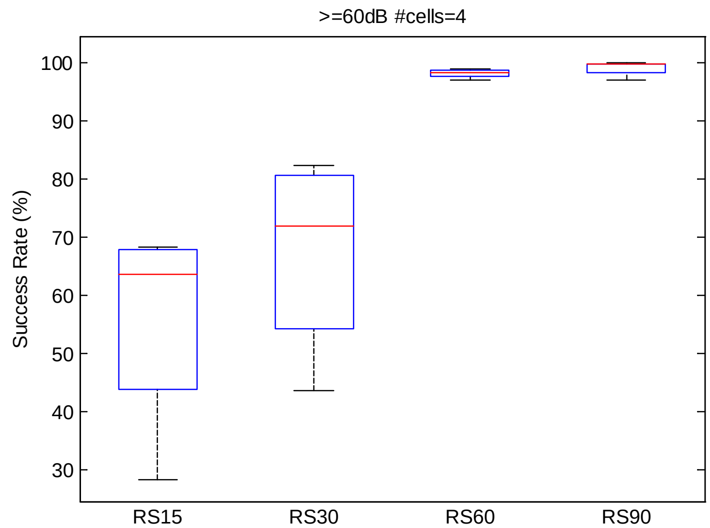

Figure C-8. Success Rate with Grid Size of 4 NM

C.4 Box Plot Definitions

Whiskers – The default whisker length w is 1.5, corresponding to approximately +/–2.7σ and 99.3% coverage if the data are normally distributed. The plotted whisker extends to the adjacent value, which is the most extreme data value that is not an outlier.

Outliers – Points are drawn as outliers if they are larger than $Q_3 + w(Q_3 - Q_1)$ or smaller than $Q_1 - w(Q_3 - Q_1)$, where Q_1 and Q_3 are the 25th and 75th percentiles, respectively.

Appendix D Sample Airport Studies

This section documents the results for all airport studies.

D.1 Repeated Sampling

To ensure that selected RSs perform consistently from one trial to the next, the sampling process was repeated several times to measure the success rate of repeated trials. This test uses data for IAD. Figures D-1 and D-2 show the results focusing on grid cells with noise levels exceeding 60 dB. Grid cells with lower noise levels performed consistently better. For 12 trials using a RS of size 15 days, the success rate varies from 20% to 50% (a spread of 30%). Increasing the RS size to 30 days resulted in more stable success rates between 70% and 85% (a spread of 15%). The results indicate some degree of unpredictability with the smaller RS of 15 days. As a result, a minimum RS of 30 days is suggested for all airports.

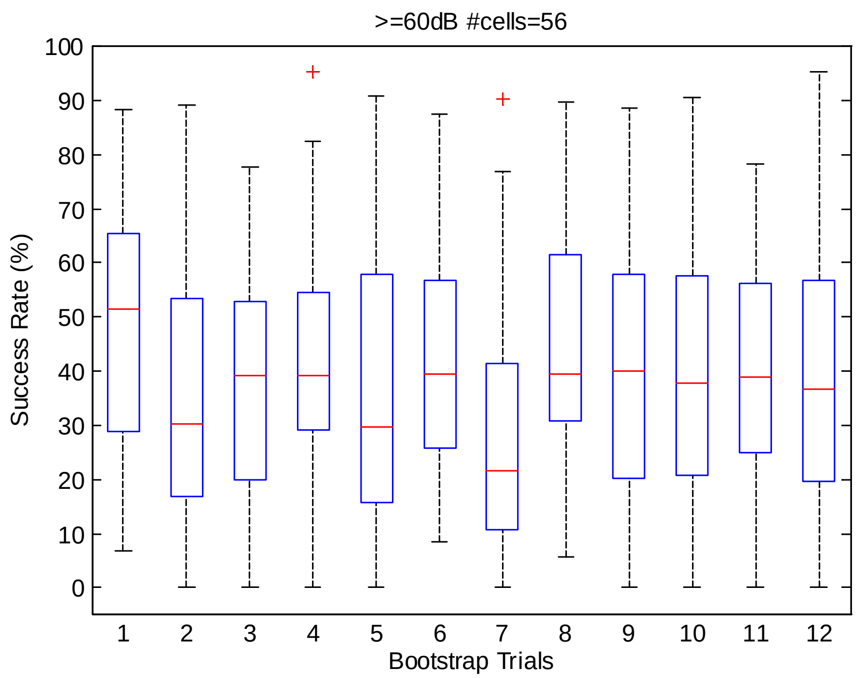

Figure D-1. Repeated Sampling with a RS of 15 Days

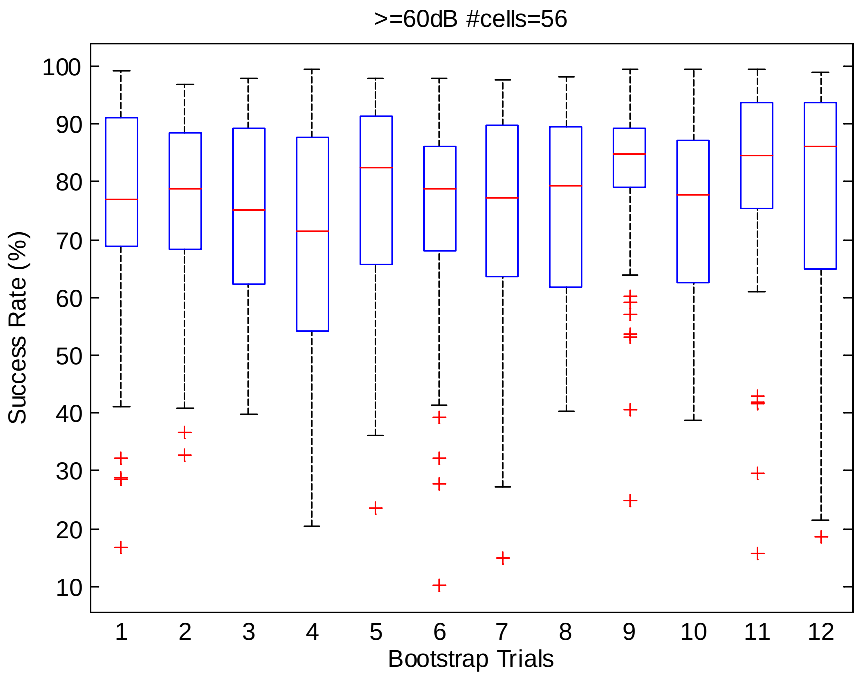

Figure D-2. Repeated Sampling with a RS of 30 Days

D.2 Hartsfield-Jackson Atlanta International Airport (ATL)

Figures D-3 and D-4 are box plots depicting the results for ATL. Figure D-3 shows that the median success rate for a RS of 45 days is more than 90% as shown by the red line on the third boxplot. The interquartile range for a RS of 45 days ranges from approximately 85% to 95%. Further, Figure D-4 shows that for the same RS, the median success rates for grid cells with noise levels above 60 dB is also more than 90%. The interquartile range is from approximately 85% to 95%. Based on the success criteria discussed in Section 3.5, a RS of 45 days would be sufficient to represent an AAD for ATL.

