ACRP

Web-Only Document 14:

Guidelines for Preparing Peak Period and Operational Profiles

Patrick Kennon
HNTB
Arlington, VA

In association with

Robert Hazel
Eric Ford
Oliver Wyman
Reston, VA

Belinda Hargrove
TransSolutions, LLC
Fort Worth, TX

Contractor's Final Report for ACRP 03-12
Submitted July 2012

Airport Cooperative Research Program
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

ACKNOWLEDGMENT

This work was sponsored by the Federal Aviation Administration (FAA). It was conducted through the Airport Cooperative Research Program, which is administered by the Transportation Research Board (TRB) of the National Academies.

TABLE OF CONTENTS

LIST OF EXHIBITS

LIST OF APPENDICES

CHAPTER ONE - INTRODUCTION

This report summarizes the findings of the ACRP 03-12: Guidelines for Preparing Peak Period and Operational Profiles effort. The study involved a detailed analysis of the factors affecting peak period activity levels and the distribution of airport passengers and operations within a daily operational profile. The ultimate results of these analyses are the Guidebook and associated software (Toolbox) (published as *ACRP Report 82: Preparing Peak Period and Operational Profiles—Guidebook* and the accompanying CRP-CD-126: *Guidebook and Toolboxes for ACRP Report 82*).

The intent of this study is to help airport planners modify annual aviation forecasts for use in facility planning or environmental analysis. Aviation forecasting is often quite technical, with subtleties that may not be as apparent to an airport planning professional as they are to a forecasting specialist. This effort is designed to bridge that technical gap, to provide a clear and defined process to follow, and to provide insight on key areas often overlooked when preparing peak period and operational profiles. Using the Guidebook and Toolbox does not require extensive forecasting experience, but some familiarity with airports and the airport planning process is assumed.

The Guidebook and Toolbox demonstrate how to quickly convert annual airport activity forecasts into forecasts of daily or hourly peak period activity. Annual forecasts of airport activity, whether measured by passengers or aircraft takeoffs and landings (operations), are widely available from the Federal Aviation Administration (FAA) and other sources. The planning and environmental evaluation of most airport facilities, however, is based on a shorter interval of time such as a representative busy day, often referred to as a *design day*, or a briefer (peak) period. These design day and peak period forecasts are not usually available.

In addition, most airport facility planning in the United States is based on the peak hour of the average day in the peak month (ADPM). Often, a single measure of peaking is insufficient to address all facility planning or environmental requirements. For example, some facilities may need to operate at an acceptable level of service 98 percent of the time while others may only need to operate at an acceptable level of service 90 percent of the time. The appropriate peak period (defined time interval) for some facilities such as security screening, may differ from other facilities, such as Customs and Border Protection. Also, some airport functions, such as ticketing, may peak at different times than other functions, such as baggage claim.

The Guidebook and Toolbox are designed to address these concerns by providing methods of converting current or forecast measures of annual passenger and aircraft activity into *peak period* estimates and *operational profiles* quickly and consistently, and to provide the level of detail appropriate for specific airport facilities and environmental issues.

1.1. Definitions

A *peak period* is an interval of time, often defined as 60 minutes, that represents the typical busy flow of passengers or aircraft operations that must be accommodated by a given airport facility. A peak period is defined with the intention of striking a balance between providing capacity at an acceptable service level for most of the time and avoiding the cost of building for the single busiest time of the year.

An *operational profile* represents the distribution of arriving and departing passengers or aircraft operations by time of day during a selected day. There are three main types of operational profiles: design day profiles, design day flight schedules, and day/night splits. Design day profiles organize passengers or aircraft operations by time of day in increments of an hour or less. Design day flight schedules are similar to design day profiles except that they are developed in greater detail so that each individual flight during the day is represented. Design day profiles and schedules are often calculated as an intermediate step when estimating peak periods. Day/night splits are used for noise analysis, and divide aircraft operations into daytime operations and nighttime operations, when people are more sensitive to noise.

Both peak period estimates and operational profiles are contingent on the selection of a *design day*. The definition of the design day depends on the purpose of the analysis. For most planning, the purpose of the design day is similar to the purpose of the peak period; it is intended to represent a busy day that characterizes the ability of the facility to provide adequate capacity most of the year while avoiding the cost of building for the single busiest day of the year. For much environmental analysis, the design day is defined as an average annual day, to represent environmental impacts that are typical for the year.

1.2. Background

The impetus for the study was a recommendation from industry experts in 2007 through the Airport Cooperative Research Program (ACRP) of the Transportation Research Board (TRB), a division of the National Academies. As stated in the Request for Proposals (RFP) the charge was to "prepare a guidebook enabling airport operators to define more effectively airport peak period and operational profiles necessary for facility and environmental planning."

A panel consisting of public and private sector industry experts (the Panel) was formed to guide the project (designated ACRP 03-12). TRB issued a request for proposals in the fall of 2007. In March of 2008, the Panel selected HNTB Corporation, along with the Oliver Wyman Group and TransSolutions, LLC as subconsultants to conduct the research and prepare a Guidebook and Toolbox. Work commenced in the fall of 2008.

The Research Team was supported by an in-house user validation group. The user validation group includes all the major user groups – environmental, airfield, terminal, and landside. The mission of the validation group was to ensure that the Guidebook and Toolbox results will be practical for intended users.

1.3. Benefits

The intended benefits of the Guidebook and Toolbox include efficiency, accuracy, consistency, and flexibility.

Estimates of peak period activity and operational profiles determine the size and design of most airport facilities. These plans and designs in turn lead to the financing and construction of projects ranging up to $1 billion or more in cost. The environmental impacts of these projects can potentially affect large numbers of people; operational profiles are used to assess these impacts and to identify potential mitigation measures. There is, therefore, a compelling need to accurately project peak period activity and operational profiles.

Forecasts of annual activity are available for most airports, in particular from the FAA's Terminal Area Forecasts (TAFs), which are updated annually for all commercial airports. There is no similar source for operational profiles or peak period estimates. The main objective of the Guidebook and Toolbox is to standardize and advance the conversion of annual activity forecasts to forecasts of peak period activity and operational profiles to help fill this gap.

The standardization and automation of many of the processes, along with the listing of data sources and default factors should lead to more rapid and efficient calculation of peak period estimates and operation profiles. Avoiding "reinventing of the wheel" with each analysis, allows more resources to be devoted to the unique aspects of the planning or environmental issue being addressed.

Once a process for defining and estimating alternative definitions of peak periods using Guidebook and Toolbox is established, sensitivity tests can be performed. This is useful if a range of trade-offs between service level and size/cost for a given facility needs to be evaluated.

The Guidebook and Toolbox are intended to serve airport planning staff, consultants, and other interested participants. Planning and environmental questions come in many forms. Some questions require an immediate, yet informed response; others allow for more detailed research and analysis. These tools are therefore designed to offer a range of analytical options – the selection of which would depend on the time, information, and resources available to the practitioner.

The approaches in the Guidebook and Toolbox are intended to be guidelines, not requirements. In the field of forecasting there is no single right answer. There is always opportunity for improvement. In addition, the variety of planning issues and data needs is too great to be fully encompassed by any guidebook or software package. Also, some airport planning issues are too complex to be fully addressed by the Guidebook or Toolbox. Chapter 3 of the Guidebook provides guidance on the appropriate tools to use in those instances.

1.4. Complements to Other ACRP Research

Although both the Guidebook and this document include many default factors, input data obtained from primary surveys will provide more accurate results. Two noteworthy documents that can assist in these survey efforts include the *Airport Passenger-Related Processing Rates Guidebook* (ACRP 03-02) *(1)* and the *Guidebook for Airport-User Survey Methodology* (ACRP 03-04) *(2)*.

Likewise, estimates prepared using the Guidebook and Toolbox can be incorporated with other ACRP planning guidance. Of note is the recently published *Spreadsheet Models for Airport Terminal Planning and Design* (ACRP 07-04) *(3).*

1.5. Organization of Report

This report is organized into eight chapters including this introduction.

Chapter 2 describes the relationship between annual forecasts and peak period estimates and the various types of operational profiles in more detail. The chapter also provides some key definitions.

Chapter 3 describes the ACRP 03-12 study effort, including the initial research and interviews, airport and airline data collection, Guidebook and Toolbox development, and validation and review.

Chapter 4 summarizes current practices as identified in the literature review and interviews.

Chapter 5 provides an overview of the research findings from this study with special emphasis on the results of the airport surveys and the airline data collection effort.

Chapter 6 provides documentation and additional background on the organization of the Guidebook and Toolbox.

Chapter 7 summarizes the validation of the Guidebook and Toolbox.

Chapter 8 concludes with a suggested implementation program and recommendations for future research.

In addition, there are nineteen appendixes that provide more detail and analysis.

This report is intended to be a complement to the Guidebook; however, some concepts are repeated in both documents to minimize the need to shift repeatedly between the two reports.

CHAPTER TWO: BACKGROUND AND KEY DEFINITIONS

This chapter provides definitions of key terms and a brief overview of the relationships between annual forecasts, design day, design day profile, design schedule, day/night profile, and peak period forecasts, and airport facility and environmental planning.

2.1. Annual Forecasts of Activity

When evaluating current conditions, direct measures of passenger boarding activity are generally not available in increments of less than one month. In addition, airport forecasts are often only prepared on an annual basis. Therefore, peak period estimates and operational profiles are usually necessarily derived from annual activity.

2.1.1. Definitions of Activity

Prior to discussing the relationship between annual forecasts, peak period estimates, and operational profiles it is useful to define major airport activity categories:

- Each time a person boards an aircraft, he or she is counted as a **passenger enplanement**.
- Each a person disembarks, they are counted as a **passenger deplanement.**
- Passengers who begin the air portion of their trip at an airport are counted as an **originating passenger** at that airport.
- Passengers who end the air portion of their trip at an airport are counted as a **terminating passenger**.
- Combined originating and terminating passengers are often referred to as **O&D passengers**.
- A passenger who transfers from one aircraft to another is counted as a **connecting passenger**.
- **Air cargo** includes **air freight** and **air mail**. As a practical matter, the distinction between the two is becoming increasingly blurred and many carriers are ceasing to distinguish between the two.
- Each aircraft takeoff is counted as an **aircraft operation** and each aircraft landing is counted as an **aircraft operation.**

2.1.2. Forecasting Annual Activity

Approaches to forecasting annual activity are discussed in more detail in Chapter 2 of the Guidebook. Useful guidance on forecast approaches can also be found in the following documents:

- FAA*, Airport Master Plans, Advisory Circular No: 150/5070-6B*. (4)
- De Neufville, R. and A. Odoni, *Airport Systems: Planning, Design and Management* (5)
- GRA, Inc. for FAA, *Forecasting Aviation Activity by Airport* (6)
- TRB, *Aviation Demand Forecasting: A Survey of Methodologies, E-Circular No. E-C040* (7)
- William Spitz and Richard Golaszewski, GRA for TRB, *Airport Aviation Activity Forecasting: A Synthesis of Airport Practice* (8)
- ICAO*, Airport Planning Manual, Doc 9184-AN/902 Part 1, International Civil Aviation Organization* (9)

2.1.3. Application of Annual Forecasts to Operational Profiles and Peak Period Forecasts

Planners are often asked to prepare an annual forecast prior to or along with the peak period estimate or operational profile, or are directed to use a specific annual forecast as a starting point. In some instances, the choice of which annual forecast to use is left to the planner. If more than one forecast is available, the key selection factors are anticipated accuracy and level of detail. Relevant factors are the level of effort devoted to the forecast, the amount of scrutiny and review to which it was exposed, how recently it was prepared, and how well it tracks current activity and recent trends.

The amount of detail available in the annual forecast is also important. Specifically, a fleet mix forecast is required to prepare day/night splits or design day flight schedules. Some of the types of annual forecasts typically available include master plans, system plans, and the FAA's TAF.

Note that design day, operational profiles, and peak period estimates can be calculated for existing conditions as well as future conditions. In many instances, existing measures of design day or peak period activity are needed to estimate current facility requirements, calibrate planning factors, or identify current environmental impacts. The relationships described below and described more fully in the Guidebook apply to both current and forecast conditions. Measures of base year or forecast annual passengers and operations provide the foundation for estimating design day activity, which in turn provides the basis for estimating operational profiles and peak period activity levels. These elements are described in more detail below.

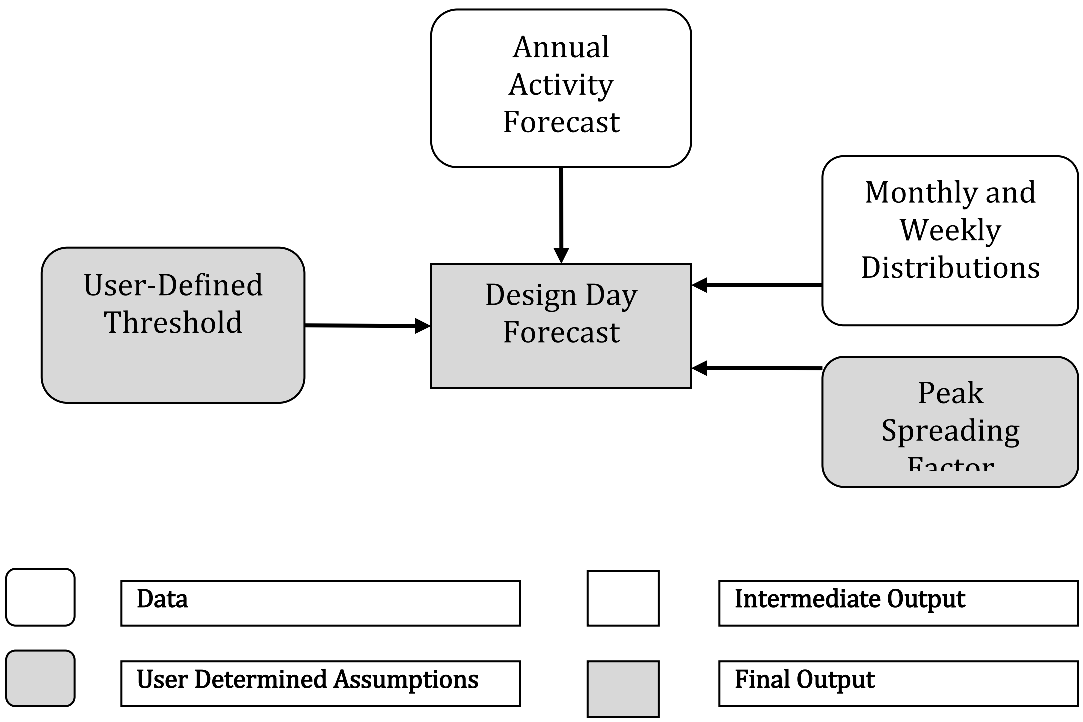
2.2. Design Day

The design day activity level is the level that airport planners use in sizing facilities and typically represents the level of activity that can be accommodated with an acceptable level of service. The intent is to strike a balance between under-designing, in which case the facility in question would perform at substandard levels of service too often in the view of airport stakeholders, and over-designing, in which case the cost of the facility, again in the opinion of the airport stakeholders, would be too high to justify the percentage of time during which the facility performs at or above an acceptable level of service. Design day passengers are the total number of passengers during the design day, and design day operations are the total number of aircraft operations during the design day.

The design day is derived from annual activity following the process in **Exhibit 2.1**.

Exhibit 2.1

Relationship between Annual Activity Forecasts and Design Day Forecasts



The following definitions apply to the exhibit:

Monthly and weekly distributions represent the distribution of annual passengers and operations by month and the share of weekly passengers and operations by day-of-the-week.

The **user-defined threshold** represents the percentage of days in the year in which passengers or operations will exceed those of the design day. For example, if the user chooses a 10 percent threshold, design day activity levels will be exceeded 10 percent of the time, or on 36 days during the year.

Peak spreading factors are user-determined assumptions regarding the percentage that the peak month or design day activity (as a percentage of annual activity) will decline over the forecast period. For example, a peak spreading factor of -5.0 percent means that a peak month percentage that is currently 10 percent of annual activity would fall to 9.5 percent (10% x (100%-5%)).

The most common current practice in the United States is to define the design day as an average day during the peak month (ADPM) or peak month average day (PMAD). This is calculated by identifying the month with the highest number of operations and passengers, and then dividing the operations or passengers in that month by the number of days in the month. The average annual day (AAD), calculated by dividing passengers or operations by 365 days, is used for many types of environmental analysis. There are several other design day definitions in use, especially outside of the United States.

2.3. Design Day Profiles

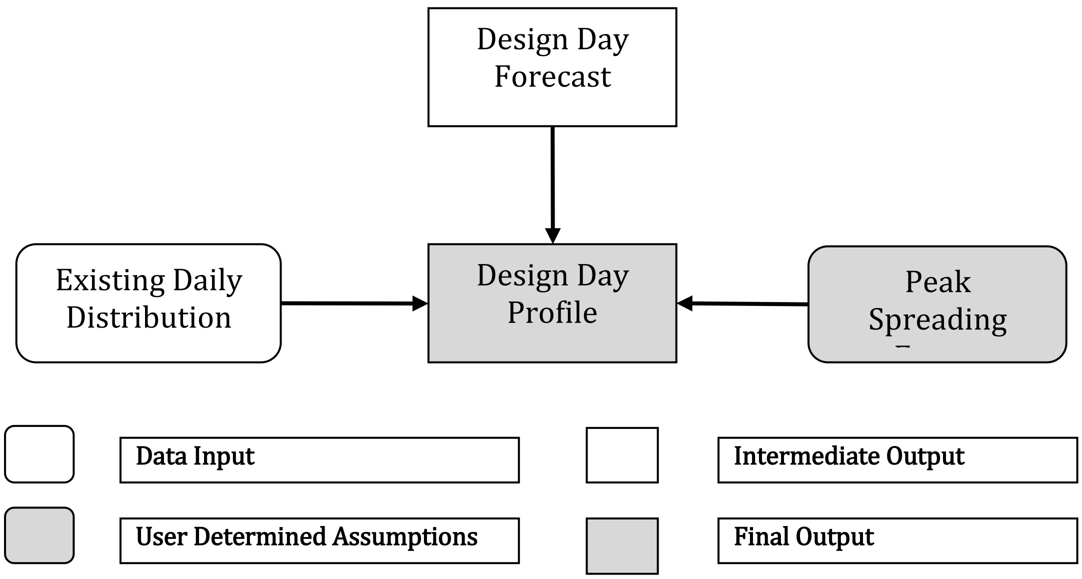
Design day profiles show arriving and departing passengers or aircraft operations by time of day, in increments of an hour or less. They are often calculated and presented graphically using rolling averages.

Design day profiles provide a measure of detail, useful for planning facilities, that is not available from peak period estimates. Many facility requirements (departure curb, ticketing, and security) are dependent on **lead time**, or the interval between the time an enplaning passenger arrives at a given facility and the time his or her flight departs the gate, while other facility requirements (baggage claim and customs) are dependent on **lag time**, or the interval between the time an aircraft arrives at a gate and the average time a deplaning passenger arrives at a given airport facility. Other facilities (restrooms, concessions) are dependent on a combination of the arriving and departing passenger flows. The peaks that emerge from these “upstream” and “downstream” passenger flows will not necessarily match the enplaning and deplaning peaks. It is much easier to estimate these derivative or second-order peaks from passenger profiles showing activity by time of day than from peak period estimates. In addition, the ability of some facilities to handle peak loads will depend on whether a queue already exists prior to the peak, which in turn depends on the level of activity prior to the peak. Design day profiles provide planners with the information needed to evaluate these issues.

Exhibit 2.2 describes conceptually how design day profiles are derived from design day forecasts.

Exhibit 2.2

Relationship between Design Day Forecasts and Design Day Profiles



The existing daily distribution is usually taken from FAA tower data or radar data for operations and from airline schedules for passenger distributions. Typically, load factor estimates are applied to seat arrivals and departures taken from the airline schedules to arrive at an estimate of passenger arrivals and departures by time of day.

There are several ways of estimating future design day profiles. The simplest way is to assume that the base year distribution of daily activity will carry forward unchanged into the future. A second alternative is to assume a peak spreading component based on relationships between airport size and peak period percentage. This dampens the peaks and fills in the gaps in the daily schedule. A third alternative is to generate daily profiles by category of activity (i.e., domestic and international passengers), project each profile to grow at the annual rate of the corresponding activity category, and then aggregate the results to generate an estimated future daily profile. The fourth alternative is to aggregate a daily profile from a design day schedule (see Section 2.4 for more details).

2.4. Design Day Schedules

The highest level of detail is provided in design day schedules. These schedules go by names such as event files, gated flight schedules, or hypothetical design day activity. They are intended to represent a snapshot of future activity at an airport or airport system on a flight-by-flight basis. The format of these schedules depends on their intended use.

Design day flight schedules serve as input files for SIMMOD, TAAM, and other airfield simulation models. They include separate records for each flight, which detail airline, aircraft type, flight time, and origin or destination. When used for terminal analysis these schedules also include passenger loads, broken down by O&D and connecting passengers. The FAA uses modified versions of these schedules for national airspace planning.

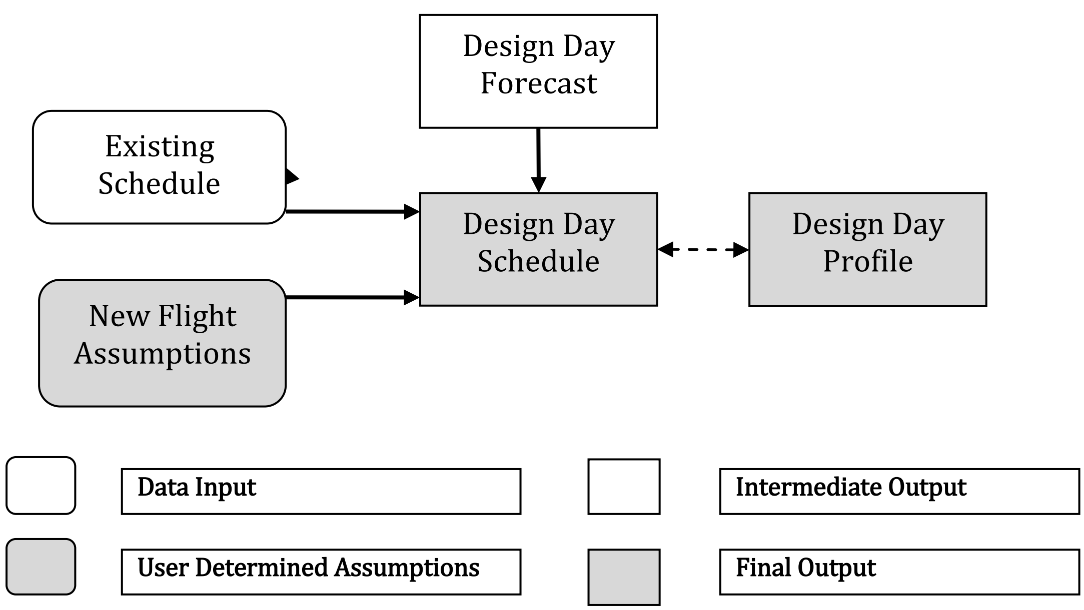
Design day schedules are also used for some types of environmental analysis. Air quality dispersion analysis requires most of the information needed for airfield planning to model aircraft emissions, and typically needs measures of local (non-connecting) passenger activity to help model ground vehicle movements. More detailed information on the appropriate tools and forecasts for planning and environmental analysis is provided in Chapter 3 of the Guidebook.

The benefits of the design day schedule approach are (a) it provides the level of detail required to examine complex airspace and airfield operational issues, and (b), numerous terminal concepts involving alternative airline allocation scenarios can be quickly analyzed, since the forecasts are disaggregated down to the individual flight level. A disadvantage of the approach, in addition to the cost, is that it does not lend itself well to forecast-related sensitivity analysis due to the effort involved in preparing design day schedules for alternative forecast scenarios.

Exhibit 2.3 shows conceptually how design day schedules are derived from design day forecasts.

Exhibit 2.3

Relationship between Design Day Forecasts and Design Day Schedules



The design day forecast provides control totals for passengers and aircraft operations. Typically, a design day schedule is prepared by modifying an existing schedule to include assumptions on new markets, additional frequencies, and fleet mix changes. In some instances daily profiles are derived from design day schedules. In other instances, previously derived daily profiles are used to guide the addition of flights for future design day schedules. See Chapter 6 of the Guidebook for additional detail.

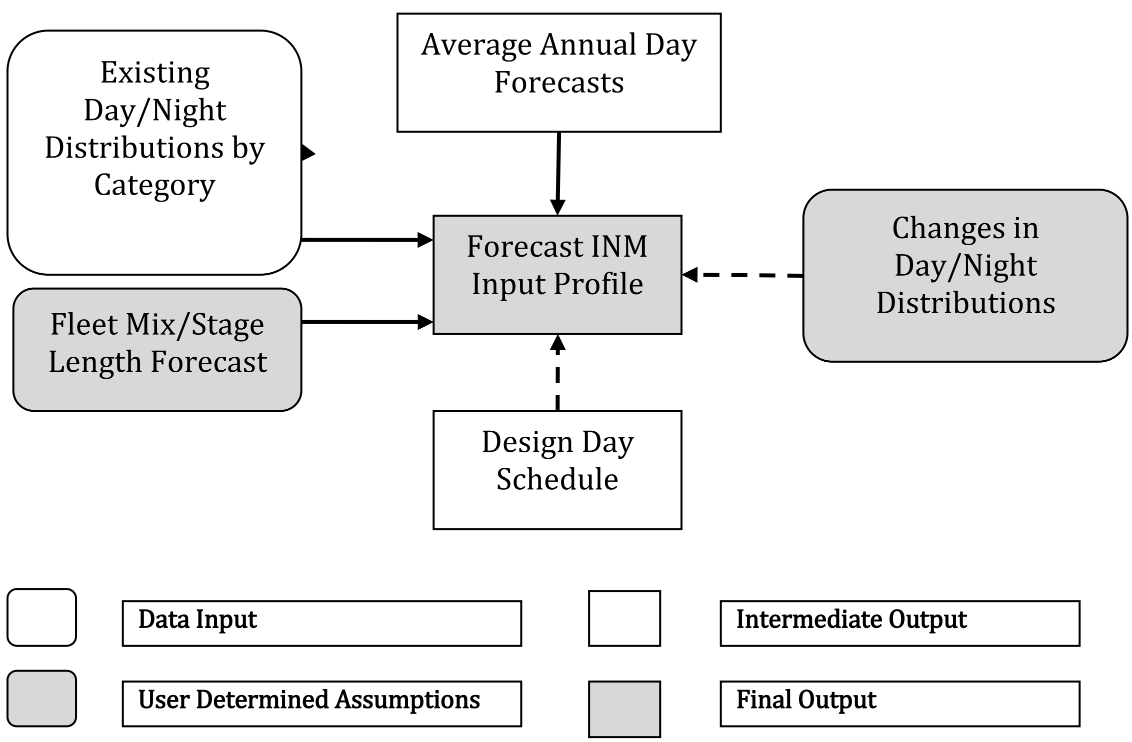
2.5. Integrated Noise Model (INM) Input Profiles

The FAA requires noise analyses to be performed for an AAD with separate weightings for daytime (7 AM to 10 PM) and nighttime (10 PM to 7 AM) flights. The California State Department of Health Services (DOHS) requires three separate weightings for noise studies in that State, with evening (7 PM to 10 PM) also included.

Exhibit 2.4 shows the relationship between the design day (defined as AAD for noise analysis), and the inputs used to generate day/night splits and stage length estimates.

Exhibit 2.4

Relationship between Average Annual Day Forecasts and INM Input Forecasts



In addition to the distribution of daytime and nighttime aircraft arrivals and departures, the day/night forecast must provide AAD aircraft operations by individual aircraft type, and aircraft departures by stage length. Aircraft type is a major determinant of the noise impact. **Stage length** represents the distance to the destination market and determines how much fuel an aircraft must carry. The amount of fuel then determines aircraft weight, which determines the amount of power (and noise) that the aircraft must generate to take off as well as its rate of climb.

In some cases, the output of simulation models is used for noise analysis. In those instances, forecast day/night splits reflect the additional fidelity associated with the future schedule design effort.

2.6. Peak Period

It is important to distinguish between the peak period definition and the peak period threshold. The peak period definition is the amount of time the peak period lasts, whether 15 minutes, 20 minutes, 30 minutes, one hour, or more. The **peak period threshold** represents the percentage of time during the year when the peak period activity is exceeded, whether five percent, 10 percent, or some other percentage. There is no single correct number for either the peak period definition or threshold. These may differ depending on the facility under analysis and the planner's needs and judgment. The design day peak period is not, and should not be, the absolute highest peak period. In general, passenger activity during the absolute peak hour is about 20 percent higher than the design peak hour (*10*).

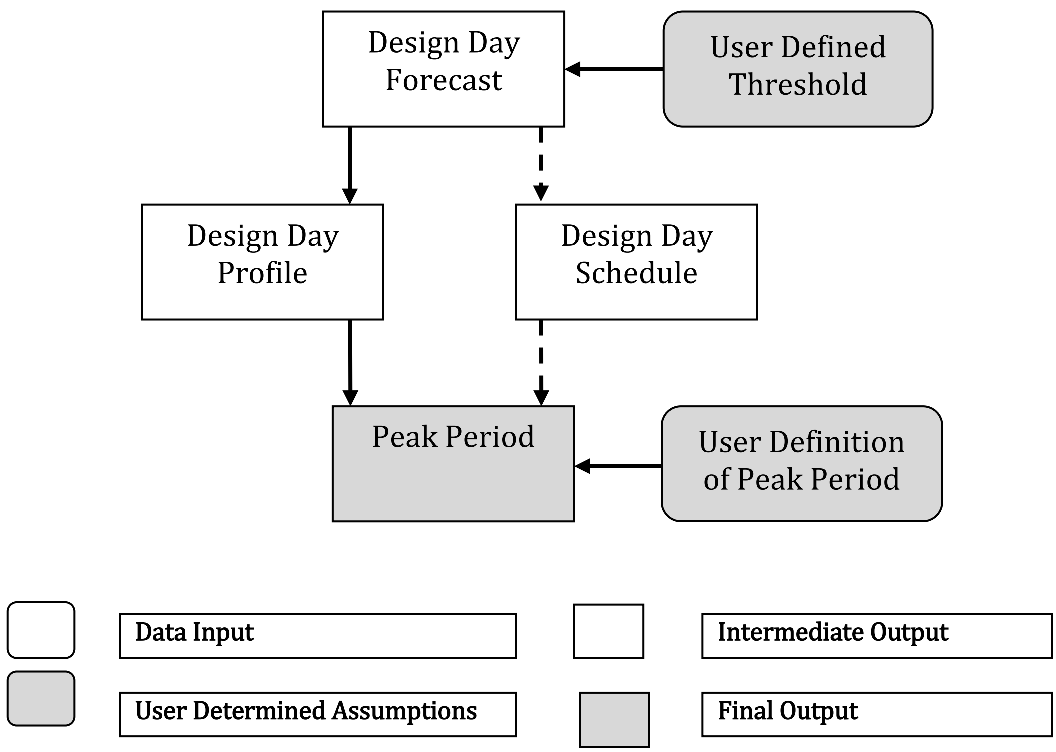
In many instances the design day calculation described in Section 2.2 is just an intermediate step towards the calculation of the peak period, often defined as the peak hour. In most master plan forecasts, there is an assumption that the peak period occurs during the design day. As is the case with the appropriate design day definition, the definition of the peak period may depend on the type of facility being planned (*4)*. Facilities that are prone to breakdown or gridlock at high activity levels, as opposed to degradation of service, may necessitate a stricter peak period definition.

Usually the peak period is derived from the rolling peak in the design day profile. If the forecast includes the construction of future design day schedules, peak period activity can be derived from those schedules. In those instances, peak spreading emerges as a result of filling in off-peak flights in the schedule construction process.

Exhibit 2.5 shows the relationship between the peak period and the design day (Section 2.2), and the design day profile (Section 2.3) or design day schedule (Section 2.4).

Exhibit 2.5

Relationship between Design Day Profiles and Schedules and Peak Period Forecasts



The peak period percentage of the busy day tends to be lower at large airports than at small airports, and should be expected to decline as an airport becomes busier, a peak spreading phenomenon similar to the monthly peak spreading described in Section 2.2.

2.7. Types of Planning

Peak period and operational profile forecasts can be used to address a variety of airport facility planning and environmental issues. For the purpose of this study, these issues have been organized into three facility categories (airside, terminal, and landside) and two environmental categories (noise and air quality). More detailed discussion of the relationship between forecasts and planning is provided in Chapter 3 of the Guidebook.

2.7.1. Airside Planning

The airside is defined as the runway, taxiway, and airfield apron areas, plus the facilities that directly support the airfield area, such as Airport Rescue and Firefighting (ARFF). Aircraft operations forecasts are most relevant for airside planning, ranging from peak period forecasts to design day schedules depending on the level of detail in the analysis.

2.7.2. Terminal Planning

The terminal area is defined as the terminal building including all concourses and gates. For the purpose of this study, the category has subdivided into four categories: gates; departure facilities such as ticket counters, security screening, and departure lounges; arrival facilities such as Customs and Border Protection and baggage claim, and other facilities such as restrooms and concessions. Gates requirements are determined, in part, by aircraft operation forecasts, but most other terminal facility requirements are determined by passenger activity. Facility requirements within security are determined by total passengers, while those outside of security are determined by O&D passengers.

Impacts on terminal facilities often lag or lead aircraft arrival or departure times; therefore design day profile and design day schedule forecasts are particularly important. They provide the detail necessary to help calculate upstream and downstream peaks that may differ from enplaning or deplaning peaks.

2.7.3. Landside Planning

The landside area is defined as the portion of the airport devoted to provide ground access to the terminal building and airfield. It encompasses the terminal curb, access roads, parking facilities, and all other ground access facilities, such as mass transit, used to access the airport. Landside facilities fall into two major categories: (1) roadway access, including curbs, and (2) parking.

Landside requirements are determined mostly by vehicle traffic, which is in turn determined by O&D passengers. Like terminal facilities, impacts on landside facilities lag or lead aircraft arrival or departure times and design day profile or design day schedule forecasts are needed.

2.7.4. Noise Analysis

Noise impacts from aircraft are usually estimated using the Integrated Noise Model (INM) which has specific input requirements, namely AAD aircraft operations broken out by day/night split and aircraft type. The Noise Integrated Routing System (NIRS) model is sometimes used instead; however, it requires a design day schedule as an input. Airports generate noise impacts from vehicular traffic as well as aircraft. These landside noise impacts can be estimated using models such as the Traffic Noise Model (TNM), which requires an AAD profile of vehicle movements, which is dependent on airport O&D passengers.

2.7.5. Air Quality Analysis

Like noise analysis, air quality analysis is directed by FAA and EPA regulations. This restricts the types of analytical approaches that can be used. An air quality inventory analysis requires a fleet mix for the average annual day. A more detailed air quality dispersion analysis requires the output from an airfield simulation model and consequently a design day schedule is needed as a forecast input.

CHAPTER THREE – DESCRIPTION OF STUDY EFFORT

The research approach was separated into two phases with ten tasks. Phase 1 included data collection and methodological development. Phase 2 involved preparation and testing of the Guidebook and Toolbox.

Phase 1 consisted of the following tasks:

Task 1 - Literature Review and Summary of Current Practices

Task 2 - Interviews

Task 3 – Airport Surveys

Task 4 - Collect Inputs for Default Factors

Task 5 - Provide Preview of Contents of Guidebook and Toolbox

Task 6 – Issues, Options and Recommendations

Phase 2 included the following tasks:

Task 7 - Complete Draft Guidebook and Toolbox

Task 8 - Field Test the Guidebook

Task 9 - Working ACRP Session

Task 10 - Final Deliverable

The approach involved in each task and the resulting findings are detailed below.

3.1. Task 1: Literature Review and Summary of Current Practices

Task 1 involved a review of academic studies and airport planning studies to identify the full range of approaches used in preparing peak hour estimates and operational profiles. Studies and data bases examined included FAA documents, Airport Master Plan and forecast documents, industry association publications, academic analyses, and data sources. Key findings of the literature reviewed are summarized in Chapter 4 and the individual documents are discussed in more detail in Appendix A.

3.2. Task 2: Interviews

As part of Task 2, a series of interviews were conducted with government, airport, and industry officials regarding issues and shortcomings associated with estimates of peak period activity and operational profiles as currently applied.

The approach to Task 2 involved the preparation of a list of interviewees that was submitted and approved by the Panel. In some instances, the initial interviews led to new contacts which were added to the list. The final interview list is presented in Exhibit 3.1. A list of questions that guided the interviews was also submitted and approved by the Panel and is included in Appendix B.

Exhibit 3.1

Task 2 Interviews
David Fish, FAA APP
Gil Neumann, FAA APP
Roger Schaufele, FAA APO
Dipasis Bhadra, FAA APO
Jake Plante, FAA APP
Robert Robeson, FAA APO
Robert Samis, FAA APO
Dan Murphy, FAA
James Bonn, Seimens
Ralph Iovinelli, FAA
Becky Cointin, FAA
Sharon Glasgow, FAA
Luis Loarte, FAA
Richard Kula, FAA
Chris Oswald, ACI
Dick Marchi, ACI
Tony Dockery, PMC representing Metropolitan Washington Airports Authority
Charles Baumer, PMC representing Metropolitan Washington Airports Authority

The respondents provided much useful information on current practices in the development and the use of peak period estimates and operational profiles. Their insights and observations are incorporated into the discussion presented in Chapter 4 – Overview of Research Findings.

3.3. Task 3: Airport Surveys

In Task 3, a detailed survey of airport planners was conducted to identify current practices for the preparation of peak period estimates and operational profiles. The selected airports included a broad spectrum crossing all time zones and spanning the range from non-hub to large hub airports.

A draft cover letter and survey instrument were prepared and submitted to the Panel for review. Following the incorporation of comments, a final cover letter (Appendix C.1) and questionnaire (Appendix C.2) were distributed to a sample of airports. The sample was designed for full geographic coverage, including all time zones in the continental United States, and an array of airport sizes ranging from non-hub to large hub airports. The questionnaires were distributed to twenty-seven airports. Following the mailing of the surveys in October 2009, two rounds of telephone follow-up calls to encourage completion of the questionnaire were completed, one in November 2009 and another in January 2010. Eight usable questionnaires were returned.

The questionnaire was organized into six sections:

1) General Questions
2) Peak period Questions
3) Day/Night Splits Questions
4) Operational Profile Questions
5) Design Day Flight Schedule Questions and
6) A place for any Final Comments or Observations.

The findings of the survey are presented in Appendix D.

3.4. Task 4: Collect Inputs for Default Factors

One of the key shortcomings of the current approaches towards developing passenger profiles is the lack of information on load factor variations by day or hour. Therefore Task 4 involved a significant data collection effort, especially from the airlines, for the purpose of developing default factors that would supplement current gaps in available data. These gaps fall into two main categories, gaps in information on weekly and hourly passenger flows, and gaps in information on potential changes in the relationship between annual and peak activity over time.

The airline data collection effort, undertaken by Oliver Wyman, focused on three key data gaps, variations in seat factor (enplaning/deplaning load factor) by day of the week, variations in seat factor by time of day, and variations in the distribution of O&D and connecting traffic by time of day. The findings are covered in more detail in Chapter 5 and in Appendix E and Appendix F

3.5. Task 5: Provide Preview of Contents of Guidebook and Toolbox

The interview, survey, and airline data collection efforts were synthesized to prepare a working draft of the Guidebook and an outline of the Toolbox for review by the Panel.

3.6. Task 6: Issues, Options and Recommendations

Task 6 involved the preparation an interim report that summarized the research and development efforts to date and included recommendations for the Phase 2 tasks. Results were presented to the Panel on May 26, 2010. Comments, advice, and direction were provided and incorporated into a revised Phase 2 work plan. A consensus was achieved on the following key points:

- The Guidebook should emphasize brevity and clarity, and be accessible and usable for a wide audience.

- The Guidebook should help identify the problem to be addressed, the tool needed to address the problem, and the type of forecast (peak period estimate, operational profile) required by that tool.
- The Guidebook should function as a user manual for the Toolbox.
- The Guidebook should provide examples for using the Toolbox.

The Phase 2 program that emerged from the Panel meeting included the following tasks:

3.7. Task 7: Complete Draft Guidebook and Toolbox

This task involved development and refining of the software Toolbox and additional revisions of the Guidebook. There were three rounds of revisions and review associated with this task, one in December 2010, a second in May 2011, and a third in September 2011. During each round the Panel provided additional comments and advice with a goal of improving the clarity and usability of the tools.

3.8. Task 8: Field Test the Guidebook

Three case study airport organizations were selected, with the input of the Panel, to validate the capabilities and usability of the Guidebook and Toolbox. Members of the Research Team visited the organizations, provided a demonstration of the Guidebook and Toolboxes and obtained comments and suggestions for improvement. In-house tests of the Toolbox were also performed. The results of the validation effort are detailed in Chapter 7.

3.9. Task 9: Working ACRP Session

Findings from the Task 8 case studies were shared with the Panel during a work session in February 2012 to solicit final comments and a recommended course of action for completing the Guidebook and Toolbox.

3.10. Task 10: Final Deliverable

The final deliverable included three elements: the final Guidebook, the final Toolbox, and this Final Report.

CHAPTER FOUR – SUMMARY OF CURRENT PRACTICES

Chapter 2 provided an overview of the relationship between the design day, the three types of operational profiles (design day profiles, design day schedules, and INM input profiles) and peak period estimates. The purpose of this chapter is to provide more detail on current practices and potential areas of improvement in estimating design day activity levels, operational profiles, and peak period activity.

There is almost universal agreement that the greater source of forecast variance in future design day and peak period estimates lies in the forecast of the annual activity from which the peak activity is derived rather than in the assumptions and processes used to derive peak period forecasts. Hence most research and direction has been devoted to advancing and standardizing approaches to preparing annual activity forecasts rather than peak period forecasts. In the majority of airport forecasts, the preparation of operational profiles and peak period forecasts has relied on a few basic approaches that have not been thoroughly examined or challenged.

As an example, the FAA requires that any annual forecast used in airport master planning or environmental analysis that differs significantly from the Terminal Area Forecast (TAF), meaning more than 10 percent within five years or 15 percent within ten years, be subject to additional review and justification (4, p. 42). There is, however, no requirement that peak period forecasts undergo this type of test. It is generally assumed that the peak period forecasts are acceptable if they are consistent with the annual forecast.

This chapter provides additional detail on current practice in estimating design day activity levels, operational profiles, and peak period activity. An examination of issues in the use of peak period numbers and operational profiles in both airport facility planning and environmental analysis follows. The review also includes upcoming developments in modeling and analysis that may affect the way these forecast elements are used. The findings are based on the search of available literature regarding current practices conducted in Task 1, and included as Appendix A, supplemented by the findings of the in-house User Validation Group and the Task 2 interviews.

4.1. Current Peak Period and Operational Profile Forecasting Practices

Current practices in defining and forecasting the design day, design day profile, design day schedule, day/night profile and peak period estimates are discussed in this section.

4.1.1 Design Day

A design day is defined to balance the need to provide adequate capacity most of the year while avoiding the cost of building for the single busiest day of the year. General practice in the United States in the evaluation of facility requirements is to define the design day as an average day during the peak month (ADPM). There are several other design day definitions in use, however, especially outside the United States. According to De Neufville and Odoni (5, p. 853) they include:

- the average week day in the peak month (AWDPM);

- the average day of the two peak months;
- the second busiest day during an average week in the peak month;
- the 20th busiest day of the year;
- the 30th busiest day of the year;
- the 40th busiest day of the year;
- the 95th percentile – corresponds to the 18th busiest day of the year;
- the 90th percentile – corresponds to the 36th busiest day of the year; and
- the average annual day (AAD) which is annual activity divided by the number of days in the year

Although the ADPM definition is less precise than most of the alternatives, it has found favor because it requires less data and effort to calculate, especially for passenger activity. The disadvantage of the ADPM method is that it can generate very different design day thresholds from airport to airport. For example, at an airport with high seasonality (i.e., the peak month accounts for a relatively high percentage of annual activity), the ADPM design day will represent a high design day threshold corresponding to the 20th or 15th busiest day of the year. Conversely, at an airport with low seasonality, especially one with some day of the week variation in activity, the ADPM design day will represent a low design day threshold corresponding to the 100th or 150th busiest day of the year. Thus, use of the ADPM design day definition can result in facilities with very different service levels depending on the airport. The appropriate balance between over-design and under-design may differ depending on the type of facility.

Although the FAA accepts the ADPM and AWDPM design day definitions for planning, other definitions are not precluded. For most environmental analysis, including noise analysis and air quality emissions inventories, the design day is defined as an AAD. In a minority of cases, such as State Implementation Plans (SIPS) prepared to show compliance with the Clean Air Act, the AWDPM is an accepted standard for airport air quality dispersion analysis (*11*). FAA and Environmental Protection Agency (EPA) guidance concerning acceptable design day definitions should be consulted, especially when preparing National Environmental Policy Act (NEPA) documents.

The available literature states that the design day (regardless of definition) comprises a smaller percentage of annual activity at busy airports than at less busy airports (*10, p. 40; 12, p. 5*.). This suggests that, as annual activity increases at an airport, design day activity should also increase, but at a slower rate. All the individual airport forecasts that were examined, however, assume a constant relationship between design day and annual activity. There has been some cross-sectional analysis comparing busy day ratios at small airports vs. large airports (*10, p. 36*). But no research has been uncovered that examines the evolution of the busy day percentage of annual activity at individual airports as they grow over time.

There is also very little discussion, either in the literature or individual airport studies, on the impact of day-of-the-week variations on load factors upon the calculation and definition of the busy day. At many airports, an average Friday is busier than an average day in the peak month, which may have implications for the sizing of facilities (see Chapter 5). Yet, without information on day-of-the-week load factor distributions, the practitioner will be unaware of these distinctions.

4.1.2 Design Day Profiles

Design day profiles provide detail not available from design day or peak period forecasts. Most peak period and hourly operational profile forecasts begin with an estimate of passenger activity at the time and place where they enplane or deplane. Many facility requirements (departure curb, ticketing, security) are dependent on the distribution of departing passengers which will precede the enplaning peak, while other requirements (baggage claim, Customs) are dependent on the distribution of arriving passengers that lag the deplaning peak. Other facilities (restrooms, concessions) are dependent on a combination of the arriving and departing passenger flows. The peaks that emerge from these passenger flows will not necessarily match the enplaning and deplaning peaks.

In many instances design day profiles are calculated by aggregating design day schedules. In some other instances (*13*) design day schedules are used to develop hourly profiles for the near term or mid-term and then extrapolated to provide operational profiles for the long-term. Cases in which hourly profiles are independently projected are less common. These are usually calculated for the base year using Official Airline Guide (OAG) data or Air Traffic Control Tower (ATCT) data on current hourly distributions, and then extrapolated into the future. Sometimes a peak spreading component based on relationships between airport size and peak period percentage is incorporated (*14, p. 55*). In some studies design day profiles are generated by category of activity (i.e., domestic and international passengers), projected to grow at the annual rates of the corresponding activity category, and then aggregated to generate an estimated future operational profile that reflects the changing share.

4.1.3 Design Day Schedules

The highest level of detail is provided in design day schedules. These schedules go by several names such as event files, gated flight schedules, or hypothetical design day activity (*15, 16, 17*). They are intended to represent a snapshot of future activity at an airport or airport system on a flight-by-flight basis. The format of these schedules depends on their intended use as shown in Exhibit 4.1.

.

Exhibit 4.1

Typical Elements in Design Day Schedule

	Airfield Planning	Terminal & Landside Planning	Airspace Planning	Air Quality Analysis (Dispersion)	Noise Analysis (NIRS)
Aircraft Type	✓	✓	✓	✓	✓
Airline	✓	✓		✓	✓
Time of Arrival	✓	✓	✓	✓	✓
Time of Departure	✓	✓	✓	✓	✓
Origin Airport for Arrivals	✓	✓	✓	✓	
Destination Airport for Departures	✓	✓	✓	✓	✓
Gate Assignment	✓	✓		✓	
Local Passengers		✓		✓	
Connecting Passengers		✓			

The FAA uses these schedules for national airspace planning, and in those instances the most important factor is the anticipated behavior of the aircraft in the air, so these schedules typically focus on aircraft type, flight tracks, and en route operations, as well as departure times and point of origin and arrivals times and destination. One of the models used to model the National Airspace System (NAS) is the Future Air Traffic Estimator (FATE) model developed by MITRE (*18, 19*).

The FAA is modeling a system of airports, rather than a single airport; therefore the concept of single busy day or peak period loses meaning since different components peak on different months. The FAA models eight different days, distributed in pairs throughout the year, to provide representative coverage.

Much of the FAA's modeling effort is focused on the busiest airports that generate the most delay. As a result they find it necessary to generate constrained design day schedules to prevent unrealistic future activity levels (activity that cannot possibly be accommodated with the facilities in place) during busy hours. Their analysis has identified relationships between maximum scheduled activity and runway capacity that varies depending on the length of the interval studied (*20*) which can be used to incorporate existing constraints into the preparation of design day flight schedules.

Design day flight schedules serve as input files for SIMMOD, TAAM and other airfield simulation models. In airfield planning, the focus is on the individual airport under study and the surrounding airspace. Consequently, less attention is devoted to airports where arriving flights originate or departing flights terminate and more attention is focused on the runway and taxiway system. Aircraft gate assignments become important then since they help determine taxiway paths and the operational efficiency of the airport.

The airfield aspects of the design day flight schedule decrease in importance when used for terminal planning. Gate assignments, gate times, and the local and connecting passengers associated with each flight are the chief elements of interest.

The approach used to prepare design day flight schedules depends on the intended purpose and the availability of data and resources. The starting point is almost always an existing schedule. New flights are then added using a variety of methods. For airspace planning the FAA uses the Fratar algorithm (Fratar) to allocate new routes depending on the anticipated growth characteristics of the origin and destination airports (*21*). The resources required for this type of network analysis are usually not available for the preparation of individual airport design day schedules. In some instances, airlines will provide future schedules from their internal network planning analysis. When resources are limited, existing flights are cloned, with a random distribution factor applied to ensure that there is no exact match in flight times. This carries an implicit assumption that the airport's future operational profile will essentially be the same as the existing operational profile and implicitly assumes there will be no peak spreading. A more resource intensive alternative to cloning is to examine schedules on an individual market basis, and to add new flights based on gaps in the existing schedule. Some types of air service analysis, such as threshold analysis, can be used to estimate new non-stop markets (*16, p. 6-13*).

Although the approaches used to prepare design day schedules are complex, they are simple compared to the real world elements they are intended to model. One of the key challenges is modeling the airline decision process. In addition to providing competitive schedule coverage, airlines need to consider revenue potential, the availability of feed traffic, behavior of competing airlines, station costs and hours, and the positioning of aircraft and flight crews.

4.1.4. Integrated Noise Model (INM) Input Profiles

As noted in Chapter 2, the FAA requires noise analyses to be performed for an average annual day (AAD) with separate weightings for daytime (7 am to 10 pm) and nighttime (10 pm to 7 am) flights. California requires three separate weightings, with evening (7 pm to 10 pm) also included. The FAA provides little guidance on how to assemble the input files, including the day/night splits, used in the analyses (*22*).

No publicly available research on the forecasting of day/night splits has been uncovered. Often, the current practice is to maintain the current day/night split in each major category, e.g., passenger, cargo, general aviation. If the relative contribution of each category to overall airport activity shifts over time, the overall day/night split will change (*23, Appendix D, p. 77*). If not, it will remain constant.

The assumption of a constant day/night split within each category may not always be applicable. Airline schedule changes, especially those that affect the organization of connecting banks, have a major impact on the day/night distribution. A **connecting bank** occurs when an airline schedules a large number of flights that arrive within a short period of time, discharge passengers that then enplane onto other aircraft, after which the same aircraft depart, again within a short period of time. In addition, nighttime flights tend to be less lucrative for the airlines, since passengers are less inclined to fly at those times. Consequently, the percentage of nighttime flights tends to increase when the economy is strong and decrease when the economy is weak. See Chapter 5 for more detail.

The output of simulation models is sometimes used for noise analysis. Future day/night splits would then reflect the additional fidelity associated with the future schedule design effort.

4.1.5. Peak Period Estimates

In many instances the design day and design day profile calculations are an intermediate step towards the calculation of the peak period, often defined as the peak hour. In most master plan forecasts, it is assumed that the peak hour occurs during the design day. The literature, however, notes that this is not always the case (*10, p. 35*). It is also noted that the design day peak hour is not, and should not be, the absolute peak hour. In general, passenger activity during the absolute peak hour is about 20 percent higher than the design peak hour (*10, p. 32*).

As is the case with the design day, most planning guidance indicates that the peak hour percentage of the design day is lower at large airports than at small airports, and should be expected to decline as an airport becomes busier, a phenomenon described as peak spreading. There are instances in which peak spreading has been incorporated in design day forecasts. Two examples are the Houston Intercontinental Airport Master Plan Update Forecast (*25, p. 68*) which assumed that the peak hour would grow at 80 percent of the annual rate, and the Tampa International Airport Master Plan Update forecast which assumed that the peak hour would grow at 87 percent of the annual rate (*14, p. 4-30*).

Forecasts that include the construction of future design day schedules often derive peak hour activity from the schedules. In those instances, peak hour spreading emerges as a result of filling in off-peak flights in the schedule construction process. There are game-changing situations, such as the entry of an airline such as Southwest that eschews connecting banks in favor of high aircraft and gate utilization, which can materially change the peak period percentage at an airport. Other potential game changers that could affect peak hour calculations and operational profiles are the relationship between mainline carriers and feeders, and airline consolidation, and the impact of facility constraints that limit growth in peak periods and therefore induce additional peak spreading.

The FAA and individual terminal planning practitioners advise that the definition of the peak hour may depend on the type of facility being planned (*4, p. 49*). More critical facilities may require a stricter peak hour definition (in terms of the percentage of annual activity encompassed) than less critical facilities. Also, facilities that are prone to breakdown or gridlock at high activity levels, as opposed to degradation of service, may necessitate a stricter peak hour definition.

The context in which the peak hour occurs is important. If the hour immediately preceding is also very busy, inherited queues and other activity may further exacerbate stresses occurring in the peak hour. Likewise, if the succeeding hour is busy, the ability of the facility to recover from the stresses of the peak will be impeded.

4.2 Planning Issues

During the course of the literature review, and discussions with the User Validation Group, and the Task 2 interviewees, several issues pertaining to the use of peak period estimates and operational profiles for planning were identified.

4.2.1 General Planning Issues

There is not much awareness on how the ADPM measure translates to an annual percentile. Those practitioners that have been contacted to date feel that the ADPM works well for their airports. At the same time, they believe that there would be value in collecting peak period information based on more specific percentile information, since some facilities are more sensitive to peak stresses than others.

Traditional peaking metrics may not be appropriate for smaller airports. At small airports, peaks are more likely to be driven by events, such as air shows, football games, or other local community events, which are both relatively uncommon and substantially different in magnitude from baseline activity. These cases may be better evaluated on an individual basis than by using a standard peaking metric.

4.2.2 Airfield Planning

It was noted that the emphasis in the analysis of peak period and operational profiles in available research appears to be on passenger carriers, and that useful information for air cargo and other non-scheduled activity is more difficult to extract. Data is less available and schedules/patterns of activity are less predictable. Therefore it is less certain that the design day or peak period estimates that emerge from traditional approaches like the ADPM are applicable to these categories. Another issue is that the peak month may differ in addition to the peak hour for some of these categories. Cargo in particular often peaks in October or December as opposed to the summertime.

The lack of a good source of data on Visual Flight Rule (VFR) operations and peaking characteristics, especially at non-towered airports, made it difficult to estimate and project these metrics. But it was also noted that the types of airfield improvements determined by peak hour projections were unlikely to be needed at the operational levels generally experienced at non-towered airports.

At towered airports, design day profiles often assume that VFR activity will match the distribution of IFR activity, but some anecdotal evidence suggests that VFR activity attempts to operate during off-peak hours. Therefore, the assumption that VFR profiles will match IFR profiles may exaggerate the estimate of peak activity.

4.2.3 Terminal Planning

The peak hour metric may not be the most appropriate for terminal planning and design. It has been noted in the literature and among planning practitioners that many terminal facilities are more sensitive to 10-, 15, or 20-minute surges of activity than to 60-minute activity levels. In those instances, forecasts of shorter peaks would be more valuable than peak hour forecasts. In addition, terminal planning is often conducted by individual component, such as a concourse. Peak period estimates and operational profiles that can be customized for these components are especially valuable, which is why gated design day flight schedules are useful for terminal planning.

Many planning factors used in terminal planning are based on comparable airports and are described as a ratio relating the size of a facility to a peak period metric. As noted earlier, however, the ADPM and corresponding peak period metric translates to differing busy day percentages, and therefore service levels, depending on the airport. Consequently, a planning factor prepared at one airport, and translated to another airport using the ADPM metric, may result in designing a facility to a different level of service than intended.

4.2.4 Landside Planning

The impact of an enplaning or deplaning peak on landside facilities is altered by the lags and delays encountered by passengers when proceeding from the landside to the airside, or vice versa. It is also difficult to translate a design day passenger profile to a profile of passenger vehicles. Anecdotally this appears to be because ground transportation mode tends to vary by time of day. As a consequence, the translation of passenger counts to vehicle counts appears to be accurate on a daily basis, but poorly matched on an hourly basis. In addition, it is important to differentiate between resident originations and visitor originations if possible. Parking demand is dependent on resident originations and rental car demand is dependent on visitor originations. Commercial vehicle traffic tends to be very sensitive to the terminating passenger peak. Also, international passengers tend to use taxies more often than domestic passengers. Therefore, a design day profile that differentiates by type of originating or terminating passenger would be very useful.

It was also noted that vehicular traffic to and from airports is a function of more than passenger activity. Airport and airport tenant employees contribute substantial traffic activity, and the timing of changes in shift will have a marked effect on vehicle activity profiles through the day.

4.2.5 Uncertainty

A common theme in the interviews was the need to account for uncertainty. Annual forecasts are often imprecise and the peak activity metrics that are derived from the annual projections will share the same uncertainty. One suggestion was to focus analyses on the key planning questions at hand, to try to best estimate the specific peak activity metrics that would affect the question, to estimate the likely range of variation associated with that metric, and to provide planning solutions or contingencies that are responsive to the full range of outcomes suggested by the range of variation.

At a smaller scale it was noted that airlines are not always able to operate consistently with their schedules. Therefore, even if a forecaster precisely projected a design day schedule, the inability of airlines to meet that schedule could result in unanticipated impacts on facilities. International facilities are particularly prone to this problem, since they need to accommodate relatively few flights with large numbers of passengers within a narrow time frame. A slight shift in one or two flights can therefore result in a concentrated peak that could overwhelm facilities that are designed for the projected schedule.

4.3. Environmental Issues

The interviews, User Validation Group, and literature review also revealed issues regarding the use of operational profiles for environmental analyses.

4.3.1 General Environmental Issues

There is a need to standardize the data in the operational files. Information on the fleet mix currently comes from many sources which have differing classifications and nomenclatures for equipment type. These are then combined into a single input file for the INM noise model or the Emissions and Dispersion Modeling System (EDMS) air quality model. The reconciliation of model requires some effort and sometimes leads to error. Any proposed method for generating operational profiles needs to account for this issue.

The future fleet mix is usually estimated at the same time the forecast of annual airport activity is prepared. These forecasts sometimes provide information by general aircraft category, and lack the detail on specific aircraft type, which is necessary for accurate noise and air quality analyses. In these instances, the practitioner must conduct additional research into the fleet plans of the airlines serving the airport in question to refine the fleet mix into usable input.

4.3.2 Noise Analysis

Noise analysis under Part 150 regulations requires that nighttime noise impacts be weighted more heavily than daytime impacts. The accurate identification of flight activity by time of day is therefore critical.

There is inconsistency in current practice in how day/night splits are assembled, especially involving the intermixing of schedule data and actual data. Since OAG schedule data is more current than other available sources of aircraft operations activity, it is a useful source of information on the day/night split of the scheduled carriers. The OAG data is supplemented with radar data from the ATCT when available for non-scheduled operations.

There are two issues associated with the use of OAG data to assemble day/night splits. First, the times listed are gate times. For arriving flights, runway touchdown will precede gate arrival by several minutes, depending on the airport. Conversely, for departing flights, actual takeoff times will lag gate departure times by several minutes. The problem is compounded at congested airports, where delay may add to the discrepancy between scheduled departure time and actual takeoff time. As a result of these discrepancies, true nighttime flights may be labeled as daytime and vice versa.

Noise analysis involves using data representing the entire year which is then averaged to represent an average annual day (AAD). A strict interpretation suggests that all aircraft, even those accounting for only one or two annual operations, should be included. This can be problematic, since much of the information comes from radar sources, which are subject to transcription and other errors. One respondent suggested focusing the analysis on aircraft types most likely to have an effect on the results, i.e. jets, and if a poorly identified aircraft can be reasonably assumed not to be a jet, it can be safely grouped in a generic category for analytical purposes.

4.3.3 Air Quality Analysis

For an emissions inventory, an AAD fleet mix is used, and the same activity profile used for noise analysis can be applied provided the fleet mix is identified in sufficient detail to accurately model emissions. An air quality dispersion analysis requires a peak period activity profile. In most instances, the airport activity peak (AWDPM) aligns fairly closely with the period of most adverse meteorological conditions (summer) for air quality. In some instances, such as Florida airports, the seasonal peaks for aircraft activity and air pollution are not coincident. In those cases, the FAA advises modeling AWDPM activity for air quality dispersion analysis to be conservative.

As was the case with facility planning, uncertainty is an issue. It was noted that each step of the simulation process introduces an element of error. These errors are propagated throughout the analysis and may have an effect on the estimated environmental consequences.

4.4. Upcoming Developments

The initial version of the Aviation Environmental Design Tool (AEDT 2a) was released in March 2012 and has replaced the NIRS model. The next version (AEDT 2b) is currently scheduled for release in 2014 and will combine and replace the INM and the EDMS models used to evaluate noise and air quality impacts respectively. With regard to aircraft movement information, the input requirements of the AEDT model will be the same as for INM and EDMS. The model will be able to generate both noise and air quality impacts using the same set of input data, and will therefore require and provide greater commonality with regard to fleet mix and aircraft movement assumptions. The AEDT will be able to directly use the output of SIMMOD or TAAM simulation models, as well as INM input files if no air quality analysis is required. Therefore, the new model should have no effect on the current requirements for daily operational profiles.

The FAA is also updating its Airport Capacity and Planning Manual (*12*). The new manual will include an accompanying spreadsheet that is intended to allow the user to accomplish three things. First it will provide a means of quickly generating estimates of hourly runway throughput based on runway configuration, fleet mix, and other factors. Secondly, it will provide the user a means of testing the impact of changes in key assumptions, such as fleet mix, on the hourly capacity. Finally, it will provide a means of converting hourly throughput to annual capacity, by incorporating some form of hourly profile or peaking factor, daily hours of operation, and other factors such as fleet and airport size. The model is still being developed, so its exact form and input requirements have not been finalized.

CHAPTER FIVE: OVERVIEW OF RESEARCH FINDINGS

Among the key issues acknowledged at the beginning of the study and reinforced during the literature review, interviews, and surveys is that there are many gaps in the information needed to translate annual activity forecasts into peak period forecasts or operational profiles. Therefore, a significant part of the ACRP 03-12 effort, embodied in Tasks 3 and 4, was an independent research effort to mitigate these data shortfalls. The results of this effort include a set of default factors that can be used in conjunction with the Guidebook and Toolbox.

The research effort addressed the following issues:

- Variation in seat factor (enplaning/deplaning load factor) by day-of-week.
- Variation in seat factor by time-of-day
- Variation in the peak month as a percent of annual activity.
- Peak spreading
- Issues in using airline schedule data for day/night splits
- Trends in day/night splits
- Resident/visitor distribution by time of day
- Appropriate peak period by facility type
- Representative lead and lag times by facility type

Many of these issues are worthy of a much more comprehensive research effort. In this study, the intent was to determine whether these issues may be significant enough to warrant concern in airport planning, and where feasible, to develop default factors for use with the Guidebook and Toolbox.

5.1 Passenger Distribution Factors

Although there is a wealth of information on the distribution of aircraft operations by day of the week and time of day, comparable information for passengers is lacking. The ideal way of collecting this passenger data would be through a comprehensive passenger survey or by enlisting the assistance of the airlines which have this information. The first method is expensive and the second method requires the cooperation of the majority of the airlines who are often reluctant to part with proprietary data. Both methods tend to be time consuming. It is relatively easy to obtain scheduled seat arrivals and seat departures from airline schedules, and that information can be converted into passenger flows provided reasonably accurate estimates of load factor by time of day and day of the week are available.

Appendix E provides a description of an analysis of day-of-the-week and time-of-day passenger distributions performed by Oliver Wyman as part of the Task 4 effort.

5.1.1 Day-of-the-Week Factors

The findings were that airlines tend to schedule more seats on weekdays than weekends, and that Saturdays, in particular, had particularly light schedules. The reverse is true for international flights, which show heavier weekend than weekday scheduling.

Seat factor (enplaning and deplaning load factor) data was collected from the airlines, and the finding was that seat factors tend to be slightly higher than average on Sundays, Mondays, and Fridays, and lower than average on Tuesdays and Wednesdays. The resulting level of passenger peaking, however, is still small, which shows that modern airline pricing and revenue management practices have to a large extent leveled out day of week travel demand between Monday and Friday. Also, as discussed in Appendix F, there is noticeable variation among airports in the day-of-week distribution of peaking, suggesting that the default factors should be used with caution.

5.1.2 Time-of-Day Factors

Oliver Wyman performed a similar analysis for time-of-day factors. They identified some distinctive scheduling patterns that varied by the four time zones. Key findings for scheduled aircraft and seat departures were as follows:

- The Eastern region has the most distinctive classic business profile with a large 5 p.m. departure peak following by an early morning peak between 8 and 9 a.m.
- The West Coast has a large departure peak between 11 a.m. and 1 p.m. and steadily decreasing flight levels after that, which reflects the fact that most flights to the East Coast have departed by early afternoon.
- The Central region has similar peaks to the East but with a more consistent level of flights during the day, reflecting the large hubs and daytime connecting banks in the Central region.
- Finally, the Mountain region shows pronounced peaking between 9 a.m. and 11 a.m., with a small peak at 9 p.m.

The arrivals information shows slightly different patterns. Eastern region arrivals do not have an early morning peak, but instead increase steadily to 4 p.m. peak. Central region arrivals have a similar pattern building to a 5 p.m. peak. Western region arrivals have a clear peak at 10 and 11 a.m. and then again from 7-9 p.m. And Mountain region airports have peaks at 9 and 10 a.m. and then again at 8 p.m.

Seat factor data was also collected by time-of-day. Arriving seat factors were slightly higher in the afternoon and early evening than in the morning. Departing seat factors showed a less distinctive pattern, although seat factors were slightly higher during the middle of the day than in the early morning or evening. As with the day-of-week seat factor data, there is relatively little variation in seat factor by time of day. Most of the peak seat factors are only a few percentage points above the average seat factor.

The variation in seat factor among airports is much greater than the amount of variation in seat factor by time-of-day (see Appendix F for additional discussion). This suggests that the default time-of-day seat factors should be used with caution. Discussions with airlines indicate that the specific markets served and the size of connecting banks in a given hour have a greater bearing on average aircraft loads in a given hour than the specific time of day. Chapter 6 of this document provides additional direction on the application of seat factors by market.

5.1.3 O&D Distribution Factors

The airlines were not able to provide usable information on the distribution of origin-destination vs. connecting traffic by time of day. At spoke airports, the O&D distribution will closely match the enplanement and deplanement distribution. At connecting hub airports, the O&D connecting distribution will be largely a function of connecting opportunities. Therefore, flights that depart prior to the initial arrival bank will have a much lower than average connecting percentage. Likewise, flights that arrive after the last departure bank of the day will also have a much lower than average connecting percentage. The number of connections on international flights tends to be higher than on domestic flights, so at international gateways, the connecting percentage should be expected to be highest during the mid-afternoon early-evening international peak.

5.2 Peak Spreading

Peak spreading is acknowledged in both the industry and the literature, but the empirical data needed to quantify this phenomenon is scarce. Peak spreading may occur on a seasonal, weekly, or daily basis, but the extent to which it occurs is unknown. The same issues can affect the relationship between day and night operations over time, and can influence the assumptions used to guide the preparation of gated flight schedules.

5.2.1 Peak Month Spreading

Appendix G provides an analysis performed by Oliver Wyman of recent peak month trends at U.S. airports. Despite steadily increasing load factors over the past decade, there is little evidence that peaking, as measuring by the number of passengers during the peak month in comparison to the average month, has become less pronounced at U.S. airports. Most large airports experience peak month passenger levels that are 10-20 percent higher than average month levels. Leisure destination airports are most likely to have higher peaks, sometimes much higher. There is a much more pronounced peaking at non-hub airports than airports in any other size category.

5.2.2 Peak Hour Spreading

Appendix H shows an analysis of a sample of airports including large, medium, small, and non-hubs spanning all four continental time zones for 2001 through 2008. The analysis compared the peak hour percentage of total daily aircraft arrivals and departures with total annual arrivals and departures. As shown, there is a gradual decline in the peak hour percentage as annual activity becomes greater, which averages about -0.5 percent per

100,000 increase in annual arrivals/departures. Perhaps more relevant is that the variability in the peak hour percentage is much greater for small airports than for large airports. Coupled with that, there appears to be a downward limit of approximately 6.5 percent, below which the peak percentage will not fall, regardless of the size of the airport. This suggests that, when estimating future changes in the peak period percentage, the practitioner should consider where the current peak period percentage lies in comparison with other airports with similar activity levels. If it is already at the low end of the range in Exhibits H.2 and H.3, peak spreading is likely to be much less than if it lies at the high end of the range.

5.3 Issues in the Distribution of Day and Night Operations

There are two assumptions often applied in noise analyses that warrant additional scrutiny. One assumption is that airline schedules provide an accurate representation of the true split of day and night activity among scheduled passenger carriers. The other is that the distribution of day and night activity remains constant over time. The analyses in Appendix I and Appendix J provide additional insight into these issues.

Appendix I suggests that day/night splits based on airline schedules underestimate the nighttime percentage of operations and the resulting noise impact. Therefore, the user should use actual data whenever possible. If actual data are not available, the user should seriously consider making adjustments to the schedule data to better represent actual conditions.

The tables in Appendix J show the trends in share of total operations accounted for by nighttime activity for a sample of large, medium, small, and non-hub airports spanning all four continental time zones. The general trend, at least for large and medium hub airports, appears to be for the share of nighttime operations to decline. The declines seem to be more marked when industry conditions are difficult, such as during the immediate post-9/11 period and during the 2008 fuel spike. There appear to have been more moderate increases in the nighttime percentage during better times such as the 2003-2006 recovery phase. Since the 2001-2008 period was very difficult for the airline industry; that may be driving the overall downward trend in the nighttime share. The latter part of the 1990s, a healthier decade, was characterized by an increase rather than a decrease in the nighttime share.

5.4. Resident/Visitor Distributions

The distinction between resident and non-resident origin-destination traffic is perhaps more important for landside facility planning and the analysis of air quality associated with ground vehicle traffic. Appendix K shows an analysis of the distribution of resident and non-resident originations and terminations at a large hub airport in the Eastern Time Zone derived from their passenger surveys. It shows that resident originations tend to prevail in the morning, and that non-resident originations tend to prevail in the late afternoon and evening. Since residents are much more likely than non-residents to use private automobiles to go to and from the airport, this phenomenon had significant implications in the modeling of ground vehicle traffic for both landside facility analysis and air quality analysis.

5.5. Relationship of Peak Periods to Facility Categories

The Airport Survey (see Section 3.3) queried respondents about the appropriate peak periods that should be used to plan for terminal building facilities and the results are summarized in Exhibit 5.1. Ticketing and passenger security screening were had the lowest suggested peak periods, and departure lounges and Customs and Border Protection had the highest recommended peak period definitions. Note that in all cases, both the mean and median peak period definitions were substantially less than one hour. There was also a broad range in the recommended peak period for all categories. This suggests that, even though there is a generally broad consensus that the appropriate peak period is less than an hour for most terminal building facilities, there is much less agreement on the precise peak period definition for each facility;.

Exhibit 5.1

Suggested Peak Period Definitions by Facility Type

	Appropriate Peak Period (minutes)			
Facility	**Median**	**Mean**	**High**	**Low**
Ticketing - Ticket Counters & Queuing	15	21	60	7
Passenger Security Screening Checkpoint	15	20	60	7
Baggage Security Screening - EDS	15	29	60	7
Baggage Makeup Area	18	41	120	15
Departure Lounges	40	38	60	15
Gates	25	33	60	15
Concourse Circulation	30	36	60	15
Customs and Border Protection (CBP)	40	38	60	15
Restrooms	18	24	60	15
Meeter/Greeter Area	25	29	60	15
Baggage Claim	20	25	60	15
Rental Car Counter/Queuing	18	31	60	15
Curb Frontage	18	31	60	15

Source: Peak Period and Operational Profile Questionnaire.

5.6. Lead and Lag Times

The impacts of lead and lag distributions upon peak periods were discussed in Chapter 2. Peak period flows at each terminal facility will vary in timing and possibly in magnitude from the peak passenger levels experienced at the time of enplaning and deplaning. The Airport Survey queried respondents about the typical lead times before departure and lag times after arrival relevant to all major terminal building facilities, as summarized in Exhibit 5.2. In general, the extent of lead times was consistent with the sequence in which passengers typically use various departure facilities. For example, they typically encounter the departure curb first (hence the longest lead time) and go on to ticketing, baggage check-in, security, and the departure lounge, and therefore each succeeding facility category has a shorter average lead time. Lag times tend to be much shorter than lead times, but also follow a logical sequence. Arriving passengers tend to go to the restrooms first, followed by baggage claim, and either the rental car counter or the arrival curb. Note that lead and lag times will vary according to the size and configuration of the airport, the degree of congestion, and anticipated processing rates and security policies at the time. Therefore, there are no generic lead or lag times that are applicable to all airports at all times.

Exhibit 5.2

Range of Lead and Lag Times by Facility Type

	Lead or Lag Time (minutes)			
Facility	**Median**	**Mean**	**High**	**Low**
Lead Time by Facility (Prior to Scheduled Aircraft Departure)				
Departure Curb	90	90	90	90
Ticketing - Ticket Counters & Queuing	74	74	80	68
Passenger Security Screening Checkpoint	64	64	68	60
Baggage Security Screening - EDS	70	70	80	60
Baggage Make-Up Area	63	63	80	45
Departure Lounges	40	40	50	30
Lag Time by Facility (After Aircraft Arrival)				
Customs and Border Protection	20	23	43	5
Restrooms	8	8	10	5
Meeter/Greeter Area	20	22	30	15
Baggage Claim	16	18	23	15
Rental Car Counter/Queuing	24	23	30	15
Arrival Curb	24	21	25	15

Source: Peak Period and Operational Profile Questionnaire.

5.7. Summary

The research findings summarized earlier in this chapter and in the appendixes are not exhaustive. They are intended to highlight issues that have a bearing on the use of forecasts of peak period activity levels and operational profiles. Many of the subjects would benefit from additional, more detailed, research.

CHAPTER SIX: GUIDEBOOK AND TOOLBOX DOCUMENTATION

The purpose of this chapter is to provide outlines of the Guidebook and Toolbox and to provide more detailed information on peak hour and operational profile estimating approaches to supplement the Guidebook.

6.1 Organization of Guidebook

The interview, focus group, and airline data collection efforts in Tasks 1 through 5 were synthesized into the Guidebook which includes the following chapters:

- Chapter 1 which defines peak period and operational profiles, describes the Guidebook's organization, and summarizes the features of the Toolbox;
- Chapter 2 which describes the relationship between annual forecasts, peak period estimates, and operational profiles, and defines additional terms;
- Chapter 3 which describes how to use the Guidebook and Toolbox, specifically providing guidance on identifying the appropriate forecasting tools for analyzing planning and environmental problems under a variety of circumstances;
- Chapter 4 which describes how to use the Toolbox to define and estimate the design day from current data or future forecasts;
- Chapter 5 which discusses how to use the Toolbox to calculate existing and to project future design day profiles of passengers and aircraft operations;
- Chapter 6 which provides guidance on the preparation of design day gated flight schedules;
- Chapter 7 which provides guidance on the preparation of day/night and stage length profiles for noise analyses;
- Chapter 8 which shows how to use the Toolbox to estimate peak period activity levels from design day profiles; and
- Chapter 9 which shows how physical or policy constraints may affect the magnitude and distribution of activity peaks and provides guidance on how to model these constraints.

The Guidebook also includes five appendices including a manual for the Toolbox, a list of data sources, day-of-week and time-of-day default factors, suggested peak period definitions by facility type, and a glossary.

6.2 Organization of Toolbox

The Toolbox that accompanies the Guidebook provides software to facilitate the calculation of many of the peak period and operational profiles discussed in this report and in the Guidebook. It is based on Microsoft Excel and consists of two modules, an **operations module** for estimating peak period activity and operational profiles for aircraft operations, and a **passenger module** for estimating peak period activity and operational profiles for passengers. Each module in the Toolbox contains an introduction with basic user documentation, a User Selected Parameters worksheet where the user defines the type of analysis, a Base Year Data worksheet where the user enters required base year data for the analysis, and several output worksheets.

The algorithms in the Toolbox essentially follow the flow diagrams contained in Chapters 4, 5, and 8 of the Guidebook and later in this chapter. In an ideal world, a Toolbox capable of preparing future day/night splits and design day flight schedules would be developed. However, the preparation of future day/night splits and flight schedules involves too much professional judgment to be properly translated to a software medium. Nevertheless, the Toolbox-generated hourly profiles can be helpful for crosschecking manually prepared day/night splits and flight schedules.

Detailed operating instructions for the Toolbox are contained in Appendix L of this report and also in Appendix A of the Guidebook.

6.3. Supplementary Information

The purpose of this section is to provide some additional supplementary guidance pertinent to the preparation of peak period or operational profiles that was not included in the Guidebook.

6.3.1. Preparation of Design Day Forecasts

Estimating design day aircraft operations is straightforward since daily operations data are available from all towered airports and the relevant steps are covered in Chapter 4 of the Guidebook.

Estimating design day passengers is more complicated because most airports do not collect passenger data on a daily basis. This is generally done by estimating or collecting information on seat arrivals and departures and then applying a load factor estimate to calculate passengers.

The simplest approach is obtain air carrier and air taxi operations by day from the FAA's Air Traffic Activity Data System (ATADS) data base, and then to use annual US DOT T-100 or OAG seat departure data to arrive at a ratio of seats to operations for the two categories. This approach is unlikely to produce accurate results at an airport with high seasonality, since this often results in changes in the average size of scheduled aircraft, or at an airport with all-cargo service, since the weekday/weekend distributions of cargo flights are very different from passenger flights, and this could skew the results.

A more accurate but more resource-intensive, approach is to use the OAG to directly obtain daily scheduled seat arrivals and departures, or to use Enhanced Traffic Management System Counts (ETMSC) data to obtain daily actual seat arrivals and departures. These approaches are still not perfect. Not all the scheduled flights in the OAG are completed, and for various technical reasons, ETMSC does not capture and identify 100 percent of all flights. This is the approach used in the Toolbox.

The next step is to obtain passenger load factor by month from local Airport statistics, if available, or the T-100 data base. If load factor is not readily available, it can be calculated by dividing monthly enplanements or deplanements by the corresponding monthly seat arrival and seat departure information (this is the approach used in the Toolbox). The next step is to obtain load factor adjustments for the day of the week. If this data cannot be obtained directly from the airlines, the default load factor adjustment factors contained in Appendix C of the Guidebook may be applied.

Users should note that even when detailed load factor data is available, the resultant daily passenger estimates will still be estimates and not actual numbers. Day-of-the-week load factors may vary by time of year, especially during holidays and this may skew the results, especially when one is estimating extreme peaks, i.e., the single busiest day of the year.

6.3.2. Preparation of Design Day Profiles

As described in Chapter 5 of the Guidebook, the estimate of design day profiles for aircraft operations is relatively straightforward, since there are several potential sources of aircraft operations by time-of-day, including airport noise monitoring programs, Enhanced Traffic Management System (ETMS), and the Performance Data Analysis and Reporting System (PDARS). The distributed Operations Network (OPSNET) data is not ideal because it is only provided by clock hour, and the desired fidelity in an operational profile is usually shorter than 60 minutes. OAG data can be used if the analysis is confined to scheduled passenger operations.

A planner may find it useful to determine whether the airport they are analyzing has a typical design day profile compared to other airports in its category, in terms of the distribution and magnitude of its peaks. Appendix M provides some comparable airport profiles and guidance. In addition, Appendix N provides some guidance on the distribution of international passenger operations. These distributions can vary markedly by world region.

Design day profiles can have an impact on gate requirements over and above total design day activity. In general, airports with more intense peaks tend to require more gates but average fewer turns per gate. Airports where activity is distributed evenly throughout the day can get by with fewer gates with a high number of turns per gate. See Appendix O for more discussion on the relationship between gate requirements and aircraft operations.

As was the case with the design day, the estimate of design day passenger profiles is more complex because of the general lack of passenger data on a daily or hourly basis. As discussed in Chapter 5, these passenger distributions are usually prepared by applying load factor estimates to seat arrival and departure information from the OAG.

The Toolbox can provide an estimate of origin-destination traffic by time of day but is limited by the assumption that the ratio of local to connecting traffic remains constant throughout the day. Greater precision requires a design day flight schedule (see Section 6.3.3. and Chapter 6 of the Guidebook).

It may also be necessary to make a distinction between resident and non-resident O&D traffic. The distinction is much more relevant for landside facilities and ground transportation planning. Residents and non-residents tend to use very different transportation modes. Residents mostly use their private automobile to arrive at the airport and are the predominate user of parking facilities. Non-residents are the predominant user of rental cars.

The distribution of residents and non-residents can vary both by season and by time-of-day. At many northern markets, residents tend to fly out when the weather is harsh (winter) and residents tend to fly in when the weather is benign (summer). This data is available on a quarterly basis from the U.S. DOT's O&D Survey. In the O&D Survey, base passengers are those who initiate their round trip at the airport; they roughly translate to resident passengers. Reference passengers are those who terminate the first segment of their round trip at the airport; they roughly translate to non-resident passengers.

The resident/non-resident split of local traffic is unavailable by time-of-day except from passenger surveys. Indications are that morning departures and evening arrivals tend to have more residents in the mix whereas morning arrivals and evening departures tend to have more non-residents in the mix. See Appendix K for more analysis.

The peak passenger impact on many terminal and landside facilities occurs at a different time than the enplanement and deplanement peaks. Enplaning passengers will impact these facilities for a period of time prior to scheduled aircraft departure while deplaning passengers will impact these facilities for a period of time after aircraft arrival. The lead and lag times will differ depending on the facility, and there will be a probability distribution associated with each lead and lag time. Exhibits 6.1 and 6.2 provide schematics of how the Toolbox estimates existing and future derivative profiles from design day profiles.

Lead and lag time distributions can vary depending on the time of day, the mix of business and leisure passengers, or current security policies. Appendix P provides an example of how these distributions can vary. Therefore, the Toolbox is designed to allow many alternative lead and lag time distributions to be tested quickly.