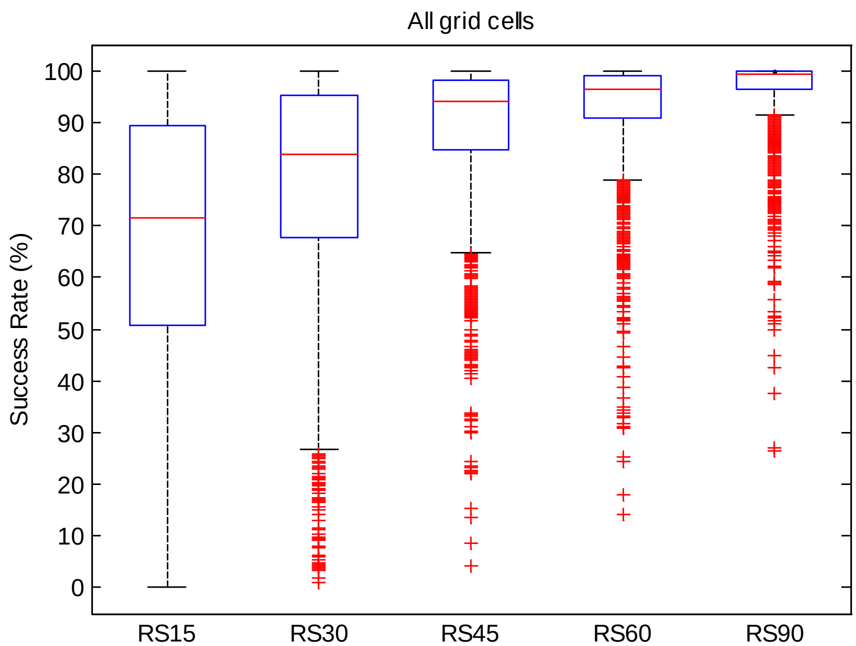

Figure D-3. AAD Analysis for ATL – All Grid Cells

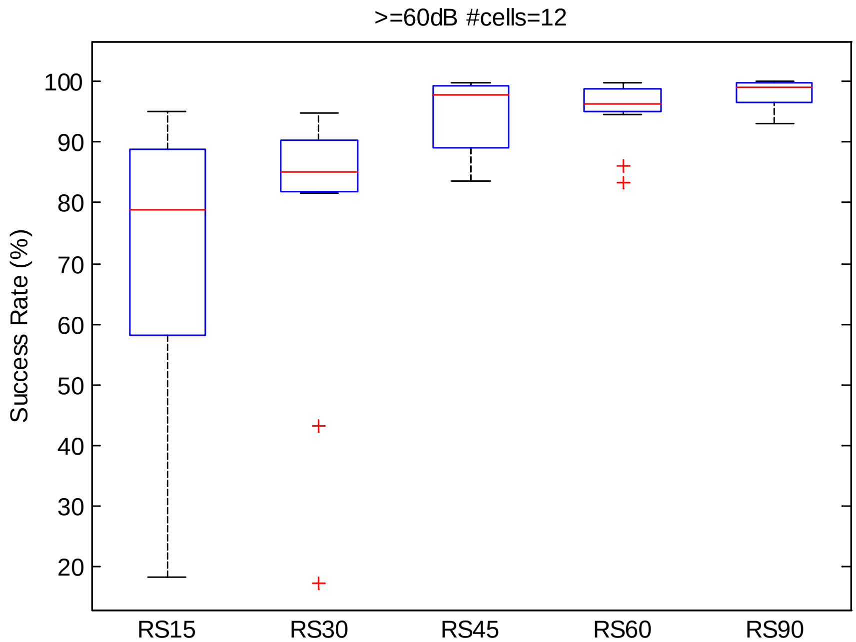

Figure D-4. AAD Analysis for ATL – Grid Cells Greater than 60 dB

D.3 Austin-Bergstrom International Airport (AUS)

Figures D-5 and D-6 are box plots depicting the results for AUS. Figure D-5 shows that the median success rate for a RS of 45 days is more than 90% as shown by the red line on the third boxplot. The interquartile range for a RS of 45 days ranges from approximately 85% to 95%. However, Figure D-6 shows that for grid cells with noise levels above 60 dB, the median success rates reaches 90% for a RS of 60 days. The interquartile range is from approximately 95% to 98%. Based on the success criteria discussed in Section 3.5, a RS of 60 days would be sufficient to represent an AAD for AUS.