Exhibit 6.1

Process for Estimating Existing Design Day Derivative Profile of Passengers

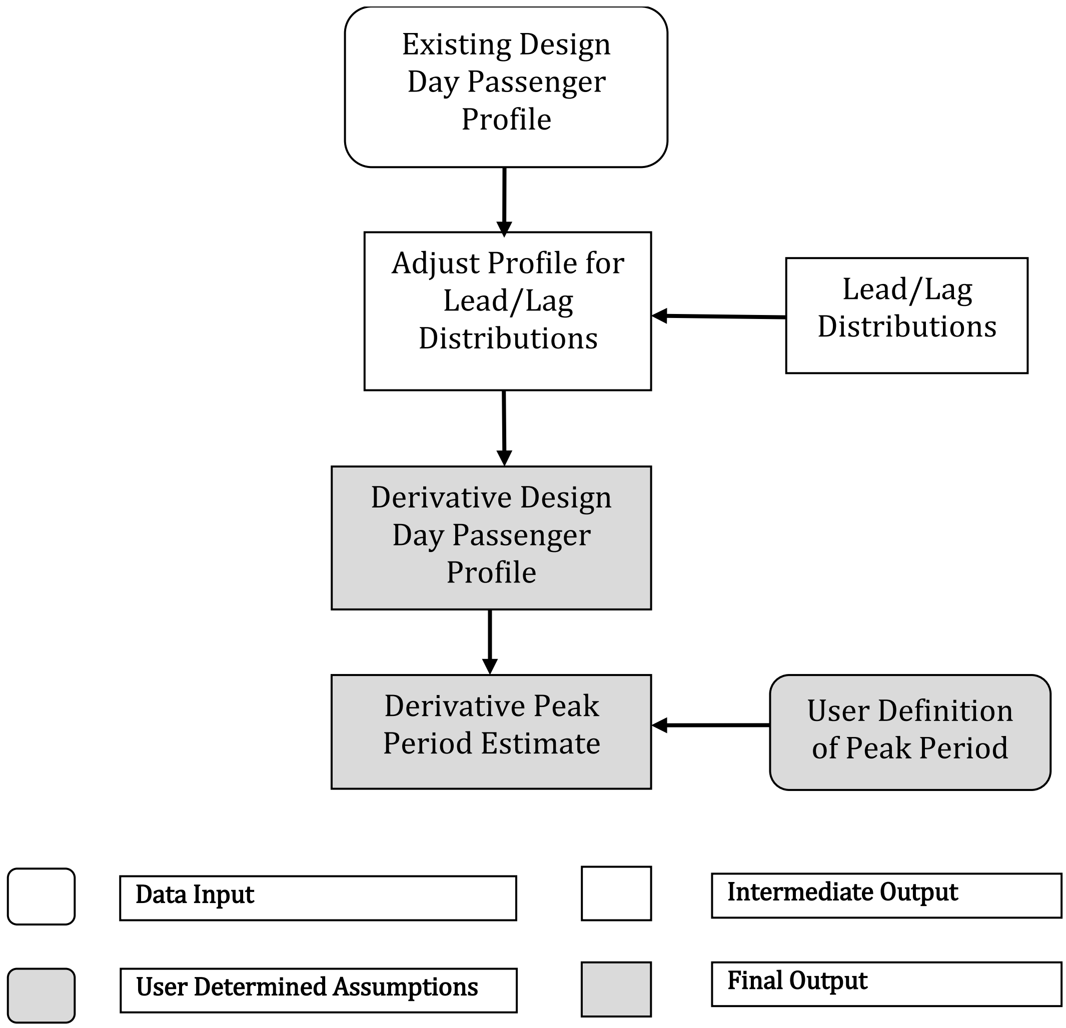
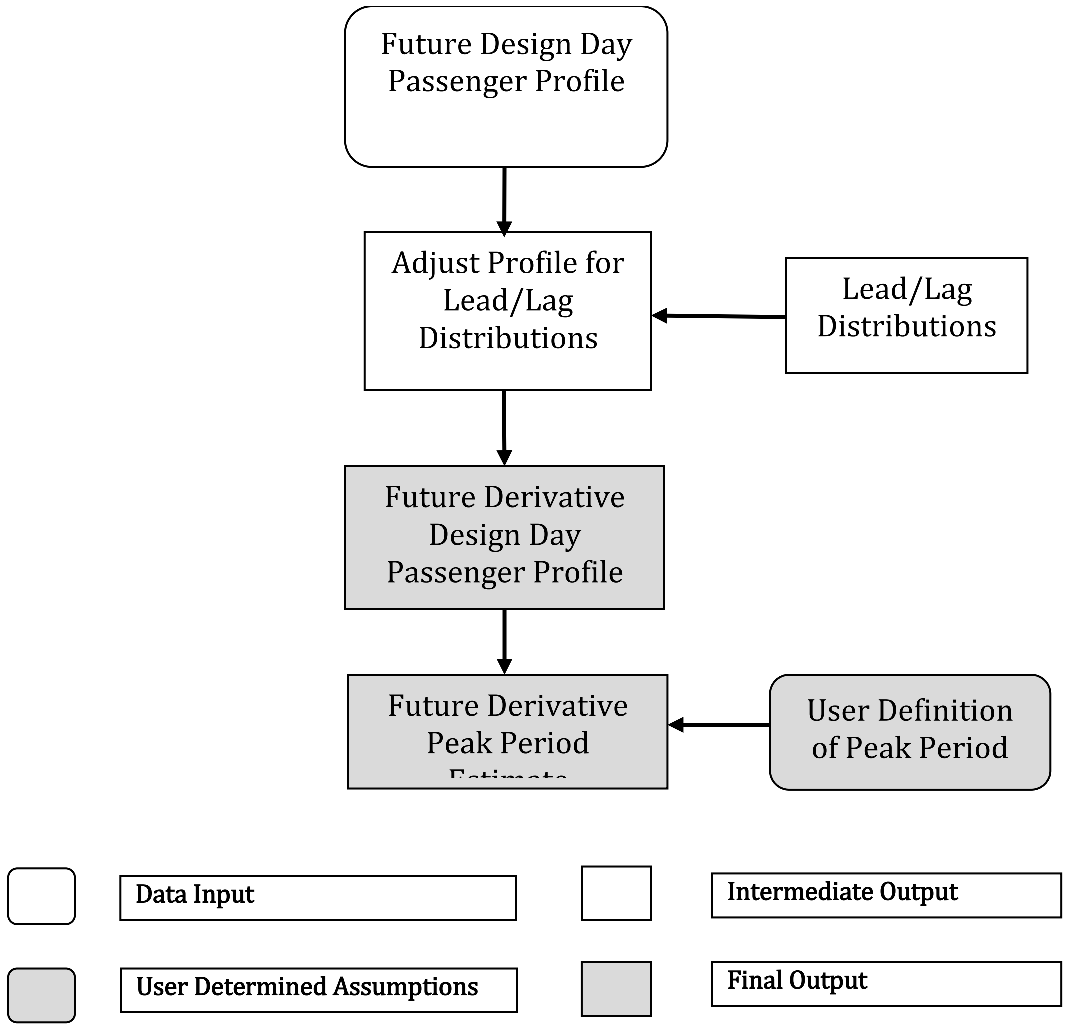


Exhibit 6.2

Process for Estimating Future Design Day Derivative Profile of Passengers



6.3.3. Preparation of Design Day Flight Schedules

General guidance on the preparation of design day flight schedules is provided in Chapter 6 of the Guidebook. The generation of design day flight schedules is too complex to be modeled in the Toolbox so more detailed step-by-step guidance is contained herein to supplement the information provided in the Guidebook.

Below is a detailed approach to preparing a design day schedule involving three major components:

- Estimating and Allocating Market Share,

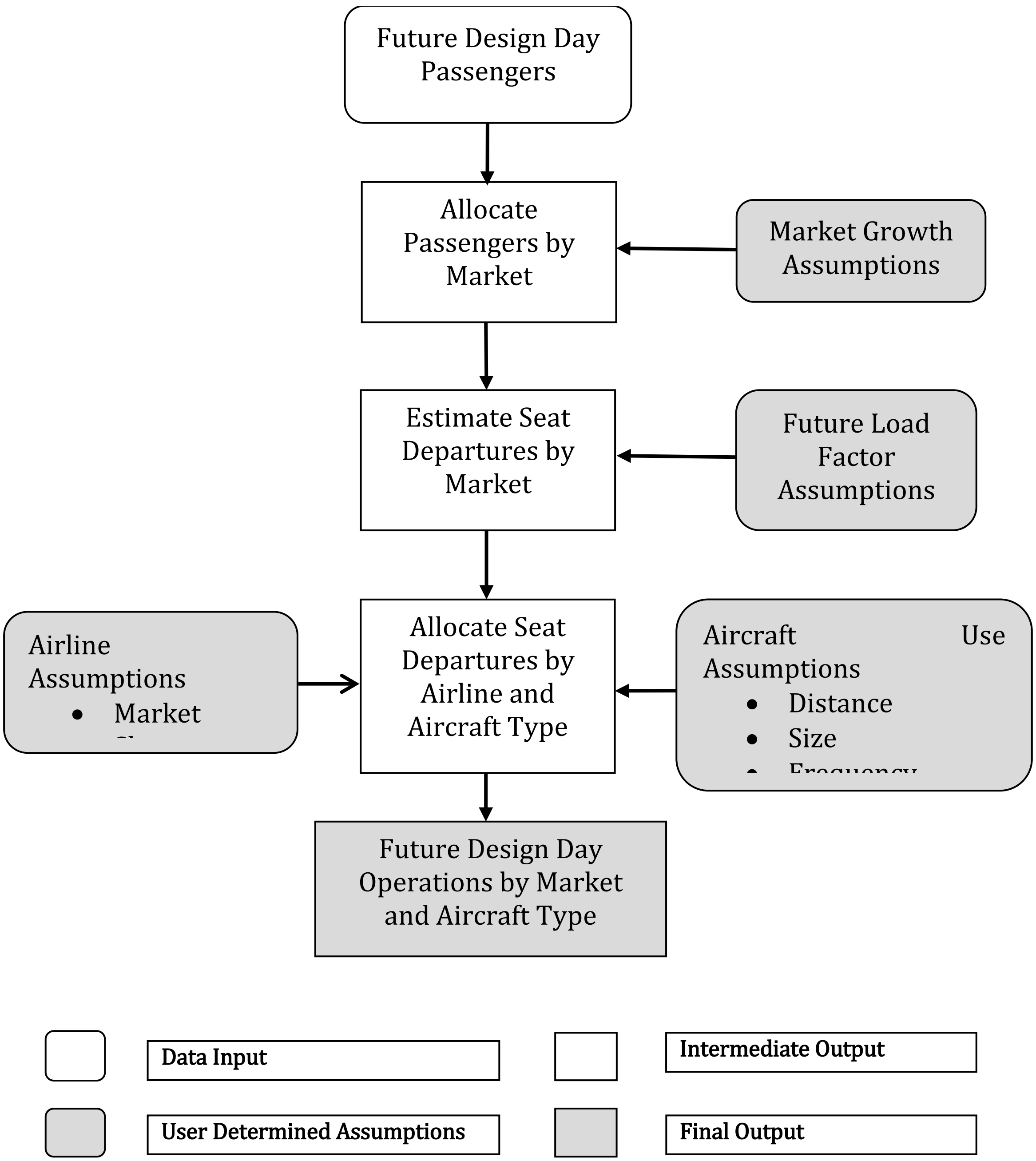
- Estimating Aircraft Operations, and
- Assigning Passengers to Flights.

Exhibit 6.3 shows a method for estimating and distributing future design day activity among markets. This is an important because origin and destination markets are a major determinant of aircraft type and passenger characteristics. The following steps are involved:

1. Estimate future design day passengers (See Chapter 5 in Guidebook).
2. Allocate passengers among markets. Potential allocation methodologies are listed below ranked in order of least complex to most complex:
    a. Allocate passengers according to existing share.
    b. Grow passengers in each market according to recent trends and then normalize results to sum to original design day total.
    c. Grow passengers in each market according to the anticipated growth in a market-demand proxy, such as income in the destination market, and then normalize results to sum to original design day total.
    d. Grow passengers in each existing market in accordance with c.), use a nonstop market threshold analysis to identify new markets, and then normalize results to sum to original design day total.
    e. Prepare a separate forecast equation for each market, use a nonstop market threshold analysis to identify new markets, and then normalize results to sum to original design day total.
3. Estimate future load factor for each market and then divide into market passenger projections prepared in Step 2 to generate a seat departure forecast for each market.
4. Estimate fleet mix most likely to account for daily seat departures to each market. This will involve some judgment and should include the following considerations:
    a. Existing service patterns to the market.
    b. Current airline route strategies
    c. Degree of competition in market. Markets in which more than one airline compete with each other tend to have more frequencies with smaller aircraft than monopoly markets of similar size and distance.

Exhibit 6.3

Process for Estimating Future Design Day Gated Flight Schedule
Estimating and Allocating Destination Market Share



d. Known planned aircraft orders and retirements for each airline.

e. Relationship between market size, average aircraft size, and flight frequency. This relationship tends to change with increased distance; long haul markets tend to be served by larger aircraft with fewer frequencies when compared to short haul markets of similar size (measured in seat departures).

The result is a fleet mix forecast showing airline, aircraft type, and daily frequency in each market.

Once the market forecast is complete, Exhibit 6.4 shows an approach for estimating the schedule of passenger aircraft operations involving the following steps:

1. Begin with the market forecast of aircraft operations by airline, aircraft type and frequency and an existing schedule of passenger aircraft arrivals and departures.

2. Beginning with each arrival market update each existing flight to reflect changes in equipment if any, and add new frequencies. When estimating scheduled times for new flights in existing markets consider the following factors:

    a. Avoid scheduling two flights to the same market by the same airline at the same time. Airlines try to avoid "wingtip-to-wingtip" flying when possible.

    b. If an airline has a connecting hub at the airport being studied, schedule flights to fill gaps within the existing connecting bank structure.

    c. If the airline has a connecting hub at the origin airport, schedule flights to fill gaps within the existing connecting bank structure at the origin airport.

    d. Schedule flights to avoid take-offs and landings during nighttime (2300-0600) at destination markets.

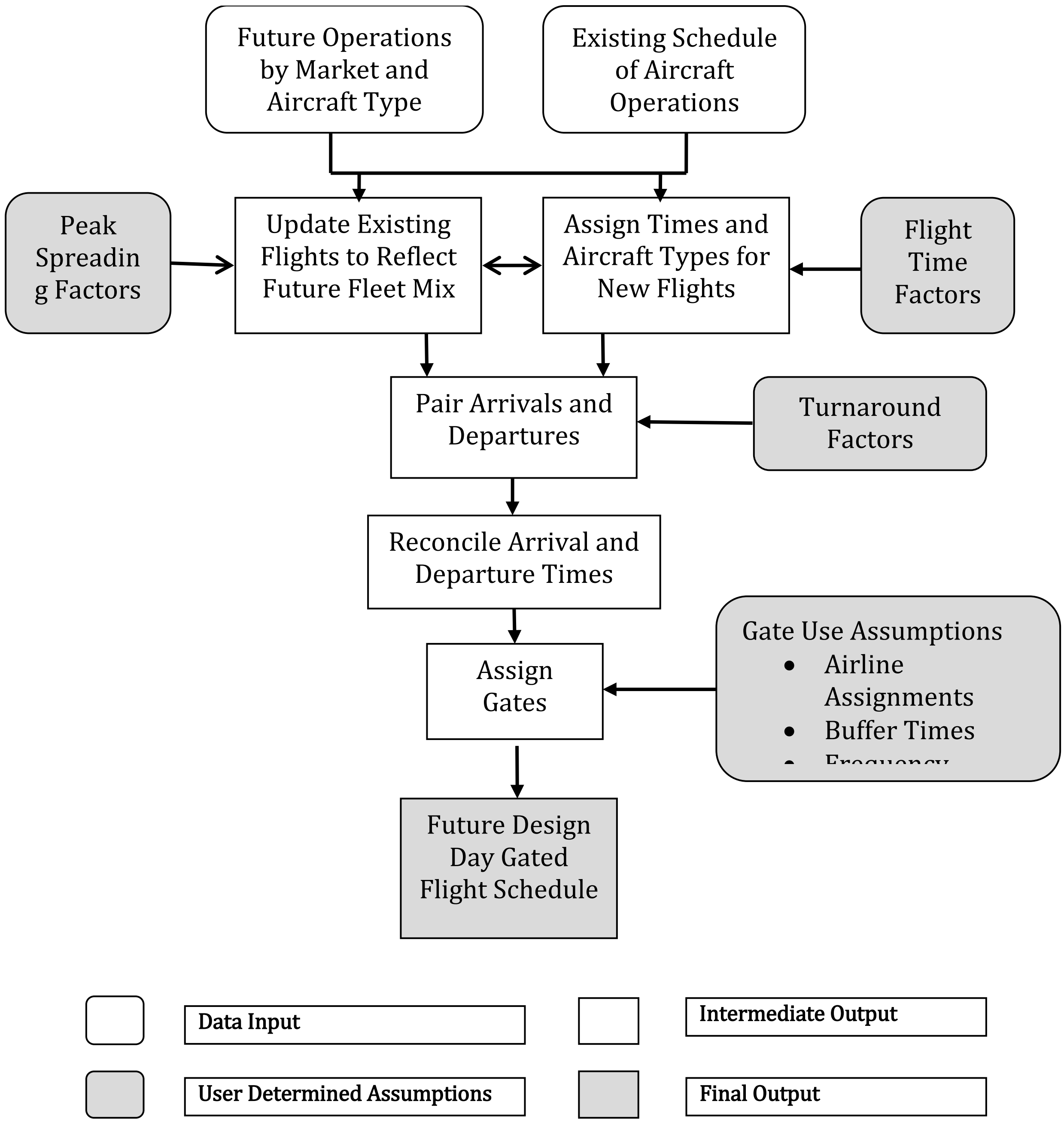
    e. Determine whether to adjust existing flight times in markets where new flights are added. See Appendix Q for additional discussion.

3. Estimate times for new markets, taking into consideration the factors described in Step 2 and Appendix Q. Use similar markets (in terms of size, distance, and time zone) with existing service as guide to likely service times.

4. Repeat Steps 2 and 3 for destination markets.

Exhibit 6.4

Process for Estimating Future Design Day Gated Flight Schedule Aircraft Operations



5. Since each aircraft that lands must take off, arriving flights must be paired with departing flights. In general, turnaround times are determined by the structure of the connecting banks and aircraft size. Small regional aircraft can often turn around in 20 to 30 minutes. Mainline aircraft generally take at least 45 minutes or more, unless they are operated by Southwest Airlines in which case they turn around in about 25 minutes. Wide-body aircraft in domestic service usually require at least one hour and wide-body aircraft in overseas international service often require a two hour turnaround time.

6. Generally after all obvious pairings of arriving and departing aircraft have been completed; there will be a few remaining flights for which no obvious pairs are available. In some instances, airlines will hold a few aircraft departures back to provide some contingency in the schedule in case of delayed arriving aircraft or mechanical breakdowns. The existing schedule should provide a good guide as to how often airlines plan for these contingencies. If the number of unmatched pairs is too high to be reasonably explained by airline contingency planning, it will be necessary to iteratively adjust flight times, while adhering to the considerations in Steps 2 and 3, until the remaining arriving and departing aircraft can be paired.

7. For many airfield simulation analyses and for terminal planning, the aircraft arrival departure pairs will need to be assigned to gates. When gating flights consider the following:

    a. Include sufficient buffer time between a departing flight and the next arriving flight at a gate. Examine current gate scheduling practices at the airport under analysis to determine the appropriate buffer times. At preferential or exclusive use gates this is typically no less than 15 minutes for a domestic flight and no less than 30 minutes for an overseas international flight. Many airlines use buffer times of 30 minutes or more even for domestic flights. If common use gates are contemplated, buffer times should be expanded because individual airlines have less internal flexibility to optimize the distribution of their aircraft among gates to accommodate disrupted schedules. Disrupted schedules are more likely at highly congested airports, so increased buffer times will be more appropriate in those instances.

    b. Many airlines, especially those who operate connecting hubs, have spare gates to accommodate disrupted schedules. Spare gates are not always obvious, and may change from hour to hour. But at any given time a certain percentage of an airline's gates will have no flights scheduled to provide for unexpected aircraft.

    c. Note that buffer times and spare gates are intended to address the same issue: to provide additional gate capacity in case flight schedules are disrupted and off-schedule flights result in a higher demand for gates than anticipated under the original schedule. Therefore it is not realistic to be too generous or too conservative with both buffer times and spare gates. If an airline has high buffer times, it can get by with fewer spare gates. If it has low buffer times, more spare gates will be required.

d. Not all gates are configured to accommodate all aircraft types. Aircraft should be assigned only to gates that can, or are planned to, accommodate those aircraft.

e. Some airlines have preferred runways for destinations in a given direction, and they assign gates to minimize taxi time to those runways. Existing gate assignment patterns should be examined for these practices. If a gate assignment chart is not available from the airport or airline, gate assignments for individual flights can be determined in real time from the internet.

f. In most instances it will be theoretically possible to pack fifteen to twenty daily flights at one gate (usually the first to be gated) and only one peak hour flight at another gate (usually the last to be gated). This does not occur in the real world. Airlines and airports will attempt to balance gate usage to avoid overly stressing a given facility. Utilization across gates in the design day schedule should be balanced to match current use patterns.

Once gated, the schedule will be ready for airfield planning or simulation. Additional steps, outlined next, will be necessary to use the schedule for terminal or landside planning.

The approach in Exhibit 6.5 shows how to assign passengers to the design day schedule prepared above. The approach involves the following steps:

1. Obtain load factors by airline for each market for the existing design day month. This data is available from the US DOT's T-100 data base.

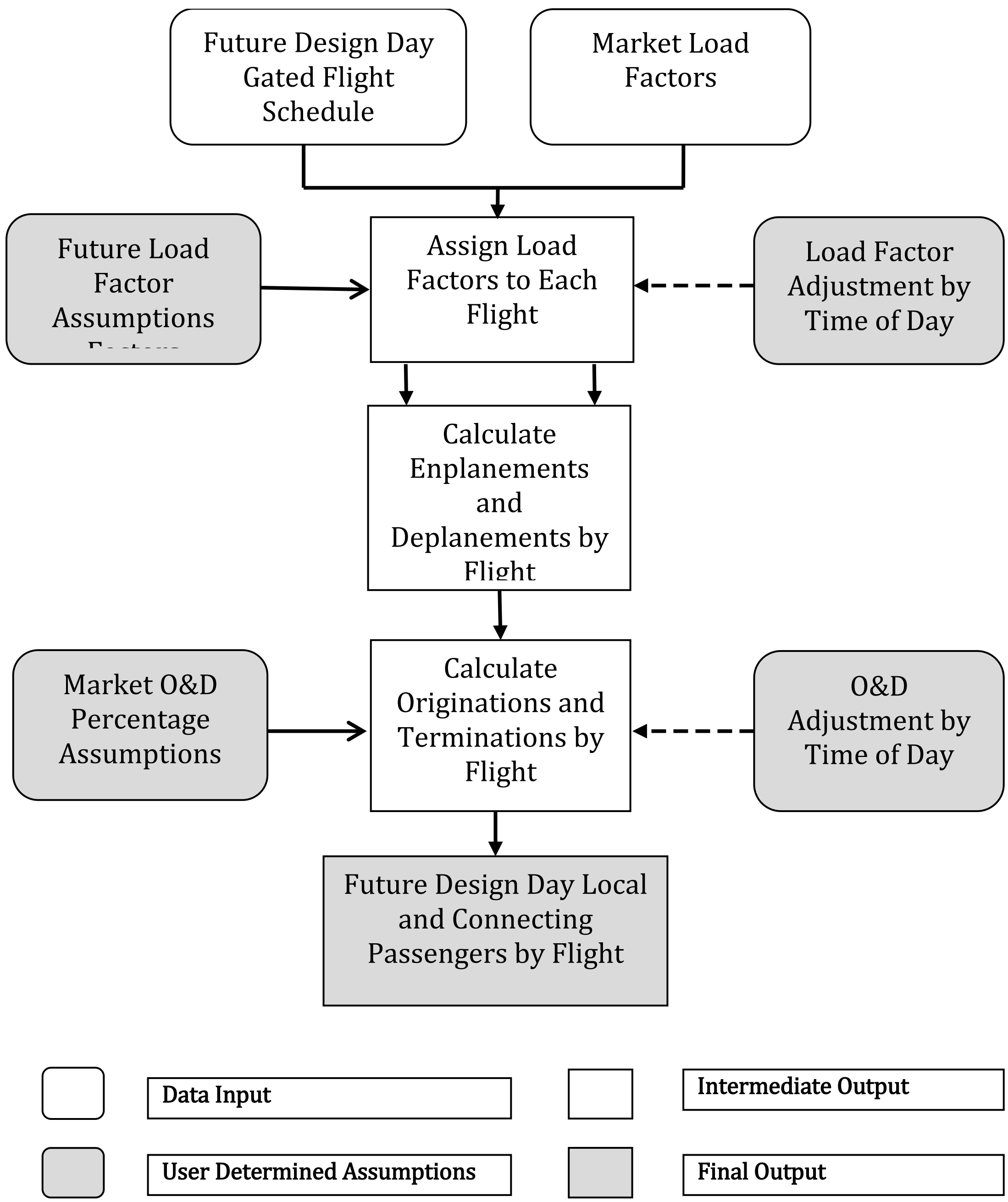
2. If the design day is intended to represent a specific day-of-the-week, adjust the load factors collected in Step 1 to represent the day-of-the-week design day, using airline data if available, and adjustment factors from Appendix C of the Guidebook otherwise.

3. If desired, use airline data if available or adjustment factors from Appendix C in the Guidebook to adjust the load factors in Step 2 for the time of day for both arrivals and departures.

4. Apply the load factors calculated in Step 3 to the available seats in the flights corresponding to those hours to generate preliminary enplanement and deplanement estimates by flight.

Exhibit 6.5

Process for Estimating Future Design Day Gated Flight Schedule Assignment of Passengers to Flights



5. Once this step is complete, normalize (proportionately adjust) the results to ensure that the average load factor across the day (total daily enplanements divided by total daily seat departures in the market) matches the daily average calculated in Step 2. Steps 3, 4, and 5 can be skipped if an airline has only one daily flight to a market, which is often the case with international markets.

6. Estimate the existing ratio of originations to enplanements (ratio of terminations to deplanements should be very similar) for each market and airline. These data are available from the O&D survey and T-100 data on a quarterly and annual basis for U.S. flag carriers). Some considerations are in order when using these ratios since on-flight origination to enplanement ratios will not always match market origination to enplanement ratios:

    a. Airlines flying to other hubs will often be carrying O&D passengers to beyond markets and a market origination enplanement ratio will understate the on-flight origination enplanement ratio. For example, an American Airlines flight leaving from Atlanta to DFW will be carrying O&D traffic from Atlanta to Phoenix, Atlanta to Tucson, and Atlanta to Albuquerque, and so on, not just O&D traffic from Atlanta to DFW. For this reason, in the case of airlines that do not hub at the airport under study, it is usually better to apply an airport-wide origination to enplanement ratio rather an individual market origination to enplanement ratio.

    b. Even for a hub carrier, some flight itineraries include multiple stops. In these instances the originations for the one-stop market would have to be added to the non-stop market to estimate true on-flight origination enplanement ratios.

    c. In many long-haul markets the market origination to enplanement ratio exceeds 1.00, which is mathematically impossible for an on-flight origination to enplanement ratio. This occurs because for various reasons, usually associated with price or schedule, passengers will take an alternative connecting flight rather than the non-stop flight to get to their final destination. In these instances it will be necessary to adjust the on-flight origination to enplanement ratios to 1.00 or less.

    d. If resources permit, examine the full routing O&D data to refine the on-flight origination enplanement ratios. If not, it will be necessary to make an across-the-board adjustment to the individual on-flight origination to enplanement ratios to ensure the aggregate origination to enplanement ratio matches the overall airport origination to enplanement ratio.

    e. The O&D Survey Data base does not provide O&D information for foreign-flag carriers. Those carriers would need to be surveyed to obtain information on their origination to enplanement ratios. In general, there is some connecting passenger activity associated with all international overseas flights. The connecting percentage is much higher for foreign-flag carriers who code-share or are in alliance with the domestic carrier, if any, hubbing at the study airport.

7. Apply any forecast changes in the origination to enplanement ratio to existing ratios prepared in Step 6 to estimate future origination to enplanement and termination to deplanement ratios for each market and airline combination. Some judgment will be required to adjust the origination to enplanement and termination to deplanement ratios by time of day and the factors below should be considered:

    a. Unless there are redeye flights from South America, or from the West Coast at East Coast airports, flights that depart prior to the first arrival bank will have virtually no connecting traffic. Likewise, flights that arrive after the last departing bank will have virtually no connecting traffic.

    b. There should be a rough correlation between deplaning connecting passengers in a given arrival bank and enplaning connecting passengers in the succeeding departure bank. At no time should the number of cumulative daily enplaning connecting passengers exceed the number of cumulative deplaning connecting passengers.

    c. At international airports the connecting percentage typically peaks during the overseas international arrival and departure peaks since that is when the connecting opportunities peak.

Following completion of the above steps, a passenger- populated design day gated flight schedule ready for use in terminal or landside planning will be available. Each design day flight schedule will provide the following information on a flight-by-flight basis:

- Time of arrival and departure
- Airline
- Aircraft type
- Domestic/international designation
- Origin and destination
- Seat capacity
- Enplanements and deplanements
- Originating and terminating passengers

The estimate of gated flight schedules is a detailed and time-consuming process, and errors are likely. Appendix R provides a quality control checklist that can be used to identify errors.

There are alternative approaches to preparing design day flight schedules, many of which use simplifying assumptions to reduce the level of effort.

6.3.4. Preparation of Day/Night Fleet Mix

Chapter 7 in the Guidebook provided guidance on the preparation of day/night fleet mixes. As noted in the chapter, it is unlikely that any data set will be complete and totally accurate with respect to the needs of noise analysis. In those instances additional research will be required on the part of the user to prepare defensible assumptions to fill in the data gaps. Some assumptions will have more of an impact on the results than others, and that should determine priorities in preparing these assumptions. In so doing, resources should be focused on the following:

- Accurately identify aircraft that represent a large number of operations rather than aircraft that represent a small number of operations.
- Accurately identify older and larger aircraft, since they tend to be noisier, with less emphasis on smaller aircraft.
- Pay special attention to all-cargo operators, since many operate older large aircraft at night.
- Recall that the loudest noise impacts occur immediately after take-off and before landing, whereas OAG times are gate times. If scheduled gate times occur just after 7 am for a large number of arrivals or just before 10 pm for a large number of departures, some adjustment may be required to ensure that true nighttime flights are not inaccurately labeled as daytime.
- Minimize effort in identifying stage lengths for piston-powered or turboprop general aviation aircraft since this information is not generally available and has little impact on the noise results.
- Minimize effort on identifying quixotic aircraft types that only appear once or twice in the annual radar data and may ultimately turn out to be a typographic error.

6.3.5. Preparation of Peak Period Forecasts

As noted at the end of Chapter 8 in the Guidebook, the peak period is sometimes defined independently of the design day. For example, there is no guarantee that the 30th busiest hour of the year will occur during the 30th busiest day. The Toolbox does not have the capability of estimating peak periods independent of the design day; therefore approaches to estimating and independent peak periods for operations and passengers are provided below. Note that these approaches tend to require much more data and more effort than those based on the design day.

Exhibit 6.6 presents an approach to estimating existing peak period aircraft operations independent of the design day. It involves the following steps:

1. Define the desired peak period threshold (5 percent busiest, 10 percent busiest, etc.).
2. Define the desired peak period term (20 minutes, 30 minutes, 60 minutes, etc.).

3. Collect operations data by time of day for every day in the year. This could be obtained from the airport if they collect radar data for noise monitoring purposes. If only passenger aircraft peaks are required, OAG data can be used. A less precise method is to use distributed OPSNET data from the FAA. This data is limited to clock hour increments and therefore will not account for peak periods that straddle two hours or peak periods that are not equal to 60 minutes.

4. Select the peak period to analyze (e.g., 20-minutes, 30-minutes, 60 minutes, 120 minutes) and use the distributions obtained in Step 3 to calculate a rolling average of operations (based on an increment equal to the selected peak period) by time of year. The same procedure can be used to calculate a rolling average of aircraft arrivals and departures, provided the operations data are broken out that way.

5. Sort the rolling operations calculated in Step 4 from highest to lowest.

6. Once the sort is complete, select the period that corresponds to the defined peak period threshold identified in Step 1. For example, if a 5 percent peak period threshold definition is selected, a period representing the level where 5 percent of the rolling average increments are higher and 95 percent are lower should be used.

The number of operations in the selected period represents the peak period level of operations.

Exhibit 6.7 describes two approaches for estimating future peak period operations independently of the design day. The first approach is simpler and can be applied if no peak spreading or other change in the distribution of operations throughout the day is anticipated. The first approach involves the steps below:

1. Select the annual operations forecast to be used and the desired year from that forecast.

2. Calculate the ratio of existing peak period operations to existing annual operations.

3. Apply the ratio calculated in Step 2 to future annual operations.

4. The result is an estimate of future peak period operations.

Exhibit 6.6

Process for Estimating Existing Peak Period Aircraft Operations (Defined Independently of Design Day)

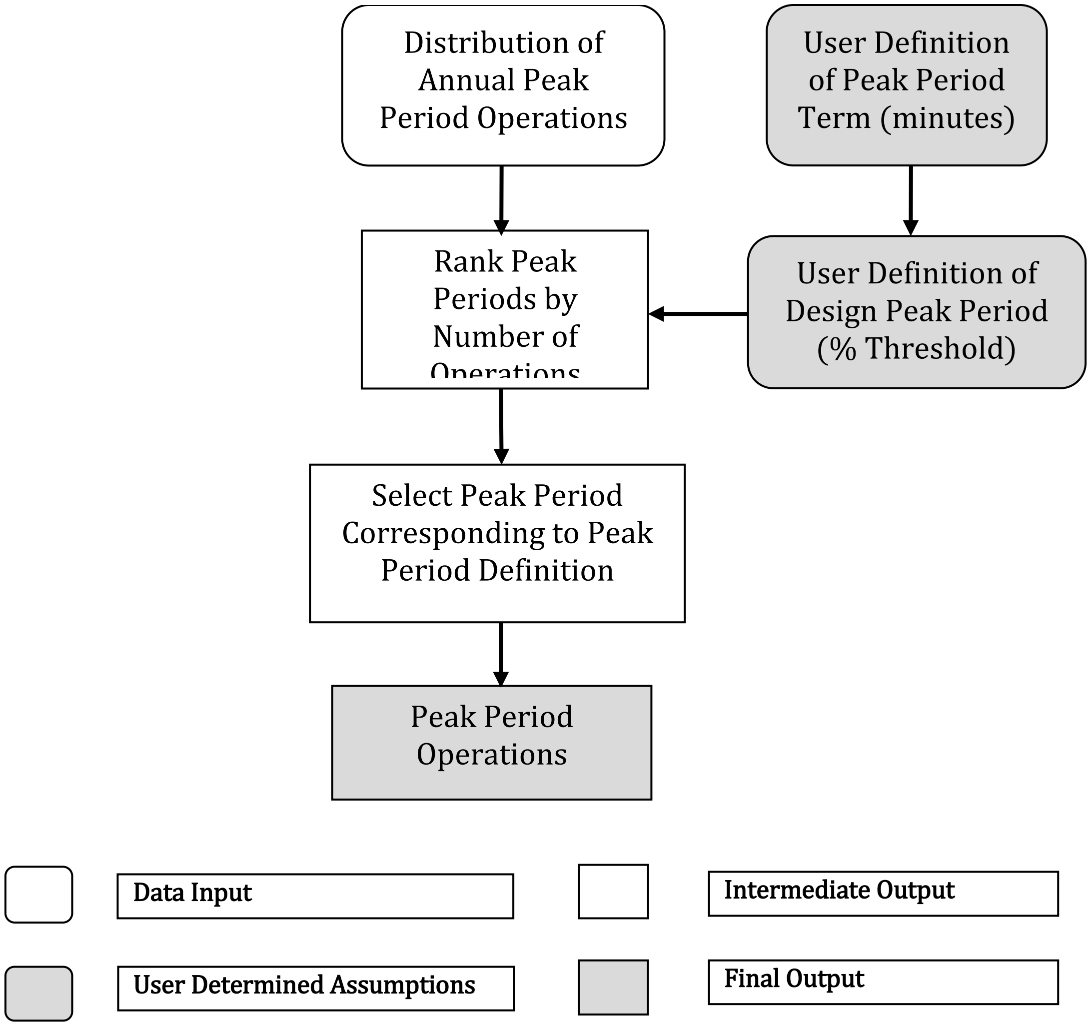
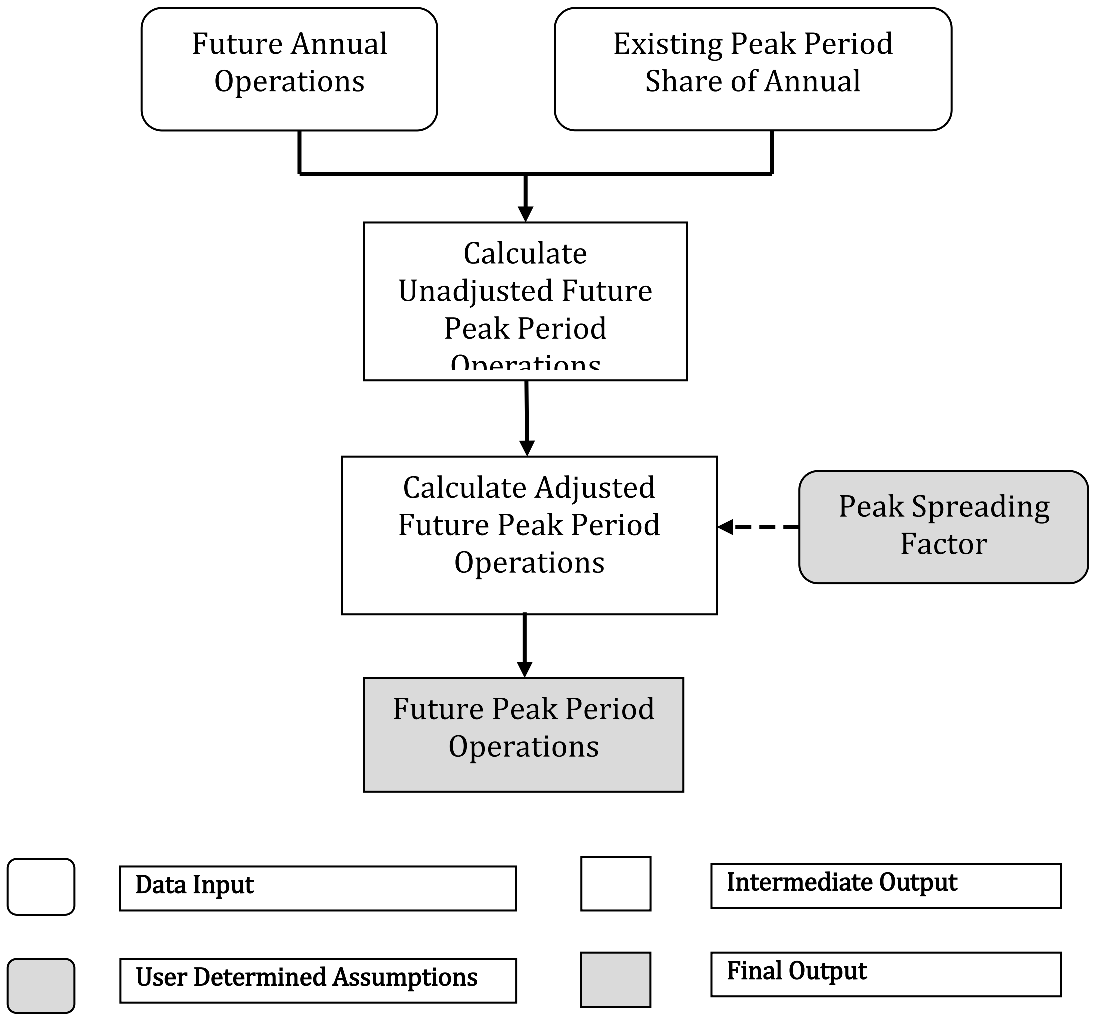


Exhibit 6.7

Process for Estimating Future Peak Period Aircraft Operations (Defined Independently of Design Day)



The second approach should be used if a peak spreading factor is applied and if separate calculations for aircraft arrivals and departures are preformed, since there is a chance that the resulting peak period operations could shift. To account for this, use the following steps:

1. Select the annual operations forecast to be used.

2. Obtain the existing annual distribution of aircraft arrivals and departures by time of day as in Step 3 of the Existing Peak Period estimate.

3. Scale up the existing distribution of aircraft arrivals and departures using the ratio of future annual operations to existing annual operations to generate an unadjusted future distribution of aircraft arrivals and departures.

4. Apply the peak spreading factor to the unadjusted future distribution of aircraft arrivals and departures to generate adjusted future distributions of aircraft arrivals and departures.

5. Sum the adjusted distributions of arrivals and departures to produce an adjusted distribution of aircraft operations.

6. Select the peak period to be analyzed (e.g., 20-minutes, 30-minutes, 60 minutes, 120 minutes) and use the distributions obtained in Step 5 to calculate a rolling average of operations (based on an increment equal to the selected peak period) by time of day.

7. Sort the rolling operations calculated in Step 6 from highest to lowest.

8. Once the sort is complete, select the period that corresponds to the defined peak period threshold. For example, if a 5 percent design day definition is chosen, select the period representing the level where 5 percent of the rolling average increments are higher and 95 percent are lower.

9. The number of operations in the selected period represents the peak period level of operations.

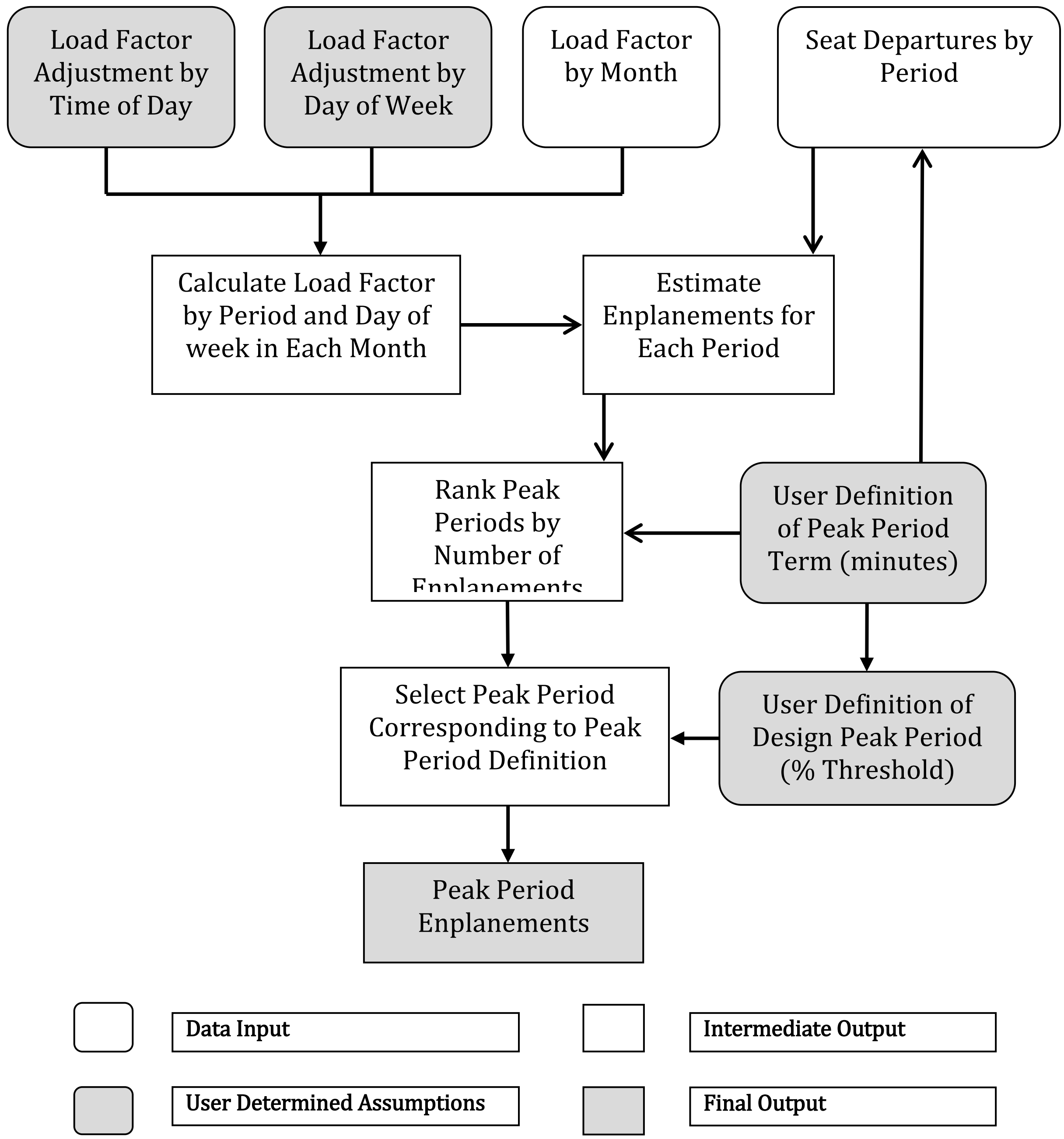
Exhibit 6.8 presents an approach for estimating existing peak period passengers independently of the design day definition. The following steps are involved:

1. Select the definition of the peak period (in minutes) and threshold for defining the peak period (5%, 10%, etc.)

2. Estimate the passenger capacity (seat departures and arrivals). Use the OAG to directly obtain the scheduled time for each flight arrival or departure in the year, along with the number of available seats in the aircraft, or use ETMS data to obtain actual seat arrivals and departures by flight time for each flight in the year. The ETMS data is not available to the public in this form, so this will require a special request to the FAA. Again, these approaches are not perfect. Not all the scheduled flights in the OAG are completed, and for various technical reasons, ETMS does not capture and identify 100 percent of all flights.

Exhibit 6.8

Process for Estimating Existing Peak Period Passenger Enplanements (Defined Independently of Design Day)



3. Next obtain passenger load factor by month from local Airport statistics, if available, or the T-100 data base. If load factor is not readily available, it can be calculated by

dividing monthly enplanements or deplanements by the corresponding monthly seat arrivals and seat departures aggregated from the information collected in Step 2.

4. Obtain load factor adjustments for the day of the week. If this cannot be obtained directly from the airlines, use the default load factor adjustment factors contained in Appendix C of the Guidebook.

5. Multiply passenger capacity (seat arrivals and departures) in each day by the average load factor for the month to generate an initial estimate of passengers for each day.

6. Adjust the passenger estimates calculated in Step 4 by the day-of-week load factor adjustment factors obtained in Step 3.

7. Obtain load factor adjustments for the hour of the day for arrivals and departures. If this cannot be obtained directly from the airlines, the default load factor adjustment factors contained in Appendix C of the Guidebook may be used.

8. Apply the load factor adjustment factors by time of day from Step 7 to the day-of-week load factor estimates in Step 6 to generate adjusted load factor by day and time of day.

9. Apply the load factors from Step 8 to the corresponding flights and associated seat capacities calculated in Step 2.

10. Use the passenger estimates calculated in Step 9 along with the peak period term defined in Step 1 to estimate rolling averages of passenger arrivals for the year.

11. Sort the periods calculated in Step 10 by the number of passengers from highest to lowest.

12. Once the sort is complete, select the period that corresponds to the defined peak period threshold identified in Step 1. For example, if a 5 percent peak period definition is chosen, select the period representing the level where 5 percent of the rolling average increments are higher and 95 percent are lower.

13. The number of passengers in the selected period represents the peak period passenger level.

Exhibit 6.9 describes two approaches for estimating future peak period passenger enplanements and deplanements independent of the design day definition. The first approach is simpler and can be applied if no peak spreading factor or changes in the hourly distribution of passengers are anticipated. The first approach involves the steps below:

1. Select the annual passenger forecast.

2. Calculate the ratio of existing peak period passengers (from Exhibit 6.8) to existing annual passengers.

3. Apply the ratio calculated in Step 2 to future design day passengers.

4. The result is an estimate of future peak period passengers. The same approach can be used to calculate peak period enplanements, deplanements, or total passenger movements.

The second approach should be used if a peak spreading factor is applied and if separate calculations for passenger enplanements and deplanements are performed to generate total passenger movements, since there is a chance that the resulting peak period for passenger movements could shift. To account for this, use the following steps:

1. Select the annual passenger forecast.

2. Obtain the existing annual rolling distribution of passenger enplanements and deplanements. This is covered in Steps 2 through 9 in the existing passenger peak period analysis (Exhibit 6.8).

3. Scale up the existing annual distribution of passenger enplanements and deplanements using the ratio of future annual passengers to existing annual passengers to generate an unadjusted future distribution of enplanements and deplanements.

4. Apply the peak spreading factor to the unadjusted future distribution of passenger enplanements and deplanements to generate adjusted future distributions of aircraft enplanements and deplanements.

5. Sum the adjusted distributions of enplanements and deplanements to produce an adjusted distribution of annual passenger movements.

6. Select the peak period to be analyzed (e.g., 20-minutes, 30-minutes, 60 minutes, 120 minutes) and use the distributions obtained in Step 5 to calculate a rolling average of enplanements, deplanements, or passenger movements (based on an increment equal to the selected peak period) by time of day for the entire year.

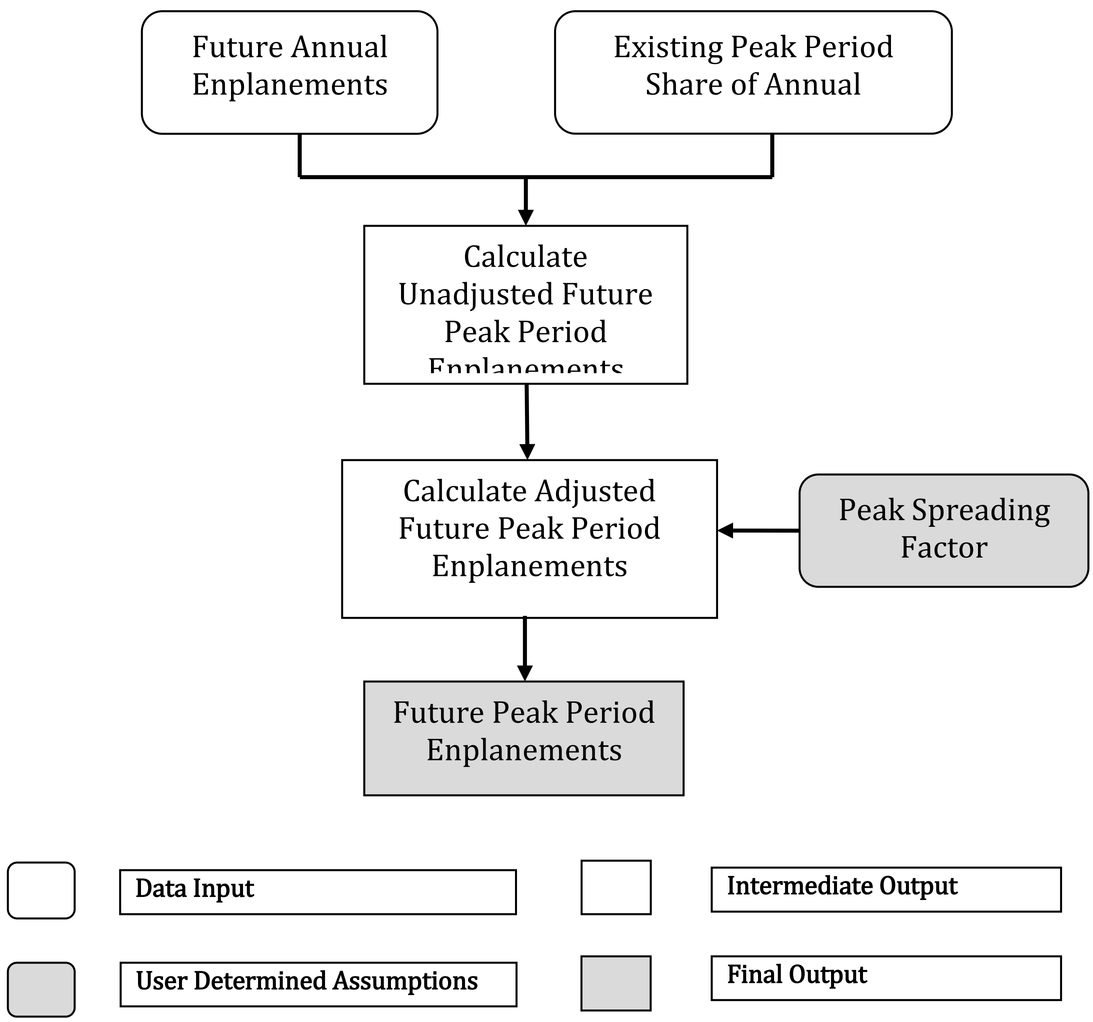
7. Sort the periods calculated in Step 6 by the number of passengers from highest to lowest.

8. Once the sort is complete, select the period that corresponds to the defined peak period threshold. For example, if a 5 percent peak period definition is selected, choose the period representing the level where 5 percent of the rolling average increments are higher and 95 percent are lower.

9. The number of passengers in the selected period represents the peak period passenger level.

Exhibit 6.9

Process for Estimating Future Peak Period Passenger Enplanements (Defined Independently of Design Day)



CHAPTER SEVEN: VALIDATION

Once completed in draft form, the Guidebook and Toolbox were tested and validated. There were two main aspects to the testing. First, field tests with representatives from a selection of airports were carried out to ensure the Guidebook and Toolbox met the needs of the intended audience. Secondly, the results of the Toolbox were tested against historical data and alternative forecasts.

7.1. Field Tests

The approach and the results of the airport field tests are described below.

7.1.1. Background

Field tests of the Guidebook and Toolboxes were conducted between November 2011 and January 2012 to assess their usability under real world conditions. Initially, the intent was to test the Guidebook and Toolboxes for each of the following types of airports:

- Non-Hub
- Small-Hub
- Medium-Hub
- Large-Hub
- International Gateway
- Domestic Connecting
- Low Fare Carrier Dominated
- Domestic O&D
- Eastern U.S. (Eastern Time Zone)
- Central U.S. (Central Time Zone)
- Rocky Mountain Area (Mountain Time Zone)
- Western U.S. (Pacific Time Zone)

During the Panel meeting of May 2010, the list of case study airports was reduced to three. Airports meeting some of the above criteria were already represented on the Panel; and it was therefore determined that three case study airports could provide coverage for a large portion of the remaining categories. The selected case study airports (or airport sponsors, since some organizations are responsible for more than one airport) cover a broad range of activity levels, geographic locations, and service roles while recognizing the limitations inherent in there being only three case study airports, available resources, and the demands on the time of participants.

The selected case study airports included:

- Port Authority of New York and New Jersey (PANYNJ)
- Sea-Tac International Airport
- Newport News/Williamsburg International Airport

The PANYNJ was chosen because they control several airports, accommodating a range of service levels and a variety of roles. These include New York JFK - a major international gateway that also serves as a hub for a major low-cost carrier (JetBlue); Newark - also a major international gateway and a hub for a major airline (United/Continental); La Guardia - a major domestic O&D airport that can also serve as a test case for slot controlled distributions; Stewart – a non-hub airport with some passenger service; and Teterboro - a major general aviation airport.

Sea-Tac International Airport is located on the West Coast, has significant international service, and serves as a domestic hub for a mid-size carrier (Alaska Airlines). Newport News/Williamsburg International Airport is located in the Southeast and is representative of small hub airports.

Since Denver, Milwaukee, and Columbus are represented on the Panel, two medium hubs and one large connecting hub covering the Central and Mountain Time Zones were already included in the review process.

7.1.2. Field Test Process

The field tests consisted of two stages.

First, the draft Guidebook and Toolboxes were submitted to the case study airport with minimal guidance other than that provided in the Guidebook. The intent was to simulate the eventual real-world use of the Guidebook and to thereby identify and detail problems (complexity, documentation, etc.) so that they could be resolved in the final deliverable.

The second stage was a visit to the Airport. This included a walk-through of the passenger and operations modules of the Toolbox, and a frank discussion on the advantages, disadvantages, and potential areas of improvement for the Guidebook and Toolbox.

7.1.3. Findings

In general, the airport representatives thought the Guidebook and Toolboxes would be useful tools especially when time and resources were short. One potential application that was noted was preliminary sketch planning for the purpose of writing tighter and more strictly defined work-scopes for consultants. The Guidebook and Toolboxes could be used to assist in initial screening to eliminate unneeded tasks.

Representatives of the case study airports also provided more detailed insights and recommendations for both the Guidebook and the Toolboxes.

Guidebook Findings

The airport representatives thought the Guidebook was generally clear and easy to follow, but provided the following recommendations for improvement:

> ***ACRP Forward:*** Make reference to the current austere times that airports are facing, and that planners will need to be more precise (something the Guidebook and Toolbox will facilitate) to make the best use of capital development dollars. There was a comment that the ACRP should promote itself more, and better explain how its research efforts assist the aviation community.
>
> ***Table of Contents:*** Add hot links to the table of contents in the final draft so that the reader can be immediately directed to their area of interest.
>
> ***Design Day Percentiles:*** Briefly describe when different percentiles would be appropriate. For example, 98 percent would be appropriate for baggage claim because of limited queuing area. Alternatively, retail concessions space requirements are based on annual numbers. This may be an appropriate discussion to include in the Comments and Cautions section of the Peak Period section.
>
> ***Peak Period Definitions:*** Include a list of peak period definitions (15 minute, 30 minutes, 1 hour, etc.) that are appropriate for planning alternative facilities, ticketing, baggage claim, etc. This could be another appendix to the Guidebook.
>
> ***Peak Spreading:*** Add more discussion of peak spreading and the factors that are involved, including the types of circumstances that would increase or decrease the rate of peak spreading.
>
> ***Screenshots:*** Expand the capture areas of the smaller screenshots to let the user to more easily determine where they are within the Toolbox worksheets. Create tags within specific parts of the screenshots to better reference the specific parts of the screenshots that are being discussed in the text.

The ACRP will determine how the first two comments are addressed at the time of publication. The remaining comments were incorporated into the final draft of the Guidebook with the exception of design day percentiles. There is insufficient information available to provide reliable guidance on the appropriate design day percentile for each facility category. Therefore, this decision will remain with the user.

Toolbox Findings

The case study airport representatives stated that they liked the relative simplicity of the Toolbox modules. In particular they appreciated that they did not have to perform much up-front data collection or assembly to generate results. They also appreciated the color coding and the pull-down menus. They offered the following recommendations for technical and documentation improvements:

> ***Design Day Profiles:*** One of the airports evaluated during the field tests with the PANYNJ was Stewart International Airport (SWF). Passenger service at SWF is

currently very limited, but expectations are that there will be significant growth there because of capacity constraints at the three main airports serving the region. One of the issues uncovered during the test is that the model does not fill in empty hours. For example, currently there are no arriving flights at SWF during the 18:00-18:59 hour and therefore no arriving passengers. This is not unusual for an airport with the 200,000 enplanements that SWF processed in 2011. This would, however, be very unusual at an airport with 7 million enplanements as the PANYNJ projects for SWF in 2025. Unfortunately, because the current version of the Toolbox does not fill in empty hours, the gap remains, and the peaks are likely slightly overstated even with the peak spreading algorithm (see Exhibit 7.1). This issue is also relevant to the peak period calculation. For example, at small airports the peak 15 minutes accounts for a larger percentage of the peak hour than at large airports. However, this spreading within the hour is not accounted for within the model. A disclaimer should be added to note that these issues arise when very large growth percentages are anticipated.

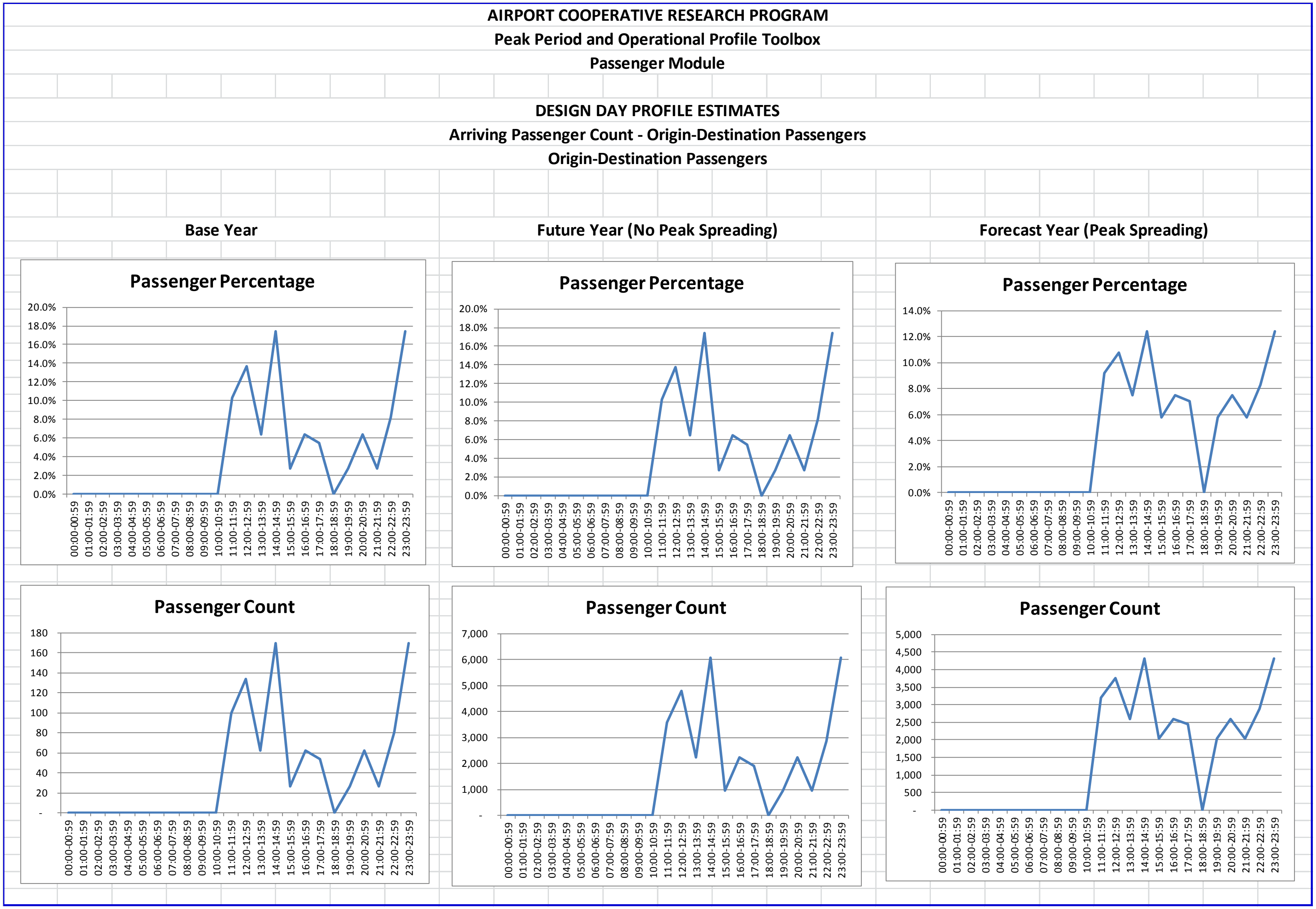
Disaggregation: Some respondents wanted the ability to disaggregate the input data and results by category. For example, separate categories of activity such as domestic and international passengers, with differing profiles and growth rates, could be entered, to derive a combined future design day profile.

Lead and Lag Factors: Two of the airport representatives noted that lead distributions in the early morning tend to be much more compressed than during the remainder of the day. They expressed the desire that the Toolbox allow separate sets of lead distributions to be entered depending on the time of day. One airport currently possesses five different sets of lead distributions depending on the day of the week and the time of day.

One airport representative noted that the lead and lag times in the draft version of the Toolbox could not exceed 130 minutes without corrupting the results.

Exhibit 7.1

SWF Design Day Profile Output



Format – User Parameters Worksheet: The following recommendations were offered to improve the User Parameters worksheet:

- Specify that monthly enplanement inputs should be for base year.
- Provide more detailed and specific explanation of day-of-the-week load factor adjustment factors.
- Alert user that there is a second page in the User Parameters worksheet.
- Provide user with option of using side area as for independent calculations. It was protected in the initial versions of the Toolbox.

Format – Base Year Data Worksheet: The following recommendations were offered to improve the Base Year Data worksheet:

- Provide an option to enter total seats (which the model would then divide by two to generate arriving and departing seats) rather than separately entering arriving and departing seats.
- Provide user with option of using side area as for independent calculations.

Format – Output Worksheets: The following recommendations were offered to improve the Output Worksheets:

- Automatically list key assumptions on each output worksheet. It will be a useful reminder when the output sheets are printed.
- Overlay the graphic output so that current and future design profiles can be directly compared.

Most of the above recommendations were incorporated into the final versions of the Toolbox modules. Because of budget limitations it was not possible to reconfigure the Toolbox modules to be able to generate results that are disaggregated by category.

7.1.4. Summary

The field tests incorporated fresh perspectives that uncovered potential problems that would otherwise been unresolved. The recommendations provided by the airport participants were thoughtful and led to the improvement of both the Guidebook and Toolbox.

7.2. In-House Testing

The passenger and operations Toolbox modules were tested against both historical data and an alternative forecast. Ideally the testing would have incorporated a large sample of airports, time periods, and alternative forecasting approaches. This was not possible for several reasons including:

- Limited resources

- Limited inexpensive historical airline schedule data
- The effort involved to reconcile alternative data sources to ensure a proper comparison
- Limited access to detailed back-up data for forecasts prepared by other consultants
- The lack of growth at most airports over the past ten years, which inhibits the testing of various features of the Toolbox such as peak spreading.

For these reasons, the testing was focused on Denver International Airport (DEN) which 1) was able to provide the required data, and 2) has grown over the past decade. The analyses involved a test against historical data and a test against a current forecast.

7.2.1 Historical Test

Using Noise and Operations Management System (NOMS) data obtained from DEN and operations data from the FAA, detailed flight schedule information was assembled for 2005. The 2005 data were entered to represent the base year in the Toolbox modules. Actual 2011 annual passenger and operations levels were entered as “forecast” numbers in the User Parameters worksheets. The 2011 “forecasts” of design day and peak period activity from the Toolboxes were then compared to actual 2011 design day and peak period activity levels.

Two sources were used to estimate the actual 2011 peak period. First, 2011 NOMS data was used to estimate these reference activity levels in the same way that the 2005 NOMS data was used to estimate base year levels. Secondly, DEN provided a current design day flight schedule (DDFS) which was used as an alternate source of information on current peak period levels.

Exhibit 7.2 summarizes the results for the operations module of the Toolbox.

Exhibit 7.2

Comparison of Design Day Flight Schedule and Operations Toolbox Results: Historical Test

	2005 "Base Year"	2011 "Forecast"	2005-2011 Growth
Annual Operations			
Actual (a)	562,039	634,680	12.9%
Toolbox	562,039	634,680	12.9%
Difference	0.0%	0.0%	
Peak Hour Arrivals			
Actual (a)	82	88	7.3%
Toolbox - without peak spreading	82	92	12.2%
Difference	0.0%	4.5%	
Toolbox - with peak spreading	82	90	9.8%
Difference	0.0%	2.3%	
Peak Hour Departures			
Actual (a)	82	97	18.3%
Toolbox - without peak spreading	82	92	12.2%
Difference	0.0%	-5.2%	
Toolbox - with peak spreading	82	90	9.8%
Difference	0.0%	-7.2%	
Combined Peak Operations			
Actual (a)	147	159	8.2%
Toolbox - without peak spreading	147	166	12.9%
Difference	0.0%	4.4%	
Toolbox - with peak spreading	147	162	10.2%
Difference	0.0%	1.9%	

(a) Actual based on NOMS data for July 2005 and July 2011.

Sources: Denver International Airport and HNTB analysis.

The 2011 "with peak spreading" projections for peak hour arriving operations and combined peak operations are similar to actual 2011 levels, varying by 2.3 percent and 1.9 percent respectively. However, the projection of peak hour departing operations is significantly understated when compared to actual peak hour departures, varying by more than 7 percent if peak spreading is assumed and by more than 5 percent even if no peak spreading is assumed.

Actual peak hour departures grew by 18.3 percent from 2005 to 2011, compared to annual operations which grew at 12.9 percent over the same period. It is unusual for an airport of DEN's size to experience an increase in the degree of peaking as activity grows. Although conjectural, it is possible that the entry of Southwest Airlines into the market since 2005 has increased the degree of competition during the mid-morning departure peak, and that has increased the number of flights during that time more than would have been the case without the entry of a major new airline.

Exhibit 7.3 presents the results for the passenger module of the Toolbox.

Exhibit 7.3

Comparison of Design Day Flight Schedule and Passenger Toolbox Results: Historical Test

	2005	"Forecast" Compared to 2011		Increase over base year	
	"Base Year"	DDFS (a)	NOMS	DDFS (a)	NOMS
Annual Passenger Enplanements					
Actual (b)	21,662,807	26,455,815	26,455,815	22.1%	22.1%
Toolbox	21,662,807	26,455,815	26,455,815	22.1%	22.1%
Difference	0.0%	0.0%	0.0%		
Average Day Peak Month Enplanements					
Actual (b)	68,812	81,393	82,155	18.3%	19.4%
Toolbox	68,812	84,025	84,025	22.1%	22.1%
Difference	0.0%	3.2%	2.3%		
Peak Hour Deplanements					
Actual (b)	6894	9038	8075	31.1%	17.1%
Toolbox - without peak spreading	6894	8418	8418	22.1%	22.1%
Difference	0.0%	-6.9%	4.2%		
Toolbox - with peak spreading	6894	8132	8132	18.0%	18.0%
Difference	0.0%	-10.0%	0.7%		
Peak Hour Enplanements					
Actual (b)	6609	9393	8853	42.1%	34.0%
Toolbox - without peak spreading	6609	8070	8070	22.1%	22.1%
Difference	0.0%	-14.1%	-8.8%		
Toolbox - with peak spreading	6609	7803	7803	18.1%	18.1%
Difference	0.0%	-16.9%	-11.9%		
Combined Peak Passengers					
Actual (b)	12744	16228	14414	27.3%	13.1%
Toolbox - without peak spreading	12744	15562	15562	22.1%	22.1%
Difference	0.0%	-4.1%	8.0%		
Toolbox - with peak spreading	12744	15041	15041	18.0%	18.0%
Difference	0.0%	-7.3%	4.3%		

(a) Design Day Flight Schedule.
(b) Actuals for 2005 and 2011 NOMS calculated from NOMS data and actuals for 2011 DDFS calculated from Design Day Flight Schedules.

Sources: Denver International Airport and HNTB analysis.

The peak hour estimates based on the NOMS and DDFS data differ in several respects. First, the flight times in the NOMS data are actual runway times whereas the flight times in the DDFS are scheduled gate times. Secondly, the NOMS-based peak data assumes a single load factor applied across all flights, whereas the DDFS load factors differ by airline and market. Since the NOMS data incorporate delays, the peaks in the NOMS data tend to be more distributed than those in the DDFS.

The Toolbox forecast overstated ADPM passenger enplanements by about 3 percent, compared to both the NOMS and DDFS 2011 data. This occurred because the peak month at DEN became less intense between 2005 and 2011. In 2005, the ADPM represented the 33rd busiest day of the year (9 percent) but by 2011 it was equal to the 53rd busiest day of the year (15 percent). Because the Toolbox assumes a constant peak month percentage, this change was not captured.

The Toolbox forecast of peak hour deplanements, with peak spreading, was very similar to the NOMS 2011 estimate (0.7 percent) but much lower than the DDFS estimate. Since the Toolbox used NOMS data for the base year, it is expected that the results would more closely match the NOMS 2011 estimates than the DDFS 2011 estimates.

The passenger Toolbox module significantly understated peak hour enplanements, in comparison to either the NOMS estimate or the DDFS estimate. This result is similar to the result from the operations Toolbox module.

The Toolbox forecast overstated combined (enplaned plus deplaned) peak hour passengers when compared to the 2011 NOMS estimate but understated peak hour passengers when compared with the DDFS estimate.

Much of the variation in the results can be explained by the ways in which the differing peak hour categories have evolved at DEN between 2005 and 2011. Using the NOMS estimates, peak hour deplanements grew 17.1 percent between 2005 and 2011 (lower than the annual growth of 22.1 percent over the same period). Conversely, peak hour enplanements grew 34.0 percent over the same period, much faster than annual enplanements. Combined peak hour passengers grew 13.1 percent, much more slowly than annual passengers.

As noted in Section 4.1.5, the entry of a new carrier such as Southwest, can be a game-changer that alters the existing pattern of peak activity at an airport, and this appears to have occurred at DEN. In addition, average load factors increased significantly between 2005 and 2011, and this may have also affected the results.

7.2.2. Comparison with Existing Forecast

The second part of the in-house testing involved a comparison of the Toolbox with the 2015 and 2020 DDFS forecasts prepared for DEN. Since the DDFS does not include cargo, general aviation, and military operations, the comparison was limited to passenger operations. Also, the 2011 DDFS was used to generate the base year data that went into the Toolboxes, to ensure a consistent comparison. Exhibit 7.4 summarizes the comparison for aircraft operations.

Exhibit 7.4

Comparison of Design Day Flight Schedule and Operations Toolbox Results: Forecast Test

				Increase over base year	
	2011	2015	2020	2015	2020
Annual Operations (a)					
Design Day Schedule	615,400	654,800	730,000	6.4%	18.6%
Toolbox	615,400	654,800	730,000	6.4%	18.6%
Difference	0.0%	0.0%	0.0%		
Peak Hour Arriving Operations (a)					
Design Day Schedule	87	92	100	5.7%	14.9%
Toolbox - without peak spreading	87	93	104	6.9%	19.5%
Difference	0.0%	1.1%	4.0%		
Toolbox - with peak spreading	87	92	101	5.7%	16.1%
Difference	0.0%	0.0%	1.0%		
Peak Hour Departing Operations (a)					
Design Day Schedule	107	111	120	3.7%	12.1%
Toolbox - without peak spreading	107	113	127	5.6%	18.7%
Difference	0.0%	1.8%	5.8%		
Toolbox - with peak spreading	107	112	124	4.7%	15.9%
Difference	0.0%	0.9%	3.3%		
Combined Peak Operations (a)					
Design Day Schedule	176	184	203	4.5%	15.3%
Toolbox - without peak spreading	176	187	209	6.3%	18.8%
Difference	0.0%	1.6%	3.0%		
Toolbox - with peak spreading	176	185	204	5.1%	15.9%
Difference	0.0%	0.5%	0.5%		

(a) Operations include only commercial passenger aircraft operations.

Sources: Denver International Airport and HNTB analysis.

The annual forecasts used to generate the Toolbox projections are the same as the projections used for the DDFS schedules, so none of the differences in the results can be attributed to differences in the annual forecasts.

The Toolbox projections of arriving operations (with peak spreading) are very similar to the DDFS projections, differing by 0.0 percent in 2015 and by 1.0 percent in 2020. Regarding departing operations, the Toolbox projects less peak spreading, even with the peak spreading assumption, than the DDFS projections. The Toolbox (with peak spreading) combined peak hour operations forecast is very similar to the DDFS projection, differing by 0.5 percent in both 2015 and 2020.

Similar to the historical data, there appears to be more divergence in the departure peak results than in the arrival peak or combined peak results.

Exhibit 7.5 provides a comparison of the passenger Toolbox module results and the DDFS peak passenger projections.

Exhibit 7.5

Comparison of Design Day Flight Schedule and Passenger Toolbox Results: Forecast Test

				Increase over base year	
	2011	2015	2020	2015	2020
Annual Passenger Enplanements					
Design Day Schedule	26,574,100	28,877,700	33,153,400	8.7%	24.8%
Toolbox	26,455,815	28,877,700	33,153,400	9.2%	25.3%
Difference	-0.4%	0.0%	0.0%		
Average Day Peak Month Enplanements					
Design Day Schedule	81,393	88,864	101,386	9.2%	24.6%
Toolbox	81,230	88,666	101,794	9.2%	25.3%
Difference	-0.2%	-0.2%	0.4%		
Peak Hour Deplanements					
Design Day Schedule	9038	9360	10365	3.6%	14.7%
Toolbox - without peak spreading	8783	9608	11031	9.4%	25.6%
Difference	-2.8%	2.6%	6.4%		
Toolbox - with peak spreading	8783	9466	10629	7.8%	21.0%
Difference	-2.8%	1.1%	2.5%		
Peak Hour Enplanements					
Design Day Schedule	9393	9932	10887	5.7%	15.9%
Toolbox - without peak spreading	9129	9964	11440	9.1%	25.3%
Difference	-2.8%	0.3%	5.1%		
Toolbox - with peak spreading	9129	9829	11050	7.7%	21.0%
Difference	-2.8%	-1.0%	1.5%		
Combined Peak Passengers					
Design Day Schedule	16228	17090	19050	5.3%	17.4%
Toolbox - without peak spreading	15815	17281	19840	9.3%	25.5%
Difference	-2.5%	1.1%	4.1%		
Toolbox - with peak spreading	15815	17047	19170	7.8%	21.2%
Difference	-2.5%	-0.3%	0.6%		

Sources: Denver International Airport and HNTB analysis.

Even though Toolbox and DDFS base year numbers were developed from the same schedule, there is a slight difference in the passenger numbers because the Toolbox applies the same load factor across all flights whereas the DDFS approach applied load factors based on airline and market.

The Toolbox and DDFS projections of ADPM enplanements are very similar, not unexpected since both forecasts use the same annual passenger projections.

Peak hour deplanement projections from the Toolbox and DDFS differ by 1.1 percent in 2015 and 2.5 percent in 2020. The true difference is greater, however, since the base year number from the Toolbox is lower. For example, the DDFS projects peak hour deplanements to increase 14.7 percent through 2020, while the Toolbox projects an increase of 21.0 percent, even with peak spreading.

The DDFS peak hour enplanement projections also assume more peak spreading than the Toolbox. Between 2011 and 2020, the DDFS projects a 15.9 percent increase in peak hour enplanements while the Toolbox, with peak spreading, projects a 21.2 percent increase. The results for combined peak hour enplanements and deplanements are closer, but the DDFS still assumes slightly more peak spreading.

7.3. Summary

The field tests and in-house testing have helped improve the usability and computational integrity of the Guidebook and Toolbox modules. Nevertheless, the tests demonstrate that the Toolbox modules cannot exactly duplicate historical trends or the results of other forecast approaches. A degree of uncertainty will always exist in any forecast approach.

CHAPTER EIGHT: RECOMMENDATIONS

This chapter concludes the study with suggestions for an implementation program and recommendations for future research.

8.1. Suggested Implementation Program

In many respects, the Guidebook and Toolbox represent a new way of doing things. Time and effort will be required to educate the aviation planning community on the uses and limitations of these tools. The Guidebook and Toolbox offer the benefits of speed, standardization, flexibility in defining service levels, and the ability to quickly model multiple scenarios. They do, however, require some investment on the part of the user to become familiar with their features.

In addition, the Toolbox requires more input data for the than traditional approaches to the calculation of peak hour and operational profile estimates. Many of these data sources are becoming readily available through the efforts of the FAA, the US DOT and others, but the additional data requirements may be intimidating to occasional users.

Finally, the Guidebook provides default factors for day-of-the-week and time-of-day load factor adjustments, as well as suggested peak period intervals. It is noted that these factors may not be representative for an individual airport, but the potential exists that they may be used incorrectly because of their accessibility.

An interactive dissemination strategy is recommended to address the above issues. After the Guidebook and Toolbox are made available the general public by the ACRP, the tools would benefit from being explained and promoted at various venues such as:

- The Transportation Research Board's annual meeting;
- The Airport Council International's (ACI) Economics and Finance Conference;
- AAAE conferences and planning workshops; and
- ACC/FAA Planning Workshops.

Whenever feasible, the emphasis should be on providing potential users hands-on experience with the Toolbox so that they can become familiar and comfortable with its capabilities.

8.2 Suggestions for Future Research

Although the literature review, interviews, surveys, and research provided much information on current practice regarding the projection of peak activity metrics and operational profiles, it also revealed gaps in the current knowledge base and assumptions that should perhaps be scrutinized more closely. Some of the more critical questions include:

- *The stability of the peak month*. Although it is acknowledged that hour peak spreading will occur as an airport becomes busier, all the airport studies that were examined assumed that the peak month share of annual activity will remain constant. The analysis in Appendix G indicates that there has been no net discernible change in the peak month percentage between 2003 and 2008, although there have been year-to-year fluctuations. Additional research needs to be conducted to determine whether the constant share assumption holds over longer periods of time, especially for fast growing airports, and whether it holds for different categories of activity such as domestic and international passengers, and commercial vs. general aviation operations.
- *The extent of peak spreading over time*. Many sources advise that the peak hour percentage declines as an airport gets busier and this phenomenon is supported by cross-sectional analysis (see Appendix H). Analysis of the evolution of the peak hour for a single airport over a long period of time is lacking, however. In addition, more work needs to be done on the factors, other than total activity, that help determine the rate of peak spreading.
- *Characteristics of extreme peaks*. It is not cost-effective to design facilities to accommodate the types of extreme peaks that may be generated by very adverse weather or other emergencies. Nevertheless, airports need contingency plans to deal with these events and to develop these plans; they need some idea of the expected activity level. These extreme peaks occur rarely, and an examination of annual data is unlikely to reveal the potential magnitude of these peaks. Research on the degree and characteristics of these peaks would be very useful for contingency planning and could possibly be incorporated into later versions of the Guidebook and Toolbox.
- *The split between O&D and connecting traffic by time of day*. The airlines were unable to provide usable information on the O&D connecting split in Task 4. There is anecdotal and theoretical evidence that the split varies significantly by time of day, but short of doing a very comprehensive passenger survey it is not possible to quantify this distribution.
- *The use of existing schedules to prepare future design day schedules*. It is a very common practice to begin with a current flight schedule when preparing a future flight schedule. New times are only selected for new flights. The analysis in Appendix Q suggests that the addition of a new flight to an existing market can trigger a rearrangement of the scheduled times of the existing flights to that market, to promote better coverage. More analysis on how airlines adjust schedules to accommodate a change in frequency would be useful.
- *Airline banking structure*. One interviewee noted that the connecting banks differed in steepness (when operations are mapped across time of day) depending on the airline. For example, Northwest’s connecting banks became much steeper after its acquisition by Delta Air Lines. This is not typically considered in the preparation of design day schedules, and may in fact be distorted by cloning approaches that use a dispersion factor that is too large.

- *The assumption that day/night splits will be constant*. Absent knowledge of future schedule changes provided by the airlines, it is standard practice to assume that the split between daytime and nighttime operations will remain constant within each major category of activity. The analysis in Appendix J indicates that the nighttime share of total traffic has declined between 2001 and 2008. More research needs to be conducted to determine the factors that affect changes in day/night distributions.
- *Changes in Lead and Lag factors.* Airport surveys indicate that these factors, especially the lead factors, increase as security requirements become more stringent and then decrease slightly as passengers become more familiar with the amount of time they need to allow for these requirements. A systematic analysis of changes in lead and lag distributions over time and the factors that generate those changes would be useful for estimating future lead and lag distributions and upper and lower limits for scenario development.
- *Uncertainty*. Typically, uncertainty in annual forecasts is dealt with using ranges or scenarios, and these adjustments are directly translated to peak period forecasts and operational profile estimates. Little work has been done on uncertainty associated with peak period estimates and operational profiles that is independent of the uncertainly associated with annual forecasts.

Some of these issues have been partially addressed in previous chapters of this report and in the Guidebook; however, there are ample opportunities for additional research. Ideally, as the research is conducted and publicized over the years, the availability of information from which default factors can be drawn will be enhanced.