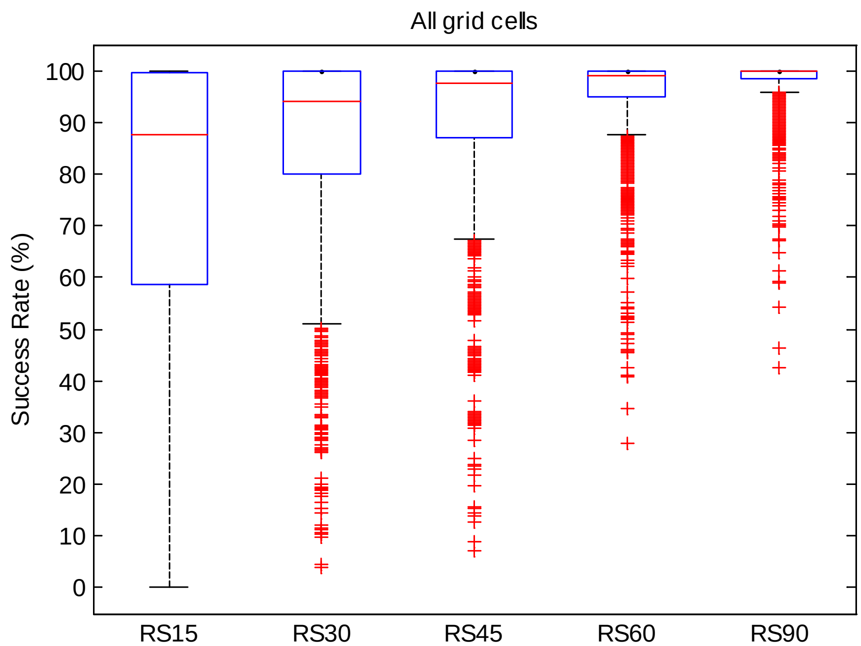

Figure D-5. AAD Analysis for AUS – All Grid Cells

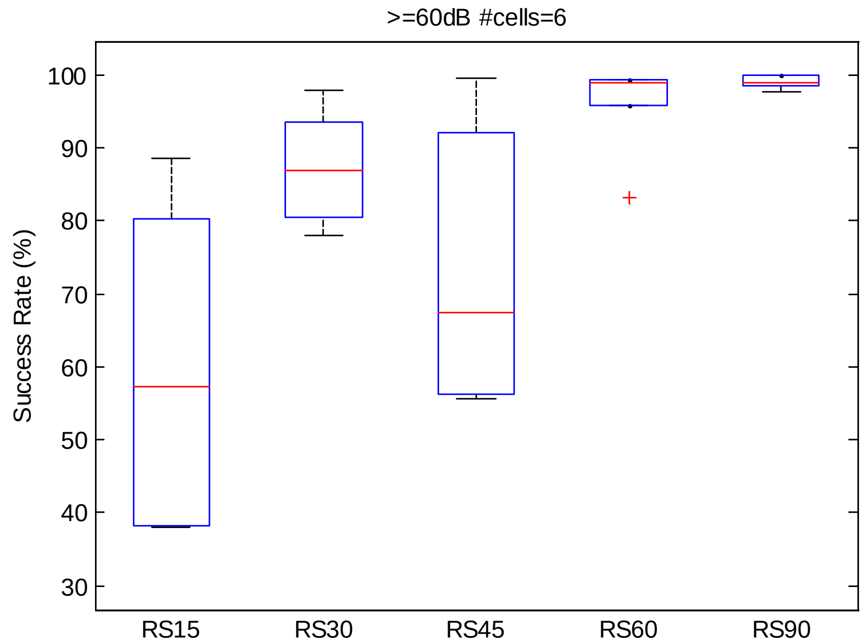

Figure D-6. AAD Analysis for AUS – Grid Cells Greater than 60dB

D.4 Dallas/Fort Worth International Airport (DFW)

Figures D-7 and D-8 are box plots depicting the results for DFW. Figure D-7 shows that the median success rate for a RS of 30 days is approximately 90% as shown by the red line on the second boxplot. The interquartile range for a RS of 30 days ranges from approximately 80% to 95%. However, Figure D-8 shows that for grid cells with noise levels above 60 dB, the median success rates reaches 90% for a RS of 45 days. The interquartile range is from approximately 85% to 95%. Based on the success criteria discussed in Section 3.5, a RS of 45 days would be sufficient to represent an AAD for AUS.

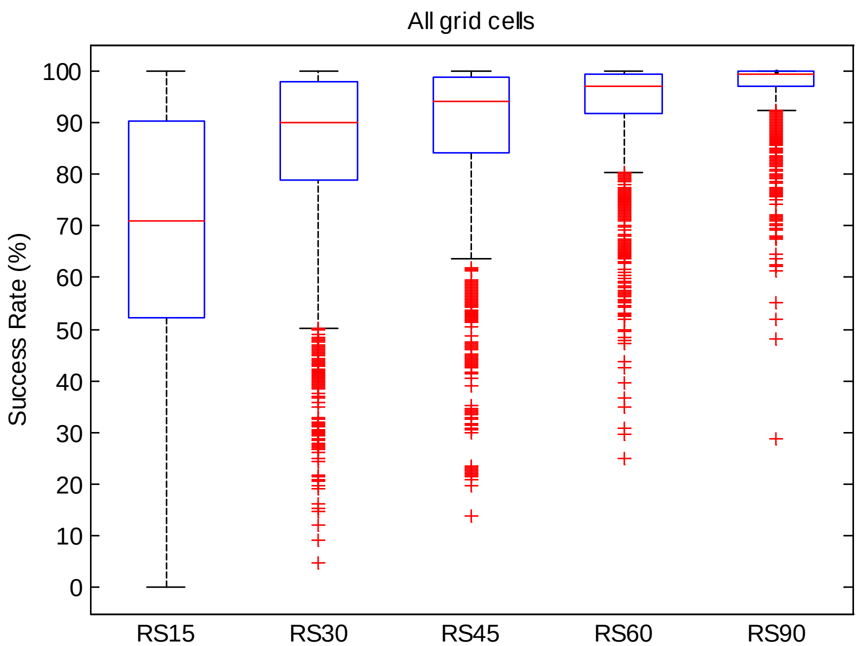

Figure D-7. AAD Analysis for DFW – All Grid Cells

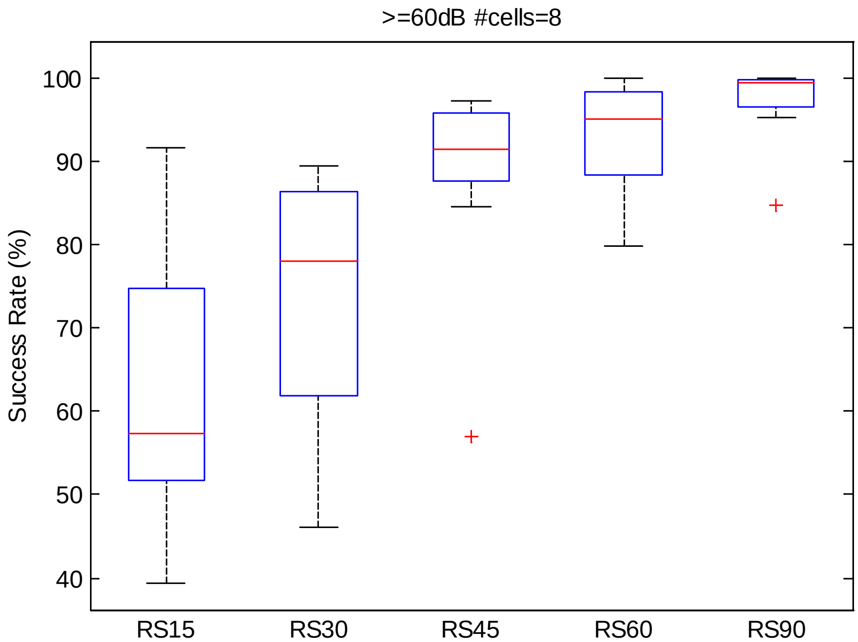

Figure D-8. AAD Analysis for DFW – Grid Cells Greater than 60 dB

D.5 Destin-Fort Walton Beach Airport (DTS)

Figure D-9 shows that the median success rate for a RS of 15 days is more 90% as shown by the red line on the first boxplot. The interquartile range for a RS of 15 days ranges from approximately 90% to 100%. While a RS of 15 days may be adequate based on the success criteria discussed in Section 3.5, a minimum RS of 30 days is recommended for more reliable results.

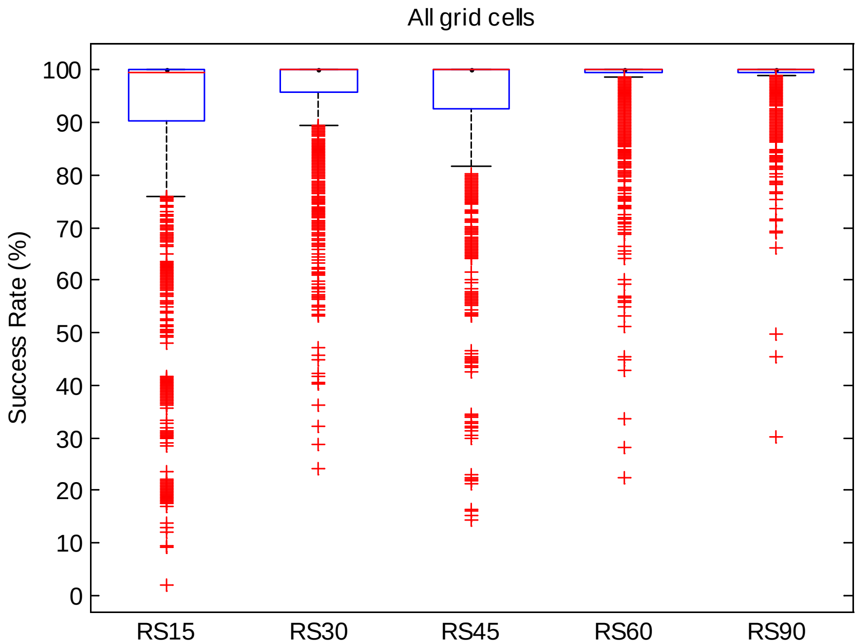

Figure D-9. AAD Analysis for DTS – All Grid Cells

D.6 Ellington International Airport (EFD)

Figure D-10 shows that the median success rate for a RS of 15 days is more 90% as shown by the red line on the first boxplot. The interquartile range for a RS of 15 days ranges from approximately 80% to 100%. While a RS of 15 days may be adequate based on the success criteria discussed in Section 3.5, a minimum RS of 30 days is recommended for more reliable results.

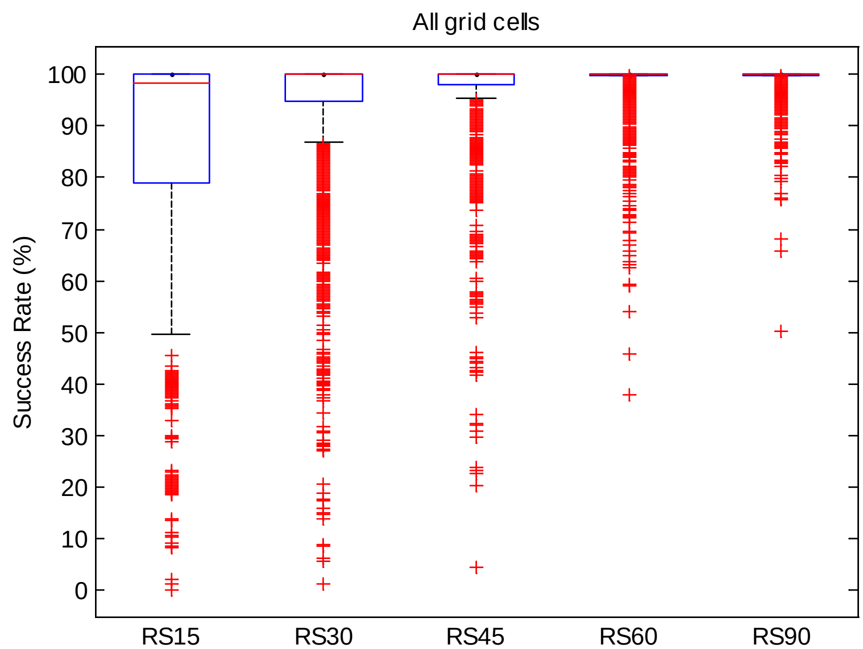

Figure D-10. AAD Analysis for EFD – All Grid Cells

D.7 Henderson Executive Airport (HND)

Figure D-11 shows that the median success rate for a RS of 15 days is more 90% as shown by the red line on the first boxplot. The interquartile range for a RS of 15 days ranges from approximately 80% to 100%. While a RS of 15 days may be adequate based on the success criteria discussed in Section 3.5, a minimum RS of 30 days is recommended for more reliable results.

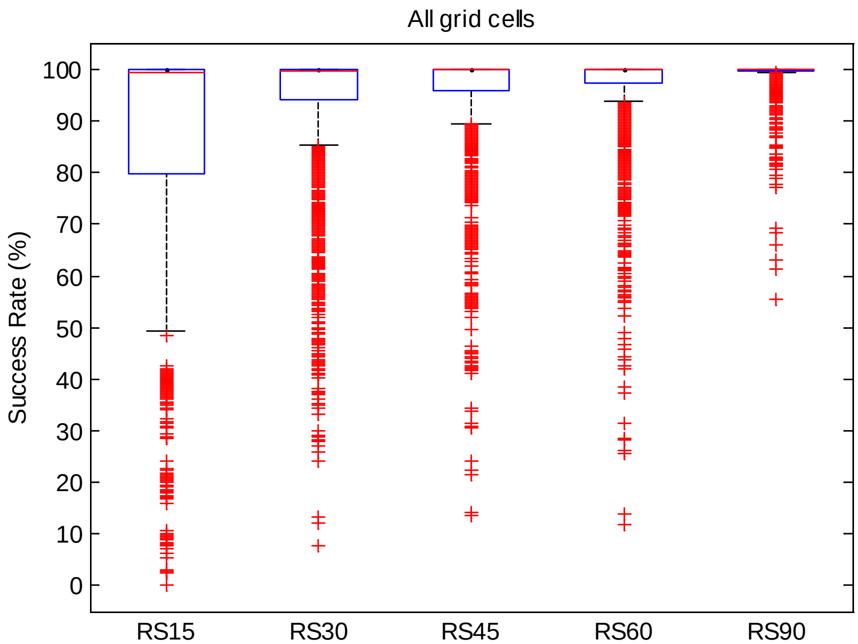

Figure D-11. AAD Analysis for HND – All Grid Cells

D.8 Dulles International Airport (IAD)

Figures D-12 and D-13 are box plots depicting the results for IAD. Figure D-12 shows that the median success rate for a RS of 30 days is approximately 90% as shown by the red line on the second boxplot. The interquartile range for a RS of 30 days ranges from approximately 80% to 100%. However, Figure D-13 shows that for grid cells with noise levels above 60 dB, the median success rates reaches 90% for a RS of slightly more than 60 days. The interquartile range is from approximately 70% to 90%. Based on the success criteria discussed in Section 3.5, a RS of 60 days would be sufficient to represent an AAD for IAD.