References:

1. Cassidy, M. and Navarrete, J., *ACRP Report 23: U.S. Airport Passenger-Related Processing Rates,* Transportation Research Board, Washington, D.C., 2009.
2. Biggs, D. C., M. A. Bol, J. Baker, G. D. Gosling, J. D. Franz, and J. P. Cripwell, *ACRP Report 26: Guidebook for Conducting Airport User Surveys,* Transportation Research Board, Washington, D.C., 2009.
3. Landrum & Brown, Hirsch Associates Ltd., Planning Technology, Inc., and Presentation & Design, Inc., *ACRP Report 25, Airport Passenger Terminal Planning and Design,* Transportation Research Board, Washington, D.C., 2010.
4. *Airport Master Plans, Advisory Circular No: 150/5070-6B,* Federal Aviation Administration, Washington, D.C., July 29, 2005.
5. De Neufville, R. and A. Odoni, *Airport Systems: Planning, Design and Management*, McGraw-Hill Companies, New York, NY, 2003.
6. GRA, Inc., Forecasting Aviation Activity by Airport, Federal Aviation Administration, July, 2001.
7. Transportation Research Board, Aviation Demand Forecasting: A Survey of Methodologies, E-Circular No. E-C040, August 2002.
8. William Spitz and Richard Golaszewski, GRA, *Airport Aviation Activity Forecasting: A Synthesis of Airport Practice*, TRB, National Research Council, Washington, DC 2007.
9. International Civil Aviation Organization, *Airport Planning Manual, Doc 9184-AN/902 Part 1*, International Civil Aviation Organization, 1987.
10. Ashford, N., Stanton, H. P. M., and Moore, C. A., *Airport Operations*, 2nd edition, McGraw-Hill Professional, New York, NY, 1996.
11. *Emissions and Dispersion Modeling System (EDMS) User's Manual, FAA-AEE-07-01*, Federal Aviation Administration, Washington, D.C., September 19, 2008.
12. *Airport Capacity and Delay, Advisory Circular No: 150/5060*, Federal Aviation Administration, Washington, D.C., September 23, 1983.
13. Parsons Brinckerhoff, Landrum & Brown, and Airport Interviewing and Research , *FAA Regional Air Service Demand Study: Task E – Assessment of Authority Airports' Capacity to Meet Current and Forecasted Demand*, Federal Aviation Administration and the Port Authority of New York and New Jersey May 2007.
14. HNTB Corporation, *Tampa International Airport: Master Plan Update Report*, Hillsborough County Aviation Authority, Tampa, FL, December 2009.
15. HNTB Corporation and the LPA Group, Inc., *Airfield Development Planning: San Francisco International Airport: Draft Unconstrained Forecasts*, San Francisco International Airport, San Francisco, CA, May 2000.
16. Hartsfield Planning Collaborative, *Hartsfield Atlanta International Airport: Aviation Forecast Update*, Atlanta Department of Aviation, Atlanta, GA, May 31, 2002

17. *Planning and Design Guidelines for Airport Terminal Facilities, Advisory Circular No: 150/5360-13*, Federal Aviation Administration, Washington, D.C., April 22, 1988.
18. Cheryl B. Scaparrotta, *Travel Forecasting Takes Off*, The MITRE Digest, March 25, 2008
19. Bhadra, D., and J. Gentry, B. Hogan, and M. Wells, "Future air Traffic Timetable Estimator," *Journal of Aircraft,* Vol. 42, No. 2 (March-April 2005), pp. 320-328.
20. Chen, X. and J. Gulding, *Assessment of System Constraints for Producing Constrained Feasible Schedules*, Federal Aviation Administration, Washington, D.C.
21. Fratar, Thomas J., "Forecasting Distribution of Interzonal Vehicular Trips by Successive Approximations," *Highway Traffic Estimation*, edited by R. E. Schmidt and M.E. Campbell, Eno Foundation for Highway Traffic Control, Saugatuck, CT, 1956, pp. 376-384.
22. *Noise Control and Compatibility Planning for Airports, Advisory Circular No. 150/5020-1*, Federal Aviation Administration, August 5, 1983.
23. Leigh Fisher Associates, *FAR Part 150 Noise Study Update: Louisville International Airport*, Regional Airport Authority of Louisville and Jefferson County, Louisville, KY, January 2003.
24. DMJM Aviation and RS&H, *George Bush Intercontinental Airport: Master Plan Technical Reports*, Houston Airport System, Houston, TX, December 2006.

Appendix A

Literature Review

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix A: Literature Review

The following sources and data bases were examined for the literature review:

- FAA and FAA-sponsored documents;
- TRB and ACRP publications;
- Industry association publications (ICAO, AAAE, ACI, ATA, IATA);
- Industry Journal Articles;
- Textbooks and Guidebooks; and
- Airport Master Plan and forecast documents.

A.1 FAA Documents

Airport Master Plans, Advisory Circular No: 150/5070-6B, 2005

The FAA's new Advisory Circular on Airport Master Planning recognizes that the traditional approach of using the peak hour of an average day in the peak month may not be appropriate for all facilities analysis (*1*). It states:

> In the U.S., the evaluation of peak hour demand is often based on the peak hour of the average day of the peak month. This approach provides sufficient facility capacity for most days of the year, but recognizes there will be some very busy days that experience congestion, queues, and delays and that it is important that facilities are neither under- nor overbuilt. However, for some critical airport systems, the peak hour of the average day of the peak month can substantially understate the demand at peak times, resulting in unacceptable levels of service or overloading of systems to a point that may approach gridlock. Some components of the passenger terminal complex, such as baggage handling systems and security checkpoints, are particularly sensitive to this issue.
>
> To address these problems, planners may wish to consider alternate methodologies for determining peak hour demand, such as the percentile of busy hours throughout the year (for example, 90th or 95th percentile). A facility sized to meet such demands should have sufficient capacity and service levels during 90 percent or 95 percent of the hours throughout the year. The specific percentile will depend on the facility being evaluated, the desired level of service, and the unique demand characteristics of the study airport. (*1, p. 49*)

The AC also states that "Master plan forecasts must include appropriately defined peak period activity levels for facilities planning, such as terminal buildings and ground access systems (*1, p. 37*)." However, the AC does not provide guidance on how to forecast peak period activity.

Airport Capacity and Delay, Advisory Circular No: 150/5060-5, 1983

The FAA's AC on Airport Capacity and Delay is focused mostly on providing guidance to evaluate airfield capacity (*2*). The AC does suggest that design be based on hourly activity levels that occur at least once a week (introductory letter). Table 2-1 in the document provides ratios of busy day to annual operations and peak hour to busy day operations for a range of airport categories depending on the mix between light and heavy aircraft and the percentage of touch and go operations. The ratios are noted as assumptions and their source is not provided.

Planning and Design of Airport Terminal Facilities at Non-Hub Locations, Advisory Circular 150/5360-9, 1980

The AC recommends collecting at least a two-week sample of hourly enplanements and deplanements from airline station records to generate a typical peak hour level of passenger activity (*3*). The peak hour should be scaled to the peak month if the collection period occurs during an off-peak month. The Circular also recommends that the defined peak hour should occur at least 100 to 150 times per year during 60-minute periods. It is also noted that the peaking factor (peak hour as a percent of annual passengers) will tend to decline gradually as enplanements decrease. The AC recommends consulting with airline facility planners and FAA District Office representatives for assistance. A rule of thumb is provided that peak hour enplanements or deplanements are roughly equal to 60 to 70 percent of peak hour passenger movements.

The AC recommends using published airline schedules to determine aircraft peaking for terminal apron planning.

Other noteworthy information in the AC includes:

- At small airports peaking is more a function of airline scheduling considerations than market forces,
- At airports with a high percentage of business passengers, peaking tends to occur in the early morning with another more spread out peak in the evening.
- Peaking for special events tends to be spread out over more hours than reflected in typical business peaks.
- Employees typically do not add to peak demand since they tend to be serving passengers rather than commuting to or from their jobs during terminal peaks.
- Automobile arrival peaks occur about one-half hour prior to flight departure peaks. (The AC was written prior to the new security requirements resulting from the 9/11 attacks)
- Public automobile parking generates three peaks: a short period prior to aircraft departures, a short peak prior to aircraft arrivals, and a longer peak during the middle of the week.

- Rental car activity tends to show peaking that is the reverse of public parking. The rental car inventory peaks during weekends and is lowest during the middle of the week.

Planning and Design Guidelines for Airport Terminal Facilities, AC 150/5360-13, 1988

This AC identifies the Average Day Peak Month (ADPM) as the most common way of determining the design day (*4, p. 7).* It is noted that peak hour passenger movements can vary from as high as 12 to 20 percent of daily activity to a theoretical low of 6.25 percent, and that the peak hour factor tends to decline as airports get busier. The Circular provides three alternatives to estimating peak hour activity.

The Hypothetical Design Day Activity Method (HDDA) is applicable for estimating and projecting both peak hour levels and daily operational profiles (*4, pp. 7-8*). It essentially involves estimating aircraft arrival and departure clock times for each flight, as well as the aircraft type and load factor. This allows enplanements and deplanements to be generated for each flight, which can then be aggregated to generate hourly profiles and peak hour estimates. Visitor movements can also be tied to passenger movements.

The application of historical peaking factors is also cited. This involves using or collecting historical hourly passenger data to determine peak hour factors and applying those factors to future busy day estimates. The AC cautions that this method is less accurate than the HDDA method because the peak hour factor is likely to decline as an airport becomes busier in the future.

The AC provides peaking graphs representing average relationships between a) busy hour and peak day aircraft operations, b) peak hour percentage and annual enplaned passengers, and c) peak hour operations and annual enplaned passengers. There is a strong warning that these relationships should only be used for initial rough estimates and not for detailed design.

Noise Control and Compatibility Planning for Airports, Advisory Circular No: 150/5020-1, 1983

The FAA's AC on Noise Control and Compatibility Planning in Airports advises that daytime (7:00 am to 10:00 pm) and nighttime (10:00 pm to 7:00 am) airport activity is a required input for noise analysis but provides no recommendations on estimating and forecasting these levels (*5*).

Chen and Gulding, Assessment of System Constraints for Producing Constrained Feasible Schedules, 2010

The purpose of this paper was to examine historical aircraft operations data and identify relationships between demand and capacity that would result in rules that could be used to estimate future schedules for use in FAA traffic analysis (*6*). The authors identified the existing relationship between scheduled demand and existing VMC capacity at JFK and Newark Airports. The authors noted from previous FAA work that although scheduled demand could exceed capacity for short periods of times, significant excesses of demand over capacity were not sustainable over long periods of time. For example the maximum demand/capacity ratio could be as high as 1.41 for a 15-minute period, but fell to 1.21 for a one-hour period, 1.14 for a two-hour period, and 1.06 for a three-hour period.

The authors used the relationships above to prepare future flight schedules at constrained airports. The initial step was to grow the base year schedule while maintaining the existing distribution of operations. If the future distribution began to violate the parameters above, new flights and VFR flights were shifted to other times within some narrow limits. If this was not feasible, the flights were trimmed.

GRA, Forecasting Aviation Activity by Airport, 2001

This document is mostly focused on forecasting of annual activity but provides some general information on peak hour estimation (*7*). It notes that the design day is typically the peak hour of an average day in the busiest month, but that an alternative definition appropriate for airports with several busy months may be the peak hour that occurs 10 percent of the days during the year.

A.2 TRB Publications

TRB, Aviation Demand Forecasting, 2002

This review includes a section by the International Air Transport Association (IATA) on estimating busy day passenger and aircraft movement forecasts (8). The example notes that IATA specifically defines the busy day as the second busiest day in an average week during the peak month. The weekly distribution of passenger traffic needs to be calculated for this method to work. IATA uses BSP data to generate these distributions. IATA notes that special events including religious festivals, trade fairs and conventions, and sports events are excluded from the peak analysis.

When forecasting, IATA identifies the relationships between peak hour, busy day, peak month, and annual demand for each route, applies these relationships to forecast annual demand for each route, and then aggregates the results to generate an aggregate peak forecast for the airport.

To estimate a busy day hourly profile, IATA examines a number of factors including flight duration, amount of connecting traffic, aircraft size, route network, curfews, time zone differences, and airline commercial considerations to generate a probability distribution of future flights.

Muia, Counting Aircraft Operations at Non-Towered Airports, 2007

This document does not directly address the estimation of peak period activity or operational profiles (*9*). However, one of the key challenges in identifying peak period and operational activity at non-towered airports is the lack of data on the existing distribution of activity. Therefore, the approaches outlined in this document are relevant in reconciling this data gap.

The report noted that the most common way of estimating operations at non-towered airports – asking the Airport Manager or Fixed Base Operator – is also the most inaccurate. Six more direct methods of counting operations were discussed: acoustical, airport guest logs, fuel sales, pneumatic, video image detection, and visual. It was concluded that the acoustical method provided the best combination of accuracy and practicality. The author also recommended collecting data for two-week periods in each of the four seasons and extrapolating the remainder if year round counts were not practical.

Although not discussed in the report, the acoustical method would also provide a means of estimating both peak period operations and hourly distributions. An implicit assumption would be that the busiest season in the sample would appropriately represent a busy period for planning purposes.

GRA, Airport Aviation Activity Forecasting: A Synthesis of Airport Practice, 2007

Although this document provides little direction for peak hour forecasting, it provides an extensive review of potential annual forecasting approaches, from which peak activity forecasts can be derived *(10).*

A.3 Other Agency Guidebooks

ICAO, Airport Planning Manual, 1987

ICAO provides a seven step process for deriving peak hour passenger traffic from annual data, but then, curiously, recommends deriving peak aircraft operations from passenger peaks rather than deriving operations peak independently (*11*). ICAO notes that sharp peaking tends occur more with long-haul operations because of time zone restrictions. (p. 1-18).

ATA, Aircraft and Passenger Data Studies, 1979 and 1981

In the late 1970's and early 1980s the Air Transport Association (ATA) commissioned studies on the hourly distribution of aircraft operations and passenger enplanements and deplanements for 100 airports in the United States during August, which was the assumed peak month (12, 13). Breakouts by day-of- the-week were not included. The intent was to provide more detailed design day and design hour estimates to evaluate airports' capabilities and requirements for runways, gates and other facilities. The data were obtained by combining Official Airline Guide (OAG) schedule data with Civil Aeronautics Board (CAB) ER-586 Service Segment Data which was collected by flight number at the time. Although the data are now very dated, they do provide a means of evaluating long-term changes in operational profiles at most major U.S. airports.

A.4 Journal Articles

Bhadra, et. al., Future Air Traffic Timetable Estimator, 2005

In this paper the authors provided an approach to estimating future operational profiles at commercial airports for use as simulation inputs for the National Airspace System (NAS)(14). The approach uses a system perspective and involves the following steps: 1) estimate future origin-destination passenger demand by market-pair, 2) Use existing route allocations to estimate future passenger itineraries, 3) determine the aircraft used to fly those routes, 4) assign arrival and departure times to the flights, 5) and 6) add non-scheduled flights. A multinomial aircraft choice model was used to estimate the type and frequency of aircraft flights from the enplanement forecasts which was then calibrated to the existing OAG schedule. A key step was the assignment of flight times. Existing flights were assumed to maintain their existing flight times for the most part, and times for new flights were based on the historical OAG data. Since the process could lead to inconsistent flight time determinations between the two airports comprising a market pair, the larger airport was given precedence.

Although the approach is likely too complex and data-intensive for individual airport forecasts, some of the elements, such as the use of historical OAG data to estimate new flight times would have applications to the forecasts of operational profiles for individual airports.

A.5 Textbooks and Guidebooks

De Neufville and Odoni, Airport Systems: Planning, Design, and Management, 2003

The authors note that a perfectly defensible definition of peak hour is impossible, as it would require an accurate quantification of the value of the level of service provided when accommodating a given activity level (15, p. 608). They also note that design load is defined differently in the United States and in the United Kingdom. In the United States the typical definition is the average day of the peak month whereas in the United Kingdom it is defined as the 30th busiest hour of the year. They further note that ICAO recommends using the peak hour of the average day of the two peak months of the year. The authors also provide some rules for rapid initial estimates of peak hour activity.

The authors caution that using historical peak hour ratios for future planning work overestimates peak activity, as peak loads tend to spread as traffic grows. It is also noted that the critical period for planning may not be sixty minutes; it may be thirty minutes instead. Also, peaks for differing categories of activity will not necessarily occur at the same time.

Seven alternative definitions of the design peak hour are identified, and the list is not exhaustive. They include:

1. The 20th, 30th, or 40th busiest day of the year
2. The peak hour of the average day of the peak month
3. The peak hour of the average day of the two peak months of the year

4. The peak hour of the 95th percentile busy day of the year
5. The peak hour of the 7th or 15th busiest day of the year
6. The peak hour of the 2nd busiest day during the average week in a peak month.
7. The 5 percent busy hour (15, p. 853)

The authors note that variations in the definition of the peak hour are fairly small when compared to potential errors resulting from the annual forecasts. Also, the monthly distribution of passengers tends to remain stable from year to year. Peaking tends to be more pronounced for passengers than for aircraft operations, as load factors tend to be higher during peaks.

Ashford, Stanton, and Moore, Airport Operations, 1996

This book is intended more as a guide for airport operations than planning but nevertheless provides some useful peak hour information (16). The authors cite a number of definitions, including:

- Standard Busy Rate (SBR) corresponding to the 30th busiest hour of the year and used in the United Kingdom.
- Busy Hour Rate (BHR) The hourly level of passenger activity marking the threshold where all busier hours account for 5 percent of annual activity.
- Typical Peak Hour Passengers (TPHP) Equivalent to Average Day Peak Month
- Busiest Timetable Hour (BTH) A definition that is constructed by applying average peak month load factors to schedules of airline seat arrivals and seat departures.
- Peak Profile Hour (PPH) Estimated by averaging each hour across the peak month and then selecting the highest of the averages.

It is noted that typically the absolute highest passenger peak is about 20 percent higher than the SBR, but that the ratio is lower at large airports and higher at small airports. The book also provides some rare day-of –the-week passenger distributions for LAX, indicating that passenger activity tends to be higher than average from Thursday through Saturday, and lower than average from Monday through Wednesday.

A.6 Master Plans and Other Airport Studies

O'Hare Modernization Program: Draft Unconstrained Demand Analysis, 2003

One of the main purposes of the O'Hare forecast was to provide design day schedules for use in detailed airfield simulation in support of the planned runway improvements (*17*). The Terminal Area Forecasts were used for annual passenger activity, and the peak month percent of activity for 1990-2000 was assumed to remain constant into the future. The average day peak month (ADPM) was used to represent the design day for planning.

The future design day schedules used the then current OAG schedule as a starting point. Airline market shares were assumed to remain constant, and new frequencies to existing markets were estimated by filling gaps in the existing schedule for each airline. Service to new domestic non-stop markets was estimated using judgment based on knowledge of airline route networks. Service to new international non-stop markets was based on a previous analysis of international air service opportunities for ORD. Passenger distributions were estimated by applying load factors to each flight. One of the hub carriers had provided load factors by time of day which permitted hourly variations in passenger loads to be incorporated.

George Bush Intercontinental Airport: Master Plan Technical Reports, 2006

In this instance, the consulting team updated an earlier forecast performed by Leigh Fisher Associates (*18*). The peak month percentage was assumed to remain constant and the design day was defined as the average day of the peak month. Peak spreading was assumed in the peak hour analysis in anticipation of Continental Airlines adopting a rolling hub schedule. As a result, peak hour passengers and commercial operations were assumed to grow at 80 percent of annual activity.

Landrum and Brown, LAX Master Plan, 2004

The LAX Master Plan employed a combination of design day flight schedules and operational profiles to evaluate the impact of airfield and gate constraints upon daily and annual activity (19). Specifically, the forecast focused on Alternative D, which was designed not to add airport capacity but rather to enhance safety and security.

The study defined the design day as the average of weekday activity during the peak month. Design day schedules were prepared for two forecast years – 2005 and 2015. In addition operational profiles for two additional years, 2008 and 2013, were derived from the design day schedules.

The number and capacity of gates served as the constraint on the frequency and size of aircraft operations. The design day schedule forecasts assumed some depeaking to allow international traffic to grow while reducing or rescheduling some of the less profitable domestic flights. Passenger flights were organized into eight different categories to facilitate analysis, including:

- U.S. Central Time Traffic
- U.S. Eastern Time Traffic
- U.S. Pacific/Mountain Time Traffic
- Commuter Traffic
- European Traffic
- Far East Traffic
- Mexico and Latin American Traffic

- Canada Traffic

Some of these categories, namely U.S. Eastern Time Traffic and Far East Traffic, were more heavily concentrated in the late morning peak, and therefore subject to more adjustment.

Leigh Fisher Associates, Operational Analysis of Centerfield Taxiway Alternatives at Logan International Airport, 2006

This study analyzed the impact of the proposed centerfield taxiway at Boston Logan International Airport (BOS) under differing operational profiles (20). To this end a design day flight schedule representing an average day in the peak month for 2010 was prepared. A detailed description of the approach to developing the design day schedule was provided.

The starting point was a schedule for a weekday in July 2005. New flights were added to represent the FAA's TAF forecast growth rates. Flights in each major activity category (air carrier, air taxi, GA) were cloned in sufficient numbers to match the TAF-based growth targets. Matched arrivals and departures were cloned as a group. In some instances, such as air taxi, flights needed to be removed to match the TAF-based targets. The cloned flights were offset from the original flights by 15 to 30 minutes to avoid unrealistic peaking.

Parsons Brinckerhoff, Landrum & Brown, and Airport Interviewing and Research, FAA Regional Air Service Demand Study, 2007

The main purpose of the study was to assess the airfield, terminal, and landside capacity of the three main airports controlled by the Port Authority of New York and New Jersey (PANYNJ), namely LaGuardia (LGA), Newark (EWR), and New York JFK (JFK) and to assess the capacity improvements needed to meet projected demand in 2015 and 2025 (*21*).

The analysis involved the preparation of operational profiles for each of the three main airports in 2015 and 2025. The selected design day was August 26th, intended to represent an average day in the peak month. The operational profiles for the design day were organized by arrival and departure and by 5 minute increments. A 2015 flight schedule was prepared based "upon an analysis of future conditions created during the preparation of the forecasts." (*21, p. I-2*) and was then converted to an operational profile. The 2015 operational profile was converted to a 2025 operational profile using the annual forecast growth rates.

The terminal analyses were conducted by individual terminal building. The analysis acknowledged that load factors are higher during the peak hour, but lacking specific data, assumed 85 to 90 percent for domestic flights and 95 percent for international flights. Data from passenger surveys was used to determine passenger arrival time distributions for each terminal, which were applied to the operational profiles to determine when each major component would experience peak surges.

Leigh Fisher Associates, Noise Study Update: Louisville International Airport, 2003

The forecast in this study was used for both the Part 150 study and subsequent airport master plan (22). The peak period analysis performed for the Master Plan element of the forecast defined the design day as the average day of the peak month, which proved to be October as a result of UPS cargo activity. Peak spreading was assumed to occur with the peak hour percentage reduced 0.14 percent per year for every 1.0 percent growth in annual activity, based on a cross-sectional analysis of ATA data. The forecast developed forecasts of operational profiles for each major category (passenger, cargo, GA, etc.) and then aggregated the individual profiles to generate overall forecasts of future airport profiles that reflected shifting trends in the make-up of airport activity. The distributions were also used to prepare estimates of future day/night splits in the Part 150 study.

HPC, Hartsfield Atlanta International Airport: Aviation Forecast Update, 2002

The aviation activity forecast performed for the Airport required very detailed design day schedules to support airfield simulation, terminal and landside analysis (23). Individual forecasts were performed for each major destination market. This element also included an origin-destination threshold analysis to determine candidates for new non-stop service from Atlanta. The peak month and design day share of annual activity was assumed to remain constant for each market but since the individual markets were projected to grow at different rates, the aggregate design day activity, as a share of annual activity, shifted to reflect the change in market share.

There were several steps involved in the generation of the design day flight schedules:

- AWDPM seat departure projections were forecasted for each market, and air service scenarios were prepared that represent the best judgment as to which airlines would serve the market, and with which aircraft and at what frequency.
- The second step consisted of assigning flight times to existing and new markets, based on filling gaps in the current schedule consistent with the connecting banks for existing markets, and estimating flight times for new non-stop markets based on service patterns at similar existing non-stop markets. The degree of peak spreading is determined by the balance of new flights to existing markets, which causes peaks to spread, and the introduction of service to new non-stop markets which tends to intensify peaks. An iterative process was required to match arriving flights with departing flights which sometimes required adjustment of flight times.
- The third major step was the assignment of gates to the flights. This required the balancing of assumptions regarding lease agreements, buffer times between departing and succeeding arriving flights, and spare gate capacity.
- The final step involved assignment of local and connecting passengers to each flight. This required the assessment of individual market load factor and origin-destination ratios to determine an overall daily average of these factors. Since hourly data on these factors was lacking, professional judgment was required to estimate the daily variation.

Once assembled, the design day schedule data could be aggregated as desired by terminal and landside planners to evaluate alternative terminal and concourse development concepts.

References to Appendix A:

1. *Airport Master Plans, Advisory Circular No: 150/5070-6B,* Federal Aviation Administration, Washington, D.C., July 29, 2005.
2. *Airport Capacity and Delay, Advisory Circular No: 150/5060*, Federal Aviation Administration, Washington, D.C., September 23, 1983.
3. *Planning and Design of Airport Terminal Facilities at Non-Hub Locations Advisory Circular No: 150/5360-9*, Federal Aviation Administration, Washington, D.C., April 4, 1980.
4. *Planning and Design Guidelines for Airport Terminal Facilities, Advisory Circular No: 150/5360-13*, Federal Aviation Administration, Washington, D.C., April 22, 1988.
5. *Noise Control and Compatibility Planning for Airports, Advisory Circular No. 150/5020-1*, Federal Aviation Administration, August 5, 1983.
6. Chen, X. and J. Gulding, *Assessment of System Constraints for Producing Constrained Feasible Schedules*, Federal Aviation Administration, Washington, D.C.
7. GRA, Inc., *Forecasting Aviation Activity by Airport*, Federal Aviation Administration, July, 2001.
8. *Aviation Demand Forecasting: A Survey of Methodologies, E-Circular No. E-C040*, TRB, National Research Council, Washington, DC, August 2002.
9. Muia, M., *ACRP Synthesis 4, Counting Aircraft Operations at Non-Towered Airports*, TRB, National Research Council, Washington, DC, 2007
10. William Spitz and Richard Golaszewski, GRA, *Airport Aviation Activity Forecasting: A Synthesis of Airport Practice*, TRB, National Research Council, Washington, DC 2007.
11. *Airport Planning Manual, Doc 9184-AN/902 Part 1, International Civil Aviation Organization*, Second Edition, Montreal, Canada, 1987.
12. I.P. Sharp Associates, Inc., *Aircraft Movement & Passenger Data for 100 U.S. Airports, AD/SC Report No. 7*, Air Transport Association of America, Washington, DC, June 1979.
13. I.P. Sharp Associates, Inc., *Aircraft Movement & Passenger Data for 100 U.S. Airports AD/SC Report No.8*, Air Transport Association of America, Washington, DC, July 1981.
14. Bhadra, D., and J. Gentry, B. Hogan, and M. Wells, "Future air Traffic Timetable Estimator," *Journal of Aircraft,* Vol. 42, No. 2 (March-April 2005), pp. 320-328.
15. De Neufville, R. and A. Odoni, *Airport Systems: Planning, Design and Management*, McGraw-Hill Companies, New York, NY, 2003.
16. Ashford, N., Stanton, H. P. M., and Moore, C. A., *Airport Operations*, 2nd edition, McGraw-Hill Professional, New York, NY, 1996.
17. Ricondo & Associates, *O'Hare Modernization Program: Draft Unconstrained Demand Analysis*, City of Chicago and Federal Aviation Administration, February 2003.
18. DMJM Aviation and RS&H, *George Bush Intercontinental Airport: Master Plan Technical Reports*, Houston Airport System, Houston, TX, December 2006.

19. Landrum & Brown, *LAX Master Plan*, Los Angeles World Airports, Los Angeles, CA, April 2004.
20. Leigh Fisher Associates, *Attachment D: Operational Analysis of Centerfield Taxiway Alternatives at Logan International Airport*, Harris, Miller Miller & Hanson Inc. and Federal Aviation Administration, May 2006.
21. Parsons Brinckerhoff, Landrum & Brown, and Airport Interviewing and Research , *FAA Regional Air Service Demand Study: Task E – Assessment of Authority Airports' Capacity to Meet Current and Forecasted Demand*, Federal Aviation Administration and the Port Authority of New York and New Jersey May 2007.
22. Leigh Fisher Associates, *FAR Part 150 Noise Study Update: Louisville International Airport*, Regional Airport Authority of Louisville and Jefferson County, Louisville, KY, January 2003.
23. Hartsfield Planning Collaborative, *Hartsfield Atlanta International Airport: Aviation Forecast Update*, Atlanta Department of Aviation, Atlanta, GA, May 31, 2002

Appendix B

Recommended Questions for Task 2 Interviewees

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix B: Recommended Questions for Task 2 Interviews

The following questions are recommended for the potential interviewees during the Task 2 surveys. Not all of the questions will be appropriate for each interviewee. Once the recommended list of interviewees is approved by the Panel, questions for each interviewee will be selected from the list below. The questions are grouped by general subject category.

General - Planning

- What is greater source of error in determining facility requirements: annual forecasts or derivative forecasts?
- What is the appropriate busy day definition for airport facility planning and funding?
- Has the FAA/others made an effort to incorporate day-of-week use patterns into facility requirements?
- What are the appropriate service and delay levels for airport facility planning and funding?
- What are the most common types of errors in calculating and using peak hour passenger estimates?
- What are the most common types of errors in calculating and using busy day passenger profiles?
- What are the most common types of errors in calculating and using peak hour aircraft operation estimates?
- What are the most common types of errors in calculating and using busy day aircraft operation profiles?
- What guidance does the FAA currently use to resolve questions regarding the preparation and use of peak hour and operational profiles?
- The FAA has standardized the way in which they prefer summary annual forecasts to be presented. Are there any plans to standardize the presentation of projections of peak hour activity or busy day operational profiles?
- Is the FAA planning on launching any new analytical programs/techniques/guidance? If so, what types of data will they require?

General - Environmental Analysis

- What is the greater source of error in environmental analysis: annual forecasts or derivative forecasts such as average annual day (AAD) profiles, fleet mix projections, and day/night splits?
- Is the AAD definition appropriate for all environmental analysis, or are there instances in which further segmentation is appropriate?

- Does daily peaking matter for environmental analysis?
- What are the most common types of errors in calculating and using AAD passenger profiles?
- What are the most common types of errors in calculating and using AAD aircraft operation profiles?
- What guidance does the FAA currently use to resolve questions regarding the preparation and use of AAD hourly and day/night profiles?
- Other than the new Aviation Environmental Design Tool (AEDT) is the FAA planning on launching any new analytical programs/techniques/guidance.

Data Source Issues

- What upcoming improvements in data availability, if any, are likely in the future
- Are current data sources at risk? Will there be continued resistance by airlines to providing O&D and T-100 data?
- What changes will there be in ETMSC and OPSNET data?
    - What are current shortcomings?
    - What are potential areas of improvement?
    - Which operations are more likely to be missed?
    - How is VFR activity best handled?
    - Will there be changes in the accessibility of the data?
- What are pros and cons of using other sources of radar data (such as Flight Explorer)

Methodology Issues – Planning and Environmental

- What are common problems encountered when translating scheduled enplanements/deplanements into terminal and landside passenger flows? Are there recommended solutions?
- What are the key issues and potential resolutions for translating passenger flows into vehicle flows?

Methodology Issues - Planning

- When planning for airport passenger facilities, under what circumstances are the following metrics most appropriate?
    - Busy day hourly profiles
    - Peak hour
    - Peak 20 minutes

- When planning for airfield facilities, under what circumstances are the following metrics most appropriate?
    - Busy day hourly profiles
    - Peak hour
    - Peak 20 minutes
- When planning for landside facilities, under what circumstances are the following metrics most appropriate?
    - Busy day hourly profiles
    - Peak hour
    - Peak 20 minutes
- What are the current most innovative and accurate approaches to forecasting peak hour passenger and operations activity?
- What are the current most innovative and accurate approaches to forecasting busy day operational profiles?
- Is there value in disaggregating peak hour/operational profiles by concourse or other facility breakout?
- Is cloning flights from existing distributions an appropriate way to generate future flight schedules for airfield modeling? Alternatively, is a bottom-up construction of a future gated flight schedule more appropriate? Does the additional fidelity warrant the additional effort and expense?
- What is best way to evaluate cargo peaks or GA peaks for which little data exists?
- What is the best way to estimate peaks and operational profiles at airports without air traffic control towers?
- What are the advantages and disadvantages of attempting to forecast changes in the peak month percentage?
- For non-scheduled activity like GA and some cargo, should the peak hour be based on the average of the busiest hour in each day, regardless of what time that activity may occur in any given day, or should it be based on the average activity for a specific time in which peak activity most often occurs?
- What is the best way of incorporating uncertainty into the preparation of peak hour forecasts and operational profiles?

Methodology Issues – Environmental Analysis

- What new issues are likely to come up as a result of the new Aviation Environmental Design Tool (AEDT)?
    - Data requirements
    - Formatting Issues

    - Will there be issues in linking SIMMOD/TAAM output to AEDT?

- What level of detail is appropriate for fleet mix forecasts? Is it reasonable to attempt to project aircraft engine type twenty years into the future?
- When using SIMMOD or TAAM to represent an AAD, what is the best way of resolving the discrepancy involved in representing an annual average with a single snapshot?
- What are the current most innovative and accurate approaches to forecasting fleet mix by day/night distribution?
- How should very small aircraft categories (less than 100 annual operations) be handled when preparing fleet mix forecasts?
- What are the advantages and disadvantages of attempting to forecast changes in the distribution of operations between day and night?
- Does accurately evaluating delay sufficiently improve AQ measures to make them worth the effort? Is using SIMMOD/TAAM to estimate delay for air quality analysis rather than planning manuals (AC 150/5060-5) worth the additional expense?

Incorporation of Airport Constraints

- What are the FAA criteria for evaluation of no-action forecasts?
- Are constraints best incorporated on a bottom-up basis (hourly/daily) or top-down (annual)?
- What is the best way to incorporate the following into forecasts of peak hour activity and operational profiles?
    - Airfield constraints?
    - Terminal constraints?
    - Landside constraints?
- What is the appropriate annual delay level to use as a maximum constraint? Is the 20-minute average annual delay cited in the FAA's Benefit-Cost Guidance too high?
- Should a different delay constraint be used when modeling a busy day?
- What should be the trigger for airline flight cancellations? How should cancellations be incorporated into operational profiles? Should different operational profiles be used for IFR and VFR conditions?

Other Sources of Insight/Information

- Are there any specific airports that may wish to have hands-on involvement in the preparation and use of the upcoming guidebook and toolbox?
- Are there any other organizations that may wish to have hands-on involvement in the preparation and use of the upcoming guidebook and toolbox?

Note that respondents may provide answers that would lead to additional unanticipated follow-up questions. The Research Team respectfully requests the flexibility to pose follow-up questions, which may not be on the list, to the interviewees.

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix C

Survey Cover Letter and Definitions,
And Survey Questionnaire

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix C: Survey Cover Letter and Definitions, And Survey Questionnaire

Appendix C.1: Survey Cover Letter and Definitions

Date

Dear Airport Director/Planner

The Airport Cooperative Research Program (ACRP) under the Transportation Research Board (TRB) is preparing a Guidebook and associated software for estimating peak period and operational profiles of passengers and aircraft operations for use in airport planning and environmental analysis.

The enclosed questionnaire is intended to help identify best practices in the efficient preparation of peak period and operational profile forecasts of passengers and aircraft operations. This will help airports better identify, size, and phase new airfield, terminal, and landside facilities, and to better assess and mitigate the environmental impacts of airport operations.

Please answer all applicable questions to the best of your knowledge. We would like the response to be as comprehensive as possible so feel free to distribute to your staff and consultants as you deem appropriate. Please answer with "NA" all questions for which you have no information or that are not applicable to your airport. We have attached a list of definitions and a data sheet showing the operational levels at your airport that would correspond to the differing design day and peak period definitions.

We understand that you are very busy, so on behalf of the Transportation Research Board (TRB) I thank you for taking the time and effort to complete this questionnaire. If you have any questions on this questionnaire or our project please call me at 703-824-5100.

Patrick Kennon
Manager, Aviation Economics
HNTB Corporation
2900 S. Quincy St.
Arlington, VA 22206

Definitions

Design Day – A representative busy day selected for planning, intended to strike a balance between providing capacity for most periods without incurring the cost of designing for the single busiest day of the year.

Peak Period - A period of time, often called the peak hour, representing the typical surge of passenger of aircraft operations activity that must be accommodated by a given airport facility. Like the design day, it is intended to strike a balance between providing capacity for most periods without incurring the cost of designing for the single busiest period of the year.

Operational Profile – The hourly distribution of arriving and departing passengers or aircraft operations during the design day

Design Day Schedule – A constructed schedule showing individual aircraft arrivals and departures by time of day and aircraft type, which can also show airline, origin/destination, and passengers associated with each flight, depending on the level of detail required.

Day/Night Split - Distribution of aircraft operations between daytime (7 am to 10 pm) and nighttime (10 pm to 7 am).

OAG – Official Airline Guide

Level of Service (LOS) – A measure of the quality of service provided by a facility. For example, as it relates to terminals, LOS A would be defined as no congestion, free-flow and excellent level of comfort, and LOS F would be defined as extreme congestion, unstable flow with unacceptable delays, near system breakdown and unacceptable level of comfort.

Departure Lounge – Interior area within an airport terminal where passengers wait just prior to boarding aircraft.

Gate – Passageway through passengers embark or disembark from an aircraft.

Appendix C.2: Survey Questionnaire

PEAK PERIOD AND OPERATIONAL PROFILE QUESTIONNAIRE

Airport ____________________ **Telephone No.** ____________________
Contact Name ____________________ **Date** ____________________
Position ____________________

General Questions

1. **Has your airport prepared or had others prepare (please check all that apply):**
   a. **Peak period projections of passengers or operations? Yes ______ No _______**
   b. **Day/night splits? Yes ______ No _______**
   c. **Hourly profiles of passengers or operations? Yes ______ No _______**
   d. **Design day flight schedules? Yes ______ No _______**

2. **What design day definition do you typically use for planning at your airport?**
   a. **Average Day Peak Month (ADPM) ______________**
   b. **Average Week Day Peak Month (AWDPM) ______________**
   c. **18th Busiest Day (95th percentile) ______________**
   d. **36th Busiest Day (90th percentile) ______________**
   e. **Other (specify) _____________________________ ______________**

3. **What definition of a day do you typically use for noise analysis at your airport?**
   a. **Average Annual Day (AAD) ______________**
   b. **Average Day Peak Month (ADPM) ______________**
   c. **Average Week Day Peak Month (AWDPM) ______________**
   d. **18th Busiest Day (95th percentile) ______________**
   e. **36th Busiest Day (90th percentile) ______________**
   f. **Other (specify) _____________________________ ______________**

4. **What definition of a day do you typically use for air quality dispersion analysis at your airport?**
   a. **Average Annual Day (AAD) ______________**
   b. **Average Day Peak Month (ADPM) ______________**
   c. **Average Week Day Peak Month (AWDPM) ______________**
   d. **18th Busiest Day (95th percentile) ______________**
   e. **36th Busiest Day (90th percentile) ______________**
   f. **Other (specify) _____________________________ ______________**

5. **If the required data were available, what do you believe would be the most useful definition of a design day for your airport?**
   a. **Average Day Peak Month** ______________
   b. **Average Week Day Peak Month** ______________
   c. **18th Busiest Day (95th percentile)** ______________
   d. **36th Busiest Day (90th percentile)** ______________
   e. **Other (specify)** _________________________ ______________

6. **Do you believe there would be value in using a range of design day definitions for:**
   a. **Identifying requirements needed to achieve alternative levels of service at a facility?**
      i) **No** ______
      ii) **Yes** ______
         - **If yes, please elaborate** ____
           ____
   b. **Using differing design day definitions to plan different types of facilities?**
      i) **No** ______
      ii) **Yes** ______
         - **If yes, please elaborate** ____
           ____

7. **Have you used passenger information by day-of-the-week when estimating design day activity?**
   a. **No** ______
   b. **Yes** ______
      i) **If yes, please describe how you obtained or estimated day-of-the-week passenger distributions.** ____
         ____
         ____

8. **Have your forecasts of design day passenger and operations activity assumed:**
   a. **A constant share of annual activity?** ___________
   b. **A changing share of annual activity?** ___________

9. **If your forecasts assumed a change in share of passenger and operations annual activity accounted for by the design day, what approach did you use to estimate the change in share?** ___
   ____
   ____

10. **What improvements, if any, do you recommend in current approaches to forecasting design day passengers and operations?** ____
    ____

11. **What improvements, if any, do you recommend in current approaches to applying design day passengers and operations estimates to airport planning? ___________________________________**
    ____
    ____

If your airport has not prepared peak period projections, please go to Question 20.

Peak Period Questions

12. **What do you believe is the most appropriate peak period metric (in minutes, e.g., 60 minutes, 30 minutes, 15 minutes, etc.) for planning the following types of facilities:**
    a. **Ticketing – Ticket Counters & Queuing __________________ min.**
    b. **Passenger Security Screening Checkpoint __________________ min.**
    c. **Baggage Security Screening - EDS __________________ min.**
    d. **Baggage Make-Up Area __________________ min.**
    e. **Departure Lounges __________________ min.**
    f. **Gates __________________ min.**
    g. **Concourse Circulation __________________ min.**
    h. **Customs and Border Protection (CBP) __________________ min.**
    i. **Restrooms __________________ min.**
    j. **Meeter/Greeter Area __________________ min.**
    k. **Baggage Claim __________________ min.**
    l. **Rental Car Counter/Queuing __________________ min.**
    m. **Curb Frontage __________________ min.**
    n. **Parking – Short Term __________________ min.**
    o. **Parking – Long Term __________________ min.**

13. **Based on your experience at your airport, have the peak period calculations referenced in Question 12 overestimated, underestimated, or accurately estimated the true demand for the following facilities:**

a.	Ticketing – Ticket Counters & Queuing	Over ____	Under ____	Accurate ____	Don't Know ____
b.	Passenger Security Screening Checkpoint	Over ____	Under ____	Accurate ____	Don't Know ____
c.	Baggage Security Screening - EDS	Over ____	Under ____	Accurate ____	Don't Know ____
d.	Baggage Make-Up Area	Over ____	Under ____	Accurate ____	Don't Know ____
e.	Departure Lounges	Over ____	Under ____	Accurate ____	Don't Know ____
f.	Gates	Over ____	Under ____	Accurate ____	Don't Know ____
g.	Concourse Circulation	Over ____	Under ____	Accurate ____	Don't Know ____
h.	Customs and Border Protection (CBP)	Over ____	Under ____	Accurate ____	Don't Know ____
i.	Restrooms	Over ____	Under ____	Accurate ____	Don't Know ____
j.	Meeter/Greeter Area	Over ____	Under ____	Accurate ____	Don't Know ____
k.	Baggage Claim	Over ____	Under ____	Accurate ____	Don't Know ____
l.	Rental Car Counter/Queuing	Over ____	Under ____	Accurate ____	Don't Know ____
m.	Curb Frontage	Over ____	Under ____	Accurate ____	Don't Know ____
n.	Parking – Short Term	Over ____	Under ____	Accurate ____	Don't Know ____
o.	Parking – Long Term	Over ____	Under ____	Accurate ____	Don't Know ____

14. **When preparing peak period estimates do you believe the greater source of error lies in:**

a. **The annual forecasts from which they are derived? ________________________**
b. **The peak period factors used to convert from annual activity forecasts? _______**

15. **Have your forecasts of peak period passenger and operations activity assumed:**
    a. **A constant share of design day activity? ___________**
    b. **A changing share of design day activity? ___________**

16. **If your forecasts assumed a change in share of design day activity accounted for by the peak period, what approach did you use to estimate the change in share? _________________________**
    ____
    ____
    ____

17. **Have you adjusted your peak period projections to incorporate constraints?**
    a. **No __________**
    b. **Yes __________**
        - **If yes, what kind of constraints did you incorporate? _____________________________**
        - **Please describe your approach. ____**
          ____
          ____

18. **What improvements, if any, do you recommend to current approaches for forecasting peak period passengers and operations? ____**
    ____
    ____
    ____

19. **What improvements, if any, do you recommend to current approaches for applying peak period passengers and operations estimates to airport planning? __________________________________**
    ____
    ____
    ____

If your airport has not prepared day/night projections, please go to Question 29.

Day/Night Split Questions

20. **Which data sources do you use to estimate day/night splits of aircraft operations (please check all that apply):**
    a. **Radar data (ARTS, ANOMS, etc.)** ___________
    b. **Manual tower counts** ___________
    c. **OAG** ___________
    d. **Other (specify)** ______________________________ ___________

21. **If you use OAG data, do you make an adjustment to convert gate times to runway times?**
    Yes __________ **No** ___________

22. **If you answered yes to Question 21, please describe your approach for converting gate times to runway times.** ____
    ____
    ____

23. **Have your forecasts of day/night splits assumed:**
    a. **A constant percentage split between daytime and nighttime operations?** ___________
    b. **A changing share of operations occurring in nighttime?** ___________

24. **If your forecasts assumed a changing nighttime share, what was the basis of the assumption?**
    ____
    ____
    ____

25. **Based on your experience at your airport, have the estimated day/night splits overestimated or underestimated true nighttime operations:**
    Over __________ **Under** ___________ **Neither** ___________ **Don't Know** _________

26. **Have you adjusted your day/night projections to incorporate constraints?**
    a. **No** __________
    b. **Yes** ___________
       - **If yes, what kind of constraints did you incorporate?** ______________________________
       - **Please describe your approach.** ____
         ____
         ____

27. **What improvements, if any, do you recommend to current approaches for forecasting the day/night split of operations?** ____
    ____

____

____

28. What improvements, if any, do you recommend to current approaches for applying the day/night split of operations to noise analysis? ____

____

____

____

If your airport has not prepared forecasts of operational profiles, please go to Question 38.

Operational Profile Questions

29. When estimating future hourly passenger or aircraft operation profiles, which approach do you use (check all that apply):

a. Scale up proportionately from existing base year hourly distribution? ______

b. Scale up from existing base year hourly distribution but with peak spreading factor? ______

c. Extract from future design day flight schedule? ______

d. Other? ____ ______

____

____

____

30. If you use a peak spreading factor when scaling up from an existing hourly distribution, please describe the approach you use to estimate the peak spreading. ____________________________

____

____

____

31. Based on your experience, have the hourly distribution profiles overestimated, underestimated, or accurately estimated the actual airfield delay at your airport?

Over _____ Under _____ Accurate _______ Don't Know ________

32. Based on your experience, have the hourly distribution profiles overestimated, underestimated, or accurately estimated the true peak demand for the following facilities:

a.	**Ticketing – Ticket Counters & Queuing**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
b.	**Passenger Security Screening Checkpoint**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
c.	**Baggage Security Screening - EDS**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**

d.	**Baggage Make-Up Area**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
e.	**Departure Lounges**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
f.	**Gates**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
g.	**Concourse Circulation**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
h.	**Customs and Border Protection (CBP)**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
i.	**Restrooms**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
j.	**Meeter/Greeter Area**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
k.	**Baggage Claim**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
l.	**Rental Car Counter/Queuing**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
m.	**Curb Frontage**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
n.	**Parking – Short Term**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**
o.	**Parking – Long Term**	**Over ____**	**Under ____**	**Accurate ____**	**Don't Know ____**

33. Based on your experience, on average, how much do peaks for the following facilities *lead* the enplaning peak at your airport?

a. Departure Curb _________ minutes
b. Ticketing – Ticket Counters and Queuing ________ minutes
c. Passenger Security Screening Checkpoint _________ minutes
d. Baggage Security Screening - EDS _________ minutes
e. Baggage Make-Up Area _________ minutes
f. Departure Lounges _________ minutes

34. Based on your experience, on average how much do peaks for the following facilities *lag* the deplaning peak at your airport?

a. Customs and Border Protection (CBP) _________ minutes
b. Restrooms _________ minutes
c. Meeter/Greeter Area _________ minutes
d. Baggage Claim _________ minutes
e. Rental Car Counter/Queuing _________ minutes
f. Arrival Curb _________ minutes

35. Have you adjusted your hourly distribution projections to incorporate constraints?

a. No __________
b. Yes __________

- **If yes, what kind of constraints did you incorporate? ______________________________**
- **Please describe your approach. ____**

36. What improvements, if any, do you recommend to current approaches for forecasting hourly passenger and operation profiles? ____

37. **What improvements, if any, do you recommend to current approaches for applying hourly passenger and operation profiles to airport planning? ______________________________________**
____
____
____

If your airport has not prepared design day flight schedules, please go to Question 45.

Design Day Flight Schedule Questions

38. **When preparing future design day flight schedules, which approach do you use:**
    a. **Begin with existing schedule and clone flights based on existing distribution? ______**
    b. **Segment existing schedule by category (e.g. domestic/international) and then clone flights based on anticipated growth in each segment? ______**
    c. **Begin with existing schedule and use professional judgment to estimate new flights? ______**
    d. **Other? ____**
    ____

39. **Based on your experience, have the design day flight schedules overestimated, underestimated, or accurately estimated the actual number of gates required at your airport?**
    Over _____ Under _____ Accurate _______ Don't Know _______

40. **Based on your experience, have the design day flight schedules overestimated, underestimated, or accurately estimated the actual airfield delay at your airport?**
    Over _____ Under _____ Accurate _______ Don't Know _______

41. **Based on your experience, have the design day flight schedules overestimated, underestimated, or accurately estimated the actual air quality impacts at your airport?**
    Over _____ Under _____ Accurate _______ Don't Know _______

42. **Have you adjusted your design day schedules to incorporate constraints?**
    a. **No __________**
    b. **Yes ___________**
        - **If yes, what kind of constraints did you incorporate? _____________________________**
        - **Please describe your approach. ____**

____
____

43. What improvements, if any, do you recommend to current approaches for forecasting design day flight schedules? ____
____
____
____

44. What improvements, if any, do you recommend to current approaches for forecasting design day flight schedules? ____
____
____
____

FINAL COMMENTS

45. Please share any other comments or observations you may have on the preparation and use of peak period and operational profile forecasts. ____
____
____
____
____
____
____
____

Thank You!

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix D

Summary of Airport Survey Responses

THIS PAGE INTENTIONALLY LEFT BLANK.

D.1 General Questions

Question 1: Has your airport prepared or had others prepare

a. *Peak period projections?*
b. *Day/night splits?*
c. *Hourly profiles of passengers or operations?*
d. *Design day flight schedules?*

One hundred percent of survey respondents reported having prepared a peak period projection, but not all respondents said they had day/night splits, hourly profiles of passengers or operations, and design day flight schedules prepared. Fifty percent of the respondents stated that have had day/night splits prepared; however, 75 percent said that they had design day flight schedules prepared and 62.5 percent said they have had hourly profiles of passengers or operations prepared.

Seven of the eight airports surveyed responded that they have prepared a peak period projection and at least two other projections (day/night splits, hourly profiles of passengers or operations, and design day flight schedules). Three of the eight airports have prepared all four types of projections, and three others have completed three of the four types of projections.

Question 2: What design day definition do you typically use for planning at your airport?

a. Average Day Peak Month (ADPM)
b. Average Week Day Peak Month (AWDPM)
c. 18th Busiest Day (95th percentile)
d. 36th Busiest Day (90th percentile)
e. Other (specify)

Seven of eight survey respondents reported that they use the Average Day Peak Month as the basis for planning at their respective airports. One of those seven also said that they use Peak Month, Average Busy Day in their Master Plan for parking but they did not define busy day. The final respondent stated that they use the Average Week Day Peak Month as their definition of a day for planning purposes at their airport. None of the respondents use the 18th or the 36th Busiest Day as their model for planning.

Question 3: What definition of a day do you use for noise analysis at your airport?

a. Average Annual Day
b. Average Day Peak Month
c. Average Week Day Peak Month
d. 18th Busiest Day (95th percentile)
e. 36th Busiest Day (90th percentile)
f. Other (specify)

More than half of the respondents (62.5%) said they use the Average Annual Day for noise analysis. One of those respondents also mentioned that when looking at the 'worst case' scenario, they will use the Average Day Peak Month definition. One of the eight respondents reported they use the Average Week Day Peak Month definition. One airport did not answer this question. None of the survey respondents reported using the 18th or the 36th Busiest Day. One airport did present a different way of defining a day in regard to noise analysis and described their definition as "two weeks in January/February and two weeks in June/July and that atmospherics dictate the times."

Question 4: What peak day definition do you typically use for air quality dispersion analysis at your airport?

a. *Average Annual Day (AAD)*
b. *Average Day Peak Month (ADPM)*
c. *Average Week Day Peak Month (AWDPM)*
d. *18th Busiest Day (95th percentile)*
e. *36th Busiest Day (90th percentile)*
f. *Other (specify)*

Half of the survey respondents reported using the Average Annual Day definition for air quality dispersion analysis at their respective airports. Two of the eight airports reported using the Average Day Peak Month definition, one of the eight is not sure which definition is used, and one did not respond. No one reported using the 18th or the 36th busiest day.

Question 5: If the required data were available, what do you believe would be the most useful definition of a design day for your airport?

a. *Average Day Peak Month (ADPM)*
b. *Average Week Day Peak Month (AWDPM)*
c. *18th Busiest Day (95th percentile)*
d. *36th Busiest Day (90th percentile)*
e. *Other (specify)*

Fifty percent of the survey respondents reported that the Average Week Day Peak Month would be the most useful definition of a design day for their respective airports. Three of the respondents thought the Average Day Peak Month would be the most useful, but one of those stated that it would not be useful for parking. None of the respondents chose the 18th or the 36th Busiest Day to define a day at their airports.

To reiterate the responses to questions two through five, none of the eight airports surveyed chose the 18th Busiest Day or the 36th Busiest Day in regard to planning, noise analysis, air quality analysis, and design day projections.

Question 6: Do you believe there would be value in using a range of design day definitions for:

6.a. Identifying requirements needed to achieve alternative levels of service at a facility? If yes, please elaborate.

More than half of the respondents (62.5%) believe there would be value in using a range of design day definitions for identifying requirements needed to achieve alternative levels of service at a facility. Those that do believe it would be valuable added that various studies have different purposes and that alternate levels of service occur for special events. It was also mentioned that differing definitions could provide a range to determine upsizing and downsizing needs and that peak day requirements can exceed average day needs by a considerable amount and coming up 'short' is not acceptable.

6.b. Using differing design day definitions to plan different types of facilities? If yes, please elaborate

The majority of the respondents (75%) agreed that using a range of design day definitions to plan different types of facilities would be beneficial. These respondents were then asked to elaborate, and some of their comments included that support facilities may require different assumptions than the terminal facilities, and that commercial aviation and general aviation may benefit from differing assumptions, just as international versus domestic facilities could benefit from differing assumptions. Another respondent commented that the type and time of year for airport traffic can make a huge difference (for example, comparing an airport that has a large winter peak to an airport which has relatively consistent seasonal activity).

Question 7: Have you used passenger information by day-of-the-week when estimating design day activity?

If yes, please describe how you obtained or estimated day-of-the-week passenger distributions.

Seventy-five percent of the respondents reported using passenger information by day-of-the-week when estimating design day activity. Two of the respondents estimated activity from the OAG schedules, while one of the respondents receives their information from contact with the airlines. Other ways the airports gather this information is through daily inspections, physical counts through the checkpoints, data from the in-line baggage system, and load factor estimates after determining best day-of-the-week fit to average-day-peak-month.

Question 8: Have your forecasts of design day passenger and operations activity assumed:

8.a. A constant share of annual activity?

More than three-fourths (87.5%) of the airports surveyed said their forecast of a design day passenger and operations activity assumed a constant share of annual activity. One respondent specified that this is only for certain applications and another stated yes, overall.

8.b. A changing share of annual activity?

Only two of the eight airports surveyed stated that activity assumed a changing share of annual activity. One of those two respondents specified that activity assumed a changing share only by airline or by type of airline as warranted by the scenario.

Question 9: If your forecasts assumed a change in share of passenger and operations annual activity accounted for by the design day, what approach did you use to estimate the change in share?

This question relates back to question 8; therefore, only two airports needed to respond. One respondent stated that the approach they used to estimate a change in share was based on the consideration of growth patterns and airline plans (if available) and includes whether airlines are established or relatively new entrants in markets and route networks. The second respondent said they use a historical seasonality analysis that is applied to generate forecasts along with regression results applied to various models.

Question 10: What improvements, if any, do you recommend in current approaches to forecasting design day passengers and operations?

Five of the eight respondents gave ideas for improvements in current approaches for forecasting design day passengers and operations. One commented that seasonal peak periods in commercial and cargo should be evaluated, whereas another said to try and keep the forecast simple because they are just projections and to not make them more complicated than necessary. Other improvements recommended included, "Avoid falling into the trap of using old models which rely on historical analysis and until 2009 that was okay, but now the paradigm has shifted," "each airport is unique, therefore, not sure you can make any improvements," and the final improvement recommended was to back into an acceptable level of service in the terminal based on the space available.

Question 11: What improvements, if any, do you recommend in current approaches to applying design day passengers and operations estimates to airport planning?

More than half of the respondents (62.5%) recommended improvements in current approaches applying to design day passengers and operations estimates to airport planning. One respondent recommended matching the design day with the intended purpose of study to ensure that seasonal and other peaks or minimum periods are adequately represented in the study results, whereas another respondent said that they do not recommend any improvements as they are from, "the school of planning for the worse case" and do not want to incur delays or constrain growth. Another airport recommended to looking at and considering spikes in demand over peak periods within a 60-minute period and stated that facilities can be sensitive to surges and can be "masked" if only considering peak hour. Additional comments included becoming more flexible in assigning traffic flow with-in the terminal facilities, and to have a better understanding of the different aspects of the design day numbers as well as how that information can and should be used.

D.2 Peak Period Questions

Question 12: What do you believe is the most appropriate peak period metric (in minutes, e.g., 60 minutes, 30 minutes, 15 minutes, etc.) for planning the following types of facilities:

12.a. Ticketing – Ticket Counters & Queuing

Half of the survey respondents reported that they believe the most appropriate peak period metric is 15 minutes in regard to planning the ticketing area. Other responses included one airport saying seven minutes is best, and another said 60 minutes is best. One airport did not respond and one airport was unsure.

12.b. Passenger Security Screening Checkpoint

Fifty-percent of the survey respondents reported that they believe the most appropriate peak period metric is 15 minutes in regard to planning the passenger security screening checkpoint. Other responses included one airport thinking seven minutes is best, another thinking 10 minutes is model, and another indicating that 60 minutes is ideal. One airport did not respond.

12.c. Baggage Security Screening – EDS

Three of the eight airports surveyed believed that the most appropriate peak period metric is 15 minutes in regard to planning the baggage security screening facility. Other responses included one airport thinking seven minutes is best and two others thinking 60 minutes is ideal. One airport did not respond, and one was unsure.

12.d. Baggage Make-Up Area

Twenty-five percent of the eight airports surveyed believed that the most appropriate peak period metric is 15 minutes in regards to planning the baggage make-up area. Other responses included best peak period metrics being 120 minutes, 20 minutes, 60 minutes, and 30 minutes. One airport did not respond, and one was unsure.

12.e. Departure Lounges

Three of the eight airports surveyed believed that the most appropriate peak period metric is 60 minutes in regard to planning the departure lounges. Other responses included one airport thinking 30 minutes is best, another reported that they think 15 minutes is best, and another said 20 minutes was ideal. One airport did not respond, and one was unsure.

12.f. Gates

Twenty-five percent of the airports surveyed believed that the most appropriate peak period metric is 60 minutes regarding planning the gate areas. Other responses included two airports thinking 15 minutes is best, one thinking 30 minutes is best, and one reporting 20 minutes is ideal. One airport did not respond, and one was unsure.

12.g. Concourse Circulation

Two of the eight airports surveyed believed that the most appropriate peak period metric is 60 minutes when planning the concourse circulation areas. Other responses included two airports thinking 30 minutes is best, one reporting 15 minutes is best, and another thinking 20 minutes is ideal. One airport did not respond, and one was unsure.

12.h. Customs and Border Protection (CBP)

Three of the eight airports surveyed believed that the most appropriate peak period metric is 60 minutes when planning the customs and border protection areas. Other responses included two airports thinking 15 minutes is best, and another reporting that 20 minutes is ideal. One airport did not respond, and one responded with not applicable.

12.i. Restrooms

Three of the eight airports surveyed believed that the most appropriate peak period metric is 15 minutes in regard to planning the restrooms. Other responses included two airports thinking 20 minutes is best, another one reported that they think 60 minutes is ideal. One airport did not respond and one was unsure.

12.j. Meeter/Greeter Area

Twenty-five percent of the airports surveyed believed that the most appropriate peak period metric is 20 minutes when planning the meeter/greeter areas. Other responses included two airports thinking 30 minutes is best, another one reported that they think 60 minutes is ideal, and lastly one said they think 15 minutes is best. One airport did not respond and one was unsure.

12.k. Baggage Claim

Three of the eight airports surveyed believed that the most appropriate peak period metric is 15 minutes when planning the baggage claim areas. Other responses included two airports thinking 20 minutes is best, one reporting60 minutes is ideal, and one thinking 30 minutes is best. One airport did not respond.

12.l. Rental Car Counter/Queuing

Three of the airports surveyed believed that the most appropriate peak period metric is 15 minutes in regard to planning the rental car facility. Other responses included two airports thinking 60 minutes is best, and one reporting that they think 20 minutes is ideal. One airport did not respond.

12.m. Curb Frontage

Three of the eight airports surveyed believed that the most appropriate peak period metric is 15 minutes in regard to planning the curb frontage area. Other responses included two airports thinking 60 minutes is best, and another one reported that they think 20 minutes is ideal. One airport did not respond, and one airport was unsure.

12.n. Parking – Short Term

Twenty-five percent of the airports surveyed believed that the most appropriate peak period metric is once-a-day in regard to planning the short term parking areas. Other responses included one airport thinking 60 minutes is best, one said 15 minutes, and another reported 30 minutes is ideal. Two airports did not respond, and one airport was unsure.

12.o. Parking – Long Term

Two of the eight airports surveyed believed that the most appropriate peak period metric is once-a-day in regard to planning the long term parking areas. Other responses included one airport thinking 60 minutes is best, one said 15 minutes, and another reported that 30 minutes is ideal. Two airports did not respond, and one respondent was unsure.

Question 13: Based on your experience at your airport, have the peak period calculations referenced in Question 12 overestimated, underestimated, or accurately estimated the true demand for the following facilities:

13.a. Ticketing – Ticket Counters & Queuing

Half of the airports surveyed responded that based on their experience, the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the ticket area. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.b. Passenger Security Screening Checkpoint

Three of the eight airports surveyed responded that based on their experience, the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the passenger security screening checkpoint. One airport stated they believe the calculation is an underestimate, while one airport thought the calculation was accurate, and one thought the calculation was an overestimate. Two airports did not respond.

13.c. Baggage Security Screening - EDS

Half of the airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the baggage security screening area. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.d. Baggage Make-Up Area

Fifty percent of the airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the baggage make-up area. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.e. Departure Lounges

Half of the airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the departure lounges. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.f. Gates

Fifty percent of the airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the gate areas. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.g. Concourse Circulation

Half of the survey respondents reported that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the concourse circulation areas. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.h. Customs and Border Protection (CBP)

Three of the eight airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the customs and border protection areas. One airport said they believe the calculation is an underestimate; whereas, one airport thought the calculation was accurate. Two airports did not respond.

One airport did not respond, one reported that this question is not applicable to their airport, and one respondent did not answer this question because they believed it was a bad question.

13.i. Restrooms

Half of the survey respondents reported that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the restrooms. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.j. Meeter/Greeter Area

Fifty percent of the survey respondents reported that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the meeter/greeter area. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.k. Baggage Claim

Three of the eight airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the baggage claim area. One airport said they believe the calculation is an underestimate, whereas two airports thought the calculation was accurate. Two airports did not respond.

13.l. Rental Car Counter/Queuing

Fifty percent of the airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the rental car facility. One airport said they believe the calculation is an underestimate, whereas one airport thought the calculation was accurate. Two airports did not respond.

13.m. Curb Frontage

Three of the eight airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the curb frontage area. One airport said they believe the calculation is an underestimate; whereas two airports thought the calculation was accurate. Two airports did not respond.

13.n. Parking – Short Term

Eight airports were surveyed and three of them reported that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the short term parking areas. One airport said they believe the calculation is an underestimate; whereas two airports thought the calculation was accurate. Two airports did not respond.

13.o. Parking – Long Term

Three of the eight airports surveyed responded that based on their experience the peak period calculations referenced in question 12 are neither overestimated nor underestimated in regard to demand at the long term parking areas. One airport said they believe the calculation is an underestimate; whereas, two airports thought the calculation was accurate. Two airports did not respond.

Question 14: When preparing peak period estimates do you believe the greater source of error lies in:

- *a. The annual forecasts from which they are derived?*
- *b. The peak period factors used to convert from annual activity forecasts?*

Fifty percent of the airports surveyed believe that the greater source of error when preparing peak period estimates lies in the annual forecasts from which they are derived. Two of the airports disagreed with that statement, one airport did not respond, and one airport reported that this question is not applicable.

Question 15: Have your forecasts of peak period activity assumed:

- *a. A constant share of design day activity?*
- *b. A changing share of design day activity?*

Three-fourths of the surveyed airports reported that their forecasts of peak period activity assumed a constant share of design day activity. One of the two airports that do assume a changing share of design day activity elaborated that project level planning may require consideration of a range.

Question 16: If your forecasts assumed a change in share of design day activity accounted for by the peak period, what approach did you use to estimate the change in share?

This question relates back to question 15b; therefore, only two airports needed to respond. One respondent stated consideration of growth patterns and airline plans (if available), which includes whether airlines are established or relatively new entrants in markets and route networks. The second airport in which this question was applicable chose not to respond.

Question 17: Have you adjusted your peak period projections to incorporate constraints?

If yes, what kind of constraints did you incorporate? Please describe your approach.

Seventy-five percent of the respondents stated they do not adjust their peak period projections to incorporate constraints. One airport said they do adjust their projections; they added that they do not officially change the forecast that the FAA approves, but make adjustments depending on gate use as some areas are more constrained than others and take longer to turn aircraft. One airport did not respond.

Question 18: What improvements, if any, do you recommend to current approaches for forecasting peak period passengers and operations?

Three of the eight airports made recommendations for improvements to the current approaches for forecasting peak period passengers and operations. These comments included: 1) having more vigilance in considering changes in aircraft fleet, 2) noting the best times/scenarios for making small adjustments, and 3) "Each airport is unique and I am not sure if you can make improvements". Fifty percent of the respondents did not answer this question, and one airport said this question was not applicable.

Question 19: What improvements, if any, do you recommend to current approaches for applying peak period passengers and operations estimates to airport planning?

Some airports made recommendations to the current approaches for applying peak period passengers and operations estimates to airport planning. These comments included: 1) aircraft fleet considerations, 2) ability to tweak for specific areas of the terminal, and 3) a better understanding of the different aspects of the design day numbers as well as how that information can and should be used. Half of the airports did not respond to this question, and one airport said this question is not applicable to them.

D.3 Day/Night Split Questions

Some survey respondents indicated in Question 1 that their airport has not prepared day/night projections, but weighed in on these questions. Four of the eight airports reported not having prepared day/night estimates, but their answers are included in the following questions. Some of these respondents were unsure about some of these questions and are, therefore, delineated as not applicable.

Question 20: Which data sources do you use to estimate day/night splits (please check all that apply):

20.a. Radar data (ARTS, ANOMS, etc.)

20.b. Manual tower counts

20.c. OAG

20.d. Other (specify)

Many of the respondents used multiple data sources to identify day/night splits. Seventy-five percent of the surveyed airports responded that they use Radar Data to estimate day/night splits. Fifty percent of the surveyed airports responded that they use manual tower counts to estimate day/night splits. Five of the eight surveyed airports responded that they use the OAG to estimate day/night splits.

Question 21: If you use OAG data, do you make an adjustment to convert gate times to runway times?

This question relates back to question 20c; therefore, five airports responded. Of those five airports that this question affects, two of them said that they do make adjustments to convert gate times to runway times and three of them said they do not make adjustments to convert gate time to runway times.

Question 22: If you answered yes to Question 21, please describe your approach for converting gate times to runway times.

This question relates back to question 21; therefore, only two airports needed to respond. One airport described their approach for converting gate times to runway times as adding average unimpeded taxi time to the gate time, and the other airport described it as assuming an average taxi time and then adding that to the runway time to get the gate time.

Question 23: Have your forecasts of day/night splits assumed:

a. A constant percentage split between daytime and nighttime operations?
b. A changing share of operations occurring in nighttime?

All of the eight airports surveyed responded that their forecasts of day/night splits assumed a constant percentage split between daytime and nighttime operations.

Question 24: If your forecasts assumed a changing nighttime share, what was the basis of the assumption?

Although no airports indicated that they assumed a changing nighttime share, some airports responded. One airport's basis for the assumption of a changing nighttime share depends on design day schedules and assumptions on peak spreading. Another respondent said they still look at nighttime needs on a daily basis for concessions, DHS, and airport staffing levels because if they do not then the customers may be without adequate facilities and customer service quality suffers.

Question 25: Based on your experience at your airport, have the estimated day/night splits overestimated or underestimated true nighttime operations:

Four of the eight airports surveyed do not know if the day/night split estimates are a true representation to nighttime operations. Two of the airports answered as neither, and two other respondents reported that this question is not applicable to them.

Question 26: Have you adjusted your day/night projections to incorporate constraints?

None of the eight surveyed airports said they do not adjust their day/night projection to incorporate constraints.

Question 27: What improvements, if any, do you recommend to current approaches for forecasting the day/night split of operations?

None of the airports surveyed had any recommendation to improvements of current approaches for forecasting the day/night split of operations.

Question 28: What improvements, if any, do you recommend to current approaches for applying the day/night split of operations to noise analysis?

One airport had a recommendation for improvements in regard to the current approaches for applying the day/night split of operations to noise analysis. The recommendation was to apply their model which runs their noise analysis 24 hours a day, 14 days in a row in January/February and then again for 14 more days in June/July . The other seven airports did not have any recommendations.

D.4 Operational Profile Questions

Question 29: When estimating future hourly passenger or aircraft operation profiles, which approach do you use (check all that apply):

- *a. Scale up proportionately from existing base year hourly distribution?*
- *b. Scale up from existing base year hourly distribution but with peak spreading factor?*
- *c. Extract from future design day flight schedule?*
- *d. Other?*

Three of the eight airports surveyed reported that they scale up proportionately from existing base year hourly distribution when estimating future hourly passenger or aircraft profiles but without a peak spreading factor. Two airports said they extract from future design day flight schedules when estimating future hourly passenger or aircraft profiles and three airports said this question was not applicable or did not know. None of the airports provided an alternative approach when estimating future hourly passenger or aircraft profiles.

Question 30: If you use a peak spreading factor when scaling up from an existing hourly distribution, please describe the approach you use to estimate the peak spreading.

One airport offered their insight and reported that their approach is judgment based, and based on existing service patterns/aircraft sizes and markets to be served.

Question 31: Based on your experience, have the hourly distribution profiles overestimated, underestimated, or accurately estimated the actual airfield delay at your airport?

Fifty percent of the surveyed airports believed that the hourly distribution profiles have accurately estimated the actual airfield delay at their respective airports. Two airports were not sure, and two airports said this question is not applicable to them.

Question 32: Based on your experience, have the hourly distribution profiles overestimated, underestimated, or accurately estimated the true peak demand for the following facilities:

32.a. Ticketing – Ticket Counters & Queuing

Half of the airports surveyed (50.0%) were not sure if the hourly distribution profiles accurately estimate the true peak demand for the ticketing area; whereas, two airports believed they were accurately estimated. Two other airports stated this question is not applicable to them.

32.b. Passenger Security Screening Checkpoint

A quarter of the airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the passenger security screening checkpoint and two airports believe they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.c. Baggage Security Screening - EDS

More than a quarter of the airports surveyed (37.5%) are not sure if the hourly distribution profiles accurately estimate the true peak demand for the baggage security screening area; whereas, one airport believes they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.d. Baggage Make-Up Area

Three of the eight airports surveyed were not sure if the hourly distribution profiles accurately estimate the true peak demand for the baggage make-up area; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.e. Departure Lounges

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.f. Gates

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.g. Concourse Circulation

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.h. Customs and Border Protection (CBP)

Twenty-five percent of the airports surveyed were not sure if the hourly distribution profiles accurately estimate the true peak demand for the customs and border protection area; whereas one airport believed they are accurately estimated. Two airports did not respond, three airports stated this question is not applicable to them.

32.i. Restrooms

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.j. Meeter/Greeter Area

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.k. Baggage Claim

Twenty-five percent of the airports surveyed were not sure if the hourly distribution profiles accurately estimate the true peak demand for the customs and border protection area; whereas one airport believed they are accurately estimated. Two airports did not respond, three airports stated this question is not applicable to them.

32.l. Rental Car Counter/Queuing

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.m. Curb Frontage

Two of the eight airports surveyed were not sure if the hourly distribution profiles accurately estimate the true peak demand for the curb frontage area; whereas two other airports believed they were accurately estimated. Two airports did not respond and two airports stated this question is not applicable to them.

32.n. Parking – Short Term

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

32.o. Parking – Long Term

Three of the eight airports surveyed are not sure if the hourly distribution profiles accurately estimate the true peak demand for the departure lounges; whereas, one airport believed they are accurately estimated. Two airports did not respond, and two airports stated this question is not applicable to them.

33. Based on your experience, on average, how much do peaks for the following facilities lead the enplaning peak at your airport?

33.a. Departure Curb

This question was answered by two of the eight airports. These two responses represent two different ends of the spectrum; one airport believed that the departure curb leads the enplaning peak at their airport by 90 minutes; whereas the other airport believed that the departure curb leads the enplaning peak by only 15 minutes.

33.b. Ticketing – Ticket Counters and Queuing

This question was answered by three of the eight airports. Respondents from two airports think that the ticketing area leads the enplaning peak at their airport by either 60 to 75 minutes or 80 minutes; whereas the other airport respondent believes that the ticketing area leads the enplaning peak by only 15 minutes.

33.c. Passenger Security Screening Checkpoint

This question was answered by three of the eight airports. Two of the airport respondents estimate that the passenger security screening checkpoint leads the enplaning peak at their airport by either 60 to 75 minutes or 60 minutes; whereas the other respondent estimates that the passenger security screening checkpoint leads the enplaning peak by only 15 minutes.

33.d. Baggage Security Screening - EDS

This question was answered by three of the eight airports. Two airport respondents stated that the baggage security screening area leads the enplaning peak at their airport by either

60 or 80 minutes; whereas the other respondent stated that the baggage security screening area leads the enplaning peak by only 10 minutes.

33.e. Baggage Make-Up Area

Three of the eight airports surveyed answered this question. These responses represent a wide range; as one airport estimates that the baggage make-up area leads the enplaning peak at their airport by only 20 minutes; whereas the other airports estimate that the baggage make-up area leads the enplaning peak by either 45 or 80 minutes.

33.f. Departure Lounges

Twenty-five percent of the airport respondents surveyed answered this question. One respondent estimates that the departure lounges lead the enplaning peak at their airport by 30 minutes; whereas the other respondent estimated that the departure lounges lead the enplaning peak by 50 minutes.

Question 34: Based on your experience, on average how much do peaks for the following facilities lag the deplaning peak at your airport?

34.a. Customs and Border Protection (CBP)

Three airports commented on how long the Customs and border protection area lags the deplaning peak at their airport. One airport reported five minutes, one airport reported 20 minutes, and another airport reported 40-45 minutes.

34.b. Restrooms

Two airports commented on how long the restrooms lag the deplaning peak at their airport. One airport reported five minutes and the other airport reported 10 minutes.

34.c. Meeter/Greeter Area

Three airports commented on how long the meeter/greeter area lag the deplaning peak at their airport. One airport reported 15 minutes, one airport reported 20 minutes, and another reported 30 minutes.

34.d. Baggage Claim

Three airports commented on how long the baggage claim area lags the deplaning peak at their airport. The responses are similar to one another. Two airports reported 15 minutes and the other airport reported a range of 20-25 minutes.

34.e. Rental Car Counter/Queuing

Three airport respondents commented on how long the rental car facility lags the deplaning peak at their airport. One respondent reported 15 minutes; another said a range of 21 to 25 minutes, and the final respondent reported 30 minutes.

34.f. Arrival Curb

Three airports commented on how long the arrival curb lags the deplaning peak at their airport. One airport reported 15 minutes; one said a range of 22 to 25 minutes, and the other airport reported 25 minutes.

Question 35: Have you adjusted your hourly distribution projections to incorporate constraints?

Six of the eight airports surveyed do not adjust their hourly distribution projections to incorporate constraints. Two airports said this question was not applicable to their airport.

Question 36: What improvements, if any, do you recommend to current approaches for forecasting hourly passenger and operation profiles?

Only one airport made a recommendation for improvements to the current approaches for forecasting hourly passenger and operation profiles. The respondent suggested considering potential for changes in characteristics in the future because they may differ from existing characteristics. None of the other airports made any recommendations for improvements.

Question 37: What improvements, if any, do you recommend to current approaches for applying hourly passenger and operation profiles to airport planning?

One of the eight airports surveyed made a recommendation for improvements to the current approaches for applying hourly passenger and operation profiles to airport planning. The respondent suggested anticipating benefits of technology and changes in demographics. The other seven airports did not make any recommendations.

D.5 Design Day Flight Schedule Questions

Question 38: When preparing future design day flight schedules, which approach do you use:

a. *Begin with existing schedule and clone flights based on existing distribution?*
b. *Segment existing schedule by category (e.g. domestic/international) and then clone flights based on anticipated growth in each segment?*
c. *Begin with existing schedule and use professional judgment to estimate new flights?*
d. *Other?*

One of the respondents stated that they segment the existing schedule and then clone flights. Four of the airports stated that they begin with an existing schedule and then use professional judgment to estimate new flights. None of the airports reported an approach that differed from those listed in the questionnaire.

Question 39: Based on your experience, have the design day flight schedules overestimated, underestimated, or accurately estimated the actual number of gates required at your airport?

Twenty-five percent of the survey respondents said the design day flight schedules accurately estimated the actual number of gates required at their respective airports. Another 25 percent reported that they were unsure. The remaining four airports did not respond, or said this question was not applicable to them.

Question 40: Based on your experience, have the design day flight schedules overestimated, underestimated, or accurately estimated the actual airfield delay at your airport?

Two of the survey respondents said the design day flight schedules accurately estimated the actual airfield delay at their respective airports. The remaining respondents stated that they did not know or did not answer.

Question 41: Based on your experience, have the design day flight schedules overestimated, underestimated, or accurately estimated the actual air quality impacts at your airport?

The respondents did not know or were not able to answer the question.

Question 42: Have you adjusted your design day schedules to incorporate constraints?

a. *If yes, what kind of constraints did you incorporate?*
b. *Please describe your approach.*

One of the eight respondents stated that they have adjusted their design day schedules to incorporate constraints, but only to evaluate alternative future scenarios. That airport reported their adjustments larger aircrafts, an increase in the percentage of international flights, and a reduction of hubbing activity. They described their approach as scenarios based on assumptions.

Question 43: What improvements, if any, do you recommend to current approaches for forecasting design day flight schedules?

Only one airport offered recommendations to improvements to current approaches for forecasting design day flight schedules. That airport stated that more vigilance is needed when considering changes in aircraft fleet.

D.6 Final Comments

Question 45: Please share any other comments or observations you may have on the preparation and use of peak period and operational profile forecasts.

One respondent offered the observation that at large airports, forecasts and existing characteristics and patterns can be highly airport-specific, much more so than at small or mid-size airports.

Appendix E

Peak Day and Hour Analysis

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix E: Peak Day and Hour Analysis

In this analysis, we look at peak day-of-week and peak hour-of-day passenger activity. Obtaining this information has long been a challenge for airport planners because it is not contained in the publicly available databases, such as the DOT T-100 and DB1A. Instead, planners have been forced to use published airline schedules which provide scheduled seats by day of week and time of day, and then apply an assumed seat factor[1] to the scheduled flights.

We begin with a review of the usual approach to estimating peak day-of-week and peak hour-of-day activity using publicly available scheduling data. We then supplement this using limited additional data, provided by to us by airline planners on a confidential basis for this project, which shows actual passenger variations by airport by day of week and hour of day.

I. Projecting Peak Day and Peak Hour Passengers Using Schedule Information

Using airline schedule information from sources such as OAG or Innovata, planners can readily estimate the number of flights arriving and departing during any defined period. Airline flight schedules, including the aircraft type and number of seats on that aircraft, are available for past flights going back a number of years. Schedules are also available for flights many months in the future, although schedule information is most reliable for flights no more than three months ahead as airlines typically "lock-in" their schedules about three months in advance.

Using airline schedule information to project the number of scheduled seats by day of week or time of day is a straightforward way to determine when peak airport activity will occur. There may be some unscheduled flights or charters that are not listed in the schedule information, but most airports will obtain a very accurate picture of flight activity through the published airline schedule information.

[1] Although the term *load factor* is most frequently used in multiple contexts, it has a different meaning from the term *seat factor*, which is the correct term to use for situations such as this. *Load factor* is calculated by the number of revenue passenger miles divided by the number of available seat miles – it therefore counts long haul passengers more heavily than short-haul passengers. *Seat factor* is calculated by the number of revenue passengers divided by the number of seats – it weights each passenger equally, and is the correct measure to use in estimating passenger peaks.

As an example, assume three daily flights with 100 seats. The first carries 90 passengers and flies to a destination 2,000 miles away. The other two carry 45 passengers and fly to destinations 500 miles away. In this case, the seat factor for the group of flights will be 60 percent (the average of 90 percent, 45 percent, and 45 percent), but the load factor will be 75 percent (total RPM.s divided by ASMs) because the longer flight provides more revenue passenger miles.

Flight	Passengers	Seats	Seat Factor	Distance	RPMs	ASMs	Load Factor
1	90	100	90%	2,000	180,000	200,000	90%
2	45	100	45%	500	22,500	50,000	45%
3	45	100	45%	500	22,500	50,000	45%
Total	180	300	60%		225,000	300,000	75%

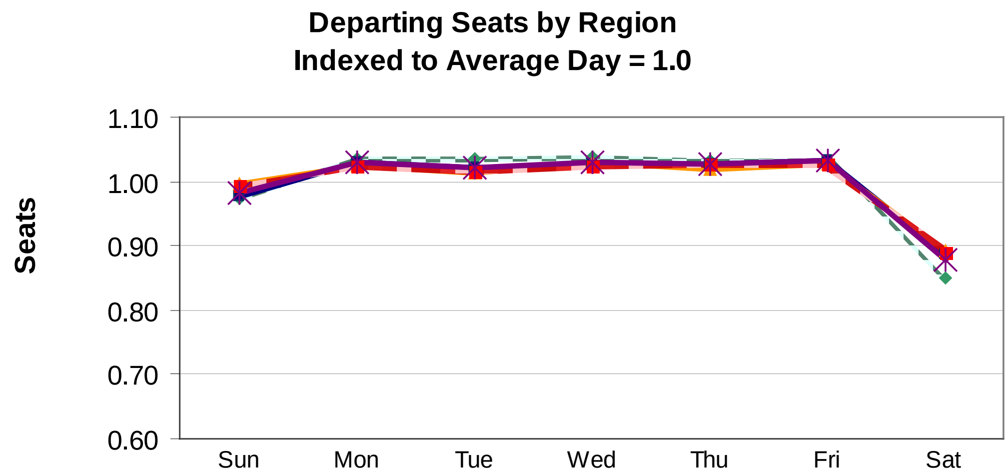
II. Day- of-Week Schedule Peaking

We have analyzed all flights to/from U.S. airports during 2008 and summarized the results for airports of different sizes and located in four different regions – Eastern, Central, Mountain, and West. Each region is defined to include all airports within that time zone; this classification was used because the airlines must schedule flights differently in each time zone in order that they meet the major hub banks. Exhibit E.1 below shows the number of departing seats by day-of-week based on an index where the number of departing seats on an average day = 1.0. So, for example, the highest peak for the Central region is Wednesday which has an index of 1.036; this means that at airports in the Central region, there are 3.6 percent more departing seats on Wednesday than on an average day.

In general, there is very little difference in the number of departing seats during the five-day work week. Friday has the most scheduled departing seats in the Eastern and Western regions and for the composite set of airports, but only by a fraction of one percent over the next busiest day. In the Eastern region, for example, Friday has only 0.5 percent more seats than Wednesday, the 2nd busiest day of the week. For the Central and Mountain regions, Wednesday is the busiest day of the week in departing seats, with Friday the 2nd busiest, with the two separated by no more than 0.5 percent.

For each region, the maximum difference in the number of seats between the busiest day of the week and the average day is less than 4 percent. Only Saturdays and Sundays are set apart, with Sunday having slightly fewer seats than an average day and Saturday having 10 to 15 percent fewer seats than an average day.

Exhibit E.1



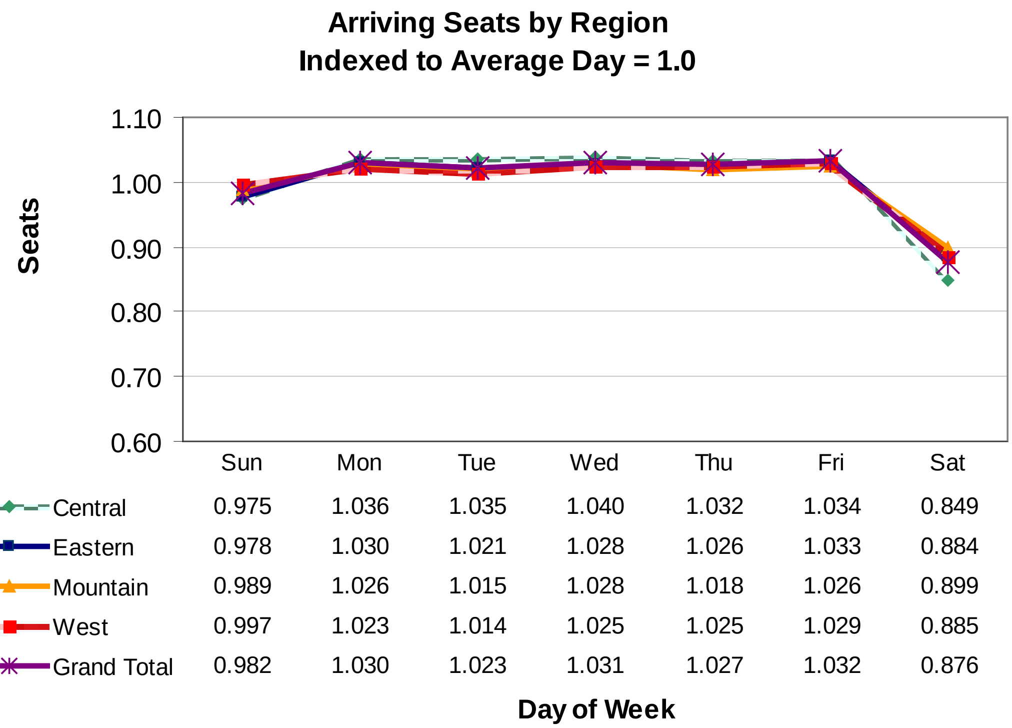
	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	0.974	1.036	1.035	1.039	1.033	1.034	0.850
Eastern	0.976	1.028	1.021	1.028	1.027	1.033	0.887
Mountain	0.996	1.025	1.014	1.028	1.018	1.027	0.892
West	0.994	1.024	1.015	1.024	1.026	1.028	0.888
Grand Total	0.981	1.029	1.023	1.030	1.028	1.032	0.878

Day of Week

Source: OAG for calendar year 2008 and Oliver Wyman analysis

Not surprisingly, as shown in Exhibit E.2, the results for arriving seats are very similar to those for departing seats in terms of the peak day-of-week and the degree of peaking that occurs.

Exhibit E.2



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	0.975	1.036	1.035	1.040	1.032	1.034	0.849
Eastern	0.978	1.030	1.021	1.028	1.026	1.033	0.884
Mountain	0.989	1.026	1.015	1.028	1.018	1.026	0.899
West	0.997	1.023	1.014	1.025	1.025	1.029	0.885
Grand Total	0.982	1.030	1.023	1.031	1.027	1.032	0.876

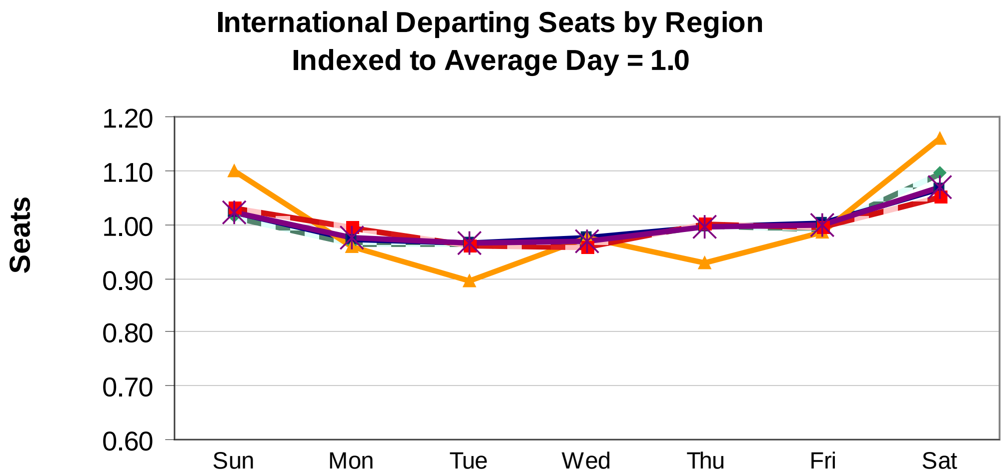
Source: OAG for calendar year 2008 and Oliver Wyman analysis

In 2008, international seats made up 10.4 percent of all seats operated in the U.S. (Source: OAG for calendar year 2008 and Oliver Wyman analysis.) International and domestic flights have slightly different peaking patterns in that there is greater travel to and from the Caribbean, Mexico, and other sun destinations on Saturday and Sunday. The result is that Saturday is usually the peak day for international travel, followed by Sunday. Between the four regions, there are few differences in day of week peaking for international travel, except for the Mountain region, which has even more pronounced international peaks on Saturday and Sunday.[2]

Exhibit E.3 shows international departing seats by day-of-week for each region based on an index where the number of departing seats on an average day = 1.0.

[2] Note that the Mountain region has very little international service compared to the other regions. International departing seats from the Mountain region make up 1.6% of the U.S. total, compared with 18.4% from the Central region, 21.4% from the West, and 58.5% from the Eastern region.

Exhibit E.3



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	1.014	0.966	0.967	0.965	0.998	0.993	1.097
Eastern	1.022	0.972	0.967	0.974	0.996	1.004	1.065
Mountain	1.099	0.957	0.895	0.975	0.929	0.986	1.159
West	1.032	0.996	0.961	0.959	1.001	0.997	1.053
Grand Total	1.024	0.976	0.964	0.969	0.997	1.000	1.070

Day of Week

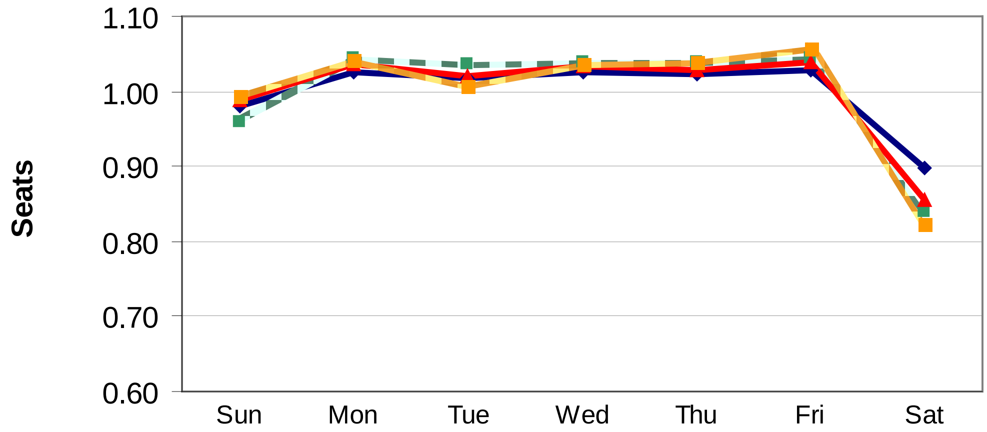
Source: OAG for calendar year 2008 and Oliver Wyman analysis

Appendix E.1 contains four charts showing separate results for domestic and international travel by region and day of week.

When the results are broken down by airport size, we see that large and small airports have similar day-of-week peaking patterns, with the smallest airports having only slightly more pronounced peaking in departing and arriving seats than the large airports. Eastern region results for departing seats from large, medium, small, and nonhub airports are in Exhibit E.4. On the peak day, Friday, large Eastern hub airports have 2.9 percent more seats than an average day, while nonhubs in the Eastern region have 5.6 percent more seats than on an average day.

Exhibit E.4

Departing Seats Eastern Region by Airport Size
Indexed to Average Day = 1.0



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Large	0.980	1.027	1.018	1.025	1.023	1.029	0.897
Medium	0.958	1.043	1.036	1.040	1.039	1.045	0.839
Small	0.989	1.035	1.020	1.034	1.029	1.038	0.855
Non	0.995	1.041	1.008	1.037	1.039	1.056	0.824

Day of Week

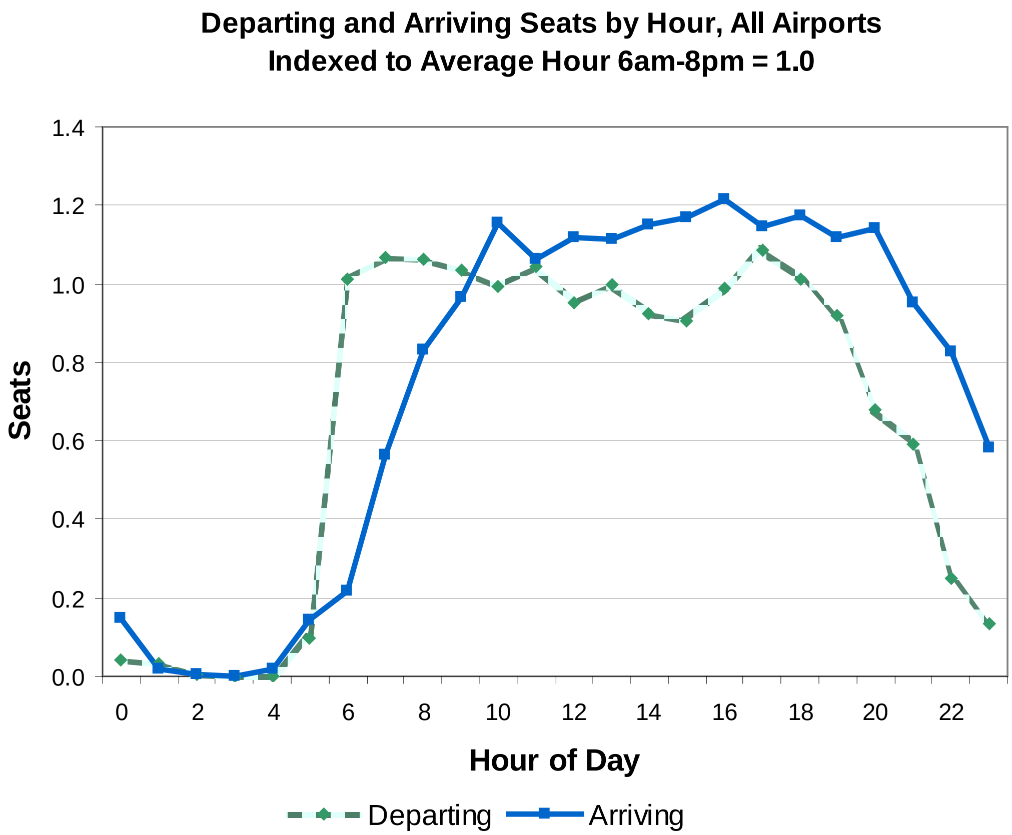
Source: OAG for calendar year 2008 and Oliver Wyman analysis

III. Time-of-Day Schedule Peaking

Exhibit E.5 shows the number of departing and arriving seats per hour at all U.S. airports based on an index whereby the average number of seats during the primary flight hours of 6a.m.-8p.m. = 1.0. So, for example, the highest peak shown is the 4 p.m. arrival peak,[3] which has an index of 1.2; this means that at U.S. airports in the aggregate, 20 percent more seats arrive (or more accurately, are scheduled to arrive) between 4 p.m. and 4:59 p.m. than during the average hour. For U.S. airports in the aggregate, the peak hours for departures are 5 p.m. and 7 a.m., while the peak hours for arrivals are 4 p.m. and 10 a.m. In the charts that follow, we will see that because hourly peaking patterns differ significantly by region and by airport size, this overall chart is of limited usefulness in understanding airport peaking other than to show the clear beginning of the travel day and sharp decline in travel between 9 p.m. and midnight. (The detailed data table showing the index by hour for each airport size category and each U.S. region is attached as Appendix E.2.)

[3] In this analysis, flights listed on the hour include all flights departing or arriving, as the case may be, between the beginning of that hour and the beginning of the next hour. So, for example, 4 p.m. flights include all flights beginning at 4 p.m. and 4:59 p.m.

Exhibit E.5



Source: OAG for calendar year 2008 and Oliver Wyman analysis

Exhibit E.6 shows the number of departing seats per hour at large airports in each of the four regions (based on the same index whereby the average number of seats during the primary flight hours of 6a.m.-8p.m. = 1.0). The differences between the four regions may not be immediately clear, but there are some.

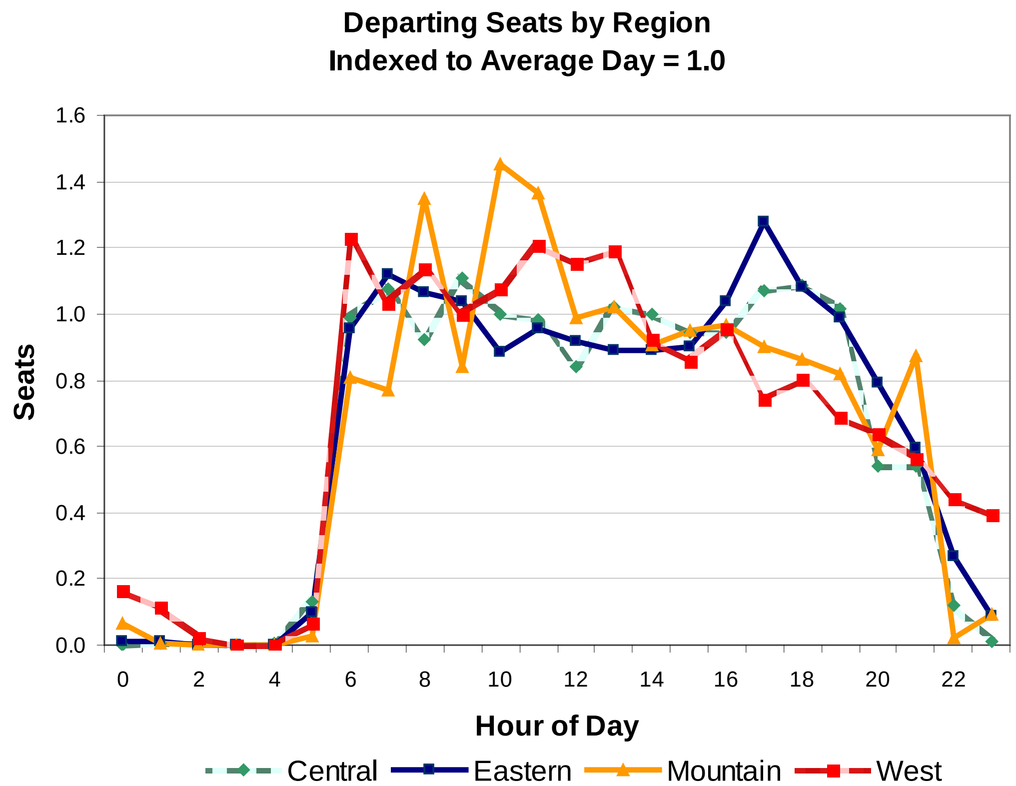
- The Eastern region has the most distinctive classic business profile with a large 5p.m. departure peak following by an early morning peak between 8 and 9 a.m..

- The West Coast has a large departure peak between 11 a.m. and 1 p.m. and steadily decreasing flight levels after that, which reflects the fact that most flights to the East Coast have departed by early afternoon.

- The Central region has similar peaks to the East but with a more consistent level of flights during the day, reflecting the large hubs and daytime connecting banks in the Central region.

- Finally, the Mountain region shows pronounced peaking between 9 a.m. and 11 a.m., with a small peak at 9 p.m.

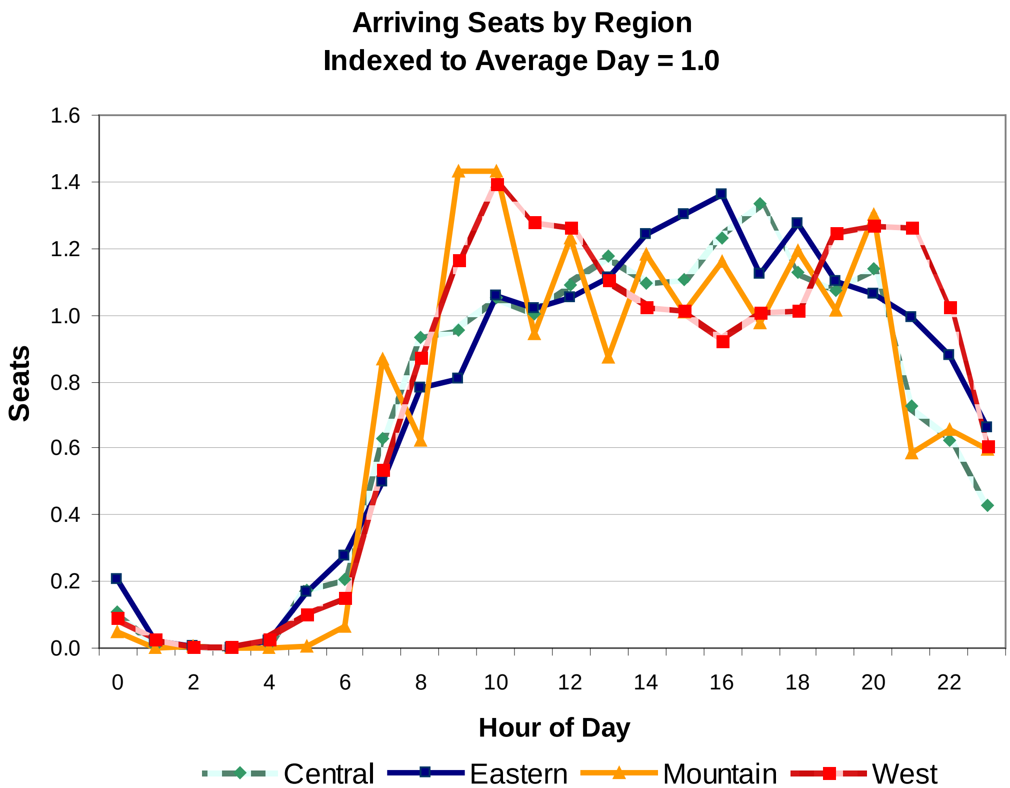
Exhibit E.6



Source: OAG for calendar year 2008 and Oliver Wyman analysis

The arrivals chart (Exhibit E.7) shows slightly different patterns. Eastern region arrivals do not have an early morning peak, but instead increase steadily to 4 p.m. peak. Central region arrivals have a similar pattern building to a 5 p.m. peak. Western region arrivals have a clear peak at 10 and 11 a.m. and then again from 7-9 p.m. And Mountain region airports have peaks at 9 and 10 a.m. and then again at 8 p.m.

Exhibit E.7

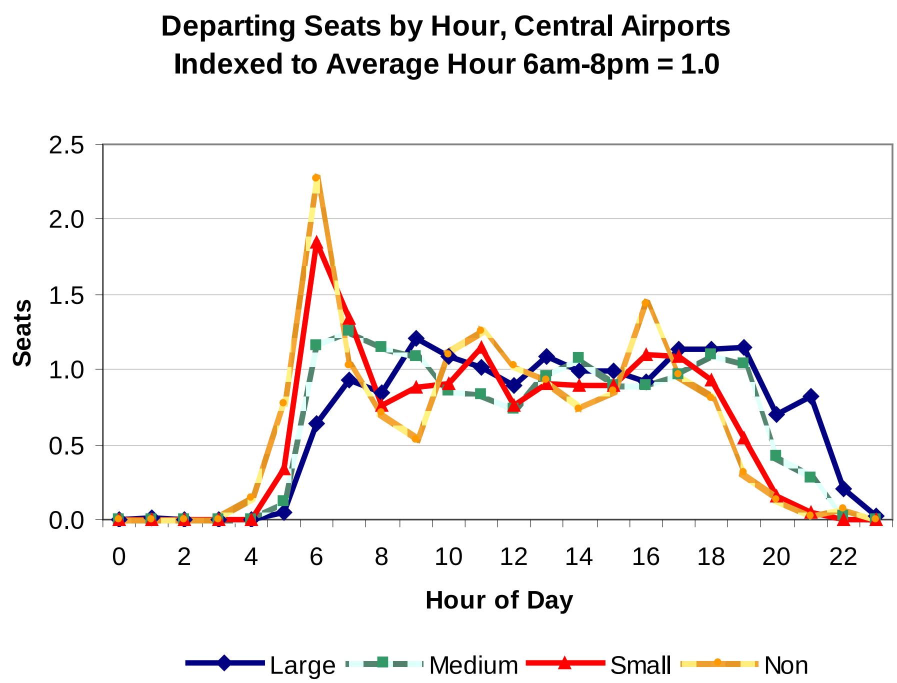


Source: OAG for calendar year 2008 and Oliver Wyman analysis

Unlike the day-of-week charts, there are significant differences in peaking by time-of-day depending on the size of the airport. The main reason for this is that the largest airports in each region are hubs, while the other airports are O&D airports. And O&D airports typically begin each day with a large number of departures, while hub airports have larger peaks later when the first or subsequent bank of flights arrives at the hub. This is evident in each of the charts below, which show that medium, small, and nonhub airports have their largest departure peak very early in the morning between 6 a.m. and 7 a.m.

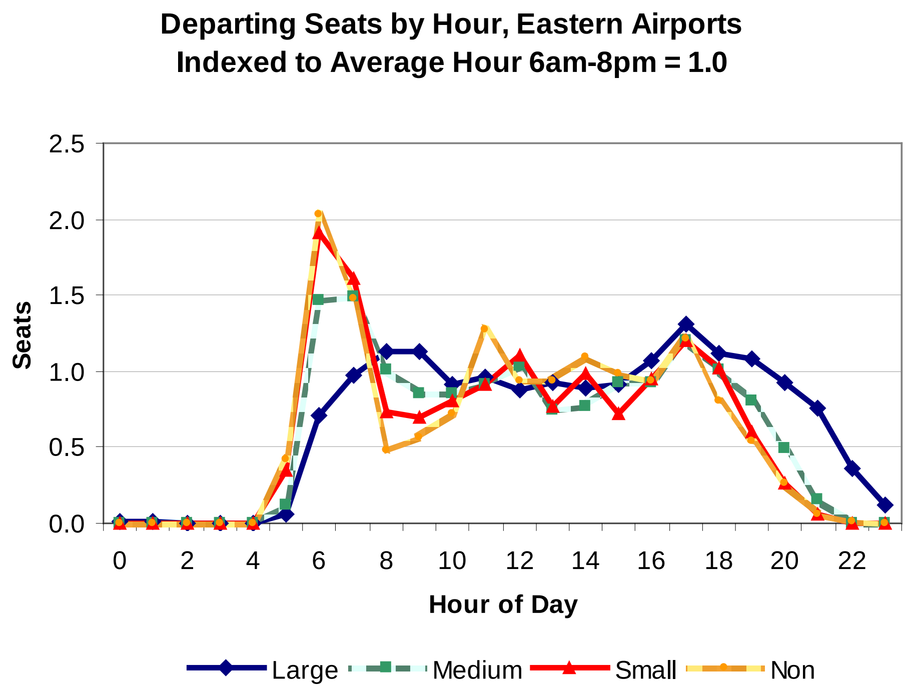
The chart for Central region airports (Exhibit E.8) shows the sharp early morning peak for departures at small and non hub airports, with a more even departure schedule at medium hubs. The large Central region hubs have smaller departure banks in the morning and continue to operate later than the smaller airports.

Exhibit E.8



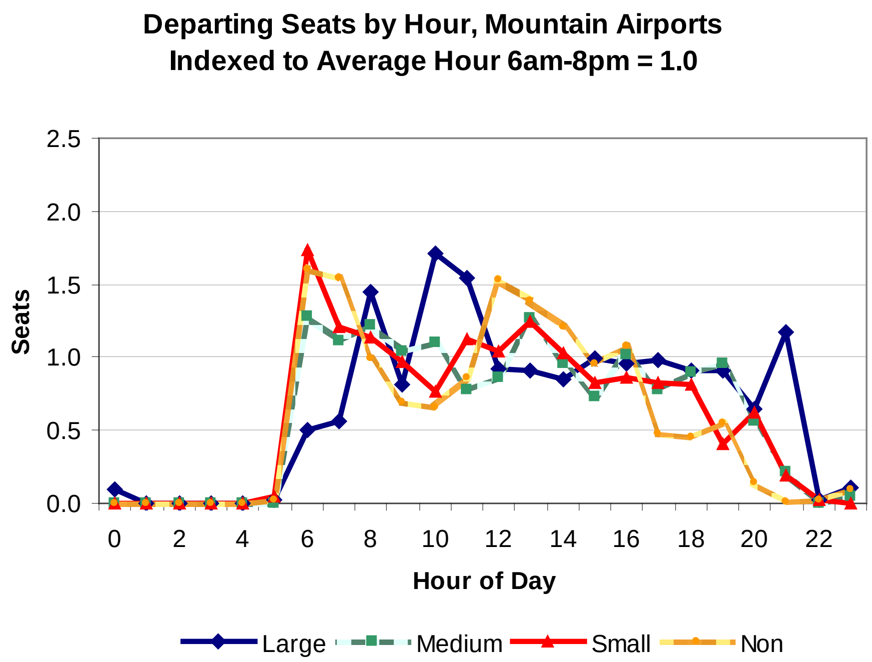
Eastern region airports have a similar profile to Central region airports, except for their strong 5 p.m. departure peak (Exhibit E.9).

Exhibit E.9



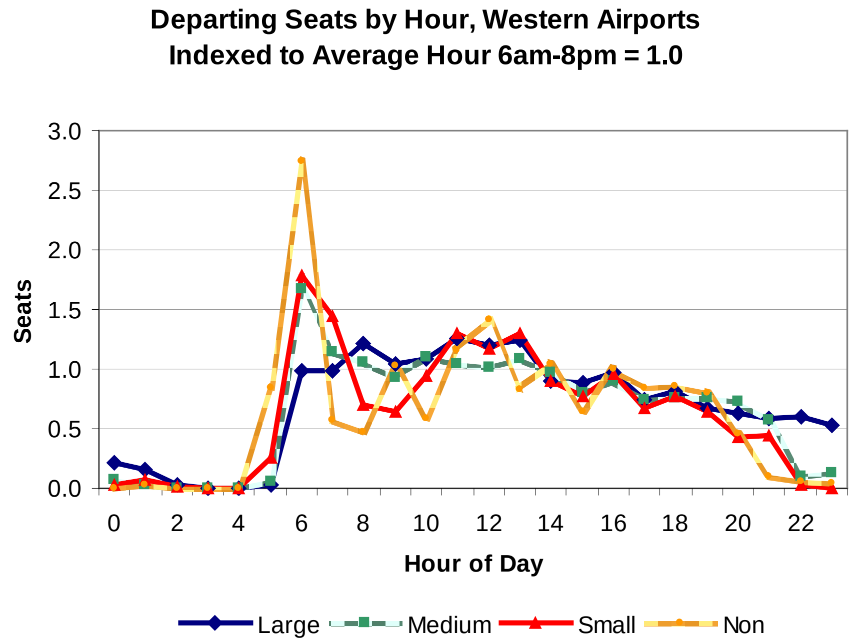
Mountain region airports have departure peaks at 1 p.m. and earlier, and the most uneven departure schedule of the different regions (Exhibit E.10).

Exhibit E.10



Apart from the early morning peak of medium, small, and nonhubs, Western airports have a second peak between 11 a.m. and 1 p.m (Exhibit E.11).

Exhibit E.11



IV. Adjusting Schedule Information to Reflect Differing Load Factors by Day of Week – Insights from Airline Data

We contacted a number of U.S. airlines to request data that would show their actual passenger and load factor peaks at different airports. Most were either unwilling or too busy to provide data. We did, however, obtain specific data from multiple U.S. airlines after committing not to disclose their names or the actual data provided. Because of limitations in the data, we are limiting our observations to Central and Eastern region airports of all sizes, and to large Western region airports. As will become evident, despite the data limitations, there are some conclusions that apply generally to U.S. airports.

Exhibit E.12 was constructed by matching the passenger data provided by the airlines with the actual flights operated, to produce seat factors for individual flights.[4] We then applied the following indexing system: The average seat factor for flights at each individual airport between 6 a.m. and 759 p.m. was assigned an index of 1.0. What the table shows is that there are very minor variations in seat factor by day of week with Tuesdays and Wednesdays typically having slightly lower seat factors and Fridays and Sundays typically having slightly higher seat factors. The magnitude of the variation is small. For large

[4] Our information regarding the time at which the actual flights operated comes from the OAG, which captures scheduled time of departure and arrival, as opposed to actual. Although we believe system-wide results based on this information will closely resemble actual arrival and departure times, there may be individual airports where delays are sufficiently frequent that actual passenger arrivals may occur slightly later than indicated by the schedule information.

Eastern airports, for example, Sunday is the peak day in terms of seat factor for departing flights, and has an average seat factor that is 3.9 percent higher than the average day. Among the large airports, the highest seat factor peak is for Friday departures at large Central airports, at 9.5 percent higher than the average, and that is also the highest peak among all airports in the large, medium, or small categories listed below. Only the nonhub airports show higher peaking, and we would refrain from drawing many conclusions about nonhubs from this limited data set.

Exhibit E.12

Index of **Arrival** Seat Factors

FAA Size	Time Zone	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Large	Central	1.043	1.076	0.968	0.906	0.950	1.038	1.020
	Eastern	1.056	1.005	0.932	0.956	1.012	1.042	1.000
	West	1.042	1.045	0.972	0.972	0.991	1.004	0.971
Medium	Central	1.046	1.083	0.953	0.933	0.970	1.040	0.973
	Eastern	1.021	1.001	0.945	0.953	1.004	1.042	1.037
Non	Central	1.073	1.092	0.968	0.941	0.894	1.039	1.013
	Eastern	0.793	0.856	0.908	1.088	1.089	1.131	1.150
Small	Central	1.042	1.020	0.989	0.964	0.982	1.036	0.966
	Eastern	1.036	1.020	0.949	0.950	0.992	1.055	0.997

Index of **Departure** Seat Factors

FAA Size	Time Zone	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Large	Central	1.000	0.974	0.913	0.963	1.044	1.095	1.012
	Eastern	1.039	1.022	0.941	0.953	1.004	1.033	1.010
	West	1.020	0.992	0.959	0.970	1.019	1.046	0.990
Medium	Central	1.030	0.992	0.910	0.962	1.070	1.079	0.955
	Eastern	1.063	1.011	0.942	0.962	1.006	1.022	0.994
Non	Central	0.908	0.923	0.957	1.046	1.121	1.056	0.999
	Eastern	1.107	1.177	1.047	0.909	0.802	0.909	1.013
Small	Central	1.033	0.964	0.953	1.020	1.033	1.038	0.962
	Eastern	1.031	1.014	0.946	0.957	1.003	1.065	0.984

Source: Confidential airline data and OAG flight information for calendar year 2008

When the schedule peaking data analyzed in the first part of this paper is combined with the seat factor data provided here, what we find is that airports tend to have slightly more seats scheduled on Fridays and Wednesdays, and in addition, the seat factor also tends to be higher on Fridays. The resulting level of passenger peaking, however, is still very small, which shows that modern airline pricing and revenue management practices have to a large extent leveled out day of week travel demand between Monday and Friday.

V. Adjusting Schedule Information to Reflect Differing Load Factors by Time of Day – Insights from Airline Data

The hour-of-day seat index table (Exhibit E.13) was produced using the same technique as the day-of-week table. (We eliminated the nonhub airports from the hour-of-day analysis because the data set was too small to provide confidence to this level of detail.) As with the day-of-week seat factor index table, what this table shows is that there is relatively little variation in seat factor by time of day. Most of the peak seat factors are only a few percentage points above the average seat factor.

In some cases, we noticed that the seat factor peak occurred during the hour that is also the peak time for departing flights. For example, for large Eastern airports, there is a seat factor peak at 5 p.m. (5.7 percent higher seat factor than the average), which is also the peak time for departing seats for large Eastern airports. For other airport categories, however, the peak time for departing or arriving seats does not necessarily have peak seat factors.

Exhibit E.13

Index of **Arrival** Seat Factors

Hour	Large Central	Large Eastern	Large West	Medium Central	Medium Eastern	Small Central	Small Eastern
0	1.048	0.982	0.917		1.008		1.012
1		0.987	0.928				
2							
3							
4		1.168		1.169			
5		1.103		1.059			
6		1.003			1.182		
7		0.902		0.946	0.593		
8	0.772	0.949	0.723	0.843	0.832		
9	0.888	0.926	0.919	0.829	0.853	1.006	0.771
10	0.949	1.035	0.932	0.899	0.864	1.019	0.891
11	0.879	0.985	1.078	0.942	1.005	0.805	0.951
12	1.064	1.039	1.070	0.996	1.042	0.866	1.012
13	1.018	1.030	1.066	1.086	1.010	1.050	1.059
14	1.036	1.040	1.044	1.026	1.007	1.018	1.033
15	1.077	1.039	0.983	1.039	1.026	1.086	1.101
16	1.054	1.065	0.867	1.098	1.026	1.023	1.038
17	0.957	1.018	1.062	1.079	1.081	1.158	0.998
18	1.044	1.028	1.044	1.053	1.075	1.184	1.074
19	1.017	1.004	1.025	0.961	1.003		1.028
20	1.026	0.958	1.054	1.041	1.036		1.027
21	1.023	0.884	1.025	0.985	0.986	0.973	0.984
22	1.080	0.921	0.888	1.028	0.974	1.014	0.994
23	0.996	1.015	0.972	1.019	1.104		0.980

Index of **Departure** Seat Factors

Hour	Large Central	Large Eastern	Large West	Medium Central	Medium Eastern	Small Central	Small Eastern
0							
1							
2							
3							
4							
5	0.983	0.850		1.033	0.774	1.093	1.009
6	1.052	0.919	0.913	1.023	0.965	1.032	0.991
7	0.986	0.922	0.999	1.028	0.995	1.065	0.944
8	1.053	0.919	1.018	1.016	1.073		1.083
9	1.064	1.004	0.872	1.131	0.999	1.340	1.052
10	1.038	0.992	1.094	1.063	1.031	1.120	1.114
11	1.035	1.049	1.048	0.978	1.047	1.163	1.076
12	0.958	0.982	1.045	1.127	1.083	0.994	1.066
13	1.084	1.023	1.003	1.020	1.085	1.116	1.077
14	1.002	1.032	1.014	1.009	1.090	0.892	1.004
15	0.857	1.028	0.958	0.993	0.981	1.053	0.967
16	1.068	1.042	0.978	1.049	0.969	0.820	0.962
17	0.926	1.057	0.966	0.939	1.001	0.888	0.950
18	0.927	1.042	0.785	0.900	0.960	0.878	0.901
19	0.908	0.983	0.851	0.814	0.880		0.849
20		0.941	0.000	0.648	0.762		0.639
21		0.963	1.019		0.697		
22		1.004	1.071				
23		0.934	1.004				

For large Western region airports, we noticed that a departure seat-factor peak occurs at 10 p.m., which is the time when the largest number of long-haul flights depart. This suggested to us that the peak seat factors may be occurring during hours with a large number of long-haul flights. We saw further evidence of this during the 11 a.m.-1 p.m. period in the West, another period with a large number of long-haul departures. And we noticed high arrival seat-factors during the 1-2 p.m. and 5-6 p.m. periods in the West, which coincide with a large number of long-haul arrivals.

Exhibit E.14 shows the average seat factor for all flights at U.S. airports in calendar year 2008, based on flight length. There is a consistent pattern of higher seat factors on longer haul flights and also on Florida flights (which consist largely of leisure passengers). Flights to/from Las Vegas in excess of 500 miles also have high seat factors, similar to Florida. Short-haul Las Vegas flights, however, which make up the largest proportion (37% of all Las Vegas passengers are traveling less than 500 miles) have a seat factor of 69%, which is similar to the U.S. average.

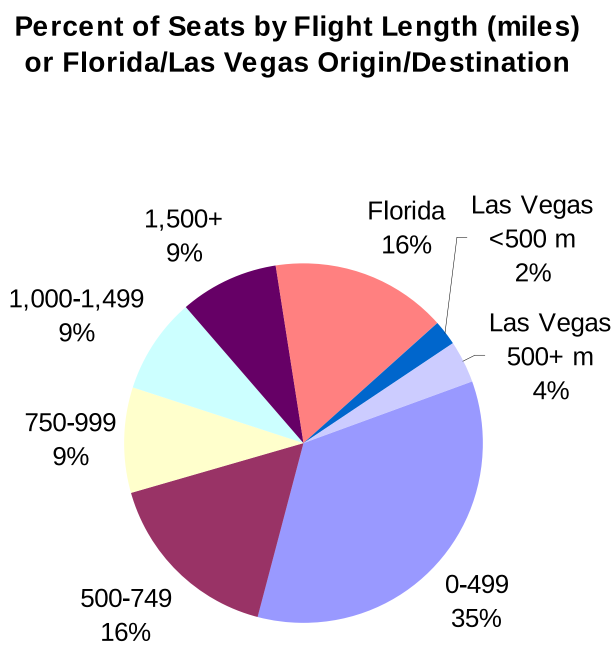
Exhibit E.14

Region	Flight Length (miles)	Seat Factor
U.S. (Non-Florida)	0-0499	68%
	500-0749	75%
	750-999	78%
	1,000-1,499	81%
	1,500+	85%
Florida	0-0499	81%
	500-0749	80%
	750-999	79%
	1,000-1,499	81%
Las Vegas	0-0499	69%
	500-0749	79%
	750-999	80%
	1,000-1,499	85%
	1,500+	87%
U.S. Average		75%

Source: T-100 for calendar year 2008

As background, the percentage of all U.S. airline seats operated by flight length, and to/from Florida and Las Vegas, is shown in Exhibit E.15 below.

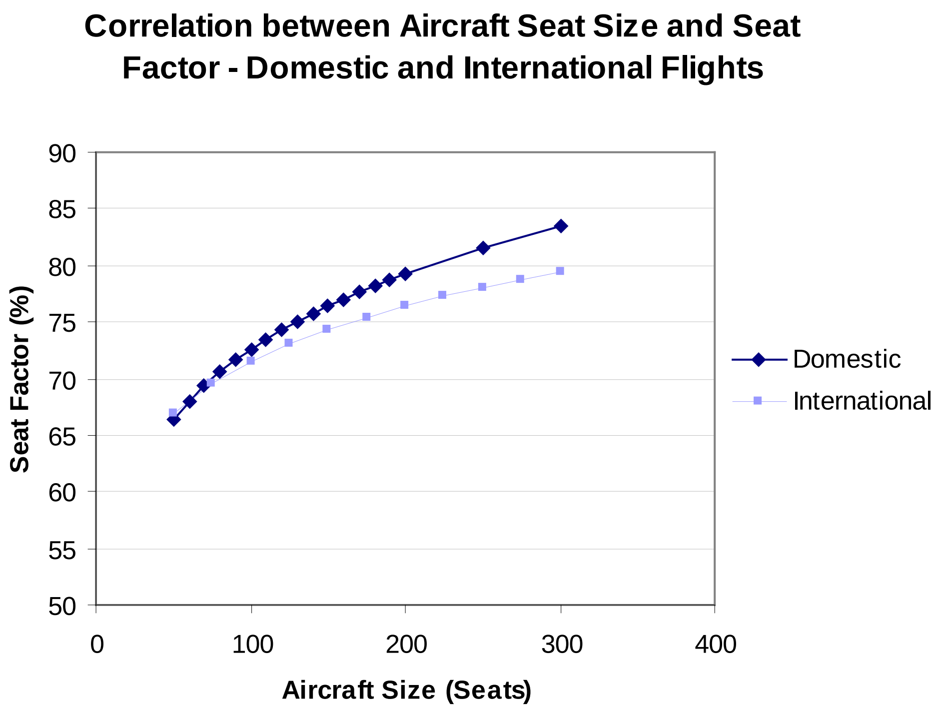
Exhibit E.15



Source: OAG for calendar year 2008 and Oliver Wyman analysis

Another way to look for higher seat factors is to look at aircraft size, as larger aircraft typically have higher associated seat factors. Exhibit E.16 shows the correlation between aircraft size and seat factor for both domestic and international flights. To a large extent, the correlation is a byproduct of the fact that longer haul aircraft also tend to be larger aircraft. The r-square for the correlation between aircraft size and seat factor (which measures how well one variable predicts the other) of 20% for domestic flights and 18% for international flights turn out to be much lower than the 32% r-square for the correlation between length of haul and seat factor. Nevertheless, aircraft size is a simple proxy for expected higher seat factor.

Exhibit E.16



Source: Oliver Wyman analysis of OAG and T-100 data for calendar year 2008

After further study of the hourly seat factor index results, our conclusion is that higher seat factors are likely to be associated with three factors:

- A demand peak as with the East Coast 5 p.m. departure peak
- A higher proportion of long-haul flights, which bring with them higher load factors because of the leisure/business flight mix and less frequent schedule requirements of passengers for long-haul travel. Larger aircraft size may also be an indicator of longer-haul flights.
- A higher proportion of Florida flights (as well as all but the shortest Las Vegas flights), which bring with them higher load factors regardless of stage length because of their heavy leisure component

VI. Conclusions

The variations in seat factor by hour-of-day and day-of-week turn out be small – the result of extensive efforts by the airlines to refine their pricing and scheduling practices. Even the revenue management specialists we work with are somewhat surprised at the success the airlines have had in leveling the seat factor in recent years.

As a practical matter, this means that airports can predict the number of passengers they will be handling based largely on schedule information, which provides the number of seats that will be arriving and departing during particular time periods. Taking the number of scheduled seats and applying an average seat factor (which is readily available for past periods on either an annual or monthly basis) results in the projected number of passengers. Airports can then adjust this passenger projection to reflect higher peak period seat factors either by applying a safety factor of 5-10% to the average seat factor, as supported by the data in this analysis, or by analyzing the schedule flights to determine the mix of long-haul and Florida flights, and applying higher seat factor assumptions to those flights.

Bob Hazel and Eric Ford

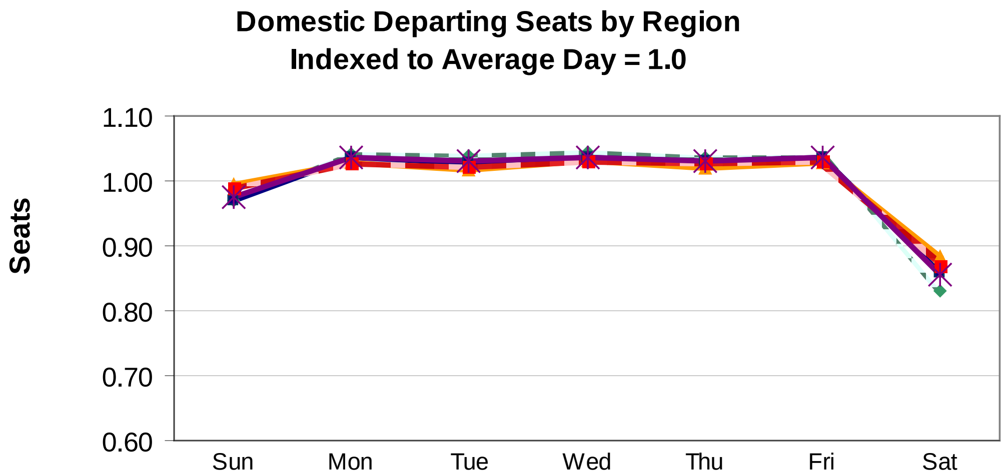
Oliver Wyman

December 21, 2009

Appendix E.1

Day-of-Week Schedule Peaking

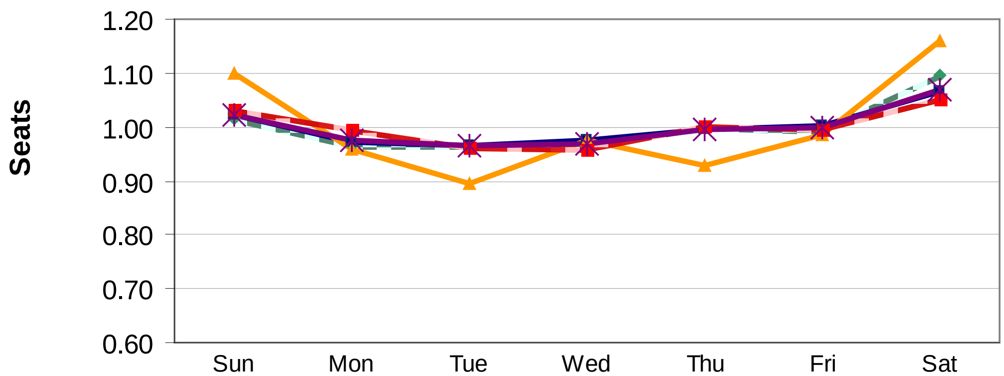
Domestic and International Flights by Region



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	0.970	1.041	1.040	1.045	1.036	1.037	0.830
Eastern	0.969	1.037	1.029	1.036	1.032	1.037	0.859
Mountain	0.993	1.027	1.017	1.030	1.020	1.028	0.885
West	0.990	1.027	1.022	1.032	1.028	1.032	0.869
Grand Total	0.976	1.035	1.029	1.037	1.031	1.035	0.856

Day of Week

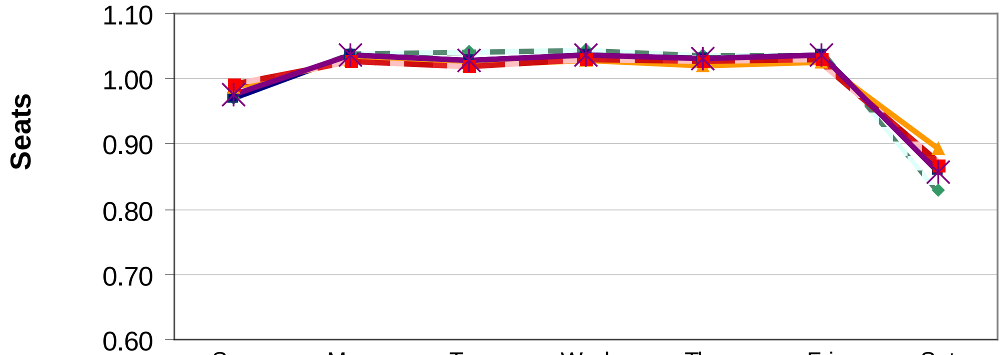
International Departing Seats by Region
Indexed to Average Day = 1.0



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	1.014	0.966	0.967	0.965	0.998	0.993	1.097
Eastern	1.022	0.972	0.967	0.974	0.996	1.004	1.065
Mountain	1.099	0.957	0.895	0.975	0.929	0.986	1.159
West	1.032	0.996	0.961	0.959	1.001	0.997	1.053
Grand Total	1.024	0.976	0.964	0.969	0.997	1.000	1.070

Day of Week

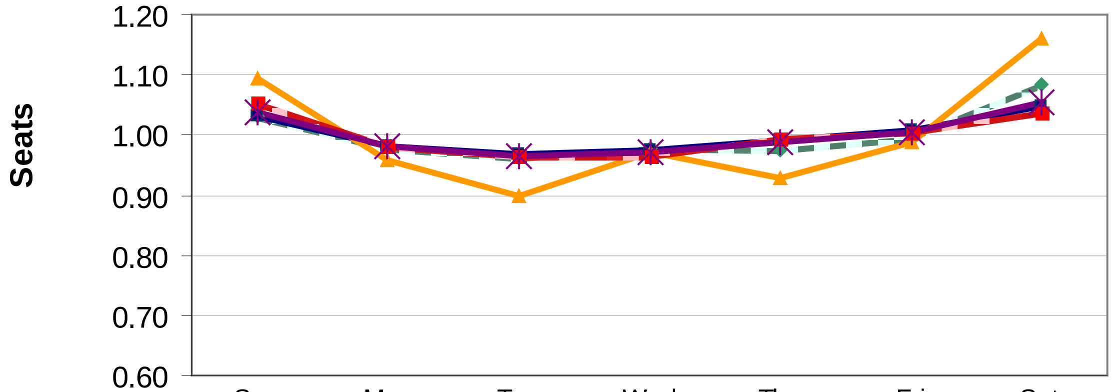
Domestic Arriving Seats by Region
Indexed to Average Day = 1.0



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	0.970	1.040	1.041	1.045	1.036	1.037	0.830
Eastern	0.970	1.037	1.029	1.037	1.031	1.037	0.859
Mountain	0.986	1.028	1.019	1.029	1.021	1.027	0.892
West	0.991	1.028	1.020	1.032	1.029	1.032	0.868
Grand Total	0.976	1.035	1.029	1.037	1.031	1.035	0.856

Day of Week

International Arriving Seats by Region
Indexed to Average Day = 1.0



	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Central	1.032	0.978	0.962	0.979	0.974	0.993	1.083
Eastern	1.031	0.982	0.967	0.974	0.990	1.007	1.049
Mountain	1.095	0.959	0.898	0.973	0.930	0.987	1.159
West	1.053	0.980	0.966	0.963	0.995	1.004	1.038
Grand Total	1.037	0.981	0.965	0.972	0.987	1.003	1.054

Day of Week

Appendix E.2

Time of Day Schedule Peaking

Index of Average **Departing** Seats Per Hour (Hourly Average of 6am - 759pm=1.00 for each Hub Type/Time

	Large				Medium				Non				Small			
Hour	Central	Eastern	Mountain	West	Central	Eastern	Mountain	West	Central	Eastern	Mountain	West	Central	Eastern	Mountain	West
0	0.000	0.012	0.096	0.207	0.000	0.000	0.000	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029
1	0.008	0.013	0.004	0.156	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.067
2	0.006	0.002	0.000	0.031	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.010
3	0.003	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.000	0.140	0.000	0.000	0.000	0.002	0.000	0.000	0.000
5	0.049	0.057	0.028	0.032	0.123	0.115	0.002	0.057	0.769	0.423	0.022	0.847	0.336	0.345	0.054	0.262
6	0.637	0.712	0.497	0.982	1.159	1.469	1.283	1.676	2.274	2.034	1.601	2.741	1.848	1.905	1.738	1.790
7	0.925	0.975	0.558	0.984	1.254	1.491	1.115	1.149	1.031	1.480	1.547	0.578	1.342	1.615	1.206	1.450
8	0.846	1.133	1.443	1.207	1.153	1.009	1.217	1.062	0.714	0.481	0.991	0.466	0.765	0.737	1.141	0.699
9	1.203	1.126	0.810	1.045	1.090	0.852	1.045	0.929	0.536	0.569	0.700	1.025	0.886	0.698	0.968	0.637
10	1.082	0.908	1.707	1.089	0.859	0.853	1.099	1.106	1.098	0.716	0.654	0.592	0.911	0.800	0.770	0.945
11	1.019	0.963	1.541	1.262	0.831	0.914	0.779	1.047	1.259	1.271	0.866	1.158	1.151	0.908	1.128	1.296
12	0.899	0.876	0.923	1.195	0.743	1.032	0.860	1.016	1.029	0.937	1.531	1.418	0.757	1.104	1.047	1.176
13	1.083	0.929	0.910	1.239	0.953	0.739	1.265	1.079	0.926	0.939	1.391	0.825	0.908	0.770	1.240	1.303
14	0.993	0.891	0.844	0.907	1.070	0.774	0.962	0.968	0.740	1.088	1.207	1.047	0.898	0.986	1.023	0.902
15	0.991	0.911	0.996	0.887	0.897	0.930	0.732	0.806	0.858	0.989	0.960	0.646	0.889	0.721	0.830	0.767
16	0.915	1.071	0.960	0.973	0.888	0.930	1.016	0.899	1.440	0.934	1.072	1.007	1.098	0.944	0.867	0.951
17	1.133	1.305	0.987	0.744	0.962	1.197	0.776	0.749	0.968	1.216	0.476	0.849	1.082	1.197	0.822	0.670
18	1.133	1.115	0.914	0.818	1.099	1.006	0.897	0.761	0.815	0.802	0.458	0.852	0.925	1.017	0.816	0.775
19	1.143	1.084	0.909	0.667	1.043	0.804	0.955	0.751	0.314	0.542	0.547	0.795	0.540	0.598	0.404	0.639
20	0.704	0.928	0.644	0.624	0.424	0.493	0.558	0.724	0.131	0.262	0.146	0.457	0.154	0.263	0.621	0.431
21	0.820	0.759	1.175	0.581	0.275	0.152	0.211	0.572	0.029	0.064	0.014	0.094	0.049	0.061	0.192	0.446
22	0.204	0.360	0.028	0.604	0.020	0.002	0.000	0.103	0.071	0.013	0.027	0.063	0.000	0.002	0.018	0.027
23	0.023	0.119	0.110	0.524	0.000	0.000	0.052	0.123	0.005	0.004	0.100	0.039	0.000	0.002	0.000	0.000

Index of Average **Arriving** Seats Per Hour (Hourly Average of 6am - 759pm=1.00 for each Hub Type/Time Zone)

	Large				Medium				Non				Small			
Hour	Central	Eastern	Mountain	West	Central	Eastern	Mountain	West	Central	Eastern	Mountain	West	Central	Eastern	Mountain	West
0	0.099	0.189	0.054	0.105	0.162	0.347	0.106	0.047	0.013	0.036	0.018	0.115	0.069	0.223	0.006	0.043
1	0.009	0.023	0.000	0.019	0.005	0.017	0.000	0.035	0.000	0.000	0.000	0.136	0.000	0.000	0.025	0.081
2	0.005	0.004	0.004	0.006	0.001	0.000	0.000	0.011	0.000	0.000	0.000	0.023	0.000	0.000	0.008	0.000
3	0.001	0.001	0.000	0.006	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000
4	0.013	0.029	0.000	0.035	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000
5	0.282	0.210	0.000	0.140	0.011	0.040	0.000	0.026	0.062	0.002	0.001	0.007	0.000	0.002	0.001	0.000
6	0.309	0.334	0.061	0.188	0.074	0.107	0.046	0.054	0.062	0.057	0.094	0.269	0.016	0.007	0.070	0.000
7	0.667	0.590	1.072	0.586	0.748	0.237	0.507	0.455	0.110	0.054	0.178	0.210	0.200	0.066	0.196	0.231
8	0.976	0.868	0.653	0.860	0.968	0.538	0.778	0.953	0.497	0.409	0.087	0.833	0.716	0.372	0.707	0.602
9	0.969	0.775	1.599	1.233	0.941	0.918	1.187	1.019	0.836	0.811	0.973	0.834	0.943	0.944	0.844	0.925
10	0.992	1.015	1.529	1.419	0.928	1.169	1.168	1.345	1.785	1.246	0.960	0.820	1.491	1.247	1.318	1.510
11	1.005	0.921	0.831	1.251	0.969	1.365	0.857	1.306	1.239	1.489	1.478	1.828	1.036	1.324	1.431	1.269
12	1.026	1.041	0.968	1.249	1.151	0.971	1.585	1.262	1.385	1.252	2.648	1.356	1.216	1.285	1.808	1.405
13	1.187	1.117	0.787	1.046	1.248	0.999	0.941	1.236	0.705	1.227	1.330	1.112	1.044	1.204	0.992	1.329
14	1.110	1.248	1.167	1.056	1.022	1.249	1.024	0.943	1.108	1.291	1.287	0.986	1.209	1.161	1.259	0.769
15	1.047	1.321	1.013	1.023	1.090	1.176	1.011	0.993	1.522	1.391	1.031	1.067	1.320	1.271	0.947	0.923
16	1.243	1.305	1.152	0.898	1.074	1.614	1.207	0.962	1.768	1.318	1.233	1.096	1.418	1.529	1.134	0.879
17	1.247	1.073	1.025	0.996	1.534	1.210	0.971	1.036	1.038	1.358	0.654	1.299	1.359	1.454	0.856	0.783
18	1.060	1.259	1.195	1.022	1.288	1.384	1.109	0.999	1.078	1.195	1.141	0.840	1.100	1.244	1.307	1.044
19	1.163	1.132	0.946	1.173	0.963	1.064	1.608	1.435	0.867	0.903	0.905	1.450	0.932	0.894	1.131	1.331
20	1.079	1.077	1.419	1.263	1.097	0.957	0.761	1.326	1.579	1.018	0.815	0.937	1.486	1.082	1.196	1.146
21	0.499	0.881	0.449	1.218	0.925	1.259	0.830	1.388	1.391	1.408	0.895	1.306	1.260	1.595	1.106	1.202
22	0.348	0.669	0.402	0.907	0.845	1.473	0.953	1.328	1.381	1.659	1.859	1.083	1.401	1.882	1.388	1.138
23	0.260	0.493	0.454	0.564	0.670	1.134	0.826	0.691	0.838	1.152	0.945	1.277	0.632	1.539	1.041	0.404

Source: OAG calendar year 2008

Appendix F

Use of Peak Day and Hour Default Factors

THIS PAGE INTENTIONALLY LEFT BLANK.

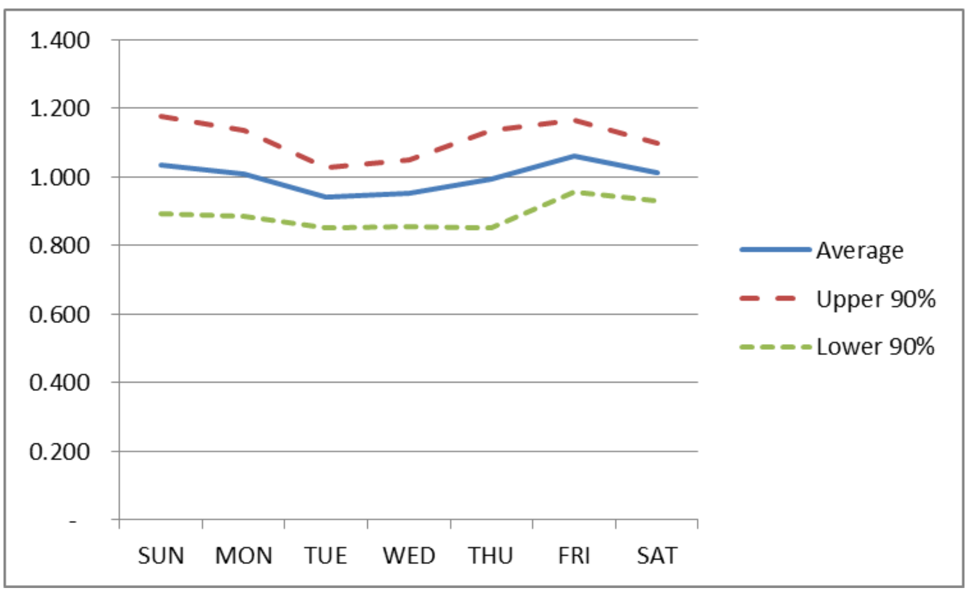
Appendix F: Use of Day-of-Weak and Time-of-Day Default Factors

At the time of the May 2010 Panel meeting, a statistical analysis of the day-of-week and time-of-day default factors developed in Appendix E was suggested. As noted in the conclusion to Appendix E, the variation in seat factors by day-of-week or time-of-day is small; the purpose of this Appendix is to determine whether these variations are statistically significant.

F.1. Day-of-Week Default Factors

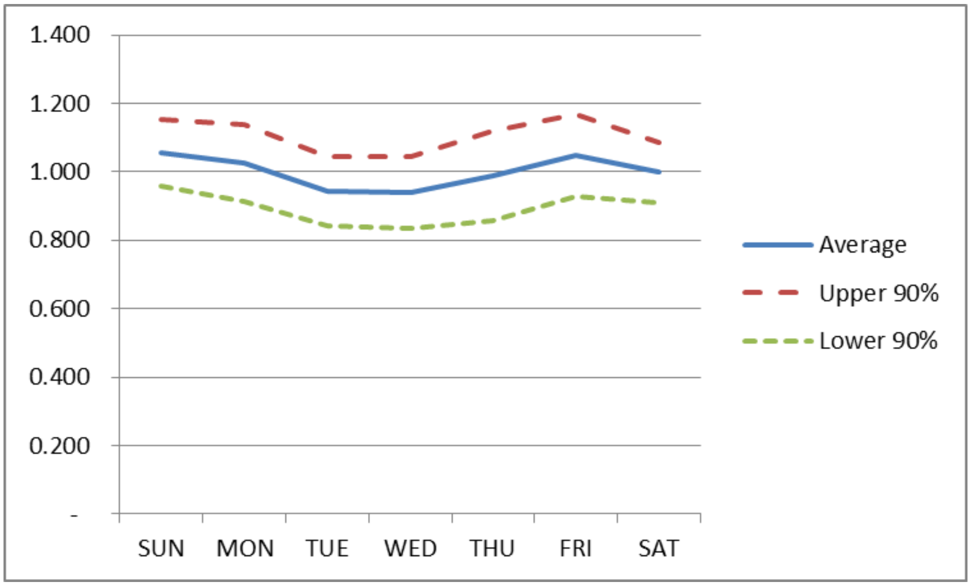
A statistical analysis was performed on the airline data collected as part of Task 4 to identify the 90 percent confidence intervals associated with each set of day-of-week default factors. Exhibits F.1 through F.6 show the confidence intervals for arriving and departing seat factor for airports in the Eastern, Central, and Pacific Time zones. The sample of Mountain Time zone airports was too small to perform a statistical analysis. The y-axis indicates each day's seat factor relative to the weekly average. The confidence intervals indicate that 90 percent of all airports in the sample had seat factors below the Upper 90% level and 90 percent of all airports had seat factors above the 90% level.

Exhibit F.1:
Distribution of Arriving Seat Factor by Day-of-Week with 90 Percent Confidence Intervals
Airports in Eastern Time Zone



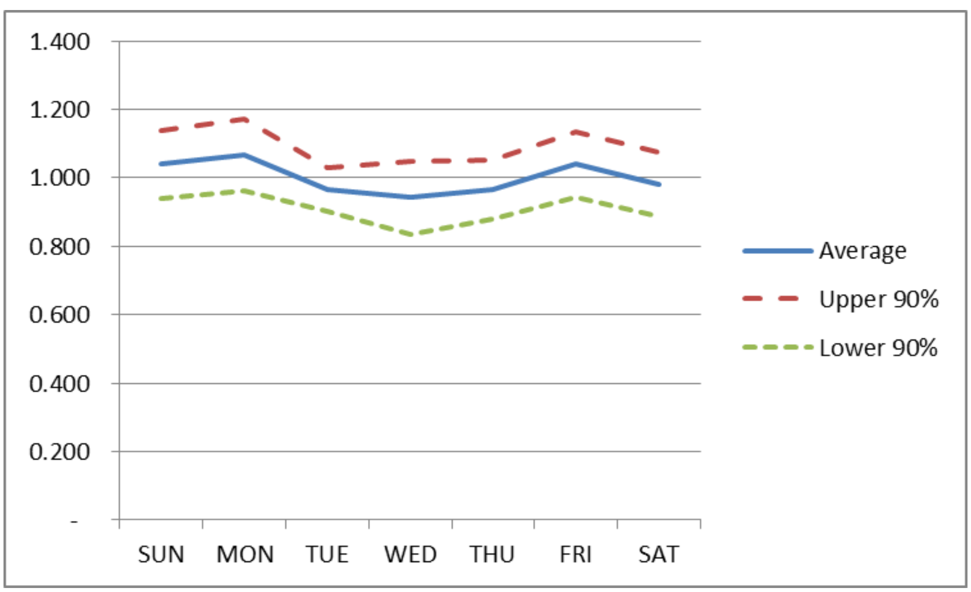
- Relative to average weekly seat factor.

Exhibit F.2:
Distribution of Departing Seat Factor by Day-of-Week with 90 Percent Confidence Intervals
Airports in Eastern Time Zone



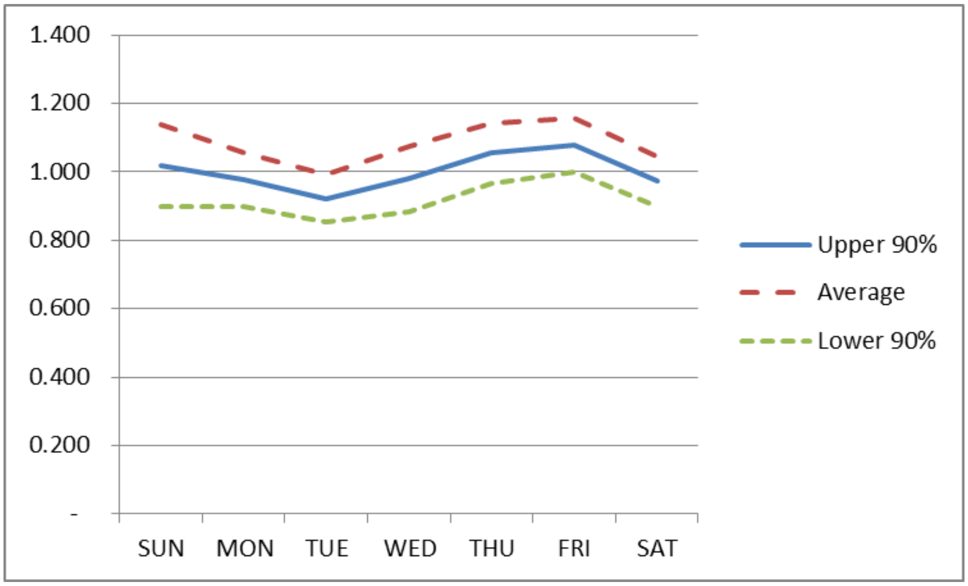
- Relative to average weekly seat factor.

Exhibit F.3:
Distribution of Arriving Seat Factor by Day-of-Week with 90 Percent Confidence Intervals
Airports in Central Time Zone



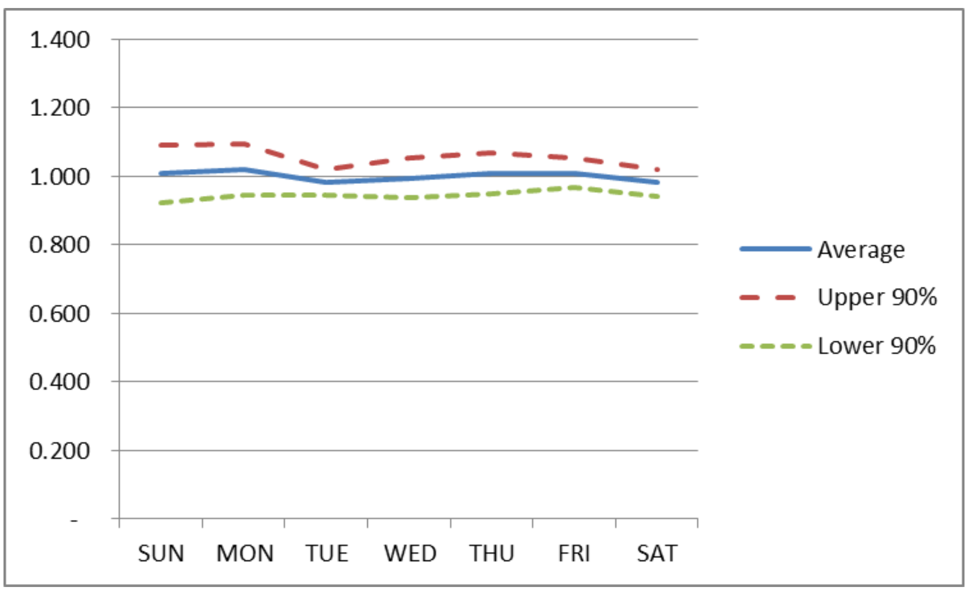
- Relative to average weekly seat factor.

Exhibit F.4:
Distribution of Departing Seat Factor by Day-of-Week with 90 Percent Confidence Intervals
Airports in Central Time Zone



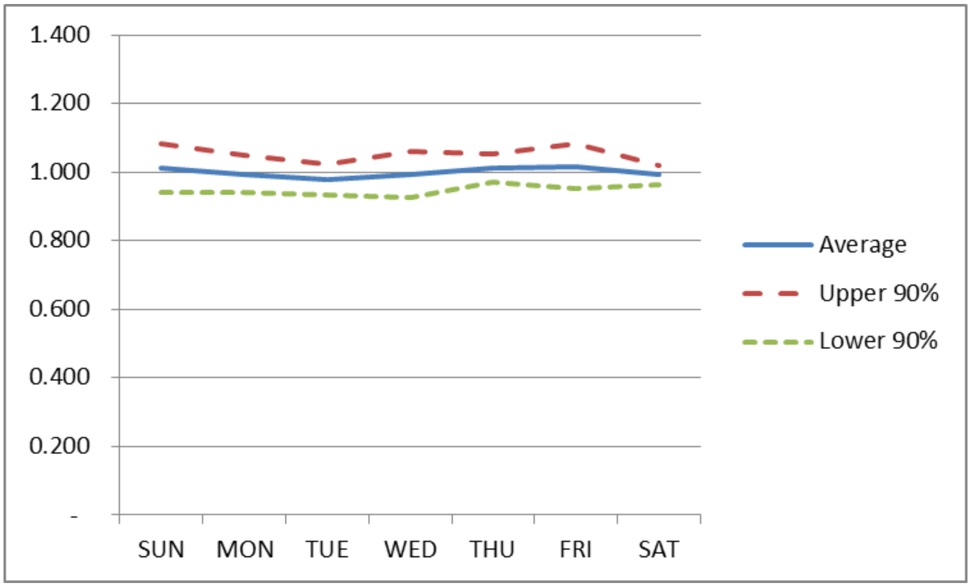
- Relative to average weekly seat factor.

Exhibit F.5:
Distribution of Arriving Seat Factor by Day-of-Week with 90 Percent Confidence Intervals
Airports in Pacific Time Zone



- Relative to average weekly seat factor.

Exhibit F.6:
Distribution of Departing Seat Factor by Day-of-Week with 90 Percent Confidence Intervals
Airports in Pacific Time Zone



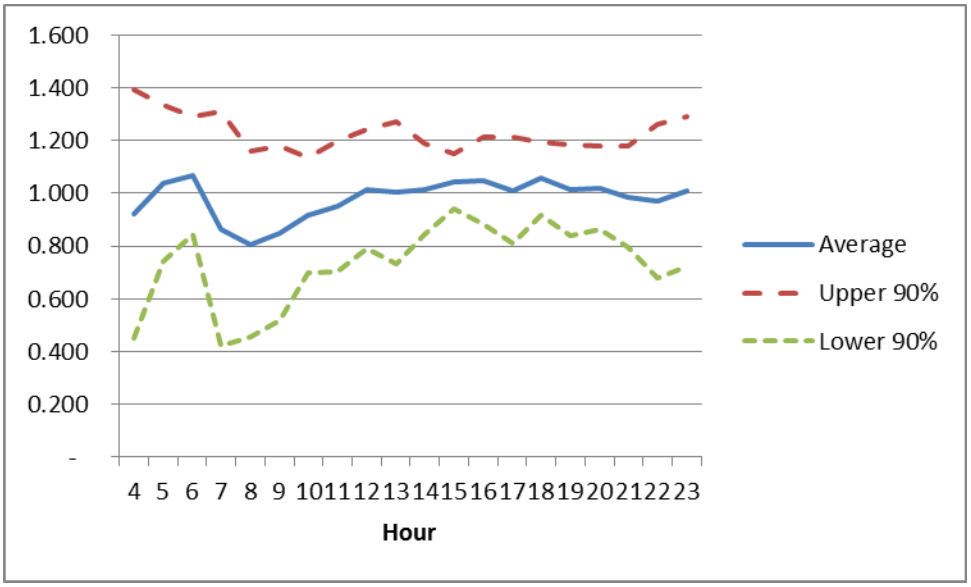
- Relative to average weekly seat factor.

The results are more pronounced for airports in the Eastern and Central Time Zones and suggest that seat factors are higher than average on Fridays and Sundays and lower than average on Tuesdays, Wednesdays and Saturdays. There is little day-of-week variation among the Pacific Time Zone airports. Although the data are suggestive, in no instance can it be stated, with more than a 90 percent degree of confidence, that the seat factor during a given day exceeds the weekly average.

F.2. Time-of-Day Default Factors

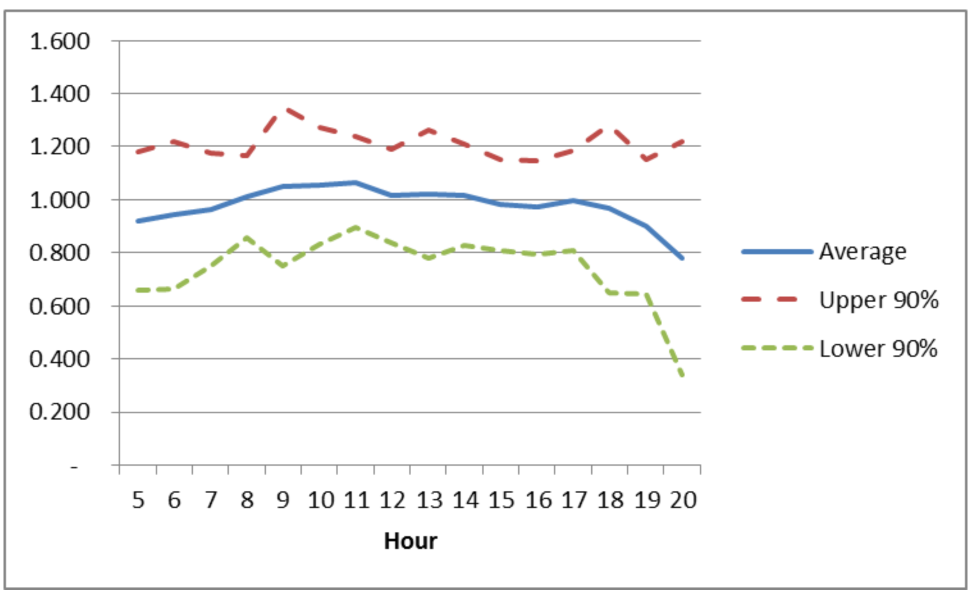
A statistical analysis was also performed on the time-of-day seat factor distributions. Exhibits F.7 through F.12 show the arrival and departure seat factor distributions, relative to the daily average, along with their associated 90 percent confidence intervals, for airports in the Eastern, Central, and Pacific Time zones.

Exhibit F.7:
Distribution of Arriving Seat Factor by Time-of-Day with 90 Percent Confidence Intervals
Airports in Eastern Time Zone



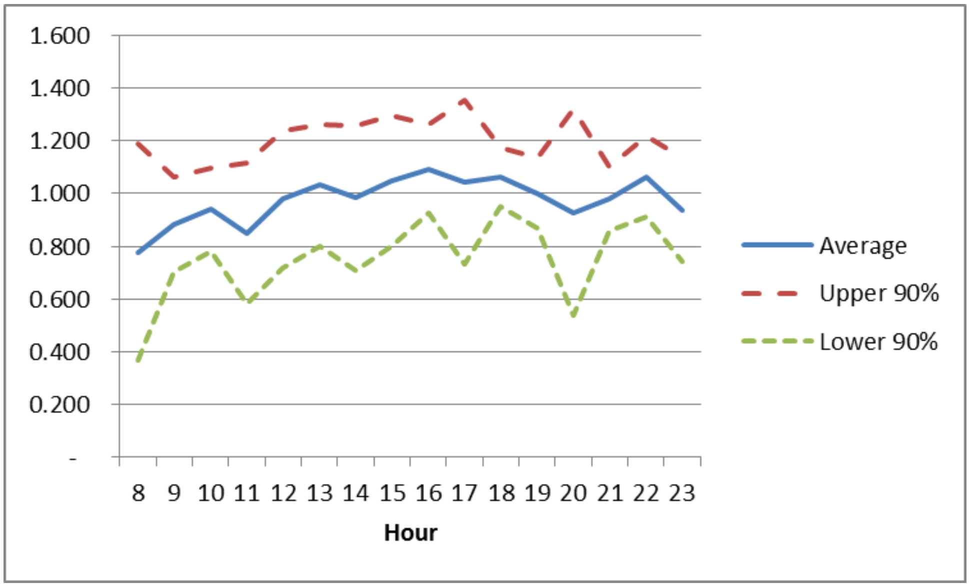
- Relative to average daily seat factor.

Exhibit F.8:
Distribution of Departing Seat Factor by Time-of-Day with 90 Percent Confidence Intervals
Airports in Eastern Time Zone



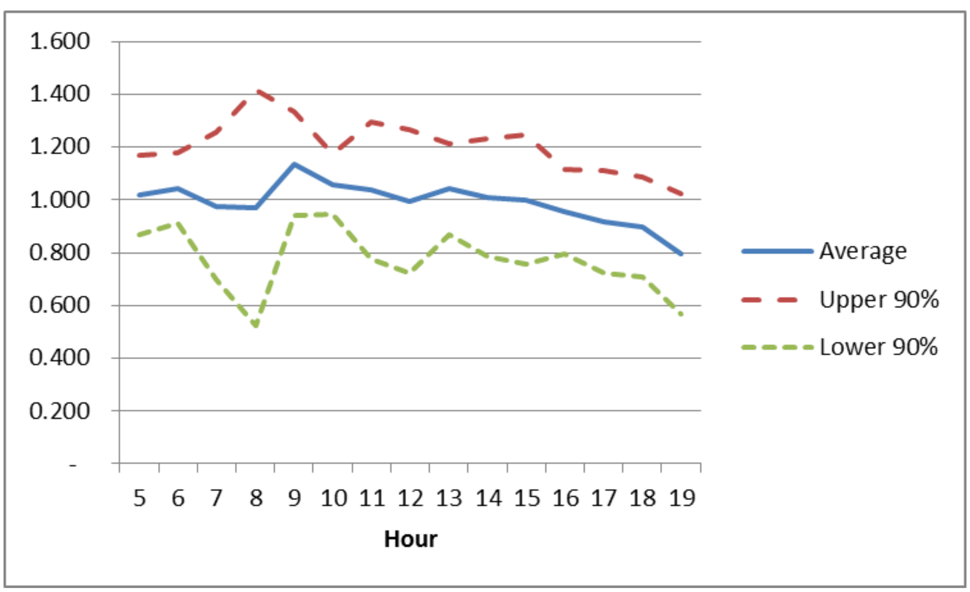
- Relative to average daily seat factor.

Exhibit F.9:
Distribution of Arriving Seat Factor by Time-of-Day with 90 Percent Confidence Intervals
Airports in Central Time Zone



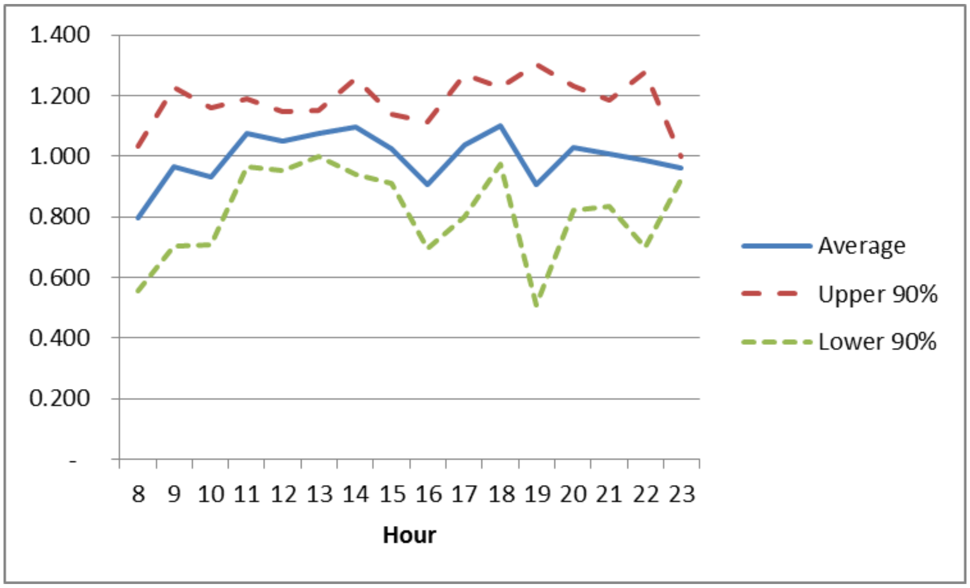
- Relative to average daily seat factor.

Exhibit F.10:
Distribution of Departing Seat Factor by Time-of-Day with 90 Percent Confidence Intervals
Airports in Central Time Zone



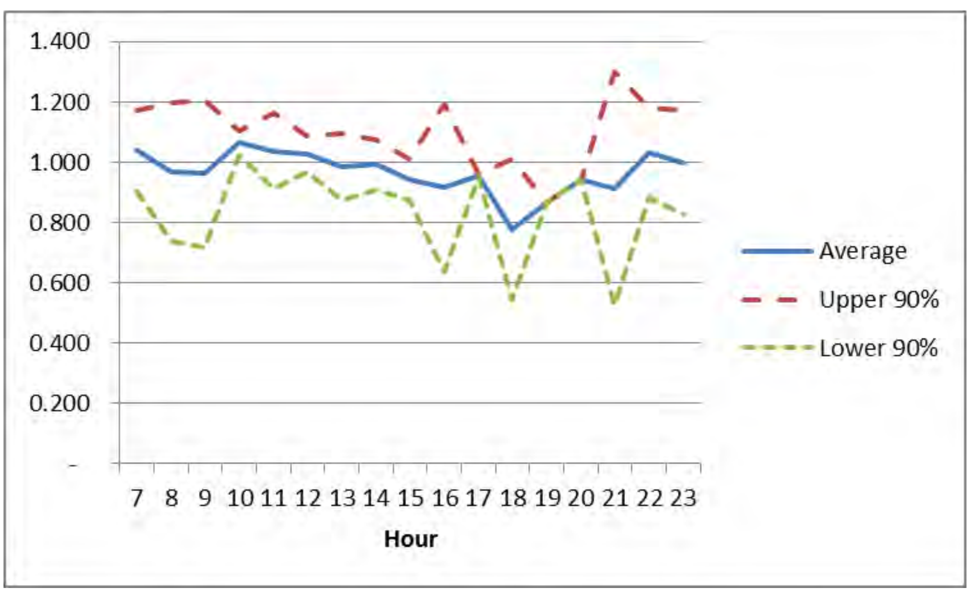
- Relative to average daily seat factor.

Exhibit F.11:
Distribution of Arriving Seat Factor by Time-of-Day with 90 Percent Confidence Intervals
Airports in Pacific Time Zone



- Relative to average daily seat factor.

Exhibit F.12:
Distribution of Departing Seat Factor by Time-of-Day with 90 Percent Confidence Intervals
Airports in Pacific Time Zone



When compared to the day-of-week seat factors, the time-of-day seat factors have wider confidence intervals, indicating that the adjustment factors are less reliable for time-of-day than for day-of-the-week. Subsequent discussions with airline staff have indicated that hourly load factors are mostly a function of two factors:

- Types of markets served during the hour - as noted in Appendix E, long haul markets tend to have higher seat factors than short-haul markets; and
- Size of connecting bank - large connecting banks offer more connecting opportunities and therefore tend to stimulate loads on incoming flights.