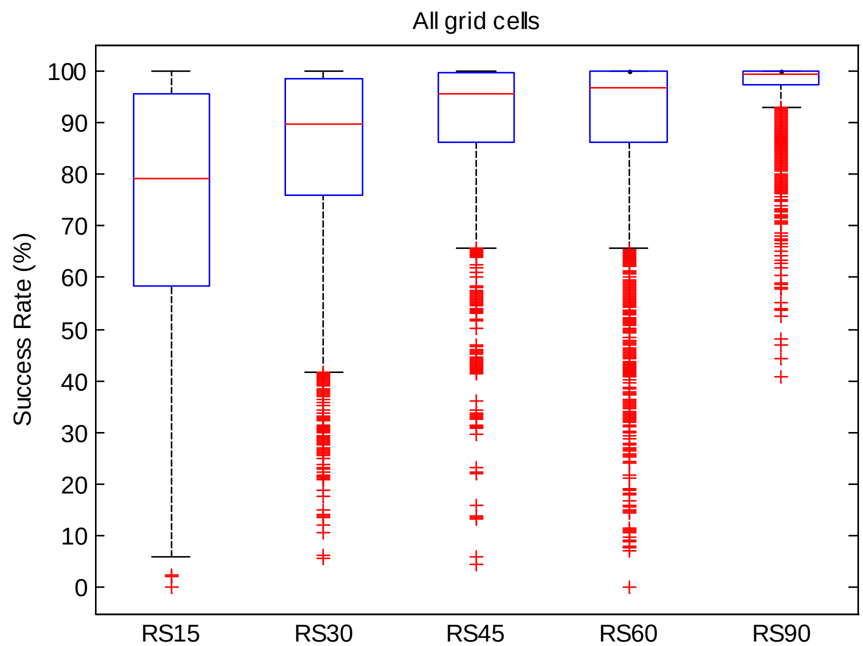

Figure D-12. AAD Analysis for IAD – All Grid Cells

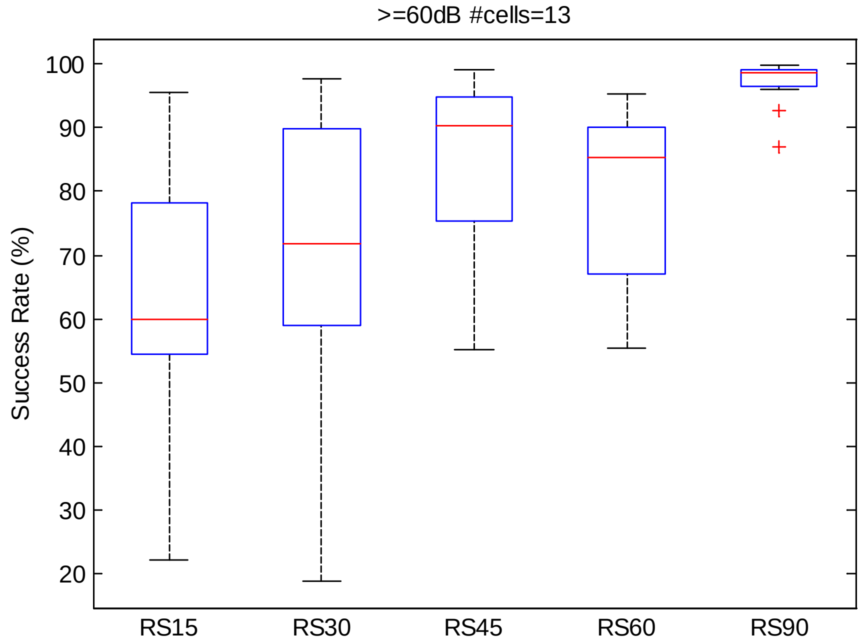

Figure D-13. AAD Analysis for IAD – Grid Cells Greater than 60 dB

D.9 George Bush Intercontinental Airport (IAH)

Figures D-14 and D-15 are box plots depicting the results for IAH. Figure D-14 shows that the median success rate for a RS of 45 days is approximately 90% as shown by the red line on the third boxplot. The interquartile range for a RS of 45 days ranges from approximately 85% to 95%. However, Figure D-15 shows that for grid cells with noise levels above 60 dB, the median success rates reaches 90% for a RS of 60 days. The interquartile range is from approximately 95% to 98%. Based on the success criteria discussed in Section 3.5, a RS of 60 days would be sufficient to represent an AAD for IAD.