Compared to these two factors, the effect of the time of day is relatively minor.

F.3. Conclusions

Based on the above analyses, it is recommended that the default factors supplied in Appendix E of this report and in Appendix C of the appendix be used for sensitivity tests only. Whenever possible, the user should obtain data specific to the airport under study.

Appendix G

Peak Month Passenger Activity

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix G: Peak Month Passenger Activity

Multiple methods are used to estimate the "design day" – the activity profile used as the baseline for terminal design. The "general practice in the United States, however, is to define the design day as an average day during the peak month (ADPM)," as discussed in the *Draft Summary of Current Practices and Literature Review*, ACRP 03-12, submitted August 2009. A primary reason why this definition used most frequently is that, unlike most other definitions, the associated data is collected by the DOT and readily available from multiple vendors.

The research team has analyzed passenger data for all U.S. airports for every month from January 2003 through December 2008 to examine peak passenger activity by month. The time period selected avoids the dislocation of 9/11 and its aftermath, and presents six full years of recent data. The results of this analysis may be useful in developing and refining design day models that rely on peak month activity.

In the analysis that follows, we look first at peak month load factors as an indicator of peak month passenger activity. This is followed by an examination of peak month enplanements/deplanements for all U.S. airports. We measure peaking primarily by looking at the peak month and calculating the percent by which that month's load factor or number of passengers exceeds the average month. (For the load factor analysis, we also show the spread in load factor points between the peak month and the average month.)

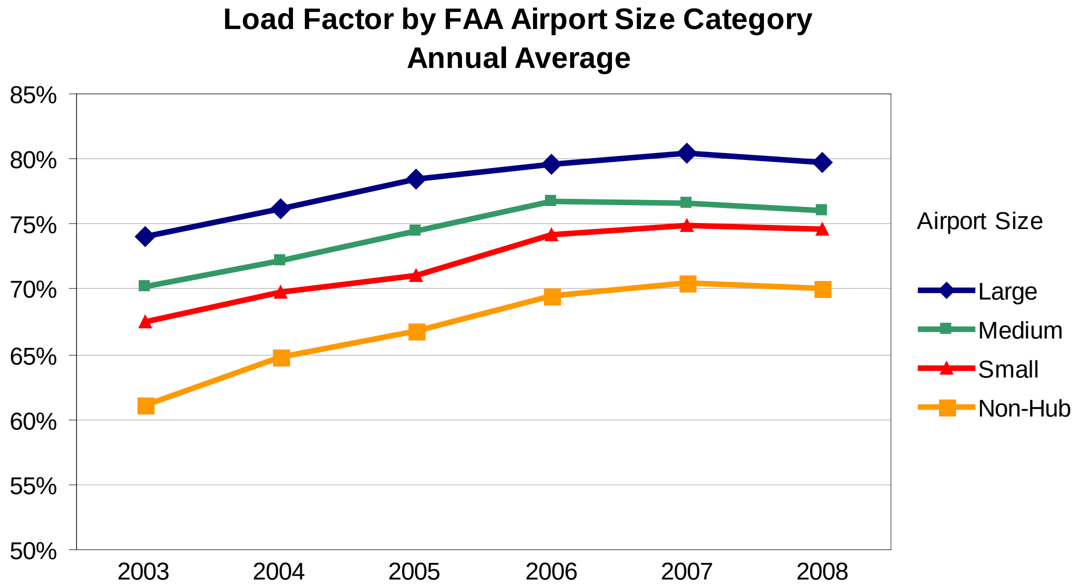
Peak Month Load Factors

As illustrated in Exhibit G.1, two patterns are evident with regard to average load factors at U.S. airports of differing sizes during 2003-2008.

- First, larger airports have experienced higher average load factors than smaller airports. For each of the six years studied, large hub airports, as defined by the FAA, have the highest average load factor, followed by medium hubs, and then small hubs, while non-hub airports have the lowest average load factor.

- Second, with the exception of a slight load factor dip in 2008 of 0.5 to 0.7 points versus the prior year, there has been a strong trend towards increasing average load factors in each of the four airport size categories over the past six years. Load factors at smaller airports in fact have increased more than those at larger airports, although not enough to change the overall rankings.

Exhibit G.1



	2003	2004	2005	2006	2007	2008
Large	74.1%	76.1%	78.5%	79.7%	80.4%	79.7%
Medium	70.2%	72.3%	74.4%	76.7%	76.6%	76.0%
Small	67.5%	69.7%	71.1%	74.2%	74.9%	74.6%
Non-Hub	61.1%	64.8%	66.8%	69.6%	70.5%	70.0%

Note: Includes U.S. and foreign flag airlines at U.S. airports. Source: U.S. DOT T-100

Based on these patterns, our expectations are, first, that airports should be experiencing smaller peaks over time and, second, that the "de-peaking" should be more obvious at larger airports because of their higher average load factors. Does this turn out to be the case? As illustrated below, for large airports, the difference between the peak month load factor and the average month load factor has decreased over time. At large airports, the increase in average load factor of five points from 74.1% in 2003 to 79.1% in 2008 has been accompanied by a decline in peaking (as measured by the percentage by which the load factor in the peak month exceeds the average load factor) of 4.4% from 11.3% in 2003 to 6.9% in 2008. (As measured in load factor points by which the peak load factor exceeds the average, the numbers range from 8.4 points in 2003 to 5.5 points in 2008.) As we look at smaller airports, the correlation between increasing load factors and decreasing peaking gets progressively weaker. For example, the nearly 9 point increase in average load factor at non-hubs from 61.1% in 2003 to 70.0% in 2008 is accompanied by only a 2.5% decrease in peaking.

The following charts (Exhibits G.2 through G.5) show the correlation between load factor changes and peaking changes.

Exhibit G.2

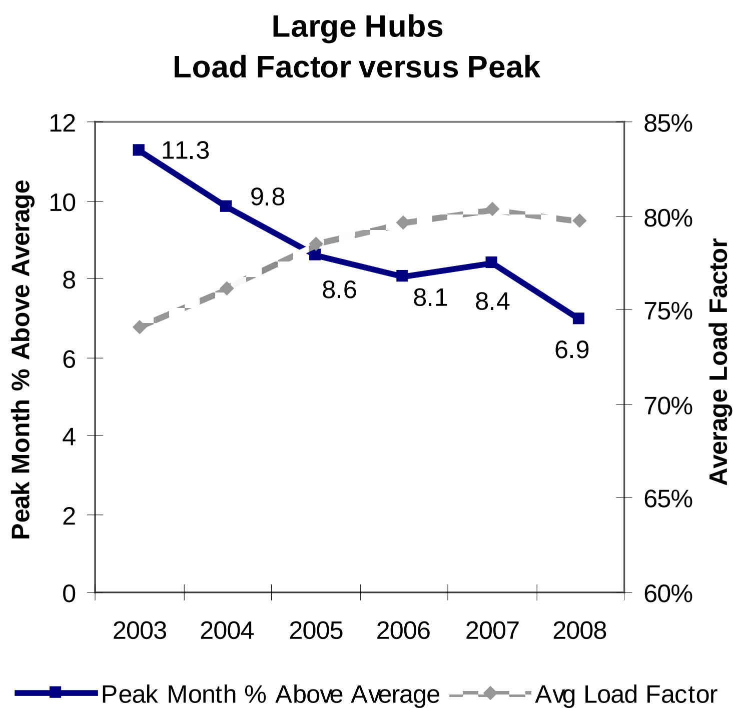


Exhibit G.3

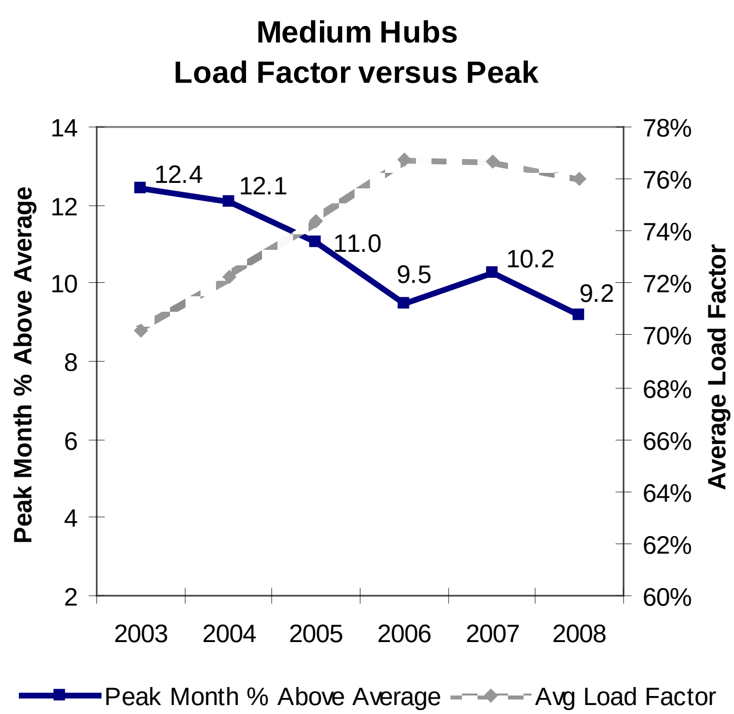


Exhibit G.4

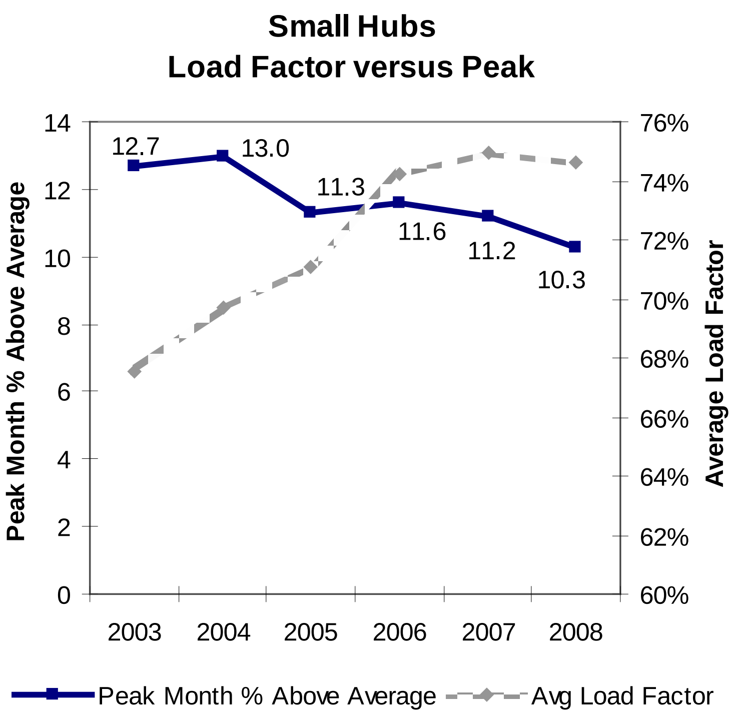
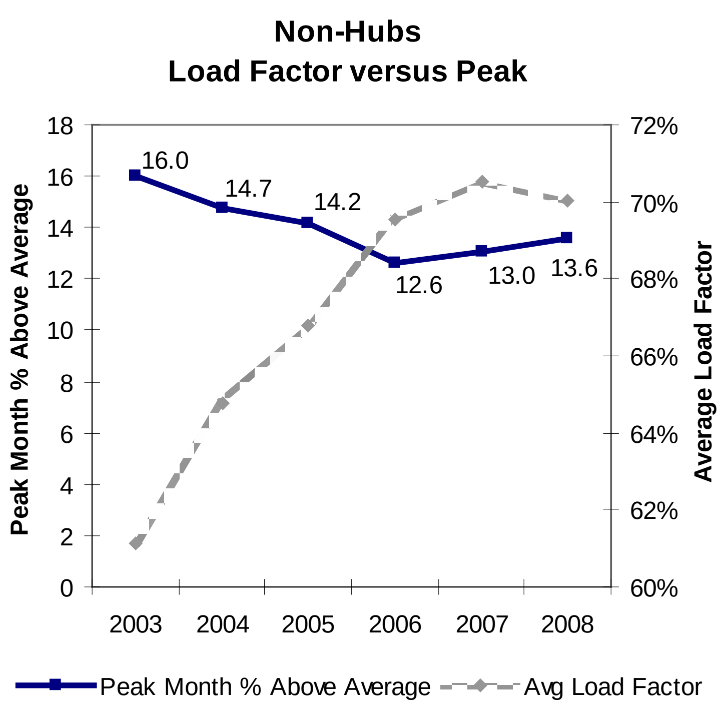


Exhibit G.5



Source: U.S. DOT T-100

Peaking data is provided in Exhibit G.6 below both (1) as a percent of average load factor; and (2) as the point difference between the load factor in the peak month and the average month.

Exhibit G.6

	Large Hubs			Medium Hubs		
Year	Average Load Factor	Peak/Avg LF Point Difference	Peak % Above Base LF	Average Load Factor	Peak/Avg LF Point Difference	Peak % Above Base LF
2003	74.1	8.4	11.3	70.2	8.7	12.4
2004	76.1	7.5	9.8	72.3	8.7	12.1
2005	78.5	6.8	8.6	74.4	8.2	11.0
2006	79.7	6.4	8.1	76.7	7.3	9.5
2007	80.4	6.7	8.4	76.6	7.9	10.2
2008	79.7	5.5	6.9	76.0	7.0	9.2

	Small Hubs			Nonhubs		
Year	Average Load Factor	Peak/Avg LF Point Difference	Peak % Above Base LF	Average Load Factor	Peak/Avg LF Point Difference	Peak % Above Base LF
2003	67.5	8.6	12.7	61.1	9.8	16.0
2004	69.7	9.0	13.0	64.8	9.6	14.7
2005	71.1	8.0	11.3	66.8	9.5	14.2
2006	74.2	8.6	11.6	69.6	8.8	12.6
2007	74.9	8.4	11.2	70.5	9.2	13.0
2008	74.6	7.7	10.3	70.0	9.5	13.6

Source: U.S. DOT T-100

This initial look at peaking is consistent with the experience of most passengers who find themselves traveling in increasingly full aircraft at most times of the year. For most passengers, the peaks seem smaller than in the past because the planes are already very full on most flights. Thus, for example, at large hub airports in 2008, the average load factor was 79.4% and the average peak month load factor was 85.2% (79.7 + 6.9%*79.7). What this experience does not take into account, however, are airline scheduling changes that match fluctuating demand by adding or cutting flights and employing different size aircraft in different markets at different times of the year. In other words, significant variations in passenger traffic may still be occurring even if every flight operates at the same load factor. The section below takes a look at peaking at U.S. airports from another perspective.

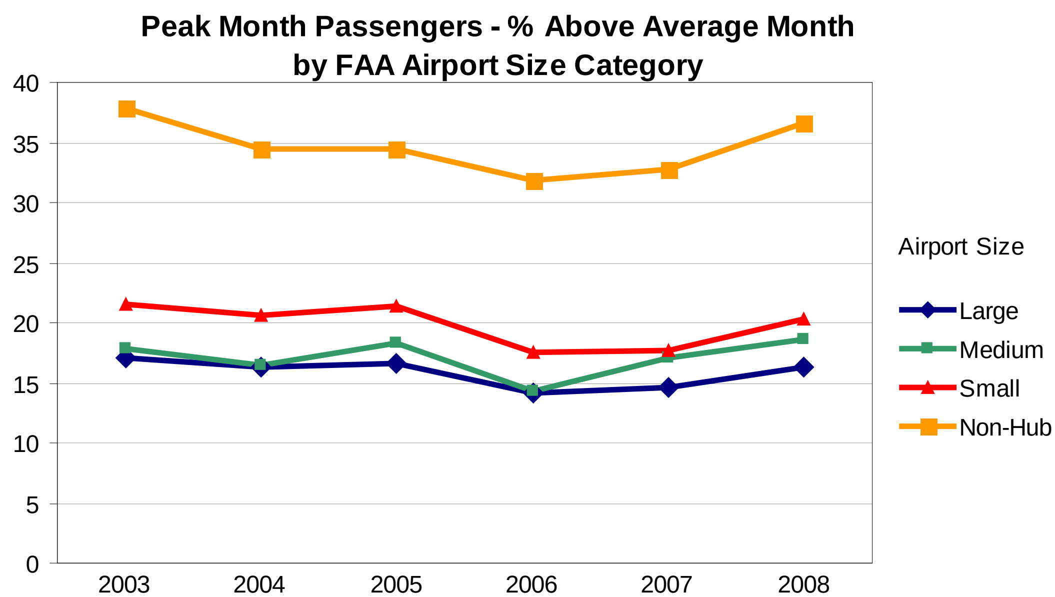
Peak Month Passengers

We analyzed 317 U.S. airports classified by the FAA as large, medium, small, or non-hubs to determine the number of passengers (enplanements + deplanements) each month from January 2003 through December 2008 (Exhibit G.7). We then calculated the percentage by which the passengers in the peak month for each airport exceeded the average monthly passenger count. This analysis tells a different story than the load factor analysis:

- First, as measured by passengers, between 2003 and 2008, there has been no clear trend towards increasing or decreasing peaking. The percentage by which the passengers in the peak month exceeded the average monthly passenger count did not change significantly during these six years in any of the four airport size categories. Thus, for example, for large airports in 2003, the number of passengers in the peak month was on average 17.1% greater than the average month, while in 2008, this figure had declined by only 0.8% to 16.3%. For medium airports, the corresponding peaking figure actually increased very slightly from 17.9% to 18.3% from 2003 to 2008. Thus, despite generally increasing load factors, the percentage of additional passengers flying during peak months has remained relatively unchanged over the past six years. Airlines are in fact better utilizing their aircraft, adding flights and using larger aircraft when possible to accommodate periods of heavier travel demand.

- Second, the degree of peaking varies between different airport size categories, but the differences between different airport size categories are not consistent in the way that load factor peaking differences are. Non-hub airports experience much more pronounced peaking than any of the other airport categories, approximately double, which is to say that an average non-hub airport has 32-38 percent more passengers during its peak month than during its average month, compared to 15-17 percent for an average large hub airport. Large airports experience the least peaking, but medium size airports have very similar peaking characteristics. And small airports experience about 4 points more peaking than large airports.

Exhibit G.7



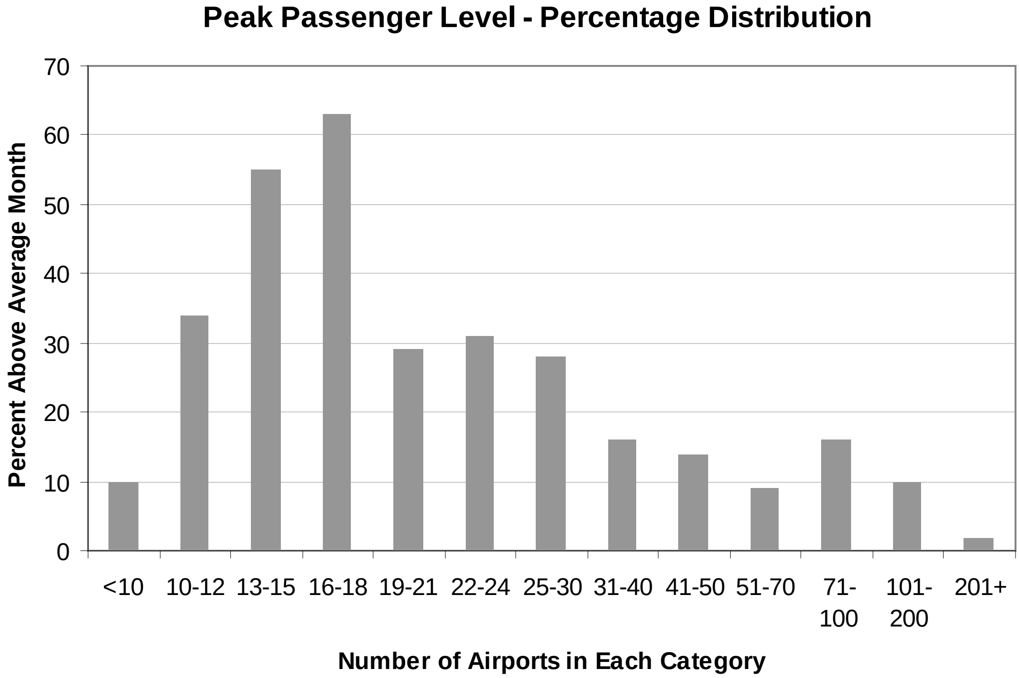
	2003	2004	2005	2006	2007	2008
Large	17.1	16.3	16.6	14.1	14.6	16.3
Medium	17.9	16.4	18.2	14.3	17.1	18.5
Small	21.6	20.6	21.3	17.5	17.7	20.4
Non-Hub	37.9	34.4	34.4	31.9	32.8	36.6

Source: U.S. DOT T-100

As might be expected, not only the average peak, but also the range of peaks is quite different among the airports within different size categories. Among large airports, the peak month passengers ranged from 9.6 to 29.4 percent higher than the average month, with nearly 80 percent of these airports having peaks that fall within a 7.4 point range (9.6 to 17 percent higher than the average month). The medium size airports include two outliers with peaks of 47.8 percent (Palm Beach) and 62.9 percent (Ft. Myers). The small airport category also has two outliers with peaks of 63.7 percent (Sarasota) and 79.2 percent (Palm Springs). The nonhub airports include many with very strong pronounced peaks, including 12 with peak activity that is more than double the average month passenger level.

The distribution of peaking in 2008 among all 317 airports analyzed is shown in the histogram below (Exhibit G.8).

Exhibit G.8

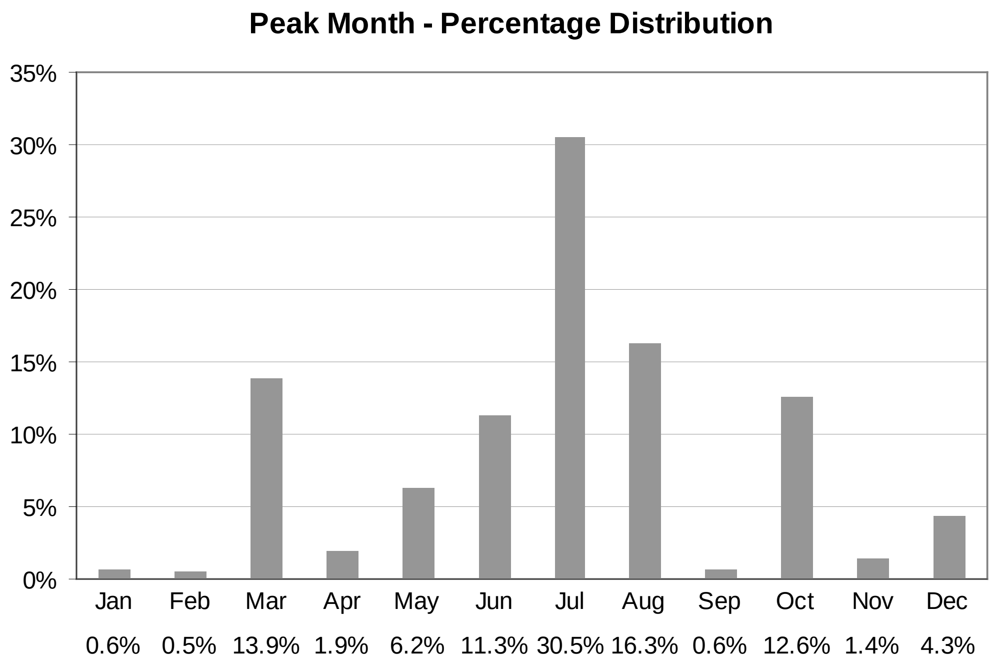


Source: U.S. DOT T-100

Peak Month

What month does the peak occur? Exhibit G.9 summarizes the data for 317 airports over six years. July is the most likely peak month, serving as the peak 30.5% of the time. August (16.3%), March (13.9%), October (12.6%), and June (11.3%), also serve as peak months on a regular basis. February is the least likely month to serve as a peak (0.5%), followed closely by January (0.6%). For travelers thinking of the very busy travel period during Thanksgiving, it turns out that November is almost never the peak month. Neither is April, despite the heavy Easter travel period that often falls within that month.

Exhibit G.9



Looking through the data, what trends are evident?

- Florida tends to peak in March, as is the case for Daytona Beach, Ft. Lauderdale, Ft. Myers, Key West, Melbourne, Orlando, Palm Beach, Panama City, and Tampa, but not for Miami or Jacksonville.

- Some other sun destinations also peak in March, such as Palm Springs, Phoenix, and Tucson, as do some snow destinations such as Aspen, Gunnison, Steamboat Springs, and Vail.

- There seems to be more of a tendency for West Coast airports to peak in August, as is the case with Burbank, Oakland, Ontario, San Jose, Orange County, and Long Beach, but usually not for Los Angeles or San Francisco.

- The five largest U.S. airports, Atlanta, Chicago, Los Angeles, Dallas/Ft. Worth, and Denver, have peak enplanements in July.

Conclusions

Despite steadily increasing load factors over the past decade, there is little evidence that peaking, as measuring by the number of passengers during the peak month in comparison to the average month, has become less pronounced at U.S. airports. Most large airports experience peak month passenger levels that are 10-20 percent higher than average month levels. Leisure destination airports are most likely to have higher peaks, sometimes much higher. And there is a much more pronounced peaking at nonhub airports than airports in any other size category.

Appendix H

Trends in Peak Hour Intensity

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix H: Trends in Peak Hour Intensity

As noted in Section 5.2 of the Report, there has been little empirical analysis of peak spreading. Therefore, an analysis of a sample of airports over several years was conducted to better define the extent of this trend. The FAA's ETMSC database was used to obtain an eight year (2001-2008) sample of hourly data by month for thirty-one airports. The airports were selected to represent a variety of hub sizes, time zones, and roles and are listed in Exhibit H.1.

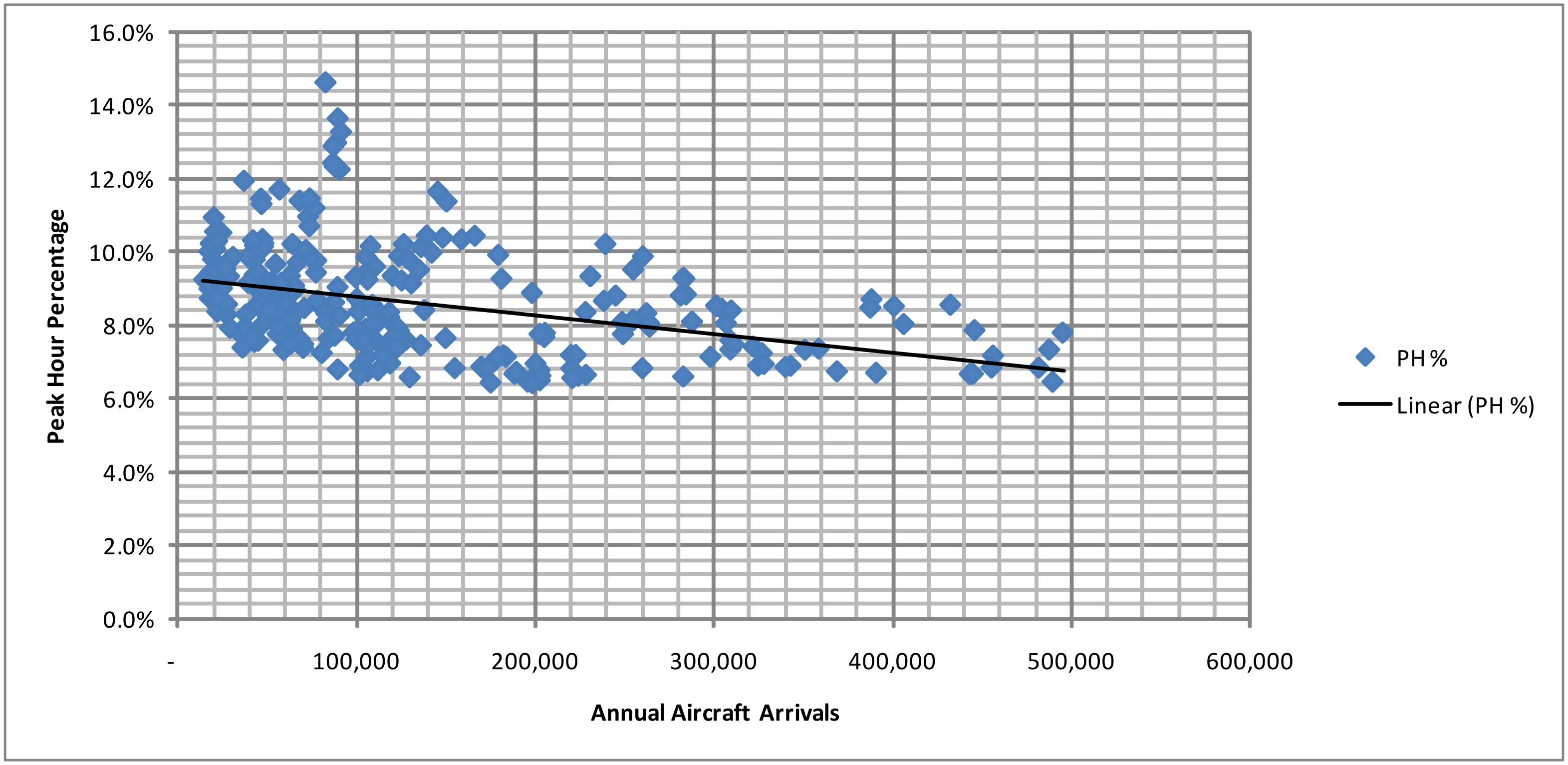
Exhibit H.1

Large Hub	Medium Hub	Small Hub	Non-Hub
Atlanta (ATL)	Columbus (CMH)	Akron (CAK)	Waco (ACT)
Denver (DEN)	Houston Hobby (HOU)	Colorado Springs (COS)	Phoenix Mesa (IWA)
Dallas-Ft. Worth (DFW)	Indianapolis (IND)	Des Moines (DSM)	Lake Charles (LCH)
Newark (EWR)	Milwaukee (MKE)	El Paso (ELP)	Rockford (RFD)
Houston Intercontinental (IAH)	Ontario (ONT)	Grand Rapids (GRR)	
New York JFK (JFK)	San Jose (SJC)	Huntsville (HSV)	
Las Vegas (LAS)	Tucson (TUS)	Midland/Odessa (MAF)	
Los Angeles (LAX)		Madison (MSN)	
New York LaGuardia (LGA)		Palm Springs (PSP)	
Seattle (SEA)		Louisville (SDF)	

Exhibits H.2 and H.3 summarize the results of the analysis for arriving and departing operations. The results of the two charts are very similar and highlight three tendencies. First, the peak hour as a percent of daily operations, declines as annual operations increase. Secondly, the variation in peak hour percentage tends to decline as annual operations increase. Third, there appears to be a minimum level, about 6.5 percent, below which the peak hour percentage will not go.

Exhibit H.2

Relationship Between Annual Aircraft Arrivals and Peak Hour Percentage
Sample of 32 Airports and Eight Years

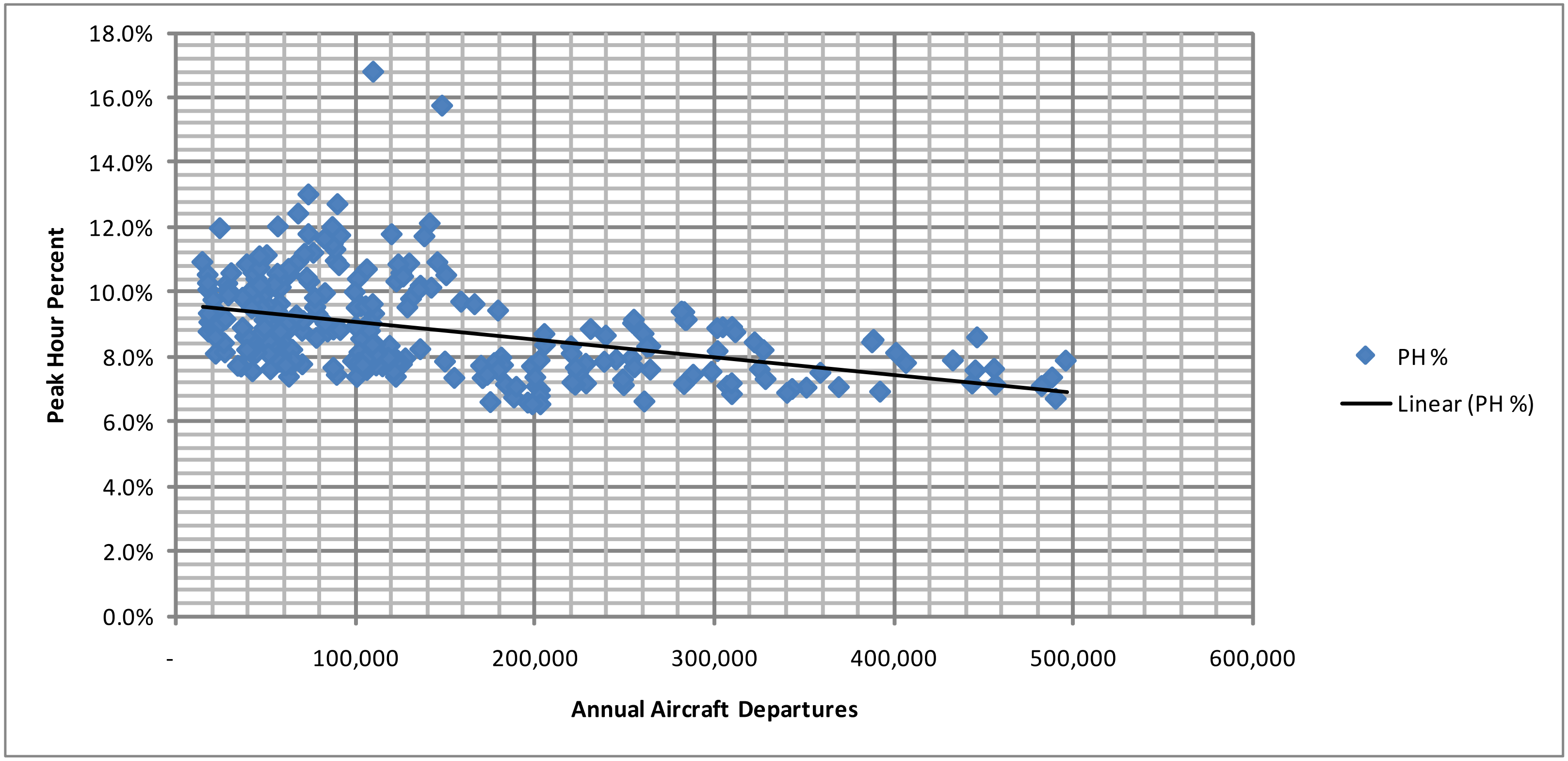


Slope = -0.52% reduction in peak hour arrival percentage per 100,000 increase in annual departures.

Sources: FAA ETMSC database and HNTB analysis.

Exhibit H.3

Relationship Between Annual Aircraft Departures and Peak Hour Percentage
Sample of 32 Airports and Eight Years



Slope = -0.54% reduction in peak hour departure percentage per 100,000 increase in annual departures.

Sources: FAA ETMSC database and HNTB analysis.

The minimum peak hour percentage is understandable if one considers that airports typically operate fully for seventeen or eighteen hours in a day. Therefore, even if activity were spread perfectly evenly over those hours of operations the percentage could not go below 5.5 percent (100%/18). The relationships in Exhibits H.2 and H.3 provided the basis for a regression equation developed to estimate peak hour spreading in the Toolbox. The formula is as follows:

$$PH_2 = (((Ops_2/Ops_1)^{-2.805}) \times (PH_1 - 0.058824)) + 0.58824$$

Where:

Ops_1 = existing annual operations

Ops_2 = future annual operations

PH_1 = existing peak hour percentage

PH_2 = future peak hour percentage

Appendix I

Scheduled and Actual Estimates of Day/Night Distribution

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix I: Scheduled and Actual Estimates of Day/Night Distributions

Often, airline schedules such as those provided by the Official Airline Guide (OAG) provide the basis for day/night splits in Part 150 studies and other noise analyses. The reasons are twofold:

1. Data from aircraft monitoring systems such as NOMS, are not available, and other sources, such as the FAA's distributed OPSNET data, do not provide the required level of detail on fleet mix; and

2. The base year is defined as the current year, for which actual data are not yet available. Airline schedule data is available for up to twelve months in advance.

Because of airspace delays and other disruptions, actual activity does not always match scheduled activity. In addition, schedules typically provide gate times, whereas noise analyses are based on runway times, and there is an offset of several minutes between gate times and runway times. It is important to know whether these factors have an impact on estimated day/night splits for scheduled passenger carriers.

Table I.1 shows a comparison of day/night splits for scheduled passenger carriers at two major airports, based on the OAG and based on actual aircraft monitoring data. In almost all cases, nighttime percentages based on actual data are measurably greater than those based on scheduled data for both arrivals and departures. This is reasonable, since delays tend to accumulate throughout the day. Therefore, it is much more likely that an evening operation scheduled for 9:55 pm will shift to 10:05 pm than a morning operation scheduled for 6:55 am will shift to 7:05 am.

In instances when there is no alternative to using scheduled data, the analyst should consider 1) making adjustments for the difference in gate and runway time and 2) using more general sources such as the distributed OPSNET data to adjust and calibrate the schedule-based day/night splits.

Table I.1

Comparison of Day/Night Splits
OAG vs. Radar Data
Scheduled Passenger Carriers

		Nighttime Percent	
Airport	**Year**	**OAG**	**Radar**
		Arrivals	
Denver	2005	4.59%	4.55%
Denver	2007	4.27%	5.86%
Denver	2009	4.02%	5.26%
MSP	2007	8.10%	10.96%
		Departures	
Denver	2005	2.95%	3.59%
Denver	2007	3.32%	5.19%
Denver	2009	2.70%	6.03%
MSP	2007	7.53%	10.17%

Sources: Official Airline Guide and Denver and Minneapolis-St. Paul International Airport Noise Operations and Management System (NOMS) data.

Appendix J

Trends in Day/Night Distributions

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix J: Trends in Day/Night Distributions

As noted in Section 5.3, it is commonly assumed that the distribution of day and night operations will remain constant when performing forecasts for noise analysis. This is because, absent a future design day schedule or schedules, there is very little information available on which to base a change.

The day/night splits for a sample of airports over several years were examined over several years to determine whether day/night splits were in fact constant over time. The sample used for the analysis was the same sample used for the peak spreading analysis (see Exhibit H.1 in Appendix H) and covers a broad range of airport hub sizes, airport roles, and time zones.

Exhibits J.1 through J.8 show the results of the analysis for commercial (air carrier and air taxi) operations broken out by hub size and arrivals and departures. Exhibits J.9 and J.10 summarize the results across all hubs. Interestingly, airports in the Eastern and Pacific Time zones tend to have significantly higher nighttime percentages than those in the Central and Mountain Time zones, most likely because of redeye flights. Overall, there was a gradual decline in the percentage of commercial nighttime operations between 2000 and 2008. The decline appeared to be greatest during poor economic periods, such as 2001-2003 and 2008, with a moderate rebound during better economic times such as 2004-2006. In addition, the decline is more apparent for arrivals than departures. Since the 2001-2008 period was very difficult for the airline industry; that may be driving the overall downward trend in the nighttime share. An examination of OAG data back to 1997 (not shown) indicates that there was an increase in the nighttime percentage between 1997 and 2000, years that were very good for the airline industry.

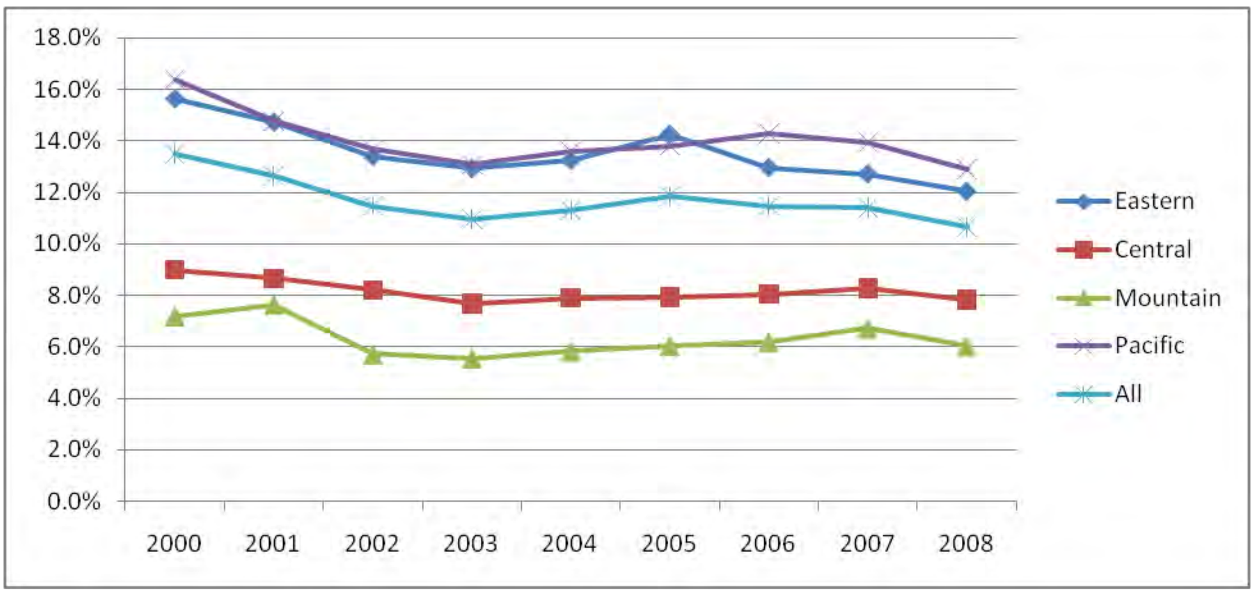
Exhibits J.11 and J.12 show the changes in nighttime distributions for general aviation aircraft arrivals and departures. As with commercial operations, there was a sharp drop off in the percentage of nighttime operations between 2000 and 2003. Since that time, the nighttime percentage of departures has remained roughly unchanged and the nighttime percentage of arrivals has increased slightly.

The changes in nighttime distributions for military aircraft arrivals and departures are shown in Exhibits J.13 and J.14. Because of the small sample size it is difficult to draw strong conclusions, but it appears that nighttime operations increased between 2000 and 2003, in contrast to the other activity categories.

Exhibit J.1

Trends in Percentage of Nighttime Operations
Large Hub - Air Carrier and Air Taxi Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	15.6%	14.7%	13.4%	12.9%	13.2%	14.3%	13.0%	12.7%	12.0%
Central	9.0%	8.6%	8.2%	7.7%	7.9%	7.9%	8.0%	8.3%	7.8%
Mountain	7.2%	7.7%	5.7%	5.6%	5.8%	6.0%	6.2%	6.7%	6.0%
Pacific	16.4%	14.8%	13.7%	13.1%	13.6%	13.8%	14.3%	13.9%	12.9%
All	13.5%	12.6%	11.5%	11.0%	11.3%	11.8%	11.5%	11.4%	10.7%

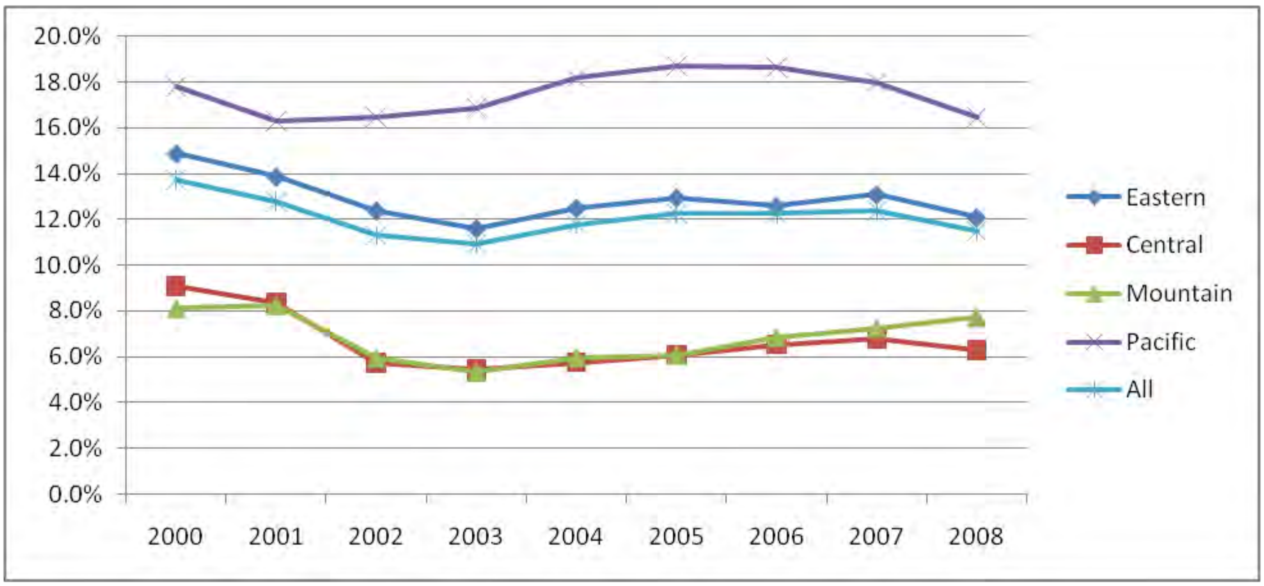


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.2

Trends in Percentage of Nighttime Operations
Large Hub - Air Carrier and Air Taxi Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	14.9%	13.9%	12.4%	11.6%	12.5%	13.0%	12.6%	13.1%	12.1%
Central	9.1%	8.3%	5.7%	5.5%	5.8%	6.1%	6.5%	6.8%	6.3%
Mountain	8.1%	8.3%	5.9%	5.3%	6.0%	6.1%	6.9%	7.3%	7.7%
Pacific	17.8%	16.3%	16.5%	16.9%	18.2%	18.7%	18.6%	18.0%	16.5%
All	13.7%	12.8%	11.3%	10.9%	11.8%	12.3%	12.2%	12.4%	11.5%

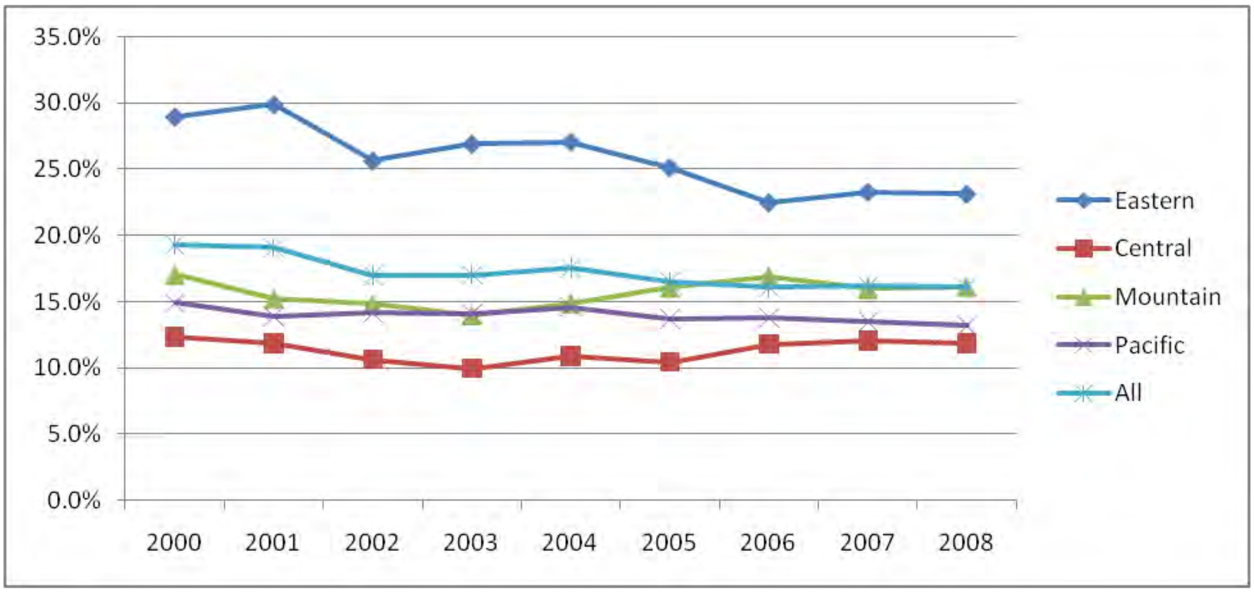


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.3

Trends in Percentage of Nighttime Operations
Medium Hub - Air Carrier and Air Taxi Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	29.0%	29.9%	25.6%	26.9%	27.1%	25.1%	22.5%	23.3%	23.1%
Central	12.4%	11.9%	10.6%	10.0%	10.9%	10.4%	11.8%	12.1%	11.8%
Mountain	17.0%	15.2%	14.8%	14.0%	14.9%	16.1%	16.9%	16.0%	16.1%
Pacific	14.9%	13.9%	14.1%	14.1%	14.6%	13.7%	13.8%	13.5%	13.2%
All	19.3%	19.1%	17.0%	17.0%	17.6%	16.5%	16.1%	16.2%	16.1%

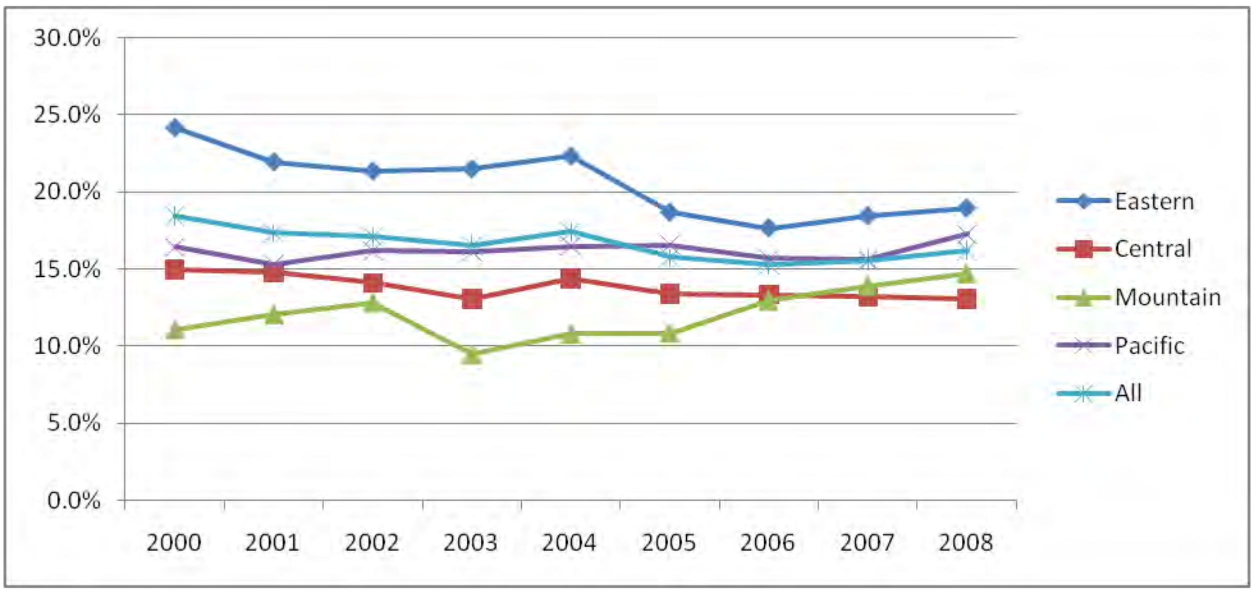


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.4

Trends in Percentage of Nighttime Operations
Medium Hub - Air Carrier and Air Taxi Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	24.2%	21.9%	21.4%	21.5%	22.3%	18.7%	17.6%	18.4%	18.9%
Central	15.0%	14.8%	14.1%	13.1%	14.4%	13.4%	13.3%	13.2%	13.1%
Mountain	11.1%	12.1%	12.8%	9.5%	10.8%	10.9%	12.9%	13.9%	14.7%
Pacific	16.4%	15.3%	16.2%	16.1%	16.5%	16.6%	15.7%	15.6%	17.2%
All	18.5%	17.3%	17.1%	16.6%	17.4%	15.8%	15.3%	15.5%	16.2%

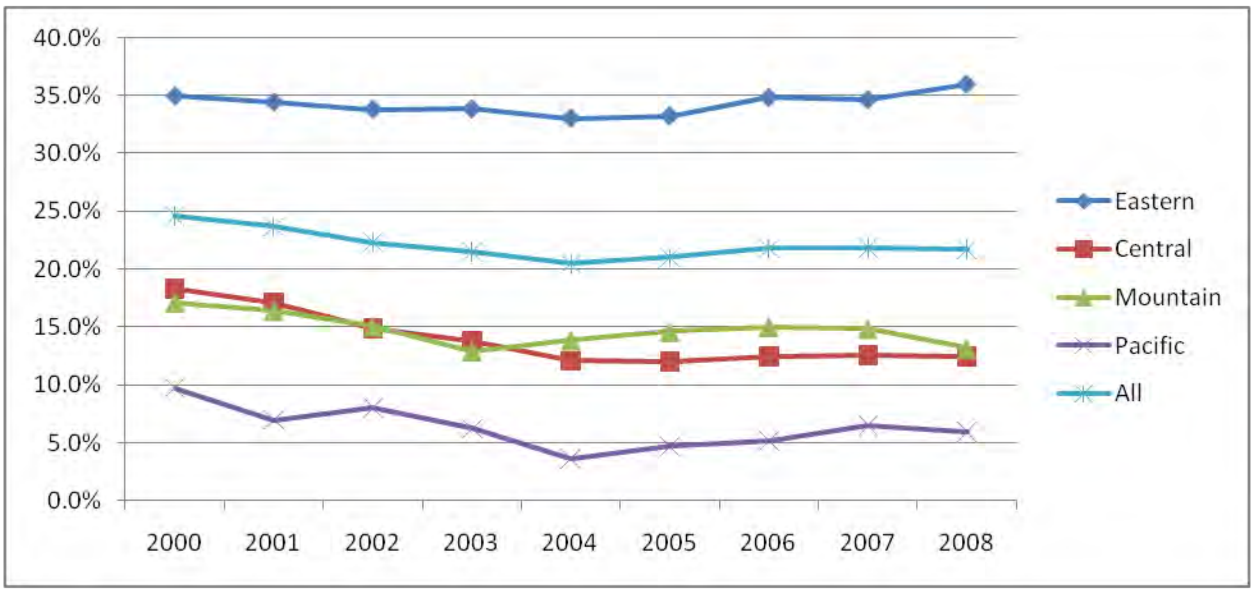


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.5

Trends in Percentage of Nighttime Operations
Small Hub - Air Carrier and Air Taxi Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	34.9%	34.4%	33.8%	33.8%	33.0%	33.2%	34.8%	34.6%	36.0%
Central	18.3%	17.1%	14.9%	13.8%	12.1%	12.0%	12.4%	12.6%	12.5%
Mountain	17.1%	16.4%	15.1%	12.9%	13.8%	14.6%	15.0%	14.9%	13.2%
Pacific	9.7%	7.0%	8.0%	6.2%	3.6%	4.7%	5.2%	6.5%	5.9%
All	24.6%	23.6%	22.3%	21.5%	20.5%	21.0%	21.8%	21.8%	21.7%

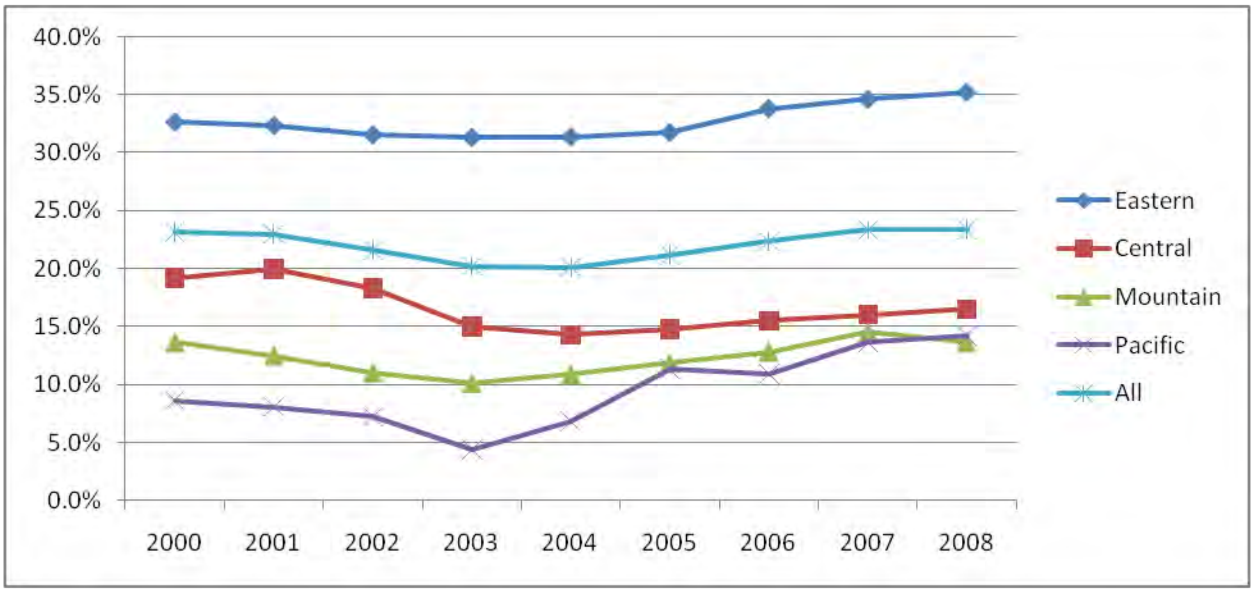


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.6

Trends in Percentage of Nighttime Operations
Small Hub - Air Carrier and Air Taxi Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	32.7%	32.3%	31.5%	31.3%	31.4%	31.7%	33.8%	34.6%	35.2%
Central	19.2%	20.0%	18.3%	15.0%	14.3%	14.8%	15.5%	16.0%	16.5%
Mountain	13.6%	12.5%	11.0%	10.1%	10.9%	11.9%	12.8%	14.5%	13.6%
Pacific	8.6%	8.1%	7.2%	4.4%	6.8%	11.3%	10.9%	13.6%	14.2%
All	23.1%	23.0%	21.6%	20.2%	20.1%	21.1%	22.3%	23.3%	23.4%

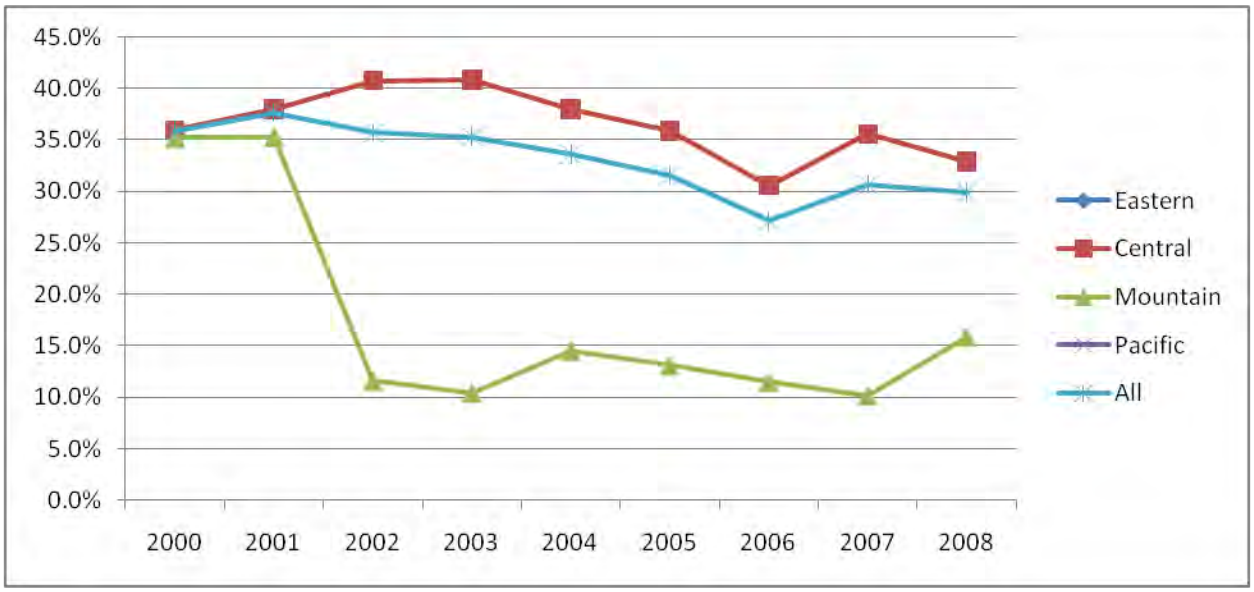


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.7

Trends in Percentage of Nighttime Operations
Non Hub - Air Carrier and Air Taxi Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern									
Central	35.9%	38.0%	40.7%	40.8%	37.9%	35.9%	30.6%	35.6%	32.8%
Mountain	35.2%	35.3%	11.6%	10.4%	14.5%	13.1%	11.5%	10.1%	15.9%
Pacific									
All	35.9%	37.6%	35.7%	35.3%	33.6%	31.6%	27.1%	30.6%	29.9%

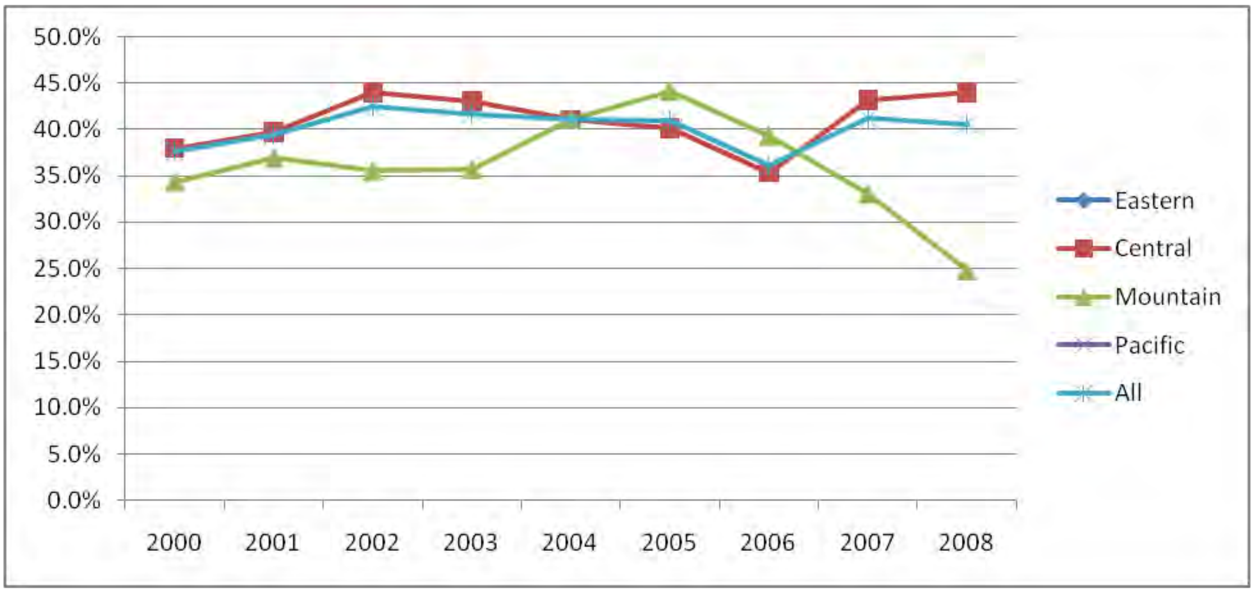


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.8

Trends in Percentage of Nighttime Operations
Non Hub - Air Carrier and Air Taxi Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern									
Central	38.0%	39.7%	44.0%	43.0%	41.0%	40.2%	35.3%	43.1%	44.0%
Mountain	34.4%	36.9%	35.5%	35.7%	41.0%	44.1%	39.3%	33.1%	24.8%
Pacific									
All	37.6%	39.4%	42.5%	41.7%	41.0%	40.9%	36.1%	41.2%	40.6%

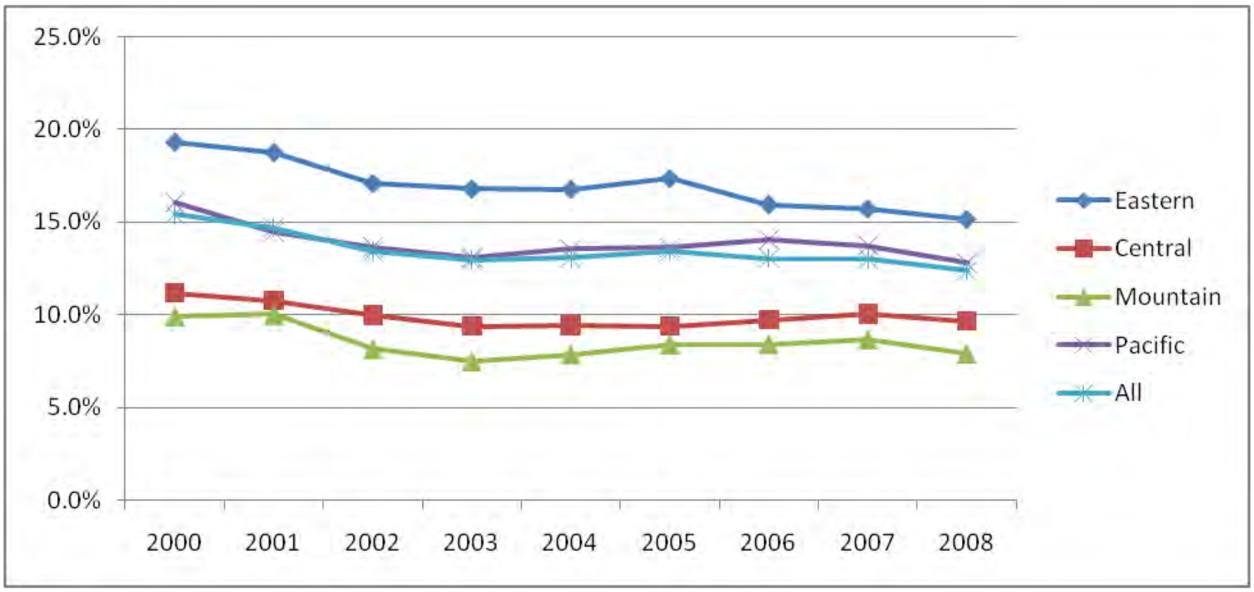


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.9

Trends in Percentage of Nighttime Operations
All Hubs - Air Carrier and Air Taxi Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	19.3%	18.7%	17.1%	16.8%	16.8%	17.3%	15.9%	15.7%	15.2%
Central	11.2%	10.8%	10.0%	9.4%	9.4%	9.4%	9.7%	10.0%	9.7%
Mountain	9.9%	10.0%	8.2%	7.5%	7.9%	8.4%	8.4%	8.7%	7.9%
Pacific	16.0%	14.5%	13.6%	13.1%	13.5%	13.6%	14.0%	13.7%	12.8%
All	15.4%	14.7%	13.4%	12.9%	13.1%	13.4%	13.0%	13.0%	12.4%

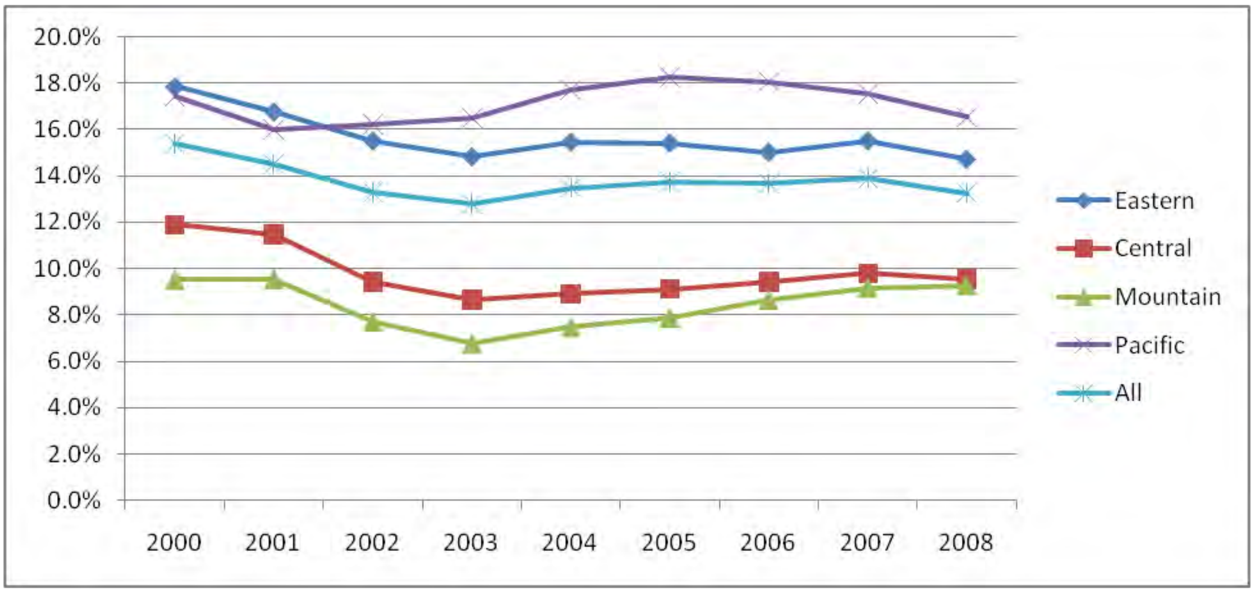


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.10

Trends in Percentage of Nighttime Operations
All Hubs - Air Carrier and Air Taxi Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	17.8%	16.8%	15.5%	14.8%	15.5%	15.4%	15.0%	15.5%	14.7%
Central	11.9%	11.5%	9.4%	8.6%	8.9%	9.1%	9.4%	9.8%	9.5%
Mountain	9.5%	9.5%	7.7%	6.8%	7.5%	7.9%	8.7%	9.2%	9.3%
Pacific	17.4%	16.0%	16.2%	16.5%	17.7%	18.3%	18.1%	17.6%	16.5%
All	15.4%	14.5%	13.3%	12.8%	13.5%	13.7%	13.7%	13.9%	13.3%

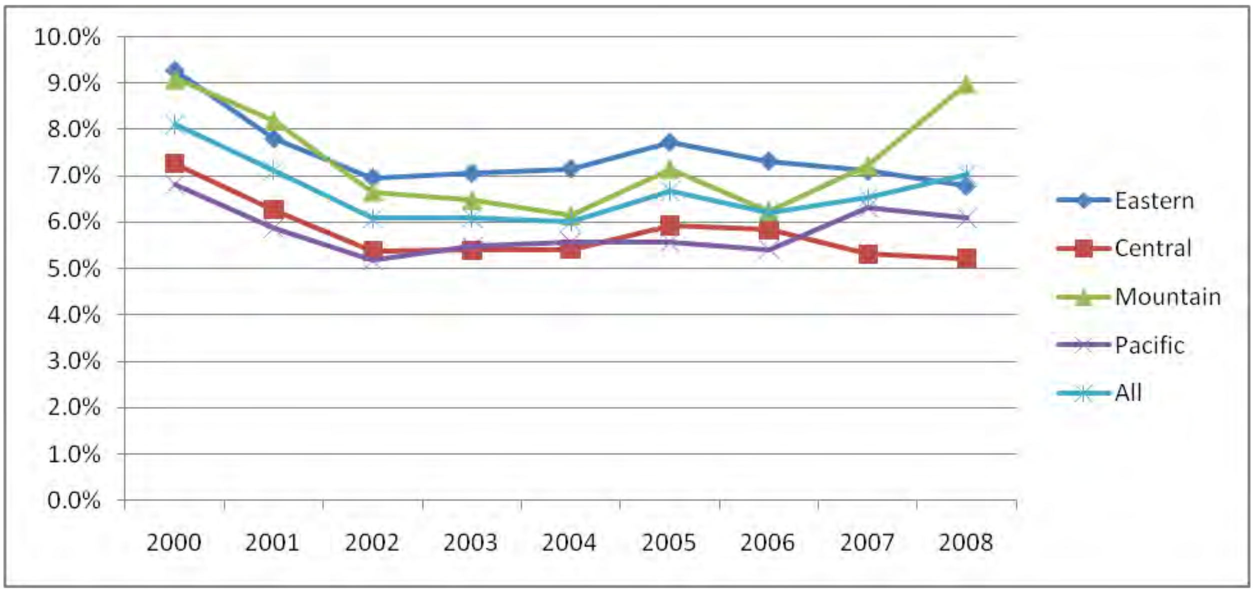


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.11

Trends in Percentage of Nighttime Operations
All Hubs - General Aviation Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	9.3%	7.8%	7.0%	7.1%	7.1%	7.7%	7.3%	7.1%	6.8%
Central	7.3%	6.3%	5.4%	5.4%	5.4%	5.9%	5.8%	5.3%	5.2%
Mountain	9.1%	8.2%	6.6%	6.5%	6.1%	7.1%	6.2%	7.2%	9.0%
Pacific	6.8%	5.9%	5.2%	5.5%	5.6%	5.6%	5.4%	6.3%	6.1%
All	8.1%	7.1%	6.1%	6.1%	6.0%	6.7%	6.2%	6.5%	7.0%

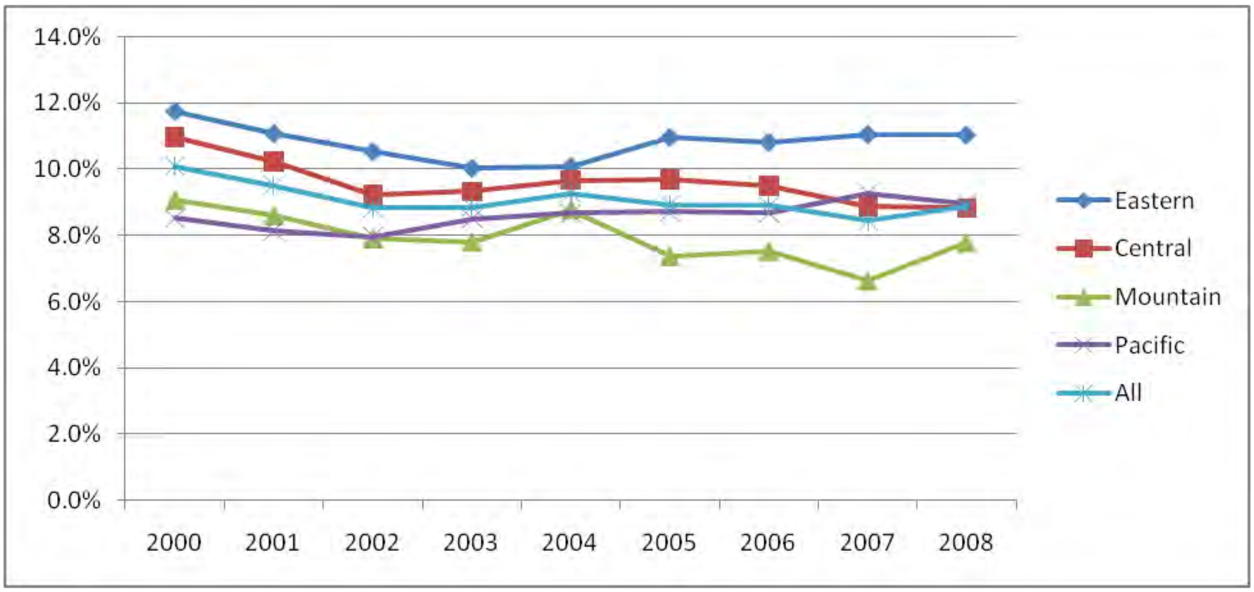


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.12

Trends in Percentage of Nighttime Operations
All Hubs - General Aviation Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	11.7%	11.1%	10.5%	10.0%	10.1%	11.0%	10.8%	11.1%	11.0%
Central	11.0%	10.2%	9.2%	9.3%	9.7%	9.7%	9.5%	8.9%	8.8%
Mountain	9.1%	8.6%	7.9%	7.8%	8.8%	7.4%	7.5%	6.6%	7.8%
Pacific	8.5%	8.1%	7.9%	8.5%	8.7%	8.7%	8.7%	9.3%	9.0%
All	10.1%	9.5%	8.8%	8.9%	9.3%	8.9%	8.9%	8.4%	8.9%

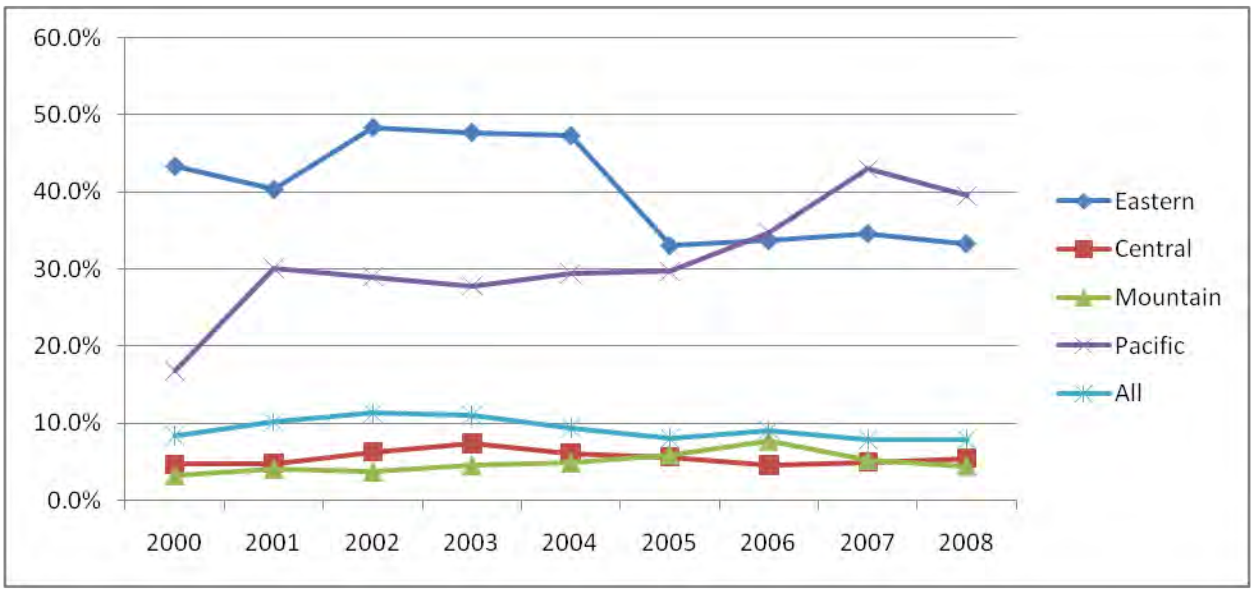


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.13

Trends in Percentage of Nighttime Operations
All Hubs - Military Aircraft Arrivals

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	43.3%	40.3%	48.3%	47.7%	47.2%	33.0%	33.7%	34.6%	33.3%
Central	4.7%	4.8%	6.3%	7.4%	6.1%	5.7%	4.6%	5.0%	5.5%
Mountain	3.2%	4.1%	3.7%	4.5%	4.9%	5.9%	7.7%	5.2%	4.5%
Pacific	16.9%	30.0%	29.0%	27.9%	29.4%	29.7%	34.7%	42.9%	39.5%
All	8.4%	10.1%	11.3%	11.0%	9.4%	8.0%	9.1%	7.9%	7.9%

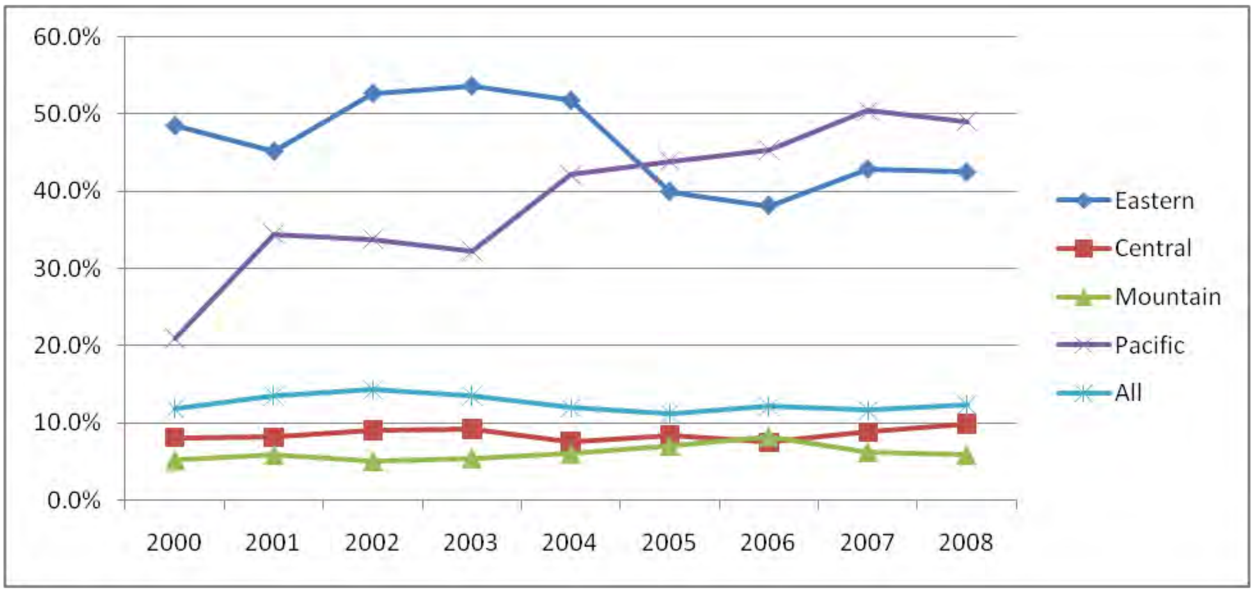


Sources: FAA ETMSC database and HNTB analysis.

Exhibit J.14

Trends in Percentage of Nighttime Operations
All Hubs - Military Aircraft Departures

	Percent Nighttime								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Eastern	48.5%	45.2%	52.7%	53.7%	51.8%	39.9%	38.1%	42.8%	42.5%
Central	8.1%	8.2%	9.0%	9.3%	7.6%	8.4%	7.5%	8.8%	9.9%
Mountain	5.2%	5.9%	5.1%	5.5%	6.0%	7.1%	8.2%	6.3%	5.9%
Pacific	21.0%	34.4%	33.8%	32.2%	42.1%	43.9%	45.3%	50.4%	49.0%
All	11.9%	13.5%	14.3%	13.5%	12.0%	11.2%	12.1%	11.7%	12.3%



Sources: FAA ETMSC database and HNTB analysis.

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix K

Resident Visitor Distribution by Time of Day and Impact on Ground Transportation

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix K: Resident Visitor Distribution by Time of Day and Impact on Ground Transportation

Originating passengers can be broken out into two categories: resident and visitor. Take for example, a passenger who flies from Airport A to Airport B and then completes his round trip by flying from Airport B to Airport A. On the first leg of his round trip he would be a resident originating passenger at Airport A and a visitor terminating passenger at Airport B. On the return leg of his round trip he would be a visiting originating passenger at Airport B and a resident terminating passenger at Airport A.

Survey information collected at a large hub airport in the Eastern Time Zone over several years indicates that originating passengers in the morning are primarily residents, but are primarily visitors in the evening (see Exhibit K.1). This makes sense since many passengers organize their itineraries to avoid the expense and inconvenience of extra overnight stays away from home.