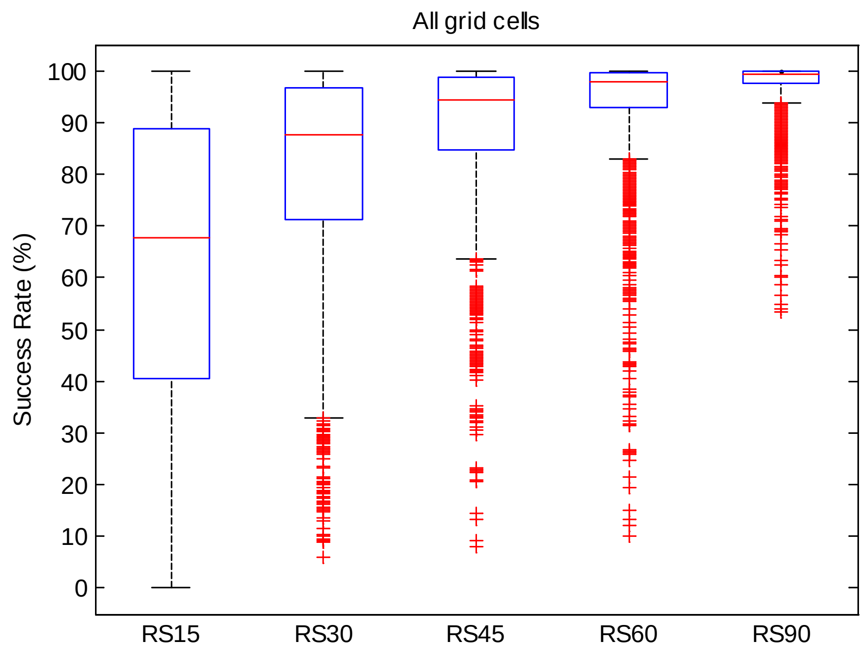

Figure D-14. AAD Analysis for IAH – All Grid Cells

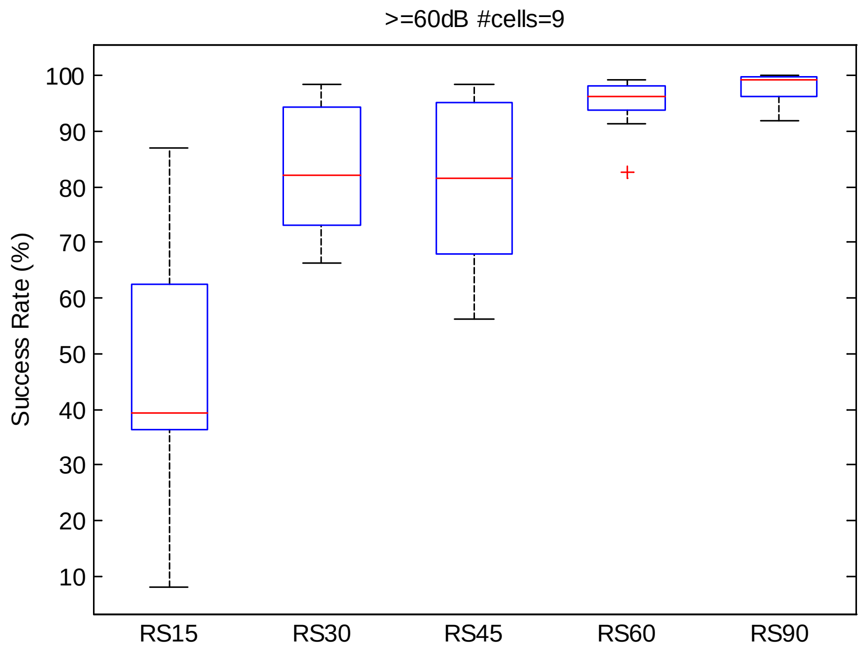

Figure D-15. AAD Analysis for IAH – Grid Cells Greater than 60 dB

D.10 Meridian Regional Airport (MEI)

Figure D-16 shows that the median success rate for a RS of 15 days is more 90% as shown by the red line on the first boxplot. The interquartile range for a RS of 15 days ranges from approximately 90% to 100%. While a RS of 15 days may be adequate based on the success criteria discussed in Section 3.5, a minimum RS of 30 days is recommended for more reliable results.

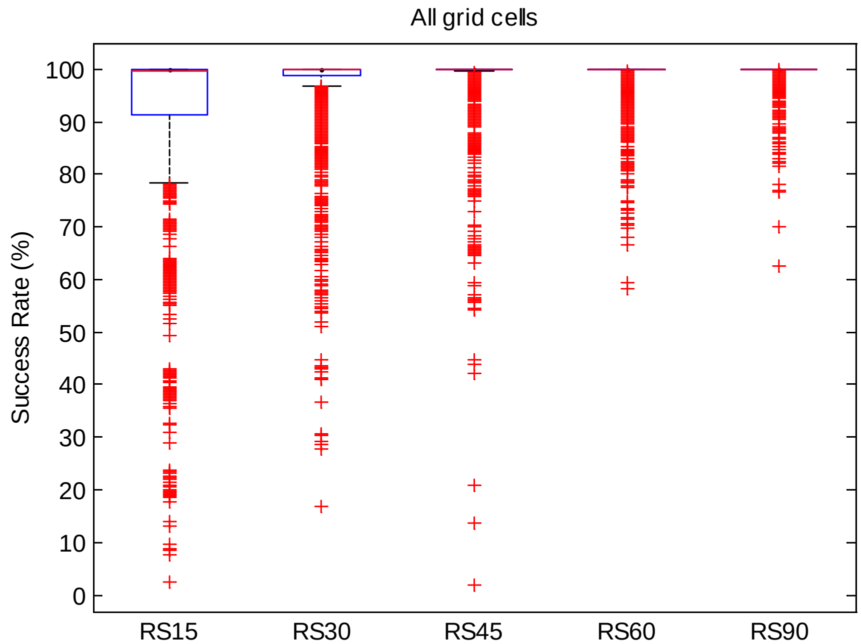

Figure D-16. AAD Analysis for MEI – All Grid Cells

D.11 Chicago O'Hare International Airport (ORD)

Figures D-17 and D-18 are box plots depicting the results for ORD. Figure D-17 shows that the median success rate for a RS of 45 days is approximately 90% as shown by the red line on the third boxplot. The interquartile range for a RS of 45 days ranges from approximately 85% to 95%. However, Figure D-18 shows that for grid cells with noise levels above 60 dB, the median success rates reaches 90% for a RS of 60 days. The interquartile range is from approximately 95% to 98%. Based on the success criteria discussed in Section 3.5, a RS of 60 days would be sufficient to represent an AAD for ORD.