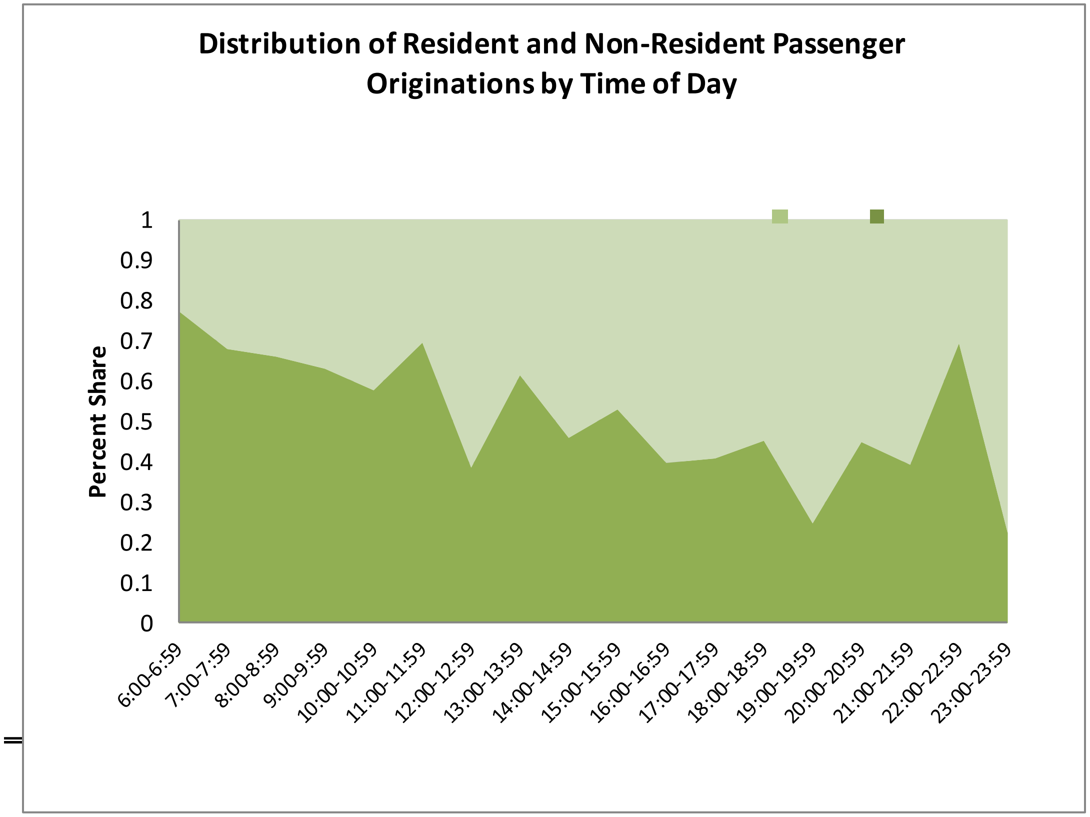
For terminal or airfield planning, the distinction between resident and visitor originations is not very important since they impact facilities in very similar ways. The distinction becomes very important for landside planning, however, since the typical transportation modes are very different for the two groups. As shown in Exhibit K.2, the vast majority of residents (86.5 percent) use a personal automobile to arrive at the airport whereas only 36.7 percent of visitors use a personal automobile to arrive at the airport. Most visitors use a combination of rental cars, taxis, or various forms of mass transit to get to the airport. The distribution of transportation modes among residents and visitors is very similar for terminating passengers (Exhibit K.3).

Since the resident/visitor mix varies by time of day, and the modal mix is very different for the two groups, landside planning that assumes the same resident/visitor mix throughout the day is liable to understate demand at some times and overstate it at other times. For example, demand at the departure curb, primarily driven by personal automobiles, is likely to be greater than expected in the morning and less than expected in the evening.

Planners should cognizant of the differences between the two categories of originations, and their differing impacts on landside facilities throughout the day.

Exhibit K.1

Split of Resident and Non-Resident Originations by Time of Departure Flight

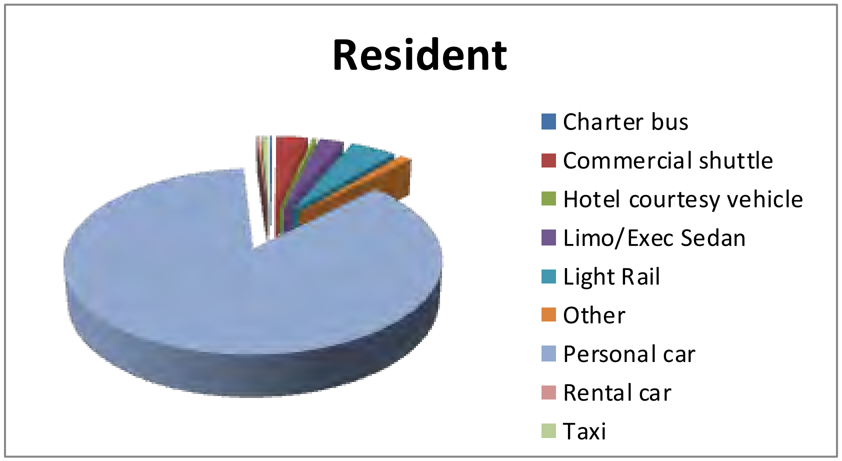


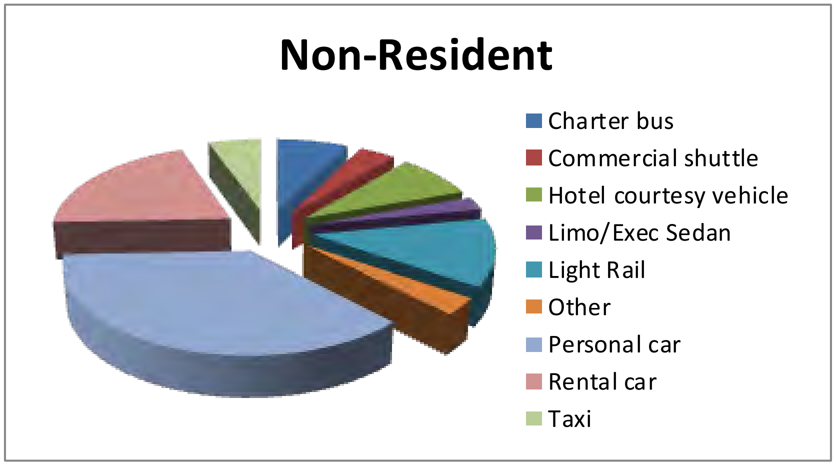
	Originations	
Hour	Resident Share	Non-Resident Share
6:00-6:59	77.3%	22.7%
7:00-7:59	67.9%	32.1%
8:00-8:59	66.0%	34.0%
9:00-9:59	63.0%	37.0%
10:00-10:59	57.7%	42.3%
11:00-11:59	69.5%	30.5%
12:00-12:59	38.5%	61.5%
13:00-13:59	61.4%	38.6%
14:00-14:59	45.9%	54.1%
15:00-15:59	52.9%	47.1%
16:00-16:59	39.7%	60.3%
17:00-17:59	40.8%	59.2%
18:00-18:59	45.2%	54.8%
19:00-19:59	24.7%	75.3%
20:00-20:59	44.9%	55.1%
21:00-21:59	39.2%	60.8%
22:00-22:59	69.3%	30.7%
23:00-23:59	22.3%	77.7%
Total	52.4%	47.6%
AM Split	63.2%	36.8%
PM Split	43.7%	56.3%

Sources: 2007, 2008, and 2009 Passenger Survey and HNTB analysis.

Exhibit K.2

Transportation Mode by Resident and Non-Resident Origination



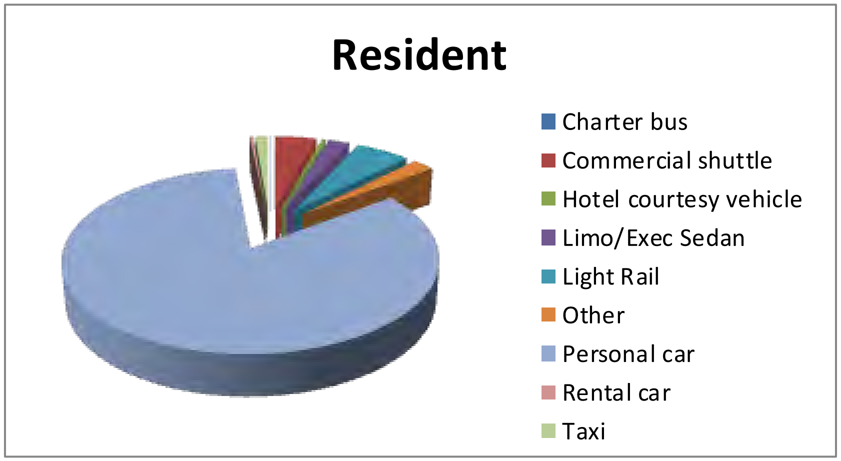


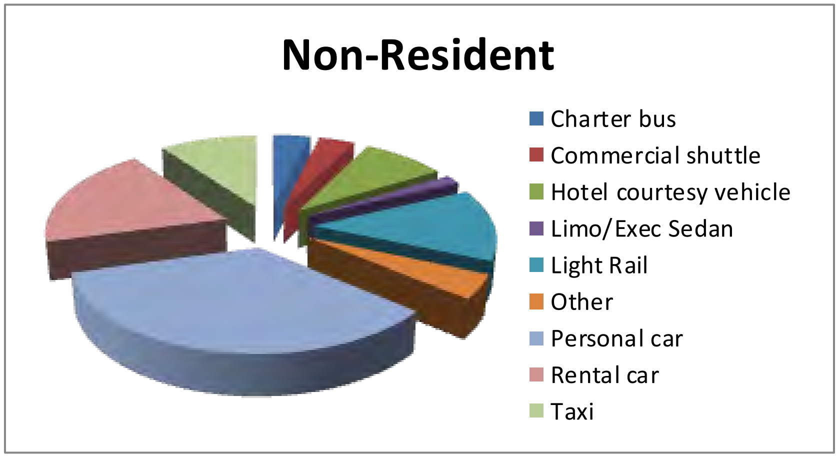
	Originating Passengers	
	Percent Distribution	
Mode	Resident	Non-Resident
Charter bus	0.2%	7.4%
Commercial shuttle	3.3%	3.8%
Hotel courtesy vehicle	0.4%	8.3%
Limo/Exec Sedan	2.5%	2.5%
Light Rail	4.8%	12.5%
Other	1.2%	3.2%
Personal car	86.5%	36.7%
Rental car	0.3%	20.2%
Taxi	0.7%	5.5%
	100.0%	100.0%

Sources: 2009 Passenger Survey and HNTB analysis.

Exhibit K.3

Transportation Mode by Resident and Non-Resident Termination





	Terminating Passengers Percent Distribution	
Mode	Resident	Non-Resident
Charter bus	0.0%	3.9%
Commercial shuttle	4.2%	3.7%
Hotel courtesy vehicle	0.4%	8.7%
Limo/Exec Sedan	2.2%	1.7%
Light Rail	5.6%	13.4%
Other	2.3%	4.4%
Personal car	83.6%	34.9%
Rental car	0.4%	19.1%
Taxi	1.3%	10.1%
	100.0%	100.0%

Sources: 2009 Passenger Survey and HNTB analysis.

Appendix L

Toolbox Documentation

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix L: Guidelines for Preparing Peak Period and Operational Profiles Manual for Toolboxes

L.1. Introduction

The Toolbox package is designed to help the planner generate design day estimates, design day profiles, and peak period estimates quickly and efficiently. The toolbox is based on Microsoft Excel, and has been programmed without the use of macros to facilitate downloading and uploading. The package comes in two modules, one for aircraft operations, and one for passengers.

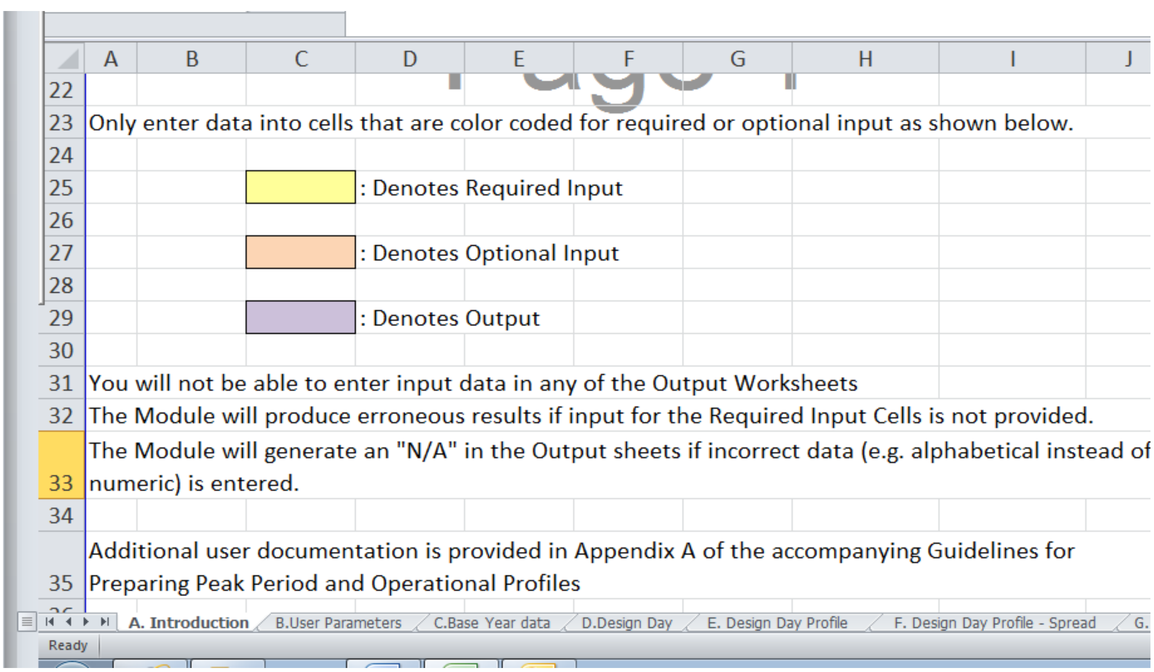
L.2. Aircraft Operations Module

The aircraft operations manual includes an introductory worksheet, two input worksheets and six output worksheets.

L.2.1. Introductory Worksheet

The introductory worksheet summarizes the potential uses of the module, and the organization of the input and output worksheets. A key part of the instructions is highlighted in Exhibit L.1. Yellow cells denote information that the user is required to enter if the Toolbox is to operate, orange cells indicate information that is required only for some of the Toolbox functions, and violet cells indicate output. Other cells are protected, and do not change. Dropdown menus and error messages help guide the user to correctly enter data.

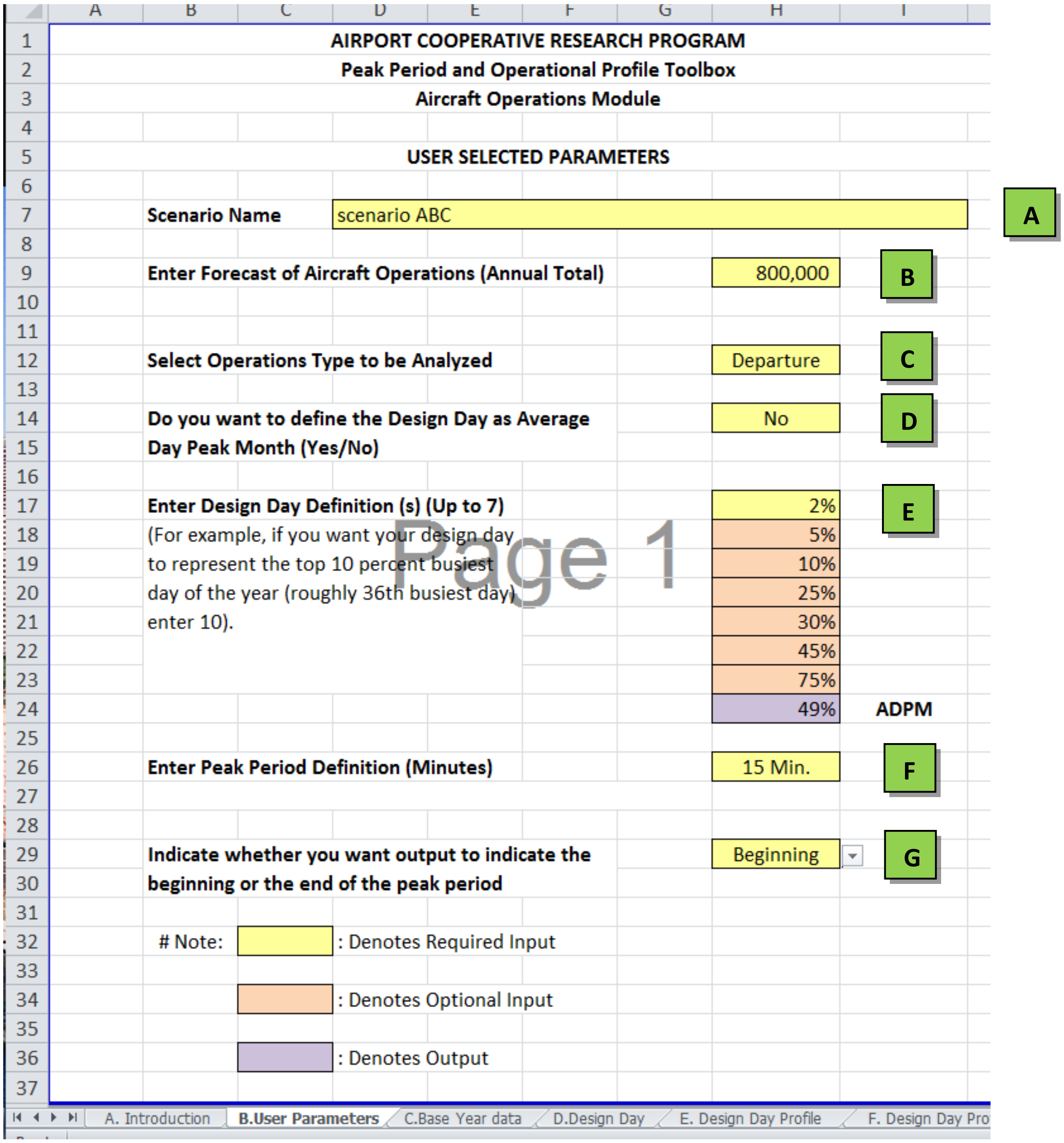
Exhibit L.1



L.2.2. Input Worksheets

The first input worksheet – *B. User Parameters* - (see Exhibit L.2 below) provides an opportunity for the user to provide input parameters to be tested.

Exhibit L.2


AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

USER SELECTED PARAMETERS

Scenario Name	scenario ABC	A
Enter Forecast of Aircraft Operations (Annual Total)	800,000	B
Select Operations Type to be Analyzed	Departure	C
Do you want to define the Design Day as Average Day Peak Month (Yes/No)	No	D
Enter Design Day Definition (s) (Up to 7) (For example, if you want your design day to represent the top 10 percent busiest day of the year (roughly 36th busiest day) enter 10).	2%	E
	5%	
	10%	
	25%	
	30%	
	45%	
	75%	
	49%	ADPM
Enter Peak Period Definition (Minutes)	15 Min.	F
Indicate whether you want output to indicate the beginning or the end of the peak period	Beginning	G

Note: : Denotes Required Input
: Denotes Optional Input
: Denotes Output

A. Introduction | B.User Parameters | C.Base Year data | D.Design Day | E. Design Day Profile | F. Design Day Pro

The user must provide the following data or assumptions:

- A name for the scenario (optional). (A)
- Forecast of annual operations including all aircraft arrivals and departures. The user will choose the source of the data. If an analysis of multiple forecast years is required, a separate run will be required for each year. (B)
- Determine the whether the operations to be analyzed are arrivals, departures, or combined arrivals and departures. To analyze both arrivals and departures separately, the Toolbox must be run twice. (C)
- Determine if the Average Day Peak Month will serve as the design day definition. (D)
- Type in the design day definition(s). For example, if the desired design day is defined as representing all but the 10 percent busiest days of the year, enter 10. As many as 7 different definitions can be included, but only one is required. The top cell entry will determine the design day definition for which the design day profile will be calculated. If the Average Day Peak Month is defined as the design day, the top cell will be blacked out. (E)
- Enter the peak period definition. There are six choices (10 minutes, 12 minutes, 15 minutes, 20 minutes, 30 minutes, or 60 minutes). To analyze multiple definitions of the peak period, the Toolbox must be run multiple times. (F)
- Indicate whether the peak period analysis should identify the beginning or the end of the peak period. For example, if a 20 minute peak period runs from 10:25 to 10:45, the Toolbox will return 10:25 if a "Beginning" is selected and 10:45 if an "End" is selected. (G)

The second input sheet – *C. Base Year Data* - (see Exhibit L.3) is where the base year data is entered.

The user will need to enter complete aircraft operations data for a representative day in columns A through D. The following data should be entered:

- The time of the aircraft operation (column A). The time should reflect the facility that is being analyzed. For example, an airfield analysis is typically based on runway times. OAG data provides gate times; therefore an airfield analysis would require that the user adjust the gate times to reflect the average taxi time from gate to runway for the specific airport under analysis.
- Whether the operation is an arrival (A) or departure (B). (column B)
- The category of operation (passenger, cargo, GA, Military). (column C)
- The aircraft type (column D)

Note that only the first two columns are required. The Toolbox will still operate if columns C and D are blank.

Potential sources of these data include OAG, PDARS, and Airport Noise and Operations Monitoring Systems (ANOMS) data. These data are typically organized so that each flight consists of a record. However, the fields (columns) may need to be reorganized to match the input requirements of the Toolbox.

Operations by day of the year should be entered in columns F through H. The following data should be entered:

- Date (column F).
- Number of aircraft arrivals during the day (column G).
- Number of aircraft departures during the day (column H).

Total operations (column I) are calculated by the Toolbox.

Exhibit L.3

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

BASE YEAR DATA

Base Year - Schedule Data for Representative Day					Base Year - Operations by Day of the Year			
Time	Arrival/Dept.	Category	Equipment		MM/DD/YYYY	Arrival	Departure	Total
12:58 AM	A	Cargo	AC Type 4		1/1/2009	361	361	722
1:10 AM	A	Passenger	AC Type 1		1/2/2009	549	549	1098
1:34 AM	A	Cargo	AC Type 5		1/3/2009	423	423	846
1:57 AM	A	Passenger	AC Type 1		1/4/2009	459	459	918
5:52 AM	A	Passenger	AC Type 4		1/5/2009	407	407	814
5:58 AM	A	Cargo	AC Type 4		1/6/2009	531	531	1062
5:58 AM	A	Cargo	AC Type 4		1/7/2009	567	567	1134
6:18 AM	A	Passenger	AC Type 3		1/8/2009	555	555	1110
6:30 AM	A	Passenger	AC Type 2		1/9/2009	542	542	1084
6:40 AM	A	Passenger	AC Type 2		1/10/2009	322	322	644
6:44 AM	A	Passenger	AC Type 2		1/11/2009	419	419	838
6:45 AM	A	Passenger	AC Type 2		1/12/2009	478	478	956
6:47 AM	A	Cargo	AC Type 5		1/13/2009	517	517	1034
6:59 AM	A	Passenger	AC Type 1		1/14/2009	584	584	1168
7:04 AM	A	Cargo	AC Type 4		1/15/2009	604	604	1208
7:06 AM	A	Passenger	AC Type 2		1/16/2009	543	543	1086
7:07 AM	A	Passenger	AC Type 1		1/17/2009	276	276	552
7:10 AM	A	Passenger	AC Type 3		1/18/2009	438	438	876
7:11 AM	A	Passenger	AC Type 1		1/19/2009	564	564	1128
7:12 AM	A	Passenger	AC Type 4		1/20/2009	547	547	1094
7:15 AM	A	Passenger	AC Type 1		1/21/2009	545	545	1090
7:17 AM	A	Passenger	AC Type 2		1/22/2009	553	553	1106
7:18 AM	A	Passenger	AC Type 1		1/23/2009	547	547	1094
7:19 AM	A	Cargo	AC Type 5		1/24/2009	291	291	582
7:20 AM	A	Passenger	AC Type 3		1/25/2009	384	384	768
7:23 AM	A	Cargo	AC Type 4		1/26/2009	477	477	954
7:24 AM	A	Passenger	AC Type 2		1/27/2009	387	387	774
7:26 AM	A	Passenger	AC Type 1		1/28/2009	547	547	1094

L.2.3. Output Worksheets

The operations module of the Toolbox provides six output worksheets.

The first output worksheet – *D. Design Day Operations* – provides the base year and future year design day operations based on the design day definitions entered by the user (see Exhibit L.4). Operations will be calculated for arrivals, departures, or combined arrivals and departures depending on the user parameter that was entered. The worksheet also provides annual operations and a calculation of average day peak month (ADPM) and average annual day (AAD) operations. Note that base year and future year operations and design day definition are recorded in each output worksheet to assist the user in tracking scnenarios.

Exhibit L.4

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

DESIGN DAY OPERATIONS ESTIMATES
scenario ABC

Base Year — Design Day & Average Annual Day (AAD) — Departures

Selected top X % busiest day	Rank	Departure Ops Count	Corresponding Calendar Date
ADPM	179	501	4/13/2009
2%	7	604	1/15/2009
5%	17	584	1/14/2009
10%	36	566	6/3/2009
25%	89	542	1/9/2009
30%	109	532	6/23/2009
45%	164	508	11/16/2009
75%	272	429	6/21/2009

Departures

Annual Total =	172,986
Average Annual Day (ADD) Total =	474

Forecast Year — Future Design Day & Average Annual Day (AAD) — Departures

Selected top X % busiest day	Rank	Future Design Day operations
ADPM	179	1158
2%	7	1397
5%	17	1350
10%	36	1309
25%	89	1253
30%	109	1230
45%	164	1175
75%	272	992

Departures

Future Annual Total =	400,000
Future Average Annual Day (ADD) Total =	1,096

ADPM: Average Day in Peak Month

Base Year Annual Operations	345,948
Forecast Year Annual Operations	800,000
Design Day Definition	2%

A. Introduction | B.User Parameters | C.Base Year data | D.Design Day | E. Design Day Profile | F. Design Day Profile - Spread | G. Peak Period | H. Peak Period - Spread

The second output worksheet – *E. Design Day Profile* – provides a distribution of design day operations by hour for the base year and the future year in which no peak spreading is assumed. Therefore, the percentage distribution of operations is the same for the base year and the future year. The total operations in the design day profile correspond to the first entry in the *C. Design Day Operations* worksheet (two percent in the example in Exhibit L.5).

Exhibit L.5

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

DESIGN DAY PROFILE ESTIMATES
(Assumes no Peak Spreading)
scenario ABC

Base Year: Design Day Profile – Departures			Forecast Year: Future Design Day Profile – Departures		
Hour	Op Count by Hour Bucket (Whole	%	Hour	Op Count by Hour Bucket (Whole	%
00:00-00:59	3	0.6%	00:00-00:59	8	0.6%
01:00-01:59	3	0.6%	01:00-01:59	8	0.6%
02:00-02:59	-	0.0%	02:00-02:59	-	0.0%
03:00-03:59	-	0.0%	03:00-03:59	-	0.0%
04:00-04:59	-	0.0%	04:00-04:59	-	0.0%
05:00-05:59	7	1.1%	05:00-05:59	16	1.1%
06:00-06:59	34	5.7%	06:00-06:59	80	5.7%
07:00-07:59	31	5.1%	07:00-07:59	72	5.1%
08:00-08:59	52	8.5%	08:00-08:59	119	8.5%
09:00-09:59	19	3.1%	09:00-09:59	44	3.1%
10:00-10:59	16	2.6%	10:00-10:59	36	2.6%
11:00-11:59	22	3.7%	11:00-11:59	52	3.7%
12:00-12:59	34	5.7%	12:00-12:59	80	5.7%
13:00-13:59	38	6.3%	13:00-13:59	88	6.3%
14:00-14:59	40	6.6%	14:00-14:59	92	6.6%
15:00-15:59	24	4.0%	15:00-15:59	56	4.0%
16:00-16:59	81	13.4%	16:00-16:59	187	13.4%
17:00-17:59	59	9.7%	17:00-17:59	135	9.7%
18:00-18:59	43	7.1%	18:00-18:59	99	7.1%
19:00-19:59	36	6.0%	19:00-19:59	84	6.0%
20:00-20:59	43	7.1%	20:00-20:59	99	7.1%
21:00-21:59	9	1.4%	21:00-21:59	20	1.4%
22:00-22:59	9	1.4%	22:00-22:59	20	1.4%
23:00-23:59	2	0.3%	23:00-23:59	4	0.3%
Total:	604	100.0%	Total:	1,397	100.0%

Base Year – Departures			Forecast Year – Departures		
Peak Value:	81	16: 00	Peak Value:	187	16:00
Peak Hour:	16:00-16:59	13.4%	Peak Hour:	16:00-16:59	13.4%

Base Year Annual Operations	345,948
Forecast Year Annual Operations	800,000
Design Day Definition	2%

The third output worksheet – *F. Design Day Profile – Spread* – is similar to *E. Design Day Profile* but also incorporates a peak spreading element. The peak represents the average reduction in the magnitude of the "peaks and valleys" of the daily distribution as airports become busier. Note that the base year operations are the same as in the E. Design Day Profile worksheet, but the future year peaks are reduced (see Exhibit L.6).

Exhibit L.6

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

DESIGN DAY PROFILE ESTIMATES
(Assumes Peak Spreading)
scenario ABC

Base Year			Forecast Year (w/ Peak Spreading)		
Design Day Profile			**Future Design Day Profile**		
Departures			**Departures**		
Hour	Op Count by Hour Bucket (Whole	%	Hour	Op Count by Hour Bucket (Whole	%
00:00-00:59	3	0.6%	00:00-00:59	22	1.6%
01:00-01:59	3	0.6%	01:00-01:59	22	1.6%
02:00-02:59	-	0.0%	02:00-02:59	-	0.0%
03:00-03:59	-	0.0%	03:00-03:59	-	0.0%
04:00-04:59	-	0.0%	04:00-04:59	-	0.0%
05:00-05:59	7	1.1%	05:00-05:59	28	2.0%
06:00-06:59	34	5.7%	06:00-06:59	76	5.5%
07:00-07:59	31	5.1%	07:00-07:59	70	5.0%
08:00-08:59	52	8.5%	08:00-08:59	106	7.6%
09:00-09:59	19	3.1%	09:00-09:59	49	3.5%
10:00-10:59	16	2.6%	10:00-10:59	43	3.1%
11:00-11:59	22	3.7%	11:00-11:59	55	4.0%
12:00-12:59	34	5.7%	12:00-12:59	76	5.5%
13:00-13:59	38	6.3%	13:00-13:59	82	5.9%
14:00-14:59	40	6.6%	14:00-14:59	85	6.1%
15:00-15:59	24	4.0%	15:00-15:59	58	4.2%
16:00-16:59	81	13.4%	16:00-16:59	157	11.3%
17:00-17:59	59	9.7%	17:00-17:59	118	8.5%
18:00-18:59	43	7.1%	18:00-18:59	91	6.5%
19:00-19:59	36	6.0%	19:00-19:59	79	5.7%
20:00-20:59	43	7.1%	20:00-20:59	91	6.5%
21:00-21:59	9	1.4%	21:00-21:59	31	2.2%
22:00-22:59	9	1.4%	22:00-22:59	31	2.2%
23:00-23:59	2	0.3%	23:00-23:59	19	1.4%
Total:	604	100.0%	Total:	1,397	100.0%

Departures			**Departures**		
Peak Value:	81	16: 00	Peak Value:	157	16: 00
Peak Hour:	16:00-16:59	13.4%	Peak Hour:	16:00-16:59	11.3%

Base Year Annual Operations	345,948
Forecast Year Annual Operations	800,000
Design Day Definition	2%

A. Introduction / B.User Parameters / C.Base Year data / D.Design Day / E. Design Day Pr

The fourth output worksheet – *G. Peak Period* – provides the rolling peak period corresponding to each of the design day selections for the base year and the forecast year. In the example below, the user selected a 15 minute peak period definition. In Exhibit L.7 below, peak 15 minute operations during the 2 percent busiest day in the forecast year are estimated at 83 operations (A). This worksheet assumes no peak spreading.

Exhibit L.7

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

PEAK PERIOD ESTIMATES
(Assumes no Peak Spreading)
scenario ABC

Base Year			Forecast Year		
Peak Period in Design Day			**Future Peak Period in Design Day**		
Departures			**Departures**		
Selected top X % busiest day	Rank	Rolling 15 min	Selected top X % busiest day	Rank	Rolling 15 min
ADPM	179	29	ADPM	179	69
2%	7	36	2%	7	83 (A)
5%	17	34	5%	17	80
10%	36	33	10%	36	78
25%	89	32	25%	89	74
30%	109	31	30%	109	73
45%	164	30	45%	164	70
75%	272	25	75%	272	59

Departures (Base Year)		Departures (Forecast Year)	
Peak Period Definition	Clock Time*	Peak Period Definition	Clock Time*
Rolling 15 min	16:41	Rolling 15 min	16:41

*** Note: Clock Time is when the given Peak Period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Operations	**345,948**
Forecast Year Annual Operations	**800,000**
Design Day Definition	**2%**

The fifth output worksheet – *H. Peak Period – Spread* is similar to the G. Peak Period worksheet except that it includes an adjustment for peak spreading in the forecast year. Therefore, in Exhibit L.8 below, peak 15 minute operations during the 2 percent busiest day in the forecast year are estimated at 70 operations (B).

Exhibit L.8

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

PEAK PERIOD ESTIMATES
(Assumes Peak Spreading)
scenario ABC

Base Year			**Forecast Year (w/ Peak Spreading)**		
Peak Period in Design Day			**Future Peak Period in Design Day**		
Departures			**Departures**		
Selected top X % busiest day	Rank	Rolling 15 min	Selected top X % busiest day	Rank	Rolling 15 min
ADPM	179	29	ADPM	179	58
2%	7	36	2%	7	70
5%	17	34	5%	17	67
10%	36	33	10%	36	66
25%	89	32	25%	89	62
30%	109	31	30%	109	61
45%	164	30	45%	164	59
75%	272	25	75%	272	50

B

Departures		**Departures**	
Peak Period definition	Clock Time*	Peak Period definition	Clock Time*
Rolling 15 min	16:41	Rolling 15 min	16:41

*** Note: Clock Time is when the given Peak Period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Operations	**345,948**
Forecast Year Annual Operations	**800,000**
Design Day Definition	**2%**

The final output spreadsheet (Exhibit L.9) provides a graphic representation of the design day profiles, including the base year design day profile, the forecast year design day profile without peak spreading, and the forecast year design day profile with peak spreading. The hourly percentage distribution of the base year and the forecast year without peak spreading is the same, so they are represented by the same line.

Exhibit L.9

AIRPORT COOPERATIVE RESEARCH PROGRAM

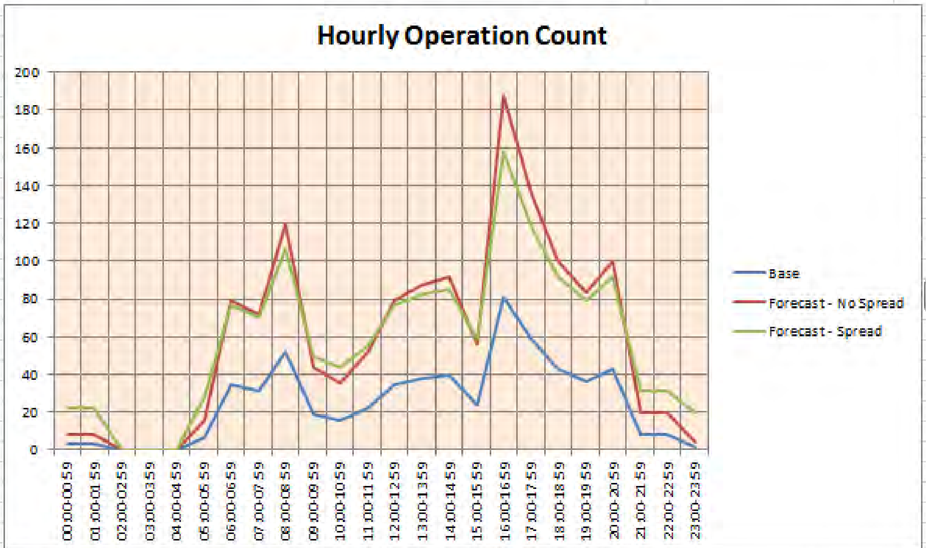
Peak Period and Operational Profile Toolbox

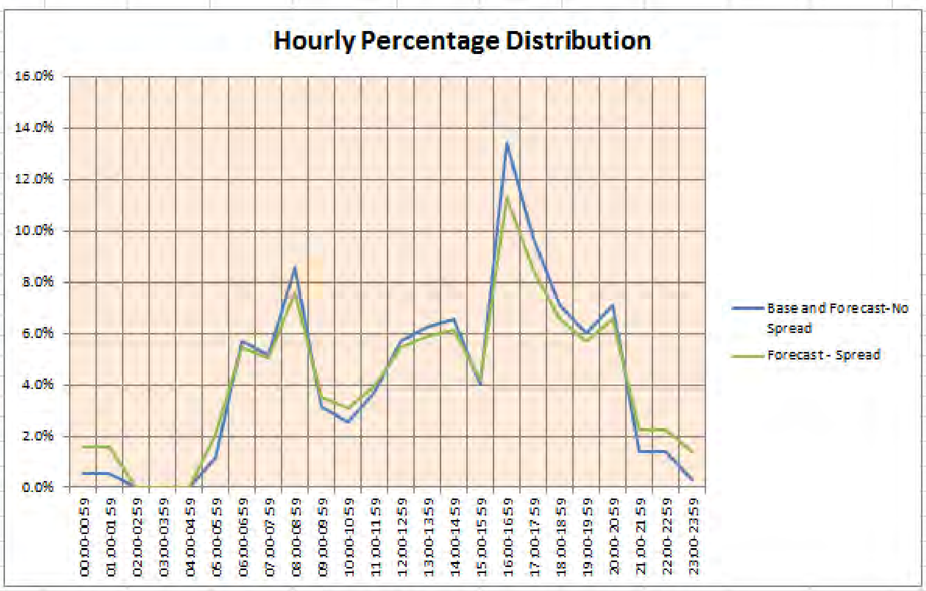
Aircraft Operations Module

PEAK PERIOD AND DESIGN DAY PROFILE ESTIMATES

scenario ABC

Departures





Base Year Annual Operations	345,948
Forecast Year Annual Operations	800,000
Design Day Definition	2%

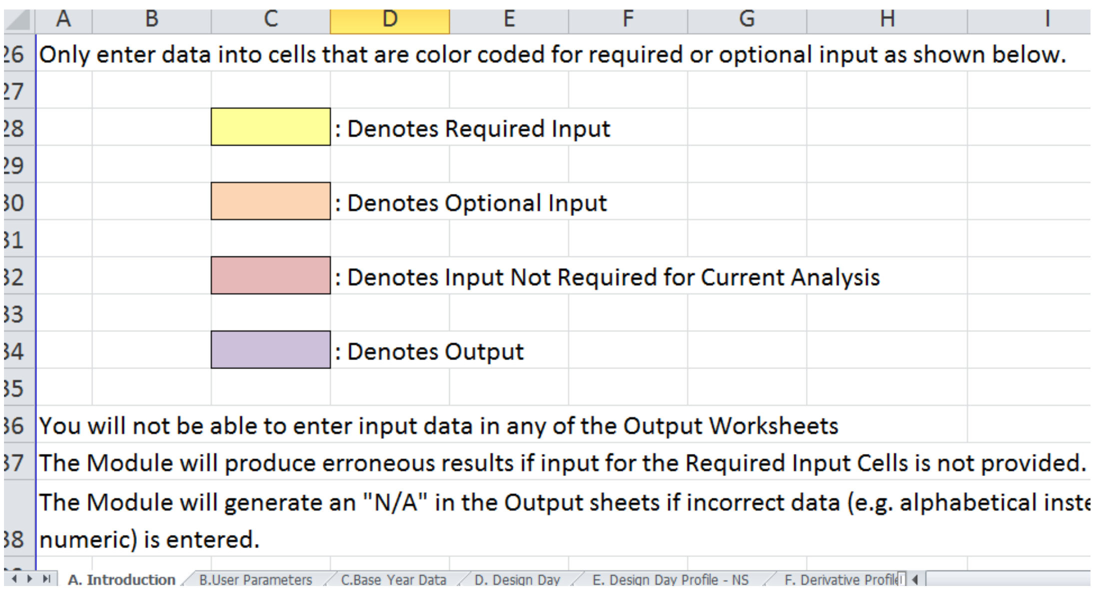
L.3. Passenger Module

The passenger module of the Toolbox consists of an introductory worksheet, two input worksheets, and nine output worksheets. The format is similar to the operations manual but contains more features.

L.3.1. Introductory Worksheet

The introductory worksheet summarizes the potential uses of the passenger module, and the organization of the input and output worksheets. The instructions differ slightly from those of the operations module because of additional burgundy colored cells that indicate that they have been rendered inactive by the user's selection of data input (see Exhibit A.10). Dropdown menus and error messages help guide the user to correctly enter data.

Exhibit L.10



L.3.2. Input Worksheets

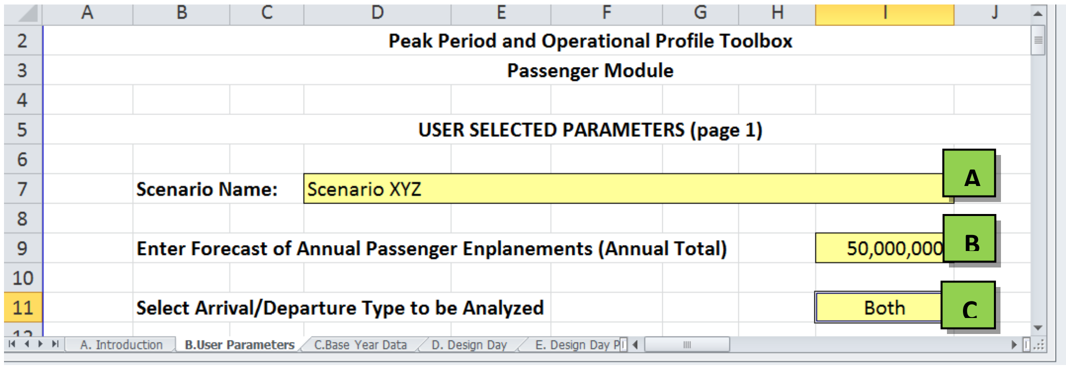
The first input worksheet – *B. User Parameters* – allows the user to input the parameters that will determine the type of analysis performed.

The following inputs are required from the user.

- The name of the scenario being run (optional)(A).
- The forecast of future annual enplanements (50,000,000 in the example below) (B). The user will choose the source of the data. If an analysis of multiple forecast years is required, a separate run will be required for each year.
- Determine the whether the passengers to be analyzed are arrivals (deplanements), departures (enplanements), or total passengers (combined enplanements and deplanements) (C). To analyze passenger arrivals and departures separately, the

Toolbox will need to be run twice. Combined enplanements and deplanements (Both) are selected in Exhibit A.11.

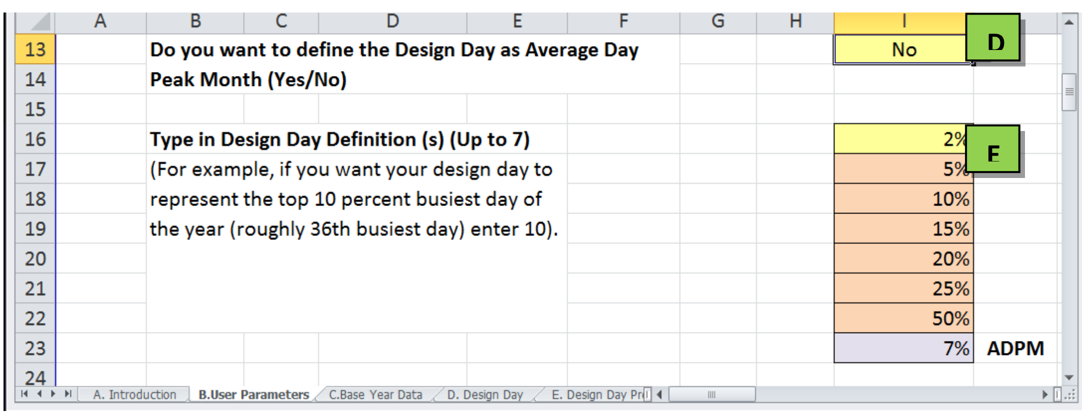
Exhibit L.11



- Determine if the Average Day Peak Month will serve as the design day definition. (D)

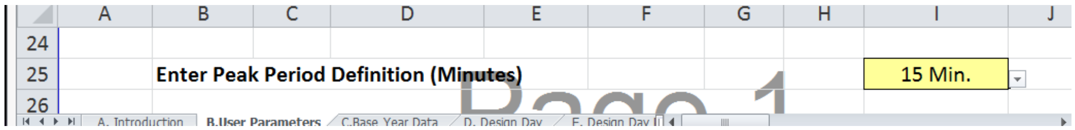
- Type in the design day definition. For example, if the desired design day is defined as representing all but the 10 percent busiest days of the year, type in 10. As many as 7 different definitions can be included, but only one is required. The top cell entry will determine the design day definition for which the design day profile will be calculated. In Exhibit L.12, the design profile will be calculated for 2 percent busiest day (E), which corresponds to the seventh busiest day of the year (365 days x 2 percent).

Exhibit L.12



- Type in the peak period definition. There are six choices (10 minutes, 12 minutes, 15 minutes, 20 minutes, 30 minutes, or 60 minutes). In Exhibit L.13, 15 minutes has been selected. To analyze multiple definitions of the peak period, the Toolbox will need to be run multiple times. Appendix D of the Guidebook provides suggestions on appropriate peak period definitions by facility category.

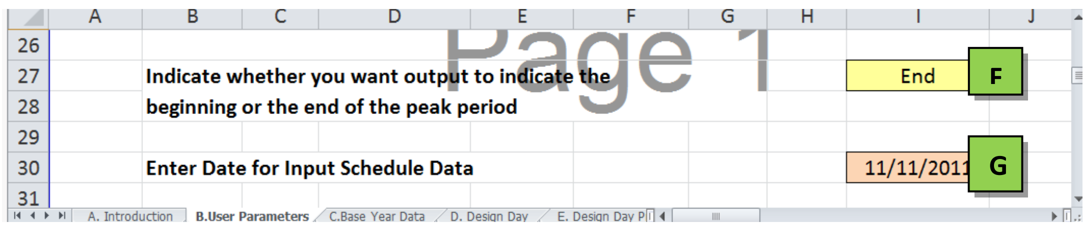
Exhibit L.13



- Indicate whether the peak period analysis should identify the beginning or the end of the peak period. For example, if a 20 minute peak period runs from 10:25 to 10:45, the Toolbox will return 10:25 if a "Beginning" is selected from the drop down menu and 10:45 if an "End" is selected. In the example in Exhibit L.14, the end time of the peak period is selected (F).

- Provide the date for which the input schedule data (see *C. Base Year Data* worksheet) was obtained (G).

Exhibit L.14



- Provide monthly enplanement data for each month for the airport being analyzed (H) (see Exhibit L.14).

- Provide the load factor adjustment factor for each day of the week at the airport under analysis (I). If the data are unavailable, default factors can be obtained from Appendix C.

Exhibit L.15

Enter Monthly Enplanements for Base Year (Each Month) H

Monthly Enplanements		
Jan.	1	2,205,340
Feb.	2	1,934,506
Mar.	3	2,446,882
Apr.	4	2,289,508
May	5	2,511,305
Jun.	6	2,693,089
Jul.	7	2,844,623
Aug.	8	2,755,555
Sep.	9	2,076,252
Oct.	10	2,294,065
Nov.	11	2,133,573
Dec.	12	2,186,540
Total		28,371,238

Enter Day of Week Load Factor Adjustment Factor (Load Factor for Day)/(Average Load Factor for Week) I

Day of Week Load Factor		
Sun	1	1.020
Mon	2	1.200
Tue	3	1.035
Wed	4	1.039
Thu	5	1.033
Fri	6	1.034
Sat	7	0.850

- Determine whether to analyze origin-destination (Origin/Dest.) passengers, or total (All) passengers from the drop down menu (J). If the user needs to analyze both passenger categories separately, he or she will need to run the model twice. The user has selected total passengers (All) in the example in Exhibit L.16.

- If an O&D analysis has been chosen, enter the average ratio of originations to enplanements (K). The cell was blacked out and a "Not Applicable" note appears in the example in Exhibit L.16 because "All" was selected.

Exhibit L.16

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

USER SELECTED PARAMETERS (page 2)

Choose origin/destination passengers or all passengers?	All	J	
If origin/designation, type in ratio of originations to enplanements		Not Applica	K

- Provide the lead and/or lag time distributions. Since both arrivals and departures were selected (see Exhibit L.11) both lead (L) and lag (M) time distributions must be entered. If arrivals were selected, the user would be prompted for lag times. If departures were selected, the user would be prompted for lead times. The lead time distribution is the percentage of passengers that arrive at an airport facility prior to enplaning, broken out by time intervals. Since lead times in the early morning (before 9:00 am) are often more compressed, the user has the option of entering two sets of lead times. In the example below, before 9:00 am, 1.0% of enplaning passengers arrive 10 minutes or less prior to scheduled aircraft departure, and 5.0% of enplaning passengers arrive between 10 and 20 minutes prior to departure. Also, 1.0% of deplaning passengers arrive at the facility 10 minutes after aircraft arrival and 10.0% of deplaning passengers arrive at the facility between 10 and 20 minutes after aircraft arrival. The distributions will depend on the facility under analysis. For example, curbside arrival will have a different lead time distribution from passenger security screening. Note that the user has the option of changing the time intervals (columns D and J) in the input worksheet.

Exhibit L.17

Enter the lead time distribution (The percentage of passenger that arrive at a facility during each time interval prior to aircraft departure) and the lag time distribution (The percentage of passenger that arrive at a facility during each time interval after aircraft arrival) (Total should add to 100.0%)

L

Lead Time (Minutes)			<9:00 am	>9:00 am
0	to	10	1.0%	0.4%
11	to	20	5.0%	0.8%
21	to	30	20.0%	2.8%
31	to	40	25.0%	13.5%
41	to	50	25.0%	15.1%
51	to	60	10.0%	15.5%
61	to	80	9.0%	14.3%
81	to	100	5.0%	11.6%
101	to	120	0.0%	14.3%
121	to	140	0.0%	6.0%
141	to	180	0.0%	3.2%
181	to	220	0.0%	1.6%
221	to	300	0.0%	0.9%
		Total:	100.0%	100.0%

M

Lag Time (Minutes)			
0	to	10	1%
11	to	20	10%
21	to	30	45%
31	to	40	10%
41	to	50	10%
51	to	60	15%
61	to	70	5%
71	to	80	3%
81	to	90	1%
91	to	100	0%
101	to	110	0%
111	to	120	0%
121	to	130	0%
Total:			100%

The second input sheet – *C. Base Year Data* - (see Exhibit L.18) is where the base year data is entered.

Airline schedule information for a representative day should be entered in columns B through E including:

- The time of the aircraft operation (column B)
- The number of seats in the aircraft (Column C).
- Whether the aircraft operation is an arrival (A) or departure (B). (column D)
- The category of operation (commercial jet, other jet, turboprop, piston). (column E)

- The aircraft type (column F)

Exhibit L.18

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

BASE YEAR DATA

Base Year - Schedule Data for Representative Day

Time	Seats	Arrival/ Dept.	Category	Equipment
12:06 AM	131	A	C	A319
12:21 AM	165	A	C	A320
12:37 AM	131	A	C	A319
12:45 AM	131	D	C	A319
12:53 AM	131	D	C	A319
12:55 AM	131	D	C	A319
1:15 AM	165	D	C	A320
1:16 AM	160	A	C	B737
1:31 AM	200	D	C	B752
1:39 AM	157	A	C	B738
2:01 AM	131	A	C	A319
2:38 AM	200	A	C	B752
3:13 AM	19	D	T	SW4
3:40 AM	266	A	C	A306
3:42 AM	266	A	C	A306
3:58 AM	200	D	C	B752
4:03 AM	266	A	C	A306
4:12 AM	19	A	T	SW4
4:30 AM	19	A	T	SW4
4:33 AM	250	A	C	DC10

Base Year - Scheduled Seats by Day of the Year

MM/DD/YYYY	Arriving	Departing	Arriving + Departing
1/1/2009	90,928	91,116	182,044
1/2/2009	101,135	101,404	202,539
1/3/2009	92,145	92,718	184,863
1/4/2009	95,763	95,970	191,733
1/5/2009	98,128	97,798	195,926
1/6/2009	98,003	97,741	195,744
1/7/2009	96,972	96,734	193,706
1/8/2009	97,536	96,987	194,523
1/9/2009	94,221	96,234	190,455
1/10/2009	94,512	95,423	189,935
1/11/2009	89,938	89,800	179,738
1/12/2009	93,522	93,189	186,711
1/13/2009	93,495	95,299	188,794
1/14/2009	95,527	94,532	190,059
1/15/2009	92,222	95,066	187,288
1/16/2009	97,018	95,928	192,946
1/17/2009	78,391	79,824	158,215
1/18/2009	90,428	90,419	180,847
1/19/2009	95,265	95,239	190,504
1/20/2009	96,237	95,842	192,079

A. Introduction | B.User Parameters | C.Base Year Data | D. Design Day | E. Design Day Profile - NS

Note that only the first three columns are required. The Toolbox will still operate if columns E and F are blank.

Scheduled seats by day of the year should be entered in columns H through J. The following data should be entered:

- Date (column H).
- Number of scheduled seat arrivals during the day (column I).
- Number of scheduled seat departures during the day (column J.

Total scheduled seat arrivals and departures (column K) are calculated by the Toolbox.

L.3.3. Output Worksheets

The passenger module of the Toolbox provides nine output worksheets.

The first output worksheet – *D. Design Day* – provides the base year and future year design day passengers based on the design day definitions entered by the user. Passengers will be calculated for arrivals, departures, or combined arrivals and departures depending on the user parameter that was entered. The worksheet also provides annual passengers and calculations of average day peak month (ADPM) and average annual day (AAD) passengers.

In the example in Exhibit L.19, the user has selected total passengers (as opposed to O&D passengers). In addition, combined arriving and departing passengers were selected. Therefore, the annual passengers shown in the example below are double the enplanement totals entered in worksheets A and B.

Exhibit L.19

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY PASSENGER ESTIMATES

Scenario XYZ
Arriving + Departing Passenger Count - All Passengers

Base Year

Design Day & Average Annual Day (AAD)

Selected top X % busiest day	Rank	Arriving + Departing Passenger Count	Corresponding Calendar Date
ADPM	47	185,239	7/10/2009
2%	7	211,500	6/22/2009
5%	18	194,133	3/9/2009
10%	36	188,209	7/28/2009
15%	54	184,470	6/10/2009
20%	73	180,361	6/9/2009
25%	91	174,542	3/19/2009
50%	182	155,304	1/2/2009

Arriving + Departing Passenger Count - All Passengers

Annual Total =	56,791,145
Average Annual Day (ADD) Total =	155,592

Forecast Year

Future Design Day & Average Annual Day (AAD)

Selected top X % busiest day	Rank	Arriving + Departing Passenger Count
ADPM	47	326,176
2%	7	372,416
5%	18	341,836
10%	36	331,405
15%	54	324,821
20%	73	317,586
25%	91	307,341
50%	182	273,465

Arriving + Departing Passenger Count - All Passengers

Annual Total =	100,000,000
Future Average Annual Day (ADD) Passengers =	273,973

ADPM: Average Day in Peak Month

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

A. Introduction | B.User Parameters | C.Base Year Data | **D. Design Day** | E. Design Day Profile - NS | F. Derivative Profile - NS | G. Design Day Profile - PS | H.Derivative Prof

The second output worksheet – *E. Design Day Profile – NS* – provides a distribution of design day passengers by hour for the base year and the future year in which no peak spreading is assumed (see Exhibit L.20). Therefore, the percentage distribution of passengers is the same for the base year and the future year. The total passengers in the design day profile correspond to the first entry in the D. Design Day worksheet (two percent in this example).

Exhibit L.20

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY PROFILE ESTIMATES
(Assumes no Peak Spreading)

Scenario XYZ
Arriving + Departing Passenger Count - All Passengers

Base Year			Forecast Year		
Design Day Profile			Future Design Day Profile		
Hour	Passengers by Hour	Percent	Hour	Passengers by Hour	Percent
00:00-00:59	821	0.4%	00:00-00:59	1,446	0.4%
01:00-01:59	680	0.3%	01:00-01:59	1,197	0.3%
02:00-02:59	331	0.2%	02:00-02:59	583	0.2%
03:00-03:59	749	0.4%	03:00-03:59	1,319	0.4%
04:00-04:59	1,123	0.5%	04:00-04:59	1,977	0.5%
05:00-05:59	696	0.3%	05:00-05:59	1,225	0.3%
06:00-06:59	3,983	1.9%	06:00-06:59	7,013	1.9%
07:00-07:59	11,504	5.4%	07:00-07:59	20,257	5.4%
08:00-08:59	12,885	6.1%	08:00-08:59	22,688	6.1%
09:00-09:59	13,875	6.6%	09:00-09:59	24,432	6.6%
10:00-10:59	17,590	8.3%	10:00-10:59	30,973	8.3%
11:00-11:59	14,823	7.0%	11:00-11:59	26,100	7.0%
12:00-12:59	13,773	6.5%	12:00-12:59	24,252	6.5%
13:00-13:59	8,942	4.2%	13:00-13:59	15,746	4.2%
14:00-14:59	11,111	5.3%	14:00-14:59	19,565	5.3%
15:00-15:59	11,532	5.5%	15:00-15:59	20,306	5.5%
16:00-16:59	11,700	5.5%	16:00-16:59	20,602	5.5%
17:00-17:59	14,612	6.9%	17:00-17:59	25,730	6.9%
18:00-18:59	13,790	6.5%	18:00-18:59	24,282	6.5%
19:00-19:59	14,862	7.0%	19:00-19:59	26,169	7.0%
20:00-20:59	13,279	6.3%	20:00-20:59	23,382	6.3%
21:00-21:59	7,777	3.7%	21:00-21:59	13,694	3.7%
22:00-22:59	7,828	3.7%	22:00-22:59	13,784	3.7%
23:00-23:59	3,233	1.5%	23:00-23:59	5,693	1.5%
Total:	211,500	100.0%	Total:	372,416	100.0%

Peak Value:	17,590	10:00	Peak Value:	30,973	10:00
Peak Hour:	10:00-10:59	8.32%	Peak Hour:	10:00-10:59	8.32%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

The third output worksheet – *F. Derivative Profile – NS* – represents the design day profile with a lead or lag distribution function applied. The example in Exhibit L.21 includes both arriving and departing passengers, so a lead factor was applied to departing passengers and a lag factor was applied to arriving passengers. Although the total number of passengers is the same as in the E. Design Day Profile example, the distribution has changed because of the application of the lead and lag factors. This feature is useful for analyzing the impact of passengers on terminal facilities away from the gate. One example would be terminal curbs: enplaning passengers arrive at the curb significantly before their flight departs and deplaning passengers arrive at the curb sometime after their flight arrives.

Exhibit L.21

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY DERIVATIVE PROFILE ESTIMATES
(Assumes no Peak Spreading)

Scenario XYZ
Arriving + Departing Passenger Count - All Passengers

Base Year			Forecast Year		
Design Day Derivative Profile			Future Design Day Derivative Profile		
Hour	Passengers by Hour	Percent	Hour	Passengers by Hour	Percent
00:00-00:59	2,692	1.3%	00:00-00:59	4,740	1.3%
01:00-01:59	487	0.2%	01:00-01:59	858	0.2%
02:00-02:59	380	0.2%	02:00-02:59	668	0.2%
03:00-03:59	456	0.2%	03:00-03:59	803	0.2%
04:00-04:59	1,273	0.6%	04:00-04:59	2,242	0.6%
05:00-05:59	3,442	1.6%	05:00-05:59	6,060	1.6%
06:00-06:59	5,072	2.4%	06:00-06:59	8,930	2.4%
07:00-07:59	11,352	5.4%	07:00-07:59	19,990	5.4%
08:00-08:59	13,000	6.1%	08:00-08:59	22,890	6.1%
09:00-09:59	15,998	7.6%	09:00-09:59	28,170	7.6%
10:00-10:59	18,878	8.9%	10:00-10:59	33,242	8.9%
11:00-11:59	14,666	6.9%	11:00-11:59	25,825	6.9%
12:00-12:59	10,197	4.8%	12:00-12:59	17,955	4.8%
13:00-13:59	9,617	4.5%	13:00-13:59	16,933	4.5%
14:00-14:59	11,360	5.4%	14:00-14:59	20,003	5.4%
15:00-15:59	11,174	5.3%	15:00-15:59	19,675	5.3%
16:00-16:59	10,897	5.2%	16:00-16:59	19,189	5.2%
17:00-17:59	16,891	8.0%	17:00-17:59	29,743	8.0%
18:00-18:59	15,141	7.2%	18:00-18:59	26,660	7.2%
19:00-19:59	10,994	5.2%	19:00-19:59	19,359	5.2%
20:00-20:59	11,900	5.6%	20:00-20:59	20,955	5.6%
21:00-21:59	10,362	4.9%	21:00-21:59	18,245	4.9%
22:00-22:59	2,251	1.1%	22:00-22:59	3,964	1.1%
23:00-23:59	3,020	1.4%	23:00-23:59	5,318	1.4%
Total:	211,500	100.0%	Total:	372,416	100.0%

Peak Value:	18,878	10:00	Peak Value:	33,242	10:00
Peak Hour:	10:00-10:59	8.93%	Peak Hour:	10:00-10:59	8.93%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

A. Introduction / B User Parameters / C Base Year Data / D. Design Day / E. Design Day Profile - N

The fourth output worksheet – *G. Design Day Profile – PS* – is similar to the E. Design Day Profile – NS worksheet but also includes a factor for peak spreading. The peak represents the average reduction in the magnitude of the “peaks and valleys” of the daily distribution of passengers as airports become busier. Note that the base year passengers are the same as in the E. Design Day Profile worksheet, but the future year peaks are reduced (see Exhibit L.22).

Exhibit L.22

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY PROFILE ESTIMATES
(Assumes Peak Spreading)

Scenario XYZ
Arriving + Departing Passenger Count - All Passengers

Base Year			Forecast Year (w/ Peak Spreading)		
Design Day Profile			Future Design Day Profile		
Hour	Passengers by Hour	Percent	Hour	Passengers by Hour	Percent
00:00-00:59	821	0.4%	00:00-00:59	4,195	1.1%
01:00-01:59	680	0.3%	01:00-01:59	3,995	1.1%
02:00-02:59	331	0.2%	02:00-02:59	3,500	0.9%
03:00-03:59	749	0.4%	03:00-03:59	4,093	1.1%
04:00-04:59	1,123	0.5%	04:00-04:59	4,622	1.2%
05:00-05:59	696	0.3%	05:00-05:59	4,018	1.1%
06:00-06:59	3,983	1.9%	06:00-06:59	8,674	2.3%
07:00-07:59	11,504	5.4%	07:00-07:59	19,331	5.2%
08:00-08:59	12,885	6.1%	08:00-08:59	21,287	5.7%
09:00-09:59	13,875	6.6%	09:00-09:59	22,690	6.1%
10:00-10:59	17,590	8.3%	10:00-10:59	27,954	7.5%
11:00-11:59	14,823	7.0%	11:00-11:59	24,033	6.5%
12:00-12:59	13,773	6.5%	12:00-12:59	22,545	6.1%
13:00-13:59	8,942	4.2%	13:00-13:59	15,701	4.2%
14:00-14:59	11,111	5.3%	14:00-14:59	18,774	5.0%
15:00-15:59	11,532	5.5%	15:00-15:59	19,371	5.2%
16:00-16:59	11,700	5.5%	16:00-16:59	19,608	5.3%
17:00-17:59	14,612	6.9%	17:00-17:59	23,735	6.4%
18:00-18:59	13,790	6.5%	18:00-18:59	22,569	6.1%
19:00-19:59	14,862	7.0%	19:00-19:59	24,088	6.5%
20:00-20:59	13,279	6.3%	20:00-20:59	21,846	5.9%
21:00-21:59	7,777	3.7%	21:00-21:59	14,050	3.8%
22:00-22:59	7,828	3.7%	22:00-22:59	14,123	3.8%
23:00-23:59	3,233	1.5%	23:00-23:59	7,613	2.0%
Total:	211,500	100.0%	Total:	372,416	100.0%
Peak Value:	17,590	10:00	Peak Value:	27,954	10:00
Peak Hour:	10:00-10:59	8.32%	Peak Hour:	10:00-10:59	7.51%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

A. Introduction / B.User Parameters / C.Base Year Data / D. Design Day / E. Design Day Profile - N

The fifth output worksheet – *H. Derivative Profile – PS* – is similar to the *F. Derivative Profile – NS* worksheet but also includes a factor for peak spreading. The peak represents the average reduction in the magnitude of the "peaks and valleys" of the daily distribution of passengers as airports become busier. Note that the base year passengers are the same as in the *F. Derivative Profile - NS* worksheet, but the future year peaks are reduced (see Exhibit L.23).

Exhibit L.23

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY DERIVATIVE PROFILE ESTIMATES
(Assumes Peak Spreading)

Scenario XYZ
Arriving + Departing Passenger Count - All Passengers

Base Year				Forecast Year (w/ Peak Spreading)		
Design Day Derivative Profile				Future Design Day Derivative Profile		
Hour	Passengers by Hour	%		Hour	Passengers by Hour	After adjust (%)
00:00-00:59	2,692	1.3%		00:00-00:59	6,846	1.8%
01:00-01:59	487	0.2%		01:00-01:59	3,722	1.0%
02:00-02:59	380	0.2%		02:00-02:59	3,570	1.0%
03:00-03:59	456	0.2%		03:00-03:59	3,678	1.0%
04:00-04:59	1,273	0.6%		04:00-04:59	4,835	1.3%
05:00-05:59	3,442	1.6%		05:00-05:59	7,908	2.1%
06:00-06:59	5,072	2.4%		06:00-06:59	10,217	2.7%
07:00-07:59	11,352	5.4%		07:00-07:59	19,116	5.1%
08:00-08:59	13,000	6.1%		08:00-08:59	21,450	5.8%
09:00-09:59	15,998	7.6%		09:00-09:59	25,698	6.9%
10:00-10:59	18,878	8.9%		10:00-10:59	29,779	8.0%
11:00-11:59	14,666	6.9%		11:00-11:59	23,811	6.4%
12:00-12:59	10,197	4.8%		12:00-12:59	17,479	4.7%
13:00-13:59	9,617	4.5%		13:00-13:59	16,657	4.5%
14:00-14:59	11,360	5.4%		14:00-14:59	19,126	5.1%
15:00-15:59	11,174	5.3%		15:00-15:59	18,863	5.1%
16:00-16:59	10,897	5.2%		16:00-16:59	18,471	5.0%
17:00-17:59	16,891	8.0%		17:00-17:59	26,964	7.2%
18:00-18:59	15,141	7.2%		18:00-18:59	24,483	6.6%
19:00-19:59	10,994	5.2%		19:00-19:59	18,608	5.0%
20:00-20:59	11,900	5.6%		20:00-20:59	19,892	5.3%
21:00-21:59	10,362	4.9%		21:00-21:59	17,712	4.8%
22:00-22:59	2,251	1.1%		22:00-22:59	6,221	1.7%
23:00-23:59	3,020	1.4%		23:00-23:59	7,311	2.0%
Total:	211,500	100.0%		Total:	372,416	100.0%

Peak Value:	18,878	10:00		Peak Value:	29,779	10:00
Peak Hour:	10:00-10:59	8.93%		Peak Hour:	10:00-10:59	8.00%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

B.User Parameters / C.Base Year Data / D. Design Day / E. Design Day Profile - NS / F. Derivative Pro

The sixth output worksheet – *I. Peak Period – NS* – provides the rolling peak period corresponding to each of the design day selections for the base year and the forecast year. In the example below, the user selected a 60 minute peak period definition. In the example in Exhibit L.24, peak 60 minute passengers during the two percent busiest day in the forecast year are estimated at 33,565 passengers. Note that the 60 minute peak is higher than the clock hour peak of 27,954 indicated in the "G" worksheet (Exhibit L.22). This worksheet assumes no peak spreading.

Exhibit L.24

AIRPORT COOPERATIVE RESEARCH PROGRAM

Peak Period and Operational Profile Toolbox

Passenger Module

PEAK PERIOD ESTIMATES

(Assumes no Peak Spreading)

Scenario XYZ

Arriving + Departing Passenger Count - All Passengers

Base Year			Forecast Year		
Peak Period in Design Day			**Future Peak Period in Design Day**		
Selected top X % busiest day	Rank	Rolling 60 min	Selected top X % busiest day	Rank	Rolling 60 min
ADPM	47	16695	ADPM	47	29397
2%	7	19062	2%	7	33565
5%	18	17496	5%	18	30809
10%	36	16962	10%	36	29869
15%	54	16625	15%	54	29275
20%	73	16255	20%	73	28623
25%	91	15731	25%	91	27700
50%	182	13997	50%	182	24646

Peak Period definition	Clock Time*	Peak Period definition	Clock Time*
Rolling 60 min	11:21	Rolling 60 min	11:21

*** Note: Listed clock time is when peak period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

G. Design Day Profile - PS | H.Derivative Profile - PS | **I. Peak Period - NS** | J. Peak Period - PS | K. Charts - Design Day Pro

The seventh output worksheet – *J. Peak Period – Spread* is similar to *the I. Peak Period – NS* worksheet except that it includes an adjustment for peak spreading in the forecast year. Therefore, in Exhibit L.25, peak 60 minute passengers during the two percent busiest day in the forecast year are estimated at 31,652 passengers.

Exhibit L.25

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

PEAK PERIOD ESTIMATES
(Assumes Peak Spreading)

Scenario XYZ
Arriving + Departing Passenger Count - All Passengers

Base Year			**Forecast Year (w/ Peak Spreading)**		
Peak Period in Design Day			**Future Peak Period in Design Day**		
Selected top X % busiest day	Rank	Rolling 60 min	Selected top X % busiest day	Rank	Rolling 60 min
ADPM	47	16695	ADPM	47	27722
2%	7	19062	2%	7	31652
5%	18	17496	5%	18	29053
10%	36	16962	10%	36	28167
15%	54	16625	15%	54	27607
20%	73	16255	20%	73	26992
25%	91	15731	25%	91	26122
50%	182	13997	50%	182	23242

Peak Period definition	Clock Time*	Peak Period definition	Clock Time*
Rolling 60 min	11:21	Rolling 60 min	11:21

***Note: Listed clock time is when peak period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

G. Design Day Profile - PS | H.Derivative Profile - PS | I. Peak Period - NS | **J. Peak Period - PS** | K. Charts - Design Day Pro

The final two worksheets - *K. Charts – Design day Profile*, and *L. Charts – Derivative Prof* - provide graphic representations of the results. Worksheet K (Exhibit L.26) shows three of the design day passenger profiles, including the base year design day profile, the forecast year design day profile without peak spreading, and the forecast year design day profile with peak spreading. Worksheet L (Exhibit L.27) provides a graphic representation of the derivative profile for each of the three cases.

Exhibit L.26

AIRPORT COOPERATIVE RESEARCH PROGRAM

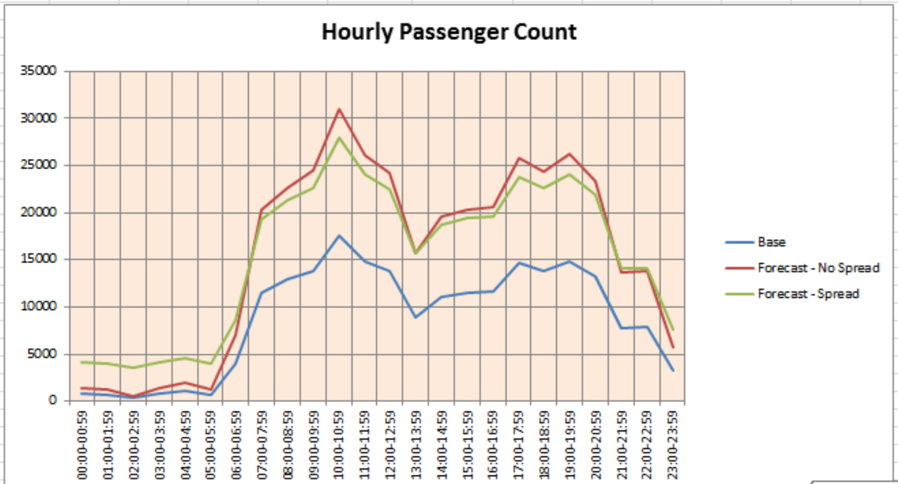
Peak Period and Operational Profile Toolbox

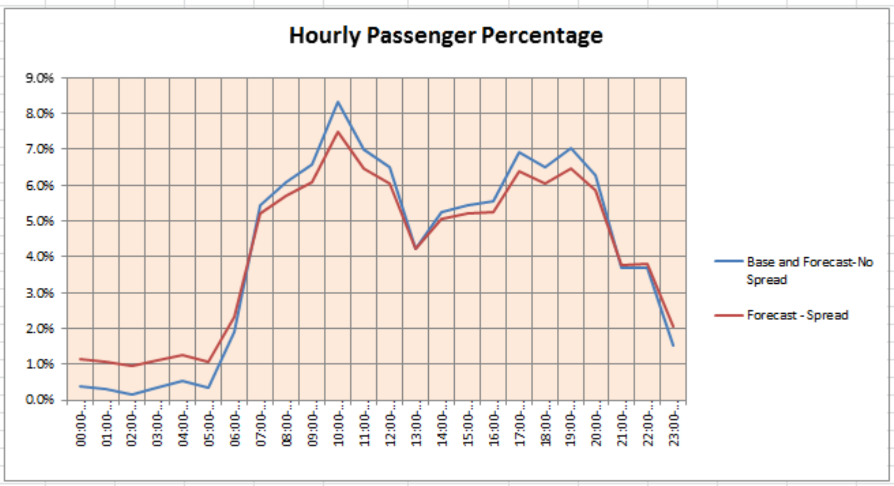
Passenger Module

DESIGN DAY PROFILE ESTIMATES

Scenario XYZ

Arriving + Departing Passenger Count - All Passengers

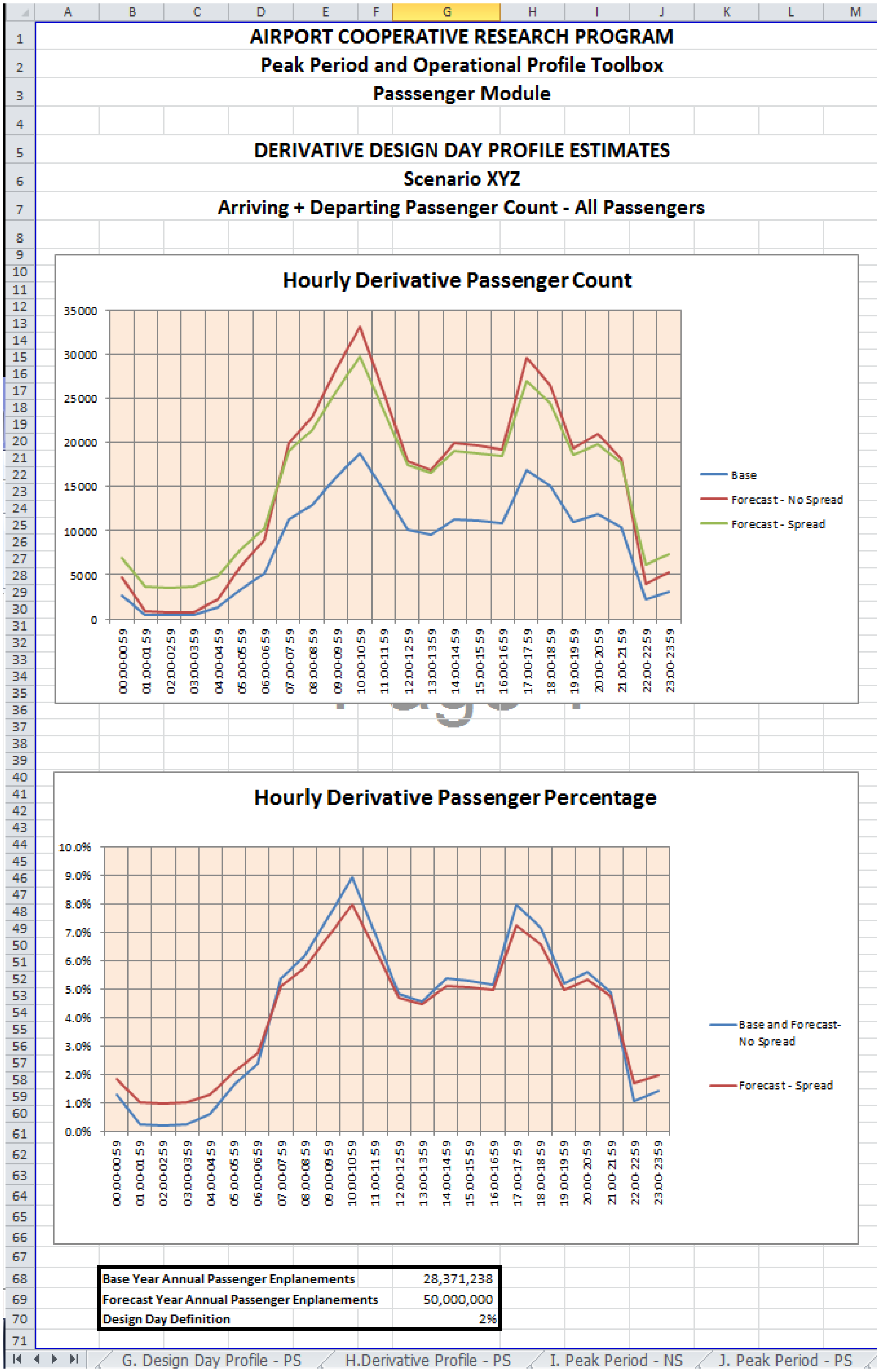




Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

G. Design Day Profile - PS | H.Derivative Profile - PS | I. Peak Period - NS | J. Peak Period - PS | K. Cha

Exhibit L.27



AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passsenger Module
DERIVATIVE DESIGN DAY PROFILE ESTIMATES
Scenario XYZ
Arriving + Departing Passenger Count - All Passengers
Hourly Derivative Passenger Count
Base
Forecast - No Spread
Forecast - Spread
Hourly Derivative Passenger Percentage
Base and Forecast- No Spread
Forecast - Spread
Base Year Annual Passenger Enplanements 28,371,238
Forecast Year Annual Passenger Enplanements 50,000,000
Design Day Definition 2%
G. Design Day Profile - PS
H.Derivative Profile - PS
I. Peak Period - NS
J. Peak Period - PS

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix M

Hourly Distributions of Aircraft Operations

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix M: Hourly Distributions of Aircraft Operations

When analyzing design day flight schedules or hourly profiles, planners may need to determine whether their airport's profile is typical of similar airports or differs markedly. If the profile differs significantly from other airports, it suggests one of two things:

1) The airport may be fundamentally unique in terms of the market it serves and the airlines it is served by; or

2) The current air service distribution is unusual and may revert to a more typical distribution in the future.

This appendix is offered as a supplement to the Guidebook to help planners determine whether the distribution of activity at their airport is unusual, warranting additional analysis, or is typical of airports in their category and can therefore be expected to continue in the future.

The exhibits in Appendix M provide a sample of the hourly distribution of arriving and departing aircraft operations based on July 2009 data from 102 airports in the FAA's distributed OPSNET files in their ETMSC database.

Exhibits M.1 through M.8 provide the hourly distribution of commercial (air carrier and air taxi) aircraft arrivals and departures for airports in the each of the four continental U.S. time zones. Exhibits M.9 through M.16 show the same data for general aviation aircraft operations, while Exhibits M.17 through M.24 show the data for total aircraft operations. Some general trends can be observed:

- Small airports tend to demonstrate much higher hourly variability than large airports.

- O&D airports have busier departure peaks in the early morning and arrival peaks in the evening. The reverse is true of connecting airports.

- Aircraft departures a concentrated slightly more towards the beginning of the day while arrivals are concentrated slightly more towards the end of the day. This is most pronounced at small and non-hub airports.

- General aviation peaks, even at large airports, tend to be more concentrated than commercial aircraft peaks.

In addition to providing a basis for comparison with airports in similar roles, these exhibits can provide a crosscheck for future profiles, especially when significant changes in activity or a change in role is anticipated.