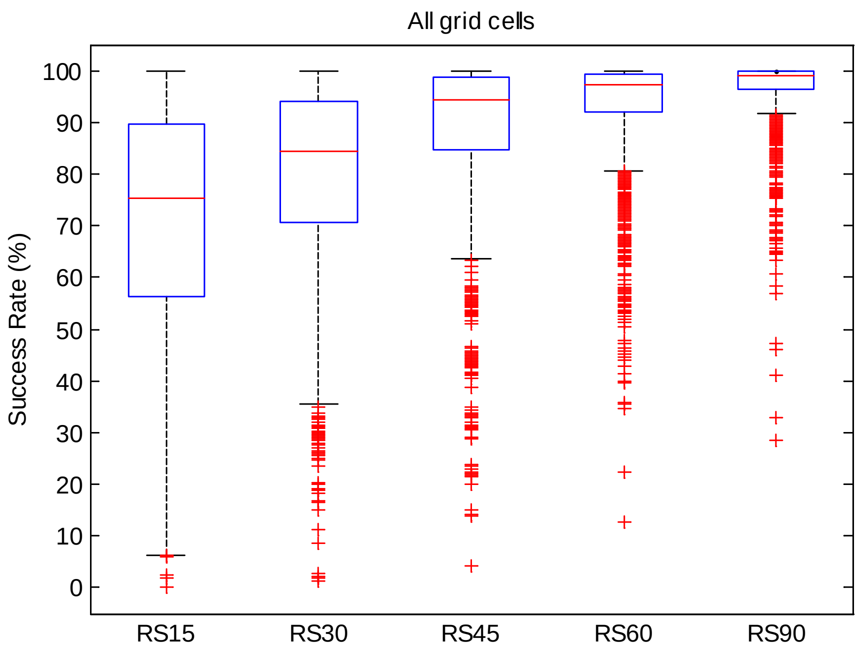

Figure D-17. AAD Analysis for ORD – All Grid Cells

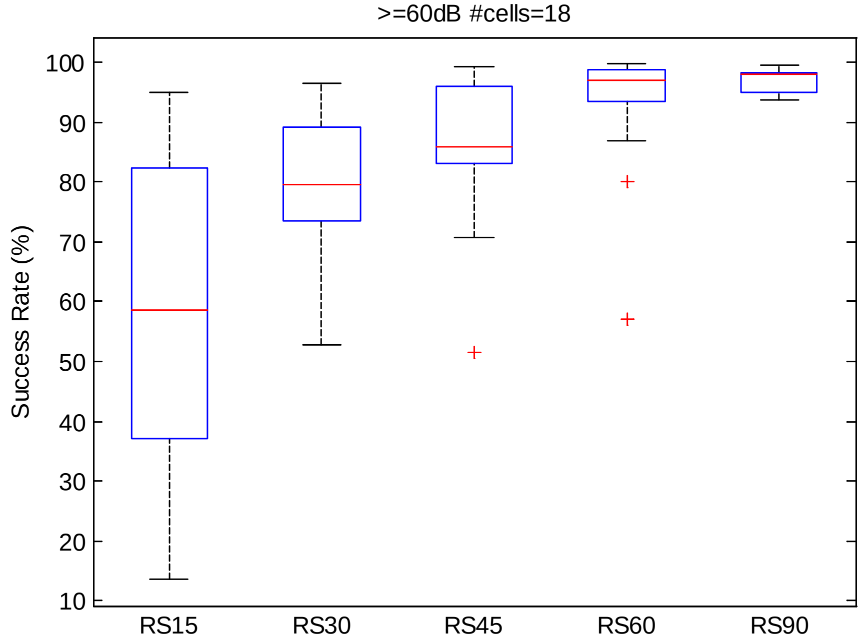

Figure D-18. AAD Analysis for ORD – Grid Cells Greater than 60 dB

D.12 Louisville International Airport (SDF)

Figures D-19 and D-20 are box plots depicting the results for SDF. Figure D-19 shows that the median success rate for a RS of 45 days is approximately 90% as shown by the red line on the third boxplot. The interquartile range for a RS of 45 days ranges from approximately 85% to 95%. Figure D-20 confirms that for grid cells with noise levels above 60 dB, the median success rate is also 90% for a RS of 45 days. The interquartile range is from approximately 90% to 95%. Based on the success criteria discussed in Section 3.5, a RS of 45 days would be sufficient to represent an AAD for SDF.

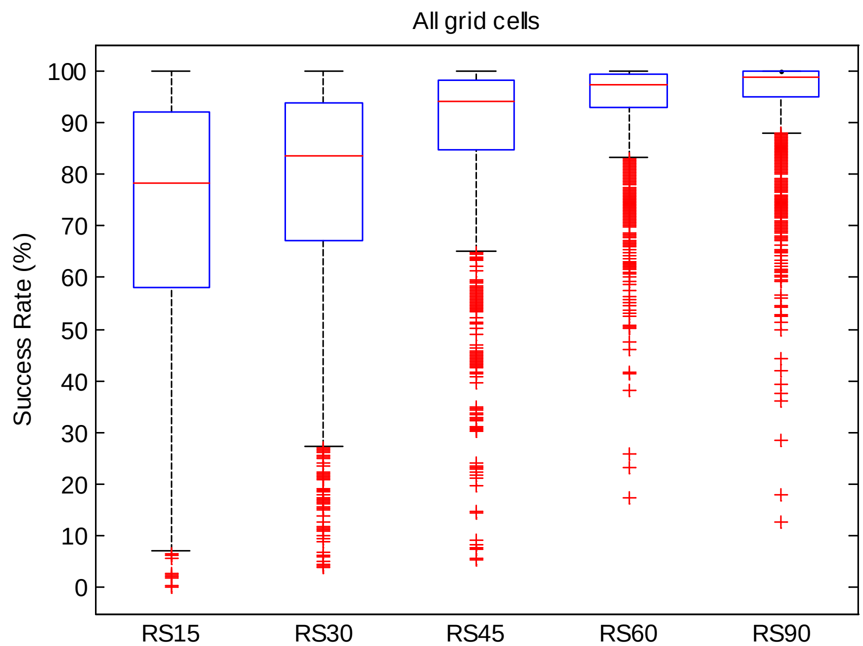

Figure D-19. AAD Analysis for SDF – All Grid Cells

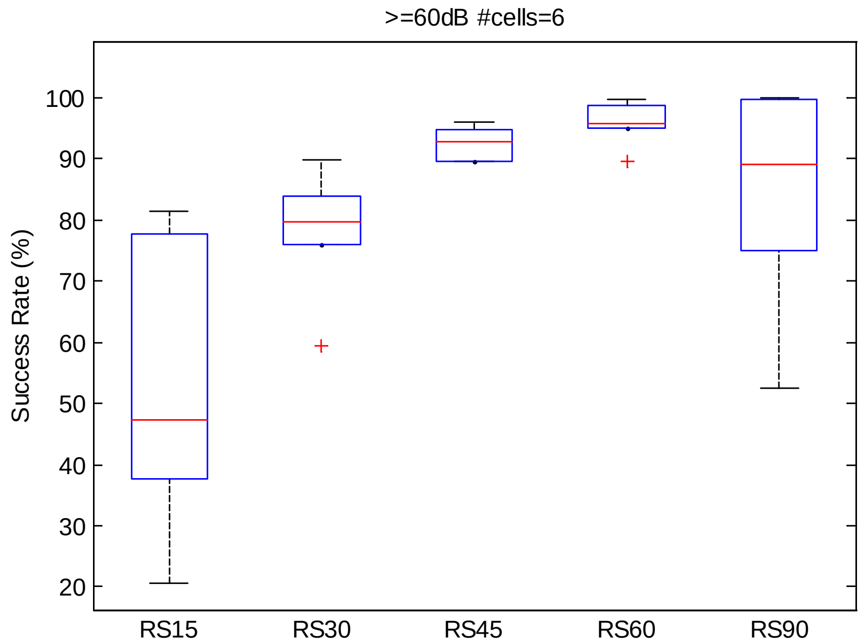

Figure D-20. AAD Analysis for SDF – Grid Cells Greater than 60 dB

D.13 San Angelo Regional Airport (SJT)

Figure D-21 shows that the median success rate for a RS of 15 days is more 90% as shown by the red line on the first boxplot. The interquartile range for a RS of 15 days ranges from approximately 95% to 100%. While a RS of 15 days may be adequate based on the success criteria discussed in Section 3.5, a minimum RS of 30 days is recommended for more reliable results.