Exhibit M.1

Distribution of Air Carrier and Air Taxi Aircraft Arrivals – Eastern Time Zone

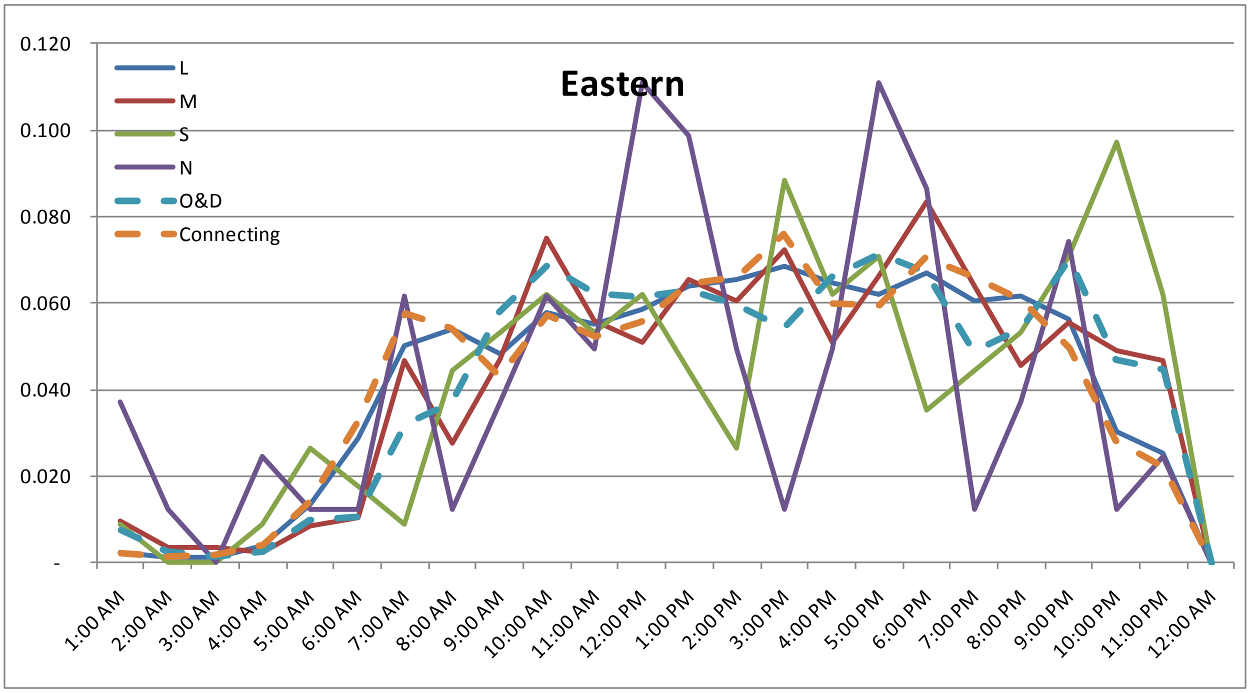


Exhibit M.2

Distribution of Air Carrier and Air Taxi Aircraft Departures – Eastern Time Zone

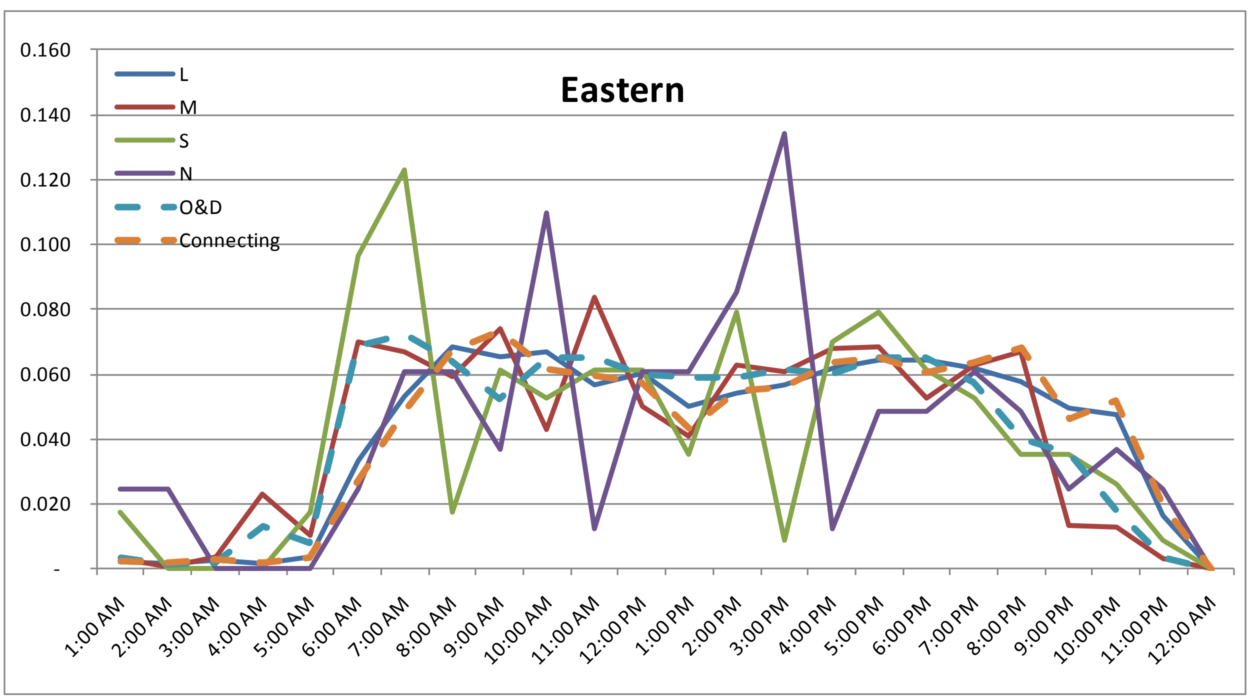


Exhibit M.3

Distribution of Air Carrier and Air Taxi Aircraft Arrivals – Central Time Zone

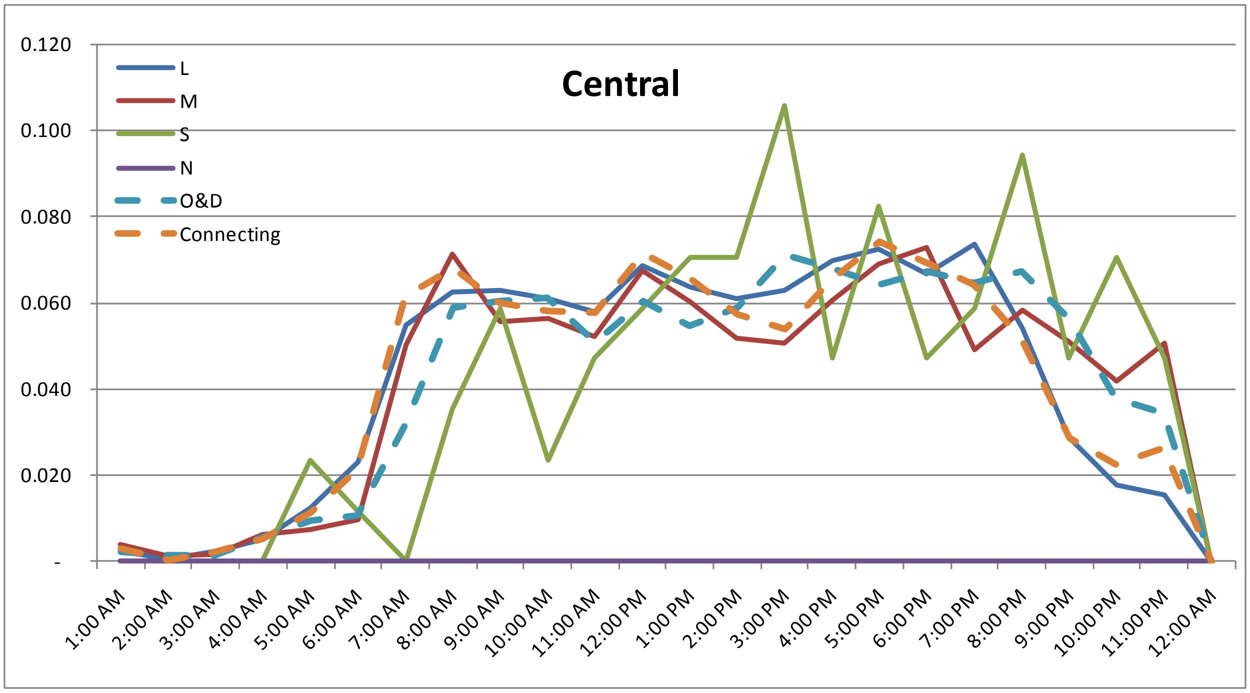


Exhibit M.4

Distribution of Air Carrier and Air Taxi Aircraft Departures – Central Time Zone

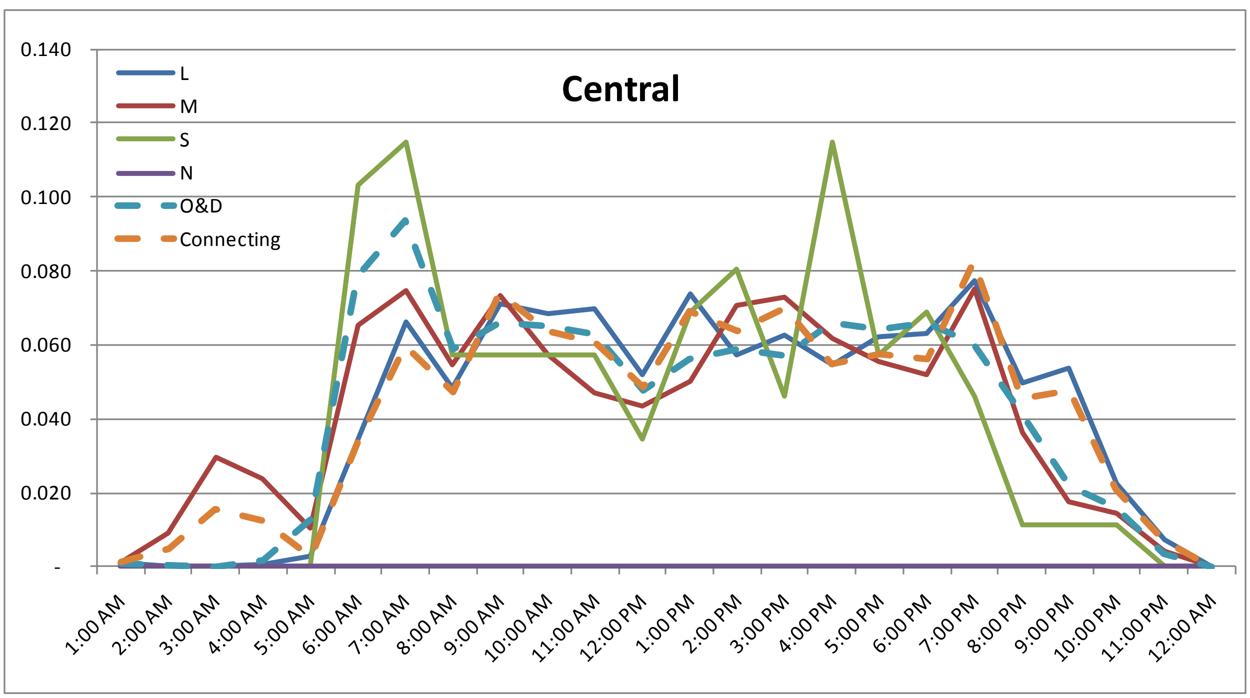


Exhibit M.5

Distribution of Air Carrier and Air Taxi Aircraft Arrivals – Mountain Time Zone

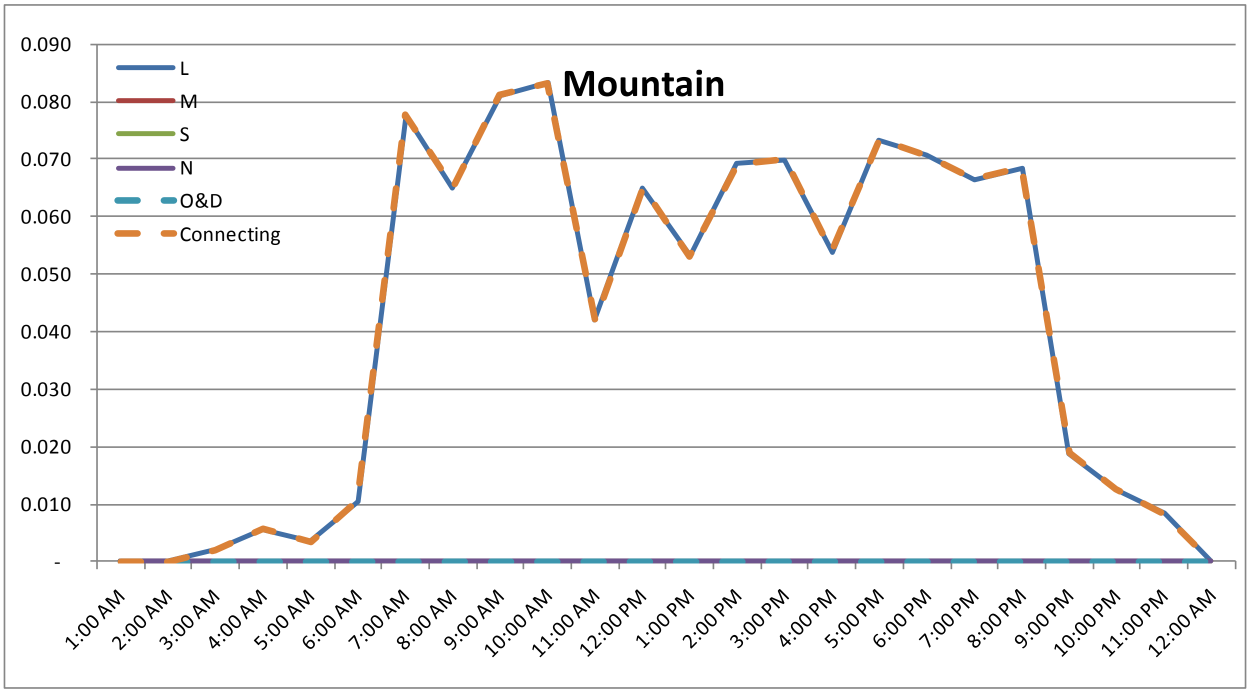


Exhibit M.6

Distribution of Air Carrier and Air Taxi Aircraft Departures – Mountain Time Zone

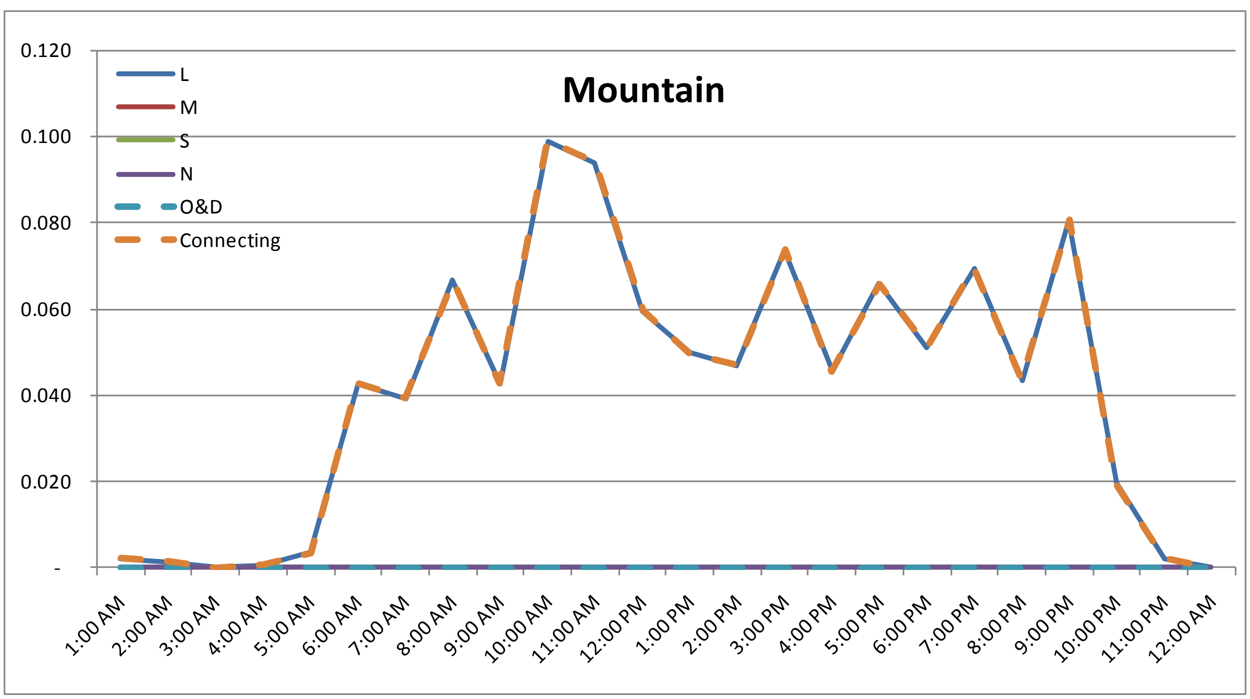


Exhibit M.7

Distribution of Air Carrier and Air Taxi Aircraft Arrivals – Pacific Time Zone

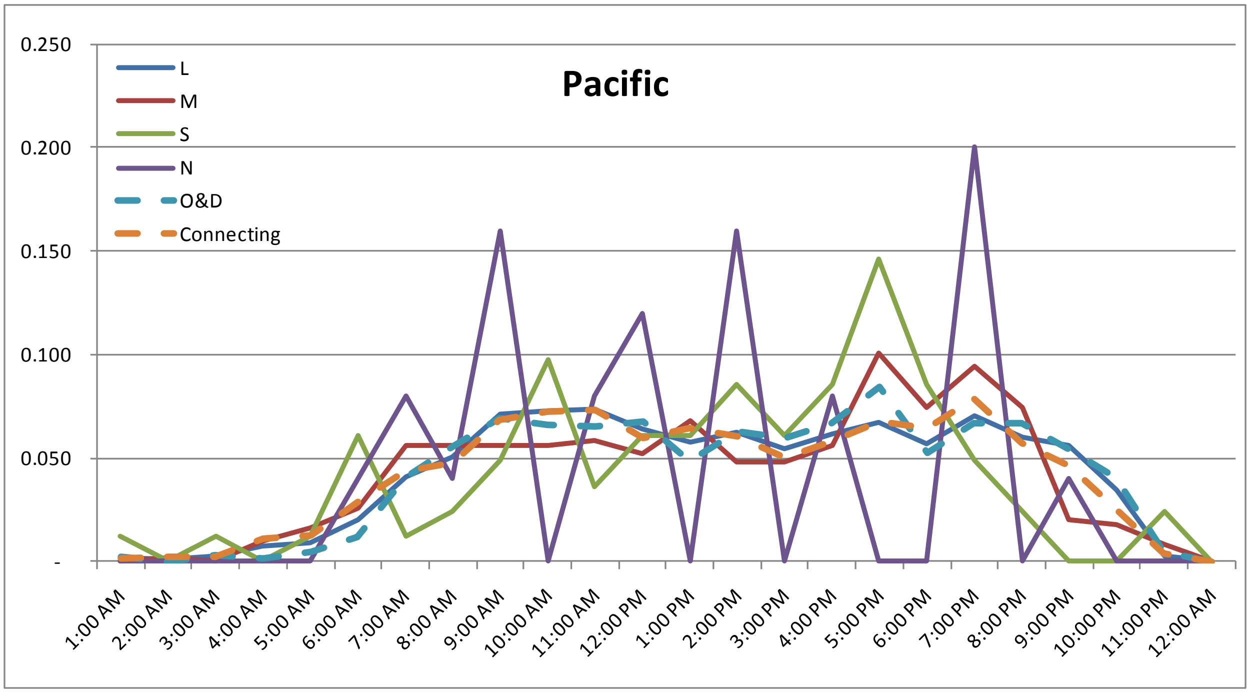


Exhibit M.8

Distribution of Air Carrier and Air Taxi Aircraft Departures – Pacific Time Zone

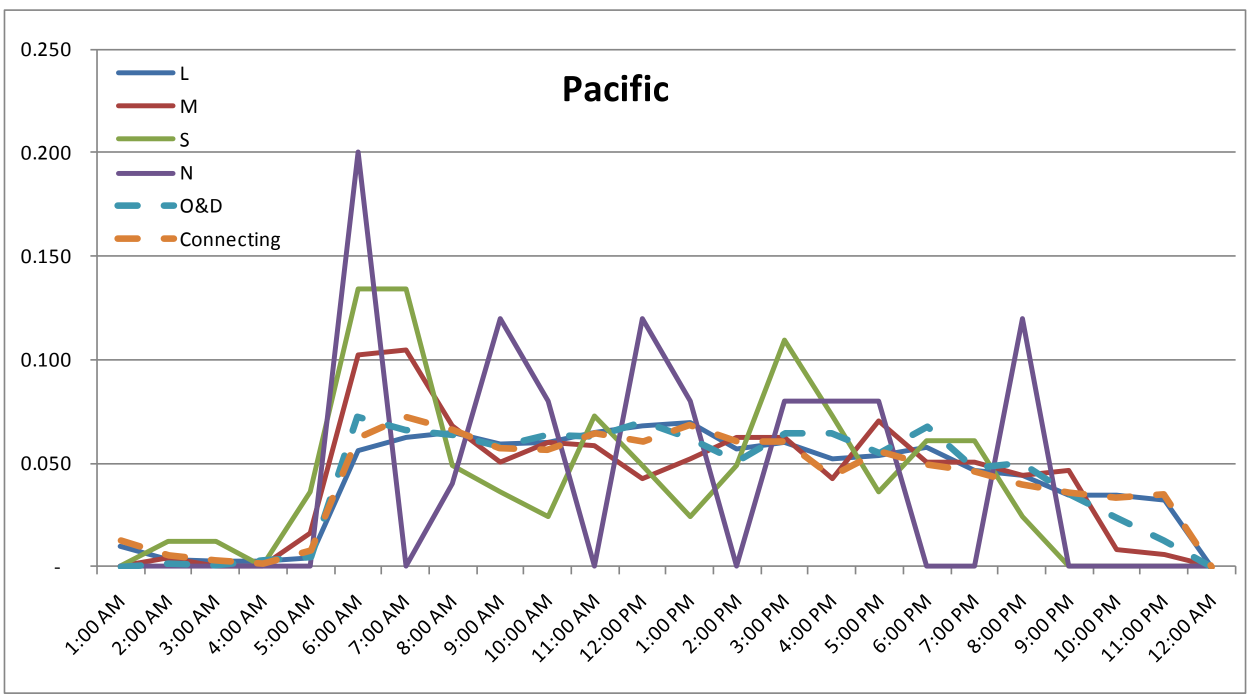


Exhibit M.9

Distribution of General Aviation Aircraft Arrivals – Eastern Time Zone

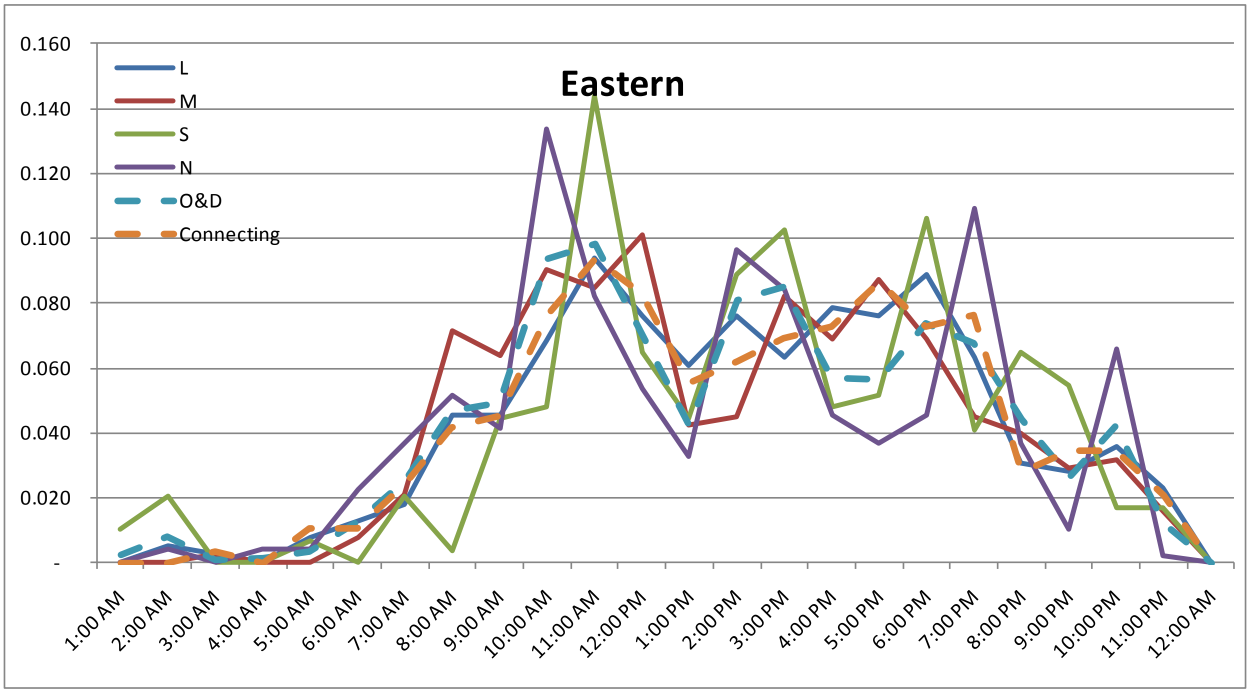


Exhibit M.10

Distribution of General Aviation Aircraft Departures – Eastern Time Zone

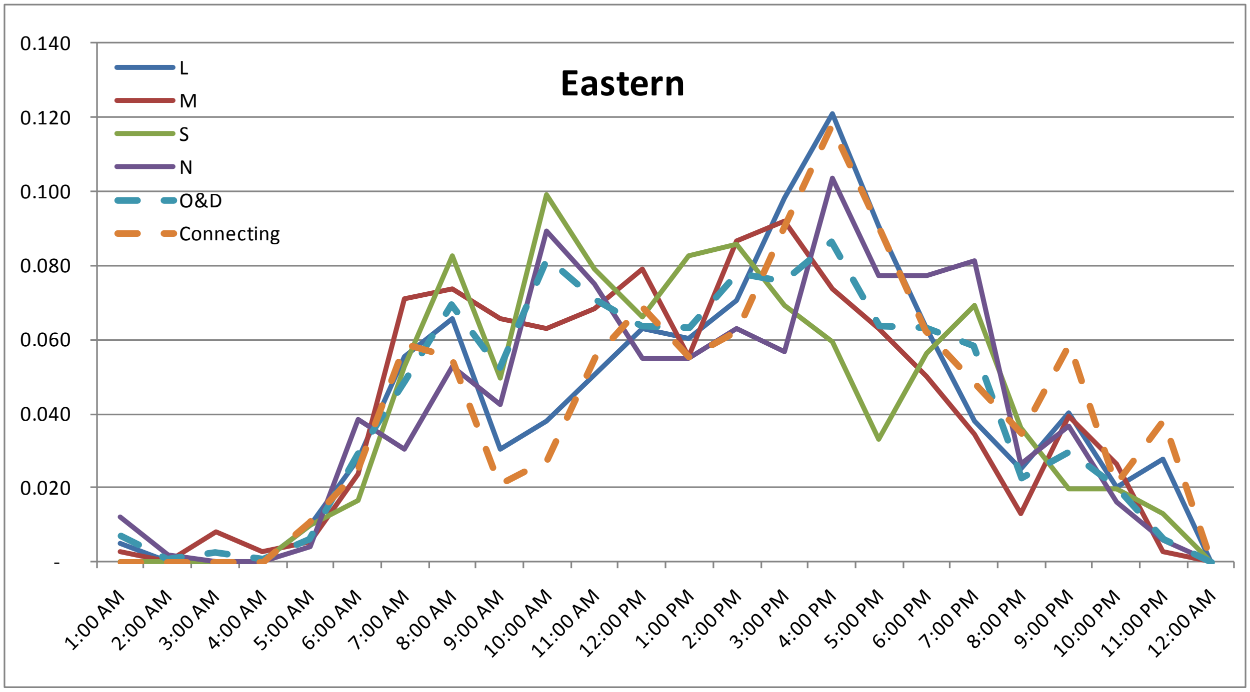


Exhibit M.11

Distribution of General Aviation Aircraft Arrivals – Central Time Zone

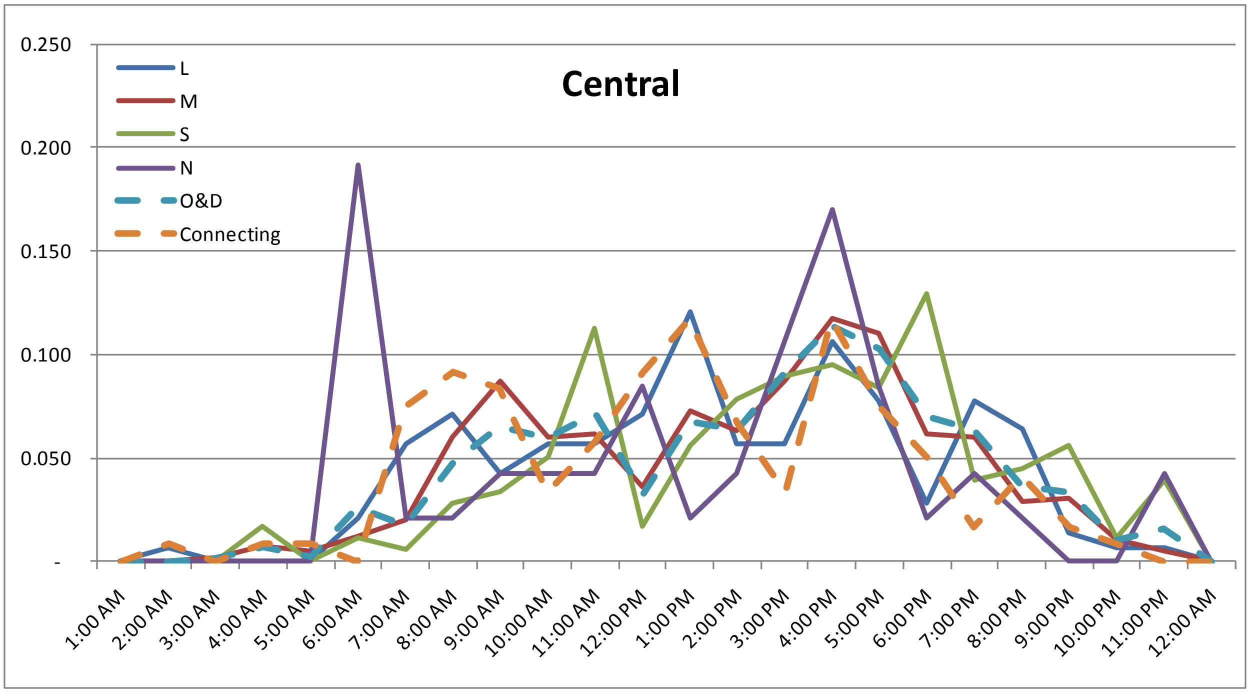


Exhibit M.12

Distribution of General Aviation Aircraft Departures – Central Time Zone

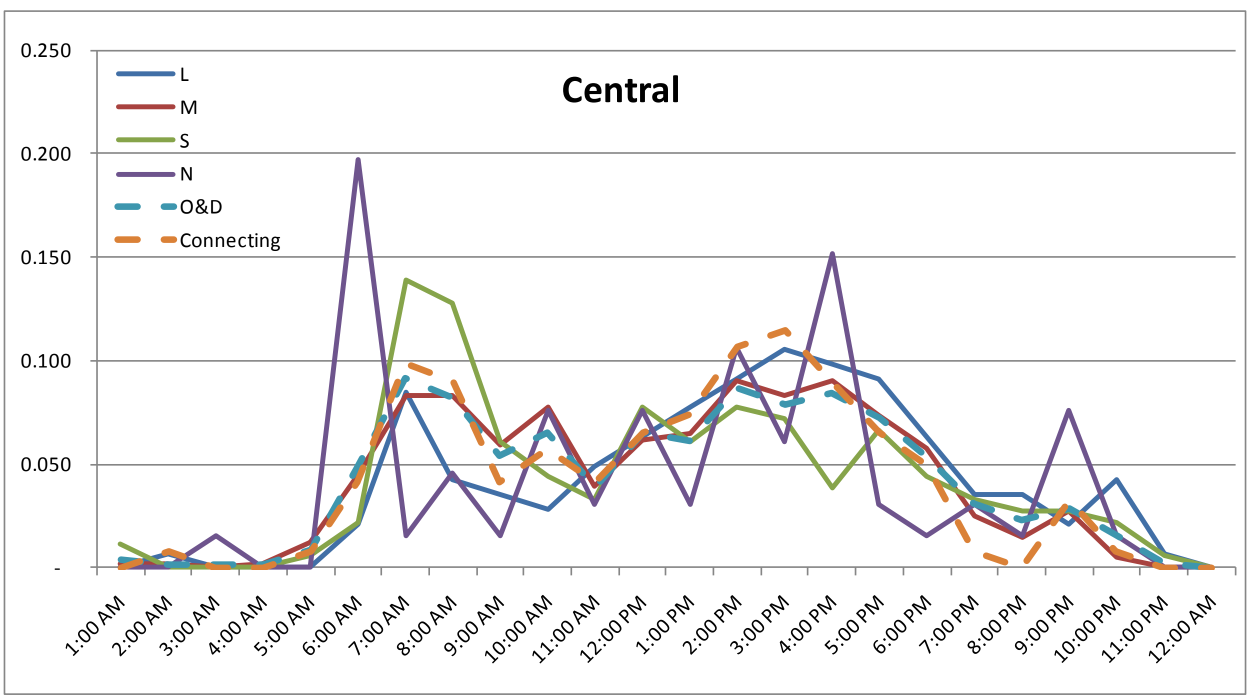


Exhibit M.13

Distribution of General Aviation Aircraft Arrivals – Mountain Time Zone

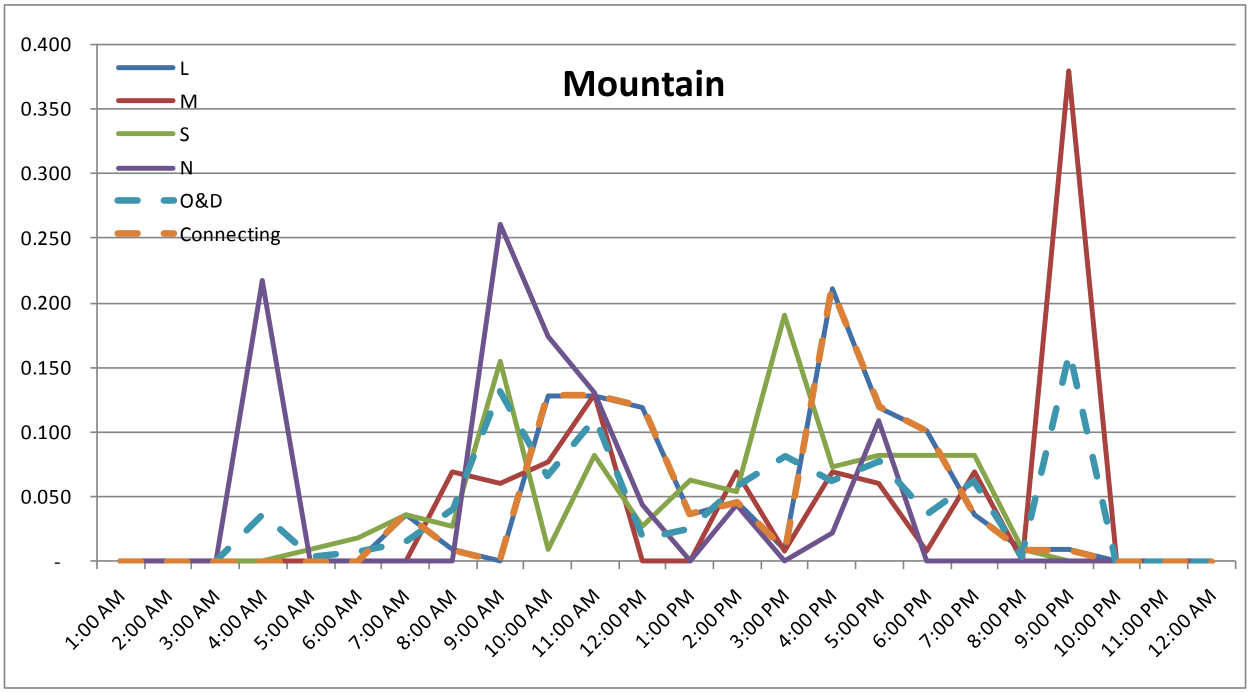


Exhibit M.14

Distribution of General Aviation Aircraft Departures – Mountain Time Zone

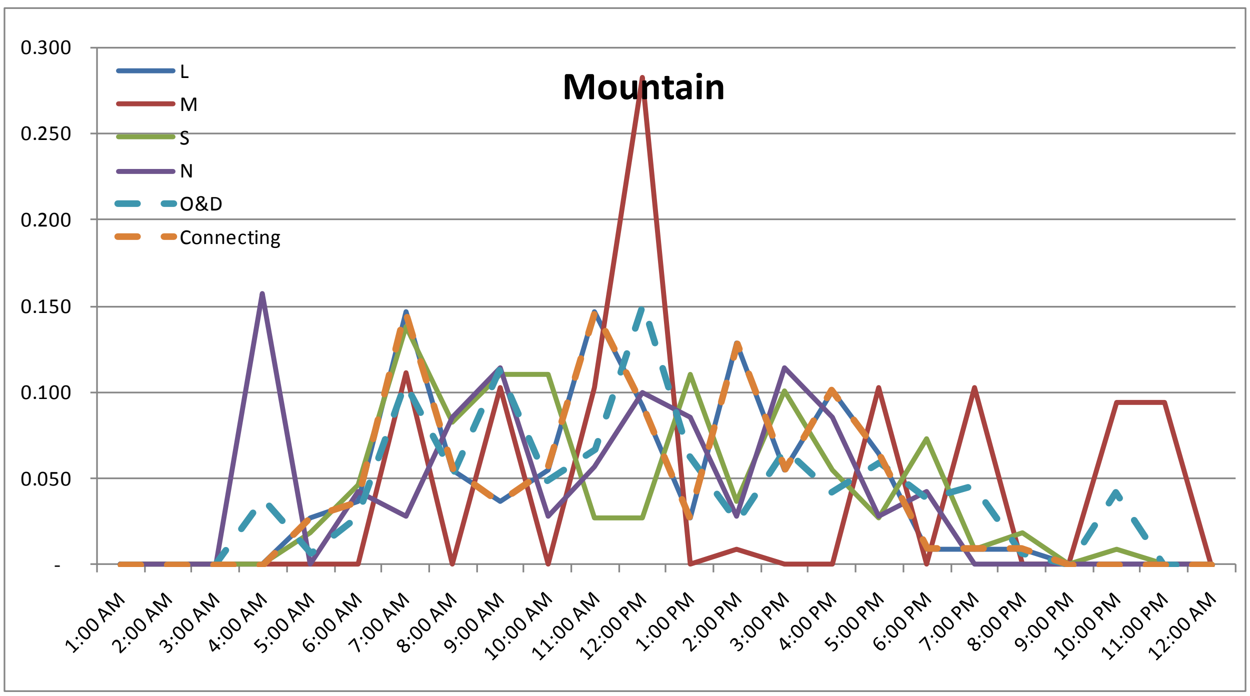


Exhibit M.15

Distribution of General Aviation Aircraft Arrivals – Pacific Time Zone

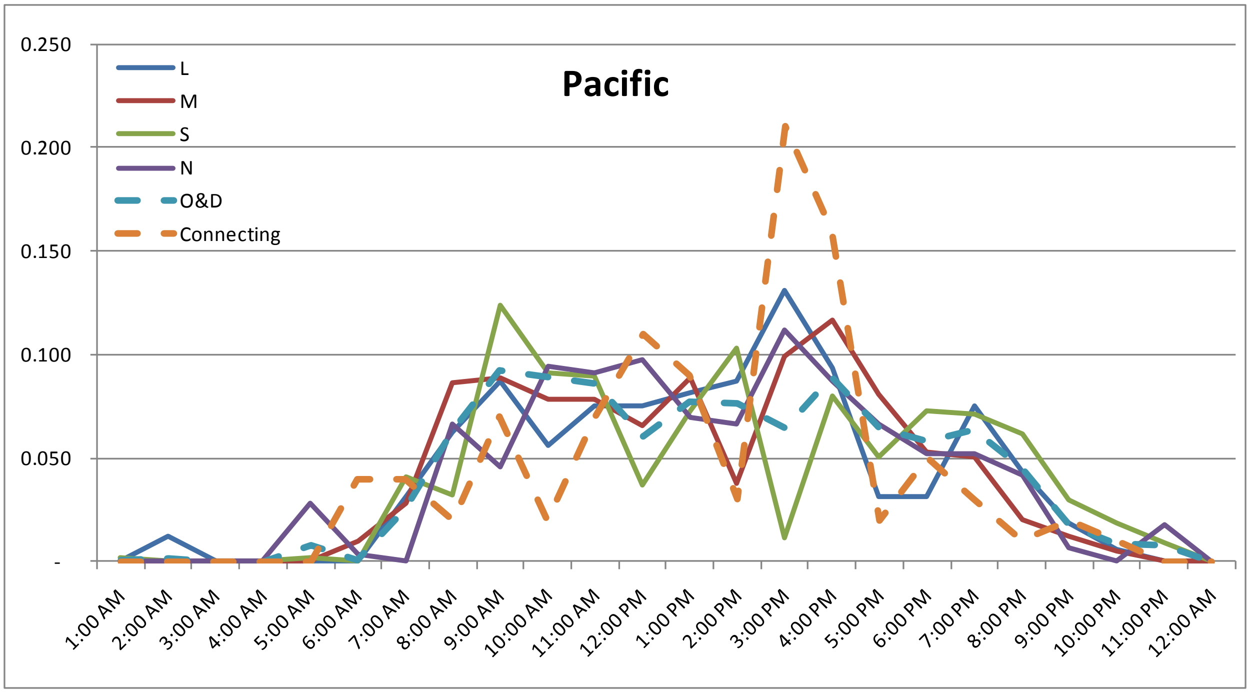


Exhibit M.16

Distribution of General Aviation Aircraft Departures – Pacific Time Zone

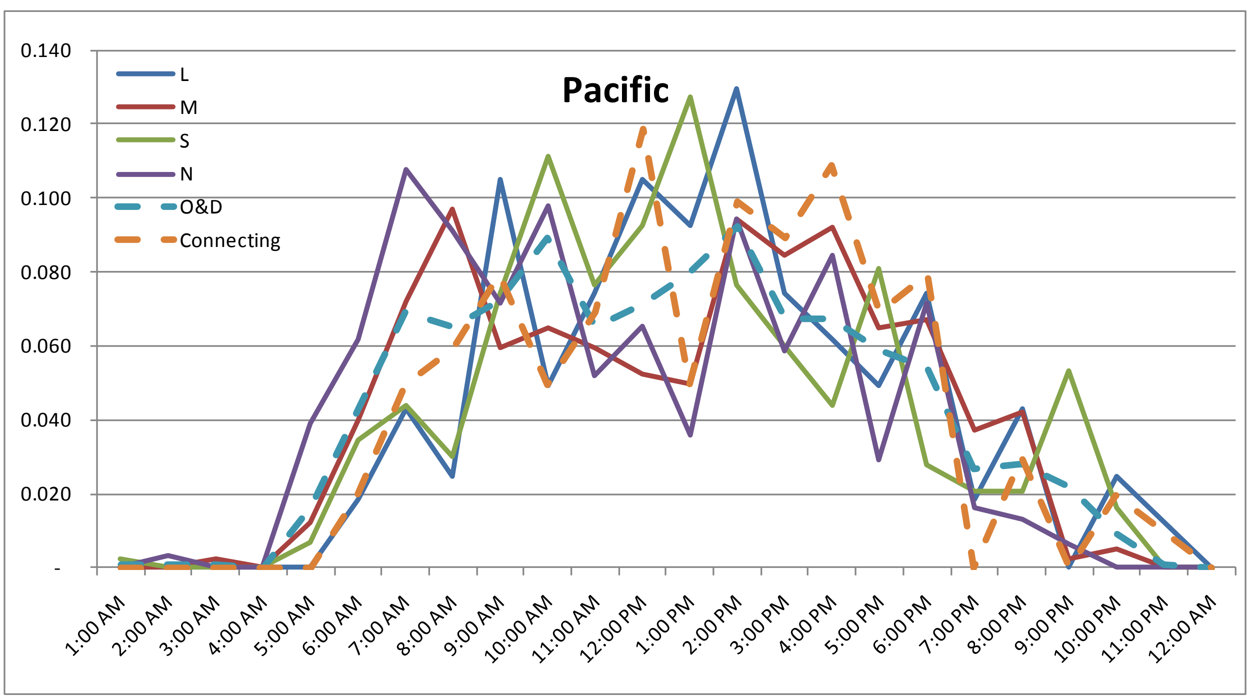


Exhibit M.17

Distribution of Total Aircraft Arrivals – Eastern Time Zone

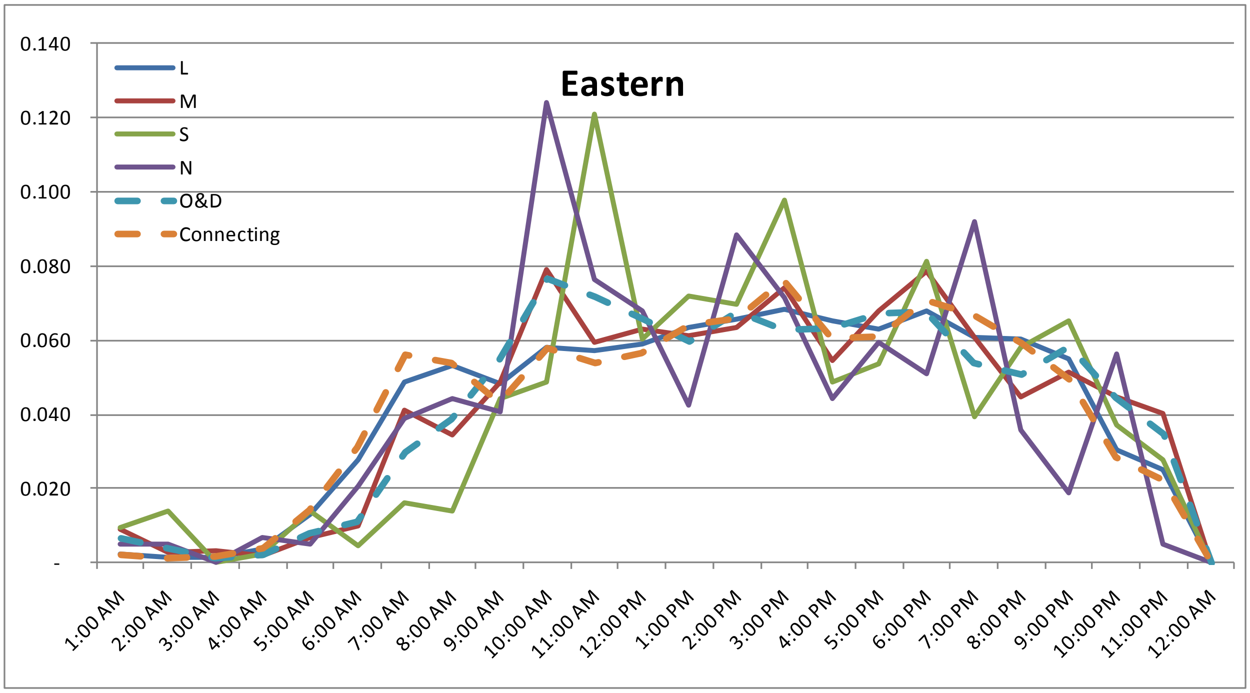


Exhibit M.18

Distribution of Total Aircraft Departures – Eastern Time Zone

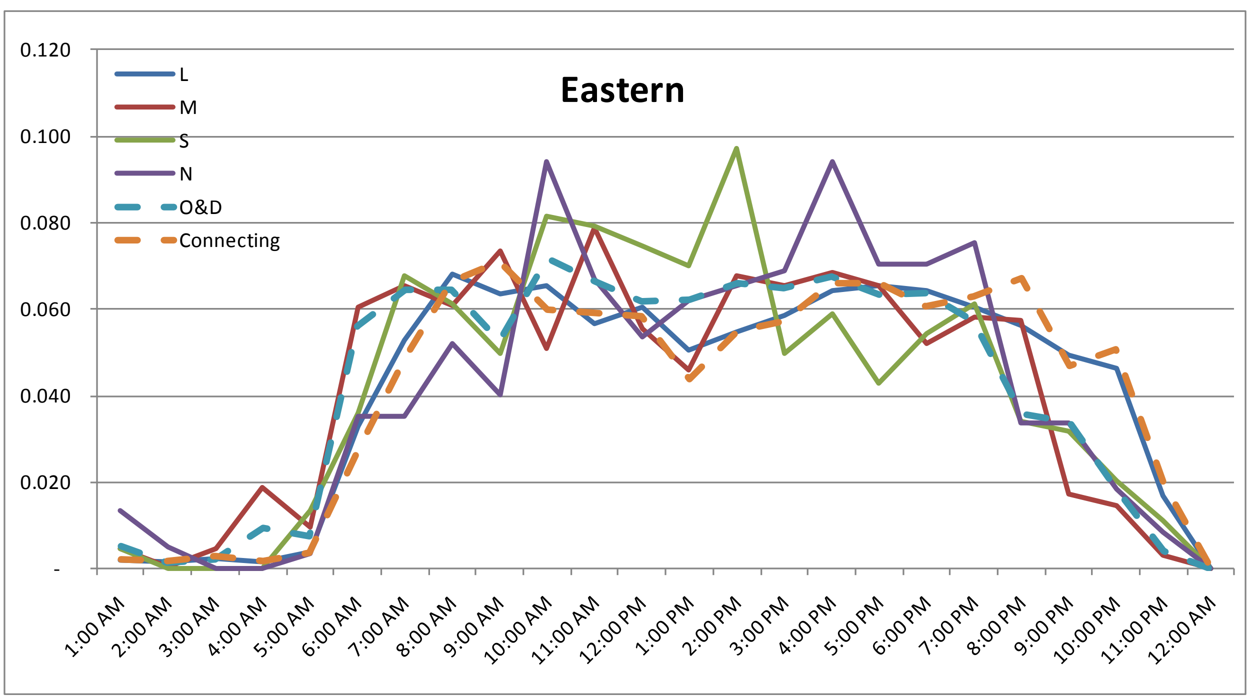


Exhibit M.19

Distribution of Total Aircraft Arrivals – Central Time Zone

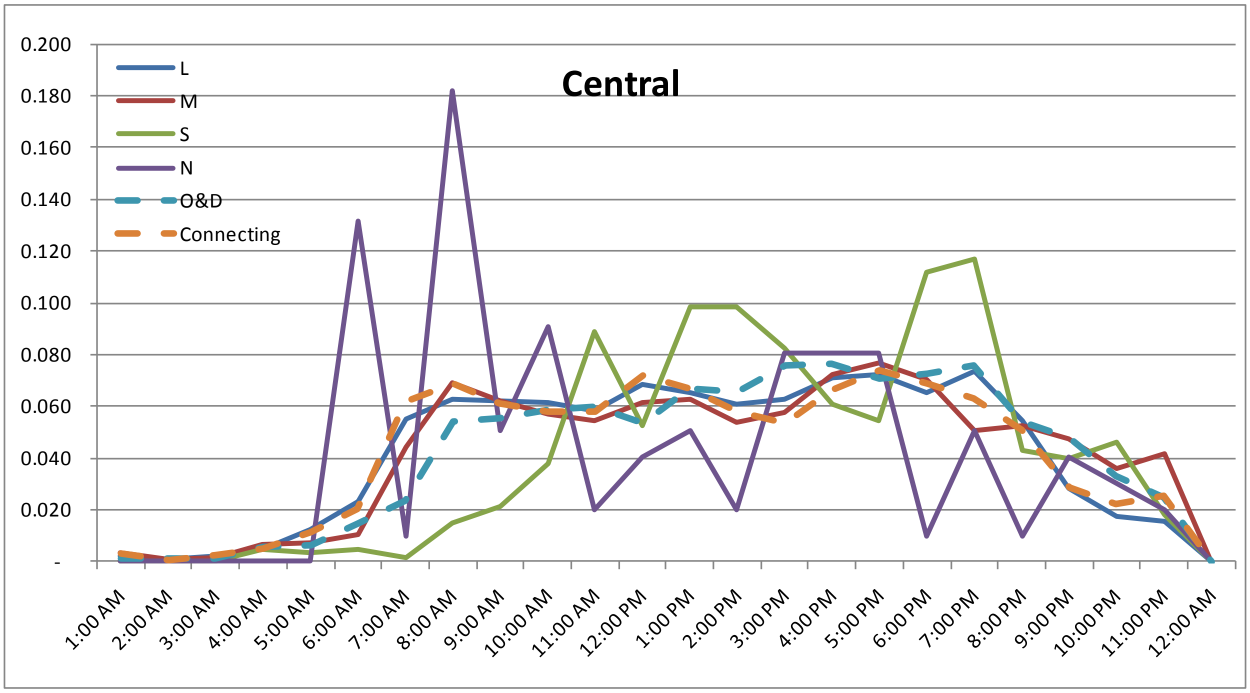


Exhibit M.20

Distribution of Total Aircraft Departures – Central Time Zone

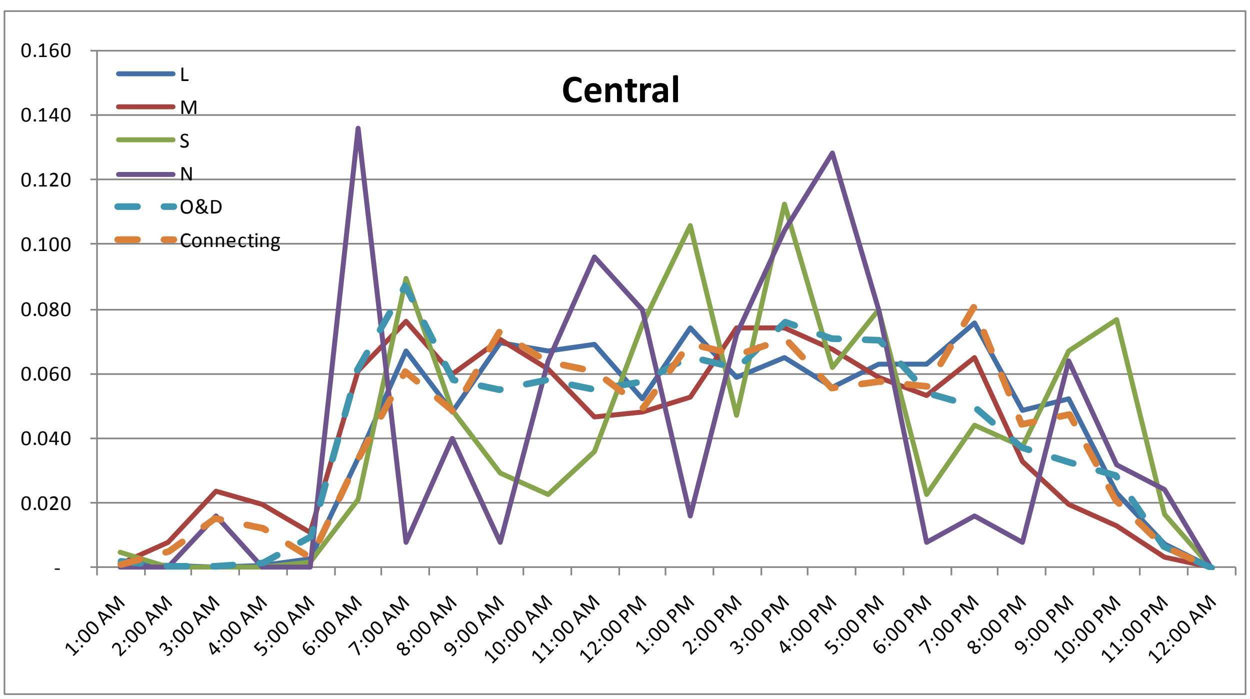


Exhibit M.21

Distribution of Total Aircraft Arrivals – Mountain Time Zone

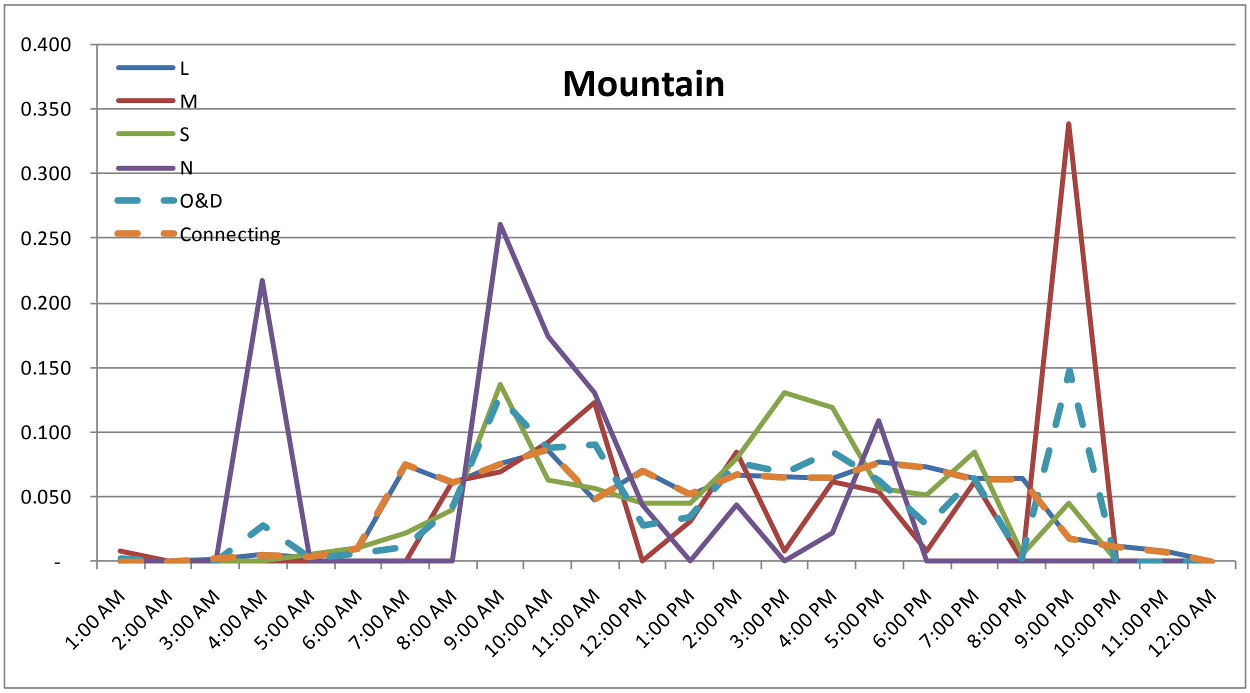


Exhibit M.22

Distribution of Total Aircraft Departures – Mountain Time Zone

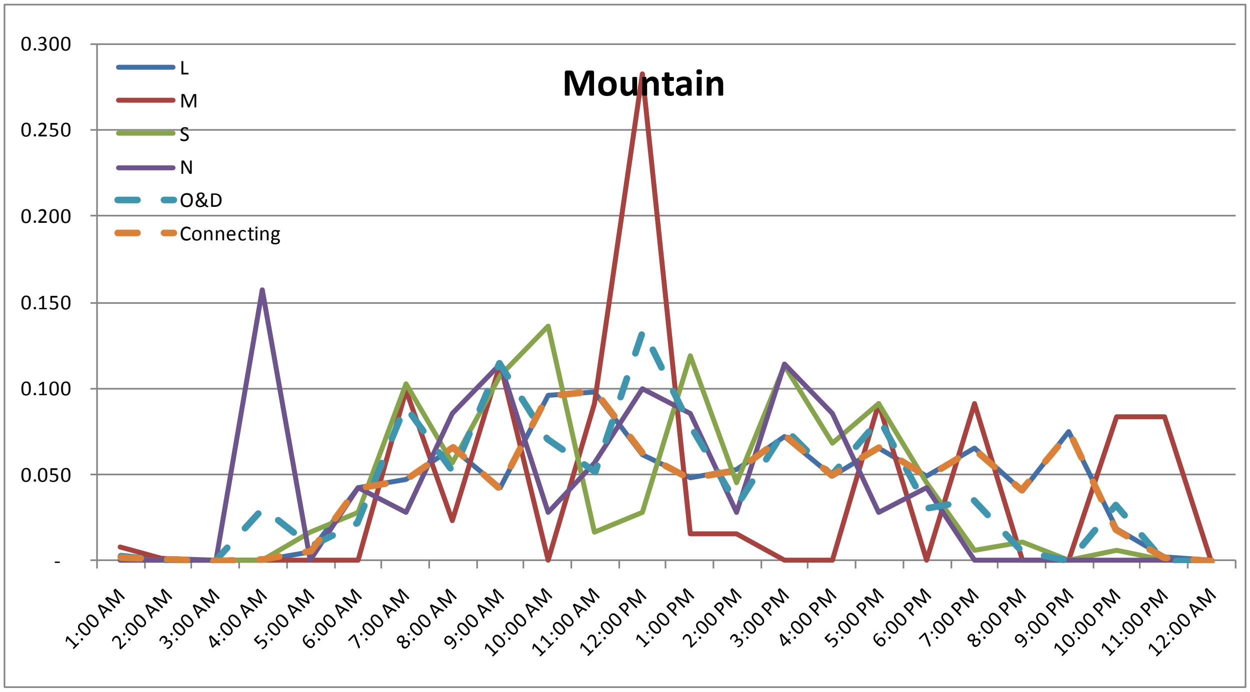


Exhibit M.23

Distribution of Total Aircraft Arrivals – Pacific Time Zone

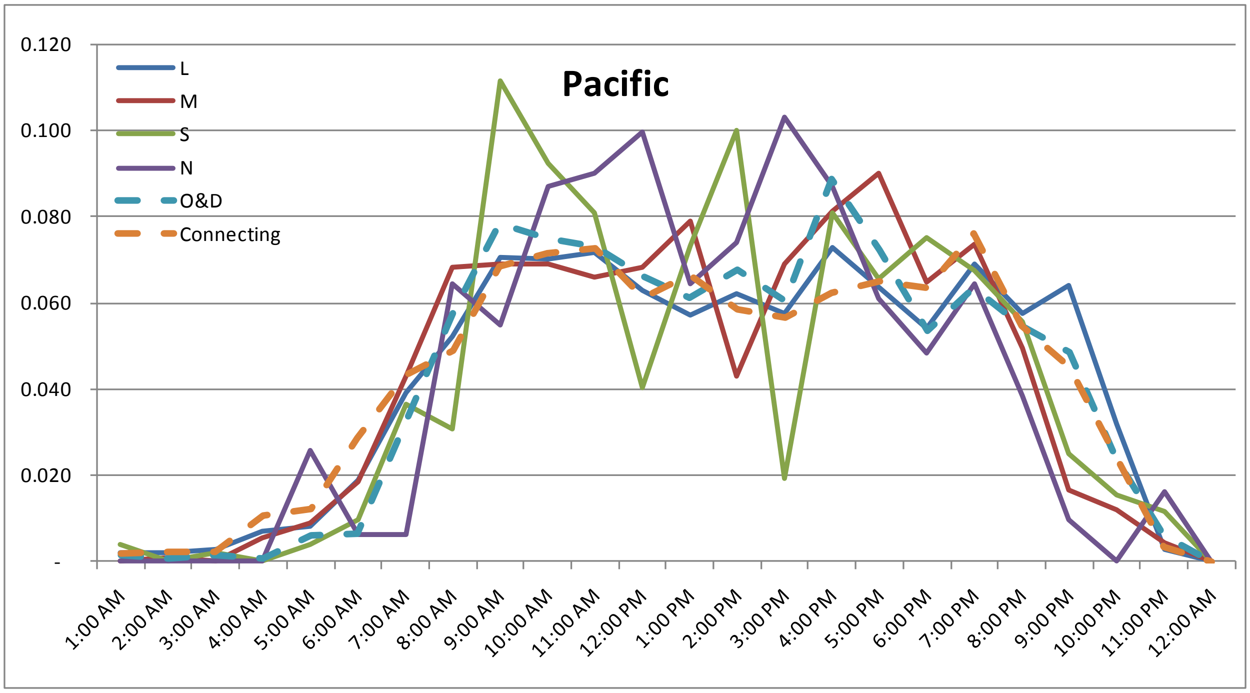
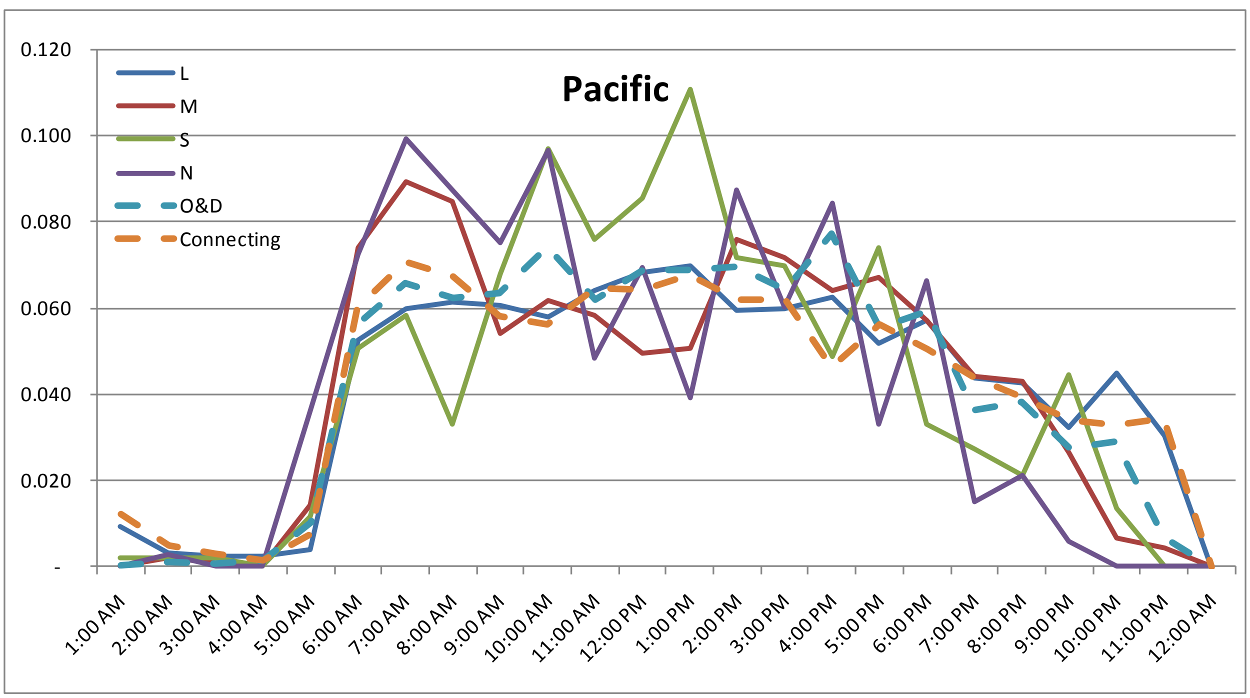


Exhibit M.24

Distribution of Total Aircraft Departures – Pacific Time Zone



THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix N

Hourly Distributions of International Aircraft Operations

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix N: Hourly Distribution of International Operations

As noted in the Guidebook, international passenger flights warrant special attention. Because of time zone differences, overseas international operations fly within relatively narrow time windows, and this leads to a much different pattern of distribution than for domestic operations. This appendix provides international distributions from OAG schedules for a sample of U.S. airports spanning all four continental time zones. The airports include the principle international gateway in each time zone (New York JFK (JFK), Chicago O'Hare (ORD), Denver (DEN), and Los Angeles (LAX)). Since distributions can vary significantly across world regions, separate breakouts are provided for Canada, Mexico/Central America, the Caribbean, South America, Europe, Africa, Middle East, East Asia, South Asia, and Pacific/Oceania. The purpose of these charts is to crosscheck international design day profiles and to assist in the preparation of design day flight schedules and day/night fleet mix projections.

Exhibits N.1 through N.4 show the consolidated international distributions for the four sample airports. JFK and ORD are busiest from the early afternoon through early evening, because of the preponderance of European and East Asian flights. DEN's international service is mostly to Canada and Mexico, which have broader windows of operation; therefore its international distribution is similar to its domestic distribution. LAX has a relatively high number of nighttime international flights, as a result of redeyes to and from the southern part of South America.

Exhibits N.5 though N.8 show the distribution of Canadian arrivals and departures for the four airports. Since Canada is relatively close to the airports, flights can operate through most of the day, and activity is therefore relatively evenly distributed.

Exhibits N.9 through N.12 show the distribution of Mexican and Central American flights. Although most of the flights occur during the daytime, there are some flights during the very late evening and very early morning.

The distribution of Caribbean flights for JFK and ORD is shown in Exhibits N.13 and N.14. DEN and LAX had little or no Caribbean service and are therefore not included. Since most of the flights cater to U.S. vacationers, the schedule reflects that market. Most departures occur in the morning so that travelers can check in to their vacation destination around noon or early afternoon. Most arrivals occur in the late afternoon or early evening, so that vacationers can check-out in late morning.

The distribution of South American flights for JFK, ORD, and LAX is presented in Exhibits N.15 through N.17. Flights to northern South America (Colombia, Venezuela) often occur during the day. However, flights to southern South America (Argentina, Chile, and southern Brazil) tend to be redeyes in both directions. Hence, there are a large number of arrivals in early morning and departures in late evening.

Exhibits N.18 through N.21 show the distribution of flight times for European arrivals and departures. These flights operate within relatively narrow windows to avoid late night arrivals or departures at either end. At JFK and ORD there are a large number of arrivals during late morning and early afternoon followed by a large number of departures later in the afternoon and early in the evening. At DEN and LAX there is less of a spread between arrivals and departures since the longer flight distance requires a shorter turnaround time to compensate.

Exhibit N.22 shows the distribution of African flights for JFK. Flight times can vary significantly depending on where in Africa the flight is arriving from or departing to. For example, flights to northern Africa show a pattern similar to Europe. Southern African flights are characterized by redeyes on the westbound leg. On the eastbound legs, flights arrive at about the same local time at which they depart (albeit one day later).

Flights to and from the Middle East (Exhibits N.23 through N.25) arrive either in the early morning or early afternoon, depending on whether they depart the Middle East late evening or early morning. Departures from the U.S. tend to occur in the afternoon.

Exhibits N.26 through N.28 provide hourly distributions of flights to and from East Asia. Flights from the northern part of the region (Japan and Korea) tend to arrive mid- to late-morning and depart early in the afternoon. The times for flights to and from other East Asian regions (China, Taiwan, Hong Kong, and the Philippines) tend to be more variable.

Flight times to South Asia are shown in Exhibits N.29 and N.30. Nonstop flights to this region have begun only recently, as the market has grown and aircraft ranges have increased to make flights economically and technically feasible. Arrivals tend to occur in the early morning and departures in the late afternoon or evening.

Exhibit N.31 shows the distribution of flight times between the Pacific region and Oceania (Australia and New Zealand) and LAX. Arrival times at LAX tend to occur in the morning and early afternoon, while departures are more concentrated in the late evening.

Exhibit N.1

Hourly Distribution of Scheduled International Flights – New York JFK

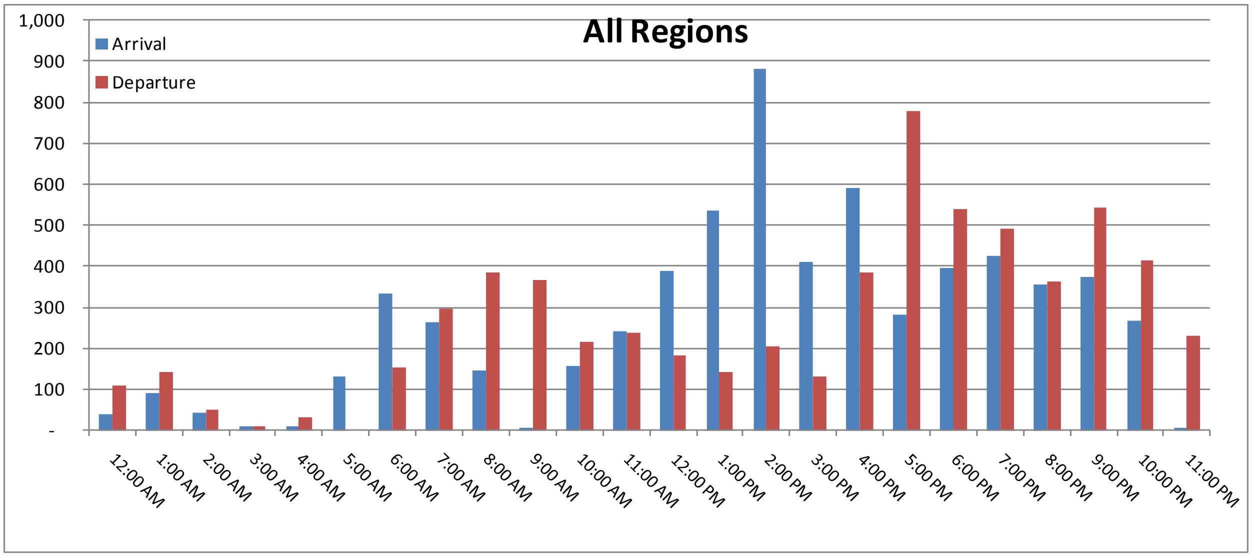


Exhibit N.2

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

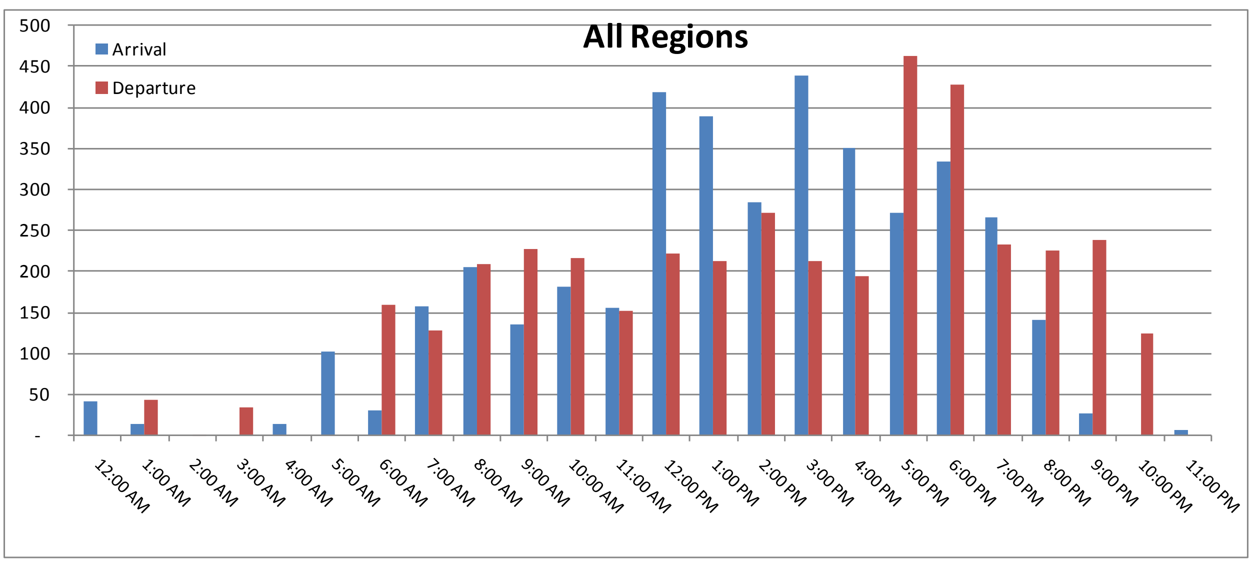


Exhibit N.3

Hourly Distribution of Scheduled International Flights – Denver International

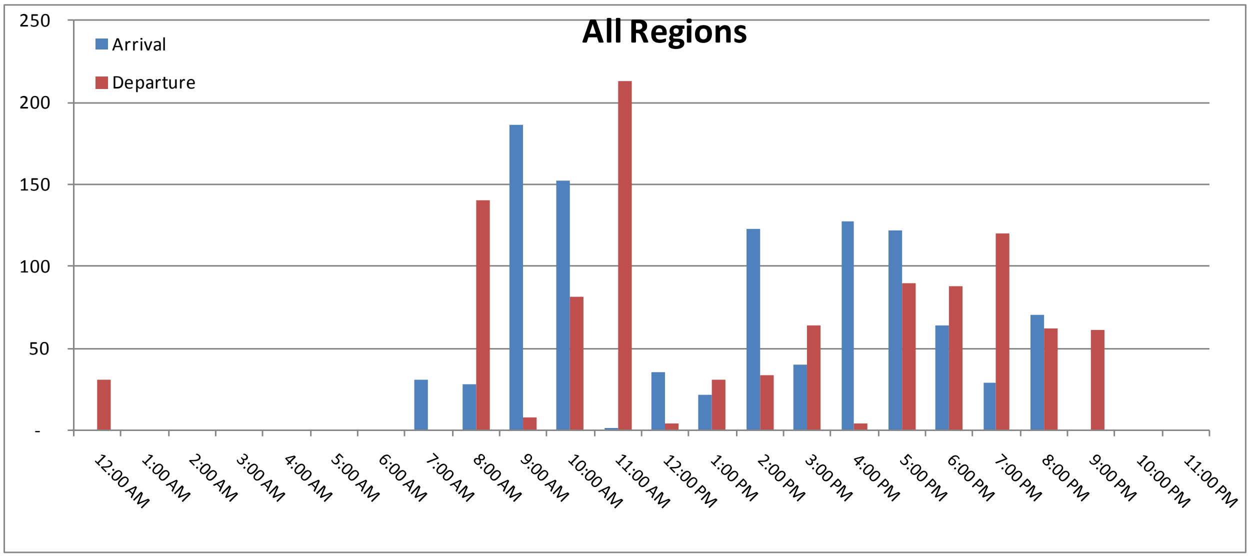


Exhibit N.4

Hourly Distribution of Scheduled International Flights – Los Angeles International

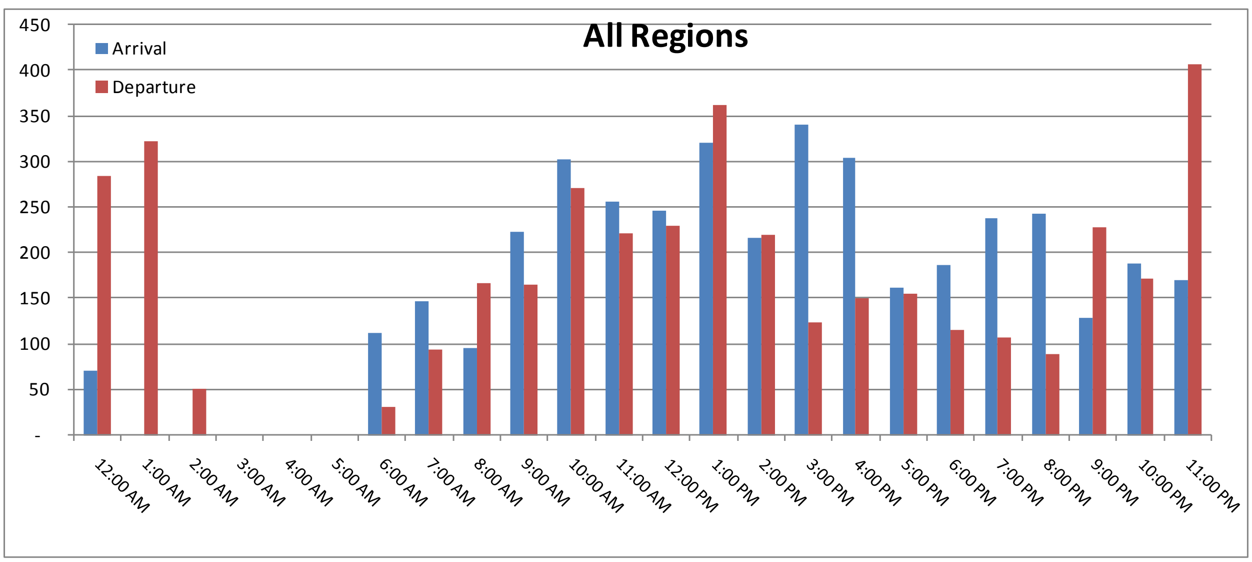


Exhibit N.5

Hourly Distribution of Scheduled International Flights – New York JFK

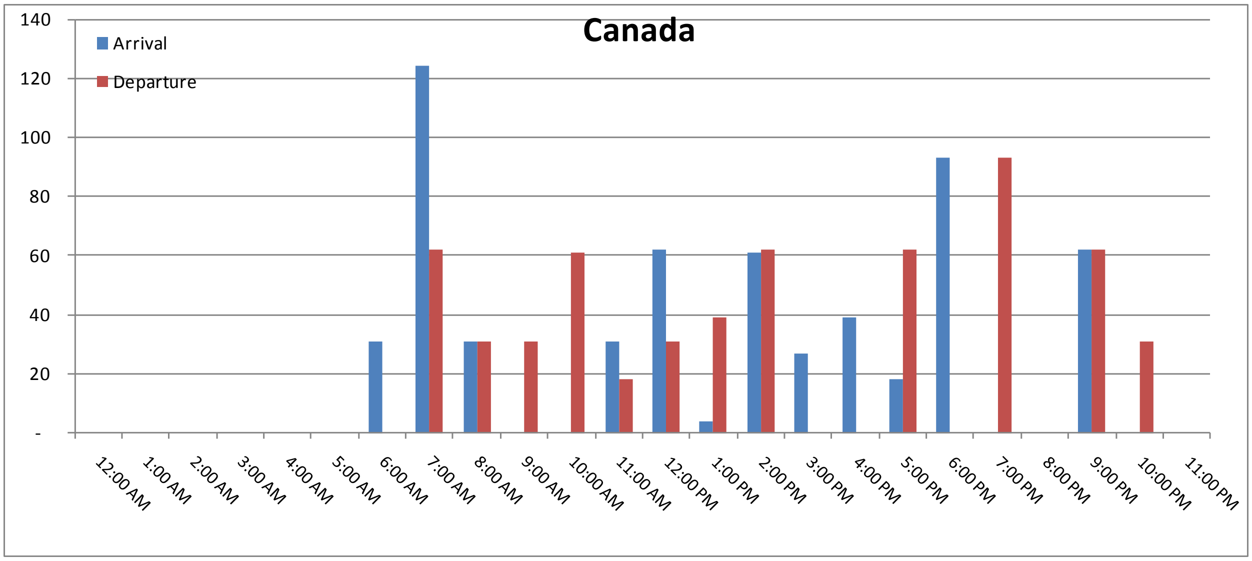


Exhibit N.6

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

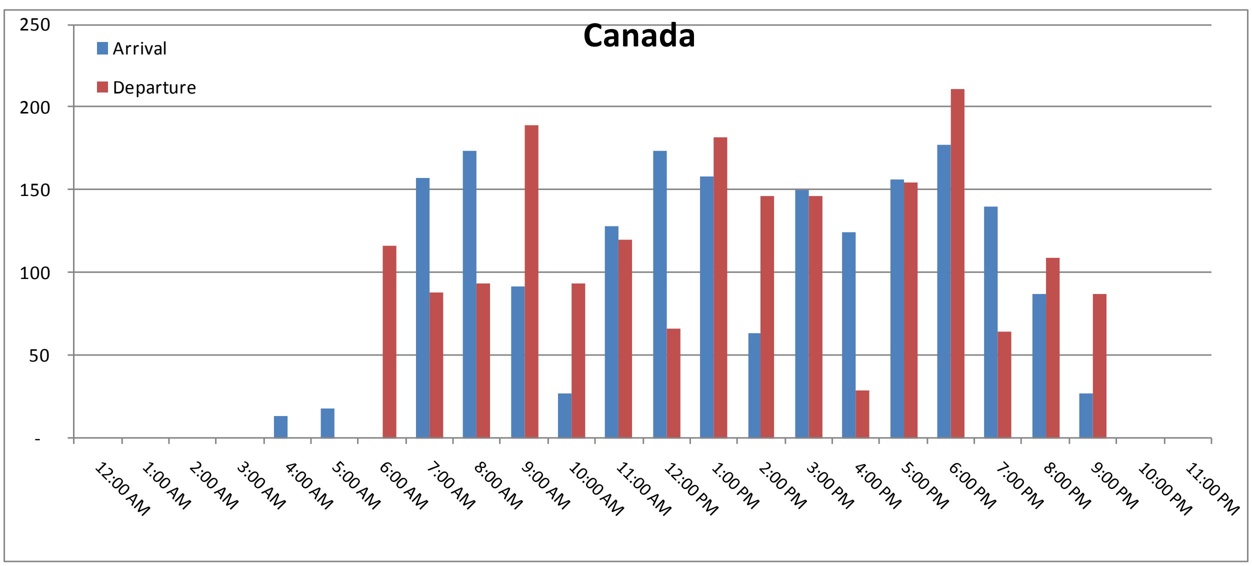


Exhibit N.7

Hourly Distribution of Scheduled International Flights – Denver International

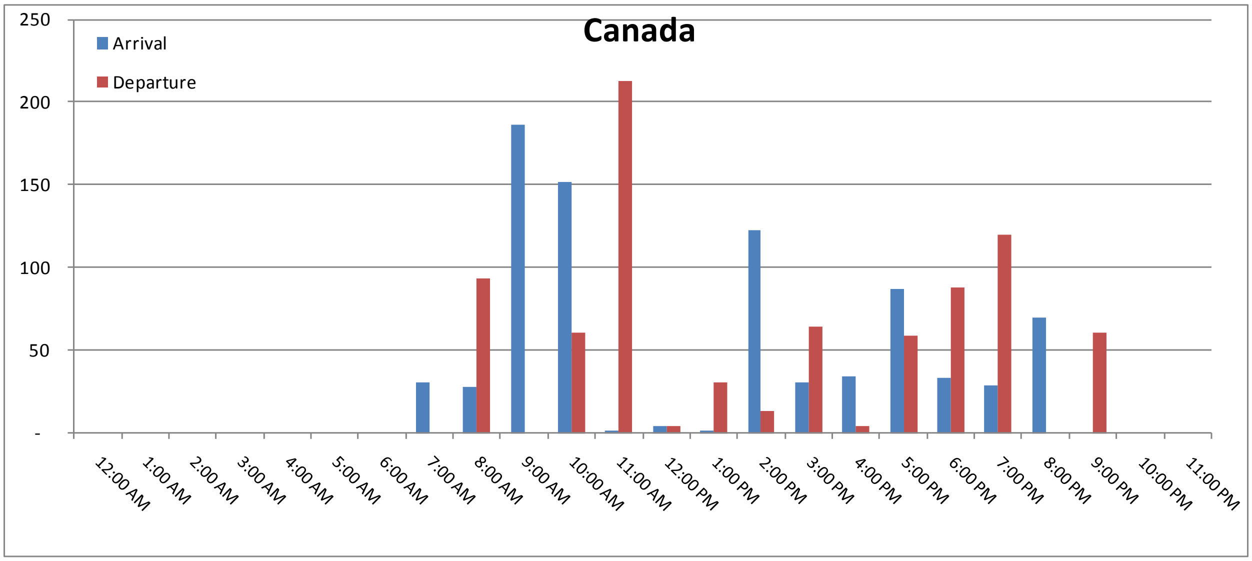


Exhibit N.8 Hourly

Distribution of Scheduled International Flights – Los Angeles International

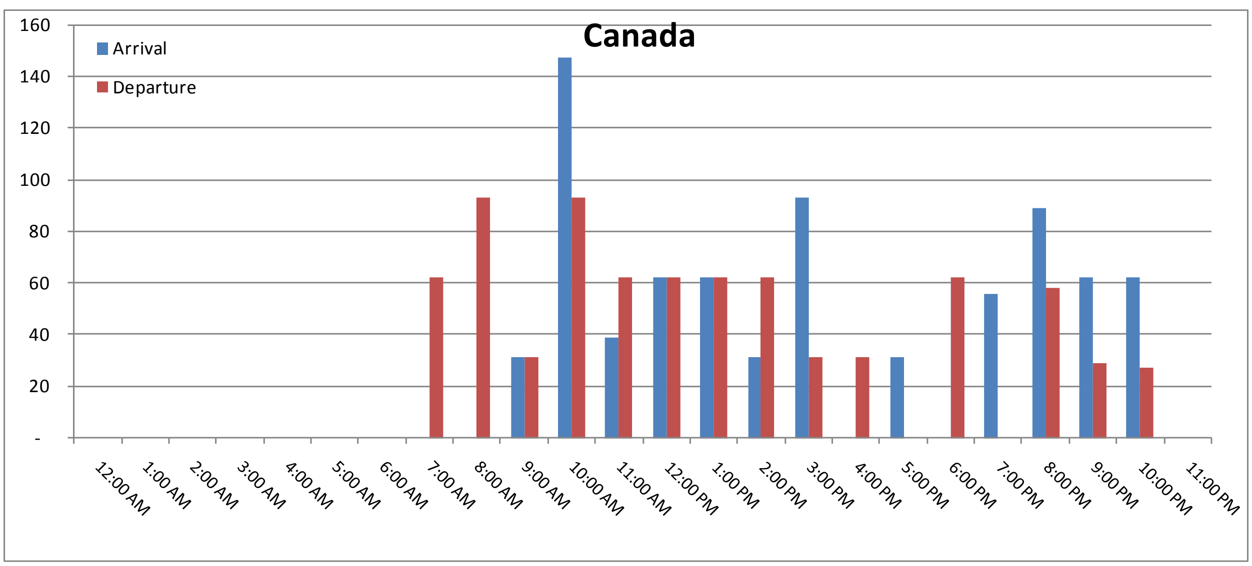


Exhibit N.9

Hourly Distribution of Scheduled International Flights – New York JFK

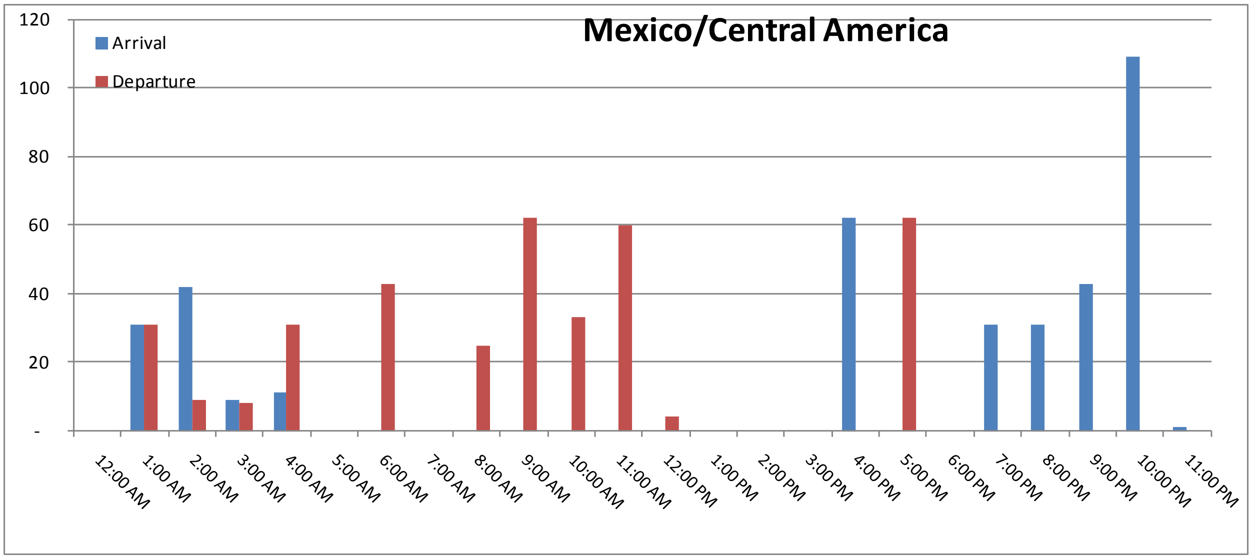


Exhibit N.10

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

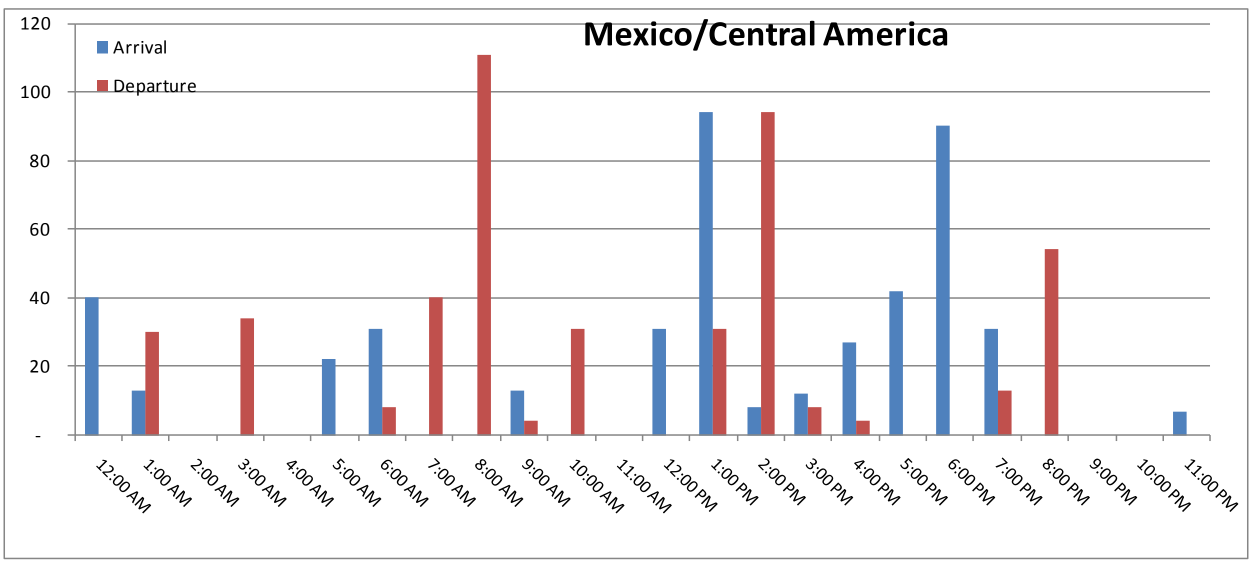


Exhibit N.11

Hourly Distribution of Scheduled International Flights – Denver International

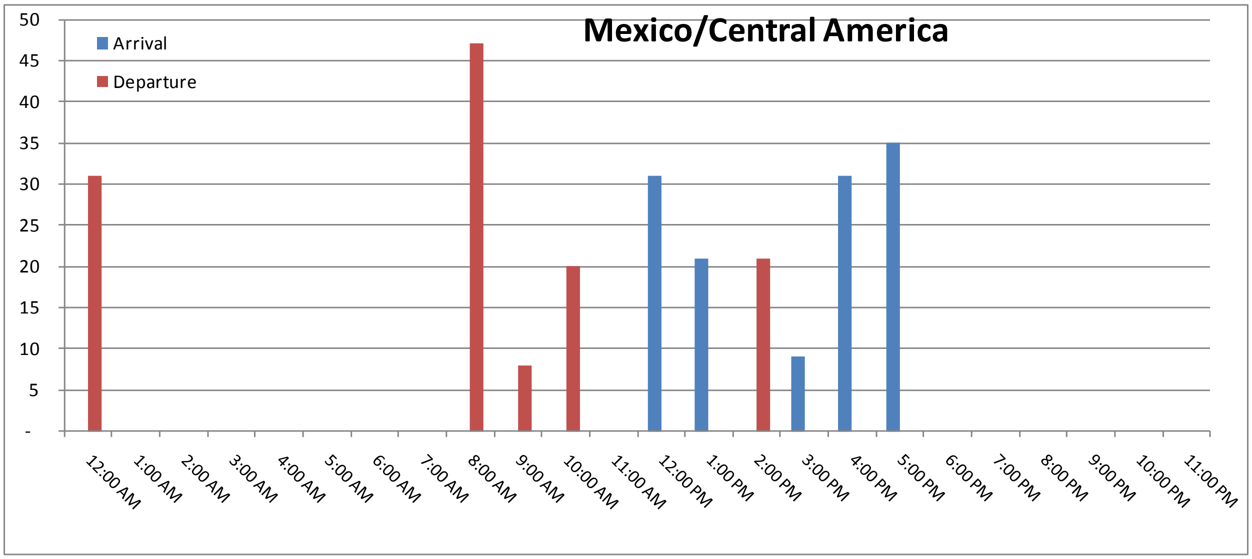


Exhibit N.12

Hourly Distribution of Scheduled International Flights – Los Angeles International