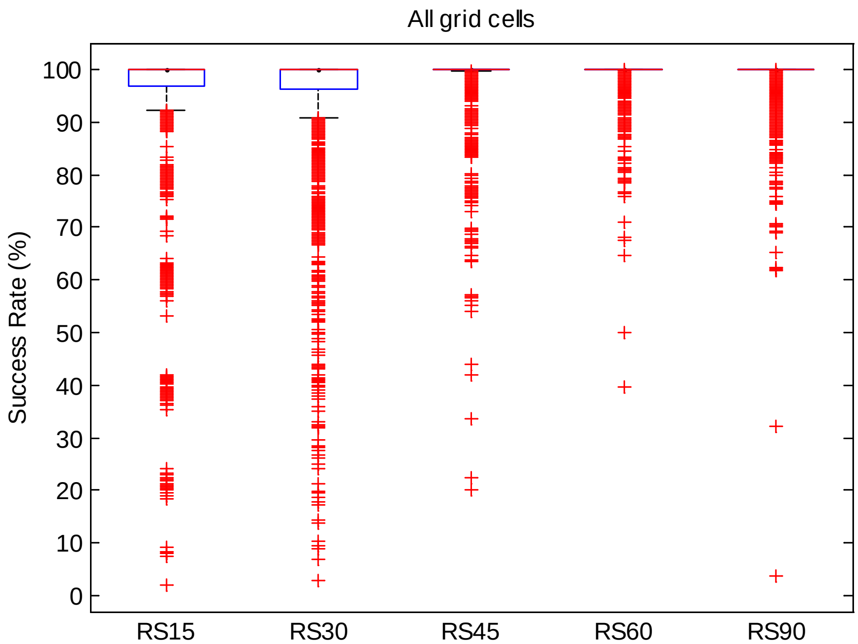

Figure D-21. AAD Analysis for SJT – All Grid Cells

D.14 Subsample Size by Airport

This section summarizes the subsample size by cluster for the various airports analyzed. Airports with strong seasonal tendencies (e.g., air shows, summer only operations, etc.) would require specific considerations in determining the dates of radar track data required for an AAD.

Table D-1. Subsample Size by Airport

Cluster	Airport Three-Digit Code	RS
1	BNA, BOS, BWI, CLE, CLT, CVG, DAL, DCA, DEN, DTW, EFD, EWR, FLL, HNL, HOU, IAD, IAH, IND, JFK, LAS, LAX, LGA, MCI, MCO, MDW, MEM, MIA, MKE, MSP, OAK, PDX, PHL, PHX, PIT, RDU, RNO, SEA, SFO, SJC, SLC, STL, TPA	60 days (30 days for small airports with one/two dominant configurations)
2	ACT, ASE, AUS, BFM, DHN, FAY, FCM, FMY, FPR, FTW, GCC, GEG, GFK, GMU, GTF, HLN, ISP, LIT, MAF, MEI, MKC, MYF, NDZ, NFW, NUW, NYL, OCF, PAE, PBI, PSC, PUB, SGJ, SJT, SLN, SUA, TXK, TYR	60 days (30 days for small airports with one/two dominant configurations)
3	ATL, DFW, ORD	45, 60, 45 days
4	AAO, ABE, ABI, ABQ, ABY, ACK, ACV, ACY, ADS, ADW, AED, AEN, AEX, AFA, AFW, AGC, AGS, ALB, AMA, ANC, ANE, APA, APC, APF, ATW, AVL, AVP, AZO, BAD, BCT, BDL, BED, BFI, BFL, BGR, BHM, BIL, BIS, BJC, BKL, BLI, BMI, BOI, BRO, BTR, BTV, BUF, BUR, BZN, CAE, CAK, CBM, CHA, CHO, CHS, CID, CLL, CMA, CMH, CMI, CNO, COS, CPR, CPS, CRE, CRG, CRP, CRQ, CRW, CSG, CWA, CWF, CYS, DAB, DAY, DBQ, DDC, DLF, DLH, DMA, DOV, DPA, DRO, DSM, DTN, DTO, DTS, DVT, DWH, EAU, ECP, EGE, ELM, ELP, END, ERI, EUG, EVV, EWN, EYW, FAR, FAT, FLG, FLO, FMN, FNT, FRG, FSD, FSM, FTY, FWA, FXE, GAI, GCK, GGG, GJT, GNV, GPI, GPT, GRB, GRK, GRR, GSB, GSN, GSO, GSP, GTU, GUM, HDN, HEF, HIO, HKO, HLI, HMK, HND, HOG, HPN, HRL, HSV, HTO, HWD, HXD, HYA, ICT, IDA, ILG, ILM, INT, ISM, IST, ITH, IWA, IXD, JAC, JAN, JAX, JKA, JQF, JSJ, JWN, JYO, JZI, LAL, LAN, LBB, LCH, LCK, LEX, LFT, LGB, LMT, LNK, LRD, LRF, LSE, LTS, LUK, LYH, LZU, MBS, MDT, MFE, MFR, MGM, MHR, MHT, MLB, MLI, MLU, MMU, MOB, MOT, MQY, MRY, MSN, MSO, MSY, MTH, MTJ, MTN, MWH, MYR, NCA, NEW, NGP, NGU, NIP, NKT, NKX, NLC, NMM, NPA, NQI, NQX, NSE, NZY, OAJ, OKC, OMA, ONT, OPF, ORF, ORL, OSU, OWD, PDK, PGD, PHF, PIA, PIE, PMD, PNE, PNS, POB, PSM, PSP, PTK, PVD, PWA, PWK, PWM, RAP, RDD, RDM, RFD, RIC, RKS, RND, ROA, ROC, ROG, ROW, RST, RSW, RVS, RYY, SAC, SAF, SAN, SAT, SAV, SBA, SBN, SBP, SDF, SDL, SFB, SGF, SGR, SHV, SKF, SMF, SMO, SMX, SNA, SPI, SPS, SRQ, SSC, SSI, STP, STS, SUN, SUS, SUU, SWF, SYR, TCL, TEB, TEX, TIK, TLH, TMB, TOL, TRI, TRM, TTN, TUL, TUS, TVC, TWF, TYS, UDD, UGN, UNV, VGT, VIS, VNY, VPS, VRB, WRI, XNA, YIP, YKM	45 days (30 days for small airports with one/two dominant configurations)

Appendix E Acronym List

AAD	Average Annual Day
AGL	Above Ground Level
ASDE-X	Airport Surface Detection Equipment, Model X
ATL	Hartsfield-Jackson Atlanta International Airport
ATO	Air Traffic Organization
AUS	Austin-Bergstrom International Airport
CAASD	Center for Advanced Aviation System Development
CEQ	Council on Environmental Quality
CS	Constrained Subsample
CY	Calendar Year
dB	Decibel
DFW	Dallas/Fort Worth International Airport
DNL	Average Day-Night Sound Level
DTS	Destin-Fort Walton Beach Airport
EFD	Ellington International Airport
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
HND	Henderson Executive Airport
IAD	Dulles International Airport
IAH	George Bush Intercontinental Airport
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
IFR	Instrument Flight Rule
INM	Integrated Noise Model Version 7.0c
MEI	Meridian Regional Airport
NAS	National Airspace System
NEPA	National Environmental Policy Act
NFDC	National Flight Data Center
NM	Nautical Mile

NOP	National Offload Program
NPD	Noise-Power-Distance
ORD	Chicago O’Hare International Airport
PC	Principal Component
PCA	Principal Component Analysis
RS	Random Subsample
SDF	Louisville International Airport
SEL	Sound Exposure Level
SJT	San Angelo Regional Airport
TARGETS	Terminal Area Route Generation Evaluation and Traffic Simulation