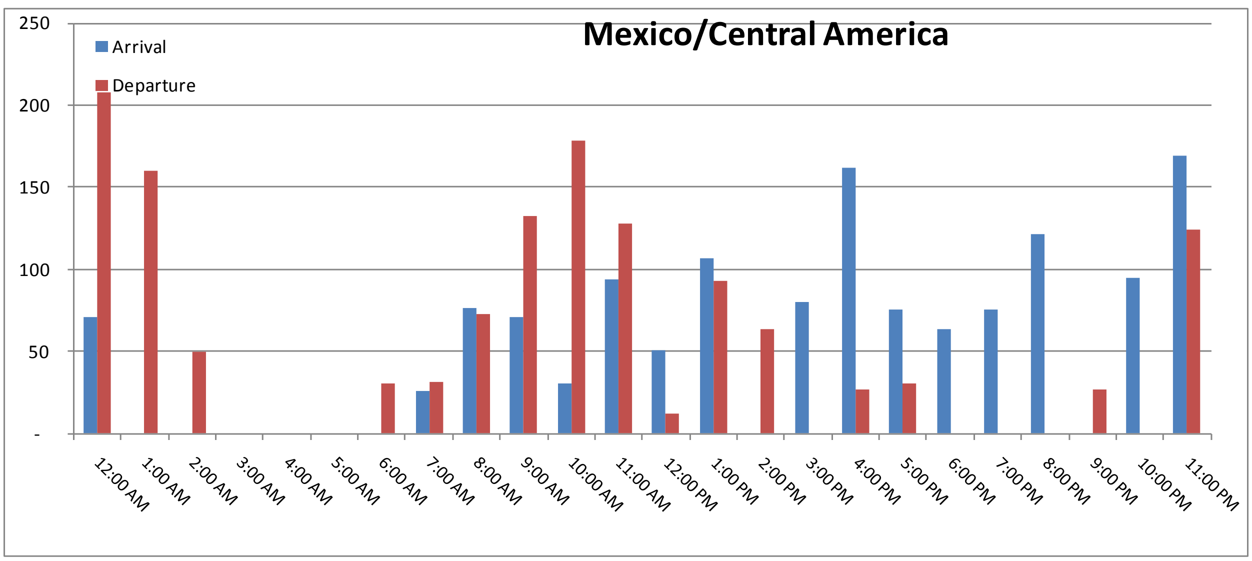


Exhibit N.13

Hourly Distribution of Scheduled International Flights – New York JFK

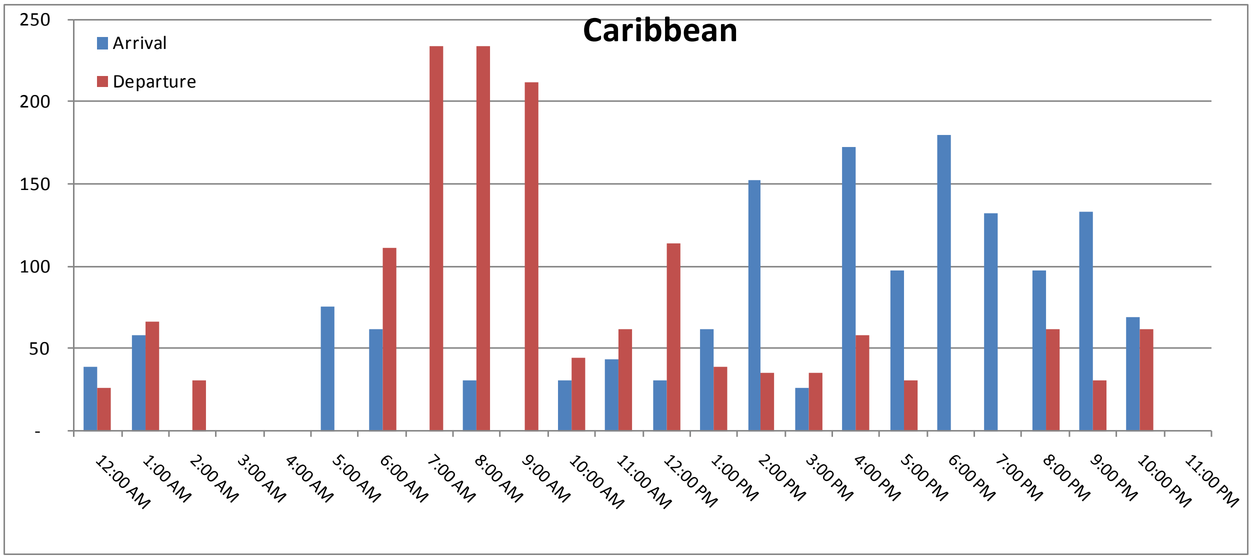


Exhibit N.14

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

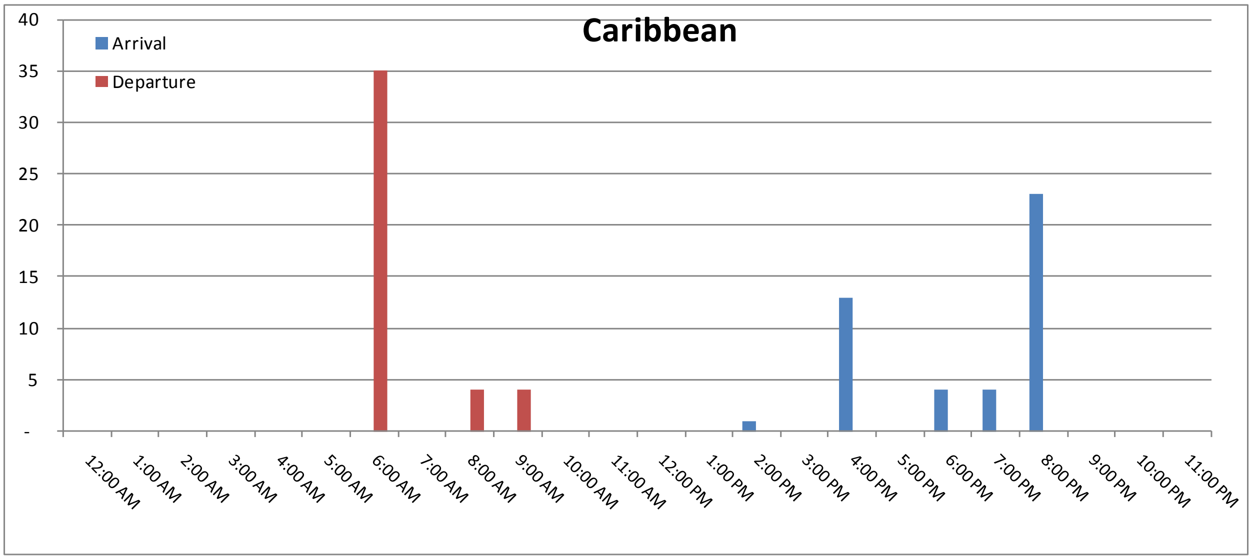


Exhibit N.15

Hourly Distribution of Scheduled International Flights – New York JFK

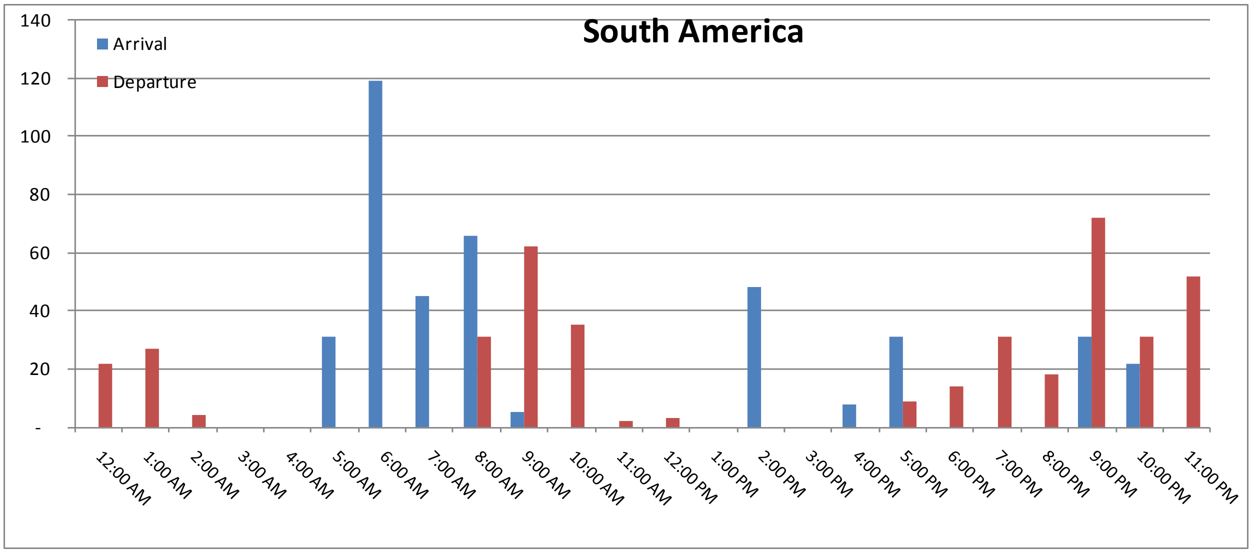


Exhibit N.16

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

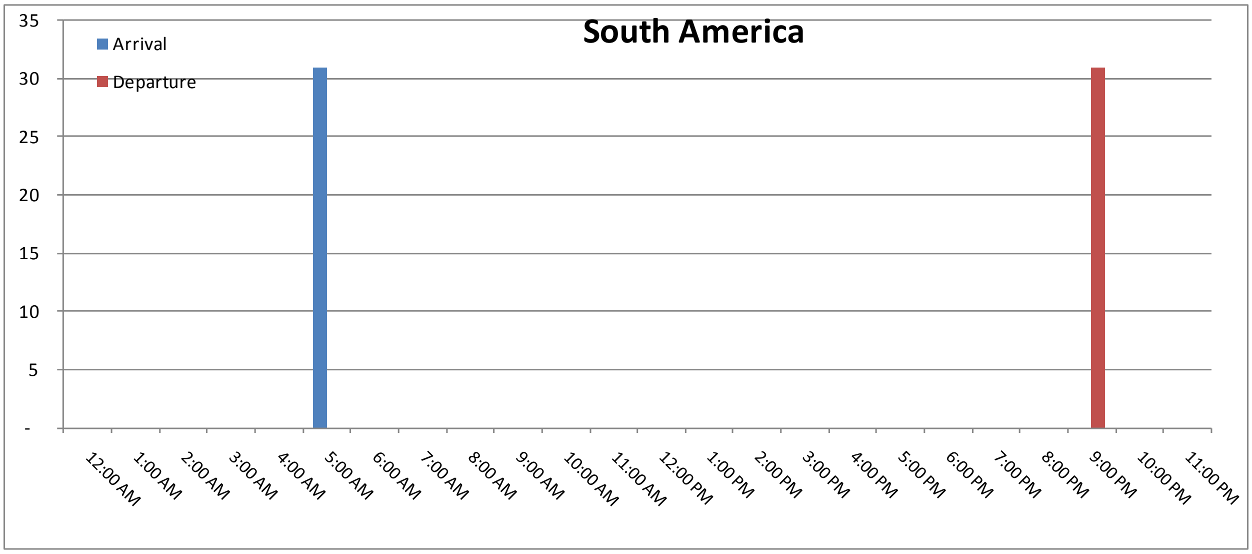


Exhibit N.17

Hourly Distribution of Scheduled International Flights – Los Angeles International

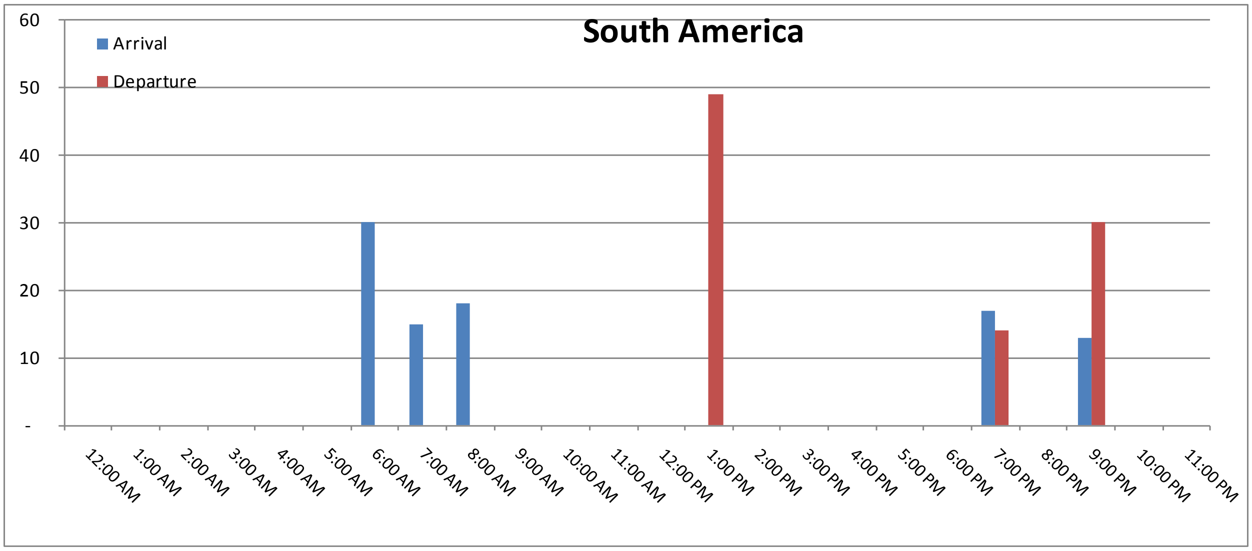


Exhibit N.18

Hourly Distribution of Scheduled International Flights – New York JFK

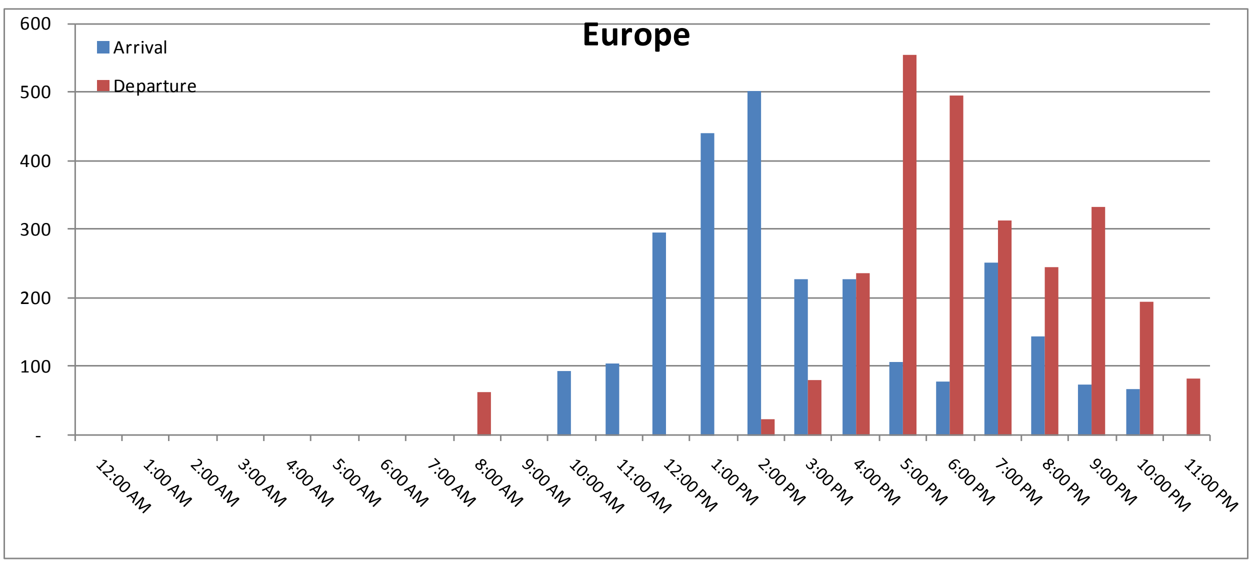


Exhibit N.19

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

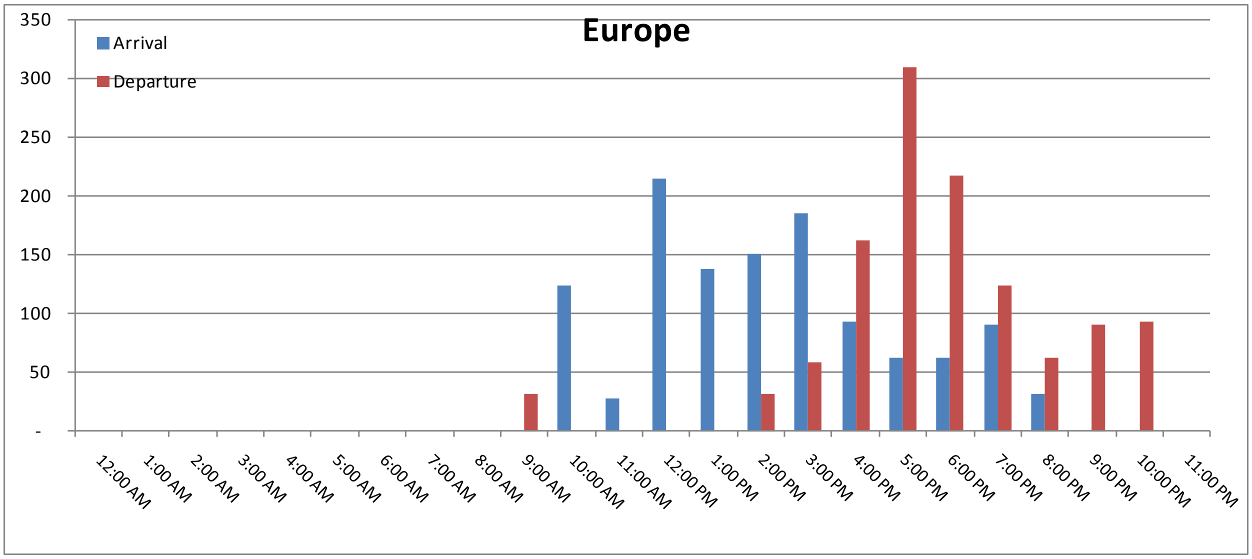


Exhibit N.20

Hourly Distribution of Scheduled International Flights – Denver International

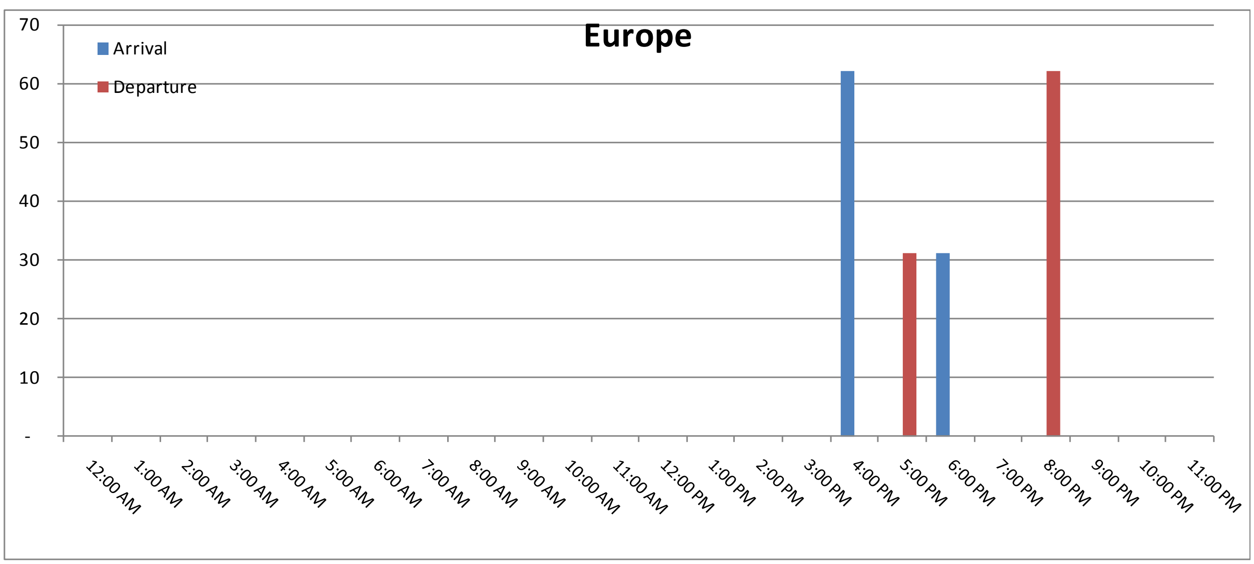


Exhibit N.21

Hourly Distribution of Scheduled International Flights – Los Angeles International

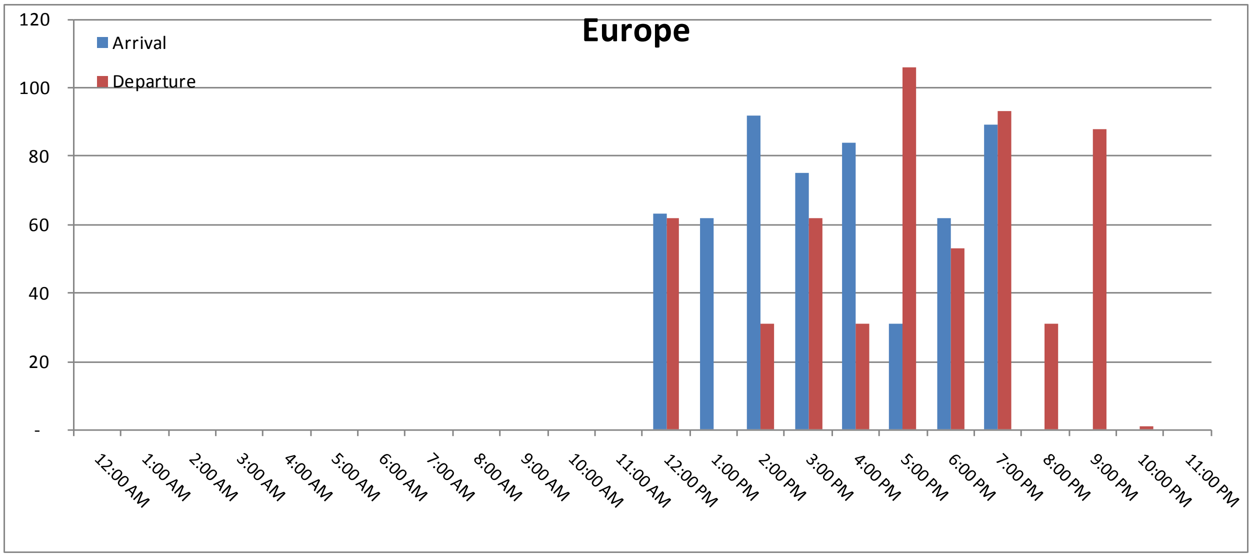


Exhibit N.22

Hourly Distribution of Scheduled International Flights – New York JFK

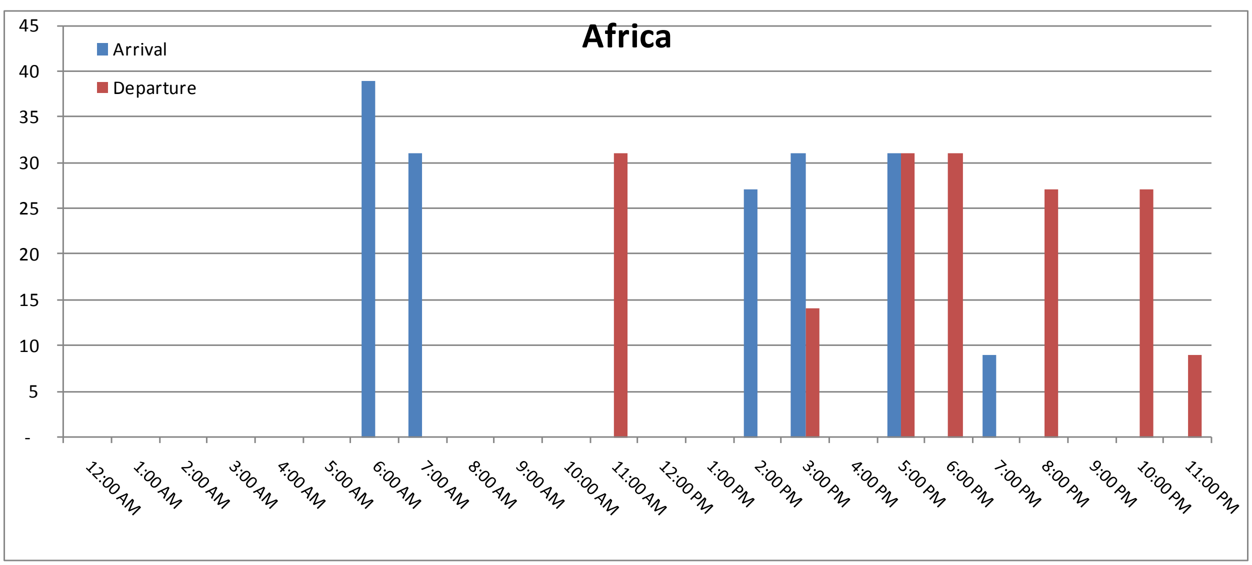


Exhibit N.23

Hourly Distribution of Scheduled International Flights – New York JFK

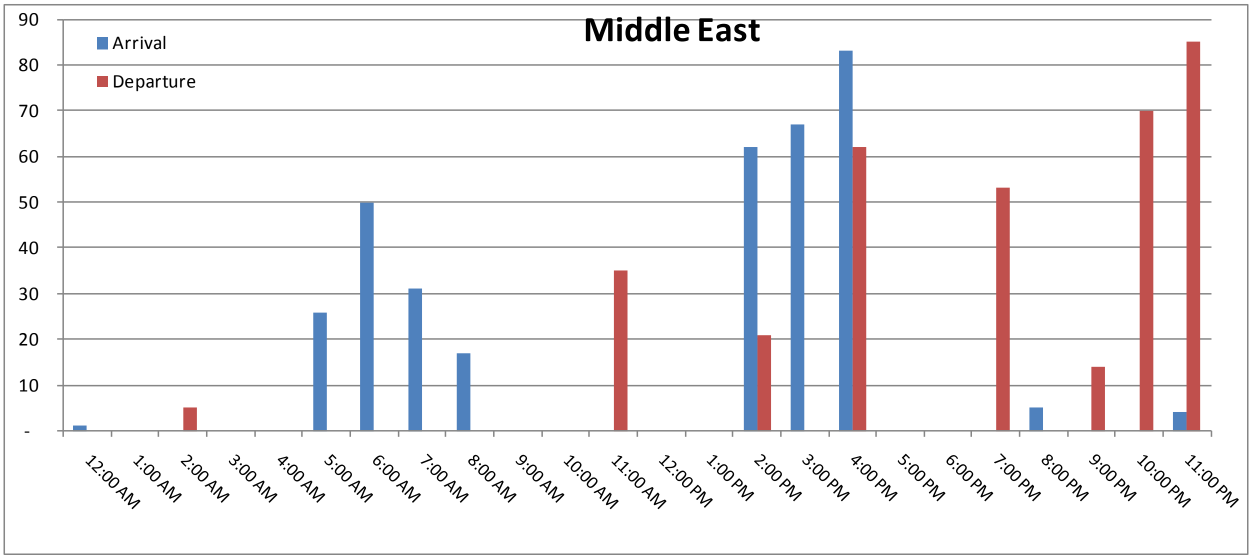


Exhibit N.24

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

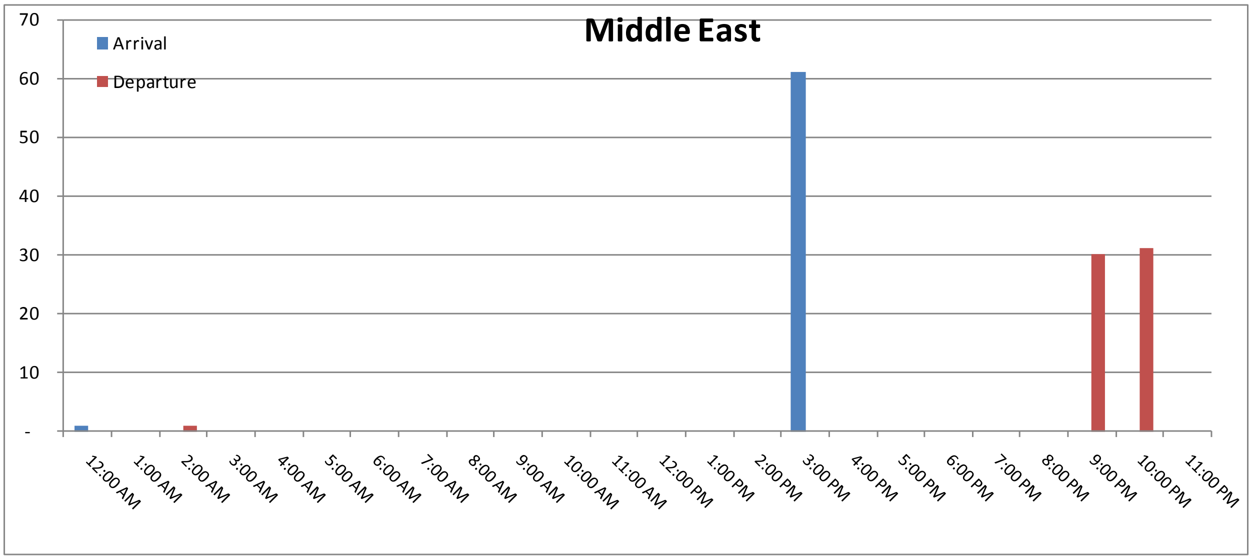


Exhibit N.25

Hourly Distribution of Scheduled International Flights – Los Angeles International

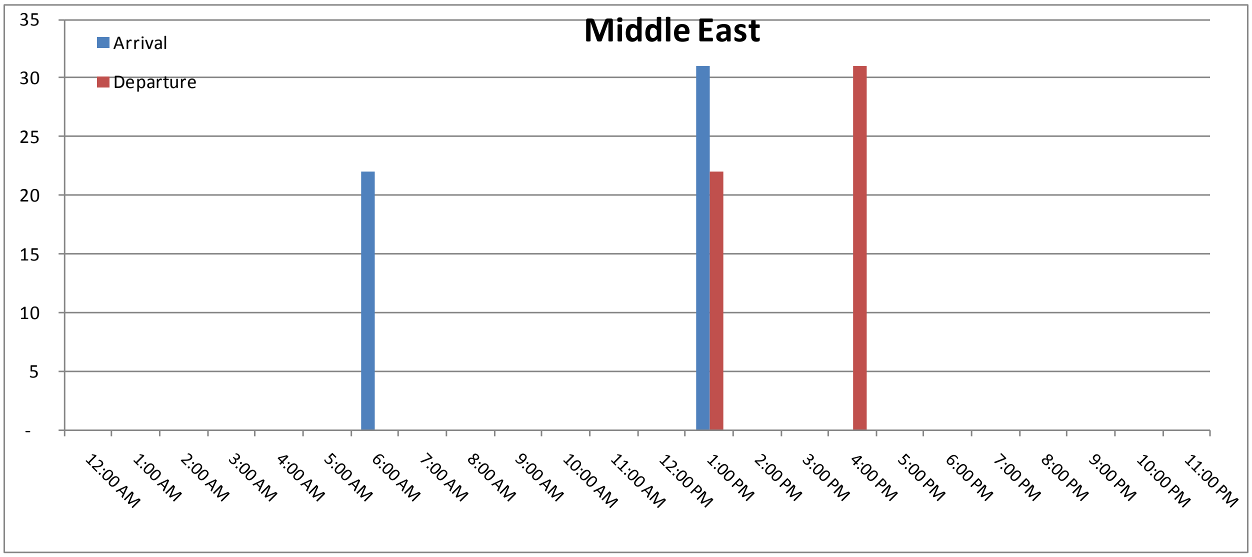


Exhibit N.26

Hourly Distribution of Scheduled International Flights – New York JFK

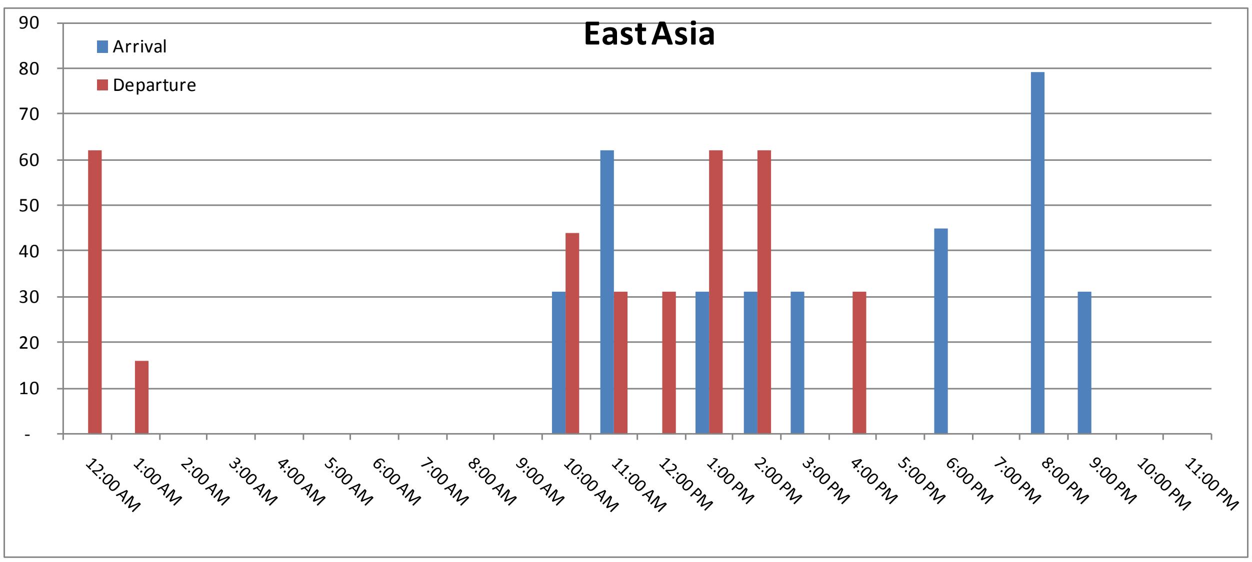


Exhibit N.27

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

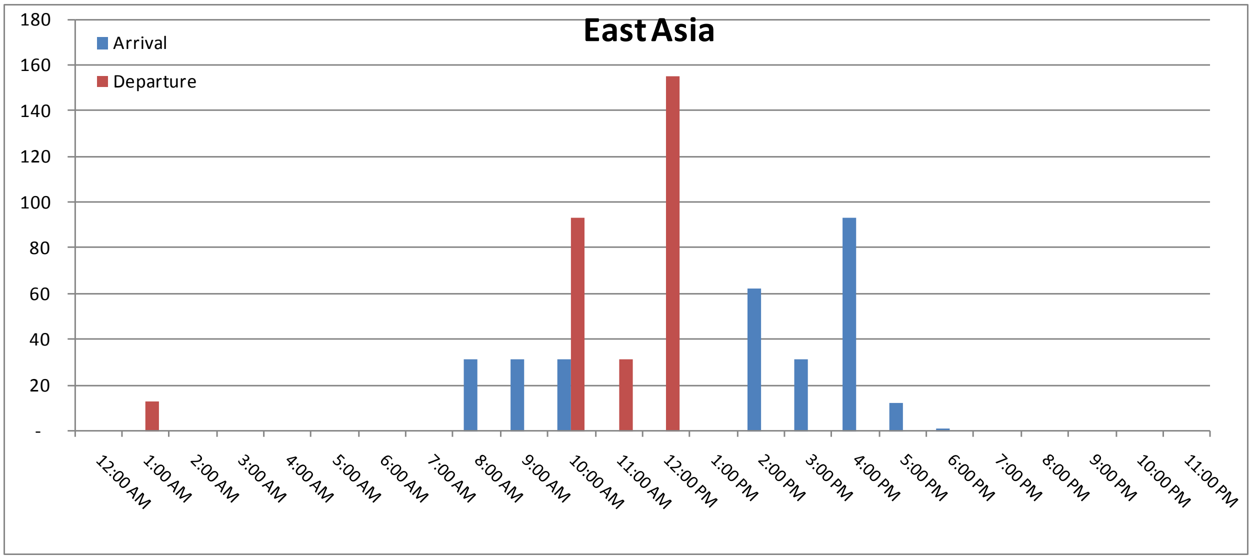


Exhibit N.28

Hourly Distribution of Scheduled International Flights – Los Angeles International

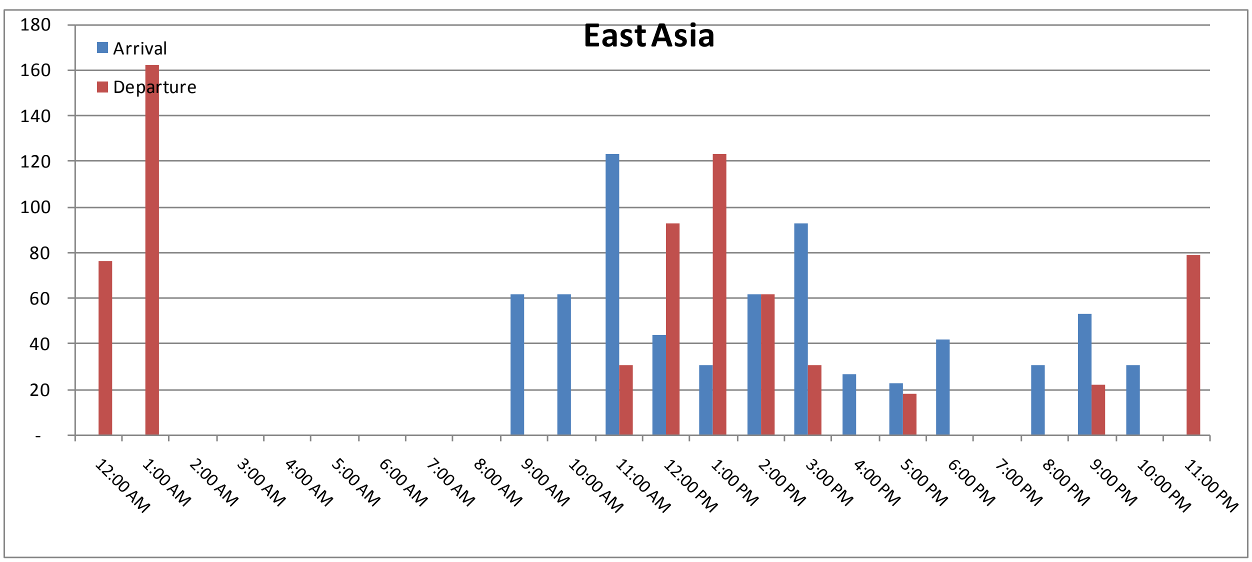


Exhibit N.29

Hourly Distribution of Scheduled International Flights – New York JFK

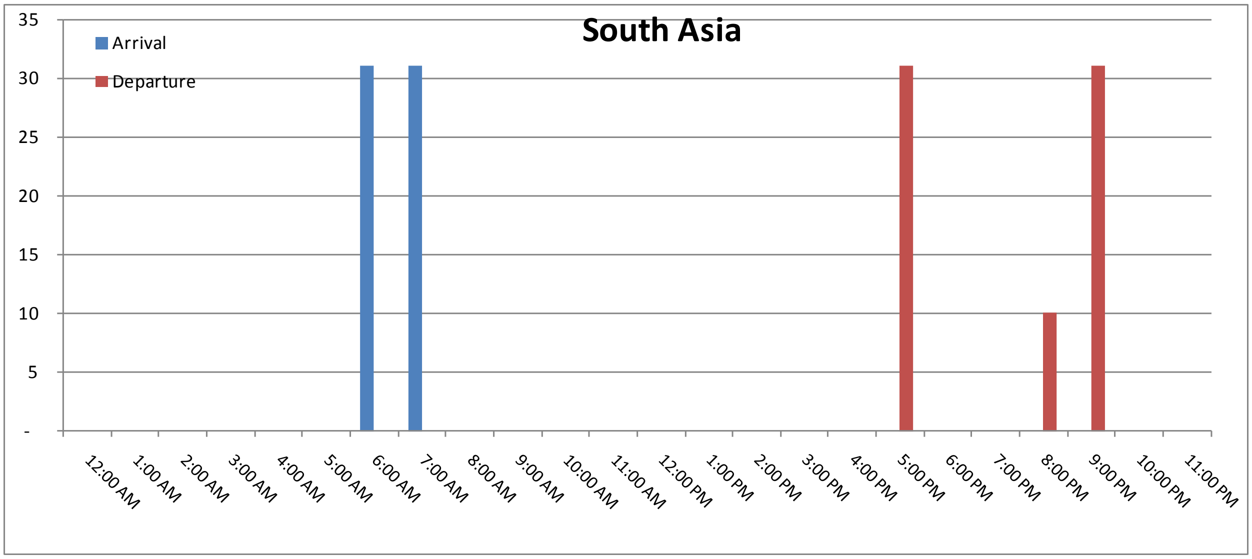


Exhibit N.30

Hourly Distribution of Scheduled International Flights – Chicago O'Hare

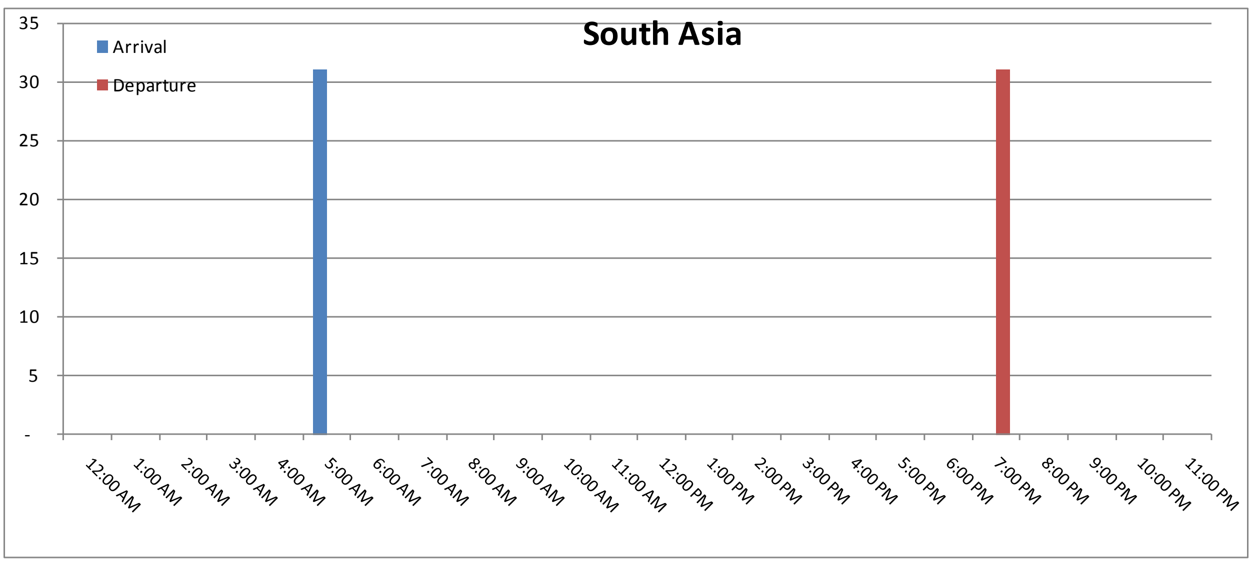
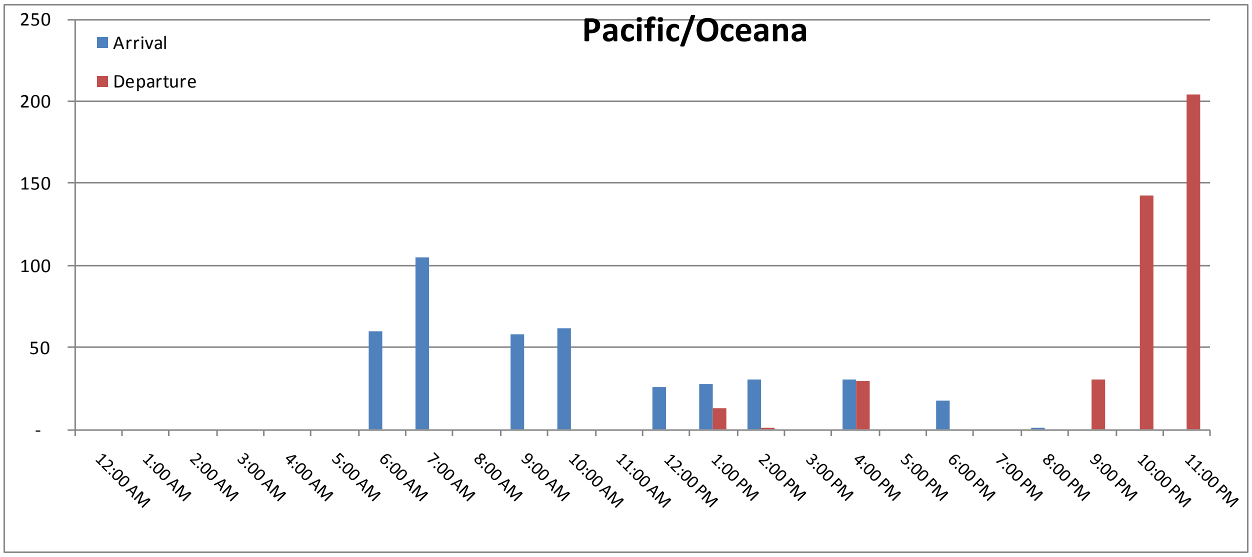


Exhibit N.31

Hourly Distribution of Scheduled International Flights – Los Angeles International



Appendix O

Relationship Between Aircraft Operations and Number of Gates

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix O: Relationship between Aircraft Operations and Number of Gates

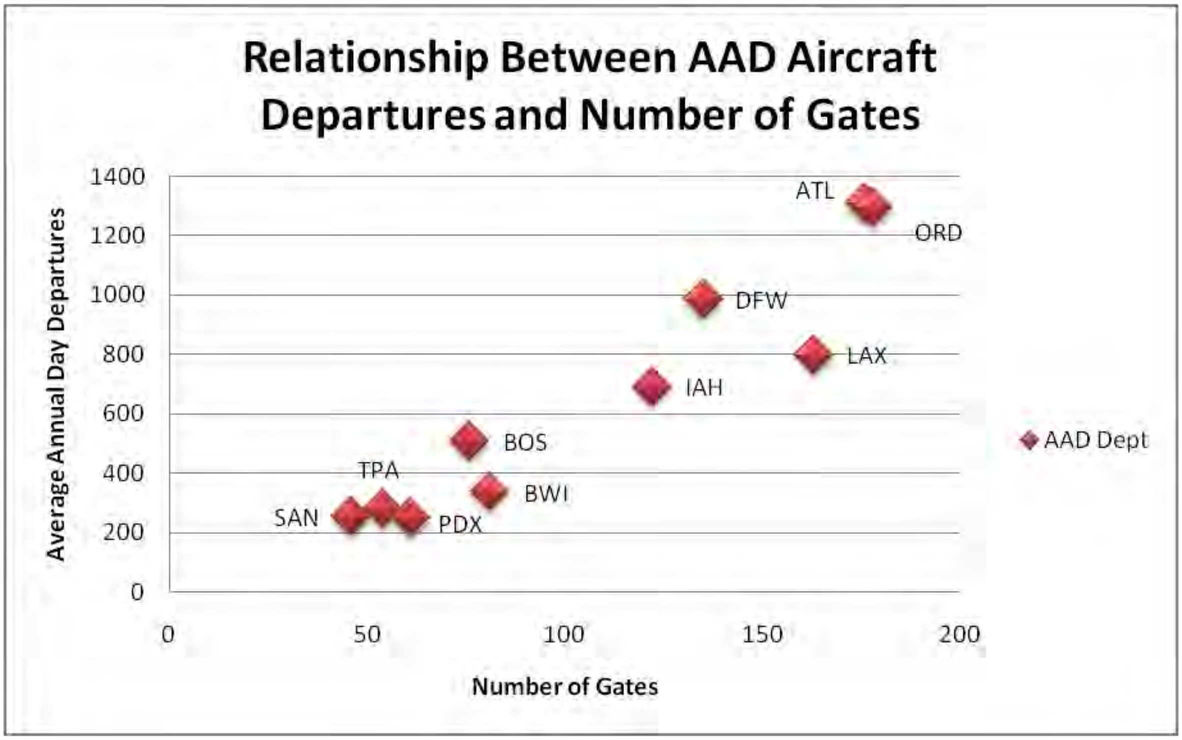
This appendix provides some examples of the relationship between passenger aircraft operations and the number of gates. These relationships may be used as a general guide to the maximum design day departures possible when the number of gates is constrained.

Exhibit O.1 shows the relationship between average annual day operations and gates for a sample of passenger carrier airports. As expected, the busier an airport becomes, the more gates it needs. However, the number of gates typically does not rise as fast as AAD operations. As noted in Appendix G, operations tend to be spread out more evenly throughout the day as an airport becomes busier. Therefore, the number of gates that can be used off-peak increases, and the number of turns per gate increases. One exception is international gateways. As noted in Appendix N, international operations often occur within narrow windows of time, and this restricts the number of times an international gate can be used each day. Therefore, airports like LAX, with a high percentage of international operations require more gates per daily operation than airports with a high percentage of domestic operations.

Exhibit O.2 shows the relationship between peak hour operations and gates for the same sample of airports. At large connecting airports there is rough correspondence between peak hour operations and the numbers gates. This relationship tends to break down at international gateways since international aircraft have longer dwell times and are more likely to be occupying a gate during an in which they neither arrive nor depart. The relationship also tends to break down at smaller O&D airports. At these airports, gate requirements tend to be driven by morning departures or evening arrivals which are not typically reflected in the operations peak.

Appendix O: Relationship Between Aircraft Operations and Number of Gates

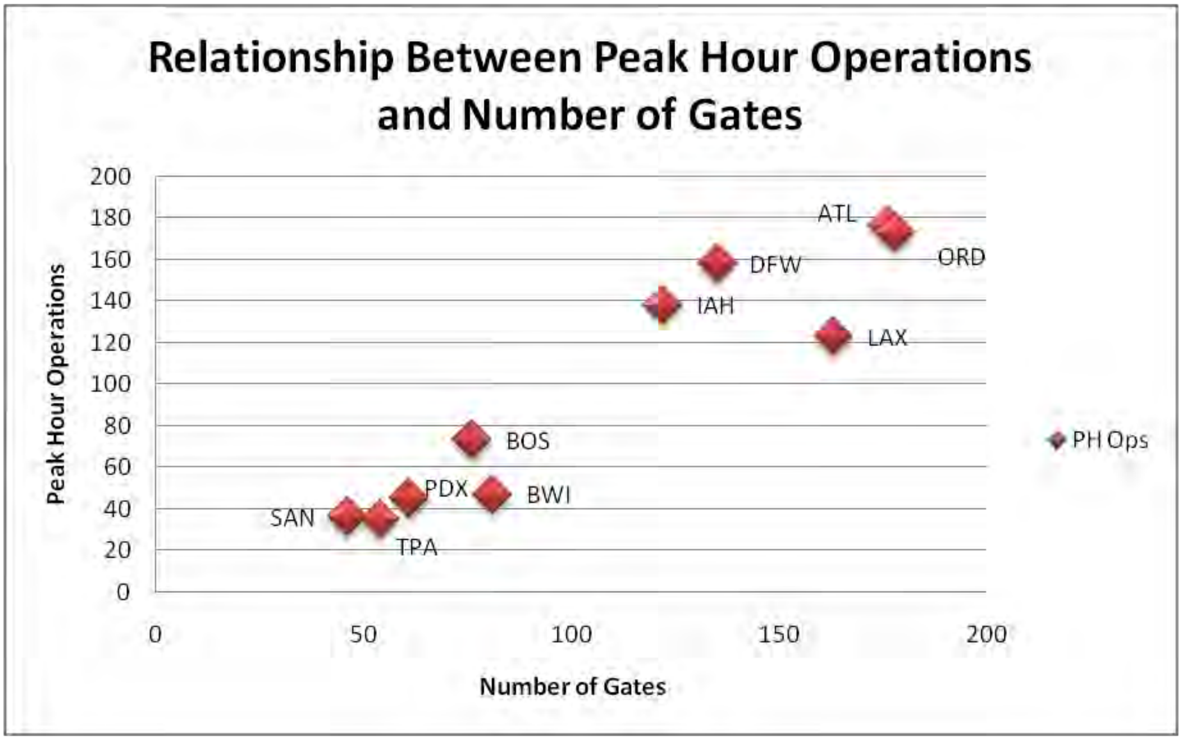
Exhibit O.1



Airport	Gates	AAD Dept
DFW	135	985
IAH	122	691
ATL	176	1309
BWI	81	336
ORD	178	1295
SAN	46	253
LAX	163	798
BOS	76	508
TPA	54	279
PDX	61	248

Source: OAG data and HNTB research.

Exhibit O.2



Airport	Gates	PH Ops
DFW	135	158
IAH	122	138
ATL	176	176
BWI	81	47
ORD	178	173
SAN	46	36
LAX	163	123
BOS	76	73
TPA	54	35
PDX	61	45

Source: FAA ETMSC data and HNTB research.

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix P

Distribution of Passenger Airport Arrival Times

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix P: Distribution of Passenger Airport Arrival Times

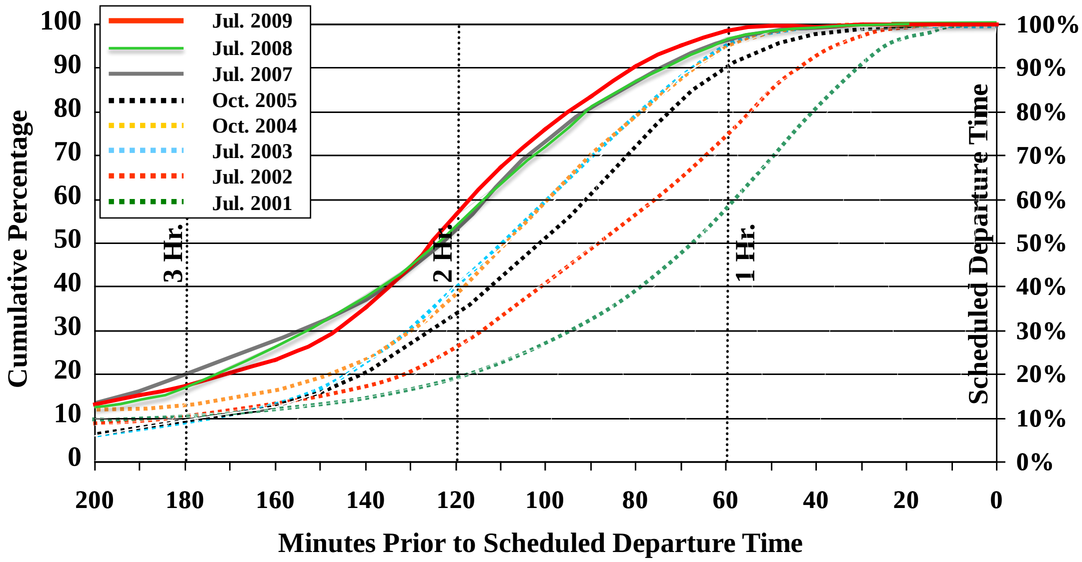
As noted in the Guidebook, departing passengers require time to check in, pass through security, and navigate the airport. Therefore, peak flows at passenger departure facilities occur in advance of the enplaning peak, which is defined as occurring when the aircraft leaves the gate. The extent of this lead time will depend on many factors including:

- the size and configuration of the airport;
- current security requirements and processing times
- the queues at the various passenger departure facilities;
- airline policies such as cut-off times; and
- the extent to which passengers build in buffer time to allow for unforeseen delays.

The lead time will not be constant; it will vary by time of day and by type of passenger. The lead time is therefore often described as a probability function where y percentage of passengers show up at the gate x minutes before scheduled departure time.

An example of how passenger distributions change over time is presented in Exhibit P.1. The exhibit shows how passenger arrivals distributions at a major hub in the Eastern Time zone changed between 2001 and 2009. In July 2001, prior to the 9/11 attacks and ensuing security measures, only 60 percent of passengers arrived at the airport more than an prior to their flight's scheduled departure. Several years later, after security screening became increasingly strict and involved, well over 95 percent of passengers arrive at the airport, an hour or more before their flight's scheduled departure time.

Exhibit P.1
Changes in Airport Arrival Distributions over Time



Appendix Q

New Flight Analysis

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix Q: New Flight Analysis

When preparing design day flight schedules (see Chapter 6 of Guidebook) a common approach is to take an existing airline schedule and then add flights in accordance with the projected growth in aircraft operations. The approach implicitly assumes that when an airline adds a new frequency to an existing market, the airline will not change the scheduled times of its existing flights in that market.

Oliver Wyman performed an analysis of OAG data to test this assumption. They examined a schedule for all U.S. airports for a Wednesday in mid-June 2009 and again in mid-June 2010. They performed the comparison year to year to avoid any kind of seasonality changes that might occur in a month to month comparison.

Exhibit Q.1 provides an analysis of all airline market pairs in which the daily frequencies increased from 1 to 2 between mid-June 2009 and mid-June 2010. There were 44 cases in which the original flight was scheduled in the morning. In 28 of those cases the new flight was scheduled in the afternoon, and in 11 cases the new flight was scheduled in the evening. In more than 80 percent these cases, the new schedule had at least one flight that was within an hour of the original flight. The situation is different in cases where the original flight was an afternoon flight; in those instances the new schedule had at least one flight within an hour of the original in only roughly half the cases. Since afternoon flights occur approximately during the middle of an airline's operating day, it is reasonable to expect the airline to shift flights so that one flight occurs in the morning and the other in the late afternoon or evening.

Exhibit Q.2 is similar to Exhibit Q.1 except that it provides an analysis of all airline market pairs in which the frequencies increased from 2 to 3 between 2009 and 2010. In 59 percent of the cases, the new schedule had flights within one hour of both flights in the original schedule, and in another 38 percent of the cases, at the new schedule had at least one flight within an hour of a flight in the original schedule. In only 3 percent of the cases did the new schedule have no flights within an hour of one of the original flights.

Some rough rules of thumb for preparing design day flight schedules emerge from the analysis.

Single Frequency Going to Two Frequencies

- If the original flight is in the morning or evening, maintain the original flight time in the new schedule
- If the original flight is in the afternoon, especially the early afternoon, consider shifting the original flight time to provide better schedule coverage in the new design day schedule.

Two Frequencies Going to Three Frequencies

- Maintain at least one of the flight times in the new schedule.
- If the original schedule had one morning and one evening flight, maintain both original flight times in the new schedule.

Exhibit Q.1

Summary of Flight Time Changes
Flights Increase From 1 to 2/Day

		Occurences		New Schedule has Flight Within 60 Minutes of Old	
Before	**After**	**Total**	**Percent**	**Total**	**Percent**
Morning	Morning/Afternoon	28	64%	24	86%
	Morning/Evening	11	25%	9	82%
	2nd Morning	3	7%	3	100%
	Afternoon/Evening	2	5%	0	0%
	Subtotal	44	100%	36	82%
Afternoon	Morning/Afternoon	25	60%	14	56%
	Afternoon/Evening	9	21%	6	67%
	Morning/Evening	5	12%	2	40%
	2nd Afternoon	3	7%	1	33%
	Subtotal	42	100%	23	55%
Evening	Morning/Evening	9	47%	9	100%
	Afternoon/Evening	9	47%	6	67%
	Morning/Afternoon	1	5%	0	0%
	Subtotal	19	100%	15	79%
	Total	105		74	

Morning defined as 4am to 1159am
Afternoon defined as Noon to 559pm
Evening defined as 6pm to 359am (to pick up red-eyes)

Source: Oliver Wyman analysis of OAG data.

Exhibit Q.2

Summary of Flight Time Changes
Flights Increase From 2 to 3/Day

		Occurences		New Schedule has 1 Flight Within 60 Minutes of 1 Old Only		New Schedule has 1 Flight Within 60 Minutes of Both Old	
Before	**After**	**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**
Both Flights Morning	Morning/Afternoon/Evening	1	33%	0	0%	1	100%
	Morning/2 Afternoon	1	33%	0	0%	1	100%
	2 Morning/Afternoon	1	33%	0	0%	1	100%
	Subtotal	3	100%	0	0%	3	100%
Morning/Afternoon	Morning/2 Evening	29	39%	12	41%	16	55%
	Morning/Afternoon/Evening	21	28%	9	43%	11	52%
	Morning/2 Afternoon	21	28%	7	33%	12	57%
	2 Morning/Evening	2	3%	2	100%	0	0%
	2 Morning/Afternoon	1	1%	1	100%	0	0%
	Subtotal	74	100%	31	42%	39	53%
Morning/Evening	Morning/Afternoon/Evening	25	78%	7	28%	18	72%
	Morning/2 Afternoon	5	16%	1	20%	4	80%
	2 Morning/Evening	1	3%	0	0%	1	100%
	2 Morning/Afternoon	1	3%	1	100%	0	0%
	Subtotal	32	100%	9	28%	23	72%
Both Flights Afternoon	2 Afternoon/Evening	4	80%	4	100%	0	0%
	Morning/Afternoon/Evening	1	20%	0	0%	1	100%
		5	100%	4	80%	1	20%
Afternoon/Evening	Morning/Afternoon/Evening	25	81%	6	24%	18	72%
	Morning/2 Afternoon	4	13%	3	75%	1	25%
	2 Morning/Evening	1	3%	1	100%	0	0%
	2 Morning/Afternoon	1	3%	1	100%	0	0%
	Subtotal	31	100%	11	35%	19	61%
	Total	145		55	38%	85	59%

Morning defined as 4am to 1159am
Afternoon defined as Noon to 559pm
Evening defined as 6pm to 359am (to pick up red-eyes)

Source: Oliver Wyman analysis of OAG data.

The analyses suggest that, when preparing design day flight schedules, existing flight times can be maintained in the majority of cases. As discussed above, however, there are instances in which planners should consider changing one or more of the existing flight times to provide more balance and schedule coverage in the new schedule.

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix R

Recommended Quality Control Checks When Preparing Design Day Schedules

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix R: Recommended Quality Control Checks When Preparing Design Day Schedules

A bottom up preparation of a design day gated flight schedule can be a laborious and tedious process and, as such, is subject to error. The following list of QC checks is recommended prior to using the schedule for any simulation or analysis. Although time consuming, debugging the schedule at this stage is much less expensive than after simulation modeling or environmental analysis is undertaken.

- Arrival/Departure Match – The number of aircraft arrivals should match the number of aircraft departures by airline and by equipment type for each airline. An exception may be made if the purpose is model a specific day of the week rather than a more general design day.

- Pairing Match – An aircraft should not change type between arrival and departure. This is obvious, but sometimes overlooked.

- Turnaround Time – There should be a sufficient interval for loading and unloading passengers and cargo and taking on fuel and supplies. Large aircraft on long-haul flights generally require more time than small aircraft on short-haul flights. This can vary by airline; for example Southwest Airlines routinely turns flights around in twenty-five minutes whereas most mainline operators require fifty minutes or more. Long-haul international flights often require two hours. Turnaround times can be a potential pitfall if a future design day schedule is prepared by up-gauging from an existing schedule. For example, if a regional flight is up-gauged to a mainline flight, the arrival time may have to be advanced or the departure time delayed to maintain a reasonable turnaround time.

- Buffer Time – This is the scheduled time between a departing flight and the next arriving flight scheduled for a given gate. Fifteen minutes is usually the minimum practical buffer time. Many airlines use twenty or thirty minutes. Since the reliability of arrival times is less with long-haul flights, the buffer times at international gates tend to be greater than at domestic gates.

- Origin/Destination Times – New flight times should be selected to ensure that the arriving time at the destination and the departing time at the origin are compatible with curfews, if any, and the market realities of when passengers are willing to fly and when airlines are willing to provide service. For example, it is very unusual for an East Coast market to see an arrival from the West Coast prior to 2:00 or 3:00 pm, since such a flight would have to depart prior to 6:00 am local time. Likewise, there is a dearth of departures for the East Coast at West Coast airports between 4:00 pm local (after which flights would arrive past midnight) and 11:00 pm (the departure time that allows "red eye" flights to arrive in the early morning).

- Gate Overlap – A final check should be made to ensure two different aircraft are not scheduled for the same gate at the same time.
- Schedule Coverage – Consistent with realistic origin/destination times, airlines will attempt to schedule flights to a given market to ensure as much coverage as possible through the day, with emphasis on the morning and late afternoon peaks.
- Consistency with Connecting Banks – New flight times for carriers with a hub-and-spoke network should be generally consistent with the connecting bank structure at their hub airports. One source of guidance is the flight times from the same market and airline to other airports with similar distances and time zones.

Appendix S

Glossary

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix S: Glossary

Air Carrier: The FAA definition is an aircraft with seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo for hire or compensation.

Air Taxi: The FAA definition is an aircraft designed to have a maximum seating capacity of 60 seats or less or a maximum payload capacity of 18,000 pounds or less carrying passengers or cargo for hire or compensation. Small regional jets and turboprop aircraft in scheduled service are considered air taxi in FAA statistics.

Aircraft Operation: An aircraft take-off or landing.

Aviation Environmental Design Tool (AEDT): An environmental analysis tool for noise and air quality being developed for the FAA that will replace the INM and EDMS models.

Airport Cooperative Research Program (ACRP): Program authorized by Congress and sponsored by the FAA with the goal of developing near-term, practical solutions to problems faced by airport operators.

Air Traffic Activity System (ATADS): A summary of tower counts that includes itinerant air carrier, air taxi, general aviation, and military operations, along with local civil and military operations, on a daily, monthly and annual basis.

Air Traffic Control Tower (ATCT): A structure from which air traffic control personnel control the movement of aircraft on or around the airport.

Average Day in the Peak Month (ADPM): Defined as peak month passengers or operations divided by the number of days in the month.

Average Weekday in the Peak Month (AWDPM): Defined as the number of weekday passengers or operations in the peak month divided by the number of weekdays in the peak month.

Bag Claim Device: Typically a mechanical device designed to hold and display checked luggage for passengers to claim upon arriving at their destination airport.

Belly Hold: Portion of aircraft below the passenger compartment frequently used to store luggage and cargo.

Clock Hour: A sixty minute period that begins at the beginning of the hour. For example 1:00 pm through 1:59 pm represents a clock hour; 1:35 pm through 2:34 pm does not.

Cloning: A process of expanding a design day schedule by duplicating flights, usually including a small random adjustment to the flight time to avoid exact duplication.

Connecting Bank: A group of aircraft, operated by a single airline system, which arrives at an airport within a narrow time interval, exchanges passengers, and then departs, also within a narrow time interval.

Customs and Border Protection (CBP), U.S.: Agency under the U.S. Department of Homeland Security (DHS) with the priority mission of keeping terrorists and their weapons out of the U.S. It also has a responsibility for securing and facilitating trade and travel while enforcing U.S. regulations, including immigration and drug laws.

Data Input Day: A representative day, for which detailed schedule or operational data is available, used to determine passenger and operational distributions in design day profiles. The data input day does need to exactly correspond to the design day.

Day/Night Split: Distribution of aircraft operations between daytime (7 am to 10 pm) and nighttime (10 pm to 7 am).

Departure Lounge: Interior area within an airport terminal where passengers wait just prior to boarding aircraft.

Deplane (Deplanement): Act of getting off an aircraft; passenger getting off an aircraft.

Derivative Operational Profiles: Operational profiles that are derived from the traditional passenger and aircraft operation profiles, usually by applying a lead or lag factor, to assess loads on specific terminal or landside facilities.

Design Day: A representative busy day selected for planning, intended to strike a balance between providing capacity for most periods without incurring the cost of designing for the single busiest day of the year.

Design Day Schedule: A constructed schedule showing individual aircraft arrivals and departures by time of day and aircraft type, which can also show airline, origin/destination, and passengers associated with each flight, depending on the level of detail required.

Domestic Travel: Typically, that portion of air travel within the borders of a particular country; may also include travel from pre-clear origins within Canada and the Caribbean.

Emissions and Dispersion Modeling System (EDMS): Model currently used to estimate airport air quality impacts.

Enplane (Enplanement): Act of boarding an aircraft; passenger getting on an aircraft.

Enhanced Traffic Management System (ETMS): FAA database of instrument flight operations that includes airline, aircraft type, and time and location of origin and destination.

Enhanced Traffic Management System Counts (ETMSC): Publically available summary of ETMS data.

EPA: Environmental Protection Agency.

Fare Class: Typically, premium or first class tickets and less expensive coach tickets.

Federal Aviation Administration (FAA): Agency under the U.S. Department of Transportation, responsible for both ensuring safety of and promoting aviation industry.

Federal Inspection Service (FIS): Facility operated by U.S. CBP, designed to process arriving international passengers and their luggage.

Fratar algorithm: A method of distributing projected traffic growth by route while ensuring that projected totals in each market are met and that time-of-day distributions in each market remain unchanged.

Gate: Passageway through passengers embark or disembark from an aircraft.

General Aviation: The FAA defines general aviation as take-offs and landings of all civil aircraft, except those classified as air carriers or air taxis.

Hub Airport: General industry definition is an airport at which a significant amount of connecting passenger activity occurs. Also an FAA classification of airports according to how many passengers they accommodate annually.

IFR Flights: Fights operated under instrument flight rules which indicate that the pilot is authorized to fly by instruments under conditions where visibility is impaired.

Integrated Carrier: All-cargo carriers, such as FedEx and UPS, which provide door-to-door service including freight forwarding and ground transportation.

Integrated Noise Model (INM): Model used to estimate airport noise impacts.

International Travel: Typically, that portion of air travel outside the borders of a particular country.

Lag Time: The interval between the time an aircraft arrives at a gate and the average time a deplaning passenger arrives at a given airport facility.

Lead Time: The interval between the time an enplaning passenger arrives at a given facility, such as a ticketing kiosk, and the time his or her flight departs the gate.

Level of Service (LOS): A measure of the quality of service provided by a facility. For example, as it relates to terminals, LOS A would be defined as no congestion, free-flow and excellent level of comfort, and LOS F would be defined as extreme congestion, unstable flow with unacceptable delays, near system breakdown and unacceptable level of comfort.

Master Plan: Document outlining the general, long-term development strategy for a facility to meet projected activity.

Nautical Mile: A unit of measure equal to 1.15078 statute miles.

Non-revenue Passenger: Typically, airline passenger or family member working for the airline industry flying at no cost. Frequent flyer passengers flying on award tickets are classified as revenue passengers in US DOT statistics.

O&D – Origin and Destination Passenger Traffic: See definitions of originations and terminations.

Official Airline Guide (OAG): Provides a database for scheduled airline activity; available in hard copy (monthly) or electronically.

Operational Profile: The distribution of arriving and departing passengers or aircraft operations by time of day during the design day. It can be a design day profile, a design schedule, or a day/night stage length distribution.

Operations Network (OPSNET): FAA source of data that provides information on operations for all FAA and FAA-contracted towered airports in the U.S.

Originations: Passengers who are beginning their air travel at an airport, having arrived by some form of ground transportation.

Noise Integrated Routing System (NIRS): A noise evaluation system designed to provide an analysis of air traffic changes over large regions

Passenger Security Screening Checkpoint (PSSCP): Operated by TSA, a screening checkpoint examines both passengers and their carry-on belongings for items that are banned from the passenger compartment of a commercial aircraft.

Peak Period: A period of time, often called the peak hour, representing the typical high flow of passenger or aircraft operations activity that must be accommodated by a given airport facility. Like the design day, it is intended to strike a balance between providing capacity for most periods without incurring the cost of designing for the single busiest period of the year.

Peak Spreading: The tendency of peaks of passengers and aircraft operations, to decline as a percentage of daily activity, as an airport becomes busier.

Performance Data Analysis and Reporting System (PDARS): Joint FAA/NASA program for tracking flight data to measure facility performance.

Pre-cleared Airport: An international airport where passengers headed for the U.S. can go through the CBP process, thereby avoiding processing upon landing at their U.S. destination.

Processing Rate: Number of entities that a single resource can process in a given unit of time.

Processing Time: Time interval between the beginning of a process on one entity and the beginning of a process on the next entity, assuming a constant rate of demand and a queue.

Regional Carrier: Airlines that operate small aircraft, usually under contract or a code-sharing with a larger air carrier. Historically, regional carriers have operated aircraft with fewer than 60 seats, but they are increasingly operating aircraft with 70 or more seats.

Revenue Passenger: Passenger paying a fare on a flight; includes passengers traveling on redeemed frequent flier miles.

Scaling: A process by which a mix of aircraft operations or passengers is increased or decreased proportionately to match a target level.

Scheduled Seat Arrivals: The sum of the seats in each scheduled arriving passenger flight over a given period of time.

Scheduled Seat Departures: The sum of the seats in each scheduled departing passenger flight over a given period of time.

Seat Factors: Also known as enplaning or deplaning load factors. They are calculated by dividing passenger enplanements by aircraft seat departures or dividing passenger deplanements by aircraft seat arrivals. Seat factors differ slightly from load factors which are calculated by dividing revenue passenger miles by available seat miles.

SIMMOD: Computerized airport and airspace SIMulation MODel.

Spoke Airport: An airport where almost all passenger traffic is O&D.

Stage Length: The distance an aircraft travels between take-off and landing.

Standard Instrument Departure (SID): Published flight procedures for aircraft on an IFR flight plan immediately after take-off.

Standard Terminal Arrival Route (STAR): Published flight procedures for aircraft on an IFR flight plan immediately preceding landing.

TAAM: Total Airport and Airspace Modeler – a computerized simulation model.

Terminal Area Forecast (TAF): Annual FAA forecast of passenger and operations activity at approximately 3000 airports in the United States

Terminations: Passengers who are ending their air travel at an airport and are leaving by some form of ground transportation. (Also, *destinations*.)

Throughput Capacity: The maximum number of units (passengers or aircraft operations) that an airport facility can process within a specified time interval.

Transportation Research Board (TRB): Part of the nonprofit National Research Council; provides leadership in transportation innovation and progress through research and information exchange.

Ticket Counter/Check-in Counter: Portion of airport terminal where departing passengers purchase tickets, check in for flights, change itineraries, etc.

Transportation Security Administration (TSA): Responsible for protecting the U.S. transportation system; operates under the DHS.

Turnaround-time: The time interval between an aircraft's arrival at the gate and its departure. Typically refers to the minimum time needed to prepare an arriving aircraft for its outbound flight.

VFR flights: Flights operated under Visual Flight Rules which indicate that visibility and weather conditions are such that the pilot can see where the aircraft is going.

Visual Meteorological Conditions (VMC): Weather conditions under which VFR flights are permitted.

Wingtip-to-wingtip flights: Multiple flights scheduled by a single airline between a single market pair within a few minutes of each other, typically within the same connecting bank